

Environment  
Effects Statement

# Technical Report Q

## Ecology





# North East Link Project

## North East Link Environment Effects Statement

### Technical report Q – Ecology

Prepared for North East Link

April 2019

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# Executive summary

## Overview

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (also known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

On 2 February 2018, the Minister for Planning declared North East Link to be 'public works' under Section 3(1) of the Environment Effects Act 1978, which was published in the Victorian Government Gazette on 6 February 2018 (No. S 38 Tuesday 6 February 2018). This declaration triggered the requirement for the preparation of an EES to inform the Minister's assessment of the project and the subsequent determinations of other decision-makers.

The EES was developed in consultation with the community and stakeholders and in parallel with the reference project development. The reference project has been assessed in this EES. The EES allows stakeholders to understand the likely environmental impacts of North East Link and how they are proposed to be managed.

GHD was commissioned to undertake an ecological impact assessment for the purposes of the ESS.

## Ecological context

The scoping requirements for the EES issued by the Minister for Planning set out the specific environmental matters to be investigated and documented in the project's EES, which informs that scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project.

The following evaluation objective is relevant to the ecological assessment:

- To avoid or minimise adverse effects on vegetation (including remnant, planted and regenerated) listed rare and threatened species and ecological communities, habitat for listed threatened species, listed migratory species and other protected flora and fauna, and address offset requirements for residual environmental effects, consistent with relevant State policies.

A summary of the key assets, values or uses potentially affected by the project, and an assessment of the project's impacts on those assets, values and uses is set out below.

## Existing conditions

A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects. Characterisation of the existing ecological conditions within the project boundary was undertaken through:

- A desktop assessment to determine the likelihood of occurrence of threatened flora, fauna and ecological communities within the project boundary
- A general field assessment to collect information on vegetation and habitat characteristics, and to inform the need for targeted surveys
- Aquatic ecosystem assessment
- Targeted surveys at specific locations that were considered likely to support threatened species or communities

## Key findings

An iterative risk assessment was undertaken to guide the assessment of potential ecological impacts associated with the project. The risk-based approach is integral to the EES. An impact assessment was then undertaken, combining existing conditions and associated construction and operational risks. The assessment includes planned (known) impacts and the risk of additional ecological impacts on indigenous vegetation, aquatic ecology and terrestrial fauna known or assumed to occur within the project boundary.

Project risks and impacts investigated included the following:

- Loss of vegetation/habitat
- Degradation of aquatic or terrestrial habitat (including contamination or spills, erosion, sedimentation, soil compaction, shading, dust)
- Modification of waterways, fragmentation of habitat (including loss of connectivity of waterways)
- Spread of weeds or pathogens
- Disturbance of fauna (including noise, vibration, lighting)
- Injury or death of fauna
- Groundwater-related (including groundwater drawdown leading to changes in groundwater-dependent ecosystems or terrestrial/aquatic ecosystems).

## Flora

The project boundary incorporates three bioregions—Gippsland Plain, Victorian Volcanic Plain and Highlands–Southern Fall. The majority of the project boundary falls within the Gippsland Plain bioregion. Landforms within the Gippsland Plain generally consist of low-lying floodplains including oxbow lakes associated with the Yarra River and flat to undulating plains. The northern part of the project boundary is characterised by undulating hills within the Highlands–Southern Fall bioregion, which drain to the Plenty River, and flat basaltic plains within the Victorian Volcanic Plain, west of the M80 Ring Road intersection and at the western end of the Eastern Freeway (west of the Yarra River).

The quality of vegetation within the project boundary is generally poor, with the ecological values present largely reflecting the long history of urban land use in the surrounding landscape. Vegetation mapped within the project boundary predominantly consists of vegetation planted for amenity purposes along public road and recreation reserves. Amenity plantings comprised of both indigenous and non-indigenous native species.

Higher quality ecological assets within the assessment area are generally associated with the major waterways and their associated floodplains including:

- The Yarra River, its floodplains and parks
- Warringal Parklands and Banyule Flats
- Bolin Bolin Billabong
- Kew Billabong and Willsmere Park
- Merri Creek
- Koonung Creek

In addition, Simpson Barracks in Yallambie also contains significant vegetation and associated ecological values.

Within the project boundary, 52.109 hectares of native vegetation patches from 14 different Ecological Vegetation Classes, 92 large trees within patches, 55 large scattered trees and 115 small scattered trees are expected to be directly impacted. In addition, 32 large trees rooted outside the project boundary may potentially be impacted by groundwater drawdown associated with the northern tunnel portal construction and operation.

The reference project has avoided direct impacts to a significant area of vegetation throughout the Banyule Creek (south of Lower Plenty Road), Banyule Flats, Warringal Parklands and Banksia Park by tunnelling through this area. It is anticipated that with further refinement of the design at the detailed design stage, the actual footprint of the project would be reduced, and as a result, further minimisation of native vegetation and mature tree removal could be achieved. Unavoidable native vegetation losses would be mitigated through an offset strategy in accordance with the Victorian *Guidelines for the removal, destruction or lopping of native vegetation* (the Guidelines) (DELWP, 2017a).

Within the study area, 48 species of rare or threatened flora have been recorded historically (VBA). Three of these species were recorded during the assessment:

- Matted Flax-lily *Dianella amoena* (95 individuals) listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) ('EPBC Act') and Flora and Fauna Guarantee Act 1988 (Vic) ('FFG Act')
- Arching Flax-lily *Dianella longifolia* var. *grandis* (five individuals) listed as vulnerable under the DELWP Advisory List
- Studley Park Gum *Eucalyptus Xstudleyensis* (13 individuals recorded but many more likely to occur at Simpson Barracks) listed as endangered under the DELWP Advisory List.

One additional species, River Swamp Wallaby-grass *Amphibromus fluitans*, listed as vulnerable under the EPBC Act, has been previously recorded within the project boundary; however, was not recorded during the current assessment.

A further six species listed under the EPBC Act or FFG Act are considered to have a moderate to high likelihood of occurring within the project boundary. Impacts to Matted Flax-lily and Arching Flax-lily would be mitigated through the implementation of a salvage and translocation plan.

After discussions with DELWP, NELP has committed to undertaking further field surveys to better understand the prevalence of Studley Park Gum at Simpson Barracks and to estimate the number of individuals potentially impacted by the project. Unavoidable loss of large trees within patches and scattered small trees of Studley Park Gum would be managed through an offsetting arrangement as per the Guidelines (DELWP, 2017a). To further mitigate impacts on Studley Park Gum, seed would be collected from individuals within the project boundary and propagated in a nursery. Propagated plants would then be incorporated into project landscaping.

Most rare or threatened flora that were considered for the project are not expected to occur within the project boundary. No threatened communities occur within the project boundary.

## **Terrestrial fauna**

### *Habitats*

The study area is considerably urbanised and fragmented, but still supports habitats for fauna. Habitats for terrestrial fauna include forests and woodlands (riparian and non-riparian), scattered trees and shrubs, waterways and wetlands. Non-native vegetation (including planted amenity trees) can also provide habitat for some fauna, and was considered in the assessment.

Areas of highest ecological value occur particularly near the Yarra River and its associated floodplain in the Banyule and Bulleen area. Numerous threatened and migratory species are recorded in the region. This waterway provides the most significant wildlife corridor within the study area and within the eastern suburbs of Melbourne. The tunnels would run beneath the southern reach of Banyule Creek and Banyule Swamp, and the Yarra River floodplain, avoiding direct impacts on the floodplain in this area entirely. South of the tunnelled section, the project would run immediately east of the Bolin Bolin Billabong, which is of high value to fauna.

Other areas of notable value to terrestrial fauna include eucalypt woodland in Simpson Barracks and along Koonung Creek, where habitats are mostly degraded and disturbed, but are likely to function as local wildlife corridors.

Where the project corridor meets the Eastern Freeway, the area has been considerably disturbed historically. Golf courses north of the Eastern Freeway provide limited habitats for native fauna, and are mostly dominated by common and adaptable bird species (such as the Noisy Miner *Manorina melanocephala*, Red Wattlebird *Anthochaera carunculata* and Rainbow Lorikeet *Trichoglossus haemotodus*). Well west of Bulleen Road, the Eastern Freeway crosses the Yarra River and Merri Creek at separate locations. At the Yarra River, the project boundary would abut but largely avoid the Flying-fox Management Area (DSE, 2005) associated with the Grey-headed Flying-fox (*Pteropus poliocephalus*) colony at Yarra Bend Park (south of the project).

### ***Species and communities***

A total of 402 species of terrestrial fauna are recorded (Victorian Biodiversity Atlas [VBA] and/or BirdLife Australia Atlas [BLA]) or predicted to occur (Protected Matters Search Tool [PMST]) within the area. Most of these are birds (305), with smaller numbers of mammals (53), reptiles (28), amphibians (14) and invertebrates (2). Thirty-one of the 402 species are non-native species.

Seventy-four species are classified as threatened fauna, including 27 species listed as threatened under the EPBC Act, 58 species listed as threatened under the FFG Act and 63 species listed as threatened on the DELWP Advisory Lists (DSE, 2009; DSE, 2013) (not including species listed as Near Threatened or Data Deficient). Eight of the 74 threatened species have never been recorded within the study area (identified by PMST only).

Most of the threatened fauna identified for the study area are considered unlikely to occur within the project boundary. Species that have a moderate or high likelihood of using or visiting within the project boundary and could be potentially impacted by the project include:

- Powerful Owl, *Ninox strenua*
- Swift Parrot, *Lathamus discolor*
- Grey-headed Flying-fox, *Pteropus poliocephalus*.

Numerous other species are likely to occur within the study area, but are not considered likely to make considerable use of areas that would be impacted by the project. Many of these are most likely to occur in the habitats of the Yarra River floodplain in the Bulleen and Banyule area, which the project would tunnel beneath to minimise impacts (species include cranes and rails, egrets, ducks, bitterns, snipe and the Grey Goshawk *Accipiter novaehollandiae*).

Twenty-six species of bird identified for the study area are listed as migratory under the EPBC Act. Six of those have never been recorded within the study area (identified by PMST only). Eighteen of the 26 species are unlikely to occur within the study area due to habitat suitability (marine and coastal species). Three species (Rufous Fantail *Rhipidura rufifrons*, Satin Flycatcher *Myiagra cyanoleuca*, Black-faced Monarch *Monarcha melanopsis*) are likely to be occasional visitors to dense forest habitats along the Yarra floodplain. One species—Latham's Snipe, *Gallinago hardwickii*—may use the Banyule Swamp area (above the tunnelled section) regularly enough and in sufficient numbers that the area could constitute 'important habitat' for that species.

One fauna community listed as threatened under the FFG Act is identified for the study area: *Victorian temperate-woodland bird community* (VTWBC). Nineteen (of 25) key indicator species and 11 (of 21) associated bird species have been recorded within the search area in the past 30 years ((VBA/BLA; since 1987). The description of this community (FFG 2000) does not match the habitats within the project boundary, nor the geographical location of the project. Therefore, the VTWBC is considered to not occur within the area, despite many of the community's members occurring in the area occasionally.

### **Aquatic ecosystems and aquatic fauna**

The project boundary is within the Yarra River catchment, and the project intersects or is adjacent to sections of the Yarra River, Banyule Creek, Merri Creek, Plenty River and Koonung Creek. A number of permanent and ephemeral natural wetlands are also present, notably including Bolin Bolin Billabong, and Banyule Swamp.

The Yarra River provides very high value aquatic habitat, and supports an abundant and diverse assemblage of aquatic fauna, including native fish, turtles and the Platypus *Ornithorhynchus anatinus*. The Yarra River supports this aquatic ecosystem, despite the cumulative pressures of heavily modified catchment landscape, including modified hydrology through river regulation, urban stormwater inputs containing chemical and litter pollution and modification of riparian zones. The floodplain wetlands of the Yarra River contain some high quality aquatic habitat, including the billabongs, although these are somewhat more degraded, with altered hydrological regime disrupting the ecological conditions of these dynamic systems.

The other waterways within the project boundary are generally more degraded, with heavy impacts of channel modification, urban stormwater and riparian zone modification affecting aquatic habitat condition and reduced aquatic biodiversity. Aquatic ecosystem assessment of these waterways revealed that most sites fail to meet State Environment Protection Policy (Waters) environmental condition objectives for aquatic ecosystems for urban waterways.

Within the study area, 32 species of fish, three species of turtle and two aquatic mammals have been recorded or are predicted to occur or have suitable habitat occurring. Ten species identified in the search area are classified as threatened fauna. These include five species listed as threatened under the EPBC Act, eight species listed as threatened under the FFG Act and seven species listed as threatened on the DELWP Advisory Lists (DSE, 2009; DEPI, 2013a).

Of the threatened species recorded in the study area, the following are considered to have a moderate or high likelihood of occurrence in waterways within the project boundary:

- Australian Grayling, *Prototroctes maraena*
- Australian Mudfish, *Neochanna cleaver*
- Macquarie Perch, *Macquaria australasica*
- Murray Cod, *Maccullochella peelii*
- Murray River Turtle, *Emydura macquarii*
- Broad Shelled Turtle, *Chelodina expansa*.

These species are considered likely to occur in the Yarra River. The ability for these fish to disperse into tributaries of the river within the project boundary (Plenty River, Koonung Creek and Merri Creek) is possible, although the likelihood is considered low that these urban waterways support these threatened species.

The inclusion of tunnels in the project design provides considerable protection from direct impacts to the highest value aquatic ecosystem and threatened species habitat in the Yarra River. Impacts from the project to other waterways would include the modification and/or covering of sections of Banyule Creek and Koonung Creek, which would effectively result in a net loss of the aquatic habitat in these sections. This would also reduce the ecosystem services provided by the waterways but these services should be able to be provided through water sensitive urban design included in project surface water and drainage design. The existing conditions of both of these waterways are considered to be poor and unlikely to support significant ecological values.

There are no Ramsar-listed or international significant wetlands within the study area. The Yarra River catchment flows into Port Phillip Bay, which contains the Ramsar-listed Port Phillip Bay (western shoreline) wetlands. These wetlands, which include intertidal area, saltmarsh, mangroves and water treatment lagoons, are more than 20 kilometres from the project boundary. The project is not expected to impact on Ramsar wetlands.

### **Groundwater dependent ecosystems**

Groundwater dependent ecosystems (GDEs) have been modelled across the study area by the Bureau of Meteorology and the Port Phillip and Westernport Catchment Management Authority (PPWCMA). These include GDEs that rely on surface expression of groundwater (wetlands and rivers) and GDEs that rely on the availability of water beneath the surface (terrestrial vegetation).

Areas adjacent to the project boundary have the potential to be impacted by groundwater changes resulting from the project. There are three main geographic areas where there is potential for impacts on terrestrial GDEs: 1) in the vicinity of the northern portal, including Simpson Barracks and the upper reaches of Banyule Creek; 2) in the vicinity of the southern portal, including the Yarra River Flats; and 3) the tunnel section between the portals, including Banyule Flats.

Some large trees outside the project boundary are likely to be accessing groundwater on occasions and have a moderate to high likelihood of being negatively impacted by groundwater drawdown during construction. These areas comprise Plains Grassy Woodland (dominated by River Red Gum, in association with Studley Park Gum) within Simpson Barracks and adjoining Commonwealth land, Colleen Reserve, Banyule Flats (Main Yarra Trail), River Gum Walk and Mercedes Court. In these areas, approximately 16 large trees have a moderate or high risk of being negatively impacted by groundwater drawdown by 2024 at the end of construction, while under the 2075 long-term operational scenario, 32 large trees would have a moderate to high chance of being negatively impacted (this number incorporates all trees affected under the 2024 scenario).

Areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary, which are likely to be accessing groundwater, are unlikely to be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra River floodplain are also unlikely to be negatively impacted.

Without mitigation controls, groundwater drawdown during North East Link's construction is expected to result in some minor lowering of water levels in the deep pool of Bolin Bolin Billabong. This aquatic habitat is highly dynamic, and major changes to environmental and ecological condition occurs during each hydrological inundation cycle (flooding or environmental flow provision, and subsequent decline in water level and retraction of aquatic habitat).

Under current conditions, as the billabong recedes from a fully inundated condition to the remnant deep pool, water quality deteriorates to the point that mobile species leave the billabong, sensitive species do not survive, and only aquatic fauna tolerant of very poor water quality remain. There is no evidence this deep pool provides refuge habitat for any threatened aquatic species. Therefore, the ecological significance of the lowered water levels is negligible. However, the pool is likely to provide water supply for the native terrestrial fauna. Managed water levels in this wetland may be required to maintain the ecological condition of the billabong.

Groundwater dependent ecosystems are modelled extensively across the Banyule Flats area. However, as groundwater drawdown resulting from the project is not predicted throughout these ecologically sensitive areas, including the Banyule Flats, the potential for negative impacts is considered negligible in this area.

### **Potentially threatening processes**

Twenty-two threatening processes identified under the EPBC Act (DoEE, 2017a; DoEE, 2017b) or FFG Act (DELWP, 2016b) are considered to be potentially relevant to the project. Of those, one is considered likely to be exacerbated by the project—'Land Clearance', a threatening process listed under the EPBC Act. The project would exacerbate this threatening process through the further loss of native vegetation within the project boundary.

### **Management of potential impacts**

Potential impacts on ecological values due to the project would be managed using the project's Environmental Performance Requirements (EPRs). A range of EPRs are proposed to manage and mitigate the identified potential ecological impacts.

The primary requirements include the implementation of a Construction Environmental Management Plan, including specific requirements for vegetation and fauna management, an offset strategy and a salvage and translocation plan for the Matted Flax-lily to be endorsed once suitable receptor sites have been selected.

Further, management of the risks and impacts on ecology would rely on EPRs from a range of other disciplines, including those related to arboriculture, contaminated land and soil, ground movement, groundwater, land use planning, landscape and visual, noise and vibration and surface water.

### **Risk and impact assessment**

Forty risk pathways relating to ecology were identified for the project. Of these, three are planned, none are High risk, five are Medium risk and the remaining 32 are considered Low risk.

#### **Planned**

Planned risks include those that involve direct and indirect loss of vegetation and habitat (risks EC01, EC02 and EC12).

These risks are expected to result in the largest impacts of the project, with total direct vegetation loss within the project boundary expected to include up to 52.109 hectares of native vegetation patches, 92 large trees within patches, 202 scattered trees (87 large, 115 small) and removal of wetland and waterway habitats along Koonung Creek and Banyule Creek. Furthermore, known populations of Matted Flax-lily are proposed to be impacted by the project. To minimise these impacts, a Matted Flax-lily salvage and translocation plan would be prepared and implemented. NELP is currently investigating potential recipient sites for Matted Flax-lily within the City of Whittlesea, City of Banyule, City of Darebin and/or in the eastern section of Simpson Barracks (EPR FF7). These sites are still being assessed for feasibility and are therefore not confirmed at this stage of the project. All sites would be subject to review as documented within a salvage and translocation plan (Appendix K) to assess their suitability for the success of the translocation (EPR FF7).

Vegetation and habitat removal would be managed and minimised through the implementation of tree retention where possible and further minimisation of the footprint (EPR AR1 and EPR LP1), adherence to the *Guidelines* (DELWP, 2017a) and establishment of no-go zones (EPR FF2 and EPR EMF2), preparation of a Tree Protection Plan (EPR AR2) and obtaining necessary permits (EPR FF5).

#### **High risks**

None of the risk pathways relating to ecology are considered to be high risk.

#### **Medium risks**

Medium risks include the groundwater dewatering resulting in changes to terrestrial GDEs during construction (risk EC06) and operation (risk EC29), the shading of waterways degrading aquatic habitat quality (risk EC30), and the loss of connectivity and impeded passage for native aquatic species due to changed waterway form (risk EC36).

Generally, these pathways are reduced from high to medium risk through the implementation of EPRs. These risks tend to be geographically confined, with extent of impacts at either the local (risks EC06, EC29, EC30) or municipal risk (EC36) level.

For risk EC06 (construction) and risk EC29 (operation), there are three main areas where effects may occur and impact terrestrial ecology: 1) vicinity of the northern portal, including Simpson Barracks and Banyule Creek, 2) vicinity of the southern portal, including the Yarra River Flats, and 3) tunnel section, including Banyule Flats. Within Simpson Barracks and other areas near the northern portal, there is a moderate to high likelihood of approximately 32 LTs being negatively impacted by groundwater drawdown over the long term. In the Yarra River Flats area, Floodplain Riparian Woodland (dominated by River Red Gum) and ephemeral billabongs are unlikely to be negatively impacted, since drawdown levels are predicted to be very minor. The deep pool at the eastern end of Bolin Bolin Billabong is an aquatic (rather than terrestrial) GDE and the risk of it being ecologically impacted by drawdown is considered to be low. For the tunnelled section, groundwater changes as a result of the portals or TBM are predicted to be negligible.

The shading of waterways from structures resulting in degradation of aquatic habitat quality (risk EC30) is almost certain, but it is expected to be local and of low severity. The loss or degradation of aquatic vegetation resulting from sections of shaded or covered channel in Koonung Creek would also reduce the existing instream ecosystem services of nutrient and sediment transport (risk EC39). The potential impact of this would be degraded surface water quality in downstream waterways. Although separate outcomes, the impacts of shading waterways would be managed to a degree by minimising a footprint that requires structures that could impact light levels on aquatic habitat (EPR FF4), minimising modifications to waterways such as containment, covering and diversion (EPR SW8) and consideration of noise wall locations (EPR LV1).

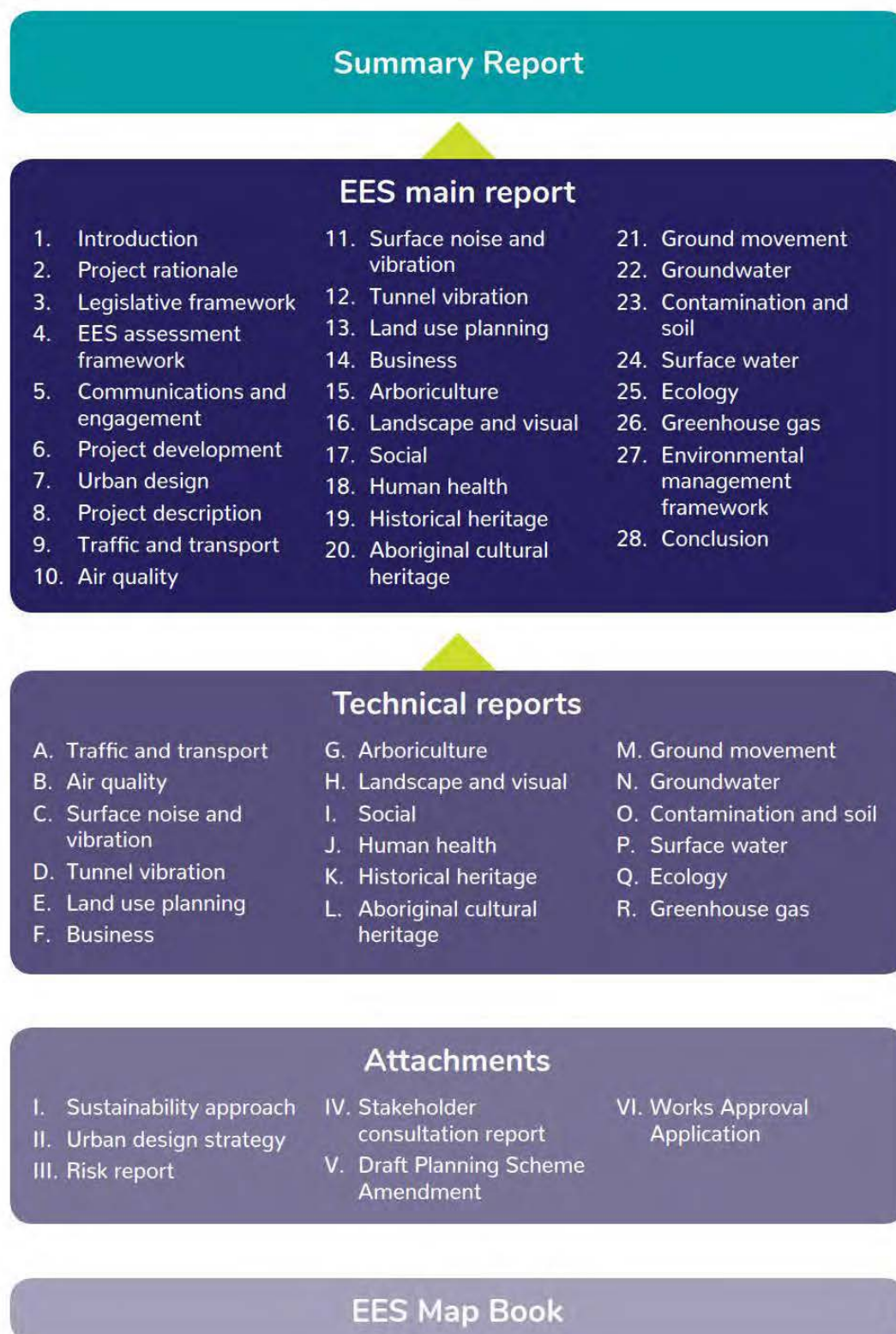
The modification of Koonung Creek includes approximately one kilometre of covered channel. Although Koonung Creek is already a highly modified waterway with existing sections of covered waterway and other barriers to fish passage, native fish do inhabit this waterway, although there is evidence that fish passage is presently impeded. Further modifications to the waterway are considered likely to create additional barriers (risk EC36). To minimise the impact of waterway modification, waterway design needs to protect (EPR FF4) and provide (EPR SW8) aquatic habitat and hydraulic requirements suitable for these aquatic species.

### Offset strategy

The construction of roads, tunnels and ancillary infrastructure would require the removal of surface vegetation including threatened flora and fauna habitat. Within the project boundary, 95 Matted Flax-lily, five Arching Flax-lily, and greater than 10 (population size/area of impacted habitat to be confirmed) Studley Park Gum occur within the area that would be impacted. Unavoidable loss of Matted Flax-lily and Arching Flax-lily would be managed through a salvage and translocation plan (EPR FF2), while the removal of large trees of Studley Park Gum would be managed through an offsetting arrangement as per the Guidelines (DELWP, 2017a) (EPR FF2). An NVR report has been completed (Appendix J) that identifies the general offset units and species-specific offsets required for the estimated unavoidable native vegetation removals.

This assessment considered total impact across the whole of the project boundary (including Simpson Barracks), and potential impacts due to drawdown. An offset strategy has been developed in order to document a process how these offsets would be secured and managed (Appendix L).

# Structure of the EES



# Abbreviations

Abbreviation	Definition
ALA	Atlas of Living Australia
BCS	Bioregional Conservation Significance
BIOR	Biodiversity Impact and Offset Report
BLA	Birdlife Australia
BOM	Bureau of Meteorology
CaLP Act	<i>Catchment and Land Protection Act 1994</i>
CAMBA	China-Australia Migratory Bird Agreement
CEMP	Construction Environmental Management Plan
CMA	Catchment Management Authority
DBH	Diameter at breast height
DoEE	Department of Environment and Energy
DELWP	Department of Environment, Land, Water and Planning
DEPI	Department of Environment and Primary Industries (now DELWP)
EAO	Environmental Audit Overlay
EGK	Eastern Grey Kangaroo
EnSym	Environmental Systems Modelling Platform
ESO	Environmental Significance Overlay
EES	Environment Effects Statement
EPA	Environment Protection Authority
EPR	Environmental Performance Requirement
EPT	Ephemeroptera, Plecoptera, Trichoptera
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EVC	Ecological Vegetation Class
FFG Act	<i>Flora and Fauna Guarantee Act 1988</i>
GDE	Groundwater dependent ecosystem
GEWVVP	Grassy Eucalypt Woodland of the Victorian Volcanic Plain
Hha	Habitat hectares
HO	Heritage overlay
HZ	Habitat zone
JAMBA	Japan-Australia Migratory Bird Agreement
LGA	Local Government Authority
MNES	Matters of National Environmental Significance
MTIA	Major Transport Infrastructure Authority
NELP	North East Link Project
NVIM	Native Vegetation Information Management
NVR report	Native Vegetation Removal report

Abbreviation	Definition
OEMP	Operations Environmental Management Plan
OMP	Offset Management Plan
PAR	Photosynthetically Active Radiation
PIW	Prescribed Industrial Waste
PMST	Protected Matters Search Tool
PPRZ	Public Park And Recreation Zone
RBA	Rapid Bioassessment
RMP	Remediation Management Plan
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEPP	State Environment Protection Policy
SIGNAL	Stream Invertebrate Grade Number – Average Level
SLO	Significant Landscape Overlay
SMP	Spoil Management Plan
SRZ	Structural Root Zone
TBM	Tunnel Boring Machine
TPZ	Tree Protection Zone
VPO	Vegetation Protection Overlay
VROTS	Victorian rare or threatened species
VBA	The Victorian Biodiversity Atlas
VQA	Vegetation Quality Assessment
WEMP	Worksite Environmental Management Plan
WoNS	Weeds of National Significance
WoV	Waters of Victoria
WSUD	Water Sensitive Urban Design

# Glossary

Term	Definition
Biodiversity	The variety of all life forms, the different plants, animals and micro- organisms, the genes they contain, and the ecosystems of which they form a part.
Bioregion	A landscape based approach to classifying the land surface using a range of environmental attributes such as climate, geomorphology, lithology and vegetation.
Bioregional conservation status (BCS)	An assessment of the conservation status of the native vegetation type (EVC) in the context of a particular bioregion, taking account of how commonly it originally occurred, the current level of depletion and the level of degradation of condition typical of remaining stands.
Department of Transport	The Victorian Department of Transport is responsible for delivering the government's transport infrastructure agenda. It was formed on 1 January 2019 when the former Victorian Department of Economic Development, Jobs, Transport and Resources transitioned into the Department of Transport and the Department of Jobs, Precincts and Regions.
e-bird	A database of bird records (at <a href="http://www.ebird.org">www.ebird.org</a> ), administered by Audubon and Cornell Lab of Ornithology, USA
Ecological Vegetation Class (EVC)	A type of indigenous vegetation classification that is described through a combination of floristics, lifeforms and ecological characteristics and through an inferred fidelity to particular environmental attributes. Each EVC includes a collection of floristic communities that occurs across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.
Exotic fauna (= non-native fauna)	Any fauna that is not native to Australia or its states and territories.
Exotic vegetation	Any vegetation that is not native to Australia or its states and territories.
Graminoid	A herbaceous plant with a grass-like morphology
Habitat hectare (Hha)	A site-based measure of quality and quantity of native vegetation that is assessed in the context of the relevant native vegetation type.
Habitat zone (HZ)	A discrete area of native vegetation consisting of a single vegetation type (EVC) with an assumed similar averaged quality. This is the base spatial unit for conducting a habitat hectare assessment.
Indigenous vegetation	Indigenous vegetation includes vegetation that is native to Australia as well as being native to a specific geographic region. In the case of North East Link, this includes vegetation that is native to the Port Phillip and Westernport Catchment Management Region.
Major Transport Infrastructure Authority	The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.
Native trees	Native trees include all trees that are native to Australia, and its states and territories.

Term	Definition
Patch	A patch of native vegetation is either: a) an area of vegetation where at least 25% of the total perennial understorey plant cover <sup>1</sup> is native, or b) any area with three or more native canopy trees <sup>2</sup> where the drip line <sup>3</sup> of each tree touches the drip line of at least one other tree, forming a continuous canopy, or c) any mapped wetland included in the <i>Current wetlands map</i> , available in DELWP systems and tools (DELWP, 2017a).
Scattered tree	A scattered tree is a native canopy tree that does not form part of a patch (DELWP, 2017a).
Threatened species	<p>For the purposes of this report, threatened species refers to species considered threatened in Victoria or Australia. This includes species that are rare, vulnerable, endangered or critically endangered in Victoria as defined by DEPI (2014), DSE (2009) or DEPI (2013a), listed under the Victorian <i>Flora and Fauna Guarantee (FFG) Act 1988</i> or listed as vulnerable, endangered or critically endangered under the Commonwealth <i>Environment Protection and Biodiversity Conservation (EPBC) Act 1999</i>.</p> <p>Species listed as near-threatened, poorly known or data deficient on DEPI (2014), DSE (2009) or DEPI (2013a) are not considered threatened.</p>
Victorian Biodiversity Atlas (VBA)	The VBA is administered by the Victorian Department of Environment, Land, Water and Planning and replaces several legacy systems, including the Flora Information System, the Atlas of Victorian Wildlife, and the Aquatic Fauna Database. The VBA encompasses vertebrate and invertebrate animals, fungi, vascular and non-vascular plants from terrestrial and aquatic environments, including marine waters to the three nautical mile statutory limit. It includes both native and naturalised exotic species (including weeds and pests) but is not intended to hold data on cultivated or domesticated species.

<sup>1</sup> Plant cover is the proportion of the ground that is shaded by vegetation foliage when lit from directly above. Areas that include non-vascular vegetation (such as mosses and lichens) but otherwise support no vascular vegetation are not considered to be a patch for the purposes of the Guidelines (DELWP, 2017a). However, when non-vascular vegetation is present with vascular vegetation, it does contribute to cover when determining the percentage of perennial understorey plant cover.

<sup>2</sup> A native canopy tree is a mature tree (that is, it is able to flower) that is greater than three metres in height and is normally found in the upper layer of the relevant vegetation type.

<sup>3</sup> The drip line is the outermost boundary of a tree canopy (leaves and/or branches) where the water drips on to the ground.

# 1. Introduction

## 1.1 Purpose of this report

North East Link ('the project') is a proposed new freeway-standard road connection that would complete the missing link in Melbourne's ring road, giving the city a fully completed orbital connection for the first time. North East Link would connect the M80 Ring Road (otherwise known as the Metropolitan Ring Road) to the Eastern Freeway, and include works along the Eastern Freeway from near Hoddle Street to Springvale Road.

The Major Transport Infrastructure Authority (MTIA) is the proponent for North East Link. The MTIA is an administrative office within the Victorian Department of Transport with responsibility for overseeing major transport projects.

North East Link Project (NELP) is an organisation within MTIA that is responsible for developing and delivering North East Link. NELP is responsible for developing the reference project and coordinating development of the technical reports, engaging and informing stakeholders and the wider community, obtaining key planning and environmental approvals and coordinating procurement for construction and operation.

On 2 February 2018, the Minister declared the works proposed for North East Link as Public Works and issued a decision confirming that an Environment Effects Statement (EES) is required for the project due to the potential for significant environmental effects.

Similarly, the project was referred to the Australian Government's Department of the Environment and Energy on 17 January 2018. On 13 April 2018, the project was declared a 'controlled action', requiring assessment and approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* ('EPBC Act'). Separate to this EES, a Public Environment Report (PER) is required to be prepared to satisfy the EPBC Act requirements, and assess the impacts of the project on Commonwealth land and matters of national environmental significance (MNES).

The purpose of this report is to assess the potential ecological impacts associated with North East Link for the purposes of the EES required for the project.

## 1.2 Why understanding ecology is important

The study of ecology in the context of this EES technical report is focused on identifying the biodiversity values of areas that may be impacted by North East Link. These values are recognised by the Australian and Victorian governments in legislation, frameworks and policies designed to facilitate their conservation and include native vegetation, migratory species, threatened species or communities, and habitat for migratory and/or threatened species.

Impacts to significant ecological values and the application of the legislation, frameworks and policies that relate to their protection are a key consideration of the EES process. Accordingly, an understanding of existing ecological values within the North East Link study area is critical in order to determine the likelihood and extent of project related impacts on significant ecological values.

This report is based on EES criteria and scoping requirements, which prioritise species and communities of conservation significance, particularly threatened and migratory species and threatened communities. Consideration of threatened species and communities and their habitats provides consideration for common (ie, non-threatened) species and communities that occur in the study area also.

## 2. EES scoping requirements

### 2.1 EES evaluation objectives

The scoping requirements for the EES issued by the Minister for Planning set out the specific environmental matters to be investigated and assessed in the EES for the Project and inform the scope of the EES technical studies. The scoping requirements include a set of evaluation objectives. These objectives identify the desired outcomes to be achieved in managing the potential impacts of constructing and operating the project in accordance with the *Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978*.

The following evaluation objective is relevant to the ecological assessment:

- To avoid or minimise adverse effects on vegetation (including remnant, planted and regenerated) listed rare and threatened species and ecological communities, habitat for listed threatened species, listed migratory species and other protected flora and fauna, and address offset requirements for residual environmental effects, consistent with relevant State policies.

### 2.2 EES scoping requirements

The scoping requirements relevant to the ecological evaluation objective are shown in Table 1, as well as the location where these items have been addressed in this report. It is noted that there are some scoping requirements under the above evaluation objective that are not relevant to the ecology assessment, but are addressed by the arboriculture assessment, and as indicated below.

Table 1 Scoping requirements relevant to ecology

Aspect	Scoping requirement	Section addressed
Key issues	Potential for significant effects on biodiversity values including effects associated with changes in hydrology or hydrogeology (including under future climate change scenarios) or threatening processes listed under the <i>Flora and Fauna Guarantee Act 1988</i> (Vic) ('FFG Act').	Sections 12.1 and 12.2
	Potential for indirect and direct impacts on riparian and in-stream environments brought about by the project both intersecting and near the project area.	Sections 12.1 and 12.2
	Potential for direct or indirect impact on vegetation and other landscape elements used by fauna listed under FFG Act or DELWP Advisory lists or by listed migratory species.	Sections 12.1 and 12.2
	Potential for adverse impacts on ecological character and key habitat locations including Bolin Bolin Billabong, Banyule Flats wetlands, Yarra River and Koonung Creek.	Sections 12.1 and 12.2
	Potential loss or degradation of habitat (and/or habitat connectivity) including tree hollows, existing canopy and woody debris, due to removal of trees.	Sections 12.1 and 12.2
	Potential for significant effects on biodiversity values including overall effects associated with actions to be approved, licensed or permitted under the <i>Wildlife Act 1975</i> .	Sections 12.1 and 12.2
	Reduction in environmental quality due to increased transmission or generation of pollutants from loss of vegetation, including aquatic vegetation and algae.	Sections 12.1 and 12.2

Aspect	Scoping requirement	Section addressed
Priorities for characterising the existing environment	Identify both habitat utilised by listed fauna and the existing or likely presence of vegetation under the FFG Act or DELWP Advisory list within the project area, associated works areas and in the broader area.	Summarised in Sections 7.1, 8.1 and 9.1. More details in sections following on from those.
	Characterise the local terrestrial and aquatic environments, identify flora and fauna likely to occur within the project area and characterise wildlife movement within the broader project area that could be directly or indirectly impacted by the project.	Summarised in Sections 7.1, 8.1 and 9.1. More details in sections following on from those.
	Identify and characterise any groundwater dependent ecosystems that may be affected by altering the hydrogeological environment (particularly by dewatering).	Section 10
	Describe the threats posed directly or indirectly by the project to biodiversity values, consistent with State policies, including: <ul style="list-style-type: none"> <li>• Direct removal or destruction of habitat (including remnant, regenerated or planted vegetation)</li> <li>• Direct and indirect alteration of habitat conditions (including light spill and impacts of altering hydrogeological characteristics)</li> <li>• Initiating or exacerbating potentially threatening processes listed under the FFG Act</li> <li>• Introduction and/or spread of any declared weeds or pathogens within or near project area</li> <li>• Increased risk of mortality of protected fauna and flora</li> <li>• Alteration of conditions that may directly or indirectly impact riparian and in-stream environments</li> </ul>	Summarised in Sections 7.1, 8.1 and 9.1. More details in sections following on from those.  Also Sections 7.3.5, 7.3.6, 8.3.4, 12, and Appendix G
	Identify current status, condition and arboricultural value of trees within the project area and those within construction areas via desktop and field study.	Technical report G – Arboriculture
	Determine species, origin, dimension, health and lifespan of trees that may be affected by the project assuming current conditions continue and appropriate care is provided.	Technical report G – Arboriculture
Design and mitigation measures	Develop rehabilitation strategies to enable the recovery or restoration of vegetation that can provide habitat for protected and listed threatened species and amenity to local community consistent with any threat abatement plan or conservation action plan.	Section 12
	Develop potential and proposed design options and measures that can avoid or minimise significant direct and indirect effects on vegetation, listed ecological communities, or other landscape elements utilised by protected fauna and flora (including remnant, planted and regenerated vegetation).	Section 12
	Develop potential and proposed design options and measures that can avoid or minimise significant effects on biodiversity values from actions to be approved, licensed or permitted under the <i>Wildlife Act 1975</i> .	Section 12
	Develop offset strategies to offset loss of native vegetation.	Sections 7.3.4 and 12.1.1

Aspect	Scoping requirement	Section addressed
Assessment of likely effects	Assess direct and indirect effects of the project on vegetation (including remnant, planted and regenerated), listed ecological communities, listed rare and threatened species and other protected flora and fauna, consistent with relevant State policies.	Sections 7.3.1, 7.3.2, 7.3.3, 7.3.4, and 12
	Assess direct and indirect effects on habitat connectivity and wildlife movement of terrestrial or aquatic fauna species that are listed under the FFG Act, DELWP Advisory list, or of listed migratory species.	Section 12.1.9
	Assess direct and indirect effects on ecological character and significant habitat sites near the project area including Bolin Bolin Billabong, Banyule Flats Wetlands, Yarra River and Koonung Creek.	Sections 9.3.3, 10, and 12
	Assess the potential direct and indirect effects of the project on arboricultural elements (including remnant, planted and regenerated trees).	Technical report G – Arboriculture
Approach to manage performance	Describe the environmental performance requirements to set biodiversity value outcomes that the project must achieve, including an offset strategy that outlines offsets that have been secured or are proposed to satisfy State offset policy requirements.	Section 13
	Describe the environmental performance requirements to set arboricultural value outcomes that the project must achieve.	Technical report G – Arboriculture

## 2.3 Linkages to other reports

This report relies on or informs the technical assessments as indicated in Table 2.

**Table 2** Linkages to other technical reports

Specialist report	Relevance to this impact assessment
Technical report C – Surface noise and vibration	Provides an assessment of potential noise and vibration during construction and operation, which may impact terrestrial and aquatic fauna.
Technical report D – Tunnel vibration	Provides an assessment of potential noise and vibration during tunnelling, which may impact terrestrial and aquatic fauna.
Technical report G – Arboriculture	Provides an assessment of arboricultural values and their potential for impacts. Particularly relevant in understanding potential impacts on wildlife.
Technical report L – Aboriginal cultural heritage	Provides an assessment of matters of Indigenous cultural heritage, which may include ecological attributes.
Technical report M – Ground movement	Provides an assessment of potential ground level changes, which may impact hydrology of aquatic ecosystems and terrestrial vegetation.
Technical report N – Groundwater	Provides an assessment of changes to groundwater that inputs to the assessment of threats to groundwater dependent ecosystems.
Technical report O – Contamination and soil	Provides an assessment of potential impact of acid sulfate soils on groundwater dependent ecosystems.
Technical report P – Surface water	Provides an assessment of the project's effects on creeks and rivers, which is used in the assessment of threats to aquatic ecology.

## 3. Project description

### 3.1 Overview

The North East Link alignment and its key elements assessed in the Environment Effects Statement (EES) include:

- **M80 Ring Road to the northern portal** – from the M80 Ring Road at Plenty Road, and the Greensborough Bypass at Plenty River Drive, North East Link would extend to the northern portal near Blamey Road utilising a mixture of above, below and at surface road sections. This would include new road interchanges at the M80 Ring Road and Grimshaw Street.
- **Northern portal to southern portal** – from the northern portal the road would transition into twin tunnels that would connect to Lower Plenty Road via a new interchange, before travelling under residential areas, Banyule Flats and the Yarra River to a new interchange at Manningham Road. The tunnels would then continue to the southern portal located south of the Veneto Club.
- **Eastern Freeway** – from around Hoddle Street in the west through to Springvale Road in the east, modifications to the Eastern Freeway would include widening to accommodate future traffic volumes and new dedicated bus lanes for the Doncaster Busway. There would also be a new interchange at Bulleen Road to connect North East Link to the Eastern Freeway.

These elements are illustrated in Figure 1.

The project would also improve existing bus services from Doncaster Road to Hoddle Street through the Doncaster Busway as well as pedestrian connections and the bicycle network with connected walking and cycling paths from the M80 Ring Road to the Eastern Freeway.

For a detailed description of the project, refer to EES Chapter 8 – Project description.

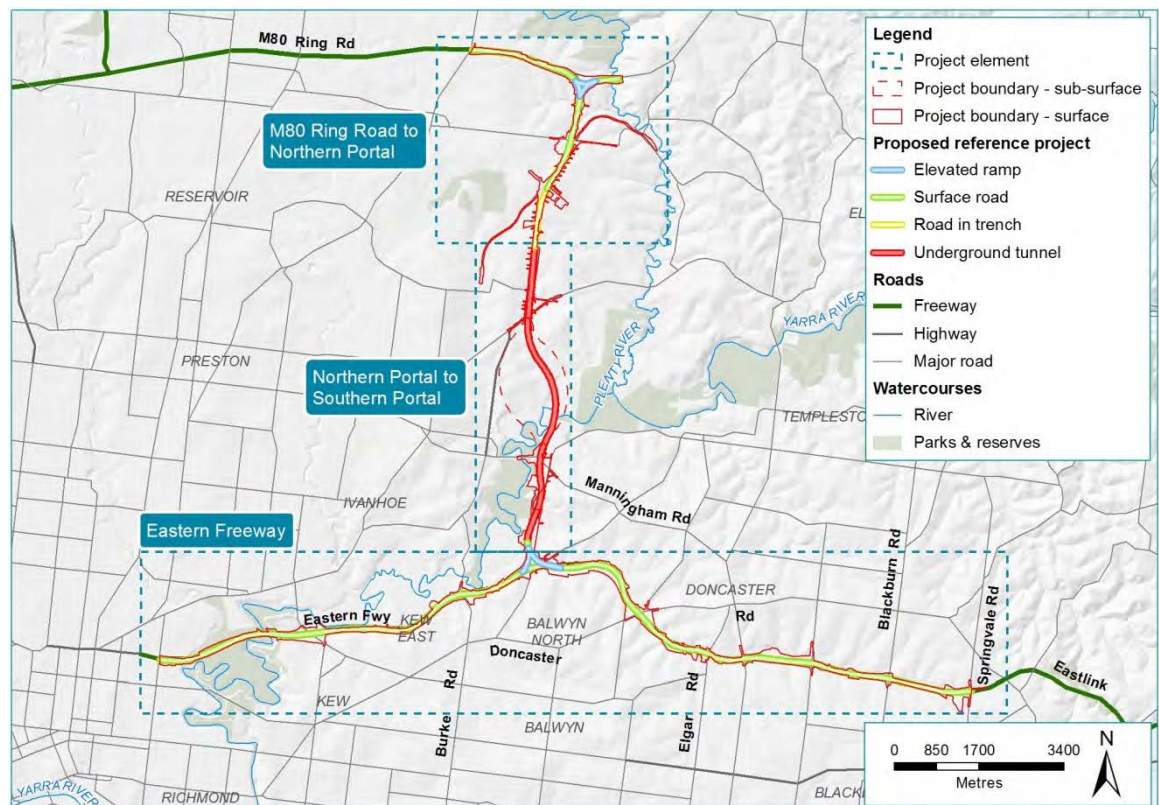


Figure 1 Overview of North East Link

### 3.2 Construction

Key construction activities for North East Link would include:

- General earthworks including topsoil removal, clearing and grubbing vegetation
- Relocation, adjustment or installation of new utility services
- Construction of retaining walls and diaphragm walls including piling
- Ground treatment to stabilise soils
- Tunnel portal and drive shaft construction
- Storage and removal of spoil
- Construction of cross passages, ventilation structures and access shafts
- Installation of drainage and water quality treatment facilities
- Installation of a Freeway Management System
- Tunnel construction using tunnel boring machines (TBMs), mining and cut and cover techniques
- Installation of noise walls
- Restoration of surface areas.

### 3.3 Operation

Following construction of North East Link, key operation phase activities would include:

- Operation and maintenance of new road infrastructure
- Operation and maintenance of Freeway Management System
- Operation of North East Link motorway control centre
- Operation and maintenance of the tunnel ventilation system
- Operation and maintenance of water treatment facilities
- Operation and maintenance of the motorway's power supply (substations)
- Maintenance of landscaping and Water Sensitive Urban Design (WSUD) features.

### 3.4 Activities and design considerations relevant to ecology

Other activities that may require consideration from an ecological standpoint include:

- Groundwater management following de-watering
- Surface water management
- Arboricultural assessments, mitigation and management.

### 3.5 Study area

#### **Project boundary**

The proposed **project boundary** for North East Link defines the area in which the project elements and construction would be contained. The project boundary is shown in Figure 1.

The project boundary encompasses all areas that would be used for permanent structures and temporary construction areas (above and below ground). It provides the basis for the ecological assessments undertaken for the EES. It should be noted that while fauna are to be assessed as part of the EES, fauna species are not necessarily located within the project boundary and may move in or out of the project boundary over time.

The project boundary would inform the 'project area' to be designated under the *Major Transport Project Facilitation (MTPF) Act* following assessment of the EES.

A number of waterways are located within or intersect the project boundary, including the Yarra River, Plenty River, Merri Creek, Koonung Creek and Banyule Creek. Several natural floodplain wetlands also occur within, or intersect, the Project boundary, including Bolin Bolin Billabong and Banyule Swamp.

### **Study area**

The term **study area** refers to a broader region surrounding the project boundary. The study area for this ecology assessment includes all land within five kilometres of the project boundary, and aquatic habitats beyond this buffer with connections to waterways in the project boundary (that is, the Yarra River catchment).

This description covers a much broader area than the expected zone of impact, and the additional information captured has been used to provide context to determine the significance of ecological features identified within the project boundary, and to identify potential listed rare or threatened species or communities that may be affected by the project.

The broader study area was only assessed at a desktop level, while the project boundary was assessed on the ground by ecologists.

### **No-go zones (adjacent to the project boundary within the study area)**

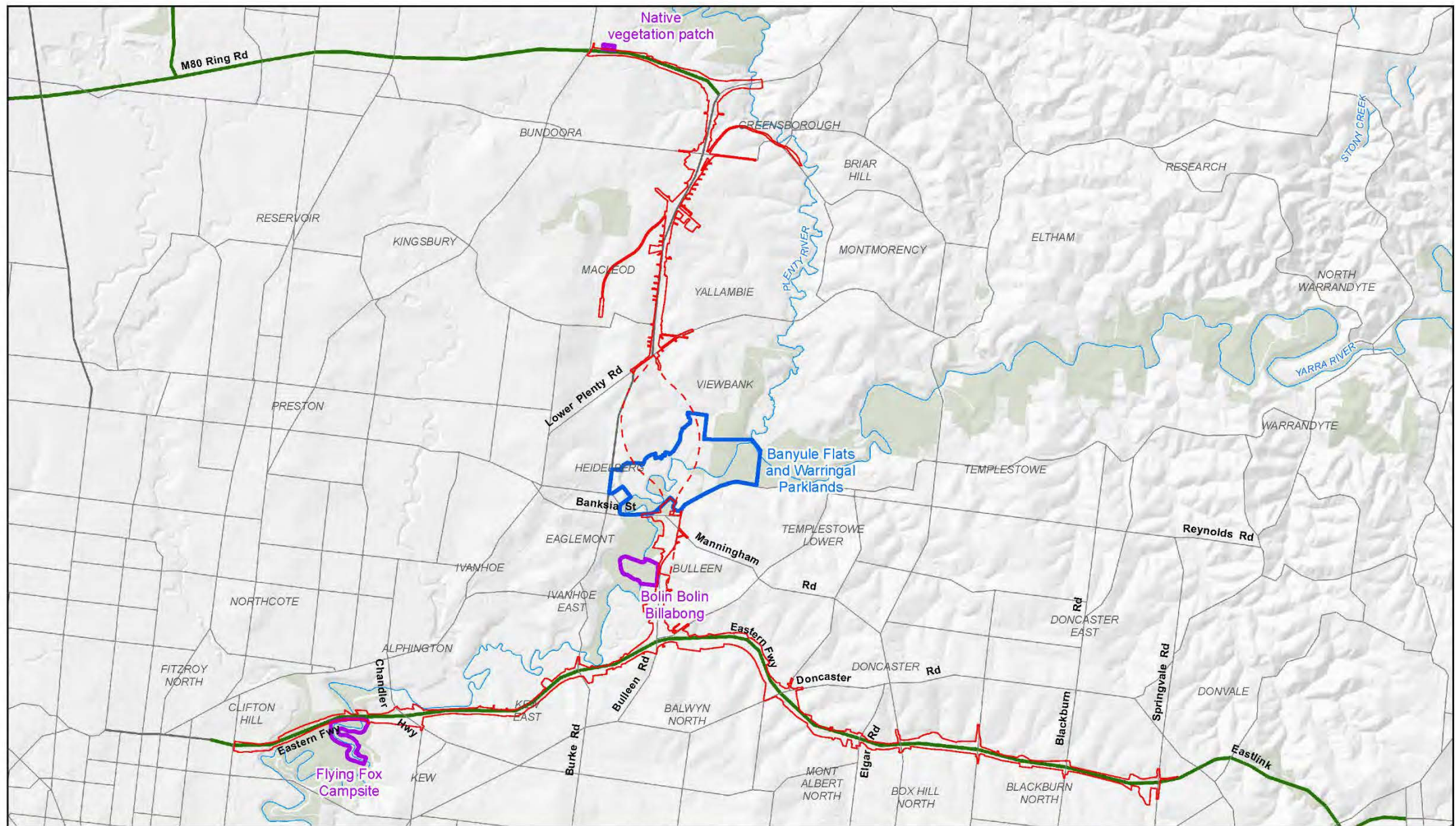
Direct impacts at a number of sensitive areas near North East Link would be avoided through the designation of no-go zones (adjacent to the project boundary), where surface works are not permitted as part of the project. No-go zones have been designated for the following sensitive areas:

- A vegetated patch near the intersection of the M80 Ring Road and Plenty Road. This area contains Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP), which is an ecological community listed under the EPBC Act as critically endangered. This area is managed by the City of Whittlesea and was established as an offset site for Plains Grassy Woodland (EVC 55) associated with the commercial development directly abutting the site.
- Bolin Bolin Billabong, located between Bulleen Road and the Yarra River. This is a known site of cultural significance and ecological value (non-EPBC related).
- A 26-hectare portion of Yarra Bend Park, south of the Eastern Freeway. This area supports a large breeding colony of the Grey-headed Flying-fox *Pteropus poliocephalus* (EPBC Act-listed as vulnerable) and is protected under the Flying-Fox Campsite Management Plan (DSE, 2005a). Tree lopping or removal would be required in the far north of this section (up to 10 metres from the southern edge of the Eastern Freeway bridge) to allow North East Link construction work to be undertaken safely. The no-go zone starts 10 metres south of the westbound bridge.

The location of these no-go zones are shown in Figure 2.

Twin tunnels are proposed beneath the Banyule Flats, Warringal Parklands and the Yarra River and its associated floodplain, as well as the Heide Museum of Modern Art and sculpture park. The tunnels would avoid surface impacts at these locations. This area has been included within a designated 'conditional no go zone' where surface works would not be permitted as part of the project with the possible exception of activities relating to site investigations, relocation of minor utilities, and ground improvement.

It is noted that although direct impacts would not occur, the potential for indirect impacts on sensitive areas within the no-go zones are considered throughout this assessment.



Paper Size A4  
0 550 1,100 2,200  
Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 55



#### Legend

- |   |  |   |
|---|--|---|
| <span style="border: 1px dashed red; padding: 2px;"> </span> Project boundary - sub-surface | <b>Roads</b>                                   | <span style="color: blue;">—</span> Watercourses                                    |
| <span style="border: 1px solid red; padding: 2px;"> </span> Project boundary - surface      | <span style="color: green;">—</span> Freeway   | <span style="color: blue;">—</span> River   |
| <span style="border: 1px solid blue; padding: 2px;"> </span> Conditional no go zone         | <span style="color: grey;">—</span> Highway    | <span style="background-color: lightgreen; padding: 2px;"> </span> Parks & reserves |
| <span style="border: 1px solid purple; padding: 2px;"> </span> No go zone                   | <span style="color: grey;">—</span> Major road |   |



North East Link Project  
Environment Effects Statement (EES)

Job Number 31-35006  
Revision F  
Date 04/03/2019

No-go zones

Figure 2

## 4. Legislation, policy, guidelines and criteria

### 4.1 Legislation, policy and guidelines – overview

Numerous legislative, policy and guidance documents were found to be relevant to this ecological impact assessment and are discussed further in this report. The key legislation, policy and guidelines that apply to the ecology impact assessment for the project are summarised in Table 3. Further detail is provided in Sections 4.2 and 4.3.

Table 3 Primary legislation and associated information

Legislation/policy	Key policies/strategies	Implications for the project	Approvals required
<b>Commonwealth</b>			
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act)	<p>Significant Impact Guidelines 1.1: Matters of National Environmental Significance (DoE, 2013)</p> <p>Significant Impact Guidelines 1.2: actions on, or impacting upon, Commonwealth land and actions by Commonwealth agencies (DSEWPAC, 2013b)</p>	<p>Provides for the conservation of biodiversity and the protection of the environment, particularly Matters of National Environmental Significance (MNES).</p> <p>DSEWPAC (2013b) provides for protection of environmental matters on Commonwealth land</p>	<p>Referral submitted to the Australian Government Minister for the Environment. Project determined to be a controlled action.</p> <p>Proposed action is to be assessed via a Public Environment Report (PER).</p>
<b>State</b>			
<i>Environment Effects Act 1978</i>	EES referral criteria for ecological matters (from DSE, 2006)	<p>Under the EE Act, projects that could have a 'significant effect' on Victoria's environment may require an EES to be developed.</p> <p>The project was referred to the Minister for Planning who determined that an Environment Effects Statement (EES) was required for the project</p>	EES to be prepared and assessed by the Minister for Planning.

Legislation/policy	Key policies/strategies	Implications for the project	Approvals required
<i>Planning and Environment Act 1987 (P&amp;E Act)</i>	Guidelines for the removal, destruction or lopping of native vegetation (DELWP, 2017a).	<p>The Guidelines are incorporated into the Victorian Planning Provisions and all planning schemes.</p> <p>They provide instruction on how an application for a permit to remove native vegetation is to be assessed under the P&amp;E Act.</p> <p>Sets the offsetting requirements for removal of native vegetation patches and scattered trees.</p>	<p>Offsets for loss of native vegetation patches, large trees within patches and scattered trees would be required.</p> <p>Offsets outlined in an Offset Management Plan (OMP).</p>
	Environmental Significance Overlays (ESOs)	Identification of areas where the development of land may be affected by environmental constraints, and to ensure that if development does happen, it is compatible with the values that are highlighted in any schedule to the identified ESO.	Work with respective councils to determine the significance of the environment, vegetation or landscape to be impacted and manage impacts using EPRs.
	Vegetation Protection Overlays (VPOs)	Specific to the removal of vegetation that has been deemed to be significant, and protects this vegetation against inappropriate development.	Permits are required in general for any removal, destruction or lopping of native vegetation, unless particular exemptions apply as outlined under Clause 52.17-7 of the Victoria Planning Provisions (VPP).
	Significant Landscape Overlays (SLOs)	Specific to the identification, conservation and enhancement of a significant landscape, particularly its character, including the protection of vegetation against inappropriate development.	Any native vegetation loss would be offset in accordance with DELWP's Guidelines for the removal, destruction or lopping of native vegetation (DELWP, 2017a).
	Heritage Overlays (HOs)	Protection of places of natural and cultural significance, with an aim to conserve and enhance the assets. This includes the protection of vegetation against inappropriate development.	Additional permits or controls may exist for both native and non-native vegetation under various overlays such as an ESO, SLO or VPO.
	Public Park And Recreation Zones (PPRZs)	This zone aims to recognise areas for public recreation and open space and to protect and conserve areas of significance where appropriate.	

Legislation/policy	Key policies/strategies	Implications for the project	Approvals required
	Environmental Audit Overlay (EAO)	To ensure that potentially contaminated land is suitable for use which could be significantly adversely affected by any contamination.	
<i>Flora and Fauna Guarantee Act 1988</i> (FFG Act)	Flora and Fauna Guarantee Regulations 2011	Provides a process for listing threatened native species and communities, protected flora and fauna, and processes and potentially threatening processes with respect to native flora and fauna.  Protected flora controls.	Protected and threatened flora controls - permit to 'take' (kill, injure, disturb or collect) protected or listed flora required if said flora are impacted. Likewise, a permit is also required to 'take' protected fish.
<i>Environment Protection Act 1970</i>	State Environment Protection Policy (Waters) 2018	Sets Framework for protection and improvement of surface water environments, including protected beneficial uses and environmental quality objectives.	Licences to discharge to waterways are issued under this legislation.
<i>Yarra River Protection (Wilip-gin Birrarung murrn) Act 2017</i>	Yarra Strategic Plan	The Act identifies the Yarra River and the many parcels of public land as one living, integrated natural entity for protection and improvement. The Plan will provide a guide for future use and development and identifies areas for protection within the Yarra corridor.	An exemption from the provision of the Act applies for projects declared under the MTPF Act. NELP will consider the long-term community vision and land use framework plan within the Yarra Strategic Plan, as well as having regard to the Yarra Protection Principles.
<i>Water Act 1989</i>	Healthy Waterways Strategy	Melbourne Water is responsible for development and delivery of the Healthy Waterway Strategy, including ecological values.	Works on Waterways

Legislation/policy	Key policies/strategies	Implications for the project	Approvals required
<i>Wildlife Act 1975</i>	Wildlife Act Regulations 2013  Procedure statement for translocation of threatened native fauna in Victoria - 2016 (DELWP, 2016a).	Under the Act it is an offence to take or destroy protected or threatened wildlife without authorisation.  Under the Wildlife Act Regulations it is an offence to damage, disturb (including removal or relocation of wildlife) or destroy any wildlife habitat unless authorised to do so under any Act.	Management Authorisation from DELWP required to undertake salvage, if salvage approved by DELWP.
<i>Catchment and Land Protection Act 1994 (CaLP Act)</i>	List of declared noxious weeds  List of established pest animals	Establishes a framework for management and protection of catchments, including responsibilities in relation to the management of pest plants and animals in Victoria.	Responsibility to take all reasonable steps to eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds and, where possible, eradicate established pest animals declared under the CaLP Act.
<i>Fisheries Act 1995</i>	List of declared noxious aquatic species	Creates a framework for regulation, management, development and conservation of Victorian fisheries, aquatic habitats and ecosystems, aquaculture industries and associated aquatic biological resources.  FFG-listed fish are also protected under the <i>Fisheries Act 1995</i> and may not be 'taken' without authorisation under both acts.	A permit may be required to 'take' fish for salvage during construction.

Legislation/policy	Key policies/strategies	Implications for the project	Approvals required
Threatened species advisory lists (Non-statutory)	<p>Advisory lists of rare or threatened species in Victoria are maintained by DELWP.</p> <p>Species are broken into the following groupings:</p> <ul style="list-style-type: none"> <li>• Rare or Threatened Plants (DEPI, 2014)</li> <li>• Threatened Vertebrate Fauna (DEPI, 2013a)</li> <li>• Threatened invertebrate Fauna (DSE, 2009)</li> </ul>	<p>There are no direct legal requirements or consequences that flow from inclusion of a species in advisory lists, although they are afforded some protection through the <i>Guidelines for the removal, destruction or lopping of native vegetation</i> (DELWP, 2017a).</p> <p>Species included in the list may also be formally listed as threatened under the EPBC Act or FFG Act.</p>	<p>No direct approvals required, but advisory list status is considered by DELWP when determining species offsets in relation to <i>Guidelines for the removal, destruction or lopping of native vegetation</i> (DELWP, 2017a)</p>

## 4.2 Commonwealth legislation

This section provides an outline of Commonwealth environmental legislation and/or policies relevant to North East Link.

### 4.2.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth Government's key piece of legislation for environmental protection. One of the main objectives of the EPBC Act is to protect Matters of National Environmental Significance (MNES), defined as:

- 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 mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

Of the MNES listed above, only listed threatened species and ecological communities, and migratory species protected under international agreements are relevant to this project.

The project could have a significant impact on MNES, so was referred to the Commonwealth on 17 January 2018. Commonwealth matters are addressed in Sections 7 (flora), 8 (fauna), 9 (aquatic) and 12 (impact assessment).

## Other matters protected by the EPBC Act

Approval under the EPBC Act may also be required for a proposed action that significantly affects the environment on Commonwealth land, or if an action is likely to significantly impact on the environment anywhere if the action is proposed by the Australian Government or its agencies. These 'other matters' are: listed marine species, whales and other cetaceans, critical habitats, Commonwealth reserves (terrestrial or marine), and Commonwealth heritage places or Commonwealth land.

North East Link would be located adjacent to and within Commonwealth land and would likely have a significant impact on the environment of Commonwealth land. Given this, the project was referred to the Commonwealth on 17 January 2018.

## Listed key threatening processes

The EPBC Act also provides for the identification and listing of key threatening processes. A key threatening process is defined as such if it could:

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

Key threatening processes do not trigger the EPBC Act as they are not MNES and they also do not regulate or prevent actions undertaken by the states, territories or individual property managers (DoEE 2017a). Threat abatement plans may be prepared for key threatening processes.

## 4.3 State legislation

This section provides an outline of Victorian environmental legislation and/or policies relevant to North East Link.

### 4.3.1 Environment Effects Act 1978

Under the *Environment Effects Act 1978* ('EE Act') projects that could have a 'significant effect' on Victoria's environment may require an Environment Effects Statement (EES) to be prepared for assessment by the Minister for Planning. The EE Act applies to any works 'reasonably considered to have or be capable of having a significant effect on the environment'.

The EES referral criteria for impacts to ecological values were considered as part of the preliminary assessments for North East Link. The criteria are summarised in Table 4. The project was referred to the Minister for Planning, who determined that an Environment Effects Statement (EES) was required for the project. The Minister's reasons included that:

- The project is a large-scale infrastructure construction project, with construction effects to span several years and some potential effects lasting beyond the construction period, in an intensively developed area used by many residents, businesses and commuters and featuring complex ground and hydrological conditions, sensitive ecological values, as well as important heritage and amenity values.
- The works have the potential for significant environmental effects on a range of environmental values, having regard to the nature of the area within which the project is proposed to be constructed and its dynamic and varied social and community setting.

Table 4 EES referral criteria for ecological matters (from DSE, 2006)

Criteria type	Criteria
Individual mandatory referral criteria for ecological matters	Potential clearing of 10 hectares or more of native vegetation from an area that: <ul style="list-style-type: none"> <li>Is of an EVC identified as endangered by the DELWP, or</li> <li>Is, or is likely to be, of very high conservation significance (as defined in accordance with Appendix 3 of Victoria's Native Vegetation Management Framework)</li> <li>Is not authorised under an approved Forest Management Plan or Fire Protection Plan.</li> </ul>
	Potential long-term loss of a significant proportion (eg 1 to 5% depending on the conservation status of the species) of known remaining habitat or population of a threatened species within Victoria
	Potential extensive or major effects on the health or biodiversity of aquatic, estuarine or marine ecosystems over the long term.
	Potential long-term change to the ecological character of a wetland listed under the Ramsar Convention or in 'A Directory of Important Wetlands in Australia' (Environment Australia, 2001).
Combination referral criteria for ecological matters	Potential clearing of 10 hectares or more of native vegetation, unless authorised under an approved Forest Management Plan
	Matters listed under the <i>Flora and Fauna Guarantee Act 1988</i> : <ul style="list-style-type: none"> <li>Potential loss of a significant area of a listed ecological community, or</li> <li>Potential loss of a genetically important population of an endangered or threatened species (listed or nominated for listing), including as a result of loss of fragmentation of habitats, or</li> <li>Potential loss of critical habitat, or</li> <li>Potential significant effects on habitat values of a wetland supporting migratory bird species.</li> </ul>
	Potential extensive or major effects on landscape values of regional importance, especially where recognised by a planning scheme overlay or within or adjoining land reserved under the <i>National Parks Act 1975</i>

#### 4.3.2 Planning and Environment Act 1987

The *Planning and Environment Act 1987* ('P&E Act') establishes the framework for the use, development and protection of land in Victoria. The P&E Act provides for planning schemes which are typically administered by local government but can also be administered by the State in certain circumstances.

## Guidelines for the removal, destruction or lopping of native vegetation

The *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP, 2017a) ('the Guidelines') are incorporated into the Victoria Planning Provisions and all planning schemes in Victoria. The Guidelines replace the previous incorporated document entitled 'Permitted clearing of native vegetation – Biodiversity assessment guidelines' (DEPI, 2013b). The new Guidelines provide instruction on how an application for a permit to remove native vegetation is to be assessed under the P&E Act, including requirements to undertake a site assessment, the required site-assessment method, and any specific conditions that may form part of a granted permit, such as offsetting. The guidelines are also used to assess native vegetation removal proposed as part of major infrastructure projects in Victoria.

Under the Guidelines, there are three pathways under which an application to remove native vegetation can be assessed – basic, intermediate and detailed. The assessment pathway determines the types of offsets that are required to be implemented for the proposed vegetation removal. This is determined via an assessment of location, whether any large trees are to be removed and the extent of risk to biodiversity of the particular project:

- Location risk is determined by assessing the likelihood that the removal of a small amount of native vegetation may impact the persistence of a rare or threatened species. Location risk has been determined for all of Victoria with areas being categorised as Location 1, Location 2 or Location 3. The location risk of a particular site is determined using the native vegetation location risk map available from the Native Vegetation Information Management (NVIM) system tool found on the DELWP website<sup>4</sup>.
- Extent risk is determined by the extent of the native vegetation including the presence or absence of large trees that is proposed to be removed.

Together, these two types of risk are used to determine the assessment pathway for a permit application to remove native vegetation (DELWP, 2017a).

Table 5 presents the assessment pathways for native vegetation removal.

**Table 5** Assessment pathways for native vegetation removal

Extent of native vegetation	Location category		
	Location 1	Location 2	Location 3
Less than 0.5 hectares and not including any large trees	Basic	Intermediate	Detailed
Less than 0.5 hectares and including one or more large trees	Intermediate	Intermediate	Detailed
0.5 hectares or more	Detailed	Detailed	Detailed

<sup>4</sup><https://www.environment.vic.gov.au/native-vegetation/native-vegetation-information-management>

The assessment pathway determines the assessment process to be followed when applying to remove native vegetation:

- Basic and intermediate pathway applications do not require a site assessment by an accredited native vegetation assessor
- Detailed pathway applications require a site assessment

Given the large project boundary area, native vegetation removal would be greater than 0.5 hectares and therefore the 'Detailed' assessment pathway will be followed for assessment of the project.

### Offset requirements

The biodiversity loss from the removal of native vegetation is required to be offset in accordance with the Guidelines (DELWP, 2017a). Offsets are designed to compensate for the loss of biodiversity value.

A combination of site-based and landscape-scale information is used to calculate the biodiversity value of the vegetation to be removed. This information is used to determine the loss in biodiversity value that needs to be compensated for with an offset that provides equivalent gain in biodiversity value. Biodiversity value is represented by a general or species habitat score.

Either a species offset or a general offset is required to compensate for any removals:

- A species offset is required when the removal of native vegetation has a significant impact on habitat for a rare or threatened species. Species offsets must compensate for the removal of that particular species' habitat.
- A general offset is required when the removal of native vegetation does not have a significant impact on any habitat for rare or threatened species.

Offsets are determined via a Native Vegetation Removal (NVR) report, which is generated by DELWP following the submission of habitat hectare assessment field and spatial data. Prior to submitting final areas of native vegetation to be removed to DELWP for processing the NVR report, the Environmental Systems Modelling Platform (EnSym) Native Vegetation Regulations Tool can be used to test clearing scenarios and therefore provide an indication of offset expectations.

### Planning overlays and planning zones

The implications of the following overlays were assessed for the purposes of this report:

- Environmental Audit Overlays (EAO): The intent of an EAO is to ensure that potentially contaminated land is suitable for a use, which could be significantly adversely affected by any contamination.
- Environmental Significance Overlays (ESO): The broad intent of an ESO is to identify areas where the development of land may be affected by environmental constraints, and to ensure that if development does happen, it is compatible with the values that are highlighted in any schedule to the identified ESO.
- Heritage Overlays (HO): A HO aims to conserve and enhance places of natural or cultural significance and to ensure that development does not adversely affect the significance of heritage places.
- Significant Landscape Overlays (SLO): The intent of an SLO is to conserve and enhance the character of significant landscapes.

- Vegetation Protection Overlays (VPO): A VPO is specific to the removal of vegetation that has been deemed to be significant, and protects this vegetation against inappropriate development.
- Public Park and Recreation Zones (PPRZ): This zone aims to recognise areas for public recreation and open space and to protect and conserve areas of significance where appropriate.

A schedule to an ESO, HO, SLO, VPO, PPRZ or EAO would contain a statement of the significance of the environmental, vegetation or landscape value that is protected by the overlay, and the objective to be achieved. Approval (via permit) is typically required to remove most vegetation within any of the overlays, and the application for an approval for vegetation removal must show the proponent has been cognisant of the intent of each overlay.

In considering any application for vegetation removal, the decision guidelines of ESOs and VPOs must be considered. Decision guidelines include but are not limited to:

- The State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- The statement of environmental, vegetation and/or landscape significance and the environmental objective contained in a schedule to the relevant overlay.
- The need to remove, destroy or lop vegetation to create defensible space to reduce the risk of bushfire to life and property.
- Any other matters specified in a schedule to the relevant ESO, HO, SLO, VPO or PPRZ.

#### 4.3.3 Flora and Fauna Guarantee Act 1988

The *Flora and Fauna Guarantee Act 1988* ('FFG Act') was established to provide a legal framework for enabling and promoting the conservation of all Victoria's native flora and fauna, and to enable management of potentially threatening processes. One of the main features of the FFG Act is the listing process, whereby native species and communities of flora and fauna, and the processes that threaten native flora and fauna, are listed in the schedules of the Act. This assists in identifying those species and communities that require management to survive and identifies the processes that require management to minimise the threat to native flora and fauna species and communities within Victoria.

The species and communities of flora and fauna and the potentially threatening processes listed under the FFG Act are published on the DELWP website at <https://www.environment.vic.gov.au/conserving-threatened-species/flora-and-fauna-guarantee-act-1988>.

The website provides links to three lists:

- Threatened species list (DELWP, 2017d) which includes taxa and communities of flora and fauna that have been listed as threatened in accordance with Section 10 of the FFG Act
- Protected flora list (DELWP, 2017e) which includes:
  - Plant taxa listed as threatened under the FFG Act
  - Plant taxa belonging to communities listed as threatened under the FFG Act
  - Plant taxa which are not threatened but require protection for other reasons
- Processes list (DELWP, 2016b) which includes processes that have been listed as potentially threatening processes in accordance with Section 10 of the FFG Act

The FFG Act also enables habitat critical to the survival of native flora and fauna to be declared and requires permits for activities that could harm threatened plants, fish and communities.

Protected and Listed flora controls under the FFG Act means it is an offence to take, trade in, keep, move or process protected or listed flora without a permit. 'Take' is defined as to kill, injure, disturb or collect. Flora controls do not apply on private land, unless the land is identified as critical habitat for the species. There are currently no critical habitat determinations under the FFG Act.

It is also an offence under the FFG Act to take, trade in or keep listed fish species.

Species relevant to the project are considered as part of the Victorian Biodiversity Atlas (VBA) data output in the desktop assessment discussed in Section 5.4.1 of this report, and in the subsequent likelihood of occurrence assessment provided at Appendix B and Appendix C.

#### 4.3.4 Environment Protection Act 1970

The *Environment Protection Act 1970* ('EP Act') provides the legislative foundation for the prevention of pollution and environmental damage by setting environmental quality objectives and establishing programs to meet them. The conservation of biological diversity and ecological integrity is one of the Principles in the Act, along with the precautionary principle and shared responsibility.

State Environment Protection Policies (SEPPs) are subordinate legislation to provide more detailed requirements and guidance. Of particular relevance to the assessment of ecology is SEPP (Waters) which outlines specific beneficial uses (environmental values and human activities) to be protected. The SEPP also includes specific environmental quality objectives for waterways and aquatic ecosystem condition. Guidelines are published by Environment Protection Authority (EPA) Victoria that include biological, nutrient and water quality assessment methods.

#### 4.3.5 Yarra River Protection (Wilip-gin Birrarung murrn) Act 2017

The *Yarra River Protection (Wilip-gin Birrarung Murrn) Act 2017* provides an overarching policy and planning framework to coordinate and harmonise planning for the use, development and protection of the Yarra River, its parklands and other land in its vicinity. A purpose of the Act is to protect the Yarra River and the surrounding parcels of public land as one living and integrated natural entity. The Act also recognises the importance of the Yarra River, and its parklands and associated public places, to the economic prosperity, vitality and liveability of Melbourne and the Yarra Valley.

The Act provides for the preparation of a Yarra Strategic Plan in accordance with Yarra Protection Principles to guide future use and development, and areas for protection within the Yarra corridor. An exemption from the provisions of the Act applies for projects declared under the *Major Transport Projects Facilitation Act 2009 (Vic)*. However, NELP has undertaken strategic planning to consider the long-term community vision and land use framework plan within the Yarra Strategic Plan, as well as having regard to the Yarra Protection Principles set out in the Act.

#### 4.3.6 Water Act 1989

The *Water Act 1989* provides the legal framework for managing Victoria's water resources, including by catchment management authorities. This includes management and planning of waterways, land and works protection. Melbourne Water is responsible for ensuring that waterways in the Port Phillip and Westernport CMA region are protected and improved, and is the lead agency for the delivery of the Healthy Waterway Strategy (HWS). The HWS identifies a vision for the region, and sets priority areas for investment and management actions. The HWS identifies seven key ecological values for the community, and the environmental conditions that support these are managed by Melbourne Water.

#### 4.3.7 Catchment and Land Protection Act 1994

The *Catchment and Land Protection Act 1994* ('CaLP Act') establishes a framework for management and protection of catchments through the management of land and water resources. The CaLP Act is the principal legislation relating to the management of pest plants and animals in Victoria. Under the Act, land owners have a responsibility to avoid causing or contributing to land degradation, including taking all reasonable steps to conserve soil, protect water resources, eradicate regionally prohibited weeds, prevent the growth and spread of regionally controlled weeds and where possible, eradicate established pest animals as declared under the CaLP Act.

Weed categories and their respective management requirements under the CaLP Act are summarised in Table 6.

Table 6 CaLP Act declared noxious weed management requirements

Weed category	Enforceable management requirement
State prohibited weeds	These include weeds that either do not occur in Victoria but are a significant threat if they do invade, or are weeds that are present and pose a serious threat but are expected to be eradicated as infestations are generally small. The Victorian Government is responsible for the eradication of these weeds and may direct land owners to prevent growth and spread.
Regionally prohibited weeds	Regionally prohibited weeds are not widely distributed in a region but are capable of spreading further. It is reasonable to expect they can be eradicated from a region and they must be managed with that goal. Land owners, including public authorities responsible for crown land management, must take all reasonable steps to eradicate regionally prohibited weeds on their land.
Regionally controlled weeds	These invasive plants are usually widespread in a region. To prevent their spread, ongoing control measures are required. Land owners have the responsibility to take all reasonable steps to prevent the growth and spread of regionally controlled weeds on their land.
Restricted weeds	This category includes plants that pose an unacceptable risk of spreading in Victoria and are a serious threat to another state or territory of Australia. Trade in these weeds and their propagules, either as plants, seeds or contaminants in other materials, is prohibited.

Lists of noxious weeds and declared pest animals under the CaLP Act are published on the Agriculture Victoria website at <<http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/protecting-victoria-from-pest-animals-and-weeds/legislation-policy-and-permits/declared-noxious-weeds-and-pest-animals-in-victoria>>.

#### 4.3.8 Wildlife Act 1975

The *Wildlife Act 1975* forms the procedural, administrative and operational basis for the protection and conservation of native wildlife within Victoria. The purposes of the Wildlife Act are to establish procedures in order to promote:

- The protection and conservation of wildlife
- The prevention of taxa of wildlife from becoming extinct
- The sustainable use of and access to wildlife.

The Wildlife Act often sits as the default reference for other associated policies regarding wildlife. For example, the operation of the FFG Act often needs to be considered in conjunction with the provisions and procedures of the Wildlife Act as some wildlife would be both protected wildlife under the Wildlife Act and listed threatened species under the FFG Act.

With the exception of pest animals declared under the CaLP Act or wildlife declared to be unprotected wildlife, the Wildlife Act makes it an offence to hunt, take or destroy protected or threatened wildlife without authorisation.

#### 4.3.9 Fisheries Act 1995

The *Fisheries Act 1995* forms the framework for regulation, management, development and conservation of Victorian fisheries, aquatic habitats and ecosystems, aquaculture industries and associated aquatic biological resources including aquatic ecological processes. One objective of the Fisheries Act is to promote sustainable fisheries, including recreational fishing opportunities; the Act also includes the list declared noxious species of fish.

FFG-listed fish are also protected under the Fisheries Act and may not be 'taken' without authorisation under both Acts. If salvage of fish is required during construction of North East Link, a permit under the Fisheries Act may be required to catch and release, and includes requirements for animal ethics approval.

#### 4.3.10 Local planning schemes

Table 7 outlines all Local Government Authorities (LGAs) with applicable planning schemes, including key environmental planning zones and overlays for the project boundary.

**Table 7** Applicable local planning schemes

Administrative boundary	Code	Description
Banyule City Council	ESO	Environmental Significance Overlay
	HO	Heritage Overlay
	SLO	Significant Landscape Overlay
	VPO	Vegetation Protection Overlay
	PPRZ	Public Park and Recreation Zone
Boroondara City Council	SLO	Significant Landscape Overlay
	PPRZ	Public Park and Recreation Zone
Manningham City Council	ESO	Environmental Significance Overlay
	HO	Heritage Overlay
	SLO	Significant Landscape Overlay
	PPRZ	Public Park and Recreation Zone
Nillumbik Shire Council	ESO	Environmental Significance Overlay
	PPRZ	Public Park and Recreation Zone
Whitehorse City Council	SLO	Significant Landscape Overlay
	VPO	Vegetation Protection Overlay
	PPRZ	Public Park and Recreation Zone

Administrative boundary	Code	Description
Whittlesea City Council	N/A	N/A – not applicable
Yarra City Council	EAO	Environmental Audit Overlay
	ESO	Environmental Significance Overlay
	HO	Heritage Overlay
	SLO	Significant Landscape Overlay
	PPRZ	Public Park and Recreation Zone

#### 4.4 Protecting Victoria's Environment – Biodiversity 2037

The Victorian Biodiversity Plan, *Protecting Victoria's Environment – Biodiversity 2037* (DELWP, 2017f), is the Victorian Government's commitment to ensuring consistency with national and international biodiversity programs and agreements. The Biodiversity Plan represents the Victorian Government's long-term vision for Victoria's biodiversity, setting the vision, priorities for action and policy agenda towards safeguarding Victoria's natural environment through:

- Engaging all Australians in biodiversity conservation
- Building ecosystem resilience in a changing climate
- Getting measurable results.

The Biodiversity Plan is implemented in this ecology impact assessment to identify biodiversity characteristics within the study area of greatest value and informs the decision-making process for the EES.

## 5. Method

### 5.1 Overview of method

This section describes the method that was used to assess the potential impacts of North East Link. A risk-based approach was applied to prioritise the key issues for assessment and inform measures to avoid, minimise and offset potential effects. Figure 3 shows an overview of the assessment method.

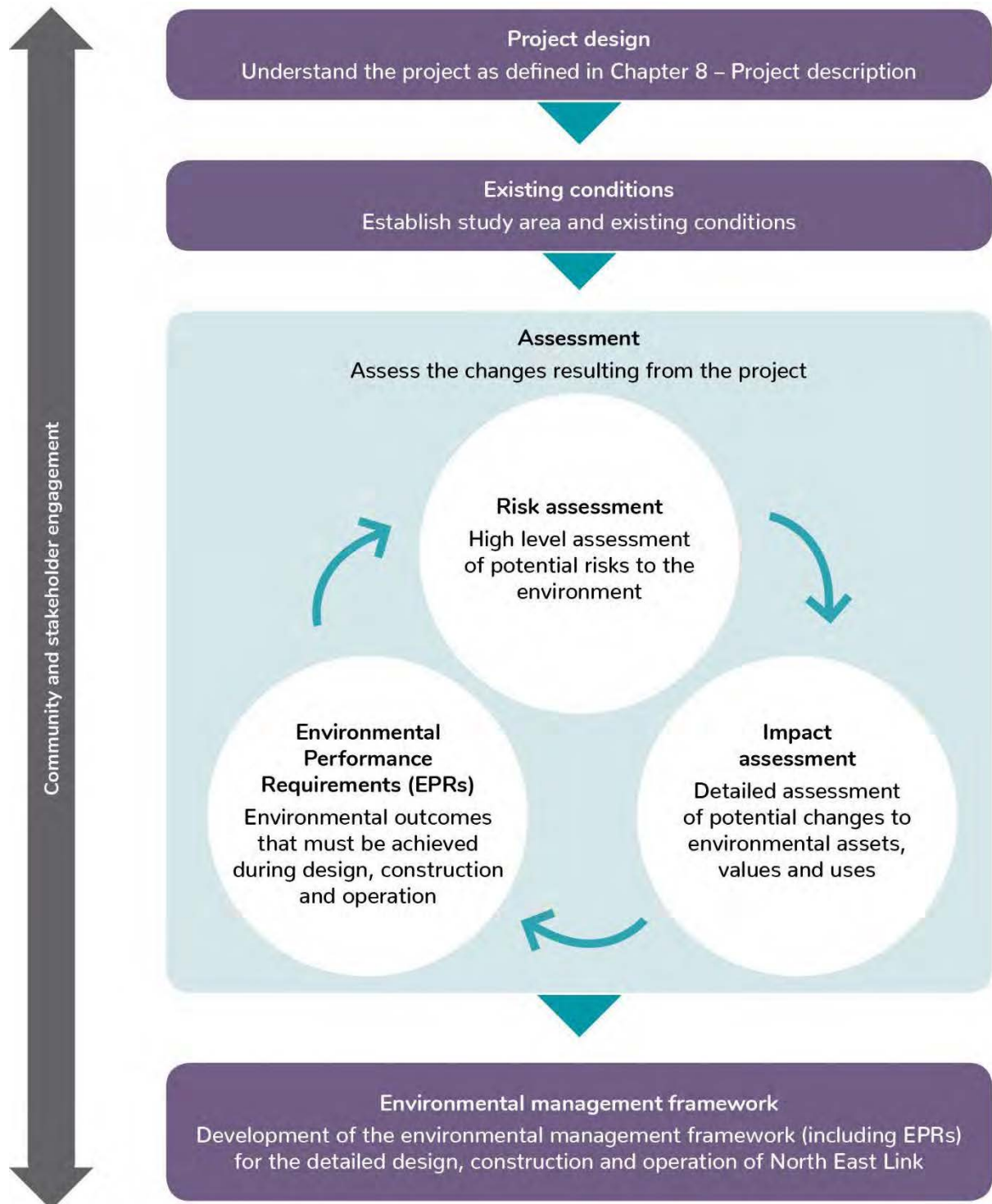


Figure 3 Overview of assessment method

The following sections outline the method adopted for the ecology impact assessment.

To assess whether ecological values would be impacted by the project works, a staged approach was adopted. This included:

- Characterisation of the existing conditions within the study area through:
  - A desktop assessment to determine the likelihood of occurrence of threatened flora, fauna and ecological communities
  - A general field assessment to collect information on vegetation and habitat characteristics, and to inform the need for targeted surveys
  - Aquatic ecosystem assessment
  - Targeted surveys at specific locations that were considered likely to support threatened species or communities
- An assessment of construction and operational risks
- An impact assessment combining existing conditions and associated construction and operational risks.

## 5.2 Defining threatened species, migratory species and ecological communities

For the purposes of this report, 'threatened species' refers to those species that are listed as threatened under the EPBC Act, FFG Act, and/or listed as vulnerable, endangered or critically endangered on the DELWP-administered Advisory Lists. Rare species are those listed solely on the DELWP-administered Advisory List. 'Threatened communities' refers to communities that are listed as threatened under the EPBC Act or FFG Act. 'Migratory species' refers to species listed as Migratory under the EPBC Act. Categories are identified in Table 8.

Table 8 Threatened species, threatened communities and migratory species listing categories by legislation

Legislation	Categories
<b>EPBC Act</b>	Vulnerable (VU)
	Endangered (EN)
	Critically Endangered (CR)
	Migratory (Mi)
<b>FFG Act</b>	Listed (L)
<b>DELWP Advisory List</b>	Vulnerable (v)
	Endangered (e)
	Critically Endangered (c)
	Rare (r)

The Marine status of fauna (as defined under the EPBC Act) was not considered because the project boundary is not within or near a Commonwealth Marine Area, and impacts on a Commonwealth Marine Area are highly unlikely.

A number of species records were eliminated from the Victorian Biodiversity Atlas (VBA) list based on their listing status, a review of relevant literature and an understanding of their preferred habitats. Records of species not considered further in this report include:

- Records older than 30 years (pre-1987) for most species – older records for some fauna species are referred to for context in the likelihood of occurrence assessment.
- Fauna species considered 'near threatened', 'conservation dependent' or 'data deficient' in the DELWP Advisory list (these species are not considered threatened species), unless they are also listed under the EPBC Act and/or FFG Act.
- Flora listed as 'Nominated' under the FFG Act.
- Flora listed as 'poorly known' in the VROTS list as the current knowledge of their distribution and abundance is not sufficient to determine whether these species should be considered as rare or threatened in Victoria.
- Some threatened flora species which are outside their natural range but are commonly used for landscaping and amenity, including Spotted Gum *Corymbia maculata*, Red Bloodwood *Corymbia gummifera* and Giant Honey-myrtle *Melaleuca armillaris*.
- Fauna reliant on marine environments, including albatross, petrel, cetaceans and marine turtles (which are in the database search results based on the proximity of the project boundary to the Port Phillip Bay marine environment) as no habitat for these species is present in the project boundary, or likely to be impacted by the project.

### 5.3 Nomenclature

Common and scientific names used for flora and fauna follow those used in the VBA (Version 3.2.0), unless otherwise stated.

For flora, many species do not have a single well-recognised common name (they may have multiple names in common use or none at all), so the species naming convention is often presented as scientific name followed by common name (where applicable). For fauna, species tend to have a single well-recognised common name, so the species naming convention is typically presented as common name followed by scientific name.

In general, both names (scientific and common) are presented for all species where first introduced, then one name is provided thereafter in that section. This convention is overlooked in some sections to make it clear which species are being referred to.

### 5.4 Existing conditions

A comprehensive ecological assessment was undertaken to understand the existing conditions of the study area to inform the environmental impact assessment for North East Link. This assessment incorporated:

- A desktop assessment and synthesis of biodiversity datasets curated by the Australian and Victorian governments
- A review of existing literature
- Consultation with specialists
- Flora and fauna field assessments
- Vegetation quality assessment (habitat hectare assessment) of recorded native vegetation
- Aquatic ecosystem assessments
- Targeted survey for threatened species, where deemed necessary
- Determination of the likelihood of threatened species and threatened species' habitat presence.

#### 5.4.1 Existing literature review

An extensive literature review was completed of previous environmental studies by public or private entities. These included public authority management plans, recovery plans and action plans, and council and other administrative bodies' environmental investigations and environmental feature descriptions. The aim of the literature review was to compile the findings of historical records, reports and information relevant to the project.

This section includes accounts of some areas that are outside the project footprint and are not expected to be directly impacted. However, for fauna in particular, these areas were considered to help build a picture of the broader ecology of the area and identify any values that may need to be protected from any indirect impacts. Table 9 summarises the reports reviewed for the literature review.

**Table 9** Reports reviewed for the literature review

Report name	Reference
Banksia Park – Park Note	Parks Victoria (2011a)
Banyule Flats Reserve	Banyule City Council (2018)
Billabong Song, Bolin Bolin Billabong Walk	Manningham City Council (n.d.)
Biodiversity Assessments and Strategies for Simpson Barracks.	HLA-Envirosciences Pty Ltd (2007)
Biodiversity Monitoring in Melbourne's East – Bird Component.	Herman, K. (2016) (Birdlife Australia)
Birrarrung Park – Park Note	Parks Victoria (2011b)
Digging up the dirty past: evidence for stormwater's contribution to pollution of an urban floodplain lake	Lintern <i>et al.</i> (2015)
Ecological assessment and recommendations for Banyule Flats	Practical Ecology (2007a)
Ecological assessments of wetlands at the Trinity Grammar School Sporting Complex, Bulleen	Practical Ecology (2007b)
Fauna surveys at specified sites on the Yarra River	Practical Ecology (2010)
Flora, fauna and biodiversity assessment report: Bolin Bolin stormwater harvest project, Bulleen	James <i>et al.</i> (2014)
Flying-Fox Campsite Management Plan; Yarra Bend Park.	DSE (2005)
Healthy habitats: bushland management strategy for council managed land	Manningham City Council (2012)
Healthy Waterways Strategy	Melbourne Water (2018)
Identifying heavy metal levels in historical flood water deposits using sediment cores	Lintern <i>et al.</i> (2016)
Inventory and assessment of indigenous flora and fauna in Boroondara	Lorimer (2006)
Koonung Creek Reserve remnant bushland patch: vegetation action plan	Practical Ecology (2017a)
Mullum Mullum Park strategic management plan	Parks Victoria (2012)

Report name	Reference
Referral guideline for management actions in grey-headed and spectacled flying-fox camps	DoE (2015)
Report on Base Security Improvement Program – Base Infrastructure Works Project. Initial Environmental Review	GHD (2011)
Simpson Barracks Flora and Fauna Monitoring Program 2016–2021	Jacobs (2016)
Simpson Barracks. Kangaroo Monitoring Program 2015	AECOM (2015)
Simpson Barracks Kangaroo Population: Status Report	Wilson Environmental (2014)
Sites of (biological) significance review	Foreman <i>et al.</i> (2004)
Sites of faunal and habitat significance in North East Melbourne Volume 1 – introduction and overview	Nillumbik Shire Council (1997)
Species distribution models derived from citizen science data predict the fine scale movements of owls in an urbanizing landscape	Bradsworth <i>et al.</i> (2017)
Sugar Gliders ( <i>Petaurus breviceps</i> ) at key biodiversity sites along the Yarra River Corridor, Boroondara City Council	Van der Ree (2017)
Swift Parrots in Banyule and surrounds	Practical Ecology (2017c)
The Koonung Creek Linear Park management plan	Manningham City Council (2011)
The palaeolimnology and current status of Yarra River Billabongs	Leahy (2007)
Warringal Parklands and Banyule Flats: Cultural Heritage Assessment	Context (2014)
Warringal Parklands and Banyule Flats ecological and conservation values assessment	Practical Ecology (2017b)
Wildlife movement and habitat needs in Manningham	Lorimer <i>et al.</i> (2009)
Yarra Bend Park environmental action plan	Parks Victoria (2000)
Yarra Bend Park Flying-fox Campsite: Review of Scientific Research	DSE (2009)
Yarra Flats Park – Park Note	Parks Victoria (2011c)
Yarra Valley Parklands management plan	Parks Victoria (2008)

## 5.4.2 Desktop assessment

### Ecological databases

A desktop assessment was undertaken to provide an account of the ecological values previously recorded or modelled to occur within the project boundary. The following databases, which are mostly curated by the Australian and Victorian governments, were accessed:

- Commonwealth EPBC Act Protected Matters Search Tool (PMST) to identify the potential occurrence of MNES
- Commonwealth Atlas of Living Australia (ALA) to capture any records not contained by the Victorian Biodiversity Atlas
- Victorian Biodiversity Atlas (VBA) administered by the Department of Environment, Land, Water and Planning (DELWP)
- Birddata - The New Atlas database (1998 – present) administered by Birdlife Australia (BLA)
- e-Bird data (<[www.ebird.org](http://www.ebird.org)>), administered by Audubon and Cornell Lab of Ornithology, USA
- NatureKit administered by DELWP
- DELWP's Native Vegetation Information Management (NVIM) tool
- DELWP's Planning Schemes online
- DELWP's MapShare - Victorian Wetland Inventory available at: <<https://www.data.vic.gov.au/data/dataset/victorian-wetland-inventory-current>>
- Groundwater Dependent Ecosystems (GDE) Atlas by the Bureau of Meteorology (BOM) (BOM, 2018)
- Potential Groundwater Dependent Ecosystem (GDE) Mapping for the Port Phillip and Westernport Catchment Management Authority (CMA) (DELWP, 2018)
- PlatypusSpot administered by CESAR
- EPA Victoria's Rapid Bioassessment (RBA) of waterways monitoring
- Aerial photographs and topographic maps.

The review of the VBA database and PMST both included a five-kilometre buffer around the North East Link project boundary. This approach has been adopted to provide a clearer picture of those species recorded within the project boundary and those found within the vicinity. The buffer was used to account for the potential lack of historic survey effort in the project boundary.

For aquatic species, the VBA database and PMST search was also conducted on the entire Yarra River catchment of waterways that intercept the North East Link project boundary, with a one-kilometre buffer from streams. This approach considers the requirement for diadromous fish species to migrate between freshwater and marine habitats for breeding. This process considers the possibility that records of occurrence may be outside the five-kilometre buffer, but the passage through the project boundary is a life cycle requirement. Records outside the five-kilometre buffer that are not diadromous species were not considered further.

The Birdlife Australia (BLA) database search was conducted for a polygon area that incorporates the project boundary, rather than for a five-kilometre buffer on the project boundary itself. This means that larger numbers of records of some bird species were obtained from BLA than from the VBA, and that a portion of those records are relatively distant from the project boundary. The BLA database search was limited to records of threatened species.

Not all locations of records in the VBA are precise; the actual accuracy of a record can range from  $\pm 1$  metre to  $\pm 500$  metres. The VBA was last updated on 3 March 2018 and data were last accessed on 29 March 2018. The validity of records accepted by the VBA has not been assessed as part of this report. Many records within the VBA are also attributed to the same coordinate. For instance, a botanist may have recorded several species of flora at the same location.

#### 5.4.3 Likelihood of occurrence assessment

A likelihood of species and ecological communities' occurrence assessment was completed for each threatened or migratory species and each threatened community identified in the desktop assessment as either occurring, or having the potential to occur, within five kilometres of the project boundary.

For threatened and migratory species, the likelihood assessment was used to determine the likelihood of each species' presence within the project boundary based on the results of the habitat assessment, and the dates and number of previous records of each species. The complete likelihood assessment for species is presented in Appendix B (flora), Appendix D (fauna) and Appendix E (migratory fauna). The following likelihood categories were used to rate each species' likelihood of occurrence:

- **Low** (= unlikely) – Preferred habitat absent from the project boundary, or if present, is limited in extent and quality. Generally, the species is unlikely to be present in the project boundary at any time or season. In the case of fauna, the species may infrequently visit for foraging but would not reside, roost or breed in, or otherwise depend on habitat in the project boundary for their survival.
- **Moderate** – Habitat is available in the project boundary, which partially meets the requirements of the species. In the case of fauna, the species may regularly visit the habitat.
- **High** – Species has been recorded in the project boundary (or within very close proximity) within the past 30 years. The project boundary contains habitat that meets the species' habitat requirements and is likely to support a population of the species.
- **Present** – (limited to flora only). Species confirmed to be present within the project boundary either through direct observation of the species or recent records in the VBA output or other reliable source). Species is likely to be present at appropriate times of the year.

This process was used to short-list species that have potential to be impacted by North East Link.

#### 5.4.4 Field assessment – overview

Extensive field assessments were conducted over seven periods in winter 2017, spring 2017, summer 2017/2018, autumn 2018, winter 2018, spring 2018 and summer 2018/2019 by up to four ecologists for flora, two ecologists for fauna, and two aquatic ecologists for the aquatic ecology assessment. Field assessments aimed to collect comprehensive information about the ecological values present or potentially present within the project boundary. Separate field surveys were undertaken for flora, terrestrial fauna, and aquatic fauna. Total field survey effort is outlined in Table 10.

Table 10 Field survey effort

Survey period by discipline	Total survey effort	Notes
<b>Flora</b>		
Spring flora assessments 2017, 16 October – 7 December 2017	34 person days	General mapping of native vegetation, scattered indigenous trees and threatened flora targeted survey (where appropriate).
Summer flora assessments 2018, 19 February – 27 February 2018	19 person days	Additional mapping of native vegetation including large trees in patches and wetland mapping.
Autumn flora assessments 2018, 14 May – 16 May 2018	12 person days	Following access granted by City of Boroondara.
Winter flora assessment 2018, 4 June – 28 August 2018	26 person days	Mapping large trees in patches, mapping large trees at risk of groundwater drawdown, targeted survey for threatened species, and survey of other minor areas with previous access constraints.
Spring flora assessment 2018, 19 October – 20 November 2018	14 person days	Vegetation mapping, targeted threatened species surveys
Summer flora assessment 2018, 3 December – 7 December 2018	6 person days	Targeted threatened species surveys
<b>Terrestrial fauna</b>		
High-level field assessment (Phase 1), 25–26 May 2017	2 days; 1 person	Overview and habitat assessment
Habitat assessments (Phases 2 and 3), 4 July 2017, 17–18 July 2017	3 days; 1 person	Habitat assessment
Targeted surveys (spring/summer), 31 October – 15 November 2017	8 days, 8 nights; 2 people	Surveys of wetland areas for Growling Grass Frog <i>Litoria raniformis</i> and other fauna active in warmer seasons
Targeted surveys (autumn) (19 April – 17 May 2018)	5 days, 5 nights; 2 people	Surveys of wetland and forested areas for Brown Toadlet <i>Pseudophryne bibronii</i> , Southern Toadlet <i>Pseudophryne semimarmorata</i> and Powerful Owl <i>Ninox strenua</i>
Targeted surveys (spring/summer) (3–14 December 2018)	3 days; 2 people	Surveys of dense grassy vegetation surrounding wetlands and billabongs for Glossy Grass Skink <i>Pseudemoia rawlinsoni</i>
<b>Aquatic ecology</b>		
Preliminary habitat assessment 10–17 July 2017	2 days (2 people)	Habitat Assessment to identify high level aquatic ecology values
Spring waterway surveys 2017, 23 October – 10 November 2017	7 survey days, 4 netting nights (2 people)	Fish surveys, including targeted surveys
Autumn waterway and wetland surveys 2018, 20 March – 4 June 2018	15 survey days, 7 netting nights (2 people)	Rapid Bioassessment of aquatic ecosystems and fish surveys, including targeted surveys.

#### 5.4.5 Field assessment – flora and vegetation

The field assessments incorporated the following:

- Native vegetation patch and scattered tree mapping and Vegetation Quality Assessments (VQA) under the *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP, 2017a)
- Habitat assessment to determine the likelihood of the project boundary to support threatened flora species
- Threatened ecological community assessments
- Mapping of incidental records of rare or threatened flora
- Assessments of the presence of rare or threatened trees.

These were collected as per protocols of FFG Act permit (No. 10008049/10008653) for the collection of protected flora for identification purposes.

Nomenclature used throughout the report in relation to flora species follows the Victorian Biodiversity Atlas.

Further details of these assessments are provided in the sub-sections below.

##### **Native vegetation mapping and quality assessment**

Native vegetation was mapped throughout the project boundary according to the Guidelines. Under the Guidelines, native vegetation is considered to be either a patch or a scattered tree, where:

A patch of native vegetation is defined as:

*...an area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native, or 'an area with three or more native canopy trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy.. (DELWP, 2017a, pg 6).*

A scattered tree is defined as 'a native canopy tree that does not form part of a patch' (DELWP, 2017a, pg 6).

The location of patches and scattered trees was mapped using ArcGIS Collector mobile app or handheld mapping units (tablet), which have a spatial accuracy of approximately five metres (dependent on access to satellites).

All patches of native vegetation were also subjected to a vegetation quality assessment using the habitat hectares (Hha) method as described by DSE (2004).

Determination of the Diameter at Breast Height (DBH) threshold for large scattered trees was conducted by overlaying the pre-1750 (pre-European settlement) EVC layer available from DELWP over the locations of scattered trees. The corresponding EVC benchmark was used to allocate DBH thresholds. As per the Guidelines (DELWP, 2017a), circumference should be provided when determining large trees but DBH was used in this instance as the available EVC benchmarks still list DBH thresholds. These values were later converted to circumference for submission to DELWP for the development of the NVR report.

## Warringal Parklands and Banyule Flats

During the current assessment, only high level EVC ground-truthing and assessment of vegetation against the condition thresholds for the EPBC Act-listed ecological community, *Seasonal Herbaceous Wetlands of the Temperate Lowland Plains* (TSSC, 2012), was conducted for the Warringal Parklands and Banyule Flats. Practical Ecology (2017b) had already conducted a detailed investigation of the sites and surface impacts are not anticipated in this section of the project boundary. In this case, the current study relied upon the comprehensive ecological investigation undertaken by Practical Ecology (2017b) to inform the values in this area.

## Planted vegetation/Amenity plantings

Under Clause 52.17 of the Victorian Planning Provisions, a permit is required to remove, destroy or lop native vegetation. However, in some instances outlined in Clause 52.17-1, a permit is not required. Of particular relevance is the exemption relating to Planted Vegetation contained in the table to Clause 52.17-7, which specifically states:

*Native vegetation that is to be removed, destroyed or lopped that was either planted or grown as a result of direct seeding. This exemption does not apply to native vegetation planted or managed with public funding for the purposes of land protection or enhancing biodiversity unless the removal, destruction or lopping of the native vegetation is in accordance with written permission of the agency (or its successor) that provided the funding.*

Exceptions to this apply when vegetation lies within an ESO, SLO or VPO. In these cases, planned removal of vegetation may require a permit under the *Planning and Environment Act 1987* (Vic).

Furthermore, in section 2.22 of the the guidance document, *Exemptions from requiring a planning permit to remove, destroy or lop native vegetation* (DELWP, 2017b), the following guidance is provided by DELWP:

*This exemption does not apply to native vegetation planted or grown with public funding for the **primary** purposes of enhancing biodiversity or protection of land, unless the funding agency (or its successor) provides written agreement to the landholder to remove the native vegetation.*

*Biodiversity purposes include improving rare and threatened species habitat, improving the condition or extent of native vegetation or improving the functioning of an ecosystem and its delivery of ecosystem services. **It does not include planting that may have biodiversity benefits, but that the main purpose of the planting was amenity, such as along a road.***

*Land protection purposes include managing salinity and erosion, or improving the quality of land or water resources. It does not include planting that may have an erosion management function, but that the main purpose of the planting was amenity, such as along a road.*

*Public funding includes money provided by any level of government or public authority. It may then be passed on to another organisation or authority to administer, or to provide in grants to third parties.*

Within the project boundary, there are numerous occurrences of revegetation or plantings on public land, which are assumed to have been planted with public money. These plantings comprise two main categories:

1. **Patches of native vegetation.** Structurally diverse revegetation using a mix of locally indigenous species representative of an EVC that would have formerly occupied the site prior to clearing following European settlement. These areas are **not exempt** from the requirement to obtain a planning permit under Clause 52.17-7, as they are likely to have been planted or managed with public funding for the primary purpose of land protection or enhancing biodiversity, such as revegetation along the Koonung Creek corridor, which has been designed to improve the condition/extent of native vegetation and improve the function of the ecosystem and its delivery of ecosystem services. Consequently, such areas are regarded as patches of native vegetation and are assessed in the same manner as patches of naturally occurring native vegetation elsewhere within the project boundary.
2. **Amenity plantings.**
  - i) Plantings in patches or as isolated trees comprising species native to Victoria or Australia but planted in a manner/context that clearly indicates the primary purpose is for visual amenity purposes, rather than land protection or enhancing biodiversity. Examples include: a) isolated trees, b) evenly spaced rows of trees, c) roadside artificial embankment plantings (such as along Eastern Freeway), and d) parkland garden bed plantings with some structural diversity (such as eucalypt species, over 1-2 shrub species, with a few robust groundcover species). While these plantings may have some biodiversity benefits, if the main purpose of the planting appeared to be for amenity purposes, then they were classified as **exempt** from the requirement to obtain a planning permit under Clause 52.17-7. Where these patches of vegetation clearly meet the exemption requirements, they have been mapped within this report as amenity plantings.
  - ii) Planting in patches comprising non-native species. These areas are **exempt** from the requirement to obtain a planning permit under Clause 52.17-7.

It should be noted that numerous planted scattered native trees occur within the project boundary, particularly within parklands, recreation reserves and along roadsides. For reasons outlined above, these trees are generally exempt from the requirement to obtain a planning permit under Clause 52.17-7. However, in instances where scattered indigenous canopy trees occurred in largely modified landscapes (such as parklands) in a mosaic of planted native vegetation, but the trees were large enough to be considered potentially remnant or naturally occurring, then these trees were assessed and mapped as scattered native trees and consequently require approval prior to removal.

### Habitat assessment

The suitability of the land within the project boundary to support threatened flora species was assessed, primarily through the consideration of habitats occurring within the project boundary, the condition of these habitats, and historic records of significant species. This information was used as part of the likelihood assessment of the presence of threatened species.

## Recording of declared weeds

Declared weeds are those listed by the CaLP Act or Weeds of National Significance (WoNS<sup>5</sup>). All weed species that were observed during the vegetation assessments and targeted surveys were noted. Due to the extensive presence of these species across the site, locations were not collected. A summary of declared weeds observed within the project investigation area is provided in Table 6 in Section 4.3.7.

### 5.4.6 Targeted surveys – EPBC Act-listed flora

Following the desktop review and initial site investigations, targeted surveys were conducted for EPBC Act-listed threatened flora deemed to have a moderate to high likelihood of occurrence within the project boundary. These included:

- Matted Flax-lily *Dianella amoena* (Endangered)
- Clover Glycine *Glycine latrobeana* (Vulnerable)
- River Swamp Wallaby-grass *Amphibromus fluitans* (Vulnerable)
- Green-striped Greenhood *Pterostylis chlorogramma* (Vulnerable).

Further information on the assessment for each of the above-mentioned species/communities is presented below.

#### Matted Flax-lily *Dianella amoena* and Clover Glycine *Glycine latrobeana*

Flora surveys for Matted Flax-lily and Clover Glycine adhered to the following protocol:

- Surveys were undertaken when plants were known to be in flower where possible.
- Surveys commenced at Simpson Barracks on 26 October 2017 when Matted Flax-lily was initially identified. A follow-up survey was undertaken on 2 November 2017 near the end of the Clover Glycine flowering season and while Matted Flax-lily was in bud (prior to flowering) and a final survey was undertaken on 21 November 2017 after Matted Flax-lily had commenced flowering and was consequently more visible. Surveys were undertaken at the Hurstbridge rail line and the M80 Ring Road interchange on 24 October 2017 and again on 6 December 2017 to confirm presence and assess abundance.
- Where plants of either species were positively identified, sites were visited twice (Simpson Barracks, Hurstbridge rail line and M80 Ring Road Interchange).
- Surveys for Matted Flax-lily were undertaken in accordance with the timing and survey guidelines outlined in the DoEE Species Profile and Threats (SPRAT) Database (November to February<sup>6</sup>). Surveys for Clover Glycine were undertaken in accordance with the flowering time of the species provided in VicFlora<sup>7</sup> (September to December) and the survey guidelines outlined in the DoEE Species Profile and Threats (SPRAT) Database.
- Targeted survey effort was directed at potential native grassland and grassy woodland habitat, particularly better quality patches with low to moderate weed cover.
- Survey teams were led by botanists/ecologists familiar with the target species.
- Teams of a minimum two ecologists slowly walked transects at 5-metre intervals (as stipulated for Matted Flax-lily in the Melbourne Strategic Assessment (Carter, 2010), in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

<sup>5</sup> <<http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html>>

<sup>6</sup> <[http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=64886](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64886)>

<sup>7</sup> <[https://vicflora.rbg.vic.gov.au/flora/search?q=Glycine latrobeana](https://vicflora.rbg.vic.gov.au/flora/search?q=Glycine+latrobeana)>

- Where individuals were observed, the species was recorded, along with number of individuals and/or patch size, and the location of the plant/patch was mapped. Additional searching effort then occurred in concentric circles out from the initially identified individual until no further individuals were observed within a 10-metre radius from the initially identified plant.
- It should be noted that it is almost impossible (except with molecular techniques) to accurately determine population size for Matted Flax-lily, owing to its mat-forming habit, which can comprise anything from dense patches to sparsely distributed tufts of leaves. Therefore, this report describes the occurrence of this species as discrete individual plants or patches separated by a gap of at least 1 metre between visible tufts of leaves. The use of this criterion implies that each plant/patch contains at least one plant but possibly more, and that where tufts are at least 1 metre apart, they are regarded as separate plants.

### **River Swamp Wallaby-grass *Amphibromus fluitans***

No specific survey guidelines are outlined for River Swamp Wallaby-grass in the DoEE Species Profile and Threats (SPRAT) Database<sup>8</sup>. Consequently, flora surveys for the species adhered to the following protocol:

- Surveys were undertaken during the flowering/fruiting season for the species (November to March) when plants were known to be in flower in areas where the species had been previously recorded within or adjacent to the project boundary.
- Surveys were undertaken in potentially suitable habitat at Trinity Grammar School Sporting Complex wetlands A, B, C and D (as defined by Australian Ecosystems 2007) on 3 December 2018 (wetlands A and B within the project boundary, wetlands C and D outside the project boundary). Surveys were also conducted in suitable habitat at Bolin Bolin Billabong, Banyule Swamp and Banyule Flats on 6 December 2018.
- Targeted survey effort was directed at potential wetland and billabong habitat, including permanent and ephemeral wetlands, both within and outside the project boundary. Wetlands outside the project boundary were selected to be surveyed based on the presence of historical records between 1995 and 2011, proximity to the boundary, and the potential for groundwater drawdown associated with tunnelling to adversely affect the species in these areas.
- Survey teams were led by botanists familiar with the target species.
- Teams of two botanists slowly walked transects at 5-metre intervals, in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

### **Green-striped Greenhood *Pterostylis chlorogramma***

Flora surveys for Green-striped Greenhood considered the *Survey Guidelines for Australia's Threatened Orchids* (Commonwealth of Australia 2013) and adhered to the following protocol:

- Survey was undertaken in the middle of the known flowering season for the species (ie July to September; Commonwealth of Australia 2013) on 26 August 2018; however, a flowering reference population was not visited.
- Targeted survey effort was directed toward moist areas of heathy and shrubby forest habitat, in the northern portion of the project boundary (near where the species had previously been recorded in the local area).

<sup>8</sup> [http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon\\_id=19215](http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=19215)

- The survey team was led by a botanist familiar with the species.
- A team of two ecologists slowly walked transects at 5-metre intervals (as recommended by Commonwealth of Australia 2013), in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

#### 5.4.7 Targeted surveys – EPBC Act-listed ecological communities

Following the desktop review and initial site investigations, targeted surveys were conducted for EPBC Act-listed ecological communities deemed to have a moderate to high likelihood of occurrence within the project boundary. These included:

- Grassy Eucalypt Woodland of the Victorian Volcanic Plain
- Seasonal Herbaceous Wetland of the Temperate Lowland Plains.

Further information on the assessment for each of the above-mentioned species/communities is presented below.

##### **Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP)**

Targeted survey for the threatened ecological community, Grassy Eucalypt Woodland of the Victorian Volcanic Plain (GEWVVP) was completed at sites within the Victorian Volcanic Plain bioregion that contained Plains Grassy Woodland. An assessment was also completed at Simpson Barracks but it was determined not to occur at the site because the underlying geology is Silurian sediments, rather than cracking clays derived from basalt, as stipulated in DSEWPaC (2011).

Only one site was considered to support the listed community – the MAB Corporation Offset Site, Enterprise Drive, Bundoora. As this site was designated as a no-go zone as shown in Figure 2 in Section 3.5, no further assessments were completed.

##### **Seasonal Herbaceous Wetlands of the Temperate Lowland Plains**

Surveys for Seasonal Herbaceous Wetlands were undertaken in accordance with *Approved Conservation Advice for the Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains* (TSSC, 2012), which generally followed the following protocol:

- Surveys were undertaken within the recommended period of spring to early summer, with one day completed on 19 December 2017 by two ecologists (one aquatic and one terrestrial)
- Vegetation assessed was an area within Banyule Flats and Warringal Parklands, but was not an extensive assessment of all vegetation in this area
- Surveys followed the key diagnostic criteria and description according to TSSC (2012)
- An overall assessment was undertaken of the wetland areas and surrounding landscape
- Where a patch was considered as having the potential to contain Seasonal Herbaceous Wetlands a detailed assessment was undertaken including identification of native vegetation.

The EVCs listed in Table 11 were identified as most likely to correspond to the Seasonal Herbaceous Wetland community and therefore were targeted during assessment where present.

Table 11 Victorian EVCs most likely to correspond to Seasonal Herbaceous Wetlands

EVC number and name	Notes
125 Plains Grassy Wetland + complexes	Complexes may include EVCs 755, 767, 959, 960
306 Aquatic Grassy Wetland	-
647 Plains Sedgy Wetland	-
678 Ephemeral Drainage-line Grassy Wetland	In gilgai systems along poorly defined drainage lines within natural temperate grassland
778 Gilgai Wetland	In gilgai systems along poorly defined drainage lines within natural temperate grassland
920 Sweet Grass Wetland	-
956 Herb-rich Gilgai Wetland	-

#### 5.4.8 Targeted surveys – FFG Act and DELWP Advisory listed flora

Other threatened flora (that is, FFG Act-listed flora and DELWP Advisory-listed flora with a classification of vulnerable or endangered) were assessed as having a moderate to high likelihood of occurrence within the study area; and targeted surveys were conducted for these species. These species included:

- Silurian Striped Greenhood *Pterostylis* sp. aff. *striata* (Silurian) (endangered)
- Short Water-starwort *Callitriche brachycarpa* (vulnerable).

Other threatened flora were assessed as having a moderate to high likelihood of occurrence within the study area but specific targeted surveys were not conducted for these species as it was determined that either sufficient survey effort had previously been conducted and the data were available, and/or the species survey could be conducted as part of general vegetation assessments and during flowering season (for orchids). These species included:

- Melbourne Yellow Gum *Eucalyptus leucoxylon* subsp. *connata*
- Studley Park Gum *Eucalyptus Xstudleyensis*
- Arching Flax-lily *Dianella longifolia* var. *grandis*
- Austral Crane's-bill *Geranium solanderi* var. *solanderi*
- Charming Spider-orchid *Caladenia amoena*
- Wine-lipped Spider-orchid *Caladenia oenochila*.

Further rationale on the survey effort for these species is presented below:

#### **Melbourne Yellow Gum *Eucalyptus leucoxylon* subsp. *connata***

Targeted surveys were not undertaken specifically for this species as it was determined the species is easily observable and could be surveyed as part of general vegetation assessments.

### **Studley Park Gum *Eucalyptus Xstudleyensis***

Targeted surveys were not undertaken specifically for this species as it was determined the species could be surveyed as part of general vegetation assessments. However, known locations were mapped at Simpson Barracks and Watsonia Station during the general vegetation assessment, and also during the large tree assessment as part of the assessment of potential impacts associated with groundwater drawdown. Only the presence of individuals that qualify as large trees within patches were mapped, owing to difficulties with accurately classifying younger trees. To supplement this, a number of reports were reviewed (notably Cameron *et al.* 1999) relating to studies that had been previously conducted in Simpson Barracks where the majority of records within the region had been found.

After discussions with DELWP, NELP has committed to undertaking further field surveys to better understand the prevalence of the species at Simpson Barracks and to estimate the number of Studley Park Gum potentially impacted by the project.

### **Arching Flax-lily *Dianella longifolia* var. *grandis***

Targeted surveys were not undertaken specifically for this species, as it was surveyed as part of the general vegetation assessment. During field assessments, field teams were aware of the potential presence of this readily observable species, and any observations were mapped.

### **Austral Crane's-bill *Geranium solanderi* var. *solanderi***

Targeted surveys were not undertaken specifically for this species, as it was surveyed as part of the general vegetation assessment.

### **Orchids**

Targeted surveys were not undertaken for Charming Spider-orchid and Wine-lipped Spider-orchid, as it was determined that field investigations were being conducted at a time when these species were observable. During field assessments, field teams were aware of the potential presence of these species. Timing of surveys across the majority of the project boundary generally overlapped with the flowering periods of each of these species. However, since orchids undergo periods of dormancy over one or more years, or may appear as non-reproductive plants (in leaf only) in some years, it is possible that species may have been undetectable at the time field work was conducted.

### **16 rare species**

Targeted surveys were not undertaken specifically for the 16 rare species initially identified as having a moderate to high likelihood of occurring within the project boundary, which are listed at Appendix B, based on the presence of potentially suitable habitat. Specific targeted surveys were not conducted for these species as it was determined that either: a) the species was a tree or shrub that would be clearly visible during general vegetation assessments in any season, and/or b) the species could be surveyed as part of general vegetation assessments. In addition, there is no legislative driver for targeted survey of rare species, given they are not listed under the EPBC or FFG Acts. Furthermore, the DELWP-generated NVR report for the project indicated that no rare flora exceeded the 0.05% modelled habitat threshold in the state for which species offsets would apply, and consequently, impacts upon unrecorded rare species are regarded as unlikely.

#### 5.4.9 Field assessment – fauna

For the fauna assessment, high priority locations to assess were identified prior to the site visit, using aerial imagery and locations of historical threatened fauna records (VBA). Native and non-native vegetation (including planted trees and other vegetation) were considered as potential fauna habitat. All areas assessed were visited during daylight hours, and some areas assessed for nocturnal fauna were also assessed at night.

The assessment was limited to publicly accessible land, and privately owned land where permission had been granted. Private land was not entered if no permission had been granted. At a few locations where the identified location (such as a dam or habitat patch) was on private land but near to public access, 'over the fence' assessment was possible to some degree, but the limitations in this are acknowledged.

At most locations, assessment was made on foot by walking into the areas considered likely to support the highest-quality and representative habitat (judgement based on aerial imagery and prior field experience). Zoologists remained adaptable in the field, and opportunistically included other nearby areas in the investigation if those areas were thought to provide higher quality habitat or help provide information on fauna that might use the project boundary. Photographs were taken at locations as a record of the habitats encountered.

Observations of threatened species were recorded at locations if seen/heard, but observations of common fauna were not recorded because abundant information on those species exists for the project boundary already, and additional records are unlikely to alter the prevailing understanding of the distribution and habitat use by those species.

Given the mobility of fauna, and the low likelihood of encountering most rare and threatened species during any given site visit, the approach adopted was to assess the condition and landscape context (including patch size and connectivity) of habitat patches that were considered most likely to attract or support threatened and migratory fauna, rather than searching for the species themselves. That said, the list of potentially relevant threatened species for each location was evaluated prior to the site visit and the potential presence of those species was considered in particular at specific sites.

Woodland/forested habitat were assessed qualitatively for the following attributes:

- Canopy trees (present/absent; density; native/non-native; large, medium or small; remnant, planted or regrowth; hollows present/absent)
- Mid-storey/shrub layer (present/absent; native/non-native; remnant, planted or regrowth)
- Understorey (present/absent; native/non-native; weediness; density (with a view to providing cover for small fauna); whether subject to weed management or revegetation efforts), and presence of litter and coarse woody debris
- Landscape context (patch size; connectivity and proximity to other patches; land management regime).

Grassland habitats were assessed qualitatively for the following attributes:

- Whether derived/natural; native/non-native; structure (whether grassland provided cover for small native fauna); apparent disturbance levels; presence/absence of trees and shrubs, and if present, density; native/non-native; large, medium or small trees and shrubs; remnant, planted or regrowth
- Landscape context (grassland patch size; connectivity and proximity to other patches; land management regime).

Waterbody and waterway habitats (in the context of threatened terrestrial fauna such as waterbirds and frogs, not aquatic fauna such as fish or turtles) were assessed qualitatively for the following attributes relevant to terrestrial fauna:

- Whether margins were vegetated; whether there was open or flowing water; apparent disturbance levels; landscape context and setting (whether in recreational area, proximity to highly-frequented public area)
- Landscape context (connectivity and proximity to other waterways/waterbodies).

Visited locations were evaluated in terms of their potential value (high, moderate, low) to native fauna, particularly threatened fauna species.

The field surveys were conducted in accordance with the following permits and approvals:

- Wildlife Act Research Permit 10008401
- Animal Research Authority issued by the accredited GHD Animal Ethics Committee Scientific Procedures Fieldwork Licence GHD SPFL20067.

#### 5.4.10 Targeted surveys – fauna

Following the general field assessment for all fauna, targeted surveys were undertaken at areas considered most likely to contain certain threatened species. Targeted surveys were conducted for three frog species (Growling Grass Frog *Litoria raniformis*, Brown Toadlet *Pseudophryne bibroni* and Southern Toadlet *P. semimarmorata*), one reptile species (Glossy Grass Skink *Pseudemoia rawlinsoni*) and two owl species (Powerful Owl *Ninox strenua* and Barking Owl *N. connivens*).

Targeted surveys were not undertaken for some threatened species that are known or likely to occur across the Melbourne area, because the result was unlikely to alter the conclusion drawn. For example, the Grey-headed Flying-fox *Pteropus poliocephalus* is well-known to have a large roosting and breeding colony at Yarra Bend Park along the Yarra River, downstream of the Eastern Freeway, and to disperse widely from the colony to forage in flowering and fruiting trees and shrubs (planted and remnant) throughout the majority of Melbourne's suburbs.

Therefore, presence of this species throughout the project boundary is presumed, without the need for targeted surveys. Contrastingly, targeted surveys for Swift Parrot *Lathamus discolor* were not conducted, because the likelihood of detecting the species was considered low, yet drawing a subsequent conclusion of absence from non-detection would have been misleading. Typically, small numbers of this species fly through the Melbourne area each year on their northerly and southerly migrations, and may visit any suitable habitat *en route*.

Therefore, assessment for this species was done by habitat assessment, with occasional presence presumed in all appropriate habitat.

See sections below for survey rationale for each species of highest concern in the project boundary.

#### **Growling Grass Frog *Litoria raniformis***

Growling Grass Frog habitat assessments were conducted in the field at locations determined through review of threatened species' record data (VBA) and considering the presence of potentially suitable habitat occurring within the project boundary, based on preliminary field surveys, aerial imagery and modelled information.

Each location was visited during daylight hours to determine the habitat suitability of the waterway or waterbody for the Growling Grass Frog. The assessment took into account the following attributes:

- Presence of surface water
- Presence of emergent and fringing vegetation
- Shading
- The known or likely presence of fish
- Water quality
- Bank suitability (such as steep or shallow)
- Potential for high flows
- Level of degradation
- Landscape context of waterbody (isolation/connection to other waterways/waterbodies).

Between 31 October and 15 November 2017, two zoologists completed between one and three rounds of targeted frog surveys at each site where habitat was deemed suitable, in accordance with EPBC survey guidelines for this species (DEWHA, 2010b). Sites deemed to not currently provide suitable habitat were not included further in the targeted surveys (some sites deemed to not currently provide suitable habitat were still surveyed at night on one occasion following the habitat assessment, simply because the ecologists were already at the site at the right time of day and under the right conditions). The survey timing was chosen to target the peak activity period of the Growling Grass Frog (November-December), and to follow survey guidelines for the species (DEWHA, 2010b). While all habitat assessments were conducted during daylight hours, all monitoring for the frogs themselves was conducted at night, because frog activity is most likely to be detected at night.

Nocturnal frog surveys targeting suitable weather conditions were undertaken at six sites as listed in Table 12 below: Simpson Barracks, Koonung Creek, Bolin Bolin Billabong, Plenty River, Merri Creek, Kew Golf Course. The protocol used at each site was:

- An initial quiet listening period (up to five minutes) was undertaken from the edge of the waterway/waterbody to detect calling of frogs.
- Playback of pre-recorded advertisement calls of Growling Grass Frog was undertaken for two to three minutes, in an attempt to elicit responses from frogs that may be present but not calling spontaneously.
- The number of frogs calling for each species was estimated using the following abundance categories 0, 1-5, 11-20, 21-50, 51+.
- A visual inspection of part or all of the site (generally focusing on the most suitable habitat, as determined during the daytime visit) was undertaken following playback, using strong head torches to scan the water's surface, aquatic and bank-side vegetation for resting/perching frogs. Searches at each site lasted for up to 40 minutes with the duration influenced by the size of the waterbody, frog activity at the site, and habitat suitability for Growling Grass Frog.

Frog surveys are best undertaken during warm, humid and windless conditions, and surveys were timed to encounter appropriate conditions and EPBC survey guidelines (DEWHA, 2010b) as much as possible. On some evenings, temperatures were below the threshold indicated in DEWHA (2010b) (night time air temperatures to be greater than 12 degrees celsius), but this was not deemed to influence the results. The temperatures were not greatly cooler than required, and other frogs were heard on those nights. At each site, weather conditions were recorded, including cloud cover (estimated %), wind speed and direction, rain at the time of survey, presence of moonlight, air temperature (°C) and relative humidity (%). Temperature, relative humidity, wind speed and direction were taken from nearest weather station to each site and accessed via <[www.eldersweather.com.au](http://www.eldersweather.com.au)>.

**Table 12** Locations visited for Growling Grass Frog surveys

Site	Species
Plenty River crossing	<ul style="list-style-type: none"> <li>• Growling Grass Frog</li> </ul>
Simpson Barracks	<ul style="list-style-type: none"> <li>• Growling Grass Frog</li> <li>• Glossy Grass Skink</li> </ul>
Bolin Bolin Billabong	<ul style="list-style-type: none"> <li>• Growling Grass Frog</li> <li>• Glossy Grass Skink</li> </ul>
Merri Creek	<ul style="list-style-type: none"> <li>• Growling Grass Frog</li> </ul>
Kew Golf Course	<ul style="list-style-type: none"> <li>• Growling Grass Frog</li> </ul>
Koonung Creek at various locations	<ul style="list-style-type: none"> <li>• Growling Grass Frog</li> <li>• Glossy Grass Skink</li> </ul>

#### **Brown Toadlet *Pseudophryne bibroni* and Southern Toadlet *P. semimarmorata***

Toadlet habitat assessments were conducted in the field at locations determined through review of threatened species' record data (VBA) and considering the presence of potentially suitable habitat occurring within the project boundary, based on preliminary field surveys, aerial imagery and modelled information.

Each location was visited during daylight hours to determine the habitat suitability of the location for toadlets. The assessment took into account the following attributes:

- Presence of surface water or dampness of gully/depression
- Presence of litter or equivalent ground cover suitable for toadlets
- Shading and tree cover
- Evidence of disturbance and/or degradation
- Landscape context of gully/waterbody (isolation/connection to other waterways/waterbodies).

Between 19 April and 4 June 2018, two zoologists completed two rounds of targeted frog surveys at sites where habitat was deemed potentially suitable for toadlets, listed in Table 13 below. The survey timing was chosen to target the peak activity period for toadlets (April to May). While all habitat assessments were conducted during daylight hours, all monitoring for the toadlets themselves was conducted at night, because frog activity is most likely to be detected at night.

Nocturnal surveys targeting suitable weather conditions were undertaken at 10 sites with the following protocol for each site:

- An initial quiet listening period (up to five minutes) was undertaken from the edge of the waterway/waterbody to detect calling of toadlets.
- Playback of pre-recorded advertisement calls of Brown Toadlet was undertaken for two to three minutes, in an attempt to elicit responses from toadlets that may be present but not calling spontaneously.
- The number of frogs or toadlets calling for each species was estimated using the following abundance categories 0, 1-5, 11-20, 21-50, 51+.
- Visual inspections of the site were undertaken briefly following playback, using strong head torches to search for resting/perching frogs/toadlets, acknowledging that toadlets are typically fossorial and unlikely to be detected visually.

Frog/toadlet surveys are best undertaken during warm, humid and windless conditions, and surveys were timed to encounter appropriate conditions as much as possible. At each site, weather conditions were recorded, including cloud cover (estimated %), wind speed and direction, rain at the time of survey, presence of moonlight, air temperature (°C) and relative humidity (%). Temperature, relative humidity, wind speed and direction were taken from nearest weather station to each site and accessed via <[www.eldersweather.com.au](http://www.eldersweather.com.au)>.

Table 13 Locations visited for Brown Toadlet and Southern Toadlet surveys

Terrestrial fauna	Fauna	Notes
Hillcrest Reserve, Donvale	Toadlets	Location is outside project alignment. Possible 'reference population' of Southern Toadlet
Willsmere Park	Toadlets	-
Kew Billabong	Toadlets	-
Kilby Reserve/Hays Paddock	Toadlets	-
Bolin Bolin Billabong	Toadlets	-
Boronia Grove Reserve	Toadlets	-
Simpson Barracks and Banyule Reserve	Toadlets	-
Yarra Flats – area south of Banksia Street	Toadlets	-
Woodland west of Freeway Public Golf Course	Toadlets	-
Alphington Park and Wetland	Toadlets	-
Banyule Creek	Toadlets	-

#### Powerful Owl *Ninox strenua* and Barking Owl *N. connivens*

Two threatened species of owl are documented to occur within the Melbourne area: Powerful Owl and Barking Owl. Of these, records of the Powerful Owl are far more common than records of the Barking Owl, which appears to occur rarely in the area, and more in larger patches of woodland in outer suburbs, rather than in the project boundary itself. Both owl species were considered here, but the Powerful Owl in particular is known to occur in well-treed areas in the inner suburbs of Melbourne, so was the main focus of the surveys.

During the October/November 2017 surveys for Growling Grass Frog, and during the autumn 2018 surveys for toadlets, two zoologists searched for owls and signs of owls at locations where habitat was deemed suitable. An evaluation of habitat suitability for owls was undertaken in the field at locations determined through review of threatened species' record data (VBA, BLA, e-Bird) and considering the presence of potentially suitable habitat occurring within the project boundary, based on preliminary field surveys, aerial imagery and modelled information. Each location was visited during daylight hours to determine the habitat suitability of the location for owls. The assessment took into account the following attributes:

- General tree size, particularly noting very large trees
- Presence of hollows, particularly very large hollows
- Suitability for high density/abundance of prey species (possums)
- Patch size and connectivity to other forest/woodland
- Level of disturbance (such as roads, golfers, walkers, dogs).

Searches were made for white wash and owl pellets around large trees

Habitat evaluation was conducted during daylight hours, and then spotlighting and call playback for owls was conducted at night, when owls are active.

Nocturnal surveys were undertaken at 10 sites which are listed in Table 14, with the following protocol for each location:

- Upon first arriving at the location, an initial quiet listening period (up to five minutes) was undertaken from the within the habitat patch to detect spontaneous calling by owls.
- A slow meander was then undertaken on foot through the potential owl habitat, using strong head torches/spotlights to search trees for movement and eye shine. Depending on the size of the habitat patch, searches lasted for up to 60 minutes at each location. Paths were followed where available, to reduce the likelihood of the observers being injured while spotlighting (such as by tripping, slipping, or being spiked or scratched by vegetation).
- During the wanderings, pre-recorded owl calls (mainly using Powerful Owl calls, but also including Barking Owl calls at some locations) were played periodically through a smart phone and loud-speaker, in an attempt to elicit responses from owls that may be nearby.

Presence of all nocturnal fauna was noted during the nocturnal site visits (including owls, frogmouths, frogs, possums, wallabies, kangaroos, flying-foxes).

Table 14 Locations visited for Powerful Owl and Barking Owl surveys

Site	Fauna	Notes
Hillcrest Reserve, Donvale	Owls	Location is outside project alignment. Possible 'reference population' of Powerful Owl
Kew Billabong	Owls	-
Bolin Bolin Billabong	Owls	-
Simpson Barracks and Banyule Reserve	Owls	-
Yarra Bend	Owls	-
Woodland west of Freeway Public Golf Course	Owls	-
Yarra Flats – area south of Banksia Street	Owls	-
Willsmere Park	Owls	-
Alphington Park and Wetland	Owls	-
Banyule Creek	Owls	-

#### Grey-headed Flying-fox *Pteropus poliocephalus*

Targeted surveys were not conducted for this species. This species is well-known to have a large roosting and breeding colony at Yarra Bend Park along the Yarra River, downstream of the Eastern Freeway, and to disperse widely from the colony to forage in flowering and fruiting trees and shrubs (planted and remnant) throughout the majority of Melbourne's suburbs. Presence of this species throughout the project boundary is therefore presumed.

On 16 November 2017, the Yarra Bend colony was visited by zoologists (accessed from Fairlea Reserve, Fairfield) to determine proximity of the project boundary to current roosting areas used by flying-foxes.

#### Swift Parrot *Lathamus discolor*

Targeted surveys were not conducted for this species. This species breeds in Tasmania only, and migrates to the mainland to forage during the winter months. Typically, small numbers of birds fly through the Melbourne area on their northerly and southerly migrations. Birds are reported sporadically in small numbers in Melbourne's northern and north-western suburbs in most years, where suitable eucalypts occur and flower at appropriate times of the year (VBA, BLA, e-Bird). Given that, the chance of detecting the species through targeted survey was considered low, yet drawing a subsequent conclusion of absence from non-detection would have been misleading. Therefore, assessment for this species was restricted to habitat assessment, with occasional presence presumed in appropriate habitat.

### **Australasian Bittern *Botaurus poiciloptilus***

Targeted surveys were not conducted for this species. This species is cryptic and difficult to detect. According to the desktop assessment (VBA, BLA and e-Bird records) and habitat assessments along the corridor, the most suitable habitat for this species is associated with the Yarra River and its associated floodplain in the Banyule/Bulleen area. These areas are proposed to be tunnelled, so would not be impacted directly by construction, and indirect impacts through groundwater changes are considered unlikely (refer to Section 12.2.7 for more information). The location where the Yarra River is crossed by the Eastern Freeway does not support habitats suitable for Australasian Bittern. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few historical records, suggests that those areas are very unlikely to support this species. Assessment for this species was restricted to habitat assessment and opportunistic observations.

### **Australian Painted Snipe *Rostratula australis***

Targeted surveys were not conducted for this species. According to the desktop assessment (VBA, BLA and e-Bird records) and habitat assessments along the corridor, the most suitable habitat for this species is in and around Banyule Swamp. This area is proposed to be tunnelled, so would not be impacted directly by North East Link's construction, and indirect impacts through groundwater changes are considered unlikely (refer to Section 12.2.7 for more information). There is potentially suitable habitat also at Bolin Bolin Billabong, although there are no historical records of the species in the VBA, BLA or e-Bird at that location. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few historical records, suggests that those areas are very unlikely to support this species. Assessment for this species was restricted to habitat assessment and opportunistic observations.

### **Latham's Snipe *Gallinago hardwickii***

Targeted surveys were not conducted for this species. This species is migratory, and is present in southern Australia only during the warmer months (August to March). According to the desktop assessment (VBA, BLA and e-Bird records) and habitat assessments along the corridor, the most suitable habitat for this species is associated with the Yarra River and its associated floodplain in the Banyule/Bulleen area. This area satisfies the criteria to be considered as 'important habitat' under section 8.3.3 of the EPBC Act. The project proposes to tunnel beneath these areas, so they would not be impacted directly by construction, and indirect impacts through groundwater changes are considered unlikely (refer to Section 12.2.7 for more information). The location where the Yarra River is crossed by the Eastern Freeway does not support habitats suitable for Latham's Snipe. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few historical records, suggests that those areas are very unlikely to support large enough numbers of birds (18 or more) to be considered important habitat (Commonwealth of Australia 2017). Assessment for this species was restricted to habitat assessment and opportunistic observations.

### ***Glossy Grass Skink Pseudemoia rawlinsoni***

Opportunistic searches for the Glossy Grass Skink were made at three locations during the daytime assessment of habitat for Growling Grass Frogs listed in Table 12 above. Sites considered were Simpson Barracks, Bolin Bolin Billabong and Koonung Creek at various locations. These locations were chosen on the basis of historical records of this species (VBA), and the presence of potentially suitable habitat based on preliminary field surveys and aerial imagery. The VBA and ALA both include only one record (the same record) of this species in the study area: 1991 Bolin Bolin Billabong.

In spring/summer of the following year, additional targeted searches were made. In suitable environmental conditions, searches for the Glossy Grass Skink were conducted at seven locations along the Yarra floodplain in December 2018. Sites were selected through review of threatened species' record data (VBA) and considering the presence of potentially suitable habitat occurring within or near the project boundary, based on preliminary field surveys, aerial imagery and modelled information.

Between 3 and 14 December 2018, two ecologists completed two rounds of targeted reptile searches at each site where habitat was deemed suitable. Sites deemed on the first visit to not currently provide suitable habitat were not visited a subsequent time.

At each site, the two observers used a slow active search method, where they walked slowly among the grassy habitat that was considered most likely to support Glossy Grass Skink. Attempts were made to get clear views of all skinks seen, and capture attempts were made where they were considered to have a reasonable chance of success.

Each location was visited during daylight hours to determine the suitability of the location for reptiles and to search for, and attempt capture of, *Pseudemoia*-like skinks. The assessment took into account the following attributes:

- Presence of long grass
- Proximity to nearest wetland or waterbody
- Presence of woody debris, such as sticks and rocks
- Presence of basking opportunities
- Shadiness (ie, canopy cover)
- Evidence of recent and older habitat disturbance.

Reptile surveys are best undertaken during warm, sunny and windless conditions, and surveys were timed to encounter appropriate conditions as much as possible. At each site, weather conditions were recorded, including cloud cover (estimated %), wind speed, rain at the time of survey, air temperature (°C).

#### 5.4.11 Field assessment – aquatic ecology

##### **Preliminary habitat assessment**

For the aquatic ecology assessment, high priority waterway and wetland locations were identified prior to the site visit. These were based on the location of proposed waterway crossings involving construction works, or a sequence of waterway sites alongside the project boundary. These waterways and wetlands are shown in the schematic map in Figure 4 further below in this section. All areas selected for assessment were visited to inspect instream habitat quality, to prioritise sites with aquatic ecosystems that could support threatened species or significant aquatic ecosystem values. The aquatic species considered included fish, turtles and aquatic mammals, but did not include amphibians or birds.

Given the mobility and cryptic nature of aquatic fauna, the approach adopted was to assess the condition and connectivity of aquatic habitat that were considered most likely to attract or support threatened fauna. Based on this preliminary assessment, the list of potentially relevant threatened species for each location was evaluated prior to the site visit and the potential presence of those species was considered at each site visited.

The assessment was limited to publicly accessible waterways, and privately owned land where permission had been granted. Private land containing wetland habitat that was not assessed for aquatic ecology values in the field included Kew Golf Course, which contains two waterbodies (Simpsons Lake and adjacent billabong). Given the use of Simpsons Lake for irrigation, disconnection from waterways (except during overbank flooding events), a high level assessment of this site using aerial imagery and existing desktop information indicated low risk to aquatic ecology values likely to be present.

Photographs were taken at locations as a record of the habitats encountered.

Visited locations were evaluated in terms of their potential value (high, moderate, low) to native aquatic fauna, particularly threatened species.

The field surveys were conducted in accordance with the following permits and approvals:

- *Wildlife Act 1975* Research Permit 10008401
- *Fisheries Act 1995* General Research Permit 1096
- *Flora and Fauna Act 1988* (FFG Act) Research Permit/Permit to Take/Keep Protected Fish Permit 10007730FFG
- Animal Research Authority issued by the accredited GHD Animal Ethics Committee Scientific Procedures Fieldwork Licence GHD SPFL20067.



**Figure 4 Schematic map of high priority waterways and wetlands considered in and adjacent to the project boundary**

## Rapid Bioassessment

The existing aquatic ecosystem condition of waterways was assessed using the EPA Victoria standard Rapid Bioassessment (RBA) method (EPA Victoria, 2003). This method uses aquatic macroinvertebrates as an indicator of aquatic ecosystem condition, integrating the impacts of multiple stressors over time. In accordance with the RapidBioAssessment (RBA) Manual for Victorian Streams and Rivers (EPA Victoria, 2003), sampling was undertaken using sweep and/or kick sampling methodology, livepicked in the field, and identified by experienced taxonomists. Biological indices calculated from the assemblage of macroinvertebrate families collected at a site provide insight to various aspects of waterway condition. EPA Victoria suggests that RBA data from a single season (autumn or spring) is sufficient for assessing aquatic ecosystem condition and objectives for ecosystem condition have been developed for urban waterways and are included in SEPP (Waters). Therefore, results of the RBA surveys were compared against the urban waterway aquatic ecosystem objectives published in SEPP (Waters) for the following biological indices:

SIGNAL 2 – Stream Invertebrate Grade Number Average Level – indicates the average pollution tolerance/sensitivity of macroinvertebrates. A high score indicates better quality water quality conditions, whereas a lower score suggests macroinvertebrates tolerant of poor water quality (Chessman, 1995, EPA Victoria, 2003, Chessman, 2003).

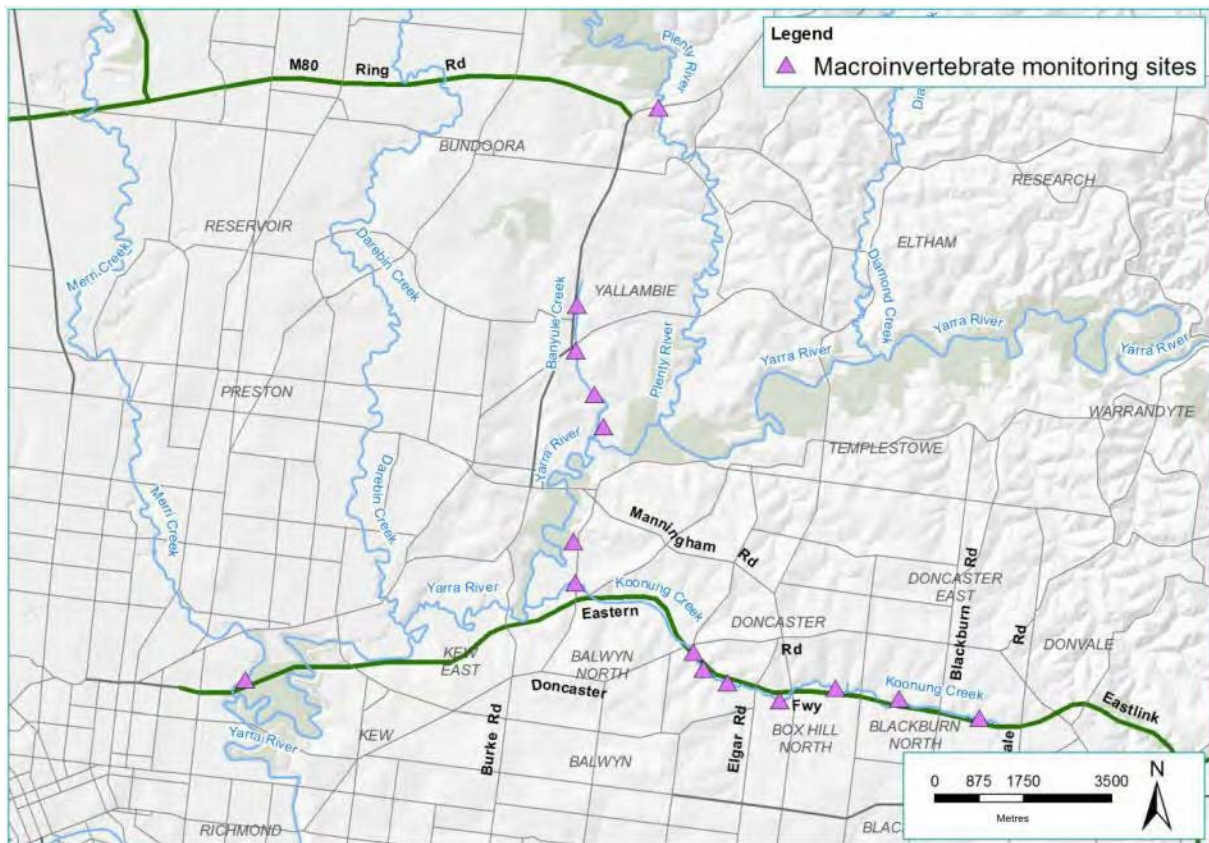
EPT – the number of families from the Orders Ephemeroptera, Plecoptera and Trichoptera; insect orders that are known to be pollution sensitive. A high EPT score indicates more of these families, suggesting a better quality aquatic ecosystem (EPA Victoria, 2003).

Number of Families – the diversity of a macroinvertebrates found at a site indicates the health of the waterway. A high score suggests good ecosystem, whereas low score suggests a degraded ecosystem (EPA Victoria, 2003).

RBA surveys were undertaken at waterways where the preliminary habitat assessment indicated aquatic habitat of sufficient to support aquatic ecology values. RBA surveys were undertaken during autumn 2018 at the following locations:

- Plenty River at Plenty River Drive, underneath the Greensborough Bypass
- Banyule Creek at Simpson Barracks
- Banyule Creek at McCrae Road, downstream of Lower Plenty Road
- Banyule Creek at Banyule Road
- Merri Creek at Yarra Bend Park, upstream of the Eastern Freeway overpass
- Koonung Creek at Bulleen Road, downstream of Thompsons Road
- Koonung Creek at Doncaster Road, near the Doncaster Park and Ride
- Koonung Creek at Jocelyn Avenue, Balwyn
- Koonung Creek at Valda Avenue, Box Hill North
- Koonung Creek at Frank Sedgman Reserve, Elizabeth Street, Box Hill North
- Koonung Creek at Church Road, Doncaster
- Koonung Creek at Boronia Grove Reserve, Leeds Street, Doncaster East
- Koonung Creek at Tunstall Road, Doncaster East.

The locations of RBA survey sites are presented in Figure 5.



**Figure 5 Location of RBA Macroinvertebrate monitoring sites**

Rapid Bioassessment was not undertaken in Glass Creek, a small tributary that passes underneath the Eastern Freeway, in Kew. Although the modified channel of Glass Creek has become somewhat naturalised, the preliminary habitat assessment and desktop assessment indicated a highly degraded habitat conditions, in an intensely urbanised catchment with very low aquatic ecosystem quality.

It is worth noting that monitoring was conducted during a particularly dry period, which may influence the assessment of aquatic ecosystems. The results from this monitoring event may or may not be representative of conditions during wet periods.

#### **Instream vegetation assessment of Koonung Creek**

An assessment of instream vegetation was completed for waterway reaches that may be impacted by the project in a manner that could significantly affect instream ecosystem processes. Waterway reaches considered are those that have greatest potential for photosynthetic nutrient uptake that could be affected by shading or channel modification. This assessment was therefore conducted in reaches of Koonung Creek located on the southern side of the Eastern Freeway that would be potentially affected by shading from new structures (between Doncaster Road busway and Station Street, Box Hill). The cover abundance of instream vegetation was assessed for continuous reaches, based on a 5-point categorical scale (Braun-Blanquet scale) to assess potential impacts to ecosystem services.

#### **Hydrology assessment of Banyule Creek**

An assessment of the surface water hydrology of Banyule Creek was undertaken to understand the contribution of groundwater or rainfall runoff to the stream flow and aquatic habitat in the waterway. This stream is known to be intermittent, and upstream reaches are anecdotally reported to dry out completely, but it is not known how much of the waterway retains water during low-flow periods.

The impact of groundwater manipulation during construction and operation of the project was considered to be a risk to the surface water aquatic ecosystem, and this assessment was planned to consider the reliance of aquatic values in Banyule Creek on groundwater inflows. During an extended period of low rainfall, the full length of Banyule Creek was walked, from Simpson Barracks down to the Yarra River. The presence and salinity of water in the stream was recorded to assess which reaches support permanent aquatic ecosystems and which reaches are likely maintained by groundwater or runoff.

### Environmental quality of Victorian lakes

EPA Victoria have developed a monitoring program recommended for the assessment of overall environmental condition of Victorian lakes (EPA. 2010). This includes a standardised assessment of aquatic ecosystem condition that has been included in the SEPP (Waters) as the standard method for lakes and wetlands. The assessment includes aquatic macroinvertebrates, water quality, habitat quality and catchment threats.

The assessment was undertaken for the following sites with significant aquatic ecosystems that are at risk of hydrological impacts from the project:

- Bolin Bolin Billabong
- Banyule Swamp.

It is worth noting that monitoring was conducted during a particularly dry period, which may influence the assessment of aquatic ecosystems. The results from this monitoring event may or may not be representative of conditions during wet periods.

#### 5.4.12 Targeted fish surveys – aquatic ecology

Following the preliminary habitat assessment of waterways and wetlands, targeted surveys were undertaken in aquatic habitat considered most likely to contain certain threatened species. Targeted surveys were conducted for four native fish species: Australian Grayling *Prototroctes maraena*, Macquarie Perch *Macquaria australasica*, Australian Mudfish *Neochanna cleaver*, and Dwarf Galaxias *Galaxiella pusilla*. As methods used for targeted surveys also survey other fish species, the targeted surveys also provided general fish survey that provided data on native and exotic fish species to inform the general aquatic ecosystem condition assessment.

Targeted surveys were not undertaken for some threatened species because the presence of these species is already known in certain waterways. For example, Australian Grayling and Macquarie Perch are known to occur in the Yarra River in the reaches in and near the project boundary. Therefore, the presence of these species in the Yarra River is presumed, without the need for targeted surveys. However recent records indicating the presence of these species is not known from the tributaries of the Yarra River within the project boundary. Due to the hydrological connectivity and potential fish passage from the Yarra River to these waterways, targeted surveys for these species were undertaken in Koonung Creek and Plenty River.

See sections below for survey rationale for each species of highest concern in the project boundary.

### Macquarie Perch, Australian Grayling and Australian Mudfish

Habitat assessments for each fish species, fyke netting and electrofishing were conducted at sites where records of the species were not known, but where connectivity to the known Yarra River population could be possible.

The recommended time to survey for Macquarie Perch is March through September (DSEWPAC, 2011). Surveys were undertaken in autumn 2018. The same methods were also used during spring 2017 during targeted surveys for other species, which may have also captured Macquarie Perch if present. Spring and summer surveys are not recommended for survey for this species due to concerns over impacts during spawning but the timing and annual pattern of migration is not well understood in the Yarra River population (DoEE, 2017c).

The Australian Grayling is a migratory species that inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. The recommended time to survey for Australian Grayling is December through to April (DSEWPAC, 2011) to maximise survey effectiveness during periods of lower flow. Surveys were undertaken during autumn 2018, but also included surveys during spring 2017 when upstream migration of this species is most likely to occur. Australian Grayling are thought to disperse as juveniles in the marine environment, and ascend freshwater systems independent of their origin (DELWP, 2015). This leads to the potential for expansion of the distribution of Australian Grayling population in the Yarra River into other tributaries with suitable habitat.

Australian Mudfish is a small bodied native fish that has been found in the Yarra River, but is seldom recorded due to nature of the species habitat and the cryptic nature of the fish. Electrofishing has been used successfully and is considered the most effective method, requiring significant amount of survey effort. Waterway sites that are closely connected to the mainstem of the Yarra River (Merri Creek) are considered suitable habitat and have the potential to support Australian Mudfish. Other tributaries have potential habitat but not known if Australian Mudfish could be present, and so were surveyed for this species.

Each site was visited during daylight hours to determine the presence of instream habitat, including the presence of pools, connectivity, substrate and degree of modification and urban stormwater runoff. The fyke netting was undertaken to target juvenile fish in these tributaries of the Yarra. Double-wing 4-millimetre mesh fyke nets were deployed overnight (12-hour soak time) in the best available habitat in the waterway reach. The wings were set to entirely cover the width of the stream; one net facing upstream and another net facing downstream. Nets were retrieved the following morning and all fish captured were identified. Fyke netting is considered to be most effective during period of rising water (DSEWPAC, 2011). However, due to workplace safety and low rainfall during the survey season, only the Plenty River was able to be surveyed during a rising flow event. Other survey sites were surveyed during stable flow conditions.

Electrofishing was undertaken using a Smith Root LR20B backpack operated by a pair of experienced aquatic ecologists, in accordance with the Australian Code of Electrofishing Practice (NSW Fisheries, 1997). Electrofishing was undertaken for between 600 and 1,000 seconds of pulse time at each site, typically extending along a length of waterway of 100 to 200 metres.

Targeted surveys for Macquarie Perch, Australian Grayling and Australian Mudfish were undertaken at the sites listed in Table 15.

### **Dwarf Galaxias**

Dwarf Galaxias are known to occur in ephemeral and intermittent waterbodies, but are typically associated with floodplain wetlands, dispersing during periods of overbank flow. This species is not known from the Yarra River catchment, although a translocated population is known from wetlands at La Trobe University (Saddler *et al.*, 2010). The presence of a similar isolated population to be present within the protected environment of Simpson Barracks was considered possible, however there are no records of fish surveys from Simpson Barracks. Targeted surveys were only conducted for this species at Simpson Barracks. A habitat assessment, dip net sampling and backpack electrofishing of any aquatic habitat was undertaken during spring 2017 and autumn 2018, as listed in Table 15.

The use of bait traps was not appropriate for the habitat in Simpson Barracks, as the water depth (typically <15cm) was too low for trap to be effective. The use of electrofishing and dip netting in this small, shallow waterway was appropriate for this targeted Dwarf Galaxias survey, in accordance with the survey guidelines for threatened fish (DSEWPAC 2011), as the aquatic habitat did not contain dense instream aquatic vegetation or high salinity that might otherwise limit the effectiveness of these methods.

Table 15 Summary of fish survey methods

Site	Targeted Round 1	Targeted Round 2
Plenty River at Plenty River Drive	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Bulleen Road	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Doncaster Road	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Jocelyn Avenue, Balwyn	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Valda Avenue, Box Hill North	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Frank Sedgman Reserve, Box Hill North	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Church Road, Doncaster	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Boronia Grove Reserve, Doncaster East	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Tunstall Road, Doncaster East	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting	1 night x 2 Fyke Nets, Backpack electrofish, Dip netting
Banyule Creek at Simpson Barracks	Backpack Electrofish, Dip netting	Dip Netting

#### 5.4.13 Declared weeds and pathogens

An assessment was undertaken of the likelihood of declared weeds and pathogens to occur in the study area. For the purpose of the assessment, declared weeds are those listed by the CaLP Act or Weeds of National Significance (WoNS) identified by the PMST.

This assessment was completed for species recorded on the VBA and/or predicted to occur by the PMST, within five kilometres of the project boundary. Likelihood definitions are as described in Section 5.4.3.

There is no method for identifying pathogens with likelihood to occur in the study area. However, key pathogens (those identified as threatening processes under the EPBC Act and/or FFG Act) have been considered in this report. One pathogen considered most relevant to the ecological impact assessment of the project boundary is Cinnamon Fungus *Phytophthora cinnamomi*. Potential range and indicative threat mapping is provided in DSE (2008) and is further explored in Section 7.3.5 and Section 7.3.6.

Another known pathogen that affects fauna is the Amphibian Chytrid Fungus, which causes the disease chytridiomycosis, which can result in high mortality of frogs. *Chytridiomycosis due to the amphibian chytrid fungus* is a listed Key Threatening Processes under the EPBC Act. The Amphibian Chytrid Fungus is known to have been in Australia since 1978 and Victoria since 1998 (Murray *et al.*, 2010), and is likely to be widespread throughout frog habitats within the project boundary already (Brannelly *et al.*, 2018). Chytrid Fungus is discussed below in Section 8.3.4 and Section 12.1.5.

#### 5.4.14 Threatening processes

An assessment was undertaken of the relevance and likelihood of threatening processes listed under the FFG Act (DELWP, 2016b) and key threatening processes listed under the EPBC Act (DoEE, 2017a; DoEE, 2017b) to occur in the project boundary. Only those threatening processes that were deemed to be relevant to the project were assessed (refer to Appendix G).

Likelihood category definitions are:

- **Low** – Threatening process not recorded in the project boundary, or the project boundary supports conditions that could encourage or exacerbate threatening processes. However, the impact of these processes is considered limited by the location of the project boundary in an urban, fragmented environment.
- **Moderate** – The project boundary supports suitable conditions that could encourage or exacerbate threatening process.
- **High** – The project boundary supports suitable conditions that are likely to encourage and/or exacerbate threatening processes.
- **Present** – Threatening process directly observed or recently recorded within the project boundary.

#### 5.4.15 Wetlands

##### Wetlands of International Importance (Ramsar) and Nationally Important Wetlands

A PMST report with a five-kilometre buffer was run on 6 March 2018 to determine whether the project would impact on Wetlands of International Importance (Ramsar) and/or Nationally Important Wetlands.

##### Mapped wetlands

Mapped wetlands were identified through DELWP's *Current Wetlands Map* (accessed 19 March 2018). Assessment of presence of mapped wetlands was introduced through the recently updated Guidelines (DELWP, 2017a) to overcome the difficulty in identifying and accurately assessing a landscape feature that responds quickly to changes in environmental conditions and may be ephemeral in nature. For the purposes of measuring removal of native vegetation by the proposed works, any extent of mapped wetland that is to be removed is considered to be a patch of native vegetation. Condition of the wetland and value in habitat hectares is determined by the modelled condition score unless a site assessment is carried out soon after inundation (DELWP, 2017a).

#### 5.4.16 Groundwater dependent ecosystems

##### Overview

Groundwater dependent ecosystems (GDEs) have been identified on the basis of those modelled to occur within the study area on the following databases:

- National Atlas of Groundwater Dependent Ecosystems administered by the Australian Government Bureau of Meteorology (BOM)

- Potential Groundwater Dependent Ecosystem Mapping for the Port Phillip and Westernport Catchment Management Authority (PPWCMA) administered by DELWP.

Each database source is described in more detail below.

#### ***DELWP (2018a): Potential Groundwater Dependent Ecosystem (GDE) Mapping for the Port Phillip and Westernport CMA***

For this layer, GDEs are ecosystems identified as likely to be at least partly dependent on groundwater. State-wide screening analysis was performed to identify locations of potential terrestrial GDEs, including wetland areas. GDE mapping was developed utilising satellite remote-sensing data, geological data and groundwater monitoring data in a GIS overlay model. The core data used in the modelling is largely circa 1995 to 2005.

The method used in this research is based upon a potential GDE area having the following characteristics:

1. Has access to groundwater. For GDEs associated with wetlands and rivers, the water table is at the surface. Terrestrial GDEs are dependent on the interaction between depth to groundwater and the rooting depth of the vegetation.
2. Has summer (dry period) use of water. Due to the physics of root water uptake, GDEs will use groundwater when other sources are unavailable (typically summer in Victoria). The ability to use groundwater during dry periods creates a contrasting growth pattern with surrounding landscapes where growth has ceased.
3. Has a consistent growth pattern. Vegetation that uses water all year round will have a perennial growth pattern.
4. Has a growth pattern similar to verified GDEs.

The DELWP mapping does not indicate the degree of groundwater dependence, only locations in the landscape that have the potential to be groundwater dependent ecosystems. The DELWP model is expected to over-estimate the extent of terrestrial GDEs.

Validation of the model through field assessment has not been performed. This dataset does not directly support interpretation of the amount of dependence or the amount of groundwater used by the regions highlighted within the maps. Further analysis and more detailed field based data collection are required to support this.

#### ***BoM (2018): Groundwater Dependent Ecosystems Atlas***

<http://www.bom.gov.au/weave/gde.html?max=true>

The GDE Atlas was developed as a national dataset of Australian GDEs to inform groundwater planning and management. The Atlas contains information about three types of ecosystems, two of which are relevant to this project (the Atlas also identifies subterranean GDEs in cave and aquifer ecosystems, which do not occur in the study area):

1. Aquatic ecosystems that rely on the surface expression of groundwater – this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs.
2. Terrestrial ecosystems that rely on the subsurface presence of groundwater – this includes all vegetation ecosystems.

#### ***Summary***

The accuracy of the GDE mapping in each of the databases is variable and likely dependent on the accuracy of input data. The collation of the BOM national atlas relied upon a combination of expert opinion, remote sensing data (from 2000 to 2010) and GIS analysis to map the potential for groundwater/ecosystem interaction (Doody *et al.*, 2017).

Since the national atlas was released in 2012, Victoria conducted a regional study generating GDE mapping for the PPWCMA. This mapping was developed using satellite remote sensing data, geological data and groundwater monitoring data. Field assessment was not undertaken to validate the GIS overlay model (DELWP, 2018a).

In principle, modelling of potential GDEs at a finer resolution than available in the two resources noted above could be done by using Landsat8 remote sensing imagery. Near Infra-Red (NIR) bands can be used to inform a model such as the Normalised Density Vegetation Index (NDVI), which can observe temporal or spatial variations in the chlorophyll signature. In turn, these variations may indicate vegetation with access to groundwater. While this was considered a potentially useful approach for this EES, further assessment indicated it would have only limited applicability in such an urban context given the likely artificial watering occurring in residential gardens, golf courses, playing fields and municipal parks. The application of the approach is also problematic around wetlands. It was therefore not considered as a reliable means of identifying GDEs in the study area and, as such, GDEs are defined on the basis of the National Atlas and the PPWCMA model only.

## 5.5 Risk assessment

An environmental risk assessment has been completed to identify environmental risks associated with construction and operation of North East Link. The risk-based approach shown in Figure 6 and is integral to the EES as required by section 3.1 of the scoping requirements and the *Ministerial guidelines for assessment of the environmental effects under the Environment Effects Act 1978*.

Specifically the EES risk assessment aimed to:

- Systematically identify the interactions between project elements and activities and assets, values and uses
- Focus the impact assessment and enable differentiation of significant and high risks and impacts from lower risks and impacts
- Inform development of the reference project to avoid, mitigate and manage environmental impacts
- Inform development of EPRs that set the minimum outcomes necessary to avoid, mitigate or manage environmental impacts and reduce environmental risks during delivery of the project.

This section presents an overview of the EES risk assessment process. EES Attachment III Environmental risk report describes each step in the risk assessment process in more detail and contains a consolidated risk register.

This technical report describes the risks associated with the project on [technical discipline]. Wherever risks relating to this study are referred to, the terminology 'risk XX01' is used. Wherever EPRs relating to this study are referred to, the terminology 'EPR XX1' is used. The risk assessment completed for this study is provided as Appendix A.

### 5.5.1 Risk assessment process

The risk assessment process adopted for North East Link is consistent with AS/NZS ISO 31000:2009 Risk Management Process. The following tasks were undertaken to identify, analyse and evaluate project risks:

- Use existing conditions and identify applicable legislation and policy to establish the context for the risk assessment
- Develop likelihood and consequence criteria and a risk matrix

- Consider construction and operational activities in the context of existing conditions to determine risk pathways
- Identify standard controls and requirements (Environmental Performance Requirements (EPRs) to mitigate identified risks
- Assign likelihood and consequence ratings for each risk to determine risk ratings considering design, proposed activities and standard EPRs.

While there are clear steps in the risk process, it does not follow a linear progression and requires multiple iterations of risk ratings, pathways and EPRs as the technical assessments progress. Demonstrating this evolution, a set of initial and residual risk ratings and EPRs are produced for all technical reports. Figure 6 shows this process.

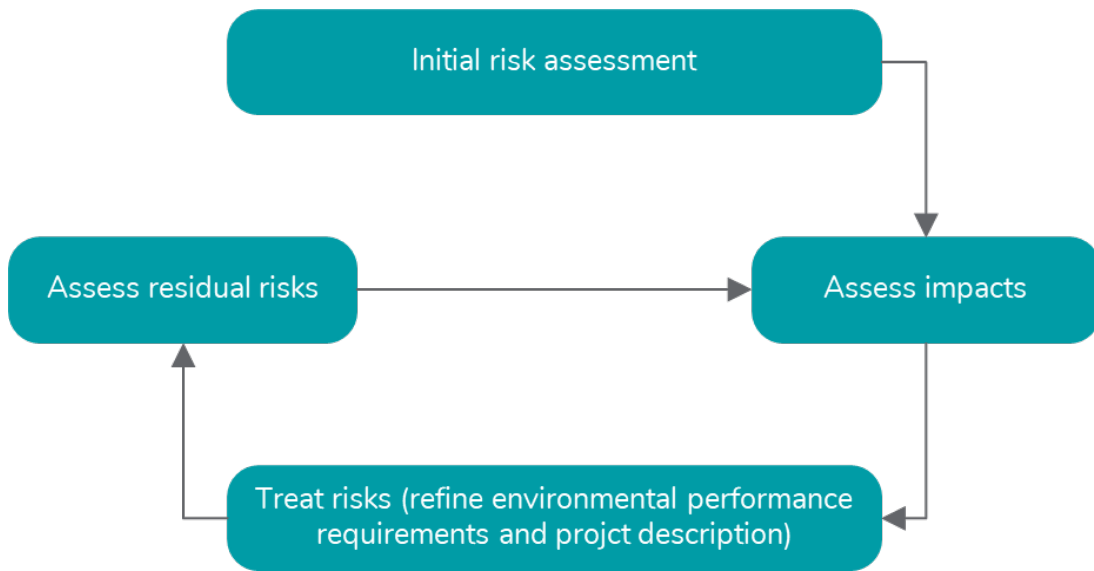


Figure 6 Risk analysis process

### ***Rating risk***

Risk ratings were assessed by considering the consequence and likelihood of an event occurring. In assessing the consequence, the extent, severity and duration of the risks were considered. These are discussed below.

### ***Assigning the consequences of risks***

‘Consequence’ refers to the maximum credible outcome of an event affecting an asset, value or use. Consequence criteria as presented in Chapter 4 – EES assessment framework, were developed for the North East Link EES to enable a consistent assessment of consequence across the range of potential environmental effects. Consequence criteria were assigned based on the maximum credible consequence of the risk pathway occurring. Where there was uncertainty or incomplete information, a conservative assessment was made on the basis of the maximum credible consequence.

Consequence criteria have been developed to consider the following characteristics:

- Extent of impact
- Severity of impact
- Duration of threat.

Severity has been assigned a greater weighting than extent and duration as this is considered the most important characteristic.

Each risk pathway was assigned a value for each of the three characteristics, which were added together to provide an overall consequence rating.

Further detail on the consequence criteria are provided in Chapter 4 – EES assessment framework.

### Assigning the likelihood of risks

'Likelihood' refers to the chance of an event happening and the maximum credible consequence occurring from that event. The likelihood criteria are presented in Table 16.

Table 16 Likelihood of an event occurring

Planned	The event is certain to occur
Almost certain	The event is almost certain to occur one or more times a year
Likely	The event is likely to occur several times within a five-year timeframe
Possible	The event may occur once within a five-year timeframe
Unlikely	The event may occur under unusual circumstances but is not expected (ie once within a 20-year timeframe)
Rare	The event is very unlikely to occur but may occur in exceptional circumstances (ie once within a 100-year timeframe)

### Risk matrix and risk rating

Risk levels were assessed using the matrix presented in Table 17.

Table 17 Risk matrix

Likelihood	Consequence				
	Negligible	Minor	Moderate	Major	Severe
Rare	Very low	Very low	Low	Medium	Medium
Unlikely	Very low	Low	Low	Medium	High
Possible	Low	Low	Medium	High	High
Likely	Low	Medium	Medium	High	Very high
Almost certain	Low	Medium	High	Very high	Very high
Planned	Planned (negligible consequence)	Planned (minor consequence)	Planned (moderate consequence)	Planned (major consequence)	Planned (severe consequence)

### Planned events

North East Link would result in some planned events, being events with outcomes that are certain to occur (ie planned impacts such as land acquisition), as distinct from risk events where the chance of the event occurring and its consequence is uncertain. Although planned events are not risks, these were still documented in the risk register as part of Attachment III – Risk report for completeness and assigned a consequence level in order to enable issues requiring further assessment or treatment to be prioritised.

These planned events were assessed further through the impact assessment process.

### Risk evaluation and treatment

The risk assessment process was used as a screening tool to prioritise potential impacts and the subsequent level of assessment undertaken as part of the impact assessment. For example, an issue that was given a risk level of medium or above, or was identified as a planned event with a consequence of minor or above, would go through a more thorough impact assessment process than a low risk.

Where initial risk ratings were found to be 'medium' or higher, or were planned events with a consequence of 'minor' or higher, options for additional or modified EPRs or design changes were considered where practicable. It should be noted that the consequence ratings presented in the risk register are solely based on the consequence criteria presented in Attachment III – Risk report. Further analysis and evaluation of the impacts potentially arising from both risks and planned events and information on how these would be managed is provided in section 12.

## 5.6 Impact assessment

This study has assessed the impacts of construction and operation of the project on ecological assets and values to be protected. The impact assessment approach included:

- Establishing the project context
- Determining the existing conditions by using the desktop assessments and field assessments to establish the likelihood of threatened species presence
- Establishing modelled GDE impacts
- Assessing impacts with consideration of:
  - The extent and quality of indigenous vegetation that would be impacted during construction and the quantum of offsets that may be necessary
  - The impact to threatened flora and fauna species
  - Impacts to known and potential fauna habitat (terrestrial and aquatic) within the study area
  - The construction and operation of the project
- Providing mitigation and/or management measures required to avoid, minimise and/or offset ecological impacts such as the removal of native vegetation to inform the development of associated performance requirements.

Losses of indigenous vegetation and scattered trees were determined by overlaying the project boundary, including temporary laydown and works areas, against the mapped existing conditions, and identifying any overlap. Within the project boundary, 100 per cent vegetation loss was assumed.

The 'existing conditions', 'risk assessment' and 'impact assessment' steps have been separated into key themes to address 'biodiversity' impacts identified within the scoping document.

These include:

- **Native vegetation:** including all remnant vegetation (patches of remnant vegetation, large trees within patches, and scattered indigenous trees) that occur in the terrestrial environment.
- **Aquatic ecology:** aquatic ecology considers plants and animals that occur in freshwater waterbodies. For this project, platypus and turtles are considered as aquatic fauna, while amphibians are considered as terrestrial fauna.
- **Terrestrial fauna:** any fauna that occur in the terrestrial environment that largely reside in the terrestrial environment for all life stages. For this project, amphibians are considered as terrestrial fauna, while platypus and turtles are considered as aquatic fauna.

Future climate change scenarios are considered in EES Technical report N – Groundwater and Technical report P – Surface water, and those considerations have been taken into account for the purposes of this assessment.

## 5.7 Limitations, uncertainties and assumptions

Circumstances and events will occur following the date on which such information was obtained that are beyond GHD's control or knowledge and which may affect the findings or projections contained in this document. GHD may not be held responsible for and specifically disclaim any responsibility for such circumstances or events.

Generally, the level of risk posed by the limitations described below is considered to be low to moderate since the ecological features of the Melbourne area (including the project boundary) have a long history of disturbance, degradation and urbanisation typical of a large city.

The likelihood of this assessment missing species or communities of high ecological value in the project boundary is considered to be low, since the ecological features of the Melbourne area tend to be relatively well studied and well understood.

Ecological limitations and assumptions of this assessment are outlined below:

- Since a detailed design for the project is yet to be established, for the purpose of this report, it has been assumed that any area within the project boundary may be subject to land clearing and native vegetation removal. The exception to this is the area above the proposed tunnels shown in Figure 2 (in Section 3.5) that would be constructed by tunnel boring machines (TBMs) which would not result in surface disturbance, and other locations where indicated (such as the conditional no-go zone areas of the Banyule Flats, the no-go zone areas of the Yarra River floodplain). It is noted this assessment is based on a reference design and that the actual impacts realised by the project would be expected to affect a significantly smaller footprint within the project boundary.
- Mapping of native vegetation (patches, scattered trees, rare or threatened flora) was conducted using hand-held Trimble PDA units, ArcGIS Collector app for iPhone, and aerial photo interpretation. The accuracy of the mapping is subject to the accuracy of the unit, access to satellite information (generally < 5 metres) and environmental conditions at the time of assessment (such as cloud cover).
- The need for targeted survey for listed threatened species was considered for those species identified by the investigation as having moderate or greater likelihood of occurrence in the study area.
- For fauna, targeted surveys were not undertaken for some threatened species that are known or likely to occur across the Melbourne area, because the result was unlikely to alter the conclusion drawn (such as Grey-headed Flying-fox *Pteropus poliocephalus*, Swift Parrot *Lathamus discolor*; as explained in Section 5.4.10).
- It is worth noting the monitoring of waterways (Rapid Bioassessment) and lakes (VLAKES index; EPA Victoria, 2010) was conducted during a particularly dry period, which may influence the assessment of aquatic ecosystems. The results from this monitoring event may or may not be representative of conditions during wet periods. This should be considered in future management plans.
- Targeted fauna (terrestrial or aquatic) surveys that do not detect the subject species cannot provide conclusive evidence that threatened species do or will not occur, just that they haven't been detected. The assessment of likelihood of occurrence is based on survey effort, background information and previous records compiled.
- The extent of field survey and information available from other sources were considered adequate for the purpose of identifying potential impacts from the project on ecological values.

- The literature review as it pertains to the project boundary was not intended to be an exhaustive synthesis of current knowledge, but rather provide a concise and consolidated account of the ecological values supported, or predicted to be supported, by these ecosystems.
- Identification of GDEs for consideration in the assessment is based on external source data (the Australian Government Bureau of Meteorology and the Department of Environment, Land, Water and Planning). The spatial extent of groundwater dependency was validated in the field for Banyule Creek as part of the aquatic ecology existing conditions assessment. However, this report does not seek to verify the accuracy of modelling or provide an indication of the level of groundwater dependence of a potential GDE.

## 5.8 Stakeholder engagement

Stakeholders and the community were consulted to support the preparation of the North East Link EES and to inform the development of the project and understanding of potential impacts.

Table 18 lists specific stakeholder engagement activities that have occurred in relation to ecology, with more general engagement activities occurring at all stages of the project.

**Table 18 Stakeholder engagement undertaken for ecology**

Activity	When	Matters discussed	Outcome
Meeting with DELWP	19/02/2018	FFG-listed and DELWP-listed fauna – seeking DELWP endorsement to project approach for fauna surveys	<p>DELWP generally happy with project approach. DELWP had the following comments:</p> <ul style="list-style-type: none"> <li>• Powerful Owl known to breed in the area – Deakin University study.</li> <li>• DELWP recommended NELP liaise with Deakin University on their Powerful Owl project.</li> <li>• DELWP mentioned Practical Ecology report for Banyule, which discussed more Migratory species at Banyule Flats.</li> </ul>
Meeting with the EPA	23/03/2018	Aquatic ecosystem assessments	<ul style="list-style-type: none"> <li>• Confirmation of requirements under the draft State Environment Protection Policy (SEPP) Waters.</li> <li>• Provision of references for background to billabongs.</li> </ul>
Meeting with Deakin University (School of Life and Environmental Sciences)	2/05/2018	Powerful Owl mostly, also Barking Owl briefly	<ul style="list-style-type: none"> <li>• Deakin University researchers provided overview of recent findings for Powerful Owl surveys across eastern suburbs of Melbourne, including parts of the project boundary.</li> </ul>

Activity	When	Matters discussed	Outcome
Meeting with Warringal Conservation Society (WCS)	17/05/2018	The ecology of Warringal Parklands and Banyule Flats in relation to the project	<ul style="list-style-type: none"> <li>Presented overview of ecology assessments.</li> <li>Opportunity to receive further information from local interest group.</li> <li>NELP to provide advice on timing for comment on Scoping document and when the EES is open for comment.</li> <li>WCS to be kept up to date with project including when DELWP EES draft scoping requirements are released.</li> </ul>
Meeting with Melbourne Water	21/05/2018	Groundwater and wetlands	<ul style="list-style-type: none"> <li>Melbourne Water to provide list of available reports and data approved for use.</li> <li>Contact established for access to data and models in future.</li> </ul>
Meeting with City of Whittlesea	24/05/2018	Matted Flax-lily translocation	<ul style="list-style-type: none"> <li>Discussion of potential translocation sites within Whittlesea.</li> <li>Discussion of potential process.</li> </ul>
Meeting with City of Banyule	4/7/2018	Matted Flax-lily translocation	<ul style="list-style-type: none"> <li>Discussion of potential translocation sites within Banyule.</li> </ul>
Meeting with DELWP	18/7/2018	NVR, offset strategy, technical matters associated with delineation of habitat zones	<ul style="list-style-type: none"> <li>DELWP suggested site visit with Port Phillip Region biodiversity officer.</li> <li>DELWP encouraged reduction of impacts to avoid/minimise requirements for species offsets.</li> </ul>
Telephone call with Arthur Rylah Institute (DELWP) (Wayne Koster, Australian Grayling researcher)	4/9/2018	Australian Grayling migration timing and sensitivity to noise impacts	<ul style="list-style-type: none"> <li>Updated report with months of Australian Grayling seasonal migration.</li> <li>Confirmed this species is likely to avoid areas of good habitat to avoid noise.</li> </ul>
Meeting with Department of Defence	11/12/18	Loss of native vegetation, alteration to Banyule Creek	<ul style="list-style-type: none"> <li>Information provided on anticipated ecological impacts and mitigation measures, eg offsets, Matted Flax-lily translocation plan, tree canopy replacement plan.</li> </ul>
Meeting with WCS	27/2/19	The ecology of Warringal Parklands, Banyule Creek and Banyule Flats in relation to the project	<ul style="list-style-type: none"> <li>Presented overview of ecology assessments.</li> <li>Opportunity to receive further information from local interest group.</li> <li>WCS encouraged to make a submission during the EES public exhibition process</li> </ul>

## 5.9 Community feedback

In addition to consultation undertaken with specific stakeholders, consultation has been ongoing with the community throughout the design development and the EES process. Feedback relevant to the ecology assessment is summarised in Table 19, along with where and how we have addressed those topics in this report.

Table 19 Community consultation feedback addressed by ecology

Issues raised during community consultation	How it's been addressed
Loss of Red Gum, Yellow Box and Studley Park Gum trees at Simpson Barracks.	As discussed in Section 12.1.1 of this report, vegetation within the project boundary at Simpson Barracks is expected to be lost due to the project, including large trees. Where possible, vegetation loss would be minimised in accordance with EPR FF2. Where the removal of native vegetation is unavoidable the project would be required to meet the assessment and offset requirements of the <i>Guidelines for the removal, destruction or lopping of native vegetation</i> .
Swift Parrot population if Yellow Box trees at Simpson Barracks are removed.	As discussed in Section 12.1.9 of this report, Swift Parrot already cope with Melbourne's fragmented landscape as determined by their continued use of trees in metropolitan areas. The majority of vegetation at Simpson Barracks, including most of the Yellow Box trees, would not be affected by the project. Some River Red-gums near Greensborough Road would be lost. Therefore, these birds would be able to continue to forage in the remaining woodland, including the eastern area where Yellow Box trees dominate.
Potential loss of Matted Flax-lily habitat and removal of established colonies.	As discussed in Section 12.1.1 of this report, native vegetation to be removed that provides habitat for Matted Flax-lily would be offset in accordance with DELWP's requirements. In addition, Matted Flax-lily affected by the project would be salvaged and translocated to alternative suitable receptor sites under a strict and formalised process to protect the survival of affected individuals.
Potential damage to sensitive environmental areas, particularly Banyule Flats, Banksia Park, Warringal Parklands and Bolin Bolin Billabong.	The project has minimised its impact on the areas of Banyule Flats, Banksia Park and Warringal Parkland by tunnelling beneath these sensitive areas. The potential for impacts at Bolin Bolin Billabong have been thoroughly investigated and are discussed throughout Sections 10 and 12 of this assessment.
Loss of habitat for native wildlife – including breeding and nesting areas – where parkland is required for construction, particularly at Simpson Barracks and in Koonung Creek park and wetland areas.	As discussed in Section 12.1.1 of this report, proposed loss of habitat due to the project has been minimised at some locations, and would be further minimised with EPR FF2, but some loss of native vegetation due to the project is unavoidable. Implications for fauna are expected to be minor and are discussed in Section 12.

Issues raised during community consultation	How it's been addressed
Ecological impacts from realigning or covering of Banyule Creek to construct and operate the interchange at Lower Plenty Road.	The impacts associated with realigning of Banyule Creek are discussed in Section 12.1.4 of this report. The loss of natural waterway in this reach of Banyule Creek has a very low risk of impacting the viability of aquatic fauna populations outside the area of direct waterway modification and impacts to threatened species are considered unlikely. The reach of waterway affected contains no native fish, and the aquatic macroinvertebrate community is typical of a highly degraded waterway. The reach within Simpson Barracks is modified by the constructed drain that receives the majority of water runoff. The reach downstream of Simpson Barracks is a constructed channel with poor habitat quality.
Ecological impacts from realigning or covering of Koonung Creek to construct and operate the upgrade Eastern Freeway.	As discussed in Section 12.1.4 of this report, the condition of the aquatic habitat in this waterway and associated ecological values are already compromised through historical waterway modifications and existing urban stormwater pressures. The effect of waterway modification is considered to be localised, with loss or degradation of habitat likely to be restricted to the immediate area of waterway modification and associated works. Reaches that are to be covered would result in a loss of aquatic habitat, similar to existing covered reaches in Koonung Creek. Reaches that are to be modified would be degraded in the short term, however these would be naturalised, and should recover to a condition similar to existing modified channel.
How native fauna in the project area would be relocated if required, particularly kangaroo populations on and near Simpson Barracks.	Fauna encountered during construction would be managed in accordance with the Wildlife Act 1975 and as described in EPR FF1.

## 5.10 Peer review

This assessment has been independently peer reviewed by Brett Lane of Brett Lane and Associates. The peer reviewer provided feedback on drafts of this report, as well as the methodology, approach, assumptions and assessment criteria applied to the assessment. The peer reviewer's methodology is set out in his peer review report, which also included addressing whether there were any additional matters which should be considered as part of the impact assessment in order to address the EES scoping requirements, 'public works' Order or to otherwise adequately assess the likely impacts of the project relevant to this assessment or the management of those impacts. The peer reviewer also considered whether there were any gaps or matters in this assessment which they disagreed with. The final peer review report is attached as Appendix M of this report. This sets out the peer reviewer's conclusions, and whether all of their recommendations have been addressed in this report.

## 6. Literature review

This section seeks to examine publicly available ecological information regarding the North East Link project boundary. It will review and identify key flora and fauna values, specifically within existing parkland and reserves. This review addresses the following areas that are either within or nearby the project boundary (areas outside the project boundary have been included where indirect impacts warrant investigation):

- Yarra Bend Park
- Yarra Flats Park
- Yarra Valley Parklands, including:
  - Birrarrung Park
  - Banksia Park
- Warringal Parklands and Banyule Flats
- Bolin Bolin Billabong
- Plenty River flats
- Koonung Creek
- Mullum Mullum Creek
- Trinity Grammar School Sporting Complex Wetlands, Bulleen
- Kew Golf Club
- Kew Billabong, Willsmere Park
- Kilby Reserve/Hays Paddock
- Simpson Barracks
- Yarra River
- Merri Creek
- Plenty River
- Banyule Creek.

### 6.1 Yarra Bend Park

Yarra Bend Park is located at the convergence of the Merri River and Yarra River in Clifton Hill and is considered one of Melbourne's most important natural areas (Lorimer, 2006). The park itself is regarded by Lorimer (2006) as a site of national significance, particularly for its population of Melbourne Yellow Gum *Eucalyptus leucoxylon* subsp. *connata* and remnant vegetation within its boundaries.

Yarra Bend Park historically supports a significant variety of EVCs, one of which is widely distributed within the park:

- Plains Grassy Woodland (Endangered): Of the historical pre-1750 extent of this EVC, less than three per cent remain in Victoria today. Eleven per cent of this total remaining extent is located within designated conservation areas, of which the Yarra Bend Park accounts for approximately 0.6 per cent, representing about a quarter of the total reserved area within the Port Phillip and Westernport Region (Parks Victoria, 2000). This community in Yarra Bend Park is considered to be significant, as it is one of the most intact representations of its kind in the region (Parks Victoria, 2000).

Additional vegetation communities occur, including:

- A few remnants of Heathy Woodland (Vulnerable) vegetation exist, predominantly on the Tertiary soils of the hills towards the southern side of the park and in a sheltered gully. These communities are considered to be remnants of a gully vegetation community (Yarra Bend Park Trust 1990, in Parks Victoria, 2000).
- Floodplain Riparian Woodland (Endangered) exists within the park land, predominantly on the floodplain in close proximity to the river and is generally dominated by River Red Gum *Eucalyptus camaldulensis* (Beardsell, 2003).
- Grassy Woodland (Endangered) occurs only in remnant patches within the park, but is considered to be in fair ecological condition (Lorimer, 2006).
- Box Ironbark Forest (Vulnerable) communities occur over several tens of hectares across the park and are described to be in fair ecological condition (Lorimer, 2006; Beardsell, 2003).
- Two FFG Act listed communities occur in the park land, namely Western (Basalt) Plains Grassland (Endangered) (nominated as Plains Grassland) and Rocky Chenopod Open Scrub Community (nominated as Rocky Outcrop Shrub-land) (Parks Victoria, 2000).
- One community (Floodplain Wetland Complex) has been reconstructed in the park area, to counter the loss of many of the wetlands and billabongs within the floodplains of the middle and lower Yarra (Parks Victoria, 2000).

In terms of indigenous flora, approximately 240 species have been recorded within Yarra Bend Park, representing about 10 per cent<sup>9</sup> of Victoria's total number of indigenous flora species (Parks Victoria, 2000). Additionally, eleven of Victoria's 1,120 threatened flora species occur within the park area (Parks Victoria, 2000; Lorimer, 2006; Beardsell, 2003) including:

- Gilgai Blown Grass *Agrostis aemula* var. *setifolia*
- Wetland Blown Grass *Agrostis avenacea* var. *perennis*
- Tall Club-sedge *Bolboschoenus fluviatilis*
- Short Water-starwort *Callitriche brachycarpa*
- Small Scurf-pea *Cullen parvum*
- Yellow Gum *Eucalyptus leucoxylon* subsp. *connata*
- Studley Park Gum *Eucalyptus Xstudleyensis*
- Arching Flax-lily *Dianella longifolia* var. *grandis*
- Blue Prickly Tussock Grass *Poa labillardieri* (Basalt Plains form)
- Pale-flower Crane's-bill *Geranium* sp. 3
- Austral Tobacco *Nicotiana suaveolens*.

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<sup>9</sup> At the time of this report this is correct, but currently this represents closer to 5 per cent.

Yarra Bend Park is part of a major ecological corridor along the Yarra River (Lorimer, 2006). Several threatened fauna have been recorded here historically including nationally threatened Regent Honeyeater *Anthochaera (Xanthomyza) phrygia*, Swift Parrot *Lathamus discolor*, Macquarie Perch *Macquaria australasica* (Lorimer 2006) and Grey-headed Flying-fox *Pteropus poliocephalus* (DSE, 2005).

Yarra Bend Park has become the main campsite in Victoria for the Grey-headed Flying-fox. A management area has been established to protect the species encompassing 26 hectares from Bellbird Picnic Area north to the Eastern Freeway, following the Yarra River (DSE, 2005). In 2004, numbers were estimated within the camp at more than 30,000 (DSE, 2005). Since that time, numbers have been shown to fluctuate seasonally and annually with winter lows as small as 5,000 in mid-2007 and 2009, but peaking during summer/autumn to 20,000 to 25,000 for static counts and up to 30,000 to 35,000 for fly-out counts (DSE, 2009).

Yarra Bend Park is also identified as providing habitat of high value for the Swift Parrot (*Lathamus discolor*) (Practical Ecology, 2017c). Within a broader area centred on the City of Banyule, Yarra Bend Park was notable for supporting a large number of preferred feeding trees (particularly Yellow Gum) and having a relatively high quality canopy cover.

Lorimer (2006) and Parks Victoria (2000) reported the presence of several native fish species in the Yarra River at Yarra Bend Park. These include Macquarie Perch, Australian Mudfish (*Neochanna cleaveri*), Freshwater Catfish (*Tandanus tandanus*), Murray Cod (*Maccullochella peelii*), Golden Perch (*Macquaria ambigua*), Pouched Lamprey (*Geotria australis*), Spotted Galaxias (*Galaxias truttaceus*), Broadfin Galaxias (*Galaxias brevipinnis*), Flatheaded Gudgeon (*Philypnodon grandiceps*), Tupong (*Pseudaphritis urvillii*) and Short-headed Lamprey (*Mordacia mordax*). Lorimer (2006) also reported the observation of a Platypus (*Ornithorhynchus anatinus*) in 2004, although they have also been listed in the Platypus Spot Database as recently as 2017. Within the Yarra Bend Park, Dights Falls fishway on the Yarra River is important on a regional scale for the distribution and migration of Australian Grayling (*Prototroctes maraena*) (Parks Victoria, 2000).

## 6.2 Yarra Flats Park

This site comprises two major habitat types—Floodplain Riparian Woodland (Endangered) and Floodplain Wetland Complex (Endangered) (Lorimer, 2006)—and is particularly recognised for its gallery of River Red Gums as well as wetlands (Parks Victoria, 2011c).

In addition, Foreman *et al.* (2004) described the park as a bio-site based on the following factors:

- Presence of state threatened species (such as Growling Grass Frog *Litoria raniformis*, Macquarie Perch *Macquaria australasica* and River Swamp Wallaby-grass *Amphibromus fluitans*) upstream and downstream of the site which may colonise the area if habitat restored/created.
- It is an EPA Victoria monitoring point for assessing the environmental health of streams in the Yarra River Catchment.

This designation has led to Manningham City Council identifying this park as a high priority with regards to bushland management (Manningham City Council, 2012). Lorimer *et al.* (2009) and Lorimer (2006) also identify Yarra Flats Park (as part of the greater Yarra River) as an important and strategic corridor for wildlife movement within the Manningham and Boroondara City Council areas respectively.

Wetland habitats are located within the Yarra Flats area. A significant feature of the Yarra River in this area is the presence of a low-level terrace approximately two metres below the floodplain that is subjected to a greater degree of scouring from high flows (Lorimer, 2006). This aids in a greater degree of regeneration of indigenous plants in the littoral zone of the Yarra River (Lorimer, 2006). Platypus (*Ornithorhynchus anatinus*) were observed in the Yarra Flats Park in 2005 (Lorimer, 2006) and as recently as 2017 (Platypus Spot Database).

### 6.3 Yarra Valley Parklands

The Yarra Valley Parklands have been significantly modified by rural and urban activities as early as the 1830s, yet are still identified as being of high environmental significance at national, state and regional level (Parks Victoria, 2008).

Today's remaining vegetation communities provide a major corridor for wildlife, facilitating the movement and dispersal of animals, helping to maintain or increase the genetic diversity of fauna and flora. This has been bolstered by extensive revegetation over the past two decades which has connected remnant communities and increased biodiversity (Parks Victoria, 2008).

The parklands are part of two Victorian bioregions—Gippsland Plain in the west and Highlands – Southern Fall in the east—with the boundary occurring along Diamond Creek. (Parks Victoria, 2008). A total of 16 different EVCs have historically been mapped across the area, eight of which are endangered (DoNRE, 2002).

The EVCs support over 600 flora species, of which 31 are classified as threatened in Victoria (DSE, 2005b). A further three are listed under the FFG Act and four (Rosella Spider-orchid *Caldenia rosella*, Wine-lip Spider-orchid *Caladenia oenochila*, Matted Flax-lily *Dianella amoena*, and Clover Glycine *Glycine latrobeana*) are listed under the EPBC Act (Parks Victoria, 2008).

With respect to fauna, 235 species have been recorded within the area, 35 of which are classified as threatened under Victorian legislation (DSE, 2007, in Parks Victoria, 2008); 25 are FFG Act-listed and 9 are EPBC Act-listed (DEWHA 2000, in Parks Victoria, 2008), making the present ecological communities a significant fauna habitat.

There are nine nationally listed species that particularly rely on the provided habitats: Australian Grayling *Prototroctes maraena*; Common (Southern) Bent-wing Bat *Miniopterus schreibersii*; Grey-headed Flying-fox *Pteropus poliocephalus*; Macquarie Perch *Macquaria australasica*; Murray Cod *Maccullochella peelii*; Australian Painted Snipe *Rostratula australis*; Regent Honeyeater *Anthochaera phrygia*; Swift Parrot *Lathamus discolor* and Growling Grass Frog (reported as Warty Bell Frog) *Litoria raniformis* (Parks Victoria, 2008). Other species depending on the ecological communities are migratory birds, of which six, including Latham's Snipe *Gallinago hardwickii*, are listed under the JAMBA/CAMBA treaties.

#### 6.3.1 Birrarrung Park

Birrarrung Park is located at the confluence of the Plenty River and Yarra River and includes two large ephemeral wetlands. Platypus (*Ornithorhynchus anatinus*) were observed in the Yarra River in Birrarrung Park during 2017 (Platypus Spot Database).

#### 6.3.2 Banksia Parklands

Banksia Park is located on the Yarra River at Bulleen. Similar to the Yarra Flats Park, Banksia Park comprises mostly Floodplain Riparian Woodland (Endangered) and is characterised by River Red Gum and wetlands.

Although almost all native vegetation was removed in the 1800s, remnant patches still exist, particularly along the riverbank. The clearing led to the disappearance of most fauna populations but exceptions such as small wombat populations and populated wetland habitats exist (for frogs, insects and birds) (Parks Victoria, 2011a).

## 6.4 Warringal Parklands and Banyule Flats

Practical Ecology (2017b) is the most recent and comprehensive ecological report outlining the natural values within the Warringal Parklands and Banyule Flats. The findings of this report, summarised below, were based heavily on a field program conducted over a two and half year period, and a report by Australian Ecosystems (in Practical Ecology, 2007a).

The ecological assessment identified a number of EVCs within the Warringal Parklands and Banyule Flats that have been significantly influenced by historic land-clearing and human usage. Historically, the area comprised River Red Gum Woodland and Box and Stringybark forest communities (Context, 2014). Today, the majority of the area consists of Floodplain Riparian Woodland, with certain creek areas comprising Creekline Grassy Woodland. Drier, more terrestrial EVCs include Plains Grassy Woodland and Grassy Woodland. The EVCs in the wetlands of Banyule Flats largely fall under the collective labels of Billabong Wetland Aggregate and/or Floodplain Wetland Aggregate. These EVCs occur in very fine-scale mosaics and reflect changes in hydrological cycles spatially and temporally.

Many large trees, including River Red Gums, occur within the Warringal Parklands and Banyule Flats. These trees are significant due to their large size and senescence (deterioration with age), leading to the development and presence of hollows of varying sizes.

Six rare or threatened flora species are known to occur within the reserve, including

- Short Water-starwort *Callitriche brachycarpa*
- Winged Water-starwort *Callitriche umbonata*
- Arching Flax-lily *Dianella longifolia* var. *grandis*
- Studley Park Gum *Eucalyptus Xstudleyensis*
- River Swamp Wallaby-grass *Amphibromus fluitans*
- Basalt Peppercress *Lepidium hyssopifolium*.

Specific note must be given to the Basalt Peppercress records in the study area, which are historic and recent survey programs have not managed to confirm a continuous presence. As such the species is now believed to be extinct in the Greater Melbourne area.

Other historically recorded species include River Swamp Wallaby-grass, which was last recorded in 1995. The species may be persisting in the seedbank and could re-emerge on site. Additionally, it also appears to be a highly mobile species, being able to re-colonise from further up the floodplain either directly or through animal vectors.

Short Water-starwort was also a confirmed record in Banyule Swamp and as such Banyule Flats is one of the few localities in which the species occurs in Victoria and Melbourne specifically (Practical Ecology, 2017b).

One recently recorded threatened species within the area is Arching Flax-lily, with specimens observed within revegetation plantings (Practical Ecology, 2017b).

The area supports a variety of fauna species, particularly wetland birds such as the White-faced Heron *Egretta novaehollandiae* and Latham's Snipe *Gallinago hardwickii* (Banyule City Council, 2018; Parks Victoria, 2011a).

Banyule Flats supports a range of habitats including permanent open water, well-vegetated shallow and deep freshwater marshes, permanent waterways, remnant trees, plantations of native trees and shrubs, flat open exotic grassland, and a steep escarpment. As a result, Banyule Flats is known to support a diverse range of fauna (Osler and Cook, 2007).

Practical Ecology assessed the Banyule Flats area in 2017 (Practical Ecology, 2017) and recorded 120 fauna species. Desktop searches identified 80 national or state-listed threatened fauna relevant to the site (five-kilometre buffer). Of these species, the following 21 threatened and migratory fauna are considered to have a moderate or high likelihood of occurrence:

- Grey Goshawk *Accipiter novaehollandiae*
- Australasian Shoveler *Anas rhynchos*
- Eastern Great Egret *Ardea modesta* (=alba)
- Hardhead *Aythya australis*
- Musk Duck *Biziura lobata*
- Australasian Bittern *Botaurus poiciloptilus*
- Little Egret *Egretta garzetta*
- Black Falcon *Falco subniger*
- White-throated Needletail *Hirundapus caudacutus*
- Little Bittern *Ixobrychus minutus*
- Swift Parrot *Lathamus discolor*
- Lewin's Rail *Rallus pectoralis*
- Growling Grass Frog *Litoria raniformis*
- Macquarie Perch *Macquaria australasica*
- Barking Owl *Ninox connivens*
- Powerful Owl *Ninox strenua*
- Blue-billed Duck *Oxyura australis*
- Baillon's Crake *Porzana pusilla*
- Grey-headed Flying-fox *Pteropus poliocephalus*
- Australian Painted Snipe *Rostratula australis*
- Latham's Snipe *Gallinago hardwickii*.

Banyule Flats is also identified as providing habitat of high value for the Swift Parrot (*Lathamus discolor*) (Practical Ecology, 2017c). Within a broader area centred on the City of Banyule, Banyule Flats was notable for having a large number of historical records of this species (post-1950), and for offering a relatively high quality canopy cover. Banyule Flats was also identified as an important location for Swift Parrot movements, providing an important habitat link between the Yarra River and Plenty Gorge, following the Plenty River.

Banyule Flats includes a large section of old river channel (Banyule Billabong), the remnants of a large back swamp (Banyule Swamp), and a number of smaller floodplain depressions (Olser and Cook, 2007). Banyule Billabong is a deep freshwater marsh (< 2 metres) which remains flooded for most of the year but may dry out once every four to five years. The smaller eastern billabong is a herb-dominated freshwater meadow typically 0.3 metres deep and wet for less than four months per year.

The hydrology of Banyule Billabong and Banyule Swamp are heavily modified, with the billabong being occasionally filled by pumping from the Yarra River by Melbourne Water, in the absence of overbank flooding that has been reduced due to river regulation. The aquatic ecosystem condition of the billabong is highly variable with hydrological regime, and has become increasingly terrestrialised. Banyule Swamp is artificially maintained as a large shallow lake, with fringing aquatic vegetation. The inflows from stormwater, and overbank flows from Banyule Creek support a relatively permanent aquatic ecosystem.

Due to stormwater inputs the waterbodies in Banyule Flats are reported to have high phosphorus concentrations and macroinvertebrate communities are indicative of severe pollution (Olser and Cook, 2007). European Carp (*Cyprinus carpio*) have been observed (Fleming, 2003) and Short-fin Eel (*Anguilla australis*) are also known to occur (Olser and Cook, 2007). It has been suggested that Southern Pygmy Perch (*Nannoperca australis*) and Dwarf Galaxias (*Galaxiella pusilla*) are likely to (or should) occur in the wetlands but only three exotic species (Mosquitofish *Gambusia holbrooki*, Weatherloach *Misgurnus anguillicaudatus* and Goldfish *Carassius auratus*) were observed in a recent study (see Ewen and Stephens, 2017).

The Australian Platypus Conservancy has indicated there have been several Platypus (*Ornithorhynchus anatinus*) sightings as far downstream as the Salt Creek confluence with the Yarra River at the edge of Warringal Parklands. The Platypus Spot Database includes sightings in the Yarra River as recently as 2017. It is also highly likely that Rakali (Water Rats *Hydromys chrysogaster*) inhabit Banyule Swamp (Ewen and Stephens, 2017). Australian Freshwater Shrimp (*Paratya australiensis*) and Common Yabby (*Cherax destructor*) have also been observed in Banyule Flats (Ewen and Stephens, 2017).

## 6.5 Bolin Bolin Billabong

Bolin Bolin Billabong is a high value ox-bow billabong on the floodplain of the Yarra River that covers 3.7 hectares and is one of the few wetlands in this area of Melbourne whose geomorphology has not been modified since European settlement. The billabong is heavily influenced by the hydrological regime, with recent management by Melbourne Water including active watering of the billabong by pumping water from the Yarra River. The billabong does not receive urban stormwater runoff, and so the water and sediment quality is not impacted by artificially elevated metals of other urban contaminants, other than general landscape inputs (Leahy, 2007). The eastern-most deep pool of the billabong is understood to be maintained by groundwater and is regarded as a permanent wetland that dries occasionally (Jacobs Group, 2016). The northern and southern arms of the billabong are not permanently wet, and the condition of the aquatic ecosystem varies greatly.

This area has been subject to a history of clearing from the 1940s to 1970s (James *et al.*, 2014). Revegetation works were undertaken approximately 25 years ago resulting in a substantial improvement in ecological values at the site (James *et al.*, 2014).

Key ecological features in the vicinity include the presence of large old River Red Gum *Eucalyptus camaldulensis*, and other commonly present native species including Manna Gum *Eucalyptus viminalis*, Swamp Paperbark *Melaleuca ericifolia*, Prickly Currant Bush *Coprosma quadrifida* and Silver Wattle *Acacia dealbata*. EVCs on the site were identified as significantly modified Floodplain Riparian Woodland and Floodplain Wetland Aggregate (James *et al.*, 2014).

Parks Victoria (2006) identified a number of EPBC Act-listed and VROT species including River Swamp Wallaby-grass, Veiled Fringe-sedge *Fimbristylis velata* and Floodplain Fireweed *Senecio campylocarpus*. No threatened flora were identified during the field assessment conducted by James *et al.* (2014).

With respect to fauna, the abundance of large hollow-bearing eucalypts (River Red Gums, Manna Gums) provides suitable habitat for a variety of arboreal hollow nesting species such as parrots, Laughing Kookaburra *Dacelo novaeguineae*, Sugar Glider *Petaurus breviceps*, Common Brushtail Possum *Trichosurus vulpecula*, Common Ringtail Possum *Pseudocheirus peregrinus*, insectivorous bats, Southern Boobook Owl *Ninox novaeseelandiae* and Australian Owlet Nightjar *Aegotheles cristatus* (James *et al.*, 2014).

The site is known to support a range of bats, birds, frogs, reptiles, and mammals (ABEZCO 2014, Parks Victoria 2006). ABEZCO (2014) identified a range of habitats including riparian floodplain and artificial drainage line wetland that are suitable for common, locally and regionally significant fauna species and at least one state-listed species in the form of foraging habitat for the Powerful Owl *Ninox strenua*. There is also a known nesting hollow for a pair of Powerful Owl less than a kilometre from the Bolin Bolin Billabong site on the banks of the Yarra River (ABEZCO, 2014) and breeding populations of Red-rumped Parrot *Psephotus haematonotus* and Sacred Kingfisher *Todiramphus sanctus* have been recorded on site in mature tree hollows (Parks Victoria, 2006).

Threatened fauna previously recorded on site include the state-listed Hooded Robin *Melanodryas cucullata* and Murray River Turtle *Emydura macquarii* (though this population is introduced) (Parks Victoria, 2006). No other threatened fauna were considered likely to make use of the site (ABEZCO, 2014).

The wetland is known to support Short-finned Eel *Anguilla australis*, European Carp *Cyprinus carpio* and Flat-headed Gudgeon *Philypnodon grandiceps* (Melbourne Water, 2017), but the presence of other fish species may be dependent on the connectivity with the Yarra River during overbank flood events. Predation by Carp is also anticipated to impact on native fish species (Melbourne Water, 2017).

## 6.6 Plenty River Flats

This area is valued for its River Red Gum (alluvial plains) grassy woodland areas, which are considered to be one of the most extensive representations of this habitat in the eastern parts of Melbourne (Nillumbik Shire Council, 1997). The site represents a strategic habitat link between the parklands of Banyule Flats along the Yarra River and Bonds Road ultimately linking to Simpson Barracks (Nillumbik Shire Council, 1997).

Key vegetation communities at the site include Manna Gum gully woodland, Long-leaf Box – Manna Gum escarpment woodland, River Red Gum grassy woodland, River Red Gum riparian woodland and Manna Gum floodplain riparian woodland (Nillumbik Shire Council, 1997).

The area provides habitat for a range of rare or threatened fauna including Swift Parrot *Lathamus discolor* (Nillumbik Shire Council, 1997; Practical Ecology 2017c).

## 6.7 Koonung Creek

Koonung Creek rises near Nunawading and follows the Eastern Freeway along much of its length before entering the Yarra River at Bulleen. The creek has a highly modified catchment, and receives high volumes of urban stormwater drainage. The channel has been extensively modified in the landscape, with erosion control works, tunnelling, and realignment all impacting the natural geomorphology and instream habitat of the waterway.

Pre-1750 EVCs mapped along Koonung Creek include: Floodplain Riparian Woodland; Floodplain Wetland Complex; Plains Grassy Woodland; Creekline Grassy Woodland; Swampy Riparian Complex and Valley Heathy Forest. Current studies suggest that Swampy Riparian Woodland, Valley Heathy Forest, Valley Grassy Forest and Creekline Grassy Woodland remain (Foreman *et al.*, 2004; Manningham City Council, 2011; Manningham City Council, 2012; Practical Ecology, 2017b; Lorimer, 2006).

Koonung Creek has been classified as a regionally significant biosite, being greater than one hectare, containing two EVCs that have a high or very high conservation status (Swampy Riparian Woodland and Valley Heathy Forest). It is also considered to be of high priority for bushland management (Foreman *et al.*, 2004; Manningham City Council, 2011; Manningham City Council, 2012). Overall, native vegetation within Koonung Creek consists of small remnants adjacent to the creek, surrounded by open parkland or extensive revegetation undertaken by Melbourne Water and Manningham City Council (Manningham Council, 2011). No threatened flora species were identified during surveys in 2006 or 2016 conducted by Practical Ecology (2017a).

Lorimer (2006) and Lorimer *et al.* (2009) also identified Koonung Creek as an important and strategic ecological corridor for wildlife movement within the Manningham City Council and City of Boroondara Council areas. Practical Ecology (2017) recognised the habitat available within the bushland of Koonung Creek Reserve will always be limited by the small size of patches, the patches' location amongst dwellings and along a recreational trail, and the surrounding urban environment. Herman (2016) evaluated the efforts of volunteer bird-watcher standardised surveys along Koonung Creek Reserve, and reported that despite mostly common species being detected, some urban-sensitive species were detected frequently also.

Overall, most of the Manningham sites along Koonung Creek remain in a considerably unmodified condition dominated by indigenous species (Manningham Council, 2011), providing suitable habitat for movement of fauna species, such as birds (Lorimer, 2006). Lorimer (2006) identifies the Koonung Creek as an ecological corridor within Boroondara, which still facilitates movements of some bird species. Much of the corridor is parkland that is regularly mowed but interspersed with planted trees, shrubs and some remnant trees and patches. There are several wetlands which are used by common birds such as herons and cormorants for feeding and some sites may be suitable for breeding. Wetlands in the area are known to contain the pest species Mosquitofish *Gambusia holbrooki* (Lorimer, 2006).

Practical Ecology (2017) found a lack of large trees within the remnant bushland patches. This has implications for breeding by owls, at least in the short to medium term. Practical Ecology (2017) also concluded that if a large tree dies, the remaining trunk and branches still provide habitat in remaining hollows, and when branches fall off coarse woody debris for ground-dwelling fauna.

The aquatic ecosystem condition of Koonung Creek is consistently assessed as poor to very poor (Melbourne Water, 2013). Major threats include sedimentation, road runoff and degraded water quality, habitat disturbance and direct impacts to aquatic fauna (GHD, 2011). Several exotic fish species inhabit Koonung Creek including Oriental Weatherloach (*Misgurnus anguillicaudatus*), Roach (*Rutilus rutilus*), Mosquitofish (*Gambusia holbrooki*) and Redfin (*Perca fluviatilis*) (Lorimer, 2006). Native aquatic species known to occur are Common Galaxias (*Galaxias maculatus*), Climbing Galaxias (*Galaxias brevipinnis*), Short-finned Eel (*Anguilla australis*) and Common Yabby (*Cherax destructor*) (Lorimer, 2006; GHD, 2011). Spotted Galaxias (*Galaxias truttaceus*) is also reported to live within Koonung Creek (Melbourne Water, 2013). There are no records of Platypus (*Ornithorhynchus anatinus*) within Koonung Creek (Platypus Spot Database) and the current status of Platypus populations are considered low (Melbourne Water, 2018).

## 6.8 Mullum Mullum Park

The Mullum Mullum Park is characterised by a total of four major EVCs, including Valley Heathy Forest (Endangered), Swampy Riparian woodland (Endangered), Valley Grassy Forest and Herb-rich Foothill Forest (Parks Victoria, 2012).

The park is located on the western fringe of the Gippsland Plain Bioregion and provides suitable habitat for a wide diversity of flora species, including numerous orchids and other plant species listed as protected under the FFG Act (Parks Victoria, 2012).

Of particular note within this park is the remnant extent of the Valley Heathy Forest EVC, as it is considered to be a significant representation of this community within the bioregion (Parks Victoria, 2012).

## 6.9 Trinity Grammar School Sporting Complex Wetlands, Bulleen

Osler *et al.* (2007) conducted a study on behalf of Manningham City Council to characterise the ecological values of the wetland within the Trinity Grammar School Sporting Complex.

The wetlands within the complex consist of four distinct wetland features, with Wetlands A and B being located within or adjacent to the current project boundary. These wetland units consisted of Floodplain Wetland Aggregate (Wetland A) and Wet Verge Sedgeland (Wetland B) EVCs.

During field survey, Osler *et al.* (2007) identified the EPBC Act-listed species River Swamp Wallaby-grass *Amphibromus fluitans* in Wetlands B and D. The VROT species Short Water-starwort *Callitriche brachycarpa* was observed in Wetland D, on the exposed banks of the wetland within the Floodway Pond Herbland (EVC 810).

The Australian Ecosystems (2007) survey identified a diverse range of fauna habitats from widespread features such as sporting ovals to other rarer features such as deep, well-vegetated marshes, which may support threatened species. The site is expected to support an array of fauna species especially water-fowl and common woodland and open-space birds.

Parts of the site, including the wetland within the project boundary may support threatened and/or migratory species such as:

- Baillon's Crake *Porzana pusilla*
- Hardhead *Aythya australis*
- Musk Duck *Biziura lobata*
- Latham's Snipe, *Gallinago hardwickii*
- Little Egret *Egretta garzetta*
- Eastern Great Egret *Ardea modesta* (=alba)
- Regent Honeyeater *Anthochaera phrygia*
- Growling Grass Frog *Litoria raniformis*
- Glossy Grass Skink *Pseudemoia rawlinsoni*.

Though the only threatened fauna recorded during the survey were the Eastern Great Egret and Baillon's Crake. Wetland D (the wetland furthest from the project boundary) is noted to support the threatened Growling Grass Frog though there is no reference to when this was recorded and it is not in any state database.

The wetlands in Trinity College are either highly altered or artificially created (Osler *et al.*, 2007). They are all freshwater, receiving runoff and stormwater inputs from the urban landscape and consequently, have high nutrients concentrations, particularly phosphorus (Osler *et al.*, 2007). Macroinvertebrate communities in the wetlands are indicative of high and/or severe pollution levels (Osler *et al.*, 2007). Introduced European Carp (*Cyprinus carpio*) are known to exist in the wetlands along with the Short-finned Eel (*Anguilla australis*) (Osler *et al.*, 2007). It is also likely they support Rakali (Water Rat *Hydromys chrysogaster*) (Osler *et al.*, 2007).

#### 6.10 Kew Golf Club

The areas assessed as Kew Golf Club within the project boundary are encompassed within the 'Burke Road Billabong, Kew East' and 'Kew Golf Club' sites described within Lorimer (2006). Lorimer (2006) describes the area as containing two EVCs—Floodplain Riparian Woodland and Floodplain Wetland Complex—as well as viable breeding populations of numerous flora and fauna species that are threatened in Boroondara or state-wide, and part of a major ecological corridor along the Yarra River and containing large River Red Gums *Eucalyptus camaldulensis*.

The topography of the floodplain and the natural flood regime has been substantially modified by the golf course. However, the remaining billabongs still represent quite significant habitat for flora and fauna. The largest billabong was dammed to create Simpsons Lake which is home to the only breeding colony of Australasian Darters *Anhinga novaehollandiae* in Melbourne and several other waterbird species were observed breeding including Great Cormorant *Phalacrocorax carbo*, Little Black Cormorant *Phalacrocorax sulcirostris*, Little Pied Cormorant *Phalacrocorax melanoleucos* and Nankeen Night Heron *Nycticorax caledonicus* (Lorimer, 2006).

Lorimer (2006) considered the billabong excellent habitat for invertebrates, potentially containing native fish, possibly good habitat for Platypus (*Ornithorhynchus anatinus*) that have been observed in the adjacent Yarra River along with Rakali (Water Rat *Hydromys chrysogaster*). This is despite the fact that the removal of riparian vegetation and nutrient inputs from the golf course appears to have substantially reduced the habitat available for waterbirds and aquatic life in general.

The site includes part of what is an almost unbroken corridor of vegetation extending along the Yarra River upstream from the Yarra Bend Park (Lorimer, 2006). Perhaps surprisingly, targeted camera surveys for the Sugar Glider (*Petaurus breviceps*) at a range of locations along the Yarra floodplain (Van der Ree, 2017) resulted in no detection of this species at five locations at Kew Golf Course, despite the species being detected upstream and downstream of those sites.

#### 6.11 Kew Billabong, Willsmere Park

Willsmere Park is a public parkland beside the Yarra River comprised of sporting grounds and trails but which also contains some of Boroondara's most ecologically intact representation of the endangered Floodplain Riparian Woodland EVC and the billabong is expected to comprise Floodplain Woodland Complex EVC (Lorimer, 2006). The Kew Billabong within Willsmere Park is one of many meander cut-offs (ox-box) billabongs along the Yarra River. The natural flooding and drying regime has been altered by pumping water into or out of the billabong, but when the billabong does contain water it provides good habitat for a range of wetland fauna, particularly waterbirds. Some of the rarer waterbirds have been recorded at Kew Billabong (such as Little Egret, *Egretta garzetta*; BLA, 2016), but are easily frightened off and considered unlikely to breed there (Lorimer, 2006). Overbank flows from the Yarra River used to occur every year but now occur only three to four years. Historically, the billabong would fill every three years but this now only occurs every 30 years.

When full, the Kew Billabong has been noted to provide good habitat for Platypus (*Ornithorhynchus anatinus*), waterbirds and frogs (Lorimer, 2006). Rakali (Water Rat *Hydromys chrysogaster*) have been observed in the billabong along with European carp (*Cyprinus carpio*) that contribute to elevated turbidity (Lorimer, 2006). The site is considered a node of the major ecological corridor that is the Yarra River (Lorimer, 2006).

The aquatic ecosystem condition of Kew Billabong is impacted by urban stormwater runoff that provides greater than natural levels of water and sediment pollutants. This contamination may be impacting the aquatic ecosystem, through acute or chronic toxicity (Leahy, 2007). In fact, a limited study undertaken by Landform-Australia (1986) of the water quality conditions and aquatic plants concluded the billabong was highly eutrophied.

Fauna surveys have been done in specific parts of the lower Yarra floodplain in recent years. Herman (2016) evaluated the efforts of volunteer bird-watcher standardised surveys at Willsmere Park, and reported that despite mostly common species being detected, urban-sensitive species were also frequently detected. Targeted camera surveys for the Sugar Glider (*Petaurus breviceps*) at a range of locations along the Yarra floodplain (Van der Ree, 2017) resulted in detection of this species at one of five locations at Kew Billabong, Willsmere Park. Detection of the Sugar Glider at this location demonstrates the continued importance of the Yarra River habitats for native fauna.

## 6.12 Kilby Reserve/Hays Paddock

Hays Paddock is public parkland that straddles Glass Creek on the edge of the Yarra floodplain and contains recreational areas, woodland, creek line and billabongs. The site includes endangered EVC Floodplain Wetland Complex, and Floodplain Riparian Woodland. The site is on the edge of the major ecological corridor along the Yarra River, at the junction with the Glass Creek corridor (Lorimer, 2006).

The billabong in the north of the site was once part of Simpsons Lake within Kew Golf Course. The construction of the Eastern Freeway in the 1970s resulted in the intersection of this wetland system; it was then engineered to provide habitat for wetland flora, fauna and invertebrates and left to revegetate naturally (Lorimer, 2006).

Glass Creek is a highly modified waterway subject to water pollution and replaced by pipe upstream (Lorimer, 2006). Major threats to Glass Creek include sedimentation, road runoff and degraded water quality, habitat disturbance and direct impacts to aquatic fauna (GHD, 2011). Glass Creek provides habitat for frogs and some fish, such as the migratory Common Galaxias *Galaxias maculatus* and Broadfin Galaxias *Galaxias brevipinnis* that have been found a short distance upstream (Lorimer, 2006).

Birds have been observed flying between habitats both north and south of the freeway (including Nankeen Night Heron *Nycticorax caledonicus* and Australasian Darter *Anhinga novaehollandiae*). For these species the Hays Paddock billabong represents an extension of the habitat at Kew Golf Course (Lorimer, 2006).

The FFG Act listed Eastern Great Egret *Ardea modesta* (= *alba*) has been observed at this site. A suite of common frogs have been recorded from the site but threatened species are notably absent (Lorimer, 2006).

### 6.13 Simpson Barracks

Simpson Barracks is an operational Defence base on 131 ha (Jacobs, 2016). It is situated on fertile soils that support Plains Grassy Woodland with a species rich grassy and herbaceous ground layer (Jacobs, 2016 and HLA, 2007). There are two natural drainage systems on the site; the east side drains to Yallambie Drain which runs into the Plenty River and the west side includes the upper catchment of Banyule Creek which drains into the Yarra River (Jacobs, 2016).

Simpson Barracks has been extensively studied over the last couple of decades, so much is known about the ecological values it supports.

The headwaters of Banyule Creek are within Simpson Barracks. Although flora and fauna studies have been undertaken within the barracks, little is known about the aquatic ecosystem values of the creek, or other aquatic habitats of small wetlands. Substantial erosion of the drainage lines are indicative of high flows that occasionally occur and there is also evidence of undercut banks and accumulation of organic debris (Jacobs, 2016).

Simpson Barracks contains a range of significant environmental values including Commonwealth and Victorian listed flora and fauna and several ecological vegetation classes. Of particular importance within the barracks are:

- A significant population of Matted Flax lily *Dianella amoena* (Commonwealth and state-listed)
- A population of Studley Park Gum *Eucalyptus Xstudleyensis* (DELWP Advisory-listed).

Previous assessment of Simpson Barracks identified potential habitat for three threatened fauna: Swift Parrot *Lathamus discolor*, Grey-headed Flying-fox *Pteropus poliocephalus* and Brown Toadlet *Pseudophryne bibroni* (Jacobs, 2016). HLA-Envirosciences Pty Ltd (2007) assessed flora and fauna in September 2006, including Elliot and pitfall trapping for fauna. During that assessment, no Swift Parrots, Grey-headed Flying-foxes, or Brown Toadlets were seen or heard, no small mammals were captured, and no threatened reptiles were detected. Potential habitat for each of these species occurs on both the east and west sides of the Barracks. HLA (2007) recorded higher fauna diversity in the eastern section of Simpson Barracks than in the western section.

HLA-Envirosciences Pty Ltd (2007) reported similar habitat findings to those for this impact assessment: typically lower than expected fauna diversity in the western part of Simpson Barracks, perhaps due to the 'prevalence of aggressive bird species such as Noisy Miner *Manorina melanocephala*, Rainbow Lorikeet *Trichoglossus haemotodus*, Australian Magpie *Gymnorhina tibicen* and Common Myna *Acridotheres tristis*'. HLA (2007) concluded: 'The low observed bird diversity probably also reflects the modified nature of much of the Barracks as well as the isolated nature of the remnant habitat'. Trees at Simpson Barracks are likely to have roosting importance for insectivorous bats (Microchiroptera) (HLA-Envirosciences Pty Ltd, 2007).

Numerous reports identify Simpson Barracks as providing potential habitat for the Swift Parrot (*Lathamus discolor*) and there is one historical record of the species from the eastern section of the land (VBA, 1992). Within a broader area centred on the City of Banyule, Practical Ecology (2017c) found that Simpson Barracks provided Swift Parrots with canopy opportunities of intermediate quality (middle of five categories) and tree basal area (an overall index of tree size) to be low (second lowest of five categories). However, the tree canopy health at Simpson Barracks was judged to be relatively good (fourth highest of five categories) and better than other notable areas of potential habitat that were included in the study (La Trobe University and Gresswell, Plenty Gorge area and Yarra Bend Park) (Practical Ecology, 2017c).

Overall, the Practical Ecology (2017c) assessment found that across the City of Banyule and surrounding areas, Simpson Barracks provided habitat opportunities of 'Secondary' rank for the Swift Parrot, compared with areas of highest (Principal) rank, which included the Yarra River floodplain (from Yarra Bend Park through to Banyule Flats), Plenty Gorge, and La Trobe University/Gresswell area.

The area surrounding Simpson Barracks is a dense urban landscape. The barracks site is considered 'closed', being entirely fenced by security mesh fencing, which restricts movement of large mammals such as Eastern Grey Kangaroo *Macropus giganteus* (EGK). The barracks supports a small population of EGK, which is considered 'closed' to immigration and emigration, and space and resources are critical to the population's viability. Smaller animals or more mobile fauna are able to move along the waterways into and out of the site or fly over the fences (Jacobs, 2016).

As a 'closed' site, there have been numerous studies of the EGK population at Simpson Barracks to estimate kangaroo abundance and density, the degree of migration into and out of the site or whether they are resident within boundaries of the barrack (Defence, 2007 [as cited in Aecom, 2011]; Aecom, 2011; Wilson, 2014; Aecom, 2015). The origins of the EGK population at the barracks are unknown.

Aecom (2015) reported that approximately 52 hectares of Simpson Barracks is grassy woodland vegetation that provides suitable habitat for EGK. In addition to the woodland areas, the barracks contains numerous areas around buildings where the grass is mowed, two large grassed sports fields and one large grassed parade ground (Long Green) that is watered during the summer (Wilson, 2014). The carrying capacity at the site is unknown, and whether or not the site is truly 'closed' to EGK migration is uncertain (AECOM, 2015).

#### 6.14 Yarra River

The Yarra River is managed by Melbourne Water as three systems – 'upper', 'middle' and 'lower' Yarra. The lower Yarra system lies downstream from Templestowe and is the focus of this assessment. Dights Falls is located in the lower Yarra system and forms a distinct barrier between freshwater and estuarine environments (Melbourne Water, 2013). The lower Yarra system is managed by Melbourne Water to protect seven key values. Of these, three are obligate aquatic values – fish, platypus and macroinvertebrates. The existing condition of these values are considered 'low', 'moderate' and 'low', respectively (Melbourne Water, 2018). This indicates that few freshwater native fish species recorded in the catchments are likely to be present, a moderate likelihood that habitat is present to support platypus *Ornithorhynchus anatinus* and poor waterway health – indicated by a low number of macroinvertebrate families predicted to be present. However, there have been several sightings of Platypus in the lower Yarra River as recently as 2017 (Platypus Spot Database).

There are a number of native fish species in the Yarra River. This includes Macquarie Perch (*Macquaria australasica*) that has developed a self-sustaining population that would persist in the absence of re-stocking (Lorimer, 2006). The Macquarie Perch population in the Yarra River is now larger than in any stream where it naturally occurred, thereby making a major contribution to the maintenance of this nationally endangered species (Lorimer, 2006). There are a number of environmental values associated with the lower Yarra River such as significant flora and fauna species including the threatened Australian Grayling (*Prototroctes maraena*) and Australian Mudfish (*Neochanna cleaveri*) (Melbourne Water, 2013).

Exotic species in the Yarra River include European Carp (*Cyprinus carpio*) and Eastern Gambusia (Mosquitofish) (*Gambusia holbrooki*) and Oriental Weatherloach (*Misgurnus anguillicaudatus*) (Lorimer, 2006).

Terrestrial fauna surveys have been conducted in specific parts of the Yarra River floodplain in the Kew/Ivanhoe/Bulleen area in recent years. A survey by Practical Ecology (2010) within the Freeway Public Golf Course detected Latham's Snipe (*Gallinago hardwickii*) and the Grey-headed Flying-fox (*Pteropus poliocephalus*). Targeted camera surveys for the Sugar Glider (*Petaurus breviceps*) at a range of locations along the Yarra floodplain (Van der Ree, 2017) detected this species at five locations on the south side of the Yarra River, east of Burke Road, and at three locations at western end of the Freeway Public Golf Course. Detection of the Sugar Glider at these locations demonstrates the continued importance of the Yarra River habitats for native fauna.

### 6.15 Banyule Creek

Banyule Creek extends from headwaters in Simpson Barracks before flowing into the Banyule Flats Reserve. Further downstream, the creek joins the Yarra River. Banyule Creek is highly modified and receives urban runoff, has a realigned channel, very little native vegetation and contains a high diversity of introduced species (Olser and Cook, 2007). Upper reaches of Banyule Creek are subject to erosion during high flow periods (HLA Environmental, 2007) and bank stabilisation works have occurred in some areas (Context, 2014). Little is known about the aquatic values of the creek (HLA Environmental, 2007). Common Galaxias (*Galaxias maculatus*) are reported to be rare and Short-finned Eel (*Anguilla australis*) are a common resident of Banyule's waterways and wetland habitats. Exotic species including Mosquitofish (*Gambusia holbrooki*), European Carp (*Cyprinus carpio*) and Redfin (*Perca fluviatilis*) have also been reported in the creek (GHD, 2011). There are no records of Platypus (*Ornithorhynchus anatinus*) within Banyule Creek (Platypus Spot Database) although Banyule City Council acknowledge they are present in the area. The Council also suggests that Burrowing Crayfish (*Engaeus* spp.) also inhabit waterways in the area (Banyule City Council, 2018).

Practical Ecology (2017c) concluded that habitats along Banyule Creek provided a secondary movement corridor for the Swift Parrot (*Lathamus discolor*) within a broader area centred on the City of Banyule. More prominent movement corridors within the area were identified along the Yarra River, and branching out from the Yarra River along Darebin Creek, through Rosanna Parklands towards Gresswell Reserve, and along the Plenty River to Plenty Gorge.

### 6.16 Merri Creek

Merri Creek is managed as two units – with the catchment upstream from Craigieburn classified as 'rural and forested' and the lower catchment classified as 'urban' – which is the focus of this assessment. Merri Creek joins the Yarra River immediately upstream of Dights Falls. The urban catchment is subject to a number of threats to ecological condition, meaning that few freshwater native fish species are likely to be present (that is, low condition) and a very low likelihood the waterway supports Platypus (*Ornithorhynchus anatinus*) or sensitive macroinvertebrate families (very low condition) (Melbourne Water, 2018). However, it is reported that urban sections of the Merri Creek (downstream of Craigieburn Road to Dights Falls) and tributaries are home to endangered and vulnerable species such as Australian Mudfish (*Neochanna cleaveri*) and Spotted Galaxias (*Galaxias truttaceus*) (Melbourne Water, 2013). During the 2011/12 Platypus survey, none were captured in the urban section of Merri Creek although there were a number of reliable sightings in the previous 18 months (Melbourne Water, 2013). A broad study of the Yarra catchment by EPA Victoria (2000) indicated the lower Merri Creek failed to meet SEPP ecological objectives, indicating very poor waterway health.

## 6.17 Plenty River

The Plenty River is managed as three units – ‘source’ (that is, protected water harvesting sub-catchments), ‘upper’ and ‘lower’. The lower catchment (downstream from Yan Yean) meets the Yarra River at Viewbank and is the focus of this assessment. The lower portion of the river, downstream of Greensborough to the Yarra River confluence, has undergone extensive development and urbanisation (Lieschke *et al.*, 2000). The condition of the key aquatic values are described as ‘moderate’, ‘very low’ and ‘low’ for fish, platypus and macroinvertebrates. This indicates that approximately 50 per cent of native freshwater fish recorded in the catchment are likely to be present but a very low likelihood the lower Plenty River supports platypus (*Ornithorhynchus anatinus*). A low number of macroinvertebrate families are likely to be present, indicating poor waterway health (Melbourne Water, 2018). EPA Victoria (2000) also reported the Plenty River generally failed to meet SEPP ecological objectives, indicating poor waterway health. In the lowest sections around Greensborough, urban stormwater runoff and other associated impacts of urban development have reduced water quality over time, but may have contributed to increased flow (Melbourne Water, 2007).

Lieschke *et al.* (2000) suggest the Plenty River may provide habitat for the vulnerable Australian Grayling (*Prototroctes maraena*). Native fish species that have been recorded in the Plenty River are Short-finned Eel (*Anguilla australis*), River Blackfish (*Gadopsis marmoratus*), Common Galaxias (*Galaxias maculatus*), Ornate Galaxias<sup>10</sup> (*Galaxias ornatus*), Spotted Galaxias (*Galaxias truttaceus*), Short-headed Lamprey (*Mordacia mordax*), Southern Pygmy Perch (*Nannoperca australis*), Flat-headed Gudgeon (*Philypnodon grandiceps*) (Lieschke *et al.*, 2000). Exotic species are Goldfish (*Carassius auratus*), Carp (*Cyprinus carpio*), Gambusia (*Gambusia holbrooki*), Weatherloach (*Misgurnus anguillicaudatus*), Redfin (*Perca fluviatilis*), Roach (*Rutilus rutilus*) and Brown Trout (*Salmo trutta*) (Lieschke *et al.*, 2000).

Platypus (*Ornithorhynchus anatinus*) has been recorded in Plenty River upstream of Greensborough and in the lower reaches close to the confluence with the Yarra River (Melbourne Water, 2007) and in lower reaches as recently as 2017 (Platypus Spot Database). This is encouraging given that no platypus were captured at Lower Plenty and Plenty Gorge during the 2011/12 survey period (Melbourne Water, 2013). Rakali (Water Rat *Hydromys chrysogaster*) have also been recorded in the Plenty River catchment (Lieschke *et al.*, 2000, Williams & Serena, 2018).

None of the macroinvertebrate species found in the Plenty River are considered threatened in Victoria and there is a general trend to more depauperate communities towards the lower sections of the system (Lieschke *et al.*, 2000).

Within a broader area centred on the City of Banyule, Practical Ecology (2017c) identified habitats along the Plenty River, particularly in the Plenty Gorge section to the north, as being important to the Swift Parrot (*Lathamus discolor*). Plenty Gorge (along with La Trobe University and Gresswell, Plenty Gorge area, and Yarra Bend Park) was identified as a hotspot for the distribution of preferred feeding trees (eucalypt species), as having high quality canopy cover and overall tree size (basal area mapping). However, it was judged to have lower tree canopy health than other notable habitat areas. Based on a resistance to movement model, habitats along the Plenty River were found to provide a narrow movement corridor favourable for Swift Parrots, linking Banyule Flats with Plenty Gorge (Practical Ecology, 2017c).

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<sup>10</sup> previously reported as Mountain Galaxias (*Galaxias olidus*)

## 6.18 Streeton Views Estate

Cameron *et al.* (1999) prepared a report describing a botanical assessment of a vegetation patch located to the east of the Simpson Barracks. At least 45 indigenous plant taxa were identified within the 3.5 ha remnant vegetation patch, including the endangered *Dianella amoena* (Matted Flax-lily) and the natural hybrid *Eucalyptus Xstudleyensis* (Studley Park Gum).

With respect to *E. Xstudleyensis*, the Simpson Barracks site to the east of Greensborough Road was described as supporting the most extensive hybrid swarm of *Eucalyptus Xstudleyensis* known, including at least 53 established trees and numerous juveniles. At the time of the report, the Greensborough Road site was listed as the best of only three known populations which were thought to be ecologically viable; the other two were also located near the Simpson Barracks. The bulk of the remaining reported populations of *E. Xstudleyensis* in the state were either poorly if at all recruiting (11 sites), or misidentified (frequently with *Eucalyptus botryoides* x *camaldulensis*, 11 sites).

With respect to *Dianella amoena*, the Simpson Barracks site to the east of Greensborough Road was described as having the largest known population of *D. amoena* (at time of writing in 1999); however, a number of relatively large populations have been discovered in Victoria over the past 20 years since the species was first described. The site to the east of the barracks had a relatively intact understorey, which was thought to benefit the long-term survival of the population. The population of *D. amoena* at this site was considered large, with around 13 patches.

The report recommended that there should be no further development within the remnant stand to the east of the barracks in order to retain the environmental values. The proposed development area supported the second largest surviving viable population of *E. Xstudleyensis* (the largest and most viable population being the site east of Greensborough Road in Simpson Barracks). The area also supported the entire population of *D. amoena* within the remaining remnant to the east of the Barracks.

## 7. Existing conditions – flora

The existing conditions of the flora assets, values and uses being considered throughout this assessment are described in the following sections.

### 7.1 Summary – flora

The project boundary intersects 14 EVCs across three bioregions: Gippsland Plain, Victorian Volcanic Plain and Highlands–Southern Fall. The northern section of the project boundary is characterised by undulating hills within the Highlands–Southern Fall bioregion, which drains to the Plenty River, and flat basaltic plains within the Victorian Volcanic Plain, west of the M80 Ring Road intersection. The middle section of the project boundary includes the north-south extent of the project and includes large areas within the Gippsland Plain bioregion, encompassing an area including the Yarra River, its low-lying floodplain including oxbow lakes and waterways associated with Banyule Creek. The southern section of the project boundary runs east-west and is associated with the Eastern Freeway and generally tracks the path of Koonung Creek to the east and the Yarra River to the west.

Native vegetation within the project boundary is generally in poor-moderate condition, with the ecological values present largely reflecting the long history of urban land use throughout the surrounding landscape. However, despite the highly urbanised landscape, the project boundary does contain substantial ecological values, particularly in the following areas:

- Simpson Barracks
- The Yarra River, its floodplains and parks (Warringal Parklands and Banyule Flats, Bolin Bolin Billabong, Kew Billabong and Willsmere Park)
- Koonung Creek
- Banyule Creek.

In addition, substantial areas of the project boundary support native vegetation planted for amenity purposes along public roads and within recreation reserves.

Continuing pressure from weed invasion and regular anthropogenic disturbance has historically negatively impacted vegetation quality throughout much of the project boundary. However, there are pockets where significant effort in revegetation and management has resulted in higher quality patches.

As mentioned above, key areas of remnant vegetation within the project boundary include Simpson Barracks and riparian and floodplain vegetation associated with the Yarra River and its tributaries. Consistent with the low-lying landforms of the Gippsland Plain bioregion, several swamps and billabongs including man-made wetlands are located within and adjacent to the project boundary. These areas include Bolin Bolin Billabong (a designated no-go zone, shown in Figure 2 (in Section 3.5), wetlands adjacent to the Eastern Freeway and wetlands associated with the Banyule Flats.

While various Ecological Vegetation Classes (EVCs) are present, the majority (77 per cent) of the native vegetation consisted of Plains Grassy Woodland (EVC 55) (18.713 hectares), Swampy Riparian Woodland (EVC 83) (15.264 hectares) and Floodplain Riparian Woodland (EVC 56) (6.396 hectares). These EVCs are characterised by mature, mixed-eucalypt canopies consisting of species such as River Red gum *Eucalyptus camaldulensis*, Swamp Gum *E. ovata*, and Manna Gum *E. viminalis*, which form remnant patches or occur as isolated scattered trees. Eucalypt trees within the project boundary range in size from saplings to very large trees with a diameter at breast height (DBH) up to 190 centimetres.

In several locations, occurrences of the EPBC Act and FFG Act listed Matted Flax-lily *Dianella amoena* were observed. This includes areas within Simpson Barracks adjacent to Banyule Creek, the Hurstbridge rail corridor and areas adjacent to the M80 Ring Road bike path at the northern end of the project boundary.

Approximately 52.109 hectares of native vegetation patches, 92 large trees within patches, 55 large scattered trees and 115 small scattered trees were recorded within the project boundary.

Within the study area, 50 species of rare or threatened flora have been recorded (VBA), while an additional nine are predicted to occur in the local area by the PMST. Three of these species were recorded during the assessment; Matted Flax-lily (95 individuals) listed as threatened under the EPBC Act and FFG Act, Arching Flax-lily *Dianella longifolia* var. *grandis* (five individuals) listed as vulnerable under the DELWP Advisory List, and Studley Park Gum *Eucalyptus Xstudleyensis* listed as endangered under the DELWP Advisory List (13 individuals recorded but many more likely to occur at Simpson Barracks). Most rare or threatened flora that were considered for the project are not expected to make substantial use of the project boundary.

No threatened ecological communities (listed under the EPBC Act) or communities of flora and fauna (listed under the FFG Act) were found to be present within the project boundary.

Nine weeds classified as Weeds of National Significance (WoNS) were observed within the project boundary and there is potential for the pathogen Cinnamon Fungus (*Phytophthora cinnamomi*) to be present within the study area.

## 7.2 Desktop assessment

This section summarises the flora-related results of the searches of ecological databases that are curated by the Australian and Victorian governments. A full assessment of the likelihood of occurrence of all threatened flora is provided in Appendix B.

### 7.2.1 Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified a number of Matters of National Environmental Significance (MNES) that may occur, or for which suitable habitat may occur within the associated five-kilometre buffer. Results of the PMST search are provided in Appendix F and summarised in Table 20.

Table 20 Summary of ecology-related PMST results for the five-kilometre buffer, including aquatic fauna within the stream network

MNES	
Wetlands of International Importance (Ramsar Sites)	None
Commonwealth Marine Area	None
Listed threatened ecological communities	Five listed communities: <ul style="list-style-type: none"> <li>• Grassy Eucalypt Woodland of the Victorian Volcanic Plain</li> <li>• Natural Damp Grassland of the Victorian Coastal Plains</li> <li>• Natural Temperate Grassland of the Victorian Volcanic Plain</li> <li>• Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains</li> <li>• White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.</li> </ul>
Listed threatened species	40 species consisting of: <ul style="list-style-type: none"> <li>• 25 listed fauna species</li> <li>• 15 listed flora species.</li> </ul>
Listed migratory species	15

All threatened flora predicted to occur by the PMST (listed in Appendix F) are combined with the VBA data in a list of threatened species in Appendix B, along with an evaluation of the likelihood of those species occurring within the project boundary.

#### 7.2.2 Victorian Biodiversity Atlas

The following section provides the results of the VBA search for records of flora listed as threatened under the EPBC Act, listed under the FFG Act and/or considered Victorian Rare or Threatened Species (VROTS) (DEPI, 2014) after the exclusions outlined in Section 5.2 have been applied.

For the location of threatened species records refer to Figure 7.

Within the project boundary, three species of rare or threatened flora have been historically recorded (this excludes those only modelled to occur by the PMST). These include one species listed as threatened under the EPBC Act, one species listed as threatened under the FFG Act and three species considered rare or threatened in Victoria (DEPI, 2014).

The listed flora species are:

- Matted Flax-lily *Dianella amoena* (EPBC – Endangered; FFG – Listed; VROTS – Endangered)
- Green Scentbark *Eucalyptus fulgens* (VROTS – Rare)
- Studley Park Gum *Eucalyptus Xstudleyensis* (VROTS – Endangered).

Within the five-kilometre buffer, 50 species of rare or threatened flora have been recorded (excludes those only modelled to occur by the PMST). These include eight flora species listed under the EPBC Act, 10 species listed under the FFG Act and 46 species considered rare or threatened in Victoria (DEPI, 2014). Those flora species listed under the EPBC and/or FFG Act and recorded within five kilometres of the project boundary are summarised in Table 21, and the full list of threatened species is provided in Table 48 in Appendix B. Species listed under the EPBC Act and modelled to occur in the local area by the PMST, but not recorded within five kilometres of the project boundary by the VBA are provided in Table 22. The EPBC Act and FFG Act species highlighted above have been listed here as they are considered to pose the greatest legislative risk to the project. In most cases, EPBC Act and FFG Act listed species are also listed under the DELWP VROTS advisory list.

**Table 21 EPBC Act and FFG Act-listed species recorded within five kilometres of the project boundary**

VU – vulnerable; EN – endangered; L – listed as threatened.

Scientific name	Common name	EPBC Act	FFG Act
<i>Adiantum capillus-veneris</i>	Venus-hair Fern	-	L
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass	VU	-
<i>Caladenia amoena</i>	Charming Spider-orchid	EN	L
<i>Callitriche brachycarpa</i>	Short Water-starwort	-	L
<i>Dianella amoena</i>	Matted Flax-lily	EN	L
<i>Geijera parviflora</i>	Wilga	-	L
<i>Geranium</i> sp. 1	Large-flower Crane's-bill	-	L
<i>Glycine latrobeana</i>	Clover Glycine	VU	L
<i>Lepidium hyssopifolium</i>	Basalt Peppercreess	EN	L
<i>Pterostylis chlorogramma</i>	Green-striped Greenhood	VU	L
<i>Senecio psilocarpus</i>	Swamp Fireweed	VU	-
<i>Xerochrysum palustre</i>	Swamp Everlasting	VU	L

Table 22 Species only modelled to occur by the PMST

VU/v – vulnerable; EN/e – endangered; CR – critically endangered; L – listed as threatened; x – presumed extinct in Victoria.

Scientific name	Common name	EPBC Act	FFG Act	VROT
<i>Caladenia rosella</i>	Little Pink Spider- orchid	EN	L	e
<i>Diuris fragrantissima</i>	Sunshine Diuris	EN	L	e
<i>Lachnagrostis adamsonii</i>	Adamson's Blown-grass	EN	L	v
<i>Pimelea spinescens</i> subsp. <i>spinescens</i>	Spiny Rice-flower	CR	L	e
<i>Pomaderris vacciniifolia</i>	Round-leaf Pomaderris	CR	L	e
<i>Prasophyllum colemaniae</i>	Lilac Leek- orchid	VU	-	x
<i>Prasophyllum frenchii</i>	Maroon Leek- orchid	EN	L	e
<i>Pterostylis cucullata</i>	Leafy Greenhood	VU	L	v
<i>Rutidosis leptorrhynchoides</i>	Button Wrinklewort	EN	L	e

### 7.2.3 Ecological Vegetation Classes (modelled and present)

Based on the DELWP NatureKit EVC modelling, there is potential for up to 22 EVCs to be present within the study area. During consequent field assessments, 14 EVCs (across three bioregions) were recorded within the project boundary. These EVCs and their Bioregional Conservation Significance (BCS) in the Highlands Southern Fall, Gippsland Plain and Victorian Volcanic Plain bioregions are listed in Table 23 and mapped in Figure 8.

Table 23 EVCs within five kilometres of the project boundary

EVC No.	EVC name	Modelled EVC	Present within project boundary?	Bioregional conservation status
<b>Gippsland Plain</b>				
22	Grassy Dry Forest	Yes	No	Least Concern
47	Valley Grassy Forest	Yes	Yes	Vulnerable
53	Swamp Scrub	No	Yes	Endangered
55	Plains Grassy Woodland	Yes	Yes	Endangered
56	Floodplain Riparian Woodland	Yes	Yes	Endangered
68	Creekline Grassy Woodland	Yes	Yes	Endangered
83	Swampy Riparian Woodland	No	Yes	Endangered
126	Swampy Riparian Complex	Yes	No	Endangered
127	Valley Heathy Forest	Yes	No <sup>#</sup>	Endangered
164	Creekline Herb-rich Woodland	No	Yes	Endangered

EVC No.	EVC name	Modelled EVC	Present within project boundary?	Bioregional conservation status
172	Floodplain Wetland Aggregate	Yes	No	Endangered
175	Grassy Woodland	Yes	Yes	Endangered
308	Aquatic Sedgeland	No	Yes	Endangered
641	Riparian Woodland	No	Yes	Endangered
821	Tall Marsh	No	Yes	Not listed*
851	Stream Bank Shrubland	Yes	No	Endangered
932	Wet Verge Sedgeland	No	No	Not listed
937	Swampy Woodland	No	Yes	Endangered
<b>Highlands–Southern Fall</b>				
18	Riparian Forest	No	Yes	Least Concern
22	Grassy Dry Forest	Yes	Yes	Least Concern
47	Valley Grassy Forest	Yes	Yes	Vulnerable
56	Floodplain Riparian Woodland	Yes	No	Endangered
<b>Victorian Volcanic Plain</b>				
55	Plains Grassy Woodland	Yes	Yes	Endangered
56	Floodplain Riparian Woodland	Yes	Yes	Endangered
641	Riparian Woodland	No	Yes	Endangered
851	Stream Bank Shrubland	Yes	No	Endangered

\*Not listed in the DELWP BCS listing at <[https://www.environment.vic.gov.au/data/assets/pdf\\_file/0012/50511/Bioregional-Conservation-Status-for-each-BioEVC.pdf](https://www.environment.vic.gov.au/data/assets/pdf_file/0012/50511/Bioregional-Conservation-Status-for-each-BioEVC.pdf)> but it is present in the bioregional benchmarks

# EVC mapped by DELWP and Foreman (2004) along Koonung Creek corridor. Ground-truthing indicated that this EVC was present within the study area in the Koonung Creek valley but outside of the project boundary.

#### 7.2.4 FFG communities

None of the flora communities listed as threatened under the FFG Act occur in the project boundary.

#### 7.2.5 Mapped wetlands

The DELWP wetland layer was interrogated and mapped (Figure 15). Wetland condition scores were provided by DELWP.

According to the *Biodiversity Assessment Handbook* (DELWP, 2015), all mapped wetlands (that is, the current wetland layer in DELWP's Biodiversity Interactive Maps) that would be impacted by the project are considered as a remnant patch, and so must be included in the extent of native vegetation removal. The modelled condition score is assigned to these wetlands.

Four mapped wetlands were identified within the project boundary (Figure 15). Table 24 summarises the ecological values of the wetlands.

Table 24 Wetlands within the study area

Wetland #	Wetland name	Total area (ha)	Total area within project boundary (ha)	Condition score	Habitat hectares within project boundary
71649	-	2.08	0.8	0.54	0.432
71602	Banyule Flat	9.21	2.91	0.6	1.746
72935	-	0.26	0.26	0.2	0.052
71601	Banyule Swamp	2.7	2.7	0.59	1.593
<b>Total</b>		<b>14.25</b>	<b>6.67</b>		<b>3.823</b>

Within the project boundary, these represent a total extent of 6.67 hectares (3.82 habitat hectares). These wetlands are likely to be groundwater dependent to some degree, and fall within the tunnelling area where no surface works would occur or would generally be avoided.

### 7.3 Field assessment

This section details the flora values observed in the project boundary. Mapping of the flora and vegetation values within the project boundary is presented in Figure 11.

#### 7.3.1 Flora and vegetation

##### Vegetation overview

The project boundary incorporates three bioregions—Gippsland Plain, Victorian Volcanic Plain and Highlands–Southern Fall. The majority of the project boundary falls within the first, the Gippsland Plain bioregion. Landforms within the Gippsland Plain generally consist of low-lying floodplains including oxbow lakes associated with the Yarra River and flat to undulating plains. The northern part of the project boundary is characterised by undulating hills within the Highlands–Southern Fall bioregion which drain to the Plenty River, and flat basaltic plains within the Victorian Volcanic Plain, west of the M80 Ring Road intersection.

The quality of native vegetation within the project boundary is generally poor, with the ecological values largely reflecting the long history of urban land use in the surrounding landscape. Continuing pressure from weed infestation and regular disturbance through urban land use and management also exacerbates reductions in vegetation quality.

Native vegetation mapped within the project boundary predominantly consists of vegetation planted for amenity purposes along public road and recreation reserves. Amenity plantings comprise a broad range of indigenous and non-indigenous native species depending on the position in the landscape and the era in which the plantings occurred.

While the project boundary occurs within a highly urbanised landscape, it does support areas of locally significant ecological values. Key areas of remnant vegetation within the project boundary generally consist of riparian and floodplain vegetation associated with the Yarra River and its tributaries. This includes Koonung Creek in the south, Banyule Drain and Yarra River in the centre and Plenty River in the northern parts of the project boundary. While various EVCs are present, the majority of the native vegetation consisted of Plains Grassy Woodland (EVC 55), Floodplain Riparian Woodland (EVC 56) and Swampy Riparian Woodland (EVC 83). These EVCs are characterised by mature, mixed-eucalypt canopies consisting of species such as River Red gum *Eucalyptus camaldulensis*, Swamp Gum *E. ovata*, and Manna Gum *E. viminalis*, which form remnant patches or occur as isolated scattered trees. Eucalypt trees within the project boundary range in size from saplings to very large trees with a diameter at breast height (DBH) of up to 190 centimetres. Riparian and floodplain areas within parks and reserves generally contain a species-rich shrub layer, but forbs and graminoids (grass-like plants) are largely absent from these areas due to the presence of a range of high threat weeds.

Consistent with the low-lying landforms of the Gippsland Plain bioregion, several swamps and billabongs including man-made wetlands are located within and adjacent to the project boundary. These areas including Bolin Bolin Billabong (a designated no-go zone shown in Figure 2 in Section 3.5), wetlands adjacent to the Eastern Freeway and wetlands associated with the Banyule Flats. These wetlands vary in quality and for the most part are man-made or have a history of modification and rehabilitation. They generally consist of an understorey of sedges, rushes and forbs including several Flat Sedge *Cyperus* spp., Rush *Juncus* spp., Club Sedge *Isolepis* spp. and Knotweed *Persicaria* spp.

Several areas of remnant vegetation contained good quality Plains Grassy Woodland (EVC 55) and Grassy Dry Forest (EVC 22) which were characterised by a mixed-eucalypt canopy over a grassy and herb-rich understorey. In several of these locations, occurrences of the EPBC Act-listed and FFG Act-listed species, Matted Flax-lily, were observed and recorded. This includes areas within Simpson Barracks adjacent to Banyule Creek, the Hurstbridge rail corridor and areas adjacent to the M80 Ring Road bike path at the northern end of the project boundary. Results of threatened species and communities surveys are discussed further in Section 7.3.2 and Section 7.3.3.

### **Species present within the project boundary**

A total of 327 flora (193 native, 134 introduced) was observed within the project boundary during field surveys for the ecology assessment.

### **EVCs present within project boundary**

Three bioregions and 14 unique EVCs occur within the project boundary. This section provides a general description of these EVCs found within the project boundary (refer to Table 23 above).

### EVC 308 – Aquatic Sedgeland

One patch of Aquatic Sedgeland was recorded within the project boundary (from the Gippsland Plain) within the Trinity Grammar Wetland B (Plate 1). This EVC is a naturally species-poor vegetation type dominated by one to several species of robust inundation-tolerant rhizomatous sedges, with vegetative growth extending into semi-permanent water. The vegetation almost exclusively comprised *Eleocharis sphacelata* Tall Spike-rush in open water.



Plate 1 – EVC 308: Aquatic Sedgeland within the project boundary, Trinity Grammar wetlands

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### EVC 68 – Creekline Grassy Woodland

Seven patches of Creekline Grassy Woodland were recorded within the project boundary (all from the Gippsland Plain). Creekline Grassy Woodland occurs on low-gradient ephemeral to intermittent drainage lines, typically on fertile colluvial/alluvial soils, on a wide range of suitably fertile geological substrates (Plate 2). This EVC is represented largely by re-vegetated and regenerating patches of native vegetation along the upper reaches of Banyule Creek, and comprises an overstorey of River Red-gum *Eucalyptus camaldulensis*. Due to the relatively young age of the patches of this EVC within the project boundary, the overstorey often contained a co-dominant canopy of mature *Acacia* species such as Silver Wattle and Blackwood. This overlies an understorey of shrubby species such as Hedge Wattle *Acacia paradoxa* and Prickly Moses *Acacia verticillata*. Groundcover was largely dominated by weedy species including high threat Kikuyu *Cenchrus clandestinus*, Blackberry and Wandering Trad *Tradescantia fluminensis*.



Plate 2 – EVC 68: Creekline Grassy Woodland within the project boundary, upper Banyule Creek

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### EVC 164 – Creekline Herb-rich Woodland

One patch of Creekline Herb-rich Woodland was recorded within the project boundary along Bushy Creek, which is a tributary of Koonung Creek (in the Gippsland Plain bioregion) (Plate 3). The EVC occurs on creek terraces and along shallow drainage lines with ephemeral flows. Soils are mostly alluvial deposits of seasonally wet sands and silts. The overstorey was co-dominated by Mealy Stringybark *Eucalyptus cephalocarpa*, Swamp Gum *E. ovata* and Manna Gum *E. viminalis* subsp. *viminalis*. There was a dense, diverse midstorey to 5 m tall, including species such as Lightwood *Acacia implexa*, Gold-dust Wattle *Acacia acinacea*, Sweet Bursaria *Bursaria spinosa* and Swamp Paperbark *Melaleuca ericifolia*. The groundcover was dominated by Spiny-headed Mat-rush *Lomandra longifolia* and a range of weed species, with Panic Veldt-grass *Ehrharta erecta*, most dominant.



Plate 3 – EVC 164: Creekline Herb-rich Woodland within the project boundary, Bushy Creek

### EVC 56 – Floodplain Riparian Woodland

A total of 30 patches of Floodplain Riparian Woodland were recorded within the project boundary (28 from Gippsland Plain, two from Victorian Volcanic Plain). This EVC occurs along the banks and floodplains of the larger meandering rivers and major creeks, often in conjunction with one or more floodplain wetland communities (Plate 4, Plate 5). Elevation and rainfall are relatively low and soils are fertile alluviums subject to periodic flooding and inundation. Patches of this EVC were generally located on the floodplain of the Yarra River and lower reaches of Koonung Creek. The overstorey of this EVC was characterised by River Red Gum, while the understorey composition and density varied greatly. Generally, understorey shrub species incorporated a relatively diverse mid-storey including Hazel Silver Wattle *Acacia dealbata*, Pomaderris *Pomaderris aspera*, Drooping Cassinia *Cassinia aculeata* and Prickly Currant-bush *Coprosma quadrifida*. The herb and grass layers varied in overall cover and showed fluctuations mostly due to previous disturbance and availability of water. These factors determined the presence of species such as Tall Sedge *Carex appressa*, Common Tussock-grass *Poa labillardierei*, Weeping Grass *Microlaena stipoides* and various Rush *Juncus* species. In most habitat zones, weed cover was > 50 per cent, with many also composed of high threat species such as Blackberry, Wandering Trad and Bridal Creeper.



Plate 4 – EVC 56: Floodplain Riparian Woodland within the project boundary



Plate 5 – EVC 56: Floodplain Riparian Woodland adjacent to the project boundary, Yarra River

## EVC 22 – Grassy Dry Forest

Nine patches of Grassy Dry Forest were recorded within the project boundary from the Highlands–Southern Fall bioregion. This EVC occurs on a variety of gradients and altitudes, and on a range of geologies. The typical Grassy Dry Forest community encountered within the site contained a mixed-eucalypt overstorey including Bundy *Eucalyptus goniacalyx*, Red Box *E. polyanthemos* and Candlebark *E. rubida* (refer to Plate 6 and Plate 7). Generally, the mid-layer and understorey were of poorer quality, with a relatively low percentage cover of shrubs, herbs and most grasses. The most abundant lifeform was medium-tufted graminoids, largely consisting of Wallaby Grass species *Rytidosperma* spp. Weed cover fluctuated from 25 per cent to >50 per cent and contained high threat species such as Serrated Tussock *Nassella trichotoma*, Spear Thistle *Cirsium vulgare* and Blackberry *Rubus fruticosus* spp. agg.



Plate 6 – EVC 22: Grassy Dry Forest within the project boundary near M80 interchange



Plate 7 – EVC 22: Grassy Dry Forest within the project boundary near M80 interchange

## EVC 175 – Grassy Woodland

This EVC was relatively uncommon with only four patches recorded within the project boundary (all from the Gippsland Plain bioregion) immediately east of the Yarra River near Yarra Boulevard (Plate 8). Grassy Woodland occurs on sites with moderate fertility on gentle slopes or undulating hills on a range of geologies. Characterised by a River Red Gum and Yellow Box overstorey, the patches were situated on drier, more elevated westerly aspects above the Yarra River. The understorey contained species such as Cherry Ballart *Exocarpos cupressiformis*, Lightwood *Acacia implexa* and Sweet Bursaria. There was also a variety of graminoids such as Black-anther Flax-lily *Dianella revoluta*. Common Wheat-grass *Anthosachne scabra*, Weeping Grass, Kangaroo Grass and Wallaby-grasses. Weed cover was moderate to high and consisted of species such as Galenia *Galenia pubescens*, Montpellier Broom *Genista monspessulana*, Chilean Needle-grass *Nassella neesiana* and Panic Veldt-grass *Ehrharta erecta*.



Plate 8 – EVC 175: Grassy Woodland within the project boundary

## EVC 55 – Plains Grassy Woodland

A total of 44 patches of Plains Grassy Woodland were recorded within the project boundary (three from Victorian Volcanic Plain and 41 from Gippsland Plain) (Plate 9, Plate 10). This EVC occupies moderately to poorly drained, fertile soils on flat or gently undulating plains at low elevations. The dominant overstorey species of this EVC was River Red Gum; however, other canopy species are present, including Studley Park Gum *Eucalyptus Xstudleyensis* and Yellow Box *E. melliodora*. Large trees are locally common, particularly at Simpson Barracks. Understorey composition and density varied among patches within the project boundary. Generally, the EVC contained a sparse to moderately dense mid-storey layer including *Acacia* species, Tree Violet *Melicytus dentatus*, Common Cassinia and Drooping Cassinia *Cassinia sifton*. Native grass cover varied across the project boundary but generally ranged from 10 to 30 per cent. The grassy assemblage typically included common species such as Kangaroo Grass, Weeping Grass, Wallaby-grasses and Grey Tussock-grass *Poa sieberiana*, while a range of forbs and rushes were also present, including Yellow Rush-lily *Tricoryne elatior*, Kidney-weed *Dichondra repens*, Wattle Mat-rush *Lomandra filiformis* and Chocolate Lily *Arthropodium strictum*. Threatened Matted Flax-lily were also observed, and are further described in Section 7.3.2. Weed cover varied greatly across the project boundary and included high threat species such as African Box-thorn *Lycium ferocissimum*, Serrated Tussock and *Agapanthus Agapanthus praecox* subsp. *orientalis*.



Plate 9 – EVC 55: Plains Grassy Woodland within Simpson Barracks (see Figure 9)



Plate 10 – EVC 55: Plains Grassy Woodland within the north-eastern no-go zone (see Figure 2 in Section 3.5)

## EVC 18 – Riparian Forest

One patch of Riparian Forest was recorded within the project boundary along the Plenty River (from the Highlands – Southern Fall bioregion). The EVC occurs along river banks and associated alluvial terraces with occasional occurrences in the heads of gullies leading into creeks and rivers. The soil is fertile alluvium, regularly inundated and permanently moist. The mapped patch of Riparian Forest largely occurred underneath the tall Greensborough Bypass bridges, and was dominated by Manna Gum *Eucalyptus viminalis* subsp. *viminalis*, in association with Silver Wattle *Acacia dealbata* and a weedy understorey.

## EVC 641 – Riparian Woodland

Six patches of Riparian Woodland were recorded within the project boundary (from the Gippsland Plain bioregion), where the Eastern Freeway crosses the Yarra River and Merri Creek (Plate 11, Plate 12).

Riparian Woodland was typically dominated by River Red Gum and a relatively high cover of a woody mid-storey, including species such as Burgan *Kunzea ericoides* spp. agg., Sweet Bursaria and Tree Violet. Underlying this was a mixed understorey comprising species such as Common Tussock-grass *Poa labillardierei*, Spiny-headed Mat-rush *Lomandra longifolia*, and Rush *Juncus* species; and herbaceous species such as Nodding Saltbush *Einadia nutans*. Weed cover varied with some habitat zones displaying > 50 per cent weed cover, of which > 50 per cent of that cover consisted of high threat species including Blackberry, Yorkshire Fog *Holcus lanatus* and Spear Thistle.



Plate 11 – EVC 641: Riparian Woodland within the project boundary, confluence of the Merri Creek and Yarra River



Plate 12 – EVC 641: Riparian Woodland within the project boundary, confluence of the Merri Creek and Yarra River

### EVC 53 – Swamp Scrub

Three patches of Swamp Scrub were recorded within the project boundary on the alluvial flats of Koonung Creek (from the Gippsland Plain bioregion). The EVC occurs at low elevations on alluvial deposits along streams or on poorly drained sites with higher nutrient availability. Swamp Paperbark *Melaleuca ericifolia* is the dominant species, growing to 7 m tall, in association with scattered emergent *Eucalyptus ovata* Swamp Gum and *Acacia melanoxylon* Blackwood. The understorey is characterised by Prickly Moses, *Goodenia ovata* (Hop Goodenia), *Gahnia radula* (Thatch Saw-sedge), Spiny-headed Mat-rush, Common Tussock-grass and *Carex appressa* (Tall Sedge). Weed cover is moderate to high depending on management history.

### EVC 83 – Swampy Riparian Woodland

A total of 21 patches of Swampy Riparian Woodland were recorded within the project boundary (all from the Gippsland Plain bioregion) (Plate 13, Plate 14). This EVC occupies low energy streams and poorly drained, fertile, alluvial flats of the foothills and plains. Within the project boundary, most examples of Swampy Riparian Woodland comprised revegetation along the Koonung Creek valley, which had been established over the past 35 years following construction of the Eastern Freeway. In some instances, usually in areas of older revegetation, the native vegetation did not fully fit the classic species profile for this EVC, mainly owing to the planting palette at the time of revegetation. However, more recent revegetation, and supplementary plantings underneath older more established patches, have tended to adhere more strictly to species that would normally occur within Swampy Riparian Woodland. Due to the variability in composition and structure along the length of Koonung Creek, all examples were generally mapped as Swampy Riparian Woodland, as this is the pre-1750 EVC that would have previously occupied the valley from Springvale Road downstream to a point west of Doncaster Road.

The dominant eucalypt species in this EVC was Swamp Gum; however some patches included River Red-gum and/or Narrow-leaf Peppermint *Eucalyptus radiata*. Patches of Swampy Riparian Woodland occasionally included large remnant trees, and generally supported a tall shrubby mid-storey of Sweet Bursaria, Burgan, Silver Wattle and Blackwood *Acacia melanoxylon*. The composition, diversity and structural integrity of the understorey was highly variable, and ranged from areas with virtually no native species and very high weed cover, to areas with a variety of native species, including Hop Goodenia, Weeping Grass and Bidgee-widgee *Acaena novae-zelandiae*, and moderate weed cover. High threat species were present and included Wandering Trad, Blackberry and Montpellier Broom *Genista monspessulana*.

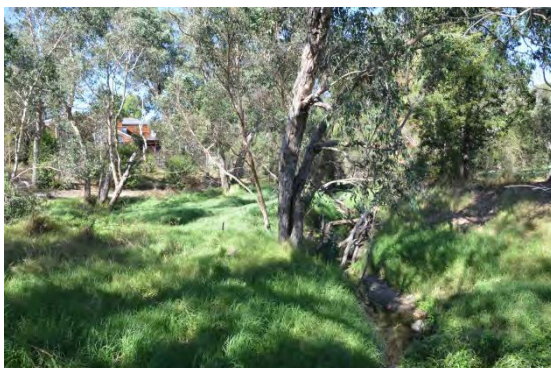


Plate 13 – EVC 83: Swampy Riparian Woodland within the project boundary, Koonung Creek

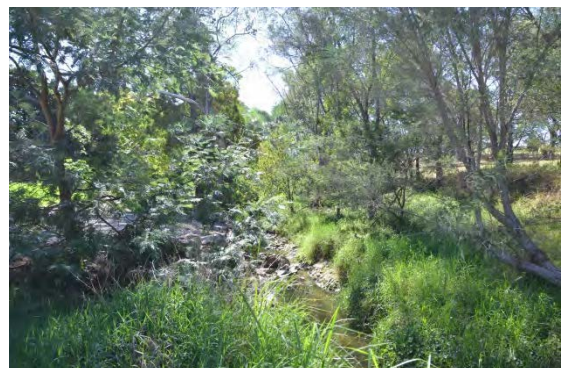


Plate 14 – EVC 83: Swampy Riparian Woodland within the project boundary, Koonung Creek

### EVC 937 – Swampy Woodland

One patch of Swampy Woodland was recorded within the project boundary (Gippsland Plain) between Koonung Creek and the sports ovals to the west of Elgar Road (Plate 15). Swampy Woodland usually occurs on poorly drained, seasonally waterlogged heavy soils, primarily on swamp deposits but extending to suitable substrates within some landscapes of sedimentary origin. Within the project boundary, this EVC was confined to a revegetated patch comprising an overstorey dominated by Swamp Gum, Mealy Stringybark *Eucalyptus cephalocarpa* and Narrow-leaf Peppermint. Understorey species included Sweet Bursaria, Common Cassinia, Hop Goodenia, Spiny-headed Mat-rush and a range of recently planted forbs and graminoids. Weed cover was relatively low, owing to heavily mulched and well-maintained garden beds.



Plate 15 – EVC 937: Swampy Woodland within the project boundary

### EVC 821 – Tall Marsh

A total of four patches of Tall Marsh were recorded within the project boundary (all from the Gippsland Plain bioregion) (Plate 16, Plate 17). This EVC occurs on Quaternary sedimentary geology; soils are peaty, silty clays, and average annual rainfall is over 600 mm. To exist, this vegetation type requires shallow water (to 1 m deep) and low current-scour, and can only tolerate low levels of salinity. The Tall Marsh EVC was represented by open bodies of shallow, standing water containing a range of aquatic and semi-aquatic graminoids and forbs. Common species included Broad-leaf Cumbungi *Typhaorientalis*, Common Water-ribbon *Cycnogeton procerum*, Tall Spike-sedge *Eleocharis sphacelata*, Common Reed *Phragmites australis* and Slender Knotweed *Persicaria decipiens*. Weed cover was generally low, and included species such as Toowoomba Canary-grass *Phalaris aquatica* and Blackberry.



Plate 16 – EVC 821: Tall Marsh within the project boundary, Koonung Creek valley



Plate 17 – EVC 821: Tall Marsh within the project boundary, Koonung Creek valley

## EVC 47 – Valley Grassy Forest

A total of nine patches of Valley Grassy Forest was recorded within the project boundary (three from Highlands–Southern Fall and six from Gippsland Plain) (Plate 18, Plate 19). This EVC occurs under moderate rainfall regimes of 700-800 mm per annum on fertile well-drained colluvial or alluvial soils on gently undulating lower slopes and valley floors. Valley Grassy Forest patches in the project boundary typically consisted of a mixed-eucalypt overstorey of Yellow Box *E. melliodora*, Bundy and Narrow-leaf Peppermint *E. radiata*, with occasional Swamp Gum. Understorey composition and density varied across the habitat zones. The shrubby mid-storey consisted of species such as Black Wattle *Acaciamearnsii*, Prickly Moses and Common Cassinia, in association with the scrambler, Small-leaf Clematis *Clematis microphylla*. In most sites, graminoids accounted for the largest proportion of ground cover and included typical species such as Kangaroo Grass *Themeda triandra*, Wallaby-grass species, Weeping Grass *Microlaena stipoides* var. *stipoides*, Black-anther Flax-lily, Spiny-headed Mat-rush and Wattle Mat-rush. One of the northern patches also contains a small population of the threatened Matted Flax-lily, which is further described in Section 7.3.2. Weed cover was generally high



Plate 18 – EVC 47: Valley Grassy Forest within the project boundary



Plate 19 – EVC 47: Valley Grassy Forest within the project boundary, Koonung Creek valley

### 7.3.2 Rare or threatened species

This section addresses the results of targeted flora surveys, previous survey effort and the general status of rare or threatened flora within the project boundary.

The likelihood of occurrence for all flora recorded within five kilometres of the project boundary (VBA) or predicted to occur within the project boundary (PMST) is outlined in Appendix B.

In summary, based on the presence of suitable habitat, of the 60 rare or threatened species recorded or predicted to occur in the study area (17 EPBC Act-listed, 18 FFG Act-listed, 59 DELWP Advisory-listed):

- Four species are present within the project boundary (two EPBC Act-listed, one FFG Act-listed, three DELWP Advisory-listed)
- Three EPBC/FFG Act-listed species have a moderate likelihood of occurring within the project boundary, but were not observed during project surveys
- One FFG Act-listed species has a high likelihood of occurring within the project boundary, but was not observed during project surveys
- Four DELWP Advisory-listed vulnerable or endangered species have a moderate or high likelihood of occurring within the project boundary, but were not observed during project surveys
- 16 DELWP Advisory-listed rare species have a moderate or high likelihood of occurring within the project boundary, but were not observed during project surveys.

These species are listed in Table 25 below.

The remainder of this section focuses on those species that were present during field assessment, are EPBC Act-listed, and/or have a moderate or higher likelihood of occurrence within the project boundary.

Table 25 EPBC Act, FFG Act and DELWP Advisory-listed species with a moderate to high likelihood of occurrence within the project boundary

Common name	Scientific name	EPBC Act	FFG Act	DELWP Advisory List	Likelihood of occurrence within project boundary (pre-targeted surveys)	Targeted survey in all areas of potentially suitable habitat?	Likelihood of occurrence within project boundary (post-targeted surveys)
Matted Flax-lily	<i>Dianella amoena</i>	EN	L	e	Present	Yes	<b>Present</b> – Simpson Barracks, M80 Ring Road interchange, Hurstbridge rail line
River Swamp Wallaby-grass	<i>Amphibromus fluitans</i>	VU	-	-	Present <sup>#</sup>	Yes	<b>Present<sup>#</sup></b> - Trinity Grammar wetlands
Studley Park Gum	<i>Eucalyptus Xstudleyensis</i>	-	-	e	Present	Partly (at Simpson Barracks)	<b>Present</b> – Simpson Barracks, Watsonia Station
Arching Flax-lily	<i>Dianella longifolia</i> var. <i>grandis</i>	-	-	v	Present	Partly (at Simpson Barracks)	<b>Present</b> – Simpson Barracks, Colleen Reserve, Yarra Bend
Clover Glycine	<i>Glycine latrobeana</i>	VU	L	v	Moderate	Yes	Moderate
Charming Spider-orchid	<i>Caladenia amoena</i>	EN	L	e	Moderate	No**	Low – moderate
Green-striped Greenhood	<i>Pterostylis chlorogramma</i>	VU	L	v	Moderate	Yes	Low – moderate
Short Water-starwort	<i>Callitriche brachycarpa</i>	-	L	v	High	Yes	Moderate
Silurian Striped Greenhood	<i>Pterostylis</i> sp. aff. <i>striata</i> (Silurian)	-	-	e	Moderate	Yes	Low – moderate

Common name	Scientific name	EPBC Act	FFG Act	DELWP Advisory List	Likelihood of occurrence within project boundary (pre-targeted surveys)	Targeted survey in all areas of potentially suitable habitat?	Likelihood of occurrence within project boundary (post-targeted surveys)
Wine-lipped Spider-orchid	<i>Caladenia oenochila</i>	-	-	v	Moderate	No**	Low – moderate
Melbourne Yellow Gum	<i>Eucalyptus leucoxylon</i> subsp. <i>connata</i>	-	-	v	High	No**	Low – tree likely to have been seen if present.
Austral Crane's-bill	<i>Geranium solanderi</i> var. <i>solanderi</i> s.s.	-	-	v	High	No**	Low – moderate
Veined Spear-grass	<i>Austrostipa rudis</i> subsp. <i>australis</i>	-	-	r	High	No**	Moderate
Common Apple-berry	<i>Billardiera scandens</i> s.s.	-	-	r	High	No**	Low – shrub likely to have been seen if present.
Winged Water-starwort	<i>Callitriche umbonata</i>	-	-	r	High	No**	Low – moderate
Fringed Helmet-orchid	<i>Corybas fimbriatus</i>	-	-	r	Moderate	No**	Low – moderate
Bear's ears	<i>Cymbonotus lawsonianus</i>	-	-	r	Moderate	No**	Low – moderate
Green Scentbark	<i>Eucalyptus fulgens</i>	-	-	r	Moderate*	No**	Low – tree likely to have been seen if present.
Yarra Gum	<i>Eucalyptus yarraensis</i>	-	-	r	Moderate	No**	Low – tree likely to have been seen if present.
Veiled Fringe-sedge	<i>Fimbristylis velata</i>	-	-	r	Moderate	No**	Low – moderate

Common name	Scientific name	EPBC Act	FFG Act	DELWP Advisory List	Likelihood of occurrence within project boundary (pre-targeted surveys)	Targeted survey in all areas of potentially suitable habitat?	Likelihood of occurrence within project boundary (post-targeted surveys)
Pale-flower Crane's-bill	<i>Geranium</i> sp. 3	-	-	r	Moderate	No**	Moderate
Rosemary Grevillea	<i>Grevillea rosmarinifolia</i> subsp. <i>rosmarinifolia</i>	-	-	r	Moderate	No**	Low – shrub likely to have been seen if present.
Slender Stylewort	<i>Levenhookia sonderi</i>	-	-	r	Moderate	No**	Low – moderate
Austral Tobacco	<i>Nicotiana suaveolens</i>	-	-	r	Moderate	No**	Moderate
	<i>Pterostylis clivosa</i>	-	-	r	Moderate	No**	Moderate
Emerald-lip Greenhood	<i>Pterostylis smaragdina</i>	-	-	r	Moderate	No**	Moderate
Floodplain Fireweed	<i>Senecio campylocarpus</i>	-	-	r	Moderate	No**	Moderate
Annual Fireweed	<i>Senecio glomeratus</i> subsp. <i>longifructus</i>	-	-	r	Moderate	No**	Moderate

# Historical record within project boundary (Australian Ecosystems, 2007) but not observed during targeted surveys as part of the North East Link assessment. Assumed to be present.

\* Historical record within project boundary (VBA) but not observed during flora surveys as part of the North East Link assessment. Assumed to have been cleared as part of Eastern Freeway construction.

\*\* Although targeted survey was not conducted for these species, the field assessment undertaken was regarded as sufficient.

### **Matted Flax-lily *Dianella amoena* (EPBC, endangered; FFG, listed; DELWP, endangered)**

Matted Flax-lily is listed as endangered under the EPBC Act and a listed species under the FFG Act. It is a small, perennial, tufted lily endemic to south-east Australia, occurring in grassland and grassy woodland habitats. Matted Flax-lily occurs in Victoria and Tasmania, and multiple populations are known from the northern suburbs of Melbourne, typically within remnant vegetation alongside road or rail corridors, conservation reserves and in translocation sites (Carter, 2010).

Much of this habitat has been cleared, and remaining populations of Matted Flax-lily are mostly small and highly fragmented. Current threats include ongoing clearing of habitat and weed invasion.

#### **Previous studies**

The population of Matted Flax-lily at Simpson Barracks is well documented, with the site listed as supporting a 'significant population' on the National Recovery Plan for the species, where it was recorded as possessing a population of 10 plants (Carter, 2010). A number of previous investigations into the populations of Matted Flax-lily present at Simpson Barracks have been undertaken, as summarised below:

- **Jacobs, May 2016, Simpson Barracks Flora and Fauna Monitoring Program 2016–2021**

This report refers to a survey program undertaken in 2016, which identified Matted Flax-lily occurring at Simpson Barracks. Overall, a total of 65 locations were recorded with a total of 603 ramets counted. This suggests the barracks supports one of the larger sub-populations in the Melbourne metropolitan area. The Matted Flax-lily was identified on both the eastern and western sides of the base, with the greatest portion of the population (87 per cent; 60 locations) occurring on the eastern side of the barracks within the higher quality native vegetation areas identified. A smaller proportion (13 per cent; five locations) of the Matted Flax-lily population was recorded in the lower quality EVC 55 Plains Grassy Woodland vegetation.

- **HLA-Envirosciences, May 2007, Biodiversity Assessments and Strategies for Simpson Barracks**

The HLA report refers to a report prepared by Kinhill in 2000 that identified two populations of Matted Flax-lily at Simpson Barracks. One population was assessed to contain approximately 50 individuals or clumps on the western section of the site. The other site was comprised of approximately 20 individuals, or clumps, in the eastern section of the barracks.

HLA-Envirosciences conducted field surveys on the site in 2006. They recorded two individuals or clumps in the western section of the site, and 39 individuals or clumps in the eastern section. HLA-Envirosciences indicated the population had declined by 90 per cent in the western section of the site but noted the difference could be attributed to the different seasonal timings of the surveys. The Kinhill surveys (2000) occurred in November/January, while the 2006 survey occurring in September outside the species' flowering season. Surveys of Matted Flax-lily should be conducted between November and February when flowers are present to increase plant visibility and thus detectability.

HLA-Envirosciences also suggested the Matted Flax-lily had been out-competed by highly invasive perennial weeds that were observed dominating the ground layer.

Given the National Recovery Plan listed a population size of 10 plants at the site, it is assumed the Kinhill and HLA-Envirosciences reports were unavailable (or confidential and unable to be released) when the National Recovery Plan was being developed in 2010.

## Results

During targeted surveys conducted between October and December 2017, and subsequent surveys of the Hurstbridge rail line reserve, a total of 95 individual Matted Flax-lily plants/patches were recorded and mapped within the North East Link project boundary as follows:

- A total of 83 individuals/patches within Simpson Barracks (including within the publicly accessible section of Commonwealth land), with individuals ranging from a few leaf tufts to large patches up to 4 x 4 metres in size (Figure 9).
- Four plants/patches near the M80 Ring Road interchange at an elevated point close to a telecommunications tower.
- Eight plants/patches along the Hurstbridge rail line, including one large patch (2 x 15 metres) and seven individuals or smaller patches at three discrete locations (Figure 11).

To place these numbers in context, an additional 200 plants/patches are reported to occur on the eastern side of Simpson Barracks, based on the following surveys (Figure 9):

- A total of 123 plants/patches were recorded outside the project boundary during surveys for North East Link in 2017–18
- Fifty plants/patches recorded by the Department of Defence (2006)
- Fifteen plants/patches recorded by Jacobs (2016)
- Eleven plants/patches recorded by HLA (2007).

It should be noted these numbers are conservative and double-counting of individuals/patches was specifically avoided. Consequently, the total known population size at Simpson Barracks is at least 283 plants/patches. Most Matted Flax-lily plants/patches observed during targeted surveys were in a healthy condition (Plate 20 to Plate 22 below). Plants showed evidence of recent flowering and leaf growth and several were observed being pollinated by the native Blue-banded Bee *Amegilla cingulata*. Matted Flax-lily occurred in a number of different habitats including at the base of River Red Gums, on rocky open areas or in shallow depressions. They often co-existed with other *Dianella* species within the project boundary, in particular Black-anther Flax-lily and Arching Flax-lily *Dianella longifolia* var. *grandis*.



Plate 20 – Matted Flax-lily amongst Black-anther Flax-lily (*D. revoluta* s.l.) below River Red Gum



Plate 21 – Matted Flax-lily at Simpson Barracks



Plate 22 Matted Flax-lily within a shallow depression in Simpson Barracks

### River Swamp Wallaby-grass *Amphibromus fluitans* (EPBC, vulnerable)

River Swamp Wallaby-grass is listed as vulnerable under the EPBC Act and is an aquatic perennial with 1-metre long decumbent culms (aerial stems growing horizontally with tips turned up at the end) and often only the inflorescence is above water. It occurs in both natural and man-made low flow water-bodies, including swamps, lagoons, billabongs and dams. Within the study area, optimal habitat for this species occurs in wetlands associated with the floodplain of the Yarra River.

### Results

River Swamp Wallaby-grass was not observed during targeted field surveys for the species in December 2018. An assessment of VBA data found a high likelihood of presence, with nine recent records within the study area. Notable VBA records in close proximity to the project boundary were at the western end of Bolin Bolin Billabong in 1994 and 2011, Yarra Flats north of Bolin Bolin (1995) and Banyule Flats (1995). Australian Ecosystems (2007) also identified the species at two wetlands (B and D) within the Trinity Grammar School Sporting Complex, Bulleen. Wetland B is within the project boundary, while wetland D is immediately east of the project boundary.

Potentially suitable habitat within the project boundary is limited to poor quality habitat confined to Banksia Park, the Yarra Flats west of Bulleen Road, and the floodplain wetlands at Trinity Grammar. Higher quality habitat occurs outside the project boundary at Bolin Bolin Billabong and Trinity Grammar (eastern-most wetland), and on the Banyule Flats where indirect impacts of the project (such as groundwater drawdown) may potentially affect the species' habitat.

Based on the quality of habitat within the project boundary, the existence of recent nearby records and the results of targeted surveys, it is assumed that River Swamp Wallaby-grass occurs within the project boundary.

### Studley Park Gum *Eucalyptus Xstudleyensis* (DELWP, endangered)

Studley Park Gum is classified as endangered under the VROTS list and is recognised as a fertile hybrid between River Red Gum *Eucalyptus camaldulensis* and Swamp Gum *E. ovata*. It is morphologically variable and is distributed in the lower Yarra River corridor in Melbourne, primarily in the suburbs of Kew, Ivanhoe, Viewbank, Rosanna, Macleod, Watsonia, Yallambie, Plenty and Templestowe, but with outlying occurrences in Lysterfield (Cameron *et al.* 1999). The sites within the Yallambie-Macleod-Rosanna area are thought to be the fragmented remnants of larger pre-settlement populations (Cameron *et al.* 1999). Individuals are generally intermediate between the two eucalypt species, with leaf, bud and fruit characters often showing a greater affinity to either parent in one or more of those characters (Maiden, 1922).

The taxon is one of eight described *Eucalyptus* hybrids formally accepted by the National Herbarium of Victoria. It is also one of two named intersectional Victorian hybrids in the genus, the other being *Eucalyptus X oxypoma*. Hybrids between distantly related parents are highly significant for their potential contribution to evolutionary novelty and speciation if they are also fertile and form hybrid swarms in the wild. When they are also observed to display niche differentiation in relation to the parent populations, they are at lower risk of introgression by either parent and therefore have the greatest potential to become incipient hybridogenous taxa and eventually stabilise to become distinct new species. *Eucalyptus X studleyensis* is the only Victorian eucalypt hybrid which has been demonstrated to combine all these qualifying characteristics<sup>11</sup>.

An analysis of the VBA indicates that 26 discrete records of Studley Park Gum are present across the greater Melbourne area, with some of these records likely to be re-sampling of the one population at different times. It should also be noted that the accuracy, reliability, currency and population size of these records is likely to be variable. A report by Cameron *et al.* (1999) detailing the ecological values of the Streeton Views Estate, which lies immediately east of the Simpson Barracks, provides important supplementary information regarding the distribution and status of known locations for this taxon. Although the report is 20 years old, it provides the best available information regarding the taxonomic status and distribution of Studley Park Gum. Nevertheless, additional surveys would be needed to verify the currency of the information in the report.

At part of the Streeton Views report, Cameron *et al.* (1999) investigated the 28 reported sites of Studley Park Gum that were known at the time. As a result of the Cameron *et al.* (1999) investigation, the following information is worth noting with respect to *E. Xstudleyensis*:

- The Simpson Barracks site east of Greensborough Road was reported to support the most extensive hybrid swarm of *Eucalyptus Xstudleyensis*, including at least 53 established trees and numerous juveniles.
- A population located immediately east of Simpson Barracks at Stage 11 of the Streeton Views Estate (117 hybrid individuals), and including the adjacent Commonwealth reserve and transmission line easement south-west of Streeton Views Estate Stage 11, is also ecologically important (note: this is regarded as two sites in the 1999 report).
- A population at the Plenty Hospital site in Macleod supports a modest population of highly introgressed hybrids.
- A further 11 sites support one or more confirmed occurrences of the taxon; however, recruitment opportunities are either greatly impaired or lost.
- Investigation at a further 11 sites indicated that the taxon was previously misidentified and does not occur at these sites.
- The status of the taxon at a further two sites was unable to be confirmed.

It should be noted that the status of these populations has not been investigated as part of the NEL project. In addition, given the difficulty in accurately and positively identifying Studley Park Gum, it is quite possible that additional unrecorded populations exist in the Melbourne area.

It is unclear how many of the 53 established trees identified in 1999 still remain or occur inside the project boundary. At the time of the 1999 assessment, the authors conclude that together with the Streeton Views Estate population, the Simpson Barracks population is one of two hybrid swarms that are likely to remain genetically stable in the long-term (Cameron *et al.* 1999).

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<sup>11</sup> Text extracted from RAMAS treatment of taxon (under IUCN Red List criteria) by David Cameron (DELWP), 26 February 2019.

Their reasoning for this statement is that the hybrid is fertile, there is a high genetic difference between the parents, the hybrid has a high level of character stabilisation and is present in distinct swarms, and it displays niche differentiation from the two parent species.

## Results

Studley Park Gum has been historically recorded within the project boundary at Banyule Flats (Practical Ecology 2017b) and at Simpson Barracks (Jacobs 2016; HLA 2007). It has also been recorded adjacent to the eastern boundary of Simpson Barracks as part of the Streeton Views Estate planning approvals process (Cameron *et al.* 1999).

The field assessment for NEL identified eight large Studley Park Gums and several cohorts of varying age within the project boundary at Simpson Barracks, two individuals on the top of the Hurstbridge rail line embankment at Watsonia railway station, and one incidental record in Banyule Flats (outside the area directly impacted by the project) (Figure 9). Targeted surveys were not undertaken for Studley Park Gum due to the inherent difficulty in accurately identifying individuals, particularly within Simpson Barracks, where thousands of eucalypts of varying age and maturity (mainly River Red Gum, with some Studley Park Gum and Yellow Box) occur within the project boundary. While Cameron *et al.* (1999) identified 53 Studley Park Gum in the western portion of Simpson Barracks, it is uncertain what proportion of these trees currently occur within the project boundary.

The known distribution of Studley Park Gum is presented in Figure 7, Figure 9 and Figure 11.

After discussions with DELWP, NELP has committed to undertaking further field surveys to better understand the prevalence of the species at Simpson Barracks and to estimate the number of Studley Park Gum potentially impacted by the project.

### Arching Flax-lily *Dianella longifolia* var. *grandis* (DELWP, vulnerable)

Arching Flax-lily is classified as vulnerable under the VROTS list. This species is a perennial graminoid reaching up to 1.3 metres tall growing in solitary tufts or loose patches. Following urban expansion, many of the remaining populations of this species are very small and fragmented in Victoria, where it is mainly concentrated in the Volcanic Plains and Riverina.

## Results

Five individuals were observed within the project boundary during field assessments; one in Simpson Barracks, one in Colleen Reserve, Yallambie, and three at Yarra Bend Park north of the Eastern Freeway (Figure 7, Figure 9 and Figure 11). Suitable habitat also exists elsewhere within the project boundary but additional individuals were not observed during field assessments. There is also an historical record of this species within the Boroondara General Cemetery/Victoria Park complex within a kilometre of the project boundary.

### Clover Glycine *Glycine latrobeana* (EPBC, vulnerable; FFG, listed; DELWP, vulnerable)

Clover Glycine is listed as vulnerable under the EPBC Act and a listed species under the FFG Act. It is a small perennial herb with leaves that look similar to common pasture clover (DPI, 2003; DSE, 2005b). It is endemic to south-east Australia and concentrated largely around South Australia, Tasmania and Victoria where it occurs mainly in grasslands and grassy woodland habitats. Clover Glycine has been heavily impacted by land clearing, grazing, weed invasion and alteration of fire regimes leading to significant fragmentation of the population.

## Results

Clover Glycine was not recorded in the project boundary despite a high likelihood of presence determined in the desktop assessment (there are 18 VBA records for Clover Glycine in the surrounding five kilometres). Much of the project boundary, including remnant patches, consisted of a modified understorey with varying levels of weediness. Generally, the most common weeds were grassy species (including Veldt-grass *Ehrharta* spp., Brome *Bromus* spp., Oat *Avena* spp.), which compete in the ground layer, generally making the environment unsuitable for Clover Glycine due to the high biomass (Carter & Sutter, 2010). Nonetheless, targeted surveys were completed during the tail-end of the flowering season to confirm the species' presence or absence.

Better quality remnant patches of Plains Grassy Woodland and Riparian Woodland such as Simpson Barracks, Banyule Reserve and some elevated flats along Koonung Creek were considered to have a higher potential to support the species because of their archetypal indigenous grassland structure, such as Kangaroo Grass, Wallaby Grass, Spear Grass *Austrostipa* spp. And Plume Grass *Dichelachne* spp. However, Clover Glycine was not observed despite extensive searching in these areas. In addition to weed cover, pressure from rabbit and kangaroo grazing is likely to be a barrier to the species' persistence in the project boundary (Carter & Sutter, 2010) as well as the wider landscape. These areas are also subject to infrequent/altered fire regimes, increasing competition and reducing recruitment opportunities for Clover Glycine.

Although no individuals were recorded, it is concluded that Clover Glycine has a moderate likelihood of occurring within the project boundary based on the presence of potentially suitable habitat, particularly at Simpson Barracks.

## Charming Spider-orchid *Caladenia amoena* (EPBC, endangered; FFG, listed; DELWP, endangered)

Charming Spider-orchid is listed as endangered under the EPBC Act and is a listed species under the FFG Act. It is also classified as endangered under the VROTS list. This species is endemic to Victoria and is located in the north-eastern suburbs of Melbourne in the Greensborough-Plenty-Hurstbridge area as well as south-central Victoria. It is typically found in grassy dry forest and on ridges and sheltered slopes in open forests. In Melbourne, it is known only from a few small remnant populations. The orchid flowers from August to October.

## Results

No individuals were observed during general vegetation field assessments conducted during the species' flowering season in October 2017, August 2018 or October 2018. Furthermore, only one common species of *Caladenia* was recorded within the project boundary during the project surveys. While potential habitat may be affected, the closest of the sparse historical records is from 1996 and locates it approximately three kilometres north of the project boundary in the Plenty Valley Parklands. Consequently, the species has a low to moderate likelihood of occurring within the project boundary.

**Green-striped Greenhood *Pterostylis chlorogramma* (EPBC, vulnerable; FFG, listed; DELWP, vulnerable)**

Green-striped Greenhood is listed as vulnerable under the EPBC Act and is a listed species under the FFG Act. It is also categorised as vulnerable under the VROTS list. The species generally prefers moist areas of heathy and shrubby forests and is often difficult to distinguish from Emerald-lip Greenhood *Pterostylis smaragdyna*. It flowers from July to September.

**Results**

No individuals were observed during targeted surveys conducted in areas of potentially suitable habitat during the species' flowering season in August 2018. However, two other species of *Pterostylis* were recorded within the project boundary during the targeted surveys. While potential habitat may be affected, the most recent historical record from the study area is from 1995. Consequently, the species has a low to moderate likelihood of occurring within the project boundary.

**Short Water-starwort *Callitriche brachycarpa* (FFG, listed; DELWP, vulnerable)**

Short Water-starwort is a listed species under the FFG Act and is classified as vulnerable under the VROTS list. It is a mostly terrestrial, creeping species from the Otway Ranges and northern outskirts of Melbourne on sites subject to inundation.

**Results**

No individuals were observed during targeted surveys conducted in areas of potentially suitable habitat at Trinity Grammar, Bolin Bolin Billabong and Banyule Swamp during the species' flowering season in December 2018. In addition, no VBA records were present within five kilometres of the project boundary. However, this species was observed by Australian Ecosystems (2007) at the Trinity Grammar School Sporting Complex wetlands (wetland D, which is in close proximity to the project boundary) and at Banyule Flats (Practical Ecology, 2017b). Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

**Silurian Striped Greenhood *Pterostylis* sp. aff. *striata* (Silurian) (DELWP, endangered)**

Silurian Striped Greenhood is classified as endangered under the VROTS list. However, it appears to have been taxonomically lumped into a more common taxon, *Pterostylis striata*, on VicFlora. Irrespective of its taxonomic status, little is known about the Silurian Striped Greenhood but it is generally confined to the Shire of Nillumbik area where it is found in the drier Box-Stringybark and Ironbark woodlands. Around Melbourne, this species is only known from a few sites within the Shire of Nillumbik area, with the closest historical record located in or immediately adjacent to the Hurstbridge rail line reserve. It flowers from May to August.

**Results**

No individuals were observed during targeted surveys conducted in areas of potentially suitable habitat during the species' flowering season in August 2018. Areas targeted included the Hurstbridge rail line near Greensborough, where a 2001 record occurs (with 500-metre accuracy). Two other species of *Pterostylis* were recorded within the project boundary during the targeted surveys. While potential habitat may be affected, the species has a **low to moderate** likelihood of occurring within the project boundary.

### Wine-lipped Spider-orchid *Caladenia oenochila* (DELWP, vulnerable)

Wine-lipped Spider-orchid is classified as vulnerable under the VROTS list. The Wine-lipped Spider-orchid is a slender, erect, perennial herb that grows from round tubers. It is largely known from the foothills immediately east of Melbourne and may respond to summer fires. Optimal habitat for this species is relatively moist, grassy forest or woodland, often in shaded habitats. The orchid flowers August to October.

#### Results

No individuals were observed during targeted surveys conducted in areas of potentially suitable habitat during the species' flowering season in spring 2018. However, one other species of *Caladenia* was recorded within the project boundary during the vegetation surveys. While potential habitat may be affected, the most recent historical record less than 30 years old is from approximately four kilometres east of the project boundary. Consequently, the species has a **low to moderate** likelihood of occurring within the project boundary.

### Melbourne Yellow Gum *Eucalyptus leucoxylon* subsp. *connata*

Melbourne Yellow Gum is categorised as vulnerable under the VROTS list. It is a gum-barked tree to 20-metres tall, not waxy, with juvenile leaves to 8-centimetres long, 7.5-centimetres wide, pairs often connate, persisting sometimes into the mature tree; adult leaves to 14-centimetres long, 2.5-centimetres wide; buds globular.

#### Results

No individuals were observed during field assessments, despite records of the taxon in close proximity to the project boundary at Yarra Bend Park. Given that it is a readily observable tree, and there is only a relatively narrow band of disturbance through the known habitat for the species (Yarra Bend Park area) it is likely the taxon has a **low** likelihood of occurring within the project boundary.

### Austral Crane's-bill *Geranium solanderi* var. *solanderi* (DELWP, vulnerable)

Austral Crane's-bill is categorised as vulnerable under the VROTS list. It is a long-lived trailing, perennial herb that is becoming increasingly rare in Victoria through loss of habitat. This species generally grows in sheltered sites in grassy woodlands with seasonally moist soils and with strong exposure to sunlight. It flowers from October to January.

#### Results

No individuals were observed during field assessments during the species' flowering season in October to November 2018. While potential habitat may be affected by the project, only a single record is present within a five-kilometre radius of the project boundary, near East Doncaster. Consequently, the species has a **low to moderate** likelihood of occurring within the project boundary.

### Veined Spear-grass *Austrostipa rudis* subsp. *australis* (DELWP, rare)

Veined Spear-grass is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. It is a tufted perennial grass to 1.3-metres tall. The flower head of this species appears either green or purplish in colour. The species is uncommon in Victoria, but can be found in cool areas of southern Victoria. Usually at moderate altitude, in open-forest on sandy or sandstone-derived soils. It is also found in parts of eastern New South Wales, eastern Tasmania and in South Australia near the Victorian border. The spear-grass flowers from November-January.

## Results

No individuals were observed during field assessments during the species' flowering season from November to December 2017 and November 2018. While potential habitat may be affected by the project, only five records are present within a five-kilometre radius of the project boundary. Consequently, the species is considered to have a **moderate** likelihood of occurring within the project boundary.

### Common Apple-berry *Billardiera scandens* s.s. (DELWP, rare)

Common Apple-berry is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. It is an ascending shrub, sometimes with stems climbing, young stems densely hairy. It flowers from November to February, with flowers being yellowish and tinged pink with age. The Apple-berry is apparently uncommon in Victoria, occurring chiefly in dry open-forests and woodlands in the north-east with isolated occurrences near Mt Macedon, the Eltham-Hurstbridge area, Eildon and Orbost. Despite being considered a 'rare' species it has a relatively wide distribution and numerous recent and past recordings within the region

## Results

No individuals were observed within the current study nor were any observed by Practical Ecology (2017b) or Lorimer (2005). Given the species is a readily observable shrub, it is likely it has a **low** likelihood of occurring within the project boundary, as it is likely to have been observed if present.

### Winged Water-starwort *Callitriche umbonata* (DELWP, rare)

Winged Water-starwort is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A low growing, mostly amphibious spreading herb. Scattered and uncommon, mainly in inland parts of Victoria, in damp and swampy places. It flowers from August to December.

## Results

No individuals were observed during field assessments during the species' flowering season in December 2018 (as part of the targeted survey for Short Water-starwort, which occurs in similar habitat). However, Winged Water-starwort has been observed by Practical Ecology (2017a) in the wetlands of Banyule Flats. While potential habitat may be affected by the project, only one record is present within a five-kilometre radius of the project boundary. Consequently, the species is considered to have a **low to moderate** likelihood of occurring within the project boundary.

### Fringed Helmet-orchid *Corybas fimbriatus* (DELWP, rare)

Fringed Helmet-orchid is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. It is a small, often inconspicuous plant with a mostly circular leaf and purplish-red or crimson flowers, with purplish-red spots. It usually forms colonies on moist, shaded sandy soil near the coast and generally east of Western Port, but with isolated occurrences near Melbourne at Gembrook, Warrandyte and Greensborough. It flowers from May to September.

## Results

No individuals were observed during field assessments conducted in areas of potentially suitable habitat during the species' flowering season in winter to spring 2017 and winter 2018. While potential habitat may be affected, only two records occur within five kilometres of the project boundary on the VBA, with the most recent record being over 20 years old. Consequently, it is considered the species has a **low to moderate** likelihood of occurring within the project boundary.

### **Bear's-ear *Cymbonotus lawsonianus* (DELWP, rare)**

Bear's-ear is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. It is a small ground cover plant with rounded fleshy leaves which are quite hairy. It flowers throughout the year and has yellow flowers. It grows in scattered in woodland communities across northern Victoria from the 'Upper Murray' and south to the Little Desert, with a few eastern collections from dryish areas south of the Great Dividing Range.

#### **Results**

No individuals were observed during field assessments conducted in areas of potentially suitable habitat. While potential habitat may be affected, only one record from 1995 records it as present within five kilometres of the project boundary on the VBA. Consequently, it is considered the species has a **low to moderate** likelihood of occurring within the project boundary.

### **Green Scentbark *Eucalyptus fulgens* (DELWP, rare)**

Green Scentbark is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. It is a rough bark eucalypt to about 20 metres tall, with glossy green leaves which can be quite long. It flowers in autumn and mainly occurs east from Healesville and Woori Yallock to the La Trobe Valley near Driffield, with some records from the eastern suburbs of Melbourne.

#### **Results**

An historical record (1989) of Green Scentbark occurs within the project boundary between Elgar Road and Doncaster Road. The species was not observed during project surveys and it is likely the tree was removed during the construction of the Eastern Freeway. Given the species is a readily observable tree, it is likely it has a **low** likelihood of occurring within the project boundary, as it is likely to have been observed if present.

### **Yarra Gum *Eucalyptus yarraensis* (DELWP, rare)**

Yarra Gum is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. This tree grows to 15 metres tall with glossy green leaves and rough bark except for some branches under 10 centimetres in diameter. The tree flowers from September to December and is endemic to Victoria, extending west from Glengarry (near Traralgon) to Melbourne and north-west to Daylesford and Ararat. A poorly known species whose distribution appears to have been much fragmented by the clearing of the natural habitat.

#### **Results**

Given the species is a readily observable tree, it is likely it has a low likelihood of occurring within the project boundary, as it is likely to have been observed if present.

### **Veiled Fringe-rush *Fimbristylis velata* (DELWP, rare)**

Veiled Fringe-rush is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A small densely tufted annual to 25 centimetres high, it flowers in spring and summer and has compound flower heads on branches to five centimetres long. It is occasionally found on drying mud beside lakes and rivers and in seasonally wet depressions, mostly in northern Victoria, but recent collections in the south from, such as the Bairnsdale and Healesville areas.

## Results

No individuals were observed during field assessments during the species' flowering season from spring to summer 2017–18 (as part of the targeted survey for River Swamp Wallaby-grass and Short Water-starwort, which occur in similar habitat). However, Veiled Fringe-rush has been noted by Australian Ecosystems (2007) as occurring nearby at Bolin Bolin Billabong. While potential habitat may be affected by the project, only three records are present within a five-kilometre radius of the project boundary. Consequently, the species is considered to have a **low to moderate** likelihood of occurring within the project boundary.

### Pale-flowered Crane's-bill *Geranium* sp. 3 (DELWP, rare)

Pale-flowered Crane's-bill is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. It has trailing, somewhat delicate perennial herb with stems to 30 centimetres long and leaves are strongly divided. In Victoria, it is currently known only from the Stawell, Yan Yean, Eltham, and Bonegilla areas and is found in open, grassy areas of dry woodland to forest. It flowers from September to January.

## Results

No individuals were observed during field assessments during the species' flowering season from spring to summer 2017–18. Potential habitat may be affected by the project, and there are 11 recorded within a five-kilometre radius of the project boundary. Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

### Rosemary Grevillea *Grevillea rosmarinifolia* subsp. *rosmarinifolia* (DELWP, rare)

Rosemary Grevillea is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. The species has narrow elliptic leaves, sometimes with sharp tips. It has a patchy distribution in Victoria, from south-west Gippsland to outer north-east fringes of Melbourne, west to Skipton and the Brisbane Ranges, to Bendigo in the north central region, extending to near Wodonga in the north-east. The Grevillea grows in open eucalypt forest or woodland or in riparian shrub associations, on rocky slopes or near creeks and flowers from July to December.

## Results

Given the species is a readily observable shrub, it is likely it has a **low** likelihood of occurring within the project boundary, as it is likely to have been observed if present.

### Slender Stylewort *Levenhookia sonderi* (DELWP, rare)

Slender Stylewort is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A tiny ephemeral herb 3 to 10 centimetres high, it flowers from September to December in a small cluster of flowers at the end of the short stem. The species is apparently endemic in Victoria. It grows in seasonally damp ground and drying swamps in lowland areas, mostly in the south-west (Little Desert, lower Glenelg River, Stawell areas) but also extending eastward to Rushworth in the north, and Beaconsfield in the south.

## Results

No individuals were observed during field assessments during the species' flowering season in summer 2018 (as part of the targeted survey for River Swamp Wallaby-grass and Short Water-starwort, which occur in similar habitat). While potential habitat may be affected by the project, only two records are present within a five-kilometre radius of the project boundary. Consequently, the species is considered to have a **low to moderate** likelihood of occurring within the project boundary.

### **Austral Tobacco *Nicotiana suaveolens* (DELWP, rare)**

Austral Tobacco is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A large herb to 1.5 metres tall with large leaves 20 to 30 centimetres long, it flowers mainly in spring and summer with a white, relatively large flower. The species is quite widespread, particularly in drier inland areas, often in rocky places.

#### **Results**

No individuals were observed during field assessments during the species' flowering season from spring to summer 2017–18. Potential habitat may be affected by the project, and there are three recorded within a five-kilometre radius of the project boundary. Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

### **Red-tipped Greenhood *Pterostylis clivosa* (DELWP, rare)**

Red-tipped Greenhood is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A flowering plant with wiry stems reaching 10 to 45 centimetres tall, it has a rosette of 3-8 rounded leaves and flowers from March to June with green and white flowers rounded plump flowers, reddish-brown towards the tip. The species is widespread across southern Victoria on slopes and ridges in drier open forests and woodlands on well-drained soils. It is characterised by its uncrowded, plump, rounded flowers that are brownish and rough towards the apex.

#### **Results**

No individuals were observed during field assessments during the species' flowering season from March to June. Potential habitat may be affected by the project, but there is only one record within a five-kilometre radius of the project boundary. Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

### **Emerald-lip Greenhood *Pterostylis smaragdyna* (DELWP, rare)**

Emerald-lip Greenhood is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. The species is to 40 centimetres tall and flowers from June to August, with shiny, translucent green flowers with dark green stripes and suffusions. The species is apparently localised in Victoria (such as in the outer north-eastern suburbs of Melbourne, the Brisbane Ranges and Ararat) but the exact range is uncertain due to confusion with allied species. The species grows in drier forests and woodlands on well-drained shallow clay loam.

#### **Results**

No individuals were observed during field assessments during the species' flowering season in winter. Potential habitat may be affected by the project, and there are 12 recorded within a five-kilometre radius of the project boundary, including nearby records in Plenty Gorge Parklands and Kalparrin Gardens. Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

### **Bulging Fireweed *Senecio campylocarpus* (DELWP, rare)**

Bulging Fireweed is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A tall herb to 1.5 metres tall, it has leaves entire (not dissected) to 24 centimetres long and daisy-like flowers that grow in groups of several bunched together. The species mostly grows throughout central Victoria and in the north-east in loam to clay soils in forest and woodland, usually in seasonally inundated areas.

## Results

No individuals were observed during field assessments. Potential floodplain habitat may be affected by the project, and there are four records within a five-kilometre radius of the project boundary. Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

### Annual Fireweed *Senecio glomeratus* subsp. *longifructus* (DELWP, rare)

Annual Fireweed is listed as rare on the DELWP *Advisory list of rare or threatened plants in Victoria – 2014*. A tall herb to 1.5 metres tall its leaves are weakly lobed, usually cobwebby on the lower surface. It flowers from spring to autumn and grows adjacent to streams and swamps throughout the south and north-east of the state.

## Results

No individuals were observed during field assessments during the species' flowering season from spring to autumn. Potential riparian and swampy habitat may be affected by the project, and there are two records within a five-kilometre radius of the project boundary. Consequently, the species has a **moderate** likelihood of occurring within the project boundary.

### Protected flora species – Flora and Fauna Guarantee Act

A total of 37 species of protected flora were recorded on public land in the project boundary during field surveys, and are likely to be impacted by the project. Table 26 below summarises all recorded FFG Act protected species.

It should be noted that section 48(4) of the FFG Act states that the Secretary must not issue a licence or permit for the taking, trading, keeping, moving or processing of protected flora if in the opinion of the Secretary to do so would threaten the conservation of the taxon or community of which the flora is a member or part.

Given that all the protected flora listed in Table 26 are relatively common, or not infrequent across the greater Melbourne area, it is the considered opinion that construction and operation of the project would not threaten the conservation of any taxon or community which the flora is a part of.

Table 26 Species recorded during field assessment listed as protected under the FFG Act

Status	Scientific name	Common name
P	<i>Acacia acinacea</i> s.s.	Gold-dust Wattle
P	<i>Acacia aculeatissima</i>	Thin-leaf Wattle
P	<i>Acacia genistifolia</i>	Spreading Wattle
P	<i>Acacia mearnsii</i>	Black Wattle
P, #	<i>Acacia provincialis</i>	Wirilda
P	<i>Acacia pycnantha</i>	Golden Wattle
P	<i>Acacia verticillata</i>	Prickly Moses
P	<i>Astroloma humifusum</i>	Cranberry Heath
P	<i>Brachyscome multifida</i>	Cut-leaf Daisy
P	<i>Caladenia carnea</i>	Pink Fingers
P	<i>Caladenia</i> sp.	-
P	<i>Cassinia aculeata</i>	Common Cassinia
P	<i>Cassinia longifolia</i>	Shiny Cassinia
P	<i>Cassinia sifton</i>	Drooping Cassinia
P	<i>Chrysocephalum apiculatum</i> s.s.	Common Everlasting
P	<i>Correa glabra</i> var. <i>glabra</i>	Rock Correa
P	<i>Correa reflexa</i>	Common Correa
EN, L, e, P	<i>Dianella amoena</i>	Matted Flax-lily
P	<i>Dipodium</i> spp.	Hyacinth Orchid
P	<i>Hardenbergia violacea</i>	Purple Coral-pea
P	<i>Laphangium luteoalbum</i>	Jersey Cudweed
P	<i>Microseris walteri</i>	Yam Daisy
P	<i>Microtis unifolia</i>	Common Onion-orchid
P	<i>Olearia lirata</i>	Snowy Daisy-bush
P	<i>Ozothamnus ferrugineus</i>	Tree Everlasting
P	<i>Prostanthera lasianthos</i>	Victorian Christmas-bush
P	<i>Prostanthera melissifolia</i>	Balm Mint-bush
P	<i>Pterostylis nutans</i>	Nodding Greenhood
P	<i>Pterostylis concinna</i>	-
P	<i>Senecio glomeratus</i> subsp. <i>glomeratus</i>	

Status	Scientific name	Common name
P	<i>Senecio hispidulus s.l.</i>	Rough Fireweed
P	<i>Senecio phelleus</i>	Rock Fireweed
P	<i>Senecio quadridentatus</i>	Cotton Fireweed
P	<i>Senecio</i> spp.	Groundsel
P	<i>Solenogyne</i> spp.	Solenogyne
P	<i>Thelymitra</i> spp.	Sun Orchid
P	<i>Xerochrysum viscosum</i>	Shiny Everlasting

Where: P= protected flora, # represent environmental weeds in some local government areas

### 7.3.3 Threatened ecological communities within the project boundary

#### EPBC Act-listed communities

Of the five EPBC Act-listed communities listed as potentially occurring within the project boundary (refer to Section 7.2.1), three were considered to not occur within the project boundary following site assessments:

- Natural Damp Grassland of the Victorian Coastal Plains
- Natural Temperate Grassland of the Victorian Volcanic Plain
- White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland

For these communities, none of the EVCs associated with these EPBC Act-listed communities were recorded during field assessments of the land within the project boundary and/or the land within the project boundary did not support the biogeographical characteristics of these communities. Consequently, these communities were not considered further.

The remaining two communities—*Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains* and *Grassy Eucalypt Woodland of the Victorian Volcanic Plain*—were considered further, owing to the presence of potentially suitable habitat within the project boundary. The presence or otherwise of these communities is discussed further below.

#### Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains

Seasonal Herbaceous Wetlands occur on the lowland plains of Victoria. The ecological community is limited to plains and lower slopes or stony rises at elevations below 500 metres above sea level. The soils on which the Seasonal Herbaceous Wetlands occur are generally fertile but poorly draining clays of various geologies (TSSC, 2012).

The community occurs on seasonally-filled drainage lines or depressions, sometimes poorly defined, that are variously categorised as isolated, closed or endorheic systems. Their inundation is typically seasonal. Inundation is not dependent on connections to riverine systems but is fed by local rainfall. There may be some groundwater influence that contributes to retention of the water in wetlands and persistence of wetland flora when climatic conditions are dry (TSSC, 2012).

The vegetation is generally treeless and dominated by a herbaceous ground layer, often with a considerable graminoid component. The herbaceous species present are characteristic of wetter sites and most of them are typically absent or uncommon in any adjoining dryland grasslands and woodlands. The type of wetland vegetation present is variable, but is often strongly represented by native species that are rooted in the soil and are emergent (that is, with shoots rising well above the water level) or have leaves floating on the water surface.

The dominant plants present are subject to seasonal and site conditions, and the diversity of the flora may range from relatively species-poor to species-rich composition (TSSC, 2012).

In the vicinity of the project, two areas of Yarra River floodplain wetlands—Bolin Bolin Billabong and Banyule Swamp/Warringal Parklands—occur in landscapes potentially associated with Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. Field surveys did not identify Seasonal Herbaceous Wetlands at either of the locations identified above.

Within the Banyule Flats and Warringal Parklands area exists an important remnant of relatively intact geomorphology, including the Banyule Swamp in the north-west and the Banyule Billabong, a large section of old river course, in the south-west; and various other apparently natural depressions. The Warringal Parklands has been significantly modified with the filling and levelling of the floodplain for sporting ovals, with the Warringal Swamp being retained. As wetlands in this area are primarily influenced by riverine processes and overbank flooding, they cannot support the Seasonal Herbaceous Wetlands community (TSSC, 2012).

Bolin Bolin Billabong is a regionally significant floodplain wetland, with largely intact riparian vegetation, but with considerable weed infestation. The greatest threat to the ecological values of the billabong appears to be the lack of hydrological connectivity with the Yarra River, resulting from increasingly rare overbank flows. Habitat hectare assessments revealed the vegetation is primarily Floodplain Riparian Woodland of the Gippsland Plain that does not meet the Seasonal Herbaceous Wetlands criteria set out by TSSC (2012).

### **Grassy Eucalypt Woodland of the Victorian Volcanic Plain**

Grassy Eucalypt Woodland of the Victorian Volcanic Plain (VVP) was identified to have some potential to occur in the study area. Although unlikely to occur within much of the study area, a patch of Grassy Eucalypt Woodland of the Victorian Volcanic Plain occurs along the M80 Ring Road in a small (approximately 1.5-hectare) patch that occurs between Enterprise Drive and the M80 Ring Road. This site is an offset site currently managed by the City of Whittlesea and contains an area of Plains Grassy Woodland (EVC 55). This patch has been designated as a no-go zone for the project, to avoid potential impacts on this community. This patch is further described in the *Flora and Fauna Guarantee Act*-listed communities section below and pictured in Plate 23 and Plate 24.

The Plains Grassy Woodland (EVC 55) that exists within Simpson Barracks was investigated for its potential to be considered Grassy Eucalypt Woodland of the Victorian Volcanic Plain. While the vegetation present on the site comprised open woodland with a grassy understorey, which resembles some of the structural characteristics of Grassy Eucalypt Woodland, the geology of the site was sandstone and not volcanic in origin, as shown in Figure 10. Therefore, since Grassy Eucalypt Woodland is 'specifically limited to the extensive Quaternary basalt plain of south-western Victoria' (as per the listing advice), it was concluded the woodland within Simpson Barracks is not Grassy Eucalypt Woodland.

### **Flora and Fauna Guarantee Act-listed communities**

No flora ecological communities listed as threatened under the FFG Act were recorded within the project boundary.

The Plains Grassy Woodland offset site between Enterprise Drive and the M80 Ring Road meets the criteria to be classified as the FFG Act-listed community, Western Basalt Plains (River Red Gum) Grassy Woodland (Figure 2 in Section 3.5). However, it should be noted that this patch has been designated as a no-go zone for the project, to avoid potential impacts on this community. The offset site is characterised by a large, open canopy of mature River Red Gum. The understorey lacks much of the shrubby mid-layer described in the community description but there is a high cover of native graminoid species including Wallaby Grasses, Kangaroo Grass and Mat Rush *Lomandra* spp. There is a relatively low cover of native forbs but the community description allows for considerable variance in understorey composition.



Plate 23 – Offset site in north-west of project boundary



Plate 24 – Offset site in north-west of project boundary

#### 7.3.4 Vegetation quality assessment

##### Patches of native vegetation

Vegetation within the project boundary was found to consist predominantly of riparian and floodplain vegetation (Swampy Riparian Woodland, Floodplain Riparian Woodland) and Plains Grassy Woodland of varying qualities within the Gippsland Plain bioregion (46.8 hectares). The northern part of the project boundary falls largely within the Highlands— Southern Fall bioregion (4.6 hectares) and consists mainly of Grassy Dry Forest. The south-west of the project boundary contains approximately 0.7 hectares of native vegetation within the Victorian Volcanic Plain bioregion. Patches of native vegetation mapped as part of the field assessment within the project boundary are summarised in Table 27 and shown in Figure 11. The full habitat hectare results for the vegetation assessment are presented in Table 28.

**It is noted that habitat in the project boundary directly above the tunnels alignment (a no-go zone) has not been included in the below estimates as no surface impacts are anticipated.**

Table 27 Summary of habitat hectare results within the project boundary

EVC No.	EVC	Status	Area of habitat within project boundary (ha)	Habitat hectares within project boundary (Hha)	No. of patches
<b>Gippsland Plain</b>					
47	Valley Grassy Forest	Vulnerable	3.314	1.359	6
53	Swamp Scrub	Endangered	0.225	0.090	3
55	Plains Grassy Woodland	Endangered	18.107	9.077	41

EVC No.	EVC	Status	Area of habitat within project boundary (ha)	Habitat hectares within project boundary (Hha)	No. of patches
56	Floodplain Riparian Woodland	Endangered	6.351	2.169	28
68	Creekline Grassy Woodland	Endangered	0.878	0.190	7
83	Swampy Riparian Woodland	Endangered	15.264	6.190	21
164	Creekline Herb-rich Woodland	Endangered	0.061	0.021	1
175	Grassy Woodland	Endangered	1.212	0.625	4
308	Aquatic Sedgeland	Endangered	0.059	0.035	1
641	Riparian Woodland	Endangered	0.211	0.082	6
821	Tall Marsh	Least Concern	0.901	0.438	4
937	Swampy Woodland	Endangered	0.228	0.125	1
Total in Gippsland Plain			46.811	20.401	123
Highlands—Southern Fall					
18	Riparian Forest	Least Concern	1.571	0.534	1
22	Grassy Dry Forest	Least Concern	2.749	0.985	9
47	Valley Grassy Forest	Vulnerable	0.304	0.094	3
Total in Highlands—Southern Fall			4.623	1.613	13
Victorian Volcanic Plain					
55	Plains Grassy Woodland	Endangered	0.606	0.167	3
56	Floodplain Riparian Woodland	Endangered	0.045	0.020	2
641	Riparian Woodland	Endangered	0.024	0.009	2
Total in Victorian Volcanic Plain			0.675	0.196	7
Total in project boundary			52.109	22.211	143

Areas containing amenity plantings (including planted native vegetation) have not been considered as part of this impact assessment. It is acknowledged that amenity plantings are of interest to various stakeholders but they have been excluded from this impact assessment as their removal does not hold direct legislative implications under the EPBC Act, P&E Act and FFG Act (refer to Section 5.4.4).

Native vegetation within the project boundary can be summarised as:

- 143 patches of native vegetation comprising 52.109 hectares (22.211 habitat hectares)

Figure 11 shows the location of ecological values within the project boundary, including habitat zones, large trees in patches, large scattered trees and small scattered trees. None of the patches mapped within the project boundary represent either FFG Act or EPBC Act-listed vegetation communities.

Table 28 Habitat hectare assessment (LC – Least concern; D – Depleted; V – Vulnerable; E – Endangered)

Habitat zones			2-C	3-U	4-S	5-S	6-S	7-S	8-U	9-C	10-C	11-C	12-E	13-C	14-C	15-C
EVC			83	56	55	55	55	55	56	83	83	83	47	83	83	83
Bioregion			GipP	VVP	GipP	GipP	GipP	GipP	VVP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E	E	E	E	E	E	E	E	V	E	E	E
Site condition	Large trees	10	0	0	0	0	0	0	0	0	0	0	8	3	3	3
	Tree canopy cover	5	5	5	5	4	5	5	5	0	3	3	5	0	0	0
	Lack of weeds	15	2	4	6	6	9	9	13	2	6	6	4	0	0	0
	Understorey	25	15	5	15	15	5	5	5	5	15	15	15	15	15	15
	Recruitment	10	6	5	6	6	0	0	5	3	6	6	6	10	10	10
	Organic litter	5	5	4	5	3	3	3	5	2	3	3	5	2	2	2
	Logs	5	0	4	4	0	0	0	2	0	2	2	2	2	2	2
	Total site score	75	33	27	41	34	22	22	35	12	35	35	45	32	32	32
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			33	27	41	34	22	22	35	12	35	35	45	32	32	32
Landscape context score			25	2	13	6	8	2	2	13	2	2	2	3	3	3
Habitat score			100	35	40	47	42	24	24	48	14	37	37	47	35	35
Habitat points = Score/100			1	0.35	0.40	0.47	0.42	0.24	0.24	0.48	0.14	0.37	0.37	0.47	0.35	0.35
Total area of habitat zone (ha)			1.048	0.013	1.772	2.898	0.016	0.039	0.032	0.051	0.035	0.302	0.144	0.000	0.001	0.496
Habitat hectares (Hha)			0.367	0.005	0.833	1.217	0.004	0.009	0.015	0.007	0.013	0.112	0.068	0.000	0.000	0.174

Habitat zones			16-C	17-N	18-N	19-C	20-C	21-C	22-L	23-L	24-S	25-L	26-N	27-L	28-N	29-L
EVC			83	22	22	83	83	83	68	68	55	68	22	68	22	68
Bioregion			GipP	HSF	HSF	GipP	GipP	GipP	GipP	GipP	GipP	GipP	HSF	GipP	HSF	GipP
Bioregional Conservation Status (BCS)			E	LC	LC	E	E	E	E	E	E	E	LC	E	LC	E
Site condition	Large trees	10	3	0	4	0	2	0	9	0	0	0	4	0	0	0
	Tree canopy cover	5	3	5	5	5	5	5	4	4	4	3	5	4	5	3
	Lack of weeds	15	7	2	2	2	2	2	2	2	2	2	6	2	6	2
	Understorey	25	15	5	5	15	15	15	0	0	5	5	15	5	15	5
	Recruitment	10	6	0	0	6	6	6	0	0	0	0	5	5	5	0
	Organic litter	5	3	5	5	5	5	5	2	2	2	2	5	2	5	2
	Logs	5	4	0	0	4	4	4	0	0	4	0	2	0	2	0
	Total site score	75	41	17	21	37	39	37	17	8	17	12	42	18	38	12
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			41	17	21	37	39	37	17	8	17	12	42	18	38	12
Landscape context score		25	3	5	5	2	5	2	2	2	2	2	5	2	5	2
Habitat score		100	44	22	26	39	44	39	19	10	19	14	47	20	43	14
Habitat points = Score/100		1	0.44	0.22	0.26	0.39	0.44	0.39	0.19	0.10	0.19	0.14	0.47	0.20	0.43	0.14
Total area of habitat zone (ha)			1.308	0.063	0.224	0.067	3.875	0.800	0.098	0.022	0.048	0.125	0.487	0.215	0.391	0.110
Habitat hectares (Hha)			0.575	0.014	0.058	0.026	1.705	0.312	0.019	0.002	0.009	0.017	0.229	0.043	0.168	0.015

Habitat zones			30-M	31-M	32-M	33-M	34-M	35-M	36-N	37-N	38-N	39-N	40-I	41-T	42-S	43-J
EVC			56	56	56	56	56	56	22	22	22	22	18	55	55	641
Bioregion			GipP	GipP	GipP	GipP	GipP	GipP	HSF	HSF	HSF	HSF	HSF	VVP	GipP	VVP
Bioregional Conservation Status (BCS)			E	E	E	E	E	E	LC	LC	LC	LC	LC	E	E	E
Site condition	Large trees	10	0	6	0	0	3	3	3	3	3	0	3	0	0	0
	Tree canopy cover	5	3	3	4	4	3	3	2	2	2	0	0	3	2	5
	Lack of weeds	15	0	0	0	0	2	2	0	0	0	6	2	4	2	0
	Understorey	25	5	15	15	15	5	15	5	5	5	15	5	5	5	5
	Recruitment	10	3	6	6	6	3	3	5	5	5	5	3	6	6	6
	Organic litter	5	2	3	2	2	2	3	4	4	4	5	2	5	3	4
	Logs	5	2	2	0	0	0	0	0	0	0	2	4	2	2	2
	Total site score	75	15	35	27	27	18	29	19	19	19	33	19	25	20	22
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			15	35	27	27	18	29	19	19	19	33	19	25	20	22
Landscape context score		25	13	13	13	13	4	5	4	4	4	5	15	4	14	13
Habitat score		100	28	48	40	40	22	25	23	23	23	38	34	29	34	35
Habitat points = Score/100		1	0.28	0.48	0.40	0.40	0.22	0.25	0.23	0.23	0.23	0.38	0.34	0.29	0.34	0.35
Total area of habitat zone (ha)			0.173	0.811	0.002	0.016	0.831	0.875	0.001	0.061	0.471	0.476	1.571	0.325	0.604	0.006
Habitat hectares (Hha)			0.049	0.389	0.001	0.006	0.183	0.219	0.000	0.014	0.108	0.181	0.534	0.094	0.205	0.002

Habitat zones			44-J	45-T	46-S	47-T	48-G	49-G	50-G	51-G	52-M	53-M	54-M	55-M	56-M	57-M
EVC			641	55	55	55	641	641	641	641	56	56	56	56	56	56
Bioregion			VVP	VVP	GipP	VVP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E	E	E	E	E	E	E	E	E	E	E	E
Site condition	Large trees	10	0	0	0	0	6	6	6	6	0	0	7	0	2	2
	Tree canopy cover	5	5	0	2	0	5	5	5	5	2	1	2	2	2	2
	Lack of weeds	15	0	6	2	6	0	0	0	0	2	0	2	2	2	2
	Understorey	25	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Recruitment	10	6	6	6	6	6	6	6	6	6	3	6	6	6	6
	Organic litter	5	4	3	3	3	3	3	3	3	2	4	2	2	2	2
	Logs	5	2	2	2	2	2	2	2	2	0	0	0	0	0	0
	Total site score	75	22	22	20	22	27	27	27	27	17	13	24	17	19	19
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			22	22	20	22	27	27	27	27	17	13	24	17	19	19
Landscape context score			25	13	4	13	4	14	14	14	13	5	5	13	13	13
Habitat score			100	35	26	33	26	41	41	41	30	18	29	30	32	32
Habitat points = Score/100			1	0.35	0.26	0.33	0.26	0.41	0.41	0.41	0.30	0.18	0.29	0.30	0.32	0.32
Total area of habitat zone (ha)			0.018	0.195	0.033	0.086	0.027	0.033	0.032	0.050	0.048	0.042	0.450	0.044	0.005	1.068
Habitat hectares (Hha)			0.006	0.051	0.011	0.022	0.011	0.014	0.013	0.021	0.014	0.008	0.131	0.013	0.002	0.342

Habitat zones			58-S	59-S	60-S	61-S	62-E	63-C	64-D	65-S	66-O	67-M	68-S	69-D	70-S	71-S
EVC			55	55	55	55	47	83	821	55	175	56	55	821	55	55
Bioregion			GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E	E	V	E	LC	E	E	E	E	LC	E	E
Site condition	Large trees	10	3	0	6	6	0	0	NA	0	0	0	0	NA	0	0
	Tree canopy cover	5	5	5	5	5	5	0	NA	5	3	5	5	NA	5	5
	Lack of weeds	15	13	6	6	6	6	9	15	7	2	0	7	15	7	6
	Understorey	25	15	15	15	15	15	15	15	0	5	10	5	10	5	15
	Recruitment	10	6	10	10	10	5	6	6	0	5	3	0	3	0	6
	Organic litter	5	5	3	3	3	5	3	3	3	2	5	3	5	3	5
	Logs	5	2	2	2	2	0	0	NA	0	4	0	0	NA	0	4
	Total site score	75	49	41	47	47	36	33	39	15	21	23	20	33	20	41
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.36	1.00	1.00	1.00	1.00	1.36	1.00	1.00
Standardised site score			49	41	47	47	36	33	53	15	21	23	20	45	20	41
Landscape context score		25	13	5	5	5	2	2	3	2	14	4	2	6	2	2
Habitat score		100	58	46	52	52	38	35	56	17	35	27	22	51	22	43
Habitat points = Score/100		1	0.58	0.46	0.52	0.52	0.38	0.35	0.56	0.17	0.35	0.27	0.22	0.51	0.22	0.43
Total area of habitat zone (ha)			9.978	0.259	0.000	0.739	0.180	0.015	0.023	0.043	0.156	0.106	0.027	0.039	0.007	0.071
Habitat hectares (Hha)			5.787	0.119	0.000	0.384	0.068	0.005	0.013	0.007	0.055	0.029	0.006	0.020	0.002	0.030

Habitat zones			72-L	73-S	74-M	75-S	76-S	77-M	78-L	79-S	80-M	81-M	82-S	83-D	84-S	85-S
EVC			68	55	56	55	55	56	68	55	56	56	55	821	55	55
Bioregion			GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E	E	E	E	E	E	E	E	E	LC	E	E
Site condition	Large trees	10	4	0	0	10	10	0	0	0	0	8	0	NA	0	0
	Tree canopy cover	5	3	5	5	3	3	5	3	5	5	5	3	NA	2	2
	Lack of weeds	15	0	0	2	9	9	6	0	6	2	9	0	15	0	4
	Understorey	25	10	0	10	5	5	10	5	5	10	15	0	10	5	5
	Recruitment	10	6	0	3	6	6	6	0	0	3	10	0	3	1	3
	Organic litter	5	4	3	5	3	3	5	0	3	5	5	2	5	3	4
	Logs	5	3	0	5	0	0	5	0	0	5	2	0	NA	0	0
	Total site score	75	30	8	30	36	36	37	8	19	30	54	5	33	11	18
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.36	1.00	1.00
Standardised site score			30	8	30	36	36	37	8	19	30	54	5	45	11	18
Landscape context score		25	2	4	13	2	2	13	2	4	13	13	2	6	4	2
Habitat score		100	32	12	43	38	38	50	10	23	43	67	7	51	15	20
Habitat points = Score/100		1	0.32	0.12	0.43	0.38	0.38	0.50	0.10	0.23	0.43	0.67	0.07	0.51	0.15	0.20
Total area of habitat zone (ha)			0.284	0.076	0.053	0.071	0.048	0.099	0.024	0.036	0.013	0.270	0.005	0.390	0.017	0.243
Habitat hectares (Hha)			0.091	0.009	0.023	0.027	0.018	0.050	0.002	0.008	0.006	0.181	0.000	0.199	0.003	0.049

Habitat zones			86-S	87-S	88-S	89-C	90-B	91-B	92-B	93-O	94-O	95-O	96-C	97-C	98-C	99-C
EVC			55	55	55	83	53	53	53	175	175	175	83	83	83	83
Bioregion			GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E	E	E	E	E	E	E	E	E	E	E	E
Site condition	Large trees	10	10	9	0	0	NA	NA	NA	1	1	1	3	3	0	0
	Tree canopy cover	5	2	2	3	4	3	3	3	3	3	3	5	5	5	5
	Lack of weeds	15	7	0	0	6	0	0	0	6	6	6	0	0	2	2
	Understorey	25	5	5	5	15	15	15	15	15	15	15	5	5	15	15
	Recruitment	10	3	0	3	6	10	10	10	6	6	6	10	10	6	6
	Organic litter	5	5	5	3	5	2	2	2	5	5	5	5	5	5	5
	Logs	5	0	0	0	4	NA	NA	NA	4	4	4	2	2	4	4
	Total site score	75	32	21	14	40	30	30	30	40	40	40	30	30	37	37
Standardiser			1.00	1.00	1.00	1.00	1.25	1.25	1.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			32	21	14	40	38	38	38	40	40	40	30	30	37	37
Landscape context score		25	2	4	4	6	2	2	2	14	14	14	3	3	3	2
Habitat score		100	34	25	18	46	40	40	40	54	54	54	33	33	40	39
Habitat points = Score/100		1	0.34	0.25	0.18	0.46	0.40	0.40	0.40	0.54	0.54	0.54	0.33	0.33	0.40	0.39
Total area of habitat zone (ha)			0.141	0.075	0.036	1.796	0.010	0.086	0.128	0.910	0.121	0.025	2.053	0.559	0.374	0.057
Habitat hectares (Hha)			0.048	0.019	0.006	0.826	0.004	0.034	0.051	0.492	0.065	0.013	0.678	0.185	0.149	0.022

Habitat zones			100-E	101-C	102-C	103-C	104-F	105-L	106-M	107-S	108-E	109-S	110-S	111-S	112-E	113-E
EVC			47	83	83	83	937	68	56	55	47	55	55	55	47	47
Bioregion			GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			V	E	E	E	E	E	E	E	V	E	E	E	V	V
Site condition	Large trees	10	0	0	0	0	8	0	0	0	0	0	0	0	0	4
	Tree canopy cover	5	5	5	5	5	5	5	0	5	3	0	5	5	3	5
	Lack of weeds	15	0	2	2	2	11	6	11	7	6	13	7	7	6	6
	Understorey	25	5	15	15	15	15	5	15	5	15	5	5	5	15	15
	Recruitment	10	10	6	6	6	6	6	0	0	6	6	0	0	6	10
	Organic litter	5	3	5	5	5	3	3	2	3	3	3	3	3	3	5
	Logs	5	2	4	4	4	2	4	0	0	4	0	0	0	4	4
	Total site score	75	25	37	37	37	50	29	28	20	37	27	20	20	37	49
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			25	37	37	37	50	29	28	20	37	27	20	20	37	49
Landscape context score		25	2	2	2	2	5	5	4	2	3	2	2	2	2	5
Habitat score		100	27	39	39	39	55	34	32	22	40	29	22	22	39	54
Habitat points = Score/100		1	0.27	0.39	0.39	0.39	0.55	0.34	0.32	0.22	0.40	0.29	0.22	0.22	0.39	0.54
Total area of habitat zone (ha)			0.162	0.058	0.414	0.210	0.228	0.061	0.087	0.017	2.124	0.070	0.021	0.021	0.337	0.366
Habitat hectares (Hha)			0.044	0.023	0.161	0.082	0.125	0.021	0.028	0.004	0.850	0.020	0.005	0.005	0.132	0.198

Habitat zones			114-S	115-S	116-S	117-S	119-M	120-S	121-G	122-G	123-M	124-M	125-M	126-M	127-M	128-M
EVC			55	55	55	55	56	55	641	641	56	56	56	56	56	56
Bioregion			GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E	E	E	E	E	E	E	E	E	E	E	E
Site condition	Large trees	10	0	8	0	0	10	0	0	0	0	0	6	0	0	10
	Tree canopy cover	5	5	5	5	5	5	3	5	5	5	3	3	3	2	5
	Lack of weeds	15	0	2	9	0	2	0	0	0	6	13	9	9	2	2
	Understorey	25	0	5	5	0	0	5	5	5	15	15	5	5	5	0
	Recruitment	10	0	5	6	0	0	5	6	6	6	6	3	3	6	0
	Organic litter	5	5	3	3	3	5	5	3	3	3	5	3	3	2	5
	Logs	5	0	5	0	0	0	0	2	2	2	2	0	0	0	0
	Total site score	75	10	33	28	8	22	18	21	21	37	44	29	23	17	22
Standardiser			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Standardised site score			10	33	28	8	22	18	21	21	37	44	29	23	17	22
Landscape context score		25	2	4	4	4	4	4	14	14	13	5	5	4	13	5
Habitat score		100	12	37	32	12	26	22	35	35	50	49	34	27	30	27
Habitat points = Score/100		1	0.12	0.37	0.32	0.12	0.26	0.22	0.35	0.35	0.50	0.49	0.34	0.27	0.30	0.27
Total area of habitat zone (ha)			0.010	0.161	0.048	0.077	0.115	0.056	0.029	0.040	0.294	0.198	0.311	0.132	0.037	0.108
Habitat hectares (Hha)			0.001	0.059	0.015	0.009	0.030	0.012	0.010	0.014	0.147	0.097	0.106	0.036	0.011	0.029

Habitat zones			129-M	130-D	131-S	132-H	133-H	134-H	135-N	136-A	137-A	138-M	139-M	140-K	141-A	142-A
EVC			56	821	55	47	47	47	22	55	55	56	56	308	55	55
Bioregion			GipP	GipP	GipP	HSF	HSF	HSF	HSF	GipP	GipP	GipP	GipP	GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	LC	E	V	V	V	LC	E	E	E	E	LC	E	E
Site condition	Large trees	10	0	NA	4	0	0	0	0	10	0	3	3	NA	10	10
	Tree canopy cover	5	5	NA	5	5	3	5	5	2	0	3	3	NA	3	3
	Lack of weeds	15	2	9	9	7	6	9	9	0	0	2	2	13	2	2
	Understorey	25	5	15	15	5	5	5	10	5	5	15	15	15	5	5
	Recruitment	10	5	6	10	5	5	5	5	0	6	3	3	6	0	0
	Organic litter	5	5	0	3	5	5	3	3	3	3	3	3	5	3	3
	Logs	5	0	NA	4	0	0	4	0	4	0	0	0	NA	2	2
	Total site score	75	22	30	50	27	24	31	32	24	14	29	29	39	25	25
Standardiser			1.00	1.36	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.36	1.00	1.00
Standardised site score			22	41	50	27	24	31	32	24	14	29	29	53	25	25
Landscape context score		25	4	5	4	2	5	5	5	2	4	5	5	6	2	2
Habitat score		100	26	46	54	29	29	36	37	26	18	34	34	59	27	27
Habitat points = Score/100		1	0.26	0.46	0.54	0.29	0.29	0.36	0.37	0.26	0.18	0.34	0.34	0.59	0.27	0.27
Total area of habitat zone (ha)			0.161	0.449	0.158	0.059	0.155	0.089	0.575	0.095	0.005	0.000	0.000	0.059	0.004	0.007
Habitat hectares (Hha)			0.042	0.206	0.085	0.017	0.045	0.032	0.213	0.025	0.001	0.000	0.000	0.035	0.001	0.002

Habitat zones			143-A	144-A	348-C
EVC			55	55	83
Bioregion			GipP	GipP	GipP
Bioregional Conservation Status (BCS)			E	E	E
Site condition	Large trees	10	10	10	3
	Tree canopy cover	5	3	3	3
	Lack of weeds	15	2	2	4
	Understorey	25	5	5	15
	Recruitment	10	0	0	6
	Organic litter	5	3	3	3
	Logs	5	2	2	4
	Total site score	75	25	25	38
Standardiser			1.00	1.00	1.00
Standardised site score			25	25	38
Landscape context score			25	2	2
Habitat score			100	27	44
Habitat points = Score/100			1	0.27	0.44
Total area of habitat zone (ha)			0.007	0.070	1.745
Habitat hectares (Hha)			0.002	0.019	0.768

## Indigenous trees

The following section provides an overview of observations of indigenous trees:

- A total of 92 large trees were recorded in patches of native vegetation within the project boundary (Table 29) (see Appendix H). This includes some trees rooted just outside the project boundary but where more than 10 per cent of their TPZ falls within the project boundary.
- A total of 202 scattered small (115) and large (87) trees were recorded within the project boundary (Table 29) (see Appendix I). Note: of the 87 large scattered trees:
  - 55 were recorded as scattered trees within the project boundary. This includes some trees rooted just outside the project boundary but where more than 10 per cent of their TPZ falls within the project boundary.
  - 32 were recorded outside the project boundary and have a moderate to high risk of suffering premature mortality due to groundwater drawdown associated with construction of the northern tunnel portal (see Section 10).

**Table 29 Summary of large trees in patches and scattered tree (large and small) results within the project boundary**

Tree type	Number of trees
Large tree in patch – within project boundary	92
Scattered large tree – within project boundary	55
Scattered large tree – outside project boundary (potential groundwater drawdown impact)	32
Scattered small tree – within project boundary	115

## Avoid and minimise statement

Prior to the development of the reference project for North East Link, a number of route alignments were considered. These route options were assessed based on their performance against a set of project objectives and guiding principles. Overall, the selected corridor was chosen as it provides a more optimal, efficient and well-used roadway than other options considered and unlocks greater capacity on the arterial road network. It also extracts the most value from existing infrastructure by making better and more efficient use of the Eastern Freeway. While delivering greater benefits, it also has significantly lower capital and operational costs than other options considered. The selection of this corridor is discussed further in EES Chapter 6 – Project development.

Once the corridor was selected, site planning has allowed for avoidance of environmental sensitive areas, including:

- Yarra River and surrounding environment, by tunnelling beneath these areas and minimising surface activities through Banyule Flats and Warringal Parklands
- Bolin Bolin Billabong, a native vegetation offset site immediately adjacent to the M80 Ring Road and Yarra Bend Park, by establishing no go zones to protect existing environments.

Simpson Barracks is acknowledged as being an environmentally sensitive area that would be affected by the project. At this location, the project's encroachment into Simpson Barracks has been minimised through careful design development. The need for space in this area is largely driven by the design of the North East Link interchanges with Lower Plenty Road and Grimshaw Street.

The design of the interchange at Lower Plenty Road does not follow a typical intersection layout because that would require acquisition of a number of homes (approximately 100 properties). Therefore, the ramp connections have been reorganised so the southbound ramps connect to Greensborough Road.

This slightly increases the footprint of land required within Simpson Barracks, but avoids the acquisition of a number of homes. The construction of the ramps and tunnels through Simpson Barracks is required to adopt a cut and cover technique because the depth of these structures at this location is too shallow for a Tunnel Boring Machine (TBM) to operate.

Another design option considered included tunnel constructed by TBM extending from beneath the Yarra River as far north as Grimshaw Street. This would avoid impacts on Simpson Barracks. However, to avoid impacting the Hurstbridge rail line, the North East Link tunnels would need to be well below the rail corridor near where it intersects with Greensborough Road. This would mean the tunnels would be too deep to provide an interchange with Grimshaw Street which would undermine the traffic functionality of the project.

More generally, the project has also minimised its impact on certain areas by selecting open space and existing cleared areas for construction compounds where possible. Further avoidance of impacts is required as an outcome of this project, as specified by the EPRs.

### Offset requirements

Offset requirements are determined based on the presence of mapped native vegetation within the project boundary. It is currently assumed that all native vegetation within the project boundary would be removed.

The process that DELWP applies for determining offsets for loss of native vegetation is outlined in Section 4.3.2. The extent and quality of the patches and the location of the large trees in patches and scattered trees would be provided to DELWP to generate a Native Vegetation Removal (NVR) report once the project design is finalised and the project boundary and extent of vegetation removal is confirmed. In the interim, the patches of native vegetation (assessed via habitat hectares assessment), large trees within patches, and scattered large and small trees were run through the Environmental Systems Modelling Platform (EnSym) Native Vegetation Regulations (NVR) Tool, which determined North East Link is to be assessed via the detailed pathway, since more than 0.5 hectares of native vegetation would be removed.

### General habitat units

The *Native vegetation removal report* received from DELWP on 8 February 2019 indicated the following requirements for general habitat:

- General offset amount: 8.025 general habitat units
- Offset attributes:
  - Large trees: 103 large trees
  - Vicinity: Port Philip and Westernport Catchment Management Authority (CMA) or the municipalities of Banyule, Boroondara, Manningham, Nillumbik and Whitehorse
  - Minimum strategic biodiversity value score: 0.155.

It should be noted that these results are not final and may change.

### Species habitat units

The *Native vegetation removal report* indicated the following requirements for species specific habitat:

- Species offset amount:
  - 22.945 species units of habitat for Grey-headed Flying-fox
  - 24.980 species units of habitat for Australian Grayling
  - 9.490 species units of habitat for Yarra Pygmy Perch
  - 17.269 species units of habitat for Small Golden Moths
  - 18.821 species units of habitat for Melbourne Yellow-gum
- Large trees: 76 trees.

It should be noted that these results are not final and may change.

### 7.3.5 Presence of declared weeds and pathogens

#### Weeds

The 16 species listed in Table 30 are weeds observed within the project boundary that are declared under the CaLP Act or Weeds of National Significance (WoNS).

Table 30 Declared weeds present within the project boundary

Scientific name	Common name	CaLP	WoNS
<i>Allium triquetrum</i>	Angled Onion	Restricted	No
<i>Asparagus asparagoides</i>	Bridal Creeper	Restricted	Yes
<i>Cirsium vulgare</i>	Spear Thistle	Regionally controlled	No
<i>Cytisus scoparius</i>	English Broom	Regionally controlled	Yes
<i>Echium plantagineum</i>	Paterson's Curse	Regionally controlled	No
<i>Foeniculum vulgare</i>	Fennel	Restricted	No
<i>Genista linifolia</i>	Flax-leaf Broom	Regionally controlled	Yes
<i>Genista monspessulana</i>	Montpellier Broom	Regionally controlled	Yes
<i>Hypericum perforatum</i> subsp. <i>veronense</i>	St John's Wort	Regionally controlled	No
<i>Lycium ferocissimum</i>	African Box-thorn	Regionally controlled	Yes
<i>Nassella neesiana</i>	Chilean Needle-grass	Restricted	Yes
<i>Nassella trichotoma</i>	Serrated Tussock	Regionally controlled	Yes
<i>Oxalis pes-caprae</i>	Soursob	Restricted	No
<i>Rosa rubiginosa</i>	Sweet Briar	Regionally controlled	No
<i>Rubus fruticosus</i> spp. agg.	Blackberry	Regionally controlled	Yes
<i>Ulex europaeus</i>	Gorse	Regionally controlled	Yes

## Pathogens

The pathogen considered most relevant to the ecological impact assessment of the study area is Cinnamon Fungus *Phytophthora cinnamomi*. The potential range and indicative threat map in DSE (2008) shows the study area falls within the potential range of this pathogen and its indicative threat is listed as between '1 –10 susceptible plant species' and '30 to < 40 susceptible plant species'. This pathogen is listed as a potentially threatening process and as such is dealt with in Section 12.1.5.

### 7.3.6 Likelihood of potentially threatening processes

Appendix G provides a list of key threatening processes identified under the EPBC Act (DoEE, 2017a; DoEE, 2017b) or FFG Act (DELWP, 2016b) as well as an assessment of the likelihood of the threatening process occurring within the study area and whether the project would likely exacerbate the threat.

The applicability of threatening processes to the project has been determined based on the location of the project, values within the study area and relevance to the proposed works. Key threatening processes that are not applicable to the project are excluded from Appendix G.

Of the threatening processes determined to be relevant to the project, five are considered to have a moderate or above likelihood of occurrence and are considered possible or likely to be exacerbated by the project. These are:

- 'Land Clearance', listed under the EPBC Act. This process is considered present within the project boundary and broader landscape due to historic and ongoing development of the urban environment for residential, industrial and transport purposes. The project would exacerbate this threatening process through the further loss of native vegetation within the project boundary. This vegetation is part of a highly fragmented mosaic across the urban north-eastern suburbs of Melbourne.
- 'Degradation of native riparian vegetation along Victorian rivers and streams', listed under the FFG Act. This process is considered present within the project boundary and broader landscape due to historic and ongoing development of the urban environment (including waterways) for residential, industrial and transport purposes. The project would exacerbate this threatening process through the further degradation of native riparian vegetation along Koonung Creek, Banyule Creek, and the Yarra River. Additional impacts are not expected to alter the ecological effectiveness of the waterways, given the extent of existing degradation.
- 'Loss of biodiversity as a result of the spread of Coast Wattle (*Acacia longifolia* subsp. *Sophorae*) and Sallow Wattle (*Acacia longifolia* subsp. *Longifolia*) into areas outside its natural range', listed under the FFG Act. This process is considered present within the project boundary—Sallow Wattle is present. The project could exacerbate this threatening process. Clearance of native vegetation may create opportunities for Sallow Wattle to invade further into the project boundary. Ongoing monitoring and mitigation would be required to reduce the likelihood of this threatening process being exacerbated by the project.
- 'Spread of *Pittosporum undulatum* in areas outside its natural distribution', listed under the FFG Act. This process is considered present within the project boundary—Sweet Pittosporum is present. The project could exacerbate this threatening process. Clearance of native vegetation may create opportunities for Sweet Pittosporum to invade further into the project boundary. Ongoing monitoring and mitigation would be required to reduce the likelihood of this threatening process being exacerbated by the project.

- ‘Wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing’, listed under the FFG Act. This process is considered present within the study area—most of the wetlands and waterways in the study area are highly modified and degraded due to human intervention. The project could exacerbate this threatening process through groundwater changes as a result of tunnelling. Groundwater changes are discussed in Section 10 on groundwater dependent ecosystems and Section 12 (impact assessment).

#### 7.3.7 Mapped wetlands

The DELWP wetland layer was interrogated and mapped (Figure 15). Wetland condition scores were provided by DELWP.

### 7.4 Warringal Parklands and Banyule Flats

#### General

This section addresses Habitat Zones HZ032 to HZ041 located in Warringal Parklands and Banyule Flats, as shown in Figure 11. **Note – where the study area intersects the Warringal Parklands and Banyule Flats, no surface works are proposed.** During the current study, these habitat zones underwent a high-level EVC mapping/confirmation exercise but vegetation quality assessment was not conducted. This was due to a comprehensive investigation conducted by Practical Ecology (2017b) cataloguing ecological values and conservation significance of the Warringal Parklands and the Banyule Flat Reserves over a 2.5-year timeframe.

Warringal Parklands and Banyule Flats are located along the Yarra River floodplain in Heidelberg and Viewbank across 81 hectares; of which approximately 50 hectares fall within the project boundary. They are surrounded by suburban Melbourne and bounded by residential housing, the Yarra River and parkland. These parklands are also on the western limits of the Gippsland Plain bioregion.

#### Ecological values

Practical Ecology (2017b) identified the modelled presence of four EVCs within the project boundary during their desktop investigation:

- Floodplain Riparian Woodland (EVC 56)
- Floodplain Wetland Aggregate (EVC 172)
- Plains Grassy Woodland (EVC 55)
- Creekline Grassy Woodland (EVC 68).

Practical Ecology (2017b) described the overall ecology prior to European colonisation as:

*The woodland vegetation on the floodplain was largely referable to Floodplain Riparian Woodland (EVC 56), which in turn was flanked by Plains Grassy Woodland (EVC 55) on less steeper parts of the adjacent more elevated ground and variously Grassy Woodland (EVC 175) or Riverine Escarpment Shrubland (EVC 82) on steeper terrain. Minor streams entering the floodplain supported a narrow band of Creekline Grassy Woodland (EVC 68) until such a point as the habitat came under the influence of the ecological factors operating on the floodplain (eg soils and flooding regime) rather than those in operation along the low gradient drainage-line further above its confluence with the river (Practical Ecology 2017b, pg. 20).*

Following an analysis of data from historical EVC distribution and on-ground surveys, Practical Ecology provided a more nuanced understanding of the distribution of EVCs within the parklands. Across the site, Floodplain Riparian Woodland covers the vast majority of the area, with more elevated areas showing presence of drier terrestrial EVCs such as Plains Grassy Woodland and Grassy Woodland.

The wetlands within Banyule Flats fall largely under aggregated EVC labels including Billabong Wetland Aggregate (EVC 334) and Floodplain Wetland Aggregate (EVC 172). Each of these aggregates contain a wide range of component EVCs which may occur at a very fine spatial scale and/or in temporal mosaics, with presence determined by variations in wetting and drying cycles. Practical Ecology note there were also some differences in mapped EVCs between their study and previous ones (that is, Osler and Cook) (2007) [Australian Ecosystems]. This was likely due to temporal variability brought about by wetting and drying cycles.

The current study conducted a high-level confirmation of EVCs within Banyule Flats and Warringal Parklands, with results mapped in Figure 11. This assessment was based on the information contained within Practical Ecology (2017b) and observed conditions at the time, which were likely to be heavily influenced by prevailing hydrological conditions. The current study identified the following EVCs:

- Plains Grassy Woodland (EVC 55)
- Floodplain Riparian Woodland (EVC 56)
- Creekline Grassy Woodland (EVC 68)
- Red Gum Swamp (EVC 292)
- Tall Marsh (EVC 821)
- Wet Verge Sedgeland (EVC 932).

In the Warringal Parklands, a patch of native vegetation approximately 1.8 hectares in extent was identified, consisting of Tall Marsh and Floodplain Riparian Woodland EVCs. In Banyule Flats, an approximately 23-hectare mosaic of EVCs was mapped around Banyule Swamp. The majority of the area (approximately 11 hectares) was mapped as Floodplain Riparian Woodland along with a variety of terrestrial EVCs such as Plains Grassy Woodland, and wetter EVCs such as Red Gum Swamp and Wet Verge Sedgeland. Practical Ecology (2017b) used the vegetation component of the Index of Wetland Condition (DEPI, 2013c) to assess vegetation quality rather than a vegetation quality assessment.

### **Threatened ecological communities**

Australian Ecosystems (2017) did not record any threatened ecological communities during their assessment. Targeted survey for Seasonal Herbaceous Wetland of the Temperate Lowland Plain conducted during this assessment also failed to identify this threatened ecological community at the Warringal Parklands and Banyule Flats. For a more detailed account of these results, see Section 7.3.3.

### **Mapped wetlands**

DELWP mapping provided in Figure 15 identifies several wetlands within the parklands, including Banyule Swamp and a variety of smaller wetlands/billabongs in the complex. These wetlands were identified as being of state significance in their extent and quality, particularly with regard to their ability to support birdlife (Beardsell, 1997). Under the new Guidelines (DELWP 2017a) they also represent areas of native vegetation in the unlikely case of impact.

## Orchids

Practical Ecology (2017b) identified one threatened orchid species that may occur within the Warringal Parklands and Banyule Flats area—Fringed Helmet-orchid *Corybas fimbriatus*. However, during their assessment it was determined the site was unlikely to contain suitable habitat for the species.

## River Swamp Wallaby-grass *Amphibromus fluitans*

No River Swamp Wallaby-grass was observed during field assessments but targeted assessments were not completed for this species (refer to Section 5.4.6). Desktop surveys found a high likelihood of presence, with nine recent records within the five-kilometre buffer of the project boundary; the most recent record from 2011. While there are some suitable areas of habitat such as Banyule Swamp and Bolin Bolin Billabong, these areas are outside the project boundary or are within no-go zones. As such, there is a low likelihood that River Swamp Wallaby-grass is located within the impacted portion of the project boundary, however it has been assumed present for the purpose of this assessment.

## Studley Park Gum

Studley Park Gum was identified by Doug Frood (Practical Ecology, 2017b) at Banyule Flats on the edge of the Banyule Billabong. A precise location for this species was not available from this report but impacts to this species at Banyule Flats are not anticipated as this area has been marked as a no-go zone which precludes surface impacts.

## Water-starworts: Short Water-starwort and Winged Water-starwort

Short Water-starwort and Winged Water-starwort *Callitriche umbonata* were observed by Practical Ecology in the wetlands of Banyule Flats. Precise locations of these species were not available from this report. A desktop assessment for this species yielded one recent record (2013) of Short Water-starwort and no recent records of Winged Water-starwort.

During the current study, these species were not observed but this may have been due to the temporal variation in the wet-dry cycles or due to the high-level nature of the investigation conducted at Warringal Parklands and Banyule Flats.

Impacts to these species at Banyule Flats are not anticipated as this area has been marked as a no-go zone, which precludes surface impacts.

## Seasonal Herbaceous Wetlands of the Temperate Lowland Plains

The EPBC Act-listed ecological community, Seasonal Herbaceous Wetlands of the Temperate Lowland Plains, was not identified during assessments of Warringal Parklands and Banyule Flats. Justification for this assessment is provided in Section 7.3.3.

## 8. Existing conditions – fauna

The existing conditions of the terrestrial fauna assets, values and uses being considered throughout this assessment are described in the following sections.

Terrestrial fauna are defined as any fauna that occur in the terrestrial environment that largely reside in the terrestrial environment for all life stages. For this project, amphibians are considered as terrestrial fauna, while platypus and turtles are considered as aquatic fauna (refer to Section 9).

### 8.1 Summary – terrestrial fauna

A review of desktop information coupled with field assessment of the project corridor was undertaken to develop a picture of the key issues for assessment and inform measures to avoid and minimise potential effects.

The project boundary is considerably urbanised and fragmented, but still supports habitats for fauna. Habitats for terrestrial fauna include forests and woodlands (riparian and non-riparian), scattered trees and shrubs, waterways and wetlands. Some non-native vegetation (including planted amenity trees) also provides habitat for some fauna, particularly where it integrates with native vegetation (eg, in wetlands and billabongs, where the canopy is remnant but the understorey is weedy and largely non-native).

Areas of highest ecological value occur particularly near the Yarra River and its associated floodplain in the Banyule and Bulleen area. Numerous threatened and migratory species are recorded in the region. This waterway provides the most significant wildlife corridor within the study area and within the eastern suburbs of Melbourne. The tunnelled section of the project would run beneath the southern reach of Banyule Creek and Banyule Swamp, and the Yarra River floodplain. South of the tunnelled section, the project corridor would run immediately east of the Bolin Bolin Billabong, which is of high value to fauna.

Other areas of notable value to terrestrial fauna include eucalypt woodland in Simpson Barracks (Department of Defence site at Yallambie) and along Koonung Creek, where habitats are mostly degraded and disturbed, but are likely to function as a local wildlife corridor.

Where the project corridor meets the Eastern Freeway, the area has been considerably disturbed historically. Golf courses north of the Eastern Freeway provide limited habitats for native fauna, but are mostly dominated by common and adaptable bird species (such as the Noisy Miner *Manorina melanocephala*, Red Wattlebird *Anthochaera carunculata* and Rainbow Lorikeet *Trichoglossus haemotodus*). Some of the wetlands in these golf courses (such as Simpson's Lake) provide specific habitat for waterbirds and potentially frogs, and lie within or immediately adjacent to the project boundary.

Well west of Bulleen Road, the Eastern Freeway crosses the Yarra River and Merri Creek at separate locations. At the Yarra River, the project boundary would abut but largely avoid the Flying-fox Management Area (DSE, 2005) associated with the Grey-headed Flying-fox (*Pteropus poliocephalus*) camp/colony at Yarra Bend Park (south of the project). This area is a designated no-go zone, beyond a small area (<10 metres) of trees at the edge of the Eastern Freeway.

A total of 402 species of terrestrial fauna are recorded (VBA and/or BLA) or predicted to occur (PMST) within the study area. Of these, 74 fauna species classified as threatened were considered for the project, and 23 were considered to have a moderate or high likelihood of occurrence within the project boundary. However, most of these species are not expected to make considerable use of the areas that would be impacted by the project. Many of these are most likely to have their core areas of habitat (in the Melbourne area) in Bulleen and Banyule, where the project would be in tunnels. Of the 23 species, three species in particular are expected to use or visit parts of the study area that would be impacted by the project:

- Powerful Owl, *Ninox strenua*
- Swift Parrot, *Lathamus discolor*
- Grey-headed Flying-fox, *Pteropus poliocephalus*.

While the impact assessment for fauna discussed in Section 12 considers all species, it focuses on these species in particular.

Twenty-six species of bird identified for the study area are listed as migratory under the EPBC Act. One species—Latham's Snipe, *Gallinago hardwickii*—may use the Banyule Swamp area (above the tunnelled section) regularly enough and in sufficient numbers that the area is likely to constitute 'important habitat' for that species.

No listed fauna communities are expected to occur within the project boundary.

## 8.2 Desktop assessment

This section summarises the results of the ecological database searches relating to terrestrial fauna. A full assessment of the likelihood of occurrence of all threatened and migratory fauna within the project boundary is provided in Appendix D and Appendix E.

### 8.2.1 Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified a number of Matters of National Environmental Significance (MNES) that may occur, or for which suitable habitat may occur within the associated five-kilometre buffer. Results of the PMST search are presented in Appendix F and summarised in Table 20 in Section 7.2.1.

All threatened and/or migratory fauna predicted to occur by the PMST that are listed in Appendix F are combined with the VBA and BLA data in lists of threatened and migratory species in Appendix D and Appendix E, along with an evaluation of the likelihood of those species occurring in the study area.

### 8.2.2 Victorian Biodiversity Atlas and Birdlife Australia Atlas

The following section provides the combined results of the VBA and BLA searches for records of fauna listed as threatened under the EPBC Act, listed under the FFG Act and/or listed as threatened species (but not Near Threatened or Data Deficient) on the DELWP-administered Advisory Lists of threatened invertebrate and vertebrate fauna in Victoria (DSE, 2009; DEPI, 2013a) after the exclusions outlined in Section 5.2 have been applied.

For the location of threatened species records refer to Figure 13 and Figure 14.

Within the study area, 402 species of fauna have been recorded (VBA and/or BLA) or are predicted to occur or have habitat occurring (PMST) within the area. Most of these are birds (305) with smaller numbers of mammals (53), reptiles (28), amphibians (14) and invertebrates (2), as listed in Table 31 below.

Seventy-four species identified for the search area are classified as threatened terrestrial fauna. These include 27 species listed as threatened under the EPBC Act, 58 species listed as threatened under the FFG Act and 63 species listed as threatened on the DELWP Advisory Lists (DSE, 2009, DEPI, 2013a) (not including species listed as Near Threatened or Data Deficient).

Of the 74 species, 49 have been recorded in the VBA or the BirdLife Australia Atlas since 1987 (last 30 years), including 10 species listed under the EPBC Act, 41 species listed under the FFG Act and 42 species listed on the DELWP Advisory Lists. Eight of the 74 threatened species have never been recorded within the search area (identified by PMST only). All threatened fauna identified for the search area by the PMST or recorded in the area since 1987 (VBA/BLA) are shown in Appendix D.

Thirty-one of the 402 species are non-native species, and 25 of those have been recorded in the study area since 1987.

**Table 31** Counts of threatened fauna species identified for the study area (all species and species recorded since 1987), grouped by taxonomic group

Group		Threatened fauna				Non-threatened fauna		Total
		EPBC	FFG	DELWP	Total	Native	Non-native	
	From all records/sources							
Mammals	9	11	9	13	30	10	53	
Birds	14	42	45	52	232	21	305	
Reptiles	1	1	4	4	24	0	28	
Amphibians	1	2	3	3	11	0	14	
Invertebrates	2	2	2	2	0	0	2	
Total	27	58	63	74	297	31	402	
	Species recorded since 1987							
Mammals	1	4	4	5	28	8	41	
Birds	7	34	32	38	198	17	253	
Reptiles	0	0	2	2	23	0	25	
Amphibians	1	2	3	3	10	0	13	
Invertebrates	1	1	1	1	0	0	1	
Total	10	41	42	49	259	25	333	

Twenty-six species of bird recorded (VBA and/or BLA) or predicted to occur or have habitat occurring (PMST) within the search area are listed as migratory under the EPBC Act. Some of those are also listed as threatened species. Twelve migratory species have been recorded within the search area since 1987. Six species have never been recorded within the search area (identified by PMST only). All migratory fauna identified for the search area by the PMST or recorded in the area since 1987 (VBA/BLA) are listed in Appendix D.

Eighty-six species (85 birds and one marine mammal) identified for the search area are listed under the EPBC Act as Marine. The Marine status of fauna is not considered further, because the project is not within a Commonwealth Marine Area, nor expected to impact on a Commonwealth Marine Area.

### 8.2.3 FFG communities

One fauna community listed as threatened under the FFG Act is identified for the study area: *Victorian temperate-woodland bird community*. The description of this community identifies 25 *key indicator bird species* (the presence of which confirm the presence of the community) and 21 *associated bird species* (the presence of which indicate the *potential* presence of the community). Nineteen key indicator species and 11 associated bird species are identified by the desktop assessment as having been recorded (VBA/BLA) within the search area in the past 30 years (since 1987).

## 8.3 Field assessment

This section details the terrestrial fauna values observed in the study area.

### 8.3.1 Fauna habitats

This section describes the habitat values for terrestrial fauna within and around the project boundary, and considers both threatened and non-threatened fauna.

#### Overview

The study area is considerably urbanised and fragmented as a result of historical land clearance for urbanisation and to enable the construction of the Eastern Freeway and major arterial roads between the Eastern Freeway and the M80 Ring Road. That said, the study area still supports a range of habitats for terrestrial fauna, though these are typically highly disturbed and often include non-native vegetation. Areas of high ecological value remain in some sections, particularly near the Yarra River and its associated floodplain in the Alphington, Kew East, Bulleen, and Banyule areas. Because this land is a floodplain within a large metropolitan area, it is characterised by expansive, well-treed, multi-use recreational parks (including golf courses), which retain important patches of high value habitat for terrestrial fauna. Representative photos of higher quality fauna habitats within the study area are shown in Plate 25.

The northern parts of the project boundary generally pass through areas that have been previously disturbed. The woodland and forest areas that remain or that have regenerated or been re-planted offer low to moderate value habitat for threatened and migratory fauna species. While some threatened species may use these habitats occasionally (such as the Swift Parrot *Lathamus discolor*), these habitats tend to be used and visited by common and adaptable fauna that occur across much of the Melbourne area.

Further south, in the suburb of Yallambie, the project corridor runs along the western fringe of the Simpson Barracks, which contains a relatively large area of remnant woodland, particularly for this part of otherwise urbanised Melbourne. This habitat is of moderately high value and the large eucalypts may attract threatened fauna species such as the Swift Parrot and Grey-headed Flying-fox *Pteropus poliocephalus* occasionally.

The corridor then courses along Banyule Creek as tunnels. The Creek is relatively degraded (weedy with non-native trees and shrubs) and generally of low to moderate value to fauna for most of its length. Banyule Creek flows into or alongside Banyule Swamp within a large area of recreational parks associated with the Yarra River floodplain where there are numerous records of threatened species. The corridor then continues along the eastern side of more high value Yarra River floodplain, including the Bolin Bolin Billabong.

Where the corridor meets the Eastern Freeway at Bulleen Road, the area has been considerably disturbed historically, mostly for the construction of the Eastern Freeway. Golf courses adjacent to the Eastern Freeway (north side, west of Bulleen Road) provide some limited habitats for native fauna, but are mostly dominated by common and aggressive bird species such as Noisy Miner *Manorina melanocephala*, Red Wattlebird *Anthochaera* and Rainbow Lorikeet *Trichoglossus haemotodus*. Threatened species may use those habitats occasionally. Fauna habitats along Koonung Creek (mainly east of Bulleen Road) are mostly degraded and disturbed, and tend to be used mostly by common and adaptable fauna.

West of Bulleen Road, the Eastern Freeway crosses the Yarra River and Merri Creek (separate locations). The fauna habitats at both locations are degraded and disturbed. Where it crosses the Yarra River, the project boundary abuts the north side of the Flying-fox Management Area (DSE, 2005) associated with the Grey-headed Flying-fox camp/colony at Yarra Bend Park. The project boundary has been designed to avoid the Flying-fox Management Area (a no-go zone) as far as possible.

a. High value woodland/forest – Simpson Barracks



b. Low value scattered trees – Greensborough Road



c. Degraded waterway – Banyule Creek upper



d. Degraded waterway – Banyule Creek lower



e. Banyule Flats



f. Banyule Swamp



g. Yarra Flats



h. Bolin Bolin Billabong



i. Yarra River – Yarra Flats



j. Yarra River – Kew



k. Golf course habitat, Kew



l. Yarra Bend at Eastern Freeway



m. Koonung Creek Linear Reserve, west of Elgar Road



n. Koonung Creek, Boronia Grove Reserve, Doncaster



**Plate 25 Representative photos of fauna habitats within the study area**

### Forests and woodlands (non-riparian)

Associated EVC: Grassy Dry Forest (22), Valley Grassy Forest (47), Plains Grassy Woodland (55) and Grassy Woodland (175).

This habitat type mainly occurs within Simpson Barracks but there are also small areas beside the M80 Ring Road at the far north of the project boundary.

This habitat type has moderate-value due to the small and fragmented nature of the remaining patches. These patches tend to be characterised by common and adaptable fauna (such as the Red Wattlebird, Rainbow Lorikeet, Noisy Miner, Common Ringtail Possum *Pseudocheirus peregrinus*, Common Brushtail Possum *Trichosurus vulpecula*) which can be aggressive and outcompete other native fauna. Occasionally or rarely, the larger of these patches (such as Simpson Barracks) may attract threatened fauna such as Powerful Owl *N. strenua*, Swift Parrot and Grey-headed Flying-fox, though this is expected to comprise foraging habitat only and these species are not expected to breed or roost here.

Because Simpson Barracks contains relatively large areas of remnant woodland in an otherwise urbanised landscape, it is likely to attract and support a range of fauna. However, because it is surrounded by urbanisation and has been considerably disturbed historically, it is generally degraded and consequently unlikely to support the full range of threatened and non-threatened fauna that would have occurred there historically.

The trees in the woodland habitat at Simpson Barracks are dominated by River Red Gum (*Eucalyptus camaldulensis*) and are visited or used by a range of common fauna, including Common Ringtail Possum, Australian Magpie *Gymnorhina tibicen*, Rainbow Lorikeet, Noisy Miner and Red Wattlebird. The understorey is dense but short, and likely to be used by a range of common reptiles, including Tiger Snake *Notechis scutatus*, Common Blue-tongued Lizard *Tiliqua scincoides*, Garden Skink *Lampropholis guichenoti*, and mammals, including Eastern Grey Kangaroo *Macropus giganteus* and Short-beaked Echidna *Tachyglossus aculeatus*.

As found during this assessment, and reported by HLA-Envirosciences Pty Ltd (2007), there is typically lower than expected fauna diversity in the western part of Simpson Barracks, perhaps due to the 'prevalence of aggressive bird species such as Noisy Miner, Rainbow Lorikeet, Australian Magpie and Common Myna', and due to 'the modified nature of much of the Barracks as well as the isolated nature of the remnant habitat'.

Species that are unusual/rare in the Melbourne area, such as Grey Goshawk *Accipiter novaehollandiae*, Black Falcon *Falco subniger*, Barking Owl *Ninox connivens* and White-throated Needletail *Hirundapus caudacutus*, may visit the Barracks occasionally, but are unlikely to be there regularly, or to depend on habitat within the site. Due to historical ground disturbance, native small mammals are not expected to persist within Simpson Barracks, a conclusion also reached by HLA (2007).

### Riparian forests and woodland

Associated EVC: Valley Grassy Forest (47), Floodplain Riparian Woodland (56), Creekline Grassy Woodland (68), Swampy Riparian Woodland (83) and Riparian Woodland (641).

The forests and woodlands that line the waterways within the project boundary are the most extensive areas of vegetation that remain. These areas generally contain high-value habitat that is likely to attract and support a range of common, uncommon and rare fauna, including threatened species.

While these areas are often a narrow strip of habitat they tend to be subject to fewer ongoing disturbances so often have several habitat features the other habitat types have now lost, such as leaf-litter, coarse woody debris, hollow-bearing trees and large trees. Some of the vegetation in this habitat type is remnant (such as on the banks of the Yarra River) but other areas comprise planted native vegetation in linear reserves along parts of Koonung Creek. These plantings were aimed at replicating natural EVCs and have been established long enough to be considered a 'patch' of native vegetation.

The main value of these patches is as wildlife corridors which facilitate landscape-scale movement of fauna between two or more areas of habitat. Corridors play an important role in linking otherwise isolated areas of habitat. Typically, wildlife corridors are linear strips of habitat that connect two larger patches of habitat, but corridors vary substantially in terms of width, length and habitat features, and their success depends upon the biology of the fauna species involved. Wildlife corridors often comprise valuable fauna habitat themselves, regardless of their connectivity.

Common fauna can be abundant in these habitats, especially the larger and more connected patches such as along the Yarra River, Bolin Bolin Billabong, Banyule Swamp and along Koonung Creek. Larger fauna such as Macropods (Eastern Grey Kangaroo and Black Wallaby *Wallabia bicolor*), Common Wombat *Vombatus ursinus*, Short-beaked Echidna and Sugar Glider *Petaurus breviceps* are able to persist here compared with the smaller more fragmented patches. These patches also tend to have a greater diversity of bird fauna (beyond the common, adaptable and often aggressive parrots and honeyeaters), including thornbills (Brown Thornbill *Acanthiza pusilla*, Yellow-rumped Thornbill *Acanthiza chrysorrhoa*), kingfishers (Azure Kingfisher *Alcedo azurea*, Sacred Kingfisher *Todiramphus sanctus*), Superb-fairy Wren *Malurus cyaneus*, smaller honeyeaters (such as the Scarlet Honeyeater *Myzomela sanguinolenta*, White-plumed Honeyeater *Lichenostomus penicillatus*) and waterbirds such as crakes, rails and waterfowl. Frogs (such as the Common Froglet *Crinia signifera*, Southern Brown Tree Frog *Litoria ewingi* and Spotted Marsh Frog *Limnodynastes tasmaniensis*) and reptiles (such as the Tiger Snake *Notechis scutatus*) are also most likely to be found in these areas.

### Scattered trees and planted roadside trees and shrubs

This habitat generally has low value for native fauna. Scattered trees and planted roadside trees and shrubs is the main habitat type most likely to be affected by the project as it makes up a large proportion of what remains within the project boundary, and impacts on larger more intact vegetation are being avoided by tunnelling or the establishment of no-go zones. The main value of this habitat is likely to be as a corridor for the movement of fauna within and through the project boundary and between the larger patches of vegetation outside the project boundary.

The value of this habitat is likely to vary, depending on the size of the roadside reserve, park or garden, its quality (for example, the presence of hollow-bearing trees, vegetation layers, leaf litter and fallen limbs and logs) and connectivity to other patches of habitat. However, many of these habitat features were often absent from this habitat type.

This habitat type tended to be characterised by common and adaptable mobile fauna (including the Red Wattlebird, Rainbow Lorikeet, Noisy Miner). Occasionally or rarely, less disturbed patches of this habitat may attract foraging threatened fauna such as Swift Parrot and Grey-headed Flying-fox.

## Waterways and Wetlands

The main ecological values within the study area are centred on the numerous waterways and wetlands, the most notable of which include:

- Banyule Creek
- Koonung Creek
- Yarra River
- Plenty River
- Merri Creek
- Yarra River billabongs, including Bolin Bolin Billabong, Kew Billabong, Simpson's Lake, and other wetlands within Kew Golf Course and the Freeway Public Golf Course
- Banyule Swamp.

The aquatic values of these areas is discussed in Section 9.3.1 but it is worth noting these areas tend to provide the most significant wildlife corridors within the study area.

Banyule Creek, Koonung Creek and the Yarra River are intercepted significantly by the project boundary and are described below (and see relevant sections of Section 9).

### **Banyule Creek**

Banyule Creek originates within Simpson Barracks. From Simpson Barracks, Banyule Creek flows south to its outfall into the Yarra River. The creek is approximately four-kilometres long.

From Blamey Road, Banyule Creek generally runs parallel to Greensborough Road through Simpson Barracks to an open reserve north of Drysdale Road. At Drysdale Road, the creek crosses under the road in a 0.6-metre diameter circular culvert and continues downstream through an open reserve to Lower Plenty Road. At Lower Plenty Road, the creek crosses under the road in two 1.575-metre diameter circular culverts. South of Lower Plenty Road, the creek continues through an open reserve near residential properties until it meets the Yarra River.

Where the project is proposed through the western part of Simpson Barracks, the waterway is small and intermittent and forms a naturally incised channel providing poor quality fauna habitat, but a series of man-made, stream-side, densely vegetated ponds provide habitat for common frogs, including Common Froglet and Southern Brown Tree Frog. Threatened wetland species, such as Growling Grass Frog *Litoria raniformis*, Latham's Snipe *Gallinago hardwickii*, Australian Painted Snipe *Rostratula australis* and Australasian Bittern *Botaurus poiciloptilus*, are unlikely to occur within this section of Banyule Creek.

### **Koonung Creek**

Koonung Creek is a tributary of the Yarra River. Koonung Creek is approximately 12-kilometres long and begins near Springvale Road, in Blackburn North, and flows west before out falling into the Yarra River just north of the Freeway Public Golf Course. The creek meanders back and forth either side of the Eastern Freeway for much of its length before it outfalls into the Yarra River. Overall, the catchment is heavily urbanised. Flows into Koonung Creek enter from local catchment drainage connections including the following Melbourne Water Drains (Blackburn Road Drain, Leeds Road Drain, Elms Grove Drain, Gardenia Road Drain, Ayr Street Drain and Minerva Avenue Drain) and creeks (Brushy Creek).

### ***Yarra River and billabongs***

The Yarra catchment lies north and east of Melbourne, beginning on the southern slopes of the Great Dividing Range in the forested Yarra Ranges National Park. The upper reaches of the Yarra River and its major tributaries flow through forested, mountainous areas. Most of the land along rivers and creeks in the middle and lower sections has been cleared for agriculture or urban development.

At the location of North East Link, the Yarra River consists of an extensive floodplain that comprises a number of land uses including but not limited to public recreation, conservation and special use zones such as golf courses. Between Banksia Street and Chandler Highway, the floodplain is generally well vegetated.

The Yarra River and its associated floodplain in the Banyule/Bulleen area retain high ecological value. This waterway provides the most significant wildlife corridor within the study area and within the eastern suburbs of Melbourne.

#### **8.3.2 Threatened species**

All threatened fauna identified for the study area are listed in Appendix D. Most of those species are considered unlikely to occur within the project boundary, as explained in Appendix D.

Habitat assessments were undertaken to determine the likely presence of species and targeted surveys for selected species were completed where it was considered likely the results would change our understanding of that species at a particular site based on existing information. The location of targeted surveys is shown in Figure 12.

Species shown in Appendix D as having a moderate or high likelihood of occurrence within the project boundary are discussed in more detail below. These tend to be the species known to visit or reside in parts of the project boundary, or considered to be of high ecological significance for some other reason (such as those considered to be nationally threatened under the EPBC Act).

Results of the threatened species habitat assessment and targeted surveys are shown in Table 32 below. None of the targeted species were detected. Weather conditions are important to frog surveys, as they influence the likelihood of success. Weather conditions experienced during the targeted surveys are shown in Table 33.

Table 32 Summary of results of threatened fauna habitat assessment and targeted surveys

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted Round 1	Targeted Round 2	Target species detected?	Other species recorded
Alphington Park and Wetland	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	23/04/2018	23/04/2018	26/04/2018	No	Common Froglet ( <i>Crinia signifera</i> )
	Powerful Owl	<i>Ninox strenua</i>	-	L	en	23/04/2018	N	N	No	Southern Boobook ( <i>Ninox novaeseelandiae</i> )
Banyule Swamp	Australasian Bittern	<i>Botaurus poiciloptilus</i>	EN	L	en	26/04/2018	26/04/2018	N	No	Common Froglet ( <i>Crinia signifera</i> ) Southern Brown Tree Frog ( <i>Litoria ewingii</i> )
Banyule Creek	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	26/04/2018	N	N	No	None
	Powerful Owl	<i>Ninox strenua</i>	-	L	en	26/04/2018	N	N	No	None
Bolin Bolin Billabong	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	19/04/2018	19/04/2018	23/04/2018	No	None
	Growing Grass Frog	<i>Litoria raniformis</i>	VU	L	en	31/10/2017	31/10/2017	8/11/2017	No	Southern Brown Tree Frog ( <i>Litoria ewingii</i> ) Peron's Tree Frog ( <i>Litoria peroni</i> ) Striped Marsh Frog ( <i>Limnodynastes peroni</i> ) Spotted Marsh Frog <i>Limnodynastes tasmaniensis</i> Southern Bullfrog <i>Limnodynastes dumerilli</i>

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted Round 1	Targeted Round 2	Target species detected?	Other species recorded
	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	31/10/2017	10-Dec-18	14-Dec-18	Possibly, outside the project boundary. Two skins (not captured) resembled <i>Pseudemoia</i>	30 x <i>Lampropholis guichenoti/delicata</i> , 1 x <i>Saproscincus mustellinus</i>
Boronia Grove	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni/P. semimarmorata</i>	-	L	en	19/04/2018	19/04/2018	N	No	None
Freeway Golf Course - wetland near eastern freeway	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	3-Dec-18	3-Dec-18	N	No	No. Not suitable habitat for Glossy Grass Skink. Second visit not done.
Freeway Golf Course - Koonung Creek	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	3-Dec-18	3-Dec-18	10-Dec-18	No	Tiger Snake ( <i>Notechis scutatus</i> ) (juv)
Hillcrest Reserve	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni/P. semimarmorata</i>	-	L	en	19/04/2018	19/04/2018	26/04/2018	No	Common Froglet ( <i>Crinia signifera</i> ) Southern Brown Tree Frog ( <i>Litoria ewingii</i> )

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted Round 1	Targeted Round 2	Target species detected?	Other species recorded
Kew Billabong (Willesmere Park)	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	17/05/2018	17/05/2018	4/06/2018	No	Victorian Smooth Froglet ( <i>Geocrinia victoriana</i> ) Southern Boobook ( <i>Ninox novaeseelandiae</i> )
	Growling Grass Frog	<i>Litoria raniformis</i>	VU	L	en	17/05/2018	N	N	No	Victorian Smooth Froglet ( <i>Geocrinia victoriana</i> )
	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	10-Dec-18	10-Dec-18	14-Dec-18	Possibly, outside the project boundary.  10 <i>Pseudemoia</i> -like skinks seen, but not captured.	<i>Lampropholis guichenoti/delicata</i> , <i>Saproscincus mustellinus</i>
Kew Golf Course	Growling Grass Frog	<i>Litoria raniformis</i>	VU	L	en	6/11/2017	6/11/2017	13/11/2017	No	Southern Brown Tree Frog ( <i>Litoria ewingii</i> ) Peron's Tree Frog ( <i>Litoria peroni</i> ) Eastern Dwarf Tree Frog ( <i>Litoria fallax</i> ) Striped Marsh Frog ( <i>Limnodynastes peroni</i> )
Kilby Reserve/Hays Paddock	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	17/05/2018	N	N	No	None

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted Round 1	Targeted Round 2	Target species detected?	Other species recorded
Koonung Creek	Growling Grass Frog	<i>Litoria raniformis</i>	VU	L	en	1/11/2017	1/11/2017	9/11/2017	No	Common Froglet ( <i>Crinia signifera</i> ) Southern Brown Tree Frog ( <i>Litoria ewingii</i> ) Striped Marsh Frog ( <i>Limnodynastes peroni</i> ) Spotted Marsh Frog <i>Limnodynastes tasmaniensis</i> Southern Bullfrog <i>Limnodynastes dumerilli</i>
Merri Creek	Growling Grass Frog	<i>Litoria raniformis</i>	VU	L	en	15/11/2017	15/11/2017	N	No	None
Plenty River Crossing	Growling Grass Frog	<i>Litoria raniformis</i>	VU	L	en	1/11/2017	N	N	No	None

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted Round 1	Targeted Round 2	Target species detected?	Other species recorded
Simpson Barracks	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	4/06/2018	4/06/2018	N	No	Common Froglet ( <i>Crinia signifera</i> )
	Growling Grass Frog	<i>Litoria raniformis</i>	VU	L	en	2/11/2017	2/11/2017	N	No	Common Froglet ( <i>Crinia signifera</i> )
	Latham's Snipe	<i>Gallinago hardwickii</i>	Mi	-	nt	2/11/2017	N	N	No	None
	Powerful Owl	<i>Ninox strenua</i>		L	en	2/11/2017	2/11/2017	N	No	None
	Swift Parrot	<i>Lathamus discolor</i>	CR	L	en	2/11/2017	N	N	No	None
Trinity Grammar Sporting Fields (Wetlands A, B, C, D)	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	3-Dec-18	3-Dec-18	10-Dec-18	Possibly, only in Wetland D outside the project boundary.  7 <i>Pseudemoia</i> -like skinks seen, but not captured.	Tiger snake ( <i>Notechis scutatus</i> ) Reptiles seen at Wetland D only. None at Wetlands A, B, C.
Woodland west of Freeway Public Golf Course	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	23/04/2018	23/04/2018	26/04/2018	No	None
	Powerful Owl	<i>Ninox strenua</i>	-	L	en	23/04/2018	N	N	No	None

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted Round 1	Targeted Round 2	Target species detected?	Other species recorded
Yarra Bend	Powerful Owl	<i>Ninox strenua</i>	-	L	en	26/04/2018	N	N	No	None
	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	3-Dec-18	3-Dec-18	10-Dec-18	No	<i>Tiliqua scincoides</i> , <i>Lampropholis guichenoti/delicata</i>
Yarra River bank (near Burke Road)	Glossy Grass Skink	<i>Pseudemoia rawlinsoni</i>	-	-	vu	10-Dec-18	10-Dec-18	14-Dec-18	No	<i>Tiliqua scincoides</i> , <i>Lampropholis guichenoti/delicata</i>
Yarra Flats	Brown Toadlet and Southern Toadlet	<i>Pseudophryne bibroni</i> / <i>P. semimarmorata</i>	-	L	en	23/04/2018	23/04/2018	N	No	Southern Brown Tree Frog ( <i>Litoria ewingii</i> )
	Powerful Owl	<i>Ninox strenua</i>	-	L	en	19/04/2018	N	N	No	None

Table 33 Weather conditions during threatened species targeted surveys

Target species	Date	Time start	Time finish	Temperature range (°C)	Relative humidity range (%)	Wind speed range (km/h)	Cloud cover (%)	Rain at time of survey	Rain on date from BoM (mm)	Weather stations
Growling Grass Frog	31/10/2017	2030	2332	10.6-12.9	65-93	2-15	100	None-light	10.6	Viewbank
	1/11/2017	2033	2325	13-13.9	76-85	4-13	80-100	None	0.6	Viewbank
	2/11/2017	2115	2210	12.1	68	7	30	None	1.2	Viewbank
	6/11/2017	2055	2127	13	54	17	30	None	0	Melbourne
	8/11/2017	2036	2222	12.1-14.1	74-81	7-9	0	None	0.2	Viewbank
	9/11/2017	2030	2328	13.5-16.9	65-88	6-15	0-25	None	0	Viewbank
	15/11/2017	2300	0010	19.5	97	<2	100	Light	0	Melbourne
Brown and Southern Toadlets	19/04/2018	1930	2100	11.7- 16.2	50-75	2-7	0	None	0	Viewbank
	23/04/2018	1850	2150	19.4-22.5	39-48	4-13	0	None	0	Viewbank, Melbourne
	26/04/2018	1725	2050	13.7-16.1	63-67	6-15	0-100	Light	0	Viewbank, Melbourne
	17/05/2018	1815	1845	13.2	83	9	0	None	0	Melbourne
	4/06/2018	1705	1915	10.6-12.5	79-92	0-9	0	None	0	Viewbank
Glossy Grass Skink	3 Dec 2018	1007	1440	15	23	0-9	50-90	none	0	Viewbank
	10 Dec 2018	0954	1633	20	23	0-9	70-0	none	0	Viewbank
	14 Dec 2018	1430	1710	23	24	0-9	40-95	none	0	Viewbank

## Mammals

**Grey-headed Flying-fox, *Pteropus poliocephalus*** (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

The Grey-headed Flying-fox uses a wide range of habitats in Victoria, from lowland rainforest and coastal Stringybark forests to agricultural land and suburban gardens. It occurs across the Melbourne area, foraging in densely vegetated flowering and fruiting trees. The VBA contains a large number of records of this species.

According to the DELWP website (DELWP, 2018b), Grey-headed Flying-foxes have been coming to Melbourne for more than 100 years. Numbers have been increasing due to a loss of habitat in New South Wales and Queensland and the creation of a reliable food supply here. In 1986, a colony of Grey-headed Flying-foxes took up permanent residence in the Royal Botanic Gardens, Melbourne. Up to 6,000 individuals roosted in the gardens year-round, increasing to 20,000 during the breeding season. By 2002, the colony was out-growing its available habitat and was killing trees and damaging heritage-listed vegetation in the Botanic Gardens. Consequently, in 2003, a large-scale dispersal program successfully relocated the colony to Yarra Bend Park, Kew, in the vicinity of Bellbird Park. The Management Plan for the Yarra Bend flying-fox colony (DSE, 2005) shows the Flying-Fox Management Area to extend upstream from about Bellbird Park to the Eastern Freeway. The camp at Yarra Bend Park is identified in DoEE's interactive National Flying-fox Monitoring Viewer as a Nationally Important Flying-fox Camp (DoE, 2014).

Colony size fluctuates with breeding season. Mating occurs in early autumn, with females giving birth in October after a six-month gestation. Dependent young suckle for three to four months and during spring and early summer they are left at the colony over night while the adults forage. Juvenile flying-foxes are usually independent after 12 weeks. Thus, over summer, the Yarra Bend colony can increase to more than 30,000 individuals, including young, but during winter the population falls to around 6,000 individuals (DELWP, 2018b).

The northern limit of the flying-fox camp was visited on 16 November 2017 to ascertain current habitat use by roosting flying-foxes. Roosting flying-foxes were observed approximately 70 metres from the Eastern Freeway (but note that given the river's meanders, this location is approximately 400 metres from the nearest freeway bridge across the river). No estimate of population size was made during the visit, but flying-foxes were observed to be roosting at high densities across a large area. Numerous individuals were seen carrying dependent young.

Aside from flying-foxes observed within the camp, the Grey-headed Flying-fox was observed in small numbers flying overhead during nocturnal field assessments at several locations across the project boundary. Targeted surveys for this species were not undertaken. Individuals are expected to forage across the entire study area, so its presence was assumed.

**Common Bent-wing Bat (eastern ssp.), *Miniopterus schreibersii oceanensis*** (FFG, Listed; DELWP, vulnerable)

The Common Bent-wing Bat is a cave-roosting and cave-breeding species, but also uses manmade structures such as abandoned mines and road culverts (Churchill, 2008). Populations are centred on maternity caves, and individuals disperse to other caves during the non-breeding season. It is considered to be a mostly uncommon bat, particularly in the inner suburban Melbourne area.

This species forages above the canopy, and is likely to forage occasionally in the airspace of the project boundary, particularly along the waterways and in larger patches of vegetation. Targeted surveys for this species were not undertaken. This species was not detected during the assessment.

## Birds

**Lewin's Rail, *Rallus pectoralis*** (FFG, Listed; DELWP, vulnerable); and

**Baillon's Crake, *Porzana pusilla*** (FFG, Listed; DELWP, vulnerable)

These two species are secretive species that prefer densely vegetated wetlands, and are rarely seen or reported. The study area contains suitable habitat for these species, particularly along the Yarra River watercourse in the Banyule and Bulleen areas. Historical records of both species exist in these areas, particularly near Banyule Swamp. There are notably more records of Baillon's Crake than there are of Lewin's Rail. There is also an isolated record of Baillon's Crake along Koonung Creek, in the wetlands area west of Elgar Road. Australian Ecosystems (2007) reported seeing a Baillon's Crake at the eastern-most wetland of the Trinity Grammar School Sporting Complex, on the opposite side of Bulleen Road to Bolin Bolin Billabong.

The habitats along the Yarra River are extensive and of high value to these species, while the habitat opportunities along Koonung Creek and Banyule Creek are of lower value, due to the small and narrow extent of habitat, their generally degraded condition, and their proximity to disturbance by humans and dogs.

Both species, particularly Baillon's Crake, may be resident along the Yarra River floodplain. Baillon's Crake also appears to occur, at least occasionally, along Koonung Creek. Either species may visit Banyule Creek also, but there are no historical records of either species from that waterway. Targeted surveys for this species were not undertaken. Neither species was detected during the assessment.

Direct impacts on the largest area of suitable habitat for these species in the project boundary are being avoided by tunnelling.

**Little Egret, *Egretta garzetta*** (FFG, Listed; DELWP, endangered)

**Intermediate Egret, *Ardea intermedia*** (FFG, Listed; DELWP, endangered)

**Eastern Great Egret, *Ardea modesta* (=alba)** (FFG, Listed; DELWP, vulnerable)

These three species of white egret forage across a wide range of habitats, including saltwater and freshwater wetlands, mudflats, estuaries, lakes, dams, river margins, small waterways and wet grassland areas. They breed in flooded or fringing trees alongside larger wetlands.

The study area contains suitable habitat for these species, particularly along the Yarra River floodplain, but also potentially along the smaller waterways Koonung Creek and Banyule Creek. The habitats along the Yarra River are extensive and of high value to these species, while the habitat opportunities along Koonung Creek and Banyule Creek are of lower value, due to the small and narrow extent of habitat, their generally degraded condition, and their proximity to disturbance by humans and dogs.

All species may visit the Yarra River floodplain to forage. None of them is likely to breed in the project boundary. The Little Egret and Intermediate Egret are likely to visit wetlands associated with the Yarra River to forage occasionally. The Eastern Great Egret is considerably more common than the Little Egret or Intermediate Egret in the Melbourne area, and is the most commonly reported egret in southern Victoria. It is likely to visit wetlands associated with the Yarra River to forage regularly, and may occasionally visit Banyule and Koonung Creeks, and dams or other waterbodies away from the rivers (such as in golf courses). An Eastern Great Egret was seen at Banyule Swamp during this assessment.

Direct impacts on the largest area of suitable habitat for these species in the project boundary are being avoided by tunnelling.

Targeted surveys for these species were not undertaken.

**Little Bittern, *Ixobrychus minutus*** (FFG, Listed; DELWP, endangered)

**Australasian Bittern, *Botaurus poiciloptilus*** (EPBC, endangered; FFG, Listed; DELWP, endangered)

These two species are cryptic species that are rarely seen or reported. They prefer dense tall vegetation in permanent freshwater swamps and wetlands, particularly when dominated by sedges, rushes and reeds. Along the Yarra River floodplain, there are notably more records of Australasian Bittern than there are of Little Bittern. However, there are additional records of the Little Bittern in the La Trobe University area. There are no records of either species along Koonung Creek or Banyule Creek.

Within the study area, suitable habitat for these species occurs mainly along the Yarra River, particularly in the expansive Banyule Swamp area, where there are small numbers of historical records of both species. The suitable habitat in this area is extensive and in good condition, and parts of it are relatively removed from disturbance sources (walking tracks, bike paths). The potential habitat along the smaller waterways (Koonung Creek, Banyule Creek) is degraded, highly disturbed, and only in relatively small and isolated patches, so is unlikely to support either species.

The Yarra River provides the most suitable habitat for these species in the project boundary, and either species may occur along or visit the river's floodplain occasionally in small numbers. Direct impacts on this area are being avoided by tunnelling. Targeted surveys for this species were not undertaken. Neither species was detected during the assessment.

**Australian Painted Snipe, *Rostratula australis*** (EPBC, endangered; FFG, Listed; DELWP, critically endangered)

The Australian Painted Snipe is a rare, nomadic species that may turn up at any suitable wetland across Australia, when conditions are favourable. This species is widespread but rare throughout most of eastern Australia.

According to the desktop assessment (VBA, BLA and e-Bird records), the most suitable habitat for this species is in and around Banyule Swamp. This area is currently proposed to be tunnelled, so would not be impacted directly. There is potentially suitable habitat also at Bolin Bolin Billabong, although there are no historical records of the species in the VBA, BLA or e-Bird at that location. Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few VBA/e-Bird records, suggests those areas are very unlikely to support this species. There is one exceptional and potentially erroneous 2012 BLA record of 80 birds in Darebin parklands ~2 kilometres north of the Eastern Freeway alignment near Chandler Highway. While the location is considered valid, this count of birds far exceeds any other VBA or BLA record for this species (the next highest count is two individuals) and is not consistent with prevailing reports from reliable sources (for example, 'usually in pairs or small parties'; Marchant and Higgins, 1993).

There is a cluster of 16 BLA records of this species at and around Banyule Swamp. All of these are from October to November 2001, with a maximum number of two birds being observed at any one time. Therefore, most of these 16 records are likely to be of the same two individuals. The VBA also contains two of those records. This species has not been recorded in the study area since then, and there is only one record before then, from 1970.

A targeted survey for this species was not undertaken due to the very low likelihood of finding the species.

**Australasian Shoveler, *Anas rhynchos*** (DELWP, vulnerable)

**Hardhead, *Aythya australis*** (DELWP, vulnerable)

**Blue-billed Duck, *Oxyura australis*** (FFG, Listed; DELWP, endangered)

**Musk Duck, *Biziura lobata*** (DELWP, vulnerable)

These four duck species use a wide range of habitats. The Shoveler is a filter-feeding duck and uses well vegetated larger wetlands, dams and lakes. The Blue-billed and Musk Ducks are diving ducks that tend to prefer deep open water in wetlands, dams, lakes and slow-flowing rivers. The Hardhead is also a diving duck, but has the least habitat specificity of these species. It uses deep permanent wetlands, dams, lakes, slow-flowing rivers, as well as brackish wetlands and water storage ponds, and occasionally estuarine and littoral habitats such as saltpans, coastal lagoons and sheltered inshore waters.

The study area contains suitable habitat for these species along the Yarra River floodplain. Suitable habitats include the river itself, Banyule Swamp, and possibly some of the larger dams within golf courses. These habitats are not overly disturbed by people, but they are of limited extent and are consequently of moderate value to these species. All species have been recorded historically at Banyule Swamp. Hardhead has been recorded at the swamp numerous times and was seen there during this assessment. The Blue-billed Duck and Musk Duck have been recorded at the Yarra Flats and Bolin Bolin Billabong also.

Larger wetlands along Koonung Creek (such as wetlands west of Elgar Road) may attract Hardhead (there is one historical record there of Hardhead) but are unlikely to attract the other species. Habitat opportunities there are of lower value due to their small and narrow extent of habitat, their isolation, generally degraded condition, and proximity to disturbance by humans and dogs. Banyule Creek is generally not considered suitable for these species.

Direct impacts on the largest areas of potentially suitable habitat for these species (Yarra River floodplain) would be avoided by tunnelling.

Targeted surveys for these species were not undertaken.

**Grey Goshawk, *Accipiter novaehollandiae*** (FFG, Listed; DELWP, vulnerable)

The Grey Goshawk is a generally uncommon but regular visitor to the Melbourne area. It favours woodlands, forests and riparian habitats in wetter areas, and in Melbourne tends to be recorded along the Yarra River floodplain and in other well-treed areas surrounding or near a wetland (such as La Trobe University). There are numerous records of Grey Goshawk in the Banyule Flats area, as recently as 2018. NatureKit identifies no breeding records of this species in the Yarra River floodplain, with the nearest record from Dandenong Ranges National Park in 2005. Thus, it appears to be a foraging visitor to suitable habitat in the study area.

Targeted surveys for this species were not undertaken and the species was not detected during the assessment. The extensive woodlands and forests along the Yarra River provide highly suitable habitat for this species. Direct impacts on this area of habitat would be avoided by tunnelling.

**Powerful Owl, *Ninox strenua*** (FFG, Listed; DELWP, vulnerable)

The Powerful Owl is the largest owl in Australia. It is a forest owl that preys predominantly on arboreal mammals, and occurs in south-east Australia from South Australia to south-east Queensland. In Victoria, the Powerful Owl favours tall wet eucalypt forests in the ranges, but also uses drier forest types which have many live large hollow-bearing eucalypt trees in association with Blackwood Wattles, diverse habitats and extensive mature forest within two to five kilometres (Webster *et al.*, 2004). Powerful Owls form breeding pairs and reportedly pair for life.

The VBA results show numerous records of this species across Melbourne. These are mostly in the well-treed outer-eastern suburbs, along with a notable cluster of records of birds in parks and gardens in the inner parts of Melbourne (such as the Royal Botanic Gardens, Flagstaff Gardens, Fitzroy Gardens). The records show this species favours well-treed areas; there are few records in very urbanised areas. The VBA results show surprisingly few records in the vicinity of the study area. The BLA database shows additional locations of this species within the study area, and begins to establish a pattern of distribution for this species in the study area – records tend to be centred on well-treed habitats along the Yarra River floodplain.

Researchers at Deakin University (Burwood campus) have been studying the Powerful Owl in the Melbourne area since the mid-1990s. Their data (published and unpublished) show that the VBA and BLA database records greatly underestimate the presence of this species across the eastern suburbs of Melbourne and across the study area (Bradsworth *et al.*, 2017). Modelling of potential habitat across Melbourne using BLA and VBA atlas records, followed by subsequent validation against GPS tracking data, suggests considerable important habitat along the entire length of the Yarra River and other major river systems around Melbourne (Bradsworth *et al.*, 2017). Their current and ongoing research uses GPS tracking of individual birds, and provides information on home range size and boundaries as well as movement paths through the landscape (Bradsworth *et al.*, 2017; and unpublished data). The research has found there are many pairs of resident Powerful Owls along the Yarra River floodplain, including parts of the study area.

The home range for a Powerful Owl pair appears to vary from 400 to 1,500 hectares across its range in Victoria (Webster *et al.*, 2004). Their home range is likely to be determined by availability of food, which in Melbourne is almost entirely possums (ringtail and brushtail). The lower the abundance and density of possums, the larger the home range needs to be to support a resident pair of owls. An area that supports a sufficient abundance and density of possums is likely to form part of a home range, and be visited by foraging Powerful Owls.

Home ranges are typically centred on densely vegetated gullies, where nesting and most roosting occurs. Nesting by Powerful Owls tends to be within large hollows (mostly trunk hollows, but also in spout hollows) in tall and large old (350+ years old; Higgins, 1999) trees along permanent watercourses. The hollow is usually sheltered by the canopy. Breeding pairs may use multiple nest trees over time. If they do, those trees are always within the defined home range.

While most roosting occurs within densely vegetated gullies and strips along creeks and rivers, Powerful Owls use multiple roost sites, and choose their site partly on the basis of temperature (Cooke *et al.*, 2002). Roosts favoured in warm conditions may differ from those favoured in cool conditions. Powerful Owls roost in suitably dense non-native trees, particularly pines and willows (Cooke *et al.*, 2002). Powerful Owls in urban areas may be susceptible to repeated disturbance, and tend to nest and roost in locations that are less disturbed. They show a reluctance to cross large roads (Bradsworth *et al.*, 2017).

The expansive well-treed parts of the Yarra River floodplain in the Kew, Bulleen and Banyule areas provide suitable habitat for the Powerful Owl (Bradsworth *et al.*, 2017). This is supported by the database and research observations. Powerful Owls are regularly reported in the Banyule Flats area, and fledging chicks have been reported there in multiple years (e-Bird.org, and confirmed by Deakin University researchers). From their home range observations, atlas records and personal observations, Deakin researchers are confident that at least two other breeding pairs reside along the Yarra River downstream of the Banyule area. Those areas are all characterised by the presence of large eucalypts in relatively dense and undisturbed forests along a permanent watercourse.

The Banyule Flats and Yarra River floodplain areas appear to be the focal home range habitats of Powerful Owls that occur within the study area. However, foraging habitat for those birds is likely to extend along the Yarra River's smaller tributaries. Koonung Creek and Banyule Creek both support foraging and possibly occasional roosting habitat, and there are records of Powerful Owls along both watercourses. There is one VBA record (2015) of Powerful Owl from the Koonung Creek Linear Reserve, west of Elgar Road, and Deakin University research shows that owls forage and possibly roost in the southern reach of Banyule Creek.

While owls visit the southern part of Banyule Creek from the Yarra River floodplain, there does not appear to be evidence they follow it all the way along the northern part to Simpson Barracks. However, because the Deakin University tracking data only covered 34 nights of activity, it remains possible that birds use the area during the year. Deakin GPS results show that at least one of the Banyule Flats Powerful Owls ventures as far as Simpson Barracks (one owl spent six hours there one night in April 2016; Cooke/White, unpubl. data), but may get there using other well-treed patches, rather than the upper reaches of Banyule Creek. However, it must be noted that GPS tracking data across nine breeding territories in the Melbourne area indicates a strong preference for creek lines and rivers for moving through the landscape (Carter, 2017, unpublished data, Deakin Honours thesis). In Simpson Barracks, owls forage among the large eucalypt trees at the western end of the site. This area was included in a targeted survey at night on two nights in November 2017, but no owls of any type were detected on either night.

The Koonung record suggests that the habitats planted historically along the Eastern Freeway are now becoming mature enough to attract and support Powerful Owls. The scarcity of records suggests these habitats do not yet support breeding/nesting.

Neither of these tributaries currently appear to have the habitat characteristics that support breeding/nesting. This may be due to inadequate tree size, absence of sufficiently large hollows, narrower patches (such as linear reserves) with higher disturbance levels, inadequate density of prey to support owls over an extended period.

No Powerful Owls or trees with apparently suitable hollows were detected in the project boundary during the targeted surveys. Note these searches were limited to areas closest to the proposed surface impacts, and did not include comprehensive searches of areas further afield or beneath the tunnelled section around Banyule Flats. While Powerful Owls were not detected, two smaller and more common (non-threatened) owls (Southern Boobook *Ninox novaeseelandiae*) were seen at two separate places along the Yarra River.

**Swift Parrot, *Lathamus discolor*** (EPBC, critically endangered; FFG, Listed; DELWP, endangered)

The Swift Parrot is a winter migrant to Victoria (and other parts of south-eastern Australia) from breeding areas in Tasmania. In Victoria, it prefers dry, open eucalypt forests and woodlands, especially Box Ironbark Forest in north-central Victoria. Occasionally, this species is recorded in urban parks, gardens, street trees and golf courses with flowering ornamental trees and shrubs. Typically, small numbers of birds fly through the Melbourne area on their northerly and southerly migrations, mostly *en route* to or from central or western Victoria and further north. Birds are reported sporadically in small numbers across Melbourne (mainly in the northern and north-western suburbs) in most years, where suitable eucalypts occur and flower at appropriate times of the year.

The VBA results identified a total of 87 Swift Parrot records within five kilometres of the project boundary, the most recent of which dates from 2009. The BLA has 90 records, most recently in April 2018.

The majority of the records relevant to the study area are from north of the Yarra River. West of Watsonia railway station, Gresswell Forest Nature Conservation Reserve and the grounds of La Trobe University are both likely to be categorised as priority habitat for Swift Parrot in the Melbourne area, as identified by the Swift Parrot Recovery Plan (Saunders and Tzaros 2011). Swift Parrots (generally no more than 20) have been regularly observed at or near those locations in recent years (2005, 2009, 2011, 2014, 2015, 2016), and up to 50 Swift Parrots were observed at La Trobe University in April and May 2018 (observations sourced from BLA database and eBird).

The trees in and around Macleod railway station may also be categorised as priority habitat in the Melbourne area. Up to 40 Swift Parrots were observed between May and July 2015 in the trees surrounding Macleod railway station (BLA, e-Bird). In 2017, small numbers of Swift Parrots were observed in a few locations around Greensborough and Plenty (eBird), north-east of the northern part of the project boundary.

Within the project boundary where impacts are expected, the habitat that was considered most likely to attract Swift Parrots was thought to be within Simpson Barracks. There is one older (1992) VBA record of five birds in the eastern section of the barracks. A site assessment at the barracks determined the western margin (within the project boundary) largely consists of non-favoured eucalypt species (mainly River Red-gum *Eucalyptus camaldulensis*), which was dominated by aggressive nectar feeders such as Noisy Miners, Red Wattlebirds and Rainbow Lorikeets which are reported to disturb or out-compete Swift Parrots. The woodland on the eastern side of Simpson Barracks, which the project would not impact on, supports superior habitat that is dominated more by Yellow Box *E. melliodora*, a favoured eucalypt species for Swift Parrot foraging.

Overall, for the City of Banyule and surrounding areas, Practical Ecology (2017c) found the Yarra River floodplain (from Yarra Bend Park through to Banyule Flats), Plenty Gorge and La Trobe University/Gresswell area support habitats considered to be of highest rank for the Swift Parrot, while habitats in other areas, including Simpson Barracks, were determined to be of lower rank.

This species was not detected during the assessment, and targeted surveys for this species in the project boundary were not done, due to: i) the low likelihood of detecting the species, and ii) the fact that not detecting the species would not lead to a conclusion that the species is absent. Through desktop investigations and field habitat assessments, it was determined that the Swift Parrot has at least some potential to visit almost any flowering trees within the project boundary occasionally, but is unlikely to use any of those habitats to any great degree. Given the dominant types of eucalypt across the project boundary, Swift Parrot visits are considered more likely towards the northern parts of the project boundary than the south-western or south-eastern extents. While Swift Parrots may forage in trees in the project boundary occasionally and opportunistically (as seen at Macleod Station in 2015), there is little evidence to suggest that trees or habitat patches within the project boundary are particularly favoured or visited regularly by this species.

**White-throated Needletail, *Hirundapus caudacutus*** (FFG, Listed; DELWP, vulnerable)

This species is reported to be almost exclusively aerial within Australia, although birds do roost in trees at least occasionally (Corben *et al.*, 1982, Day, 1993; Quested, 1982; Tarburton, 1993; in DoE, 2018f). This species occurs over most types of habitat, particularly wooded areas, including forest and rainforest and less commonly above woodland.

Needletails are likely to forage occasionally in the airspace of the project boundary, but unlikely to have a substantial association with the terrestrial habitats. Impacts on this species are not expected.

The White-throated Needletail was not detected during the assessment.

## Reptiles

### Glossy Grass Skink, *Pseudemoia rawlinsoni* (DELWP, vulnerable)

The Glossy Grass Skink is a poorly known and rarely recorded species, with only two VBA records in the study area. Both records are along the Yarra River watercourse: one from Bolin Bolin Billabong (1991) and the other along the Plenty River (1988). The Plenty River record is potentially mis-located (labelled as 'Barber Creek: 1 km S. of Yan Yean').

This species prefers swamp and lake edges, saltmarshes and boggy creeks with dense vegetation. The project boundary is likely to contain potentially suitable habitat along each of the waterways, but particularly along the Yarra River floodplain. However, the long history of disturbance across the Melbourne area, along with introduced predators such as cats, rats and foxes may mean this species is less abundant than the habitat presence suggests. The species' ability to cope with disturbance is unknown.

Smaller waterways within the project boundary (Koonung Creek and Banyule Creek) are considered unlikely to support this species due to their narrow habitat extent and their history of disturbance and degradation.

Opportunistic searches for this species and all reptiles were undertaken at all locations that were visited during the daytime in October and November 2017, and targeted searches for the species were undertaken at seven locations in December 2018. No Glossy Grass Skinks were captured and confirmed present, because no *Pseudemoia* skinks could be captured without the aid of traps or shelters (they consistently evaded capture attempts in the warm conditions and dense habitats with numerous cracks and crevices in the soil, litter and vegetation). However, *Pseudemoia*-like skinks were seen fleetingly at three of the seven sites, all outside the project boundary: Trinity Grammar Playing Fields (Wetland D), Kew Billabong (higher western end), and Bolin Bolin Billabong (higher western end). Given the habitat characteristics at those sites (damp grassy areas near wetlands), it is considered at least possible, if not likely, that those skinks are the Glossy Grass Skink. However, it is also possible that the individuals seen are not the Glossy Grass Skink (ie, there are two similar, closely related, non-threatened and probably more common species, Southern Grass Skink, *Pseudemoia entrecasteauxii* and Eastern Three-lined Skink, *Acritoscincus duperreyi*). In the absence of confirmation, it is assumed here that at least some are the Glossy Grass Skink.

At the three locations where *Pseudemoia*-like skinks were seen, the individuals were detected only at the far end of the wetlands, outside the project boundary (west end of Bolin Bolin Billabong, west end of the Kew Billabong and Wetland D at the east end of the wetland series at the Trinity Grammar Sporting Fields). At Bolin Bolin Billabong, and to a lesser degree at Kew Billabong (but not at Trinity Grammar Sporting Fields, where no skinks were detected at wetlands A, B or C), many skinks were detected within or near the project boundary, but all were identified as *Lampropholis* sp (behaviourally different and bold in basking) and one *Saproscincus mustellinus* (captured). At those locations, the habitats within and outside the project boundary differed. The areas within the project boundary at two sites were suitable for skinks (*Lampropholis* sp.), but at none of the sites does the habitat within the project boundary appear to be suitable for Glossy Grass Skink.

## Frogs

**Growling Grass Frog, *Litoria raniformis*** (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

The Growling Grass Frog is a member of the 'Bell Frog' species complex (Anura: Hylidae) and is distributed across a large portion of south-east Australia. In Victoria it was previously widespread and common, absent only from the driest and highest parts of the state. In the last few decades, the species suffered widespread population declines and has now disappeared from most of its former range. Causes of this decline are likely to be multifactorial and include invasion by the novel disease Chytridiomycosis, caused by the Amphibian Chytrid Fungus. On-going loss of habitat and habitat connectivity may have increased the severity and consequence of the disease, by limiting genetic resilience in the frogs.

The species is found mostly amongst non-shaded emergent vegetation, including rushes, reeds and sedges, in or at the edge of still or slow-flowing water bodies such as lagoons, swamps, lakes, ponds and farm dams. Growling Grass Frogs may utilise permanent or semi-permanent waterbodies. Persistence of the species now appears to depend on access to a matrix of connected wetlands/waterbodies/waterways, rather than one wetland alone (Heard, 2013). Typical habitats include lowland grasslands, open vegetated wetlands, flooded paddocks and drains. Floodplains tend to provide suitable habitat for this species, in that they are predominantly wet and contain a range of waterbody types.

There are large numbers of VBA records of this species across the Melbourne area and the study area, mainly along the Yarra River floodplain, but also along small and large tributaries. None of the records in the study area is more recent than 1991, which is likely to have been during or pre population declines. Records most relevant to the study area include Chelsworth Park in Ivanhoe East (1788 and 1988), Bolin Bolin Billabong (1991), Banyule Swamp (two records in 1991) and along Koonung Creek (1788, 1977 and 1989). Australian Ecosystems (2007) reports a record of Growling Grass Frog from a small wetland at far eastern end at Trinity Grammar School Playing Fields (not impacted by the project), with no date or source. It is unknown if this is an actual record (it's not in the VBA), or speculation the species is likely to occur there on the basis of habitat characteristics and the nearby record at Bolin Bolin Billabong. Lorimer (2006) indicates this species is believed to be extinct within Boroondara, having disappeared well over a decade ago from their last known habitat.

All VBA records in the eastern part of the Melbourne area since 2010 are beyond the study area. One record comes from Corhanwarrabul Creek in Scoresby (2012; more than 12 kilometres south-east of the Eastern Freeway at Springfield Road), numerous records from the upper reaches of Merri Creek between Campbellfield and Craigieburn (up to 2013; more than 10 kilometres west of the Greensborough Road and M80 Ring Road intersection) and a handful of records from the upper reaches of Darebin Creek in Bundoora and Thomastown (up to 2014; within four kilometres west of the Greensborough Road and M80 Ring Road intersection).

No Growling Grass Frogs were detected during targeted surveys. At present, the Growling Grass Frog is not expected to significantly utilise or rely on the habitats/resources within the project boundary. However, on the basis of historical records, the Yarra River floodplain clearly provides potentially suitable habitat, and some individuals may still use the waterways/waterbodies if they disperse across the landscape.

**Brown Toadlet, *Pseudophryne bibroni*** (FFG, Listed; DELWP, endangered)

**Southern Toadlet, *Pseudophryne semimarmorata*** (DELWP, vulnerable)

Toadlets are small (<30 millimetres), short-limbed, ground-dwelling frogs in the Family Myobatrachidae (Southern Frogs) that tend to walk rather than jump. Most species have coarse black/brown and white marbling on the belly, and orange or yellow in the groin and/or armpits.

These two species (Brown Toadlet and Southern Toadlet) overlap in their distribution and have very similar ecological characteristics. Both species are known from moist soaks, depressions, dams and watercourses in woodland and open forest, where there is sufficient litter or other ground cover. The Southern Toadlet is also known from heathlands. For both species, adults shelter beneath leaf litter and other debris in damp areas. Males call to attract females in autumn and eggs are laid on land in damp depressions. Eggs and tadpoles develop in those depressions that flood following autumn rains.

Toadlets appear to be most threatened by habitat loss and habitat degradation. Their status with respect to the Amphibian Chytrid Fungus is unknown.

There is a handful of VBA records of both species across the Melbourne area, but a larger number of records occur towards the less-urbanised outer suburbs and beyond. Most records near to the study area are old (pre-1980) and are of Brown Toadlet. One 2005 record from Alphington Park/Wetlands (north side of the Yarra River) suggests that toadlets may persist in small areas of suitable habitat. There is an old record (1956) along Koonung Creek in Doncaster. Slightly more recent records occur at La Trobe University in Bundoora (1987; approximately two kilometres west of the project) and in the upper reaches of Darebin Creek in Thomastown (1991; >four kilometres west of the Greensborough Road and M80 Ring Road intersection). The nearest record of Southern Toadlet is from the Yarra River floodplain in the Templestowe area (1988; >four kilometres east of the project at Manningham Road). Lorimer (2006) indicates these species are believed to be extinct within Boroondara, having disappeared well over a decade ago from their last known habitat.

The study area contains potentially suitable habitat, mostly along the Yarra River floodplain. Targeted surveys were undertaken in April and May 2018 and determined that habitat locations are mostly disturbed and degraded. Neither toadlet species was detected during targeted surveys but another comparable species was: Victorian Smooth Froglet, *Geocrinia victoriana*. Like toadlets, this species is an autumn breeder and lays its eggs in terrestrial locations that later flood. It is considered non-threatened, but is unusual in the Melbourne area. It was found in a billabong of the Yarra River among the golf courses north of the Eastern Freeway, in an area the project would not impact on. The persistence of this species in the study area suggests that toadlets may also persist in localised areas. Results of the targeted survey led to the conclusion that, if present, either toadlet species is likely to be very localised and in small numbers only. The most suitable areas of potential habitat are being avoided by the project.

### 8.3.3 Migratory species

Twenty-six species (all birds) known or predicted to occur within the study area are listed as Migratory under the EPBC Act. These species are listed in Appendix D. The Migratory listing of some Australian fauna under the Commonwealth EPBC Act is intended to protect and conserve habitat within Australia for species that depend on habitats within and outside Australia. While some of those species may use or visit habitats within the project boundary occasionally, field assessment of the potentially suitable habitats determined that most species are unlikely to use the project boundary in large numbers or frequently.

Five of the species are predominantly coastal or marine species (shearwater, terns, Osprey *Pandion haliaetus*) that are not likely to use habitats within the project boundary. Thirteen are shorebird species (such as plovers, sandpipers, curlews) that are also not likely to use the project boundary. One species (Glossy Ibis *Plegadis falcinellus*) uses open wetlands and flooded grasslands, but is an occasional or rare visitor to the Melbourne area. Two of the species are aerial species (White-throated Needletail *Hirundapus caudacutus* and Fork-tailed Swift *Apus pacificus*) that may forage in the airspace above the project, but are unlikely to have any substantial association with terrestrial habitats within the project boundary. Three species are bushbirds (Rufous Fantail *Rhipidura rufifrons*, Satin Flycatcher *Myiagra cyanoleuca*, Black-faced Monarch *Monarcha melanopsis*), and small numbers of birds are likely to visit the habitats with dense mid-storey along the Yarra River floodplain. These three species are relatively common species that occur along a range of wet, damp and dry forest types in the east of Australia, and their habitat strongholds are outside the urbanised areas of Melbourne.

One species—Latham's Snipe, *Gallinago hardwickii*—may use parts of the study area regularly, as discussed below.

### **Latham's Snipe, *Gallinago hardwickii***

Latham's Snipe is listed as Migratory under the EPBC Act and as Near Threatened on the Advisory List of Threatened Vertebrate Fauna in Victoria (DSE, 2013). Latham's Snipe is a summer migrant/visitor to south-eastern Australia, returning each year to Japan and eastern Russia to breed during the northern summer. This species is present in southern Australia only during the warmer months, from August to March.

Latham's Snipe is a highly mobile species that forages in wet and flooded grasslands that are subjected to little disturbance. Preference of habitat does not appear to be determined by the diversity of native or introduced plants, but more related to the availability of suitably damp/wet habitat, food resources and level of disturbance (particularly people on foot, and presence of dogs). The species is omnivorous and feeds predominately on seeds, plant material and invertebrates.

In terms of the EPBC Act, an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

For Latham's Snipe, if the habitat regularly supports 18 or more individuals, then it should be considered important habitat (DEWHA, 2013).

The BLA database has 187 sightings of Latham's Snipe in the search area until as recently as 2015. The VBA has 104 records up to 2013. This suggests that Latham's Snipe is a regular visitor to the study area. Many of the records are from the Yarra River floodplain, between Kew and Warrandyte. There is another notable cluster of records from La Trobe University, west of the study area, and from Dandenong Creek, well south-east of the study area.

Of the records along the Yarra River floodplain, two are within the Kew Golf Course area north of the Eastern Freeway (1970 and 1991). The record from 1970 is reported as 'roughly two kilometres SW of Ivanhoe', so may contain locational error and may not actually be within the study area. Further upstream, there is a handful of pre-1991 records from the Bolin Bolin Billabong area, with a maximum count of five birds. Then, in the Banyule Swamp and Banyule Flats area, there are numerous records, including records of 20 birds as recently as 2013. This area appears to be the focus of Latham's Snipe habitat along this section of the Yarra River floodplain and is likely to be considered important habitat under the EPBC Act. Direct project impacts on this area would be avoided by tunnelling.

There is no indication that any other site along the alignment supports or attracts an ecologically significant proportion of the Latham's Snipe population. Other locations within the project boundary where this species may occur are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. There is one record from Tram Road Reserve along Koonung Creek (1989), and none from Banyule Creek. That suggests those waterways are not likely to be considered important habitat for Latham's Snipe.

#### 8.3.4 Likelihood of fauna-related pathogens

One known pathogen that affects fauna is the Amphibian Chytrid Fungus, which causes the disease chytridiomycosis, which can result in high mortality of frogs. *Chytridiomycosis due to the amphibian chytrid fungus* is a listed Key Threatening Processes under the EPBC Act. The Amphibian Chytrid Fungus is known to have been in Australia since 1978 and Victoria since 1998 (Murray *et al.*, 2010), and is likely to be widespread throughout frog habitats within the project boundary already (Brannelly *et al.*, 2018).

#### 8.3.5 Threatened ecological communities (fauna) within the study area

##### **EPBC Act-listed communities**

No fauna communities listed as threatened under the EPBC Act were recorded or are expected to occur within the study area.

##### **Flora and Fauna Guarantee Act-listed communities**

One fauna community listed as threatened under the FFG Act is identified for the study area: *Victorian temperate-woodland bird community*. This community is defined in part by habitats (box-ironbark, yellow box, cypress pine and other woodlands) and in part by geographical area, which is broadly defined as: 'the country that lies in the south-east along the slopes and plains of the Great Dividing Range' (FFG, 2000). This description does not match the habitats within the project boundary, nor the geographical location of the project. Therefore, the VTWBC is considered to not occur within the area, despite many of the community's members occurring in the area occasionally.

#### 8.3.6 Likelihood of potentially threatening processes

Potentially threatening processes are discussed in Section 7.3.6.

#### 8.3.7 Non-native and pest animals

There are records of 33 non-native terrestrial fauna species in the study area, including 22 birds, 10 mammals, and one frog (no non-native reptiles are recorded from the study area). These are listed in Table 34. These species vary in their abundance and in their environmental impact. Not all are considered pest species. Species considered to be most detrimental to the natural ecology of the Melbourne area are identified as having a high level of impact (current).

Table 34 Non-native fauna species identified for the study area, with an evaluation of their status as environmental pests

Common name	Scientific name	Level of impact in study area (current)	Likelihood of impact increasing from project
<b>Mammals</b>			
Dog	<i>Canis familiaris</i>	High	Low
Black Rat	<i>Rattus rattus</i>	High	Low
Brown Rat	<i>Rattus norvegicus</i>	Low	Low
House Mouse	<i>Mus musculus</i>	Low	Low
Eastern Grey Squirrel	<i>Sciurus carolinensis</i>	Low	Low
European Rabbit	<i>Oryctolagus cuniculus</i>	Low	Low
European Hare	<i>Lepus capensis</i>	Low	Low
Red Fox	<i>Canis vulpes</i>	High	Low
Cat	<i>Felis catus</i>	High	Low
Ferret	<i>Mustela furo</i>	Low	Low
<b>Birds</b>			
Indian Ringneck Parrot	<i>Psittacula krameri</i>	Low	Low
Pale-headed Rosella	<i>Platycercus adscitus</i>	Low	Low
Chestnut-breasted Mannikin	<i>Lonchura castaneothorax</i>	Low	Low
European Skylark	<i>Alauda arvensis</i>	Low	Low
Domestic Goose	<i>Anser anser (domestic)</i>	Low	Low
Domestic Duck	<i>Anas sp.</i>	Low	Low
Northern Mallard	<i>Anas platyrhynchos</i>	Low	Low
Rock Dove	<i>Columba livia</i>	High	Low
Spotted Turtle-dove	<i>Streptopelia chinensis</i>	Low	Low
European Goldfinch	<i>Carduelis carduelis</i>	Low	Low
European Greenfinch	<i>Carduelis chloris</i>	Low	Low
Common Blackbird	<i>Turdus merula</i>	Low	Low
Song Thrush	<i>Turdus philomelos</i>	Low	Low
Nutmeg Mannikin	<i>Lonchura punctulata</i>	Low	Low
Eurasian Tree Sparrow	<i>Passer montanus</i>	Low	Low
House Sparrow	<i>Passer domesticus</i>	Low	Low
California Quail	<i>Lophortyx californicus</i>	Low	Low
Indian Peafowl	<i>Pavo cristatus</i>	Low	Low

Common name	Scientific name	Level of impact in study area (current)	Likelihood of impact increasing from project
Red-vented Bulbul	<i>Pycnonotus cafer</i>	Low	Low
Red-whiskered Bulbul	<i>Pycnonotus jocosus</i>	Low	Low
Common Myna	<i>Acridotheres tristis</i>	High	Low
Common Starling	<i>Sturnus vulgaris</i>	High	Low
<b>Frogs</b>			
Eastern Dwarf Tree Frog	<i>Litoria fallax</i>	Low	Low

## 9. Existing conditions – Aquatic ecology

The existing conditions of the aquatic ecosystem assets, values and uses being considered throughout this assessment are described in the following sections.

Aquatic ecology considers plants and animals that occur in freshwater waterbodies. For this project, platypus and turtles are considered as aquatic fauna, while amphibians are considered as terrestrial fauna (refer to Section 7.3.5).

### 9.1 Summary – aquatic fauna and ecosystems

The study area is within the Yarra River catchment, and the project intersects or is adjacent to sections of the Yarra River, Merri Creek, Plenty River, Koonung Creek and Banyule Creek. A number of permanent and ephemeral natural wetlands are also present, notably including Bolin Billabong and Banyule Swamp.

The Yarra River provides very high value aquatic habitat, and supports an abundant and diverse assemblage of aquatic fauna, including native fish, turtles and platypus. The Yarra River supports this aquatic ecosystem, despite the cumulative pressures of heavily modified catchment landscape, including modified hydrology through river regulation, urban stormwater inputs containing chemical and litter pollution and modification of riparian zones. The floodplain wetlands of the Yarra River contain some high quality aquatic habitat, including the billabongs, although these are somewhat more degraded, with altered hydrological regime disrupting the ecological conditions of these dynamic systems.

The other waterways within the study area are generally more degraded, with heavy impacts of channel modification, urban stormwater and riparian zone modification affecting aquatic habitat condition and reduced aquatic biodiversity. Aquatic ecosystem assessment of these waterway revealed most sites fail to meet environmental condition objectives for aquatic ecosystems for urban waterways (EPA Victoria, 2003; DEWLP, 2018).

Within the study area, 32 species of fish, three species of turtle and two aquatic mammals have been recorded or are predicted to occur or have suitable habitat occurring. Ten species identified for the search area are classified as threatened fauna. These include five species listed as threatened under the EPBC Act, eight species listed as threatened under the FFG Act and seven species listed as threatened on the DELWP Advisory Lists (DSE, 2009; DEPI, 2013a).

Of the threatened species recorded in the study area, the following are considered to have a moderate or high likelihood of occurrence in waterways that intercept the project boundary:

- Australian Grayling, *Prototroctes maraena*
- Australian Mudfish, *Neochanna cleaver*
- Macquarie Perch, *Macquaria australasica*
- Murray Cod, *Maccullochella peelii*
- Murray River Turtle, *Emydura macquarii*
- Broad Shelled Turtle, *Chelodina expansa*.

These species are considered likely to occur in the Yarra River. The ability for these fish to disperse into tributaries of the river within the project boundary (Plenty River, Koonung Creek and Merri Creek) has been considered, and although possible, there is a low likelihood these urban waterways support these threatened species.

There are no Ramsar-listed or international significant wetlands within the study area. The Yarra River catchment flows into Port Phillip Bay, which contains the Ramsar-listed Port Phillip Bay (western shore) wetlands. These wetlands, which include intertidal area, saltmarsh, mangroves and water treatment lagoons, are over 20 kilometres from the project boundary.

## 9.2 Desktop assessment

This section summarises the results of the Commonwealth and State-curated ecological database searches relating to aquatic fauna. A full assessment of the likelihood of occurrence of all threatened aquatic fauna is provided in Appendix D. The catchment-wide database searches for aquatic fauna did not reveal additional diadromous species. This indicates the five-kilometre buffer is appropriate for detecting aquatic species likely to reside and move through the project boundary.

### 9.2.1 Protected Matters Search Tool

The Protected Matters Search Tool (PMST) identified a number of Matters of National Environmental Significance (MNES) that may occur, or for which suitable habitat may occur within the associated five-kilometre buffer. Results of the PMST search are presented in Appendix F and summarised in Table 20 in Section 7.2.1.

All threatened aquatic species predicted to occur by the PMST are listed in Appendix F and combined with the VBA data in a list of threatened fauna in Appendix D, along with an evaluation of the likelihood of those species occurring in the study area.

### 9.2.2 Victorian Biodiversity Atlas

The following section provides the results of the VBA search for records of aquatic fauna listed as threatened under the EPBC Act, listed under the FFG Act and/or listed as threatened species on the DELWP-administered Advisory Lists of threatened invertebrate and vertebrate fauna in Victoria (DSE, 2009; DEPI, 2013a) after the exclusions outlined in Section 5.2 have been applied. This section also includes the aquatic ecological values identified in the Healthy Waterways Strategy (Melbourne Water, 2018).

For the location of threatened species records refer to Figure 13.

Within the search area, 32 species of fish, three species of turtle and two aquatic mammals have been recorded (VBA) or are predicted to occur or have habitat occurring (PMST) within the area. These are listed in Table 35. Of the 37 species, 36 have been recorded in the VBA in the last 30 years.

Ten species identified for the search area are classified as threatened fauna. These include five species listed as threatened under the EPBC Act, eight species listed as threatened under the FFG Act and seven species listed as threatened on the DELWP Advisory Lists (DSE, 2009; DEPI, 2013a) (not including species listed as Near Threatened or Data Deficient).

All threatened fauna identified for the search area by the PMST or recorded in the area since 1987 (VBA) are listed in Appendix D.

Nine of the species are non-native species.

Table 35 Counts of aquatic fauna species identified for the study area

Group	Threatened fauna				Non-threatened fauna		Total
	EPBC	FFG	DELWP	Total	Native	Non-native	
Fish	5	7	5	7	23	9	32
Turtles	-	1	2	2	3	-	3
Mammals	-	-	-	-	2	-	2
Total	5	8	7	9	26	9	37

The threatened or high value aquatic species identified in the database searches are described in the next sections, with an explanation of the likelihood of occurrence in various waterways in the study area.

### Fish

**Australian Grayling *Protroctes maraena*** (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

Australian Grayling are the largest native salmoniform fish in Australia and the last surviving member of the family Prototroctidae (Ingram *et al.*, 1990; DoE, 2018a). The species occur in coastal rivers and streams in south-eastern Australia from the Shoalhaven River in New South Wales through to the Hopkins River in Victoria (Backhouse *et al.*, 2008). They usually prefer cool, clear waters with a gravel substrate and alternating pool and riffle habitats (Bishop & Bell, 1978; Berra, 1982) but can also occur in turbid water (Jackson & Keohn, 1988). They may form large schools, especially before spawning periods (Gomon & Bray, 2011). Adults prefer moderate to fast-flowing water, usually below altitudes of 200 metres, although in Victoria they have also been recorded above 1,000 metres (Gomon & Bray, 2011).

During autumn (February to May) Australian Grayling undertake large migrations to spawn in lower reaches of rivers (Allen, 1989; Gomon & Bray, 2011). Larvae hatch after around 10 to 20 days and drift out to sea where they spend approximately six months as juveniles before migrating back into freshwater during spring where they remain for the rest of their life (DPI, 2015; Gomon & Bray, 2011). They are known to travel inland well over 100 kilometres (Jackson & Keohn, 1988). The environmental flows recommendations for the Yarra River include provision of high flows from December to May and from October to November facilitate the downstream and upstream migration of Australian Grayling respectively (Sinclair Knight Merz, 2012). Koster *et al.* (2013) found that Australian Grayling migrated 15 to 30 kilometres downstream from upper reaches of the Bunyip River to reaches immediately upstream of the estuary in response to high flows in late March to late April. In late May, many of the individuals tracked moved back upstream to the upper reaches where their migration began (Koster *et al.*, 2013). This is important given they have a relatively short life span and most individuals spawn only once before they die (Backhouse *et al.*, 2008).

As early as the 1990s Australian Grayling were reported to be impacted by competition with introduced trout, barriers to migration, and loss of habitat and on the mainland were restricted to isolated populations from the Grose River (NSW) to the Otway River in Victoria (Ingram *et al.*, 1990).

Although there are no reliable population estimates, Australian Grayling are reported to be relatively uncommon and often only caught in small numbers, and research suggest there can be large, annual fluctuations in abundance depending on prevailing conditions (DoE, 2018c). It is also not known if the species ascend their own natal streams, or whether there is mingling in coastal areas and ascension (swimming upstream) into any convenient river (Berra, 1982).

In the Yarra River, the construction of a fishway at Dights Falls has aided in the recovery of the species with increased recolonization of upstream reaches (Backhouse *et al.*, 2008). They are known to occur in the Yarra River between Mullum Mullum Creek and Dights Falls (Sinclair Knight Merz, 2012) and eggs and larvae have been retrieved at Fairfield (Koster *et al.*, 2017). Consequently, due to connectivity with the Yarra River there is potential for Australian Grayling to also exist in Merri Creek. This is despite modelled distribution of the species suggesting a low probability that they would exist in Merri Creek (Walsh *et al.*, 2013). The habitat assessment of Plenty River was found to potentially allow passage/migration corridors for the species from the Yarra River and this is also suggested by (Lieschke *et al.*, 2000).

The habitat assessment of all other waterways in the study area concluded that the presence of Australian Grayling was unlikely, but is possible in waterways with direct connectivity to the Yarra River and where suitable habitat was present. The habitat assessment of Banyule Creek identified significant barriers to fish passage that would prevent Australian Grayling from moving upstream from the Yarra River. Koonung Creek was also found to contain some significant covered sections that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. However, other fish species were located upstream of these covered sections, which indicates passage maybe possible for some species. Australian Grayling are not expected to inhabit the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

**Macquarie Perch *Macquaria australasica*** (EPBC, endangered; FFG, Listed; DELWP, endangered)

Macquarie Perch are a native fish freshwater species whose populations have declined in Victoria (DoE, 2018). They are now restricted to a small number of fragmented populations mostly in relatively undisturbed upland catchments, such as King Parrot Creek in the Goulburn Broken Catchment in northern Victoria (Bray & Thompson, 2018a). However, a self-sustaining population exists in the Yarra River from fish translocated in the 1920s (Bray & Thompson, 2018a) and possibly represents the most secure population in Australia (Douglas, 2002 cited in Ryan *et al.*, 2003). The species inhabits cool and clear freshwater reaches of rivers with deep holes and shallow riffles, as well as lakes and reservoirs (Bray & Thompson, 2018a). In rivers, they prefer cool areas with aquatic vegetation, large boulders, woody debris and overhanging banks (Cadwallader & Eden, 1979; Bray & Thompson, 2018).

In a study of fish movement in the Yarra River, Macquarie Perch were found to typically occupy restricted reaches (<450 metres) although movements up to one kilometre in response to large flow variations during the spawning season were observed (Koster *et al.*, 2013). However, there was no evidence of synchronised migration or movement of multiple fish to specific locations (Koster *et al.*, 2013). In rivers and stream they spawn in shallow, fast-flowing areas in the lower reaches from October to December, usually when water temperatures rise above 16°C (Bray & Thompson, 2018a) although the DoE (2018e) suggest that the breeding season can extend into mid-January.

In the 1990s, the distribution of the species was reported as fragmented with only small, discrete populations remaining in the upper reaches of the Mitta Mitta, Broken, Campaspe and Goulburn Rivers in northern Victoria, and the upper reaches of the Lachlan and Murrumbidgee Rivers in southern New South Wales (Ingram *et al.*, 1990). However, the Yarra River is now reported to have an abundant and healthy Macquarie Perch population and they are distributed throughout the majority of the river (Commonwealth of Australia, 2017; Ecosure, 2011). Finns Reserve in Templestowe is considered an important habitat and the flow requirements of the species have been incorporated into environmental flow recommendations to maintain suitable habitat throughout the Yarra River (Sinclair Knight Merz, 2012).

Due to connectivity with the Yarra River, there would be a high potential for the species to also occur in Merri Creek. The species is reported as living in Mullum Mullum Creek and the Plenty River Melbourne Water (2012). As previously stated, substantial barriers to fish passage prevent fish passage upstream from the Yarra River into Banyule Creek. Koonung Creek was also found to contain some significant covered sections that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. Given that the movements of Macquarie Perch are generally limited (Koster *et al.*, 2013), it is unlikely this species inhabits Banyule and Koonung Creeks. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

**Dwarf Galaxias *Galaxiella pusilla*** (EPBC, vulnerable; FFG, Listed; DELWP, endangered)

Dwarf Galaxias are a mid-water, free swimming species with its entire life spent in freshwater (Saddler *et al.*, 2010). Typically they occur in slow flowing and still, shallow, permanent and temporary, freshwater habitats including swamps, drains and backwaters that often contain dense stands of aquatic macrophytes and emergent plants (Cadwallader & Backhouse, 1983). However, they can also occur in creeks and streams (Bray, 2016) and in larger pools individuals are usually found amongst marginal vegetation (Saddler *et al.*, 2010). Temporary wetland habitats rely on seasonal flooding and connectivity to other sites where the species occur for habitat and population replenishment (Saddler *et al.*, 2010). They are also known to live association with burrowing crayfish (*Engaeus* spp.) with the burrows providing refuge from predators and dry conditions (Beck, 1985; McDowell, 1996). It is not clear if they are capable of aestivation during dry conditions or if they rely on refuges such as crayfish burrows (Saddler *et al.*, 2010) or wet vegetation (Coleman *et al.*, 2016).

Dwarf Galaxias are a short-lived species that probably has poor dispersal abilities (Saddler *et al.*, 2010), reach sexual maturity in their first year, and likely die soon after spawning (Bray, 2016). Spawning occurs in late winter to spring with eggs usually attached on the underside of aquatic vegetation or on hard surfaces such as rock or timber (Saddler *et al.*, 2010). However, Bray (2016) suggests they can spawn all year round in suitable conditions. Larvae hatch after about two to three weeks and are around 4.5 millimetres long (Saddler *et al.*, 2010).

Across most of the range of the Dwarf Galaxias, there are large numbers of and expansive stretches of waterways that are either unsurveyed or have been surveyed using methods not particularly suited to the species (such as electrofishing). DoE (2018b) suggest the very small body size of the species limits the use of electrofishing and their preferred habitat (swamps, drains and the backwaters of streams and creeks) are less commonly surveyed than main channel habitats. Off-stream habitats are also difficult to survey due to abundant aquatic vegetation, often higher electrical conductivities and soft sediments (DoE, 2018d). These habitat factors, combined with their short life span, leads to populations fluctuating annually reflecting variability in habitat desiccation and connectivity, spawning and recruitment success, dispersal and colonisation/recolonisation (Australian Government, 2018d).

Although the Dwarf Galaxias is still widely distributed, populations are fragmented and patchy and in the Yarra River catchment, only translocated populations are known to exist in the La Trobe University wetlands (Saddler *et al.*, 2010). Their presence in the study area is considered unlikely. However, small aquatic habitats in the protected environment of Simpson Barracks may contain a similarly translocated population, which may be isolated due to lack of connectivity. The absence of fish records from this site means the presence of Dwarf Galaxias at this site is unlikely but possible.

**Murray Hardyhead *Craterocephalus fluviatilis*** (EPBC, endangered; FFG, Listed; DELWP, critically endangered)

The native Murray Hardyhead is endemic to the lower Murray-Darling River system in South Australia, Victoria and New South Wales (Backhouse, Lyon & Cant, 2008). It was once considered widespread and common throughout its range but there has been an extensive decline in distribution and abundance and it is now one of the most threatened vertebrate species in Australia (Backhouse *et al.*, 2008). It now exists in only a few isolated areas in Victoria (Backhouse *et al.*, 2008). The species prefers relatively salty fringing wetlands in floodplains and lakes (Lintermans, 2007; Bray & Thompson, 2011). They can survive in isolated and salty ephemeral wetlands on the fringes of floodplain during dry seasons before dispersing out over the floodplain during wet seasons (Lintermans, 2007; Bray & Thompson, 2011).

The exact distribution of the Murray Hardyhead is unclear due to confusion in identification with other Hardyheads that appear similar (Backhouse *et al.*, 2008). A review of distribution in Victoria suggests that it has been recorded and restricted to lakes near Mildura and several in the Swan Hill-Kerang district (Backhouse *et al.*, 2008). It is likely the records in the VBA database are of species other than Murray Hardyhead. This species is unlikely to occur within the study area.

**Murray Cod *Maccullochella peelii*** (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

The iconic Murray Cod is the largest freshwater fish in Australia but populations have reduced markedly throughout their natural range, and the species is now rare in some areas (National Murray Cod Recovery Team, 2010; Bray & Thompson, 2018b). They live in a variety of habitats including rivers, lakes and billabongs but are very territorial and in rivers prefer deep holes with boulders, fallen trees and other woody debris and banks with overhanging vegetation (Doe, 2018a; Bray & Thompson, 2018b). Although they prefer the main channel of rivers they can be found in inundated floodplain channels during high flows although this is reported as limited (DoE, 2018a; Bray & Thompson, 2018b). Tracking studies in the Murray River found the species was strongly associated with structural woody habitat, deep (>2.4 metres), slow flowing water (<0.2 metres s<sup>-1</sup>) close river banks (Koehn & Nicol, 2014).

Murray Cod undertake a spawning migration each year and in rivers have been found to travel several hundred kilometres upstream (Koehn *et al.*, 2009). In southern areas, spawning tends to occur from early October to mid-December (Humphries, 2005; DoE, 2018b). They form breeding pairs prior to spawning and select a site or nest that is usually a sunken log in lowland rivers, or a submerged rock in upland streams (DoE, 2018b). Females lay demersal eggs that are guarded and fanned by her male partner until they hatch into pelagic larvae after about 25 days (Humphries, 2005; Bray & Thompson, 2018b). After spawning, adults move back downstream and return to the same territory occupied before upstream (Koehn *et al.*, 2009).

The species is endemic to river systems of the Murray–Darling Basin in south-eastern Australia. However the species has been successfully introduced in the Yarra River (National Murray Cod Recovery Team, 2010; DoE, 2018b). Although the Murray Cod's EPBC Vulnerable status does not apply protection to the populations outside the natural range in the Murray-Darling basin, FFG status does apply to this species across the state, including the introduced Yarra River population. There is no overall Murray Cod population monitoring program within Victoria (National Murray Cod Recovery Team, 2010) which makes estimation of population sizes problematic. Recreational catches of Murray Cod over 1-metre long have been reported in the Yarra River at Eltham, Wonga Park and Templestowe. The presence of Murray Cod in these areas, including the Plenty River catchment, is also reported by Melbourne Water (2012). Environmental flow recommendations have been made to support Murray Cod in the Yarra River between Yering Gorge and Dights Falls (Sinclair Knight Merz, 2012). Given the territorial and sedentary nature of the species, and their preference to inhabit deeper areas of rivers, the Murray Cod is expected to occur within the project boundary in the Yarra River. However, there is a high probability it also occurs in Merri Creek and Plenty River and due to connectivity with the Yarra River and available habitat. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp, nor in Banyule and Koonung Creeks due to the presence of barriers to movement and absence of suitable habitat.

**Yarra Pygmy Perch *Nannoperca obscura*** (EPBC, vulnerable; FFG, Listed; DELWP, vulnerable)

The Yarra Pygmy Perch is a small freshwater fish endemic to south-eastern Australia and is found in South Australia and Victoria (Saddler & Hammer, 2010; Bray & Thompson, 2018c). Although still widely distributed, populations are fragmented and patchy across the landscape due to habitat changes to rivers, creeks and shallow freshwater wetlands (Saddler & Hammer, 2010). They are a free-swimming species and their entire life cycle is completed in freshwater (Cadwallader & Backhouse, 1983; DoE, 2018a). They typically occur in slow-flowing or still waters with large amounts of aquatic vegetation such as lakes, ponds and slow-flowing rivers (Saddler & Hammer, 2010; Bray & Thompson, 2018c).

Yarra Pygmy Perch spawn during spring (September to October) and although little is known of the breeding biology, it is assumed that breeding behaviour is similar to the closely related Southern Pygmy Perch (*N. australis*), which lays demersal, non-adhesive eggs on aquatic vegetation and the substrate (Kuiter, 2013). It is believed to be a short-lived species with poor dispersal ability (Saddler & Hammer, 2010).

The species is distributed from the Bunyip River basin in West Gippsland through to South Australia near the mouth of the Murray River (Saddler & Hammer, 2010). Some populations are very small and located in extremely limited ephemeral habitat, while others are quite large and extensive and occur in permanent waterways (Saddler & Hammer, 2010). The DoE (2018a) suggests that small, isolated populations exist between Melbourne and the Hopkins River system in south-west Victoria, but the major Victorian populations are located between the Barwon River and the South Australia border. Since European settlement it has been reported that the Yarra River population disappeared in 1872 but a small population remains in Deep Creek on private land in Lancefield (Saddler & Hammer, 2010; Bray & Thompson, 2018c). The fragmented and patchy nature of its remaining habitat across the landscape, and variability of this habitat between seasons and years, makes the species extremely vulnerable to local extinctions (Saddler & Hammer, 2010). Although an original resident of the Yarra River Basin, it is unlikely to be present within the study area.

**Australian Mudfish *Neochanna cleaver*** (FFG, Listed; DELWP, critically endangered)

The preferred habitat of Australian Mudfish includes dense aquatic or inundated terrestrial vegetation and a mud or silt substrate (DSE, 2003). Typically, the preferred habitat of adults are freshwater marshes, inundated floodplains, while open freshwater areas are unlikely to be used (Koehn & Raadik, 1991). It is only known from low-lying areas in Victoria, virtually at sea level, and they tend to inhabit permanent and ephemeral stagnant freshwater swamps and drains, preferring areas with muddy or silty bottoms and thick instream and emergent vegetation (Andrews, 1991; Gomon & Bray, 2018). Andrews (1991) suggests they appear unable to migrate very far inland and into upland waterways.

The breeding ecology of the taxon is not well known but it appears that adults migrate downstream in late winter to estuaries to spawn (Koehn & Raadik, 1991; Gomon & Bray, 2018). It is also likely that juveniles spend at least part of their early life at sea and return to freshwater at approximately two months of age, often in association with other Galaxias species (Koehn & Raadik, 1991). The species is capable of at least partial aestivation (Koehn & Raadik, 1991) and is therefore likely to survive some natural drying of its wetland habitat (DSE, 2003; Gomon & Bray, 2018).

Large areas of suitable wetland habitat for the species have been lost due to drainage and development (DSE, 2003). Australian Mudfish are considered to live within Merri Creek (Melbourne Water, 2012) and the lower Yarra River (Melbourne Water, 2007). In the Yarra River it has been found below Dights Falls near Melbourne (Koehn & Raadik, 1991). The absence of the species in surveys may also be related to difficulties in identification due to the similarities in morphology with Climbing Galaxias (*Galaxias brevipinnis*) and Mountain Galaxias (*Galaxias olidus*) that may occur within the same river system (Koehn & Raadik, 1991). Given they appear unable to migrate very far inland (Andrews, 1991) it is unlikely they would be within other waterways in the study area.

**Freshwater Catfish *Tandanus tandanus*** (FFG, Listed; DELWP, endangered)

Gomon & Bray, (2018a) suggest that Freshwater Catfish are only known in the Murray-Darling system and although they were once widespread in eastern Australia, populations have suffered in both distribution and abundance since the 1980s. However, the species has been introduced into the Yarra River but it is not considered a self-sustaining population (DSE, 2005). The species usually inhabits slow-flowing streams and lakes and are relatively sedentary although juveniles sometimes form loose aggregations (Gomon & Bray, 2018a). They show a preference for slower flowing habitats with some form of structure such as aquatic vegetation and undercut banks or root masses, although the importance of particular habitat components is not well understood (Clunie & Koehn, 2001). While they are more abundant in lakes and backwaters they do occur in flowing rivers and streams (Clunie & Koehn, 2001).

Spawning generally occurs during spring and summer and males construct a circular gravel and pebble nest with a central depression into which females lay large, spherical non-adhesive eggs (Gomon & Bray, 2018a). Larvae hatch after about seven days and the species are known to spawn multiple times during a season (Gomon & Bray, 2018a). The species is not considered migratory and spawning occurs throughout its range (Clunie & Koehn, 2001).

Given they are not expected to be a self-sustaining population it is unlikely they inhabit the study area.

## Reptiles

### **Murray River Turtle *Emydura macquarii*** (DELWP, vulnerable)

The Murray River Turtle inhabits lagoons, rivers and backwater (Chessman, 1988) and males can grow to about 2.2 kilograms and females sometimes in excess of 4 kilograms (Thompson & Spencer, 2006). They sometimes bask on logs in the water but rarely come out of the water, except to nest which are likely to be located close to an individual's home range (Thompson & Spencer, 2006). Nesting time is generally early November through to late December, with eggs taking six to eight weeks to hatch (Thompson & Spencer, 2006).

The Murray River Turtle is known from the Yarra River upstream of the project boundary, but is not likely to inhabit other waterways in the project boundary due to an absence of suitable deep pool habitat.

### **Broad Shelled Turtle *Chelodina expansa*** (FFG, Listed; DELWP, endangered)

The Broad-shelled Turtle has the longest neck of any turtle in the world and lives only in permanent, deep water (Thompson & Spencer, 2006). Females may exceed 5 kilograms and males may reach almost 4 kilograms (Thompson & Spencer, 2006). Broad-shelled turtles nest in autumn and nests can be more than 500 metres from the water (Thompson & Spencer, 2006).

The Broad Shelled Turtle is recorded from the Yarra River upstream of the project boundary, and may possibly be found in the Yarra near the project boundary. It is not likely to inhabit other waterways in the study area due to an absence of suitable deep pool habitat.

## 9.2.3 Regional Waterway Strategy – Aquatic Ecological Values

### **Native fish community**

Native fish are a key ecological value in the Melbourne Water Healthy Waterway Strategy (Melbourne Water, 2018), which is the regional waterway strategy for the Port Phillip and Westernport Catchment Management Authority region. Melbourne Water recognise the Yarra River catchment provides an important habitat for native freshwater fish, plus estuarine fish species.

The fish recorded in the VBA from the study area (including the wider Yarra Catchment) are listed in Table 36. Native fish include populations that have been translocated from other catchments. The Healthy Waterways Strategy prioritises the conservation and improvement of native fish species, and the exotic fish species are considered a threat to the native fish community.

Table 36 Fish of the Yarra catchment likely to occur in the study area

Common name	Scientific name	ORIGIN
Australian Bass	<i>Macquaria novemaculeata</i>	
Australian Grayling	<i>Prototroctes maraena</i>	
Australian Mudfish	<i>Neochanna cleaveri</i>	
Australian Smelt	<i>Retropinna semoni</i>	
Climbing Galaxias	<i>Galaxias brevipinnis</i>	
Common Galaxias	<i>Galaxias maculatus</i>	
Congolli/Tupong	<i>Pseudaphritis urvillii</i>	
Dwarf Galaxias	<i>Galaxiella pusilla</i>	Translocated
Eastern Blue-spot Goby	<i>Pseudogobius sp. 9</i>	
Flathead Gudgeon	<i>Philypnodon grandiceps</i>	
Freshwater Catfish	<i>Tandanus tandanus</i>	Translocated
Golden Perch	<i>Macquaria ambigua</i>	
Macquarie Perch	<i>Macquaria australasica</i>	Translocated
Murray Cod	<i>Maccullochella peelii</i>	Translocated
Pouched Lamprey	<i>Geotria australis</i>	
River Blackfish	<i>Gadopsis marmoratus</i>	
Shorthead Lamprey	<i>Mordacia mordax</i>	
Silver Perch	<i>fam. Terapontidae gen. Bidyanus</i>	Translocated
Southern Pygmy Perch	<i>Nannoperca australis</i>	
Southern Shortfin Eel	<i>Anguilla australis</i>	
Spotted Galaxias	<i>Galaxias truttaceus</i>	
Brown Trout	<i>Salmo trutta</i>	Exotic
Eastern Gambusia (Mosquitofish)	<i>Gambusia holbrooki</i>	Exotic
European Carp	<i>Cyprinus carpio</i>	Exotic
Goldfish	<i>Carassius auratus</i>	Exotic
Oriental Weatherloach	<i>Misgurnus anguillicaudatus</i>	Exotic
Rainbow Trout	<i>Oncorhynchus mykiss</i>	Exotic
Redfin	<i>Perca fluviatilis</i>	Exotic
Roach	<i>Rutilus rutilus</i>	Exotic
Tench	<i>Tinca tinca</i>	Exotic

## Platypus, *Ornithorhynchus anatinus*

Platypus are a key aquatic ecological value in the Healthy Waterway Strategy (Melbourne Water, 2018) and although not listed as a threatened species under State or Commonwealth legislation, this species is prioritised for management of waterways by the Port Phillip and Westernport Catchment Management Authority and Melbourne Water. Platypus is a semiaquatic monotreme endemic to Australia and are found along the east coast from around Cooktown in Queensland to Tasmania (Grant & Temple-Smith, 1998). They are largely nocturnal and their habitat includes both riverine and riparian areas, with burrow and nesting areas constructed on the banks – usually in areas of slow-flowing water and coverage by reeds or trees (Grant & Temple-Smith, 1998). Platypus have a single breeding season with mating occurring in late winter or spring, and with young emerging after about three to four months (Grant & Temple-Smith, 1998). Recapture studies suggest there may be both transient and resident populations (Grant & Temple-Smith, 1998).

Although they occupy much the same areas as prior to European settlement (excluding loss in South Australia) there is local fragmentation of distribution due to habitat modification (Grant & Temple-Smith, 1998). They are found throughout Victoria excluding the semi-arid north-west (Furlan *et al.*, 2011). They were known to inhabit waterways within five kilometres of Melbourne recently as the 1950s but due are now rarely observed within 15 kilometres of the city centre (Serena & Pettigrove, 2005). Ultimately, Serena & Pettigrove (2005) suggest that Platypus in the Melbourne region are sensitive to poor sediment and water quality, either through direct toxicity or by reduction in the platypus' benthic invertebrate food source. Other research has suggested that stormwater inputs are impacting Platypus distribution and abundance (Martin *et al.*, 2014; Webb *et al.*, 2014). However, they are known to be resilient and are often found in highly urbanised areas (Grant & Temple-Smith, 1998).

Platypus are known to occur within the Yarra River Basin (Furlan *et al.*, 2011) and have been observed in the Yarra River (Melbourne Water, 2012; Webb *et al.*, 2014). Waterways with well vegetated riparian zones and undercut banks provide habitat for Platypus burrows (Webb *et al.*, 2014). Modelling of Platypus distribution in upland reaches of Merri Creek suggests their absence is a result of the isolation of these areas from source populations (Walsh *et al.*, 2013) and urban stormwater runoff (Martin *et al.*, 2014). This was confirmed by a survey in 2011–12 where no Platypus were retrieved from Merri Creek (Melbourne Water, 2012). They have been observed in upper reaches of the Plenty River but none were retrieved in lower urban sections during a survey in 2011–12 (Melbourne Water, 2012).

## Macroinvertebrates

Aquatic macroinvertebrates are a key aquatic ecological value in the Melbourne Water Healthy Waterway Strategy (Melbourne Water, 2018). Aquatic macroinvertebrates are a diverse collection of insects and other invertebrates that inhabit aquatic ecosystems. Collectively, macroinvertebrates are considered the most useful biological indicators for assessing aquatic ecosystem condition. This is due to the multiple trophic levels and ecological niches occupied by the various types of macroinvertebrate, and the well-studied range of tolerances and sensitivity to anthropogenic impacts.

Macroinvertebrates also provide critical role in aquatic ecosystems, including being a major source of food for larger aquatic fauna, including fish, platypus and birds. Hence the protection of a healthy community of aquatic macroinvertebrates provides an indication of river health, but also supports biodiversity.

## 9.3 Field assessment

This section details the aquatic ecological values observed in the study area.

### 9.3.1 Aquatic ecology

#### Overview

The project boundary lies within the urban waterway reaches of the Yarra River catchment. The aquatic ecosystem of the Yarra River has been well studied, and the very high values, both for resident aquatic species and for migratory fish species, are well established and recognised. Field assessment of the Yarra River was not undertaken as confidence in the assessment of existing conditions would not be improved through further biological assessment of fish or aquatic macroinvertebrates.

The tributaries of the Yarra River that lie within the project boundary are known to be heavily impacted, and the long history of waterway monitoring undertaken by Melbourne Water and EPA Victoria indicate these are modified ecosystems. However, significant investment in waterway and stormwater management has gone some way to minimising the impacts from pollution, scouring and habitat loss. Nevertheless, the condition of aquatic ecosystems in these urban streams are somewhat less well known, and individual reaches of waterways vary considerably along these corridors. All aquatic ecosystems assessed were impacted by urban stormwater drainage, and to varying extent some riparian zone modification.

#### Rapid Bioassessment and fish surveys

The results of Rapid Bioassessment (that is, aquatic macroinvertebrate surveys) undertaken in Plenty River, Banyule Creek, Koonung Creek and Merri Creek are presented in Table 37. The dark grey highlighted cells indicate the index score for sites that did not meet the objective for urban waterways in the SEPP. The results support the assessment these waterway sites support macroinvertebrate communities that are degraded by water pollution (SIGNAL 2 below SEPP objectives) and many sites contain a depleted community of macroinvertebrate families ('Number of families' below SEPP objectives). The EPT score indicates the presence of typically sensitive families, which is expected to be low in these urban streams. The use of a single season of macroinvertebrate data is more suited to the Draft SEPP (Waters) objectives, which have been developed and are currently in use by EPA Victoria for assessing aquatic ecosystems.

Table 37 Biological indices from Rapid Bioassessment of waterways – shaded cells indicate noncompliance with SEPP objectives

Location	Number of families		SIGNAL 2		EPT	
	pool	riffle	pool	riffle	pool	riffle
Plenty River at Plenty River Drive	14	10	3.4	3.6	3	2
Banyule Creek at Banyule Road	14	-	3.0	-	1	-
Banyule Creek at River Gum Walk	10	-	2.9	-	1	-
Banyule Creek at Simpson Barracks	3	-	3	-	0	-
Koonung Creek at Bulleen Road	15	-	2.7	-	2	-
Koonung Creek at Doncaster Park & Ride	19	-	3.0	-	2	-
Koonung Creek near Jocylen Avenue	12	10	3.1	3.4	2	2
Koonung Creek at Valda Avenue	15	9	3.3	2.8	2	1
Koonung Creek at Elizabeth Street		11		2.9		1
Koonung Creek at Church Road	18	-	2.8	-	2	-
Koonung Creek at Boronia Grove	13	-	2.8	-	1	-
Koonung Creek at Tunstall Road	11	16	3.2	2.7	1	1
Merri Creek upstream of Eastern Freeway	13	8	3.0	4.9	2	4
<i>SEPP (Waters) objectives – autumn</i>	14	13	3.1	3.9	1	4

‘-’ no data recorded due to pool or riffle habitat not present.

Fish surveys undertaken in Plenty River, Banyule Creek and Koonung Creek reveal a relatively depauperate native fish community, with exotic fish species dominant at several locations.

Fish surveys were undertaken in the Plenty River involved fyke netting and electrofishing in spring 2017 and autumn 2018. The most abundant native fish collected at Plenty River were Common Galaxias and Short-finned Eel, with a few individuals of Flatheaded Gudgeon and an individual Australian Smelt. However, the most abundant fish surveyed were the exotic Oriental Weatherloach, with several Eastern Mosquitofish, European Carp and Roach also collected.

Fish surveys undertaken in Banyule Creek involved dip netting in spring 2017 and electrofishing and dip netting in autumn 2018. The only native fish observed in Banyule Creek was the Common Galaxias with only two individuals observed during the habitat assessment. The exotic Oriental Weatherloach was considerably more abundant. No fish were found upstream of Lower Plenty Road, with no flow present during the autumn sampling, except in Simpson Barracks during early winter. No fish were found in Simpson Barracks.

Fish were surveyed at eight locations in Koonung Creek adjacent to the project boundary. Surveys involved both fyke netting and electrofishing in both spring 2017 and autumn 2018. Common Galaxias were the most abundant native species present, and the surveys at the most upstream sites (Tunstall Road and Boronia Grove) revealed a notable population of large mature specimens. A single specimen of Climbing Galaxias was also found at the most upstream site. Short-finned Eels were present, but were not found at all sites. The most abundant fish was the exotic Oriental Weatherloach, which was found at every site along the length of Koonung Creek surveyed. In some reaches the number of Weatherloach observed during electrofishing exceeded 100 along a reach of less than 100-metres long indicating their dominance of the fish community. Other exotic fish found included only a few Eastern Mosquitofish and European Carp observed in the pool adjacent to the Doncaster Park and Ride.

### **Instream vegetation assessment of Koonung Creek**

The vegetation in reaches of Koonung Creek that could potentially be impacted by shading or channel modification was identified from field assessment as approximately two kilometres of channel on the south side of the Eastern Freeway between Station Street, Box Hill North and Doncaster Road, Doncaster. For the purposes of this instream vegetation assessment, the creek in this region can be divided into two discrete reaches. Assessment of fringing vegetation, substrate algal cover, riparian vegetation cover and substrate type was not sufficiently discriminatory along this length of Koonung Creek, as most of the channel is engineered for bank stability and planted with a dense, narrow band of riparian canopy. However, the instream vegetation along this length of Koonung Creek did vary.

Station Street to Elgar Road – Instream vegetation included beds of submerged plants (Canadian Pondweed *Elodea canadensis* and Pondweed *Potamogeton* spp.) and occasional stands of emergent vegetation, (predominantly Cumbungi *Typha* spp. And some Rush *Juncus* spp.). Instream vegetation covered more than 50 per cent of the stream bed for approximately 30 per cent of the reach, and more than 10 per cent of the stream bed for a further 50 per cent of the reach, leaving only 20 per cent of the reach substrate with thick benthic algal cover.

Elgar Road to Doncaster Park and Ride – Instream vegetation was notably less dense, with less than 20 per cent of the stream bed containing more than 10 per cent instream vegetation. Most of the substrate in the remaining 80 per cent of the stream bed was covered with benthic algae, with 85 per cent of the reach having greater than 50 per cent algal cover. Several sites in this reach were heavily shaded by existing freeway noise walls, and these locations had little vegetation or algal cover, although there was a substantial riparian vegetation canopy present also. The presence of riparian vegetation did diminish in reaches closer to Doncaster Road, near where the creek had been realigned through a cutting and along to where the creek passes underneath the Eastern Freeway.

The assessment of this length of Koonung Creek confirmed the presence of considerable instream aquatic vegetation. The ability of this aquatic ecosystem to provide nutrient process services in Koonung Creek has not been quantified. However, this survey confirms the ecosystem may be capable of reducing the load of contaminants to the Yarra River and should be considered as providing an ecosystem service that could be impacted by shading or channel modification.

Several stormwater treatment wetlands located adjacent to Koonung Creek also contain substantial aquatic vegetation. Although these were not assessed as part of this assessment due to their construction as stormwater treatment assets, the performance of these assets may also be impacted by changes to shading or channel modification.

### Hydrology assessment of Banyule Creek

In conjunction with fish and aquatic macroinvertebrate surveys undertaken in Banyule Creek, the stream flow and salinity in the creek was observed from Simpson Barracks down to the Yarra River to characterise baseflow conditions. This provides some indication of the reliance on runoff and groundwater for aquatic ecosystems in Banyule Creek during low flow periods.

The flow in Banyule Creek during periods of low/no rainfall is sporadic, with the reach upstream of Lower Plenty Road observed to dry out and not maintain aquatic habitat. Downstream of Lower Plenty Road, various freshwater inputs from several stormwater drains provide some flow which maintains levels in a series of pools. This maintains relatively permanent freshwater aquatic habitat but initial surveys suggest poor aquatic ecological values.

At various location between Lower Plenty Road and Banyule Road, the very low surface water flow ceased, presumably shifting to shallow groundwater flow or lost to evapotranspiration from riparian vegetation.

Near where River Gum Walk diverges from Banyule Creek, a notable increase in groundwater inputs is present, with some indication of a highly localised source of moderately saline water (~6 mS/cm compared with 0.3 mS/cm upstream). The sequence of pools with varying salinity indicates this is not a major source of water for the creek, but would likely maintain permanent aquatic habitat suitable for species able to tolerate this higher salinity. Notably, this was the upstream extent of where native fish (two Common Galaxias) were observed but the aquatic ecology values are likely poor to moderate. As the stream passed downstream of Banyule Road, the salinity had reduced, presumably with additional drainage inputs diluting groundwater contribution to the creek.

At Banyule Swamp, Banyule Creek is a long channel, with no apparent flow. There is no direct surface water connectivity between the swamp and the creek, but there may be groundwater connection, or mutual connection with the Yarra alluvial aquifer.

### Environmental quality of Victorian lakes

#### Banyule Swamp

The major modifications to the lake habitat in Banyule Swamp include the exotic groundcover vegetation in the riparian zone, the artificial bank construction used to maintain the lake water level, the inlet of stormwater from drains, the control of riparian vegetation along some sections of the lake, and the presence of algal blooms (observed during field assessment). There was no evidence of erosion or shore line modification.

The structural complexity of riparian vegetation at Banyule Swamp was moderate, with trees >5 metres tall, and shrubs and grasses generally present at >10 per cent cover. Approximately half the lake riparian zone had a dense tree canopy, with the remainder having scattered trees and parkland or groundcover. The trees and shrub layer present were native species, although the percentage of native groundcovers were considerably lower. The substrate of the lake shore and bed was silt, and although this was the natural substrate for the area, there was little diversity in benthic habitat. The depth of the lake appeared less than one metre deep for the entire area. Emergent and submerged aquatic macrophytes fringed the lake, and a narrow band of Water Ribbons *Cyanogeton* spp. was present in beds near the edges.

No aquatic vegetation occurred beyond this fringing band, and the majority of the lake appears to not contain aquatic plants. The presence of aquatic habitat features was limited to small amounts of woody debris, and coarse particulate organic matter, and some overhanging vegetation close to the shore.

Water quality measured in the lake indicated conditions suitable for healthy aquatic ecosystem (dissolved oxygen 8.7 mg/l, electrical conductivity 327  $\mu$ S/cm, pH 7.5). At the time of the assessment, the water clarity was low as indicated by a high turbidity (119 NTU). Nutrient concentrations tested revealed high concentrations of total phosphorus (1.4mg/L) and total nitrogen (11 mg/L). These nutrient concentrations are more than 10 times greater than the environmental quality guidelines for floodplain lakes (EPA Victoria, 2010), and indicate high risk of eutrophic conditions. An algal bloom was observed at the time, and laboratory analyses of a water sample identified total algal biovolume of 151 mm<sup>3</sup>/L including a potentially toxic blue-green algae biovolume of 2.2 mm<sup>3</sup>/L. These algal concentrations are very high, and typical for eutrophic system.

Shortfinned Eels were the only native fish found in the fyke net fish survey in the lake, and the exotic Eastern Mosquito fish were prolific. One Eastern-long necked turtle was found in the surveys.

The macroinvertebrate samples collected from Banyule Swamp revealed a community less diverse than the environmental quality guideline values for a floodplain lake. The VLAKES index score for Banyule Swamp samples was also below the guidelines (EPA Victoria, 2010). These macroinvertebrate indices are the main biological indicator of ecosystem condition, which suggests the condition of the aquatic ecosystem condition of Banyule Swamp is poor, and potentially at risk from threats from urban stormwater containing contaminants, elevated nutrients, exotic fish species, modified riparian vegetation and modified hydrology.

### **Bolin Bolin Billabong**

At the time of the environmental assessment of Bolin Bolin Billabong in autumn 2018, water in the billabong was restricted to the deepest pool at the eastern end of the billabong.

The assessment of aquatic ecosystem condition was based around this pool. It is recognised that the extent of the lake does change with natural and artificial filling, and a broader environmental assessment of Bolin Bolin Billabong needs to consider the hydrological history of the site. Nevertheless, the assessment undertaken in autumn 2018 provides a useful assessment of habitat modification and habitat quality, and is more typical of hydrological conditions.

Lake modification of Bolin Bolin Billabong is minimal. The riparian zone contains mostly native tree and shrub vegetation, although the groundcover is mostly exotic grasses. This natural land cover of the surrounding area has no evidence of modified shore zone or artificial banks. Human pressures affecting the lake include input of litter and other evidence of human recreational activity. The inflake conditions are mostly natural, with no use of the waterbody for human purposes other than amenity. A small amount of bank erosion was observed, although this does not appear to be spreading or increasing.

The quality of habitat at Bolin Bolin Billabong is good, with a largely intact native tree and shrub layer providing significant amount of woody debris and coarse particulate organic matter to the waterbody. Significant large trees surround the billabong, and these are supplemented by considerable revegetation and weed control. The riparian habitat is being managed for a trajectory of improvement. The substrate of the shore and lake bed are fine sediments – silts and clay – and this is natural substrate for the floodplain. There was no evidence of aquatic vegetation, although there is evidence of inundated terrestrial vegetation in the waterbody, and regeneration of terrestrial and semi-aquatic vegetation in the billabong bed previously wetted but now dry.

Water quality measured in the lake indicated conditions at the time of assessment were marginally suitable for a healthy aquatic ecosystem, and indicative of high biochemical oxygen demand (dissolved oxygen 4.6 mg/L, electrical conductivity 578  $\mu\text{S}/\text{cm}$ , pH 6.6). At the time of the assessment, water clarity was low as indicated by high turbidity (87 NTU). Nutrient concentrations tested revealed high concentrations of total phosphorus (0.43 mg/L) and total nitrogen (5.1 mg/L). These nutrient concentrations are more than four times greater than the environmental quality guidelines for floodplain lakes (EPA Victoria, 2010), and indicate risk of eutrophic conditions. An algal bloom was not observed at the time of the assessment, but laboratory analyses of a water sample identified total algal biovolume of 14.7  $\text{mm}^3/\text{L}$ , which included low proportion of potentially toxic blue-green algae biovolume 0.009  $\text{mm}^3/\text{L}$ . These conditions are not unusual for a diminishing waterbody with significant organic load.

Shortfinned Eels were the only native fish found in a fyke net fish survey in the billabong, and the exotic Eastern Mosquito fish were also found. Large mature European Carp were abundant, and the surface of the billabong contained numerous carp carcasses. It is likely the water quality conditions, particularly the low dissolved oxygen concentration, would cause fish mortality. In addition, the presence of a relatively large quantity of dead fish biomass would further impact environmental conditions for other aquatic life.

The macroinvertebrate samples collected from Bolin Bolin Billabong revealed low diversity of macroinvertebrate families, which was less diverse than the environmental quality guideline values for a floodplain lake. The VLAKES index score for Bolin Bolin Billabong samples was also below the guidelines, as shown in Table 38 (EPA Victoria, 2010). These macroinvertebrate indices are the main biological indicator of aquatic ecosystem condition, which suggests the condition of the aquatic ecosystem condition of Bolin Bolin Billabong was poor at the time of the assessment. Floodplain wetlands that are intermittently filled with water from the river are expected to vary from very high to very poor aquatic ecosystem conditions naturally, due to changes in water quality and environmental condition. Natural black water events can follow inundation of wetlands containing high levels of organic material. Although this condition can impact amenity quality of the site, the environmental conditions of billabongs are naturally variable. Risks to the aquatic ecosystem conditions are likely from exotic fish species, and modified hydrology.

**Table 38** Biological indices from aquatic ecosystem assessment of Victorian lakes – shaded cells indicate noncompliance with SEPP objectives

Location	VLAKES		Number of macroinvertebrate families	
	Sample 1	Sample 2	Sample 1	Sample 2
Bolin Bolin Billabong	4.0	3.4	7	7
Banyule Swamp	3.9	3.7	11	7
<i>SEPP (Waters) objectives – Floodplain Wetland</i>	4.3		15	

### 9.3.2 Threatened species

All threatened aquatic fauna identified for the study area are listed in Appendix D. Some of those species are considered unlikely to occur within the project boundary, as explained in Appendix D and Section 9.2.2. The Yarra River is known to support several species of threatened fish and turtle species, and thus targeted surveys for these known 11 species would not improve the assessment of likelihood. The presence of threatened aquatic species in the other waterways in the project boundary is considerably less likely. The targeted surveys for threatened species were thus undertaken to improve the confidence in the assessment of likelihood of occurrence in Koonung Creek, Plenty River and Banyule Creek.

Table 39 summarises the fish surveys, including the non-threatened fish species detected during surveys. Most notably, no threatened fish species were collected during the spring 2017 or autumn 2018 surveys. All fish surveys, except those in Simpson Barracks, resulted in detection of fish. All species detected were either common native species (Common Galaxias, Short-Finned Eel, Flathead Gudgeon, Climbing Galaxias, and Australian Smelt) or exotic species (Oriental Weatherloach, Eastern Gambusia, Roach, European Carp). This survey result provides some indication the survey methods were effective for detecting fish that were present at the site, but provides no evidence that would increase the assessment of likelihood of threatened aquatic species occurrence.

Table 39 Summary of results of fish surveys

Site	Species recorded
Plenty River at Plenty River Drive	Shortfinned Eel Common Galaxias Flatheaded Gudgeon Australian Smelt European Carp Oriental Weatherloach Eastern Mosquitofish Roach
Koonung Creek at Bulleen Road	Shortfinned Eel Common Galaxias Oriental Weatherloach Eastern Mosquitofish
Koonung Creek at Doncaster Road	Shortfinned Eel European Carp Oriental Weatherloach Eastern Mosquitofish Roach Eastern long-necked turtles Yabby

Site	Species recorded
Koonung Creek at Jocelyn Avenue, Balwyn	Shortfinned Eel Common Galaxias Oriental Weatherloach Eastern Mosquitofish Yabby
Koonung Creek at Valda Avenue, Box Hill North	Common Galaxias Oriental Weatherloach Eastern Mosquitofish Roach Yabby
Koonung Creek at Frank Sedgman Reserve, Box Hill North	Common Galaxias Oriental Weatherloach Eastern Mosquitofish Yabby
Koonung Creek at Church Road, Doncaster	Shortfinned Eel Common Galaxias Oriental Weatherloach Eastern Mosquitofish Yabby
Koonung Creek at Boronia Grove Reserve, Doncaster East	Common Galaxias Oriental Weatherloach Eastern Mosquitofish Yabby
Koonung Creek at Tunstall Road, Doncaster East	Common Galaxias Climbing Galaxias Oriental Weatherloach Yabby
Banyule Creek at Simpson Barracks	None

### Macquarie Perch and Australian Grayling

Existing records of Macquarie Perch and Australian Grayling are known from the Yarra River. This includes numerous records from around Dights Falls fishway, which is located within 500 metres of the Merri Creek confluence with the Yarra River. There are no barriers to fish passage between the Yarra River and Merri Creek. Therefore, this assessment considers the Yarra River and the reach of Merri Creek within the study area (immediately upstream of the confluence with the Yarra River) to provide habitat and are likely to contain these threatened fish species at some times of the year, although not at all times.

Within other waterways, habitat assessments were undertaken to determine the likely presence of species and targeted surveys for selected species were completed where it was considered likely the results would change the understanding of that species at a particular site based on existing information. The initial habitat assessment of all other waterways indicated the presence of threatened species was unlikely. However, given the relatively recent improvement of fish passage in the Yarra River provided by the Dights Falls fishway, it is possible these fish are present in waterways with direct connectivity to the Yarra River, where suitable habitat is present. The poor environmental conditions in these urban waterways, particularly with impacts from stormwater pollution and scouring stress from peak inflows, and modification and degradation of stream habitat, suggest that tributaries in the highly urbanised landscape provide poor habitat for these species.

Prior to the surveys, the aquatic habitat in Koonung Creek and Plenty River that were surveyed were assessed as marginally suitable for resident populations but may be potential passage/migration corridors for the threatened species known in the Yarra River. Koonung Creek contains some significant covered sections that are potential barriers to fish passage. However, other native fish species were located upstream of these covered sections, which indicates passage is possible for some species. Nevertheless, these covered sections of Koonung Creek may impede the upstream movement of Australian Grayling and Macquarie Perch from the Yarra River. The lower Plenty River contains some considerable deep pool sections downstream of the project site. However, the habitat present in the study area did not include these suitable habitats. It is notable that upstream reaches of the Plenty River are known for good quality aquatic habitat, and so the lower Plenty River including the reach in the study area may provide passage for native species to these better quality habitats.

Although no Australian Grayling were retrieved during the fish surveys, this may have been due to the surveys not occurring during appropriate migration windows, or because current populations are rare and fragmented. Records of the Australian Grayling in the Yarra River main stem are not common or abundant, which indicates this species would be less likely to be observed in tributaries with sub-optimal habitat, such as Koonung Creek and Plenty River.

It is not surprising the limited surveys for Macquarie Perch undertaken in small tributaries of the Yarra River for this assessment did not retrieve any individuals. This species is difficult to survey (particularly while electrofishing) as they are nocturnal and furtive (DoE, 2018e). Furthermore, given that adults of the species are known to prefer deep water pool habitats (usually 15 to 30-metres long and at least 1.5-metres deep) (DoEE, 2017) and these habitats are uncommon in these smaller waterways.

The absence of detection of Australian Grayling and Macquarie Perch in this and other previous surveys supports the assessment these waterways do not support populations of these fish. These streams may be able to provide habitat for dispersing individuals at some times of the year, but they are not likely to provide important habitat for the populations.

### **Australian Mudfish**

Occasional records of Australian Mudfish are known from the Yarra River. This includes records from around Dights Falls fishway. Therefore, this assessment considers the Yarra River and the reach of Merri Creek within the study area (immediately upstream of the confluence with the Yarra River) to provide suitable habitat for this species and likely to contain this fish species.

Australian Mudfish was not detected during spring 2017 or autumn 2018 surveys of Koonung Creek or Plenty River. Australian Mudfish are known to be cryptic and difficult to detect due to the nature of the species habitat and the cryptic nature of the fish (DSE, 2003). It is reported they may be generally inactive during the day, resting either on the substrate or amongst vegetation, and more active in open water during the night (Andrews, 1991; Koehn & Raadik, 1991). While electrofishing has been used successfully it requires a significant amount of time to conduct surveys and the removal of much aquatic vegetation may also be required to in small isolated patches (DSE, 2003). This species may not have been detected during the surveys as effort was restricted to open water areas rather than wetlands and marshes. The species also appears to be solitary, increasing the difficulty in detection (Andrews, 1991).

The absence of this species from surveys does not provide conclusive evidence of absence from the tributaries, and their presence may still be possible but with a low likelihood.

### **Dwarf Galaxias**

The targeted surveys for Dwarf Galaxias within Simpson Barracks did not detect this species. No fish of any kind were found in the headwaters of Banyule Creek, nor in wetlands surveyed. The habitat assessment of Banyule Creek supported the assessment that this site is disconnected from downstream reaches of Banyule Creek, with significant barriers to fish passage disconnecting Banyule Creek from the Yarra River. The survey supports the assessment that the aquatic habitat surrounded by protected native landscape does not contain any fish.

#### **9.3.3 Likelihood of potentially threatening processes**

Potentially threatening processes are discussed in Section 7.3.6.

## **9.4 Wetlands**

### **9.4.1 Wetlands of International Importance (Ramsar)**

Under the Ramsar Convention, a wide variety of habitats are classified as wetlands including natural, man-made, permanent and temporary bodies. Sites are designated which contain representative, rare or unique wetlands, or wetlands that are important for conserving biological diversity. Once designated, these sites are added to the Convention's List of Wetlands of International Importance and become known as Ramsar sites.

No Ramsar sites were identified by the PMST report (refer to Section 7.2.1 and Appendix F) within five kilometres of the project boundary.

The nearest Ramsar site is the Port Phillip Bay (western shoreline), which is approximately 20 kilometres south-west from the study area. The project is not expected to impact on this Ramsar site.

The waterways within the study flow into the Port Phillip Bay, which contains the Ramsar site. This site is located along the western shoreline of Port Phillip Bay, extending from Altona to the Bellarine Peninsula, including the Western Treatment Plant. These wetlands comprise intertidal flats, saltmarsh and mangroves. Indirect impacts from the project are not expected to occur.

#### 9.4.2 Nationally Important Wetlands

Nationally Important Wetlands (NIW) are those wetlands cited in the 'A Directory of Important Wetlands in Australia' (DoEEH, 2001) plus various additions for wetlands listed after 2001.

The project boundary does not intersect a NIW and the PMST did not identify any NIW within five kilometres of the project boundary, but much of the Yarra River between North Warrandyte and Warburton is listed as a NIW (Yarra River VIC156) starting from approximately 30 kilometres to the east of where the project boundary crosses the Yarra River.

##### **Yarra River Vic156 NIW Description**

The Yarra River runs through forested public land, and the Yarra River corridor consists of riparian forest of varying condition. Downstream, the Yarra River is located within the major agricultural area of the Yarra Valley and consists of degraded riparian vegetation. The Yarra River reach is recognised for its remnant flora and fauna values (DNRE, 2000).

The Yarra River contains habitat for a suite of threatened flora and fauna including important habitat for native fish species. It is characterised by a diverse aquatic habitat, and supports a high diversity of fish species, including the second largest known population in the state of the threatened species Macquarie Perch (though the population occurs outside of its native range). This portion of the Yarra River is also used by the threatened Australian Grayling *Prototroctes maraena* (DNRE, 2000).

Direct and indirect impacts to this NIW are expected to be negligible with the implementation of appropriate Environmental Performance Requirements (refer to Section 12).

# 10. Groundwater dependent ecosystems

## 10.1 Overview

Groundwater dependent ecosystems (GDEs) are complex dynamic structures that rely on groundwater for some or all their water requirements, either on a permanent or intermittent basis (Richardson *et al.*, 2011; G2eoscience Australia, 2018). In Australia, an estimated 34 per cent of the landscape supports GDEs (Doody *et al.*, 2017).

### *Types of GDEs*

Multiple types of GDEs have been identified in Australia (Geosciences Australia, 2018), and these can be grouped into two categories as per Eamus (2009):

- GDEs that rely on surface expression of groundwater. These include:
  - Wetland areas
  - Rivers where groundwater discharge provides a significant baseflow component to the system
- GDEs that rely on the availability of water beneath the surface (subsurface)
  - Terrestrial vegetation that relies on groundwater close to the surface (within the root depth of the vegetation) which in turn supports animal communities
  - Aquifer and cave ecosystems
  - Estuarine systems that rely on submarine groundwater discharge.

Three GDE layers were obtained from two sources, as described in Section 5.4.16.

### *Variability in groundwater dependency*

GDEs vary in the extent to which they draw upon groundwater, which is influenced by temporal scale dependency (such as wet-dry season, extreme drought) (Colvin *et al.*, 2003), groundwater availability, depth of saturated zone, quality of groundwater and location of discharge (Eamus *et al.*, 2006a; Sinclair Knight Merz, 2001). In addition, individual plant species within a GDE can differ in their degree of dependency upon groundwater.

**Obligate groundwater dependency** occurs where plant species are entirely dependent upon groundwater, with the absence of groundwater leading to mortality of such species (Eamus *et al.*, 2006b). However, not all species within a GDE usually display obligate dependency. Consequently, some species may remain and others may be lost from a system when groundwater is removed, leading to partial alteration of the ecosystem.

**Facultative groundwater dependency** is observed in species and ecosystems where groundwater is used but only when available, such as during dry periods (Eamus *et al.*, 2006b; Serov *et al.*, 2012).

In general, vegetation extracts water from the sources where the least amount of energy is required, meaning that shallow water will be utilised before deeper soil water or groundwater is used; which typically only occurs during periods of low rainfall when plants are under the greatest stress (Serov *et al.*, 2012; Kuginis *et al.*, 2012; Eamus and Froend, 2006).

Given the response to groundwater regime changes can differ among plant species, age and ecosystem type, it is inherently difficult to establish the degree and nature of groundwater dependency in most ecosystems (Eamus *et al.*, 2006b).

### **Groundwater quality**

The quality of groundwater and its ability to be utilised by plants can vary naturally based on salinity. However, salinity is only likely to be a factor to be considered when groundwater levels rise, rather than when groundwater levels decrease. In addition, water quality can be influenced by human factors such as heavy metal contamination. Tunnelling and construction activities have potential to introduce contaminants to groundwater, which could impact surface waters in areas of groundwater/surface water interaction. The risk of groundwater pollution is considered in Technical report N – Groundwater in accordance with SEPP (Waters) (Victorian Government, 2018). This groundwater assessment considers the risk of contamination of surface waters and GDEs by contaminated groundwater as low.

### **Terrestrial wetland interaction with groundwater**

The water within most terrestrial wetland systems is sourced from groundwater and rainfall (Hatton and Evans, 1998), including inflows from shallow groundwater systems (Harrington & Cook, 2014) or irrigation and run off, which is particularly common in urban areas. Yet for many wetland communities, the reliance on water sources and the degree of groundwater dependency is largely unknown (Hatton & Evans, 1998; Kuginis *et al.*, 2012).

Dependency may shift over climatic conditions, as the constituent species of some wetlands may be completely dependent on groundwater discharge under all climatic conditions (that is, obligate dependency) while others may have dependence only under dry conditions or at certain times of the year (for example, facultative dependency) (Thorburn *et al.*, 1994).

Many of the species common in terrestrial wetlands have shallow root systems that are relatively intolerant of drying out (Kuginis *et al.*, 2012).

### **Terrestrial waterway interaction with groundwater**

Waterways or wetlands where groundwater discharge provides a contribution to the hydrology of the system can contain aquatic ecosystems that are dependent on the contribution of groundwater. These may include streams with a baseflow that is maintained by groundwater inputs (that is, a gaining system) or wetlands where a pool maintained by groundwater inputs provides aquatic habitat. The ecological significance of groundwater dependent aquatic ecosystems is the ability for these systems to provide aquatic habitat during periods of low rainfall runoff, which can act as drought refugia for aquatic species. In some systems, these drought refugia can support isolated populations of species that can then disperse or recolonise other habitats following rainfall events and reconnection with other aquatic habitats.

### **Terrestrial woodland interaction with groundwater**

Access to, and demand for, groundwater in terrestrial woodlands varies between species and temporal scales and is shaped by rainfall patterns, temperature, the frequency and duration of flooding events, soil type, and species position in the landscape (Zencich *et al.*, 2002; Senior, 2018). Groundwater is usually accessed directly through a tap root, via the capillary fringe or vadose zone, located just above the water table (Eamus *et al.*, 2006b), but can also be accessed directly from the saturated zone below the water table. Expansion of rooting depth has the potential to draw on the water table indirectly via the capillary effect and from the moist soil directly above the water table, to either sustain transpiration and/or growth through a dry season (Eamus *et al.*, 2015; Hatton & Evans, 1998) but scant information exists regarding rooting depth of eucalypts.

Certain species have the ability to actively manage their groundwater dependency, such as deep-rooted perennials found within terrestrial woodlands (such as River Red Gum). The available evidence suggests that River Red Gum roots can penetrate to 10 metres (Davies 1953) and potentially deeper but this evidence comes from floodplain forests rather than non-floodplain trees (such as on slopes). Kath *et al.* (2014) determined that River Red Gum condition on floodplains deteriorated significantly when a groundwater depth threshold was reached (12 to 22 metres depending on the model used). This conclusion supported earlier work that proposed groundwater depth thresholds for River Red Gum of 12 to 15 metres on Murray River floodplain forests (Horner *et al.*, 2009) and 13 to 16 metres for the upper Condamine floodplain (Reardon-Smith 2011), whereby trees dependent on groundwater would suffer significant declines in condition or premature mortality when groundwater levels moved below these ranges. It should be noted the evidence presented by Kath *et al.* (2014) strongly suggests that decline in tree health was threshold related, rather than displaying a linear trend of decreasing condition with decreasing groundwater level.

River Red Gums have the ability to rapidly increase root depth and establish extensive root systems (Bacon *et al.*, 1993) following a decline in water table depth during dry periods (summer), and contract their root system in wetter periods (winter) in response to increased water availability (Canham *et al.*, 2012). However, if a groundwater depth threshold is reached, whereby tree roots are no longer able to access available soil moisture, tree condition is likely to deteriorate and trees may suffer premature death. Flow-on effects of population failure in a dominant tree species may then result in altered community composition and structure, and potential cascading effects in avifauna communities (Kath *et al.*, 2014).

It should be noted that most studies on groundwater-tree condition relationships are undertaken in riparian and floodplain environments. However, River Red Gum is a widely distributed species that frequently occurs in both floodplain and foothills landscapes, where depth to groundwater can differ by more than an order of magnitude. While the threshold response principle is likely to remain between both environments, the depth to groundwater and degree of dependency (if any) is likely to differ between River Red Gums occurring in the floodplain and the non-floodplain (slopes) environments of the study area. Also, in the absence of studies on other species, for the purpose of this assessment it is assumed that Studley Park Gum behaves in a similar manner to River Red Gum, especially given it is a hybrid between River Red Gum and Swamp Gum.

## 10.2 Groundwater characteristics within the study area

The project is described in Section 3 and a full overview of the hydrogeology of the project area and immediate environs within the study area is outlined in Technical report N – Groundwater. Of greatest importance to GDEs in the study area and their reliance upon groundwater is the modelled depth to groundwater. Modelled depth to groundwater is the water level that has been generated through a numerical model—that is, applying rainfall to the model and checking against a number of points from the North East Link groundwater monitoring network. In addition, modelled groundwater drawdown provides an indication of the extent of groundwater drawdown across the study area, using construction methods (such as a tanking scenario) as outlined in Technical report N – Groundwater.

In summary, groundwater levels (depth to groundwater) vary considerably across the study area from surface expression at places such as the Yarra River and Bolin Bolin Billabong to depths greater than 35 metres at higher elevation recharge areas, such as at the Simpson Barracks hilltop east of the project boundary.

Also of importance is groundwater condition, particularly salinity. According to Technical report N – Groundwater, the hydrogeology of the project can be broadly divided into two aquifer systems, an alluvial (floodplain) aquifer and a deeper bedrock aquifer system. The bedrock aquifer groundwater is saline with salinities averaging 5,700 mg/L TDS (Total Dissolved Solids). The alluvial aquifer has an average groundwater salinity of 2,658 mg/L TDS, which reflects its interaction with waterways and shorter recharge pathways. Shallower groundwater levels (generally within six metres of the surface) have been identified within the floodplains/alluvial sediments. The deeper water levels occur within the bedrock aquifer, in the topographically elevated parts of the area.

Within the study area, groundwater drawdown in the vicinity of sensitive ecological receptors (such as mapped GDEs or native vegetation) is modelled to be greatest in the immediate vicinity of the northern and southern tunnel portals (Figure 16).

Outside the project boundary, modelled groundwater drawdown in late 2024 after construction is completed is expected to be 0.1 to 3 metres at sensitive ecological receptors near the northern portal and 0.1 to 0.5 metres at sensitive ecological receptors near the southern portal (Figure 16). There are areas of greater drawdown outside sensitive ecological receptors (such as in suburban gardens at the junction of cut-and-cover and tunnels where predicted drawdown is 15 to 20 metres) and slight groundwater mounding of 0.1 to 0.5 metres is predicted for the area east of the project boundary near the southern portal, within the Trinity Grammar School Playing Fields. Fifty years after construction (2075), drawdown in the vicinity of sensitive ecological receptors is modelled to be less at the northern portal (0.1 to 3 metres) and less again at the southern portal (0.1 to 0.5 metres) (Figure 17). Slight groundwater mounding of 0.1 to 0.5 metres is predicted for the area east of the project boundary within the Trinity Grammar School Playing Fields.

### 10.3 Groundwater dependency of GDEs within the study area and potential impacts of groundwater drawdown

As outlined in Section 5.4.16, GDEs have been modelled across the study area by the Bureau of Meteorology and the PPWCMA. These are presented in Figure 15 and include:

- GDEs that rely on surface expression of groundwater: wetlands and rivers
- GDEs that rely on the availability of water beneath the surface (sub-surface): terrestrial vegetation.

Given the mapping of GDEs is inherently conservative, it is assumed that all areas not mapped as supporting GDEs are in fact not groundwater dependent.

Areas adjacent to the project boundary have the potential to be impacted by groundwater changes resulting from the project. There are three main geographic areas of focus in relation to GDEs where indirect effects may occur:

1. Vicinity of the northern tunnel portal, including Simpson Barracks and Banyule Creek
2. Vicinity of the southern tunnel portal, including the Yarra River Flats
3. Tunnels section, including Banyule Flats.

These areas are discussed in Sections 10.3.1 to 10.3.3 respectively.

Although GDEs are mapped within the project boundary, these areas are not discussed here as the majority of vegetation within the project boundary is proposed to be directly removed as a part of the project and has been factored into vegetation loss calculations in Section 7.3.4. While GDEs are also mapped within the broader study area, such as in the Yarra River floodplain and Koonung Creek valley, these areas are not discussed here, as subsurface works (tunnelling) are not proposed in these areas and consequently, GDEs adjacent to the project boundary are unlikely to be impacted.

#### 10.3.1 Northern portal – Simpson Barracks, Banyule Creek and surrounds

At the northern portal, the headwaters of Banyule Creek is mapped as a GDE relying on the surface expression of groundwater. In addition, parts of the Plains Grassy Woodland mapped within Simpson Barracks are mapped as a GDE.

##### *Simpson Barracks and Commonwealth land*

##### **Type of GDE**

'GDE – subsurface expression' (BOM) and 'GDE' (PPWCMA) is mapped partly in areas supporting Plains Grassy Woodland at Simpson Barracks (Figure 16). The dominant tree species are River Red Gum in the lower western section closest to the project boundary, in association with Yellow Box and Studley Park Gum. These trees generally reach mature heights greater than 20 metres at Simpson Barracks.

##### **Groundwater dependency**

To determine level of groundwater dependency and potential risk to native vegetation and terrestrial GDEs at Simpson Barracks, a spatio-temporal model was developed based on: a) current groundwater depth, b) mapped GDEs and native vegetation including large trees, c) known rooting depth of eucalypts based on literature, and d) modelled groundwater drawdown under 2024 (post-construction) and 2075 (operation) scenarios.

The first step in the process was to develop a baseline vegetation layer, derived from EVC mapping undertaken during project fieldwork, DELWP EVC mapping and vegetation mapping at Simpson Barracks (HLA, 2007). This was then overlaid with mapped Bureau of Metrology (BoM) and PPWCMA GDE layers. Current modelled groundwater levels using five-metre contour intervals (and one-metre contour levels where depth to groundwater was less than five metres) were then overlaid on top of the vegetation and GDE mapping. Fourth, a polygon was created, capturing any mapped EVCs or GDEs within the 10<20-metre groundwater depth band; this denotes the area most at risk of groundwater drawdown. Next, the modelled groundwater drawdown layer was overlaid in the following increments (0.1<0.5 metres, 0.5<1 metre, 1<2 metres, 2<3 metres and >3 metres in the Simpson Barracks). It should be noted that multiple scenarios were run and the 95<sup>th</sup> percentile of scenarios was used to determine drawdown levels, thus factoring conservativity into the model. Finally, level of risk of native canopy trees declining in condition or suffering premature mortality was determined according to the rationale provided in Table 40.

It should be noted the size threshold for determining potential impacts upon trees within terrestrial GDEs was set at the EVC Large Tree (LT) benchmark, which for EVCs in this area (Plains Grassy Woodland EVC 55, Creekline Grassy Woodland EVC 68) is 80 centimetres DBH. LTs were used as the threshold for two primary reasons: a) they are the trees most at risk of impact associated with groundwater drawdown, and b) removal of LTs within patches of native vegetation is an impact that needs to be offset, in accordance with the *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP, 2017a). All LTs within the modelled 10<20-metre groundwater depth zone were thoroughly ground-truthed and mapped in the field.

Table 40 Rationale for determining risk of premature tree mortality or tree condition decline due to groundwater drawdown associated with construction of the northern tunnel portal at Simpson Barracks

Risk	Current modelled groundwater depth (m)	Modelled groundwater drawdown (m)	Rationale
Very high	15<20	2.0<3.0	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be close to maximum threshold depth by which they are able to access groundwater</li> <li>Likely that a 2&lt;3-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
High	10<15	2.0<3.0	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be accessing groundwater periodically</li> <li>Possible to likely that a 2&lt;3-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
High	15<20	1.0<2.0	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be close to maximum threshold depth by which they are able to access groundwater</li> <li>Possible that a 1&lt;2-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
Moderate	10<15	1.0<2.0	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be accessing groundwater periodically</li> <li>Possible that a 1&lt;2-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
Moderate	15<20	0.5<1.0	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be close to maximum threshold depth by which they are able to access groundwater</li> <li>Possible to unlikely that a 0.5&lt;1-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
Low	10<15	0.5<1.0	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be accessing groundwater periodically</li> <li>Unlikely that a 0.5&lt;1-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
Negligible	10<20	<0.5	<ul style="list-style-type: none"> <li>Highly unlikely that a 0.1&lt;0.5-m drawdown would decrease the water table to a depth unable to be accessed by tree roots</li> </ul>
Negligible	<10	NA	<ul style="list-style-type: none"> <li>Roots of mature trees likely to be accessing groundwater due to proximity to surface and any drawdown is unlikely to be beyond the depth able to be reached by tree roots</li> </ul>
Negligible	>20	NA	<ul style="list-style-type: none"> <li>Roots of mature trees unlikely to be accessing groundwater</li> </ul>

#### *Lower slopes – depth to groundwater <10 metres*

On the lower slopes of Simpson Barracks where depth to groundwater is modelled to be 10 metres or less (based on groundwater depth contours in Figure 16), it is assumed that River Red Gums/Studley Park Gums are accessing subsurface groundwater for at least part of the year (during summer) or during drought conditions. Groundwater drawdown in these areas is unlikely to negatively affect tree health or cause premature tree death, as the 0.5 to 3 metres modelled drawdown in 2024 and 2075 respectively is unlikely to decrease the water table to a level below that which River Red Gum/Studley Park Gum roots are able to access. Consequently, there is anticipated to be negligible impacts in these areas.

#### *Upper slopes – depth to groundwater >20 metres*

On the upper slopes of Simpson Barracks where depth to groundwater is greater than 20 metres (based on groundwater depth contours in Figure 16) it is assumed that River Red Gum, Studley Park Gum and Yellow Box do not access subsurface groundwater and so trees in this zone are unlikely to be impacted by any potential groundwater drawdown (Figure 18, Figure 19).

#### *Lower to mid slopes – depth to groundwater 10<20 metres*

On the lower to mid slopes of Simpson Barracks (east of the project boundary) where depth to groundwater is 10 to 20 metres (based on groundwater depth contours in Figure 16) it is assumed that River Red Gums/Studley Park Gums may be accessing subsurface groundwater for at least part of the year (during summer) or during drought conditions. Drawdown in these areas has a low to high likelihood of negatively affecting tree health or causing premature tree death at some stage between construction (Figure 18) and 50 years post-construction (Figure 19) as the modelled drawdown in 2024 and 2075 (up to 3 metres depending on scenario) may be enough to tip the groundwater depth beyond a threshold by which River Red Gum/Studley Park Gum roots are unable to access groundwater. Refer to Table 40 above for a more detailed outline of risk of impact.

#### **Large Tree mapping<sup>12</sup>**

All Large Trees (LTs; >80 centimetres DBH) within the modelled 10<20-metre groundwater depth zone were mapped in the field, with tree numbers likely to be impacted based on risk zones presented in Table 41. Seven LTs within the Simpson Barracks would have a moderate to high chance of being negatively impacted by 2024 at the end of construction, and a further 13 LTs would have a low chance of being impacted in the absence of any mitigation measures. Under the 2075 long-term scenario, 19 LTs within Simpson Barracks would have a moderate to high chance of being negatively impacted, while a further 10 LTs would have a low chance of being impacted in the absence of any mitigation measures. All trees predicted to be impacted are River Red Gums, apart from three (one moderate, two low risk) Studley Park Gum under the 2024 scenario and six (three moderate, three low risk) Studley Park Gum under the 2075 scenario.

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<sup>12</sup> The classification of Large Tree was previously referred to as Large Old Tree in Native vegetation removal regulations (DELWP)

Table 41 Number of Large Trees expected to suffer premature mortality or condition decline due to groundwater drawdown associated with construction of the northern tunnel portal at Simpson Barracks

Risk	2024	2075
Very high	0	0
High	1 (0 Studley Park Gum)	4 (0 Studley Park Gum)
Moderate	6 (1 Studley Park Gum)	15 (3 Studley Park Gum)
Low	13 (2 Studley Park Gum)	10 (3 Studley Park Gum)
TOTAL	20 (3 Studley Park Gum)	29 (6 Studley Park Gum)

#### *Scarred Trees*

Two of the LTs at Simpson Barracks are registered as scarred trees and have been included in the calculations within Table 41 (Tree no. 7922-0584 & 7922-0585). Current advice from ALA indicate that Wurundjeri have confirmed these are not culturally significant scarred trees. However, these trees are still considered scarred trees until Aboriginal Victoria agree to remove them from the register. It has been advised this request is underway.

#### **Potential mitigation measures**

Excluding tanking, mitigation measures are available to minimise the risk of adverse impacts on LTs at Simpson Barracks, particularly in the short-term during construction.

#### *Watering*

The most effective measure would involve monitoring canopy condition of LTs within moderate to high risk zones and in nearby control sites unaffected by modelled groundwater drawdown, to determine whether canopy condition was deteriorating. If canopy condition displayed a negative trajectory, then a supplementary watering program could be initiated over a number of years to support the trees through the period of greatest stress during and immediately following construction completion, when the drawdown is expected to be greatest. However, all trees likely to be affected during construction (up to 2024) are also likely to be affected over the long-term (up to 2075) and consequently, watering is unlikely to be a feasible long-term mitigation measure.

#### *Offsetting*

If trees are predicted to have a moderate to high likelihood of suffering premature mortality due to groundwater drawdown (that is, beyond construction and extending to the 2075 scenario), and long-term watering is not a feasible and realistic mitigation option, these trees would be regarded as a loss in accordance with the *Guidelines* (DELWP, 2017a). Consequently, offsets would need to be sourced for the loss of 19 LTs from Simpson Barracks over the long term (2075). Trees with a low risk of suffering condition decline or premature mortality are not regarded as requiring offsets in accordance with the *Guidelines*.

#### **Overall residual risk**

While the risk to individual trees is categorised from low to high, the overall residual risk rating on the project risk register is considered to be moderate.

#### **Groundwater salinity**

In all areas around the northern portal, groundwater salinity is not expected to influence the impact of groundwater changes. The models predict drawdown rather than mounding, which would result in decreasing (if any) rather than increasing groundwater salinity for the trees which have facultative groundwater dependency.

### Other points to note

Although 19 LTs within Simpson Barracks have the potential (moderate to high likelihood) to suffer premature mortality over the long term, there are currently thousands of other younger trees approximately 10 to 20 metres in height (with diameter at breast height (DBH) ranging from 20 to 70 centimetres) within the moderate to high risk zones at Simpson Barracks. From 2024 to 2075, these trees are expected to grow and self-thin (due to density-dependent mortality), with many trees likely to develop into the LT category by 2075. While groundwater levels may be slightly lower over the long-term, these trees are likely to have never accessed groundwater during their development, owing to their relatively smaller size at the time of the construction of North East Link, and subsequently, are unlikely to be affected by the projected drawdown as they are not dependent on groundwater.

It should be noted that it is quite possible, even likely, that any LT losses due to groundwater drawdown may be counteracted by other trees growing and moving into the LT cohort over time. For example, it is estimated that more than 200 trees ranging in size from 50 to 79 centimetres DBH occur in the moderate to high risk zones at Simpson Barracks. While some of these trees may suffer premature mortality due to groundwater drawdown, many are likely to have root systems that do not penetrate deep enough to access groundwater, and by inference, drawdown would not impact these individuals. Consequently, over the 50-year timespan from 2024 to 2075, many of these trees are likely to become LTs (conservatively adding girth of c. 0.5 centimetres per year (for example, Bennetts and Jolly 2017 reported 0.44 centimetres per year<sup>-1</sup> growth in River Red Gum in floodplain forests), resulting in a scenario where it is quite probable there would be no net loss of LTs at Simpson Barracks.

### Matted Flax-lily

Matted Flax-lily (*Dianella amoena*) is unlikely to be impacted by groundwater drawdown at Simpson Barracks, as roots are unlikely to penetrate deeper than one metre, and so are unlikely to be groundwater dependent. Any potential decrease in canopy cover caused by tree dieback in the 10<20-metre groundwater depth zone is unlikely to negatively impact the Matted Flax-lily population, as the species is known to persist in grasslands with no tree cover.

### Conclusion – Simpson Barracks and Commonwealth land

Nineteen LTs (16 River Red Gum, three Studley Park Gum) within Simpson Barracks and abutting Commonwealth land, but outside the project boundary, are likely to be accessing groundwater on occasions (10<20-metre groundwater depth zone) and have a moderate to high likelihood of being negatively impacted by groundwater drawdown over the long term (2075 scenario). This implies that in this groundwater depth zone, LTs have a reasonable likelihood of suffering a decline in health and/or premature death. Short-term watering may reduce the number of trees impacted in the long term. Any LTs predicted to be affected over the long term would need to be offset in association with the project's offset strategy, which is currently being developed. Areas outside the 10<20-metre groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

### **Type of GDE**

'GDE – surface expression' (BOM) and 'GDE' (PPWCMA) is mapped in the headwaters of Banyule Creek at Simpson Barracks and south of Lower Plenty Road along Banyule Creek and River Gum Walk (Figure 16).

### **Groundwater dependency**

Field surveys south of Simpson Barracks (Colleen Reserve) and also south of Lower Plenty Road indicate this area is not a GDE dependent on the surface expression of groundwater (refer to Section 9.3.1). However, River Red Gums along Banyule Creek and River Gum Walk may rely on the subsurface availability of water, following the reasoning outlined above for Simpson Barracks.

### **Large Tree mapping<sup>13</sup>**

Mapping of Large Trees (LTs; >80 centimetres DBH) within the 10<20-metre groundwater depth zone has been completed for areas outside Simpson Barracks and Commonwealth land, with tree numbers based on risk zones presented in Table 42. A total of nine LTs are considered to have a moderate to high chance of being negatively impacted by 2024 at the end of construction, and a further five LTs are considered to have a low chance of being impacted in the absence of any mitigation measures. Under the 2075 long-term scenario, approximately 13 LTs are considered to have a moderate to high chance of being negatively impacted, while a further seven LTs have a low chance of being impacted in the absence of any mitigation measures.

**Table 42** Number of Large Trees expected to suffer premature mortality or condition decline due to groundwater drawdown associated with construction of the northern tunnel portal in areas outside Commonwealth land

Risk	2024	2075
Very high	0	0
High	0	1
Moderate	9	12
Low	5	7
TOTAL	14	20

### **Mitigation measures**

The mitigation measures outlined for Simpson Barracks and Commonwealth land also apply to any LTs potentially affected at Colleen Reserve, Banyule Flats (Main Yarra Trail), River Gum Walk and Mercedes Court.

### **Conclusion – northern portal, outside Simpson Barracks and Commonwealth land**

Given the portion of Banyule Creek supporting native vegetation within the project boundary (north of Lower Plenty Road and for a short distance immediately south of Lower Plenty Road) is proposed to be fully removed during construction, it is not considered further in this section, as any effects of groundwater drawdown do not require assessment given these trees are deemed to be removed as part of the project (Figure 18).

<sup>13</sup> The classification of Large Tree was previously referred to as Large Old Trees in Native vegetation removal regulations (DELWP)

However, at Colleen Reserve (near Simpson Barracks) and other areas south of Lower Plenty Road, nine LTs have a moderate risk of being negatively impacted by groundwater drawdown by 2024 at the end of construction (Figure 20) and a further five LTs have a low chance of being impacted in the absence of any mitigation measures. Under the 2075 long-term scenario (Figure 21), 13 LTs (in addition to those identified for the Simpson Barracks) have a moderate to high chance of being negatively impacted, while a further seven LTs have a low chance of being impacted in the absence of any mitigation measures. LTs predicted to be affected over the long term would need to be offset in association with the project's offset strategy, which is currently being developed. Areas outside the 10<20-metre groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

### Conclusion – northern portal

Considering all areas identified by the criteria described in Table 40 in the vicinity of the northern portal, 16 LTs would have a moderate or high risk of being negatively impacted by groundwater drawdown by 2024 at the end of construction. (Figure 20; Table 43) and a further 18 LTs would have a low chance of being impacted in the absence of any mitigation measures. Under the 2075 long-term scenario (Figure 21), 32 LTs would have a moderate to high chance of being negatively impacted, while a further 17 LTs would have a low chance of being impacted in the absence of any mitigation measures. Any LTs predicted to be affected over the long-term would need to be offset in association with the project's offset strategy, which is currently being developed. Areas outside of the 10<20-metre groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

It should be noted that groundwater modelling would be refined at the detailed design stage and during construction. Consequently, projected impacts on LTs would be recalculated and offsets adjusted accordingly as required.

**Table 43** Number of Large Trees expected to suffer premature mortality or condition decline due to groundwater drawdown associated with construction of the northern tunnel portal (all areas combined)

Risk	2024	2075
Very high	0	0
High	1	5
Moderate	15	27
Low	18	17
TOTAL	34	49

#### 10.3.2 Southern portal – Yarra Flats

At the southern portal, the majority of the Yarra River floodplain (characterised mainly by Floodplain Riparian Woodland) adjacent to the project boundary is mapped as GDEs relying on the surface or subsurface expression of groundwater. The GDEs in this area are thought to be accessing an alluvial aquifer, which is understood to be strongly interconnected with Yarra River surface water levels, though local groundwater levels and flux pathways are affected by local geology and topography.

## **Type of GDE**

'GDE – subsurface expression' (BOM), 'GDE – surface expression' (BOM) and 'GDE' (PPWCMA) is mapped across much of the area supporting Floodplain Riparian Woodland on the Yarra River floodplain (Figure 16). The dominant tree species is River Red Gum, generally reaching mature heights of 20 to 25 metres. In addition, Floodplain Wetland Aggregate (EVC 172) is mapped by DELWP within Bolin Bolin Billabong as 'GDE – surface expression' (BOM).

## **Groundwater dependency**

### *River Red Gums on the Yarra floodplain*

On the floodplain of the Yarra River where depth to groundwater is modelled to be 0 to 10 metres (based on groundwater depth and modelled drawdown) it is assumed that River Red Gums within the Floodplain Riparian Woodland EVC are accessing subsurface groundwater (Figure 18). Drawdown in these areas is unlikely to affect tree health or cause premature tree death at any stage between construction (Figure 18) and 50 years post-construction (Figure 19) because the 0.1 to 1-metre modelled drawdown in 2024 and 2075 in sensitive ecological receptors is unlikely to decrease the water table to a level below that which River Red Gum roots are able to access.

### *Billabongs associated with the Yarra River*

In billabongs associated with the Yarra River floodplain, where depth to groundwater is modelled to be 0 to 5 metres (based on groundwater depth and modelled drawdown), it is assumed these wetlands are largely filled by overland flow during floods or local runoff from natural or stormwater catchment, and so do not have obligate dependency. Connection to groundwater is expected to occur during and immediately following flooding or inundation events, as the water collected in the billabong seeps into the groundwater. Drawdown in these areas is unlikely to affect billabong condition as they are ephemeral systems in a constant state of flux depending on flooding of the Yarra River and seasonal rainfall.

### *Bolin Bolin Billabong*

Bolin Bolin Billabong is a high value ox-bow lake on the floodplain of the Yarra River west of Bulleen Road (Jacobs, 2017). The eastern end of Bolin Bolin Billabong contains a deep pool, with an area of permanent surface water, which dries out rarely (approximately once per decade) (Jacobs, 2017). This deep pool spanning an area of approximately 0.2 hectares is recognised by Melbourne Water as groundwater dependent (Jacobs, 2017) and at typical base-flow water levels is approximately 1.8-metres deep. The pool is located in the deepest section of the billabong. The permanency of surface water in this pool is largely due to the depth of the scour pool in this excised palaeo channel, which allows the pool to intersect the quaternary alluvial groundwater, which maintains the pool hydrology.

Bolin Bolin Billabong has highly variable hydrology that can be characterised in two distinct phases. During the flooded phase the majority of the billabong is inundated with water from the Yarra River, either due to flooding overbank flows, or managed watering events. During this phase, the water in the billabong gradually seeps into the groundwater and the water level declines until it reaches an equilibrium with the alluvial groundwater. During the dry phase, water is present only in a deep pool, located at the eastern end of the billabong. It is recognised by Melbourne Water that this pool is a surface expression of the alluvial groundwater, and is often referred to as permanent water maintained by groundwater. The projected drawdown of 0.1 to 0.5 metres in this area has a moderate to high likelihood of lowering the water level in the pool by a similar difference. However, under Melbourne Water's intended managed hydrological regime of mostly annual flood and dry phases, this change in water level would only affect the billabong during the dry phase, and this change in the pool depth is considered minor compared with the annual hydrological variability in the billabong. Under the 2024 (Figure 16) and 2075 (Figure 17) scenarios, the ecological consequence of this change to water level is some shrinking of the extent of wetland permanently inundated and potentially altering water quality. However, the significance of this consequence is minor, as the species and ecosystem that inhabit the deep pool during the dry phase and that would be impacted by this change are dominated by tolerant generalists, common colonisers, and weed/pest species. Nevertheless, the cultural and amenity significance of the permanent pool and associated ecosystem may be greater than the ecological significance of the pool itself. Native vegetation is not expected to be affected, due to the small change relative to the depth to groundwater.

#### **Potential mitigation measures**

Given the variability and uncertainty in dependency of GDEs within the study area, potential impacts would be monitored and managed through:

- Implementation of groundwater monitoring (EPR GW2)
- Implementation of a groundwater dependent ecosystem monitoring and mitigation plan (EPR FF6).

If required, water levels within Bolin Bolin Billabong could potentially be maintained either by pumping water from the Yarra River, or by groundwater injection. Melbourne Water are actively managing the hydrological regime of the billabong. The adopted method would need to consider existing water chemistry of the billabong and the water quality of source water to ensure contaminants are not introduced that may then impact GDEs in areas of groundwater/surface water interaction. The planning for any supplementation of water to the billabong should include consideration of impacts to the billabong and Yarra River.

#### **Overall residual risk**

The overall residual risk rating on the project risk register is considered to be low.

#### **Groundwater salinity**

In all areas around the southern portal, groundwater salinity is not expected to influence the impact of groundwater changes. The models predict a slight drawdown rather than mounding in areas supporting native vegetation along the Yarra River floodplain, which would result in decreasing (if any) rather than increasing groundwater salinity for the trees which have obligate groundwater dependency.

## Conclusion

Areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary which are likely to be accessing groundwater are unlikely to be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra River floodplain are also unlikely to be negatively impacted. However, the deep pool at the eastern end of Bolin Bolin Billabong has a low residual risk of being negatively impacted by groundwater drawdown.

In all areas around the southern portal, groundwater salinity is not expected to influence the impact of groundwater changes on terrestrial ecosystems. The models predict drawdown rather than mounding, which would result in decreasing rather than increasing salinity for the terrestrial ecosystem. Changes (reduction) in salinity in groundwater dependent wetlands and billabongs (such as Bolin Bolin Billabong) could result in ecological changes in those waterbodies.

### 10.3.3 Tunnels – Banyule Flats

Groundwater dependent ecosystems are modelled extensively across the Banyule Flats area. However, as short-term and long-term groundwater drawdown resulting from the project's construction is modelled to be less than 0.1 metres throughout the main tunnelled section of the project boundary that includes ecological values, including the Banyule Flats (Figure 17), this area is not considered further. Any impacts on ecological values in this area are expected to be negligible. Areas predicted for more significant drawdown are limited to the suburban areas along and beyond the escarpment along Buckingham Drive, west of the Banyule Flats area.

# 11. Risk assessment

A risk assessment of project activities was performed in accordance with the methodology described in Section 5. The risk assessment has been used as a screening tool to prioritise the focus of the impact assessments and development of EPRs. The risk pathways link project activities (causes) to their potential effects on the environmental assets, values or uses that are considered in more detail in the impact assessment. Risks were assessed for the construction and operation phases of the project.

The identified risks and associated residual risk ratings are listed in Table 44. The likelihood and consequence ratings determined during the risk assessment process and the EPRs to be achieved are presented in Appendix A.

Table 44 Ecological risks

Risk ID	Potential threat and effect on the environment	Risk rating
<i>Construction</i>		
Risk EC01	Land clearing during construction impacting threatened flora and ecological communities	Planned (moderate consequence)
Risk EC02	Land clearing during construction impacting non-threatened flora and ecological communities	Planned (moderate consequence)
Risk EC03	Construction activities resulting in erosion/sedimentation, dust, litter or release of contaminants leading to loss or degradation of non-threatened flora and ecological communities	Low
Risk EC04	Construction activities resulting in erosion/sedimentation, dust, litter or release of contaminants leading to loss or degradation of threatened flora and ecological communities	Low
Risk EC05	Construction activity leading to the introduction or spread of weeds, pest species, or pathogens that leads to the reduction of ecological values	Low
Risk EC06	Dewatering of groundwater during construction resulting in changes to terrestrial groundwater dependent ecosystems	Medium
Risk EC07	Construction activity causes soil compaction that leads to the loss or degradation of threatened flora and ecological communities	Low
Risk EC08	Construction activity causes soil compaction that leads to the loss or degradation of non-threatened flora and ecological communities	Low
Risk EC09	Construction noise, vibration and/or lighting resulting in elevated disturbance of threatened fauna	Low
Risk EC10	Construction noise, vibration and/or lighting resulting in a significant impact on non-threatened fauna	Low
Risk EC11	Land clearing during construction resulting in the loss or degradation of habitat supporting threatened fauna	Low
Risk EC12	Land clearing during construction resulting in the loss or degradation of habitat supporting non-threatened fauna	Planned (moderate consequence)

Risk ID	Potential threat and effect on the environment	Risk rating
Risk EC13	Construction activities resulting in the loss of important habitat for EPBC Act Migratory species	Low
Risk EC14	Habitat fragmentation resulting in reduced effectiveness of terrestrial wildlife corridors and creation of barriers to fauna movement	Low
Risk EC15	Construction activities resulting in erosion/sedimentation, litter or release of contaminants into wetlands and waterways leading to degradation of terrestrial fauna habitat	Low
Risk EC16	Construction activities resulting in erosion/sedimentation, litter or release of contaminants into wetlands and waterways leading to degradation of aquatic fauna habitat	Low
Risk EC17	Land clearing during construction resulting in reduced viability of non-threatened native fauna populations	Low
Risk EC18	Waterway modification (eg channelisation, piping, bank stabilisation) resulting in loss or degradation of habitat for non-threatened native aquatic fauna.	Low
Risk EC19	Construction activities resulting in the death or injury of native fauna	Low
Risk EC20	Construction activities within/around waterways resulting in loss or degradation of habitat for threatened aquatic and terrestrial fauna	Low
Risk EC21	Construction activities within/around waterways resulting in loss of connectivity and impeded passage for threatened aquatic species	Low
Risk EC22	Construction activities within/around waterways resulting in loss of connectivity and impeded passage for non-threatened native aquatic species	Low
Risk EC23	Construction activities within/around waterways resulting in loss or degradation of habitat for non-threatened native aquatic and terrestrial fauna	Low
Risk EC24	Dewatering of groundwater during construction resulting in changes to aquatic groundwater dependent ecosystems	Low
Risk EC25	Construction of tunnels causes ground settlement that changes drainage flow and/or hydrology of wetlands	Low
Risk EC26	Construction of tunnels causes ground settlement or tree root interactions causing death of native trees, degradation of vegetation quality or vitality of native vegetation	Low
<i>Operation</i>		
Risk EC27	Shading from structures causing the loss or degradation of non-threatened flora and ecological communities	Low
Risk EC28	Shading from structures causing the loss or degradation of threatened flora and ecological communities	Low
Risk EC29	Groundwater changes during operation resulting in changes to terrestrial groundwater dependent ecosystems	Medium
Risk EC30	Shading of waterways from structures causing the loss or degradation of aquatic and riparian vegetation that degrades aquatic habitat quality	Medium
Risk EC31	Operational noise, vibration and/or lighting resulting in elevated disturbance to threatened fauna	Low

Risk ID	Potential threat and effect on the environment	Risk rating
Risk EC32	Operational noise, vibration and/or lighting resulting in significant impact on non-threatened native fauna	Low
Risk EC33	Enclosing waterways resulting in reduced viability of native aquatic species	Low
Risk EC34	Increased volumes of traffic resulting in death or injury of native fauna	Low
Risk EC35	Groundwater changes during operation resulting in changes to aquatic groundwater dependent ecosystems	Low
Risk EC36	Changed waterway form resulting in loss of connectivity and impeded passage for native aquatic species	Medium
Risk EC37	Changes to stormwater drainage resulting in hydraulic impact to waterways that degrades aquatic ecosystems	Low
Risk EC38	Increased road traffic resulting in increased pollutants (metals, hydrocarbons) in stormwater runoff to waterways that degrades aquatic ecosystems.	Low
Risk EC39	Shading of waterways resulting in reduced nutrient processing, leading to increased nutrient transport that degrades downstream aquatic ecosystems	Medium
Risk EC40	Groundwater changes in the vicinity of the tunnel causing long-term detrimental changes in terrestrial and aquatic ecosystems	Low

## 12. Impact assessment

This section discusses the expected and potential impacts of North East Link and associated EPRs that aim to reduce impacts to as low a level as possible. EPRs referred to are defined in Section 13.

This section is divided into construction and operational impacts and then is further grouped by similar impacts to avoid repetition.

### 12.1 Construction impacts

This section describes the potential impacts on ecological assets, values and uses from activities and consequences that occur during construction of North East Link. Risk pathways relevant to each impact category are provided in Table 44 in Section 11.

#### 12.1.1 Removal of vegetation and habitat

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC01, Risk EC02, Risk EC12	Planned (moderate consequence)
Risk EC11, Risk EC13, Risk EC17	Low

#### Land clearing during construction impacting threatened flora and ecological communities (risk EC01)

The construction of roads, tunnels and ancillary infrastructure would require the removal of surface vegetation including threatened flora. This section details impacts to threatened flora and communities, with impacts to native vegetation in general addressed under Risk EC02 below. This assessment has conservatively assumed that any flora or communities located within the project boundary would be lost due to the project. This assessment considered total impact across the whole of the project boundary (including Simpson Barracks).

The likelihood of occurrence of rare or threatened species recorded on the VBA and/or predicted to occur by the PMST is presented in Appendix B. Two species—Matted Flax-lily and River Swamp Wallaby-grass—listed as threatened under the EPBC Act, and two species—Arching Flax-lily and Studley Park Gum—listed as vulnerable and endangered under the DELWP Advisory List, are known to be present within the project boundary. Locations of these species are discussed further in Section 7.3.2.

In total, 95 Matted Flax-lily, five Arching Flax-lily and greater than 10 individuals of Studley Park Gum occur within the project boundary. Numbers of River Swamp Wallaby-grass within the project boundary are unknown but assumed to be low, as the only record is from a report by Australian Ecosystems (2007) indicating the species was present within a small wetland at the Trinity Grammar School Sporting Complex, which is within the project boundary. Following field surveys undertaken as part of the project, an additional nine rare or threatened flora are regarded as having a moderate possibility of occurring within the project boundary (Table 25), and thus the potential to be impacted.

A Native Vegetation Report has been completed (Appendix J) that identifies the general offset units and species offset units required for the worst case vegetation removals. A draft ecological offsetting strategy is provided at Appendix L.

Following discussions with DELWP, NELP has committed to undertaking further field surveys to better understand the prevalence of Studley Park Gum at Simpson Barracks and to estimate the number of individuals potentially impacted by the project. Losses of Studley Park Gum must be minimised (EPR FF2). Unavoidable loss of large trees within patches and scattered small trees of Studley Park Gum would be managed through an offsetting arrangement as per the Guidelines (DELWP, 2017a) (EPR FF2). To further mitigate impacts on Studley Park Gum, seed would be collected from individuals within the project boundary and propagated in a nursery. Propagated plants would then be incorporated into project landscaping (EPR AR3). It should be noted that successful seed collection and propagation of Studley Park Gum has previously been achieved at Streeton Views Estate, Yallambie, in close proximity to Simpson Barracks.

Based on the reference project, the loss of Matted Flax-lily habitat is unavoidable at Simpson Barracks. As this land is owned by the Commonwealth, it would be managed through the EPBC Act referral process and legislative requirements of the project would be determined by the Commonwealth government (DoEE).

To mitigate impacts to the identified Matted Flax-lily and Arching Flax-lily plants, individuals are proposed to be translocated to a suitable alternative site (EPR FF7). Currently, NELP is investigating potential recipient sites within the City of Whittlesea, City of Darebin and City of Banyule, as well as in the eastern section of Simpson Barracks. Sites under investigation include:

- Southern Redgum Reserve, Enterprise Drive, Bundoora
- Mernda Village Conservation Reserve (east of Brahe Drive), Mernda
- 185 Bridge Inn Road, Wollert
- Harry Pottage Reserve, Macleod
- Gresswell Forest Nature Conservation Reserve.

These sites are still being assessed for feasibility and are therefore not confirmed at this stage of the project. All sites would be subject to review as documented within a salvage and translocation plan (Appendix K) to assess their suitability for the success of the translocation (EPR FF7). Furthermore, the translocation plan would include methods to optimise the success of the translocations including:

- A number of clones would be taken for each plant removed from the ground to ensure persistence of the plants
- Stock would be maintained in an approved nursery with experience in the management and handling of Matted Flax-lily
- Recipient sites would be selected based on a process approved by DELWP and DoEE
- A detailed monitoring plan would be implemented to determine progress over time, incorporating thresholds of plant condition and survivorship for which additional management action will be required.

It should be noted that DELWP has provided in principle support of the translocation plan (on 29 November 2018) prior to recipient site selection, provided that the Department's comments on the draft translocation plan are addressed to the Department's satisfaction.

Following the selection of recipient sites, and after the translocation plan has been updated with all of the required information to the satisfaction of the Department, formal approval of the translocation plan by DELWP would be provided in accordance with the relevant planning processes.

Despite its assumed presence within the project boundary at Trinity Grammar wetland B, River Swamp Wallaby-grass is not expected to be significantly impacted as the majority of suitable habitat falls within areas not being directly impacted by the project's surface works. Potential groundwater drawdown (0.1 to 0.5 metres) in the vicinity of the southern portal due to tunnelling activities under the Yarra River may reduce water available to wetlands reliant on groundwater to some degree, and subsequently have the potential to affect population viability.

A total of 37 species listed under the FFG Act-protected flora controls are present within the project boundary (Table 26 in Section 7.3.2). Loss of individuals of protected flora would reduce the abundance of these species within the project boundary. A permit to take (kill, injure, disturb or collect) flora species protected under the FFG Act is required from DELWP. Total losses of 'Protected' species should be quantified and all FFG Act permits must be obtained prior to commencement of construction (EPR FF5).

While a permit and offsets are required for removal of threatened or protected flora, it would not reduce the loss of these flora species. Where possible, impact to threatened and protected flora species should be avoided and minimised through minimisation of the construction footprint (EPR LP1) and maximising the retention of trees (EPR AR1). To avoid inadvertent impacts to threatened or protected species during construction, a CEMP and Tree Protection Plan would be developed that clearly identifies measures to guard against vegetation loss and, protected areas such as no-go zones and tree protection zones (EPR EMF2 and EPR AR2).

Threatened ecological communities are discussed in Section 7.3.3. No threatened EPBC Act or FFG Act-listed ecological communities were mapped within the impacted area of the project. Therefore, there would be no impacts to threatened ecological communities.

#### **Land clearing during construction impacting non-threatened flora and ecological communities (risk EC02)**

Vegetation mapped within the project boundary during the assessment includes 52.109 hectares of patches of native vegetation, 92 large trees within patches, and 170 Scattered Trees (115 small and 55 large). Within the project boundary, it is assumed that 100 per cent of vegetation would be removed.

The current design has avoided direct impacts to a significant area of non-threatened vegetation throughout the Banyule Flats and Warringal Parklands by tunnelling underneath this area. It is anticipated that with further refinement during the detailed design stage, the actual construction footprint of the project would be reduced, and as a result, further minimise removal of native vegetation and/or mature trees (> 30 centimetres DBH) (EPR AR1 and EPR LP1). Unavoidable vegetation losses would be mitigated through offsets in accordance with the Guidelines (DELWP 2017a). In addition, substantial areas disturbed during construction would be revegetated using locally indigenous species (utilising seed collected from species within the project boundary where possible), which are suited to the landscape profile and setting being revegetated.

An NVR report (dated 8 February 2019) summarising the project offset requirements has been prepared for the impact on native vegetation associated with the reference project (Appendix J). A summary of offset requirements as calculated by DELWP in the attached Native Vegetation Removal (NVR) report (Appendix J) is provided in Table 45.

Table 45 Offset requirements for the project boundary

Risk-based pathway	Minimum strategic biodiversity value score	Total no. of large trees	Offset requirements	
			Offset amount (biodiversity equivalence units)	Offset attributes
Detailed	0.155	179	8.025 general units 22.945 species units of habitat for Grey-headed Flying-fox <i>Pteropus poliocephalus</i> 24.980 species units of habitat for Australian Grayling <i>Prototroctes maraena</i> 9.490 species units of habitat for Yarra Pygmy Perch, <i>Nannoperca obscura</i> 17.269 species units of habitat for Small Golden Moths <i>Diuris basaltica</i> 18.821 species units of habitat for Melbourne Yellow-gum <i>Eucalyptus leucoxylon subsp. connata</i>	PPWCMA or Banyule City, Boroondara City, Manningham City, Nillumbik Shire and Whitehorse City

A draft ecological offsetting strategy is provided as Appendix L. Offsetting of native vegetation located on Commonwealth land would follow the State process.

It should be understood that a NVR report would need to be completed by DELWP to determine final offset requirements, based on the final design of the project. Offsets would need to be secured by the project prior to construction.

Prior to construction works starting, a Tree Protection Plan would be implemented to clearly identify trees to be retained and those to be removed. Identification and establishment of Tree Protection Zones<sup>14</sup> (TPZs) must be addressed so that retained trees are adequately protected from construction or related activities. Where TPZs would be encroached upon, it should clearly indicate where works can and cannot occur so that not more than 10 per cent of the TPZ would be impacted (EPR AR2). In addition, where Structural Root Zones<sup>15</sup> (SRZs) would be impacted trees would be regarded as a loss.

While the Australian Standards provide clear guidance regarding TPZs and SRZs, they are generally silent on the depth of protection required for subsurface works. While maximum rooting depths for River Red Gum are unknown, the available evidence suggests that roots can penetrate down to 10 metres (Davies, 1953) and potentially deeper. The Melbourne Metro Arboriculture Impact Assessment (AJM JV, 2016), produced for the Melbourne Metro Rail Authority, indicates the depth of tunnelling—3.1 metres at its shallowest point—is below the zone of anticipated growth. The assessment indicates that impact may occur through ground stabilisation practices associated with tunnelling such as grouting and soil mixing to limit the impact of ground setline and potential for major settlement.

<sup>14</sup> TPZ: A specified area above and below ground and at a given distance from the trunk set aside for the protection of a tree's roots and crown to provide for the viability and stability of a tree to be retained where it is potentially subject to damage by development.  $TPZ = DBH \times 12$ . A TPZ should not be less than two metres nor greater than 15 metres (except where crown protection is required) (AS4970-2009).

<sup>15</sup> SRZ: The area around the base of a tree required for the tree's stability in the ground. The woody root growth and soil cohesion in this area are necessary to hold the tree upright. The SRZ is nominally circular with the trunk at its centre and is expressed by its radius in metres. This zone considers a tree's structural stability only, not the root zone required for a tree's vigour and long-term viability, which will usually be a much larger area. The SRZ is determined following the formula provided in AS 4970-2009 (Council of Australian Standards, 2009) where:  $SRZ\ radius = (D \times 50)^{0.42} \times 0.64$ , where  $D$  = trunk diameter, in m, measured above the root buttress.

Given uncertainties around rooting depths of trees, it is difficult to present a precise discussion on the levels of protection required for individual trees. However, from an impact assessment perspective the following approach has been applied when considering whether a large tree is considered lost for offsetting purposes (EPR FF2):

- Any tree that has >10 per cent encroachment within the TPZ is considered lost
- Any tree that has any encroachment within the SRZ is considered lost
- Where tunnelling impacts only the sub-surface area, a minimum depth of two times the depth of the SRZ must be avoided for the tree to be considered not impacted.

Any trees that have:

- Greater than 10 per cent encroachment within the TPZ should be assessed by a qualified arborist to verify the acceptable level of encroachment
- Encroachment (tunnelling) at a depth greater than the depth of the SRZ but less than two times the depth of the SRZ should be assessed by a qualified arborist to verify the acceptable level of encroachment.

Impacts to individual trees are likely to vary based on the tree species, age, magnitude of settlement and/or volume of altered soil conditions in contact with the root zone of trees. Given this uncertainty, it is proposed that the documentation of tree losses and retention is completed following EPR AR1. Where trees are designated 'at risk', a Tree Protection Plan would be completed (EPR AR2).

During construction, impacts on remnant vegetation to be retained must be avoided to prevent loss of vegetation not earmarked for loss. Efforts should be made to minimise the footprint and surface disturbance of works during construction, and implementing a CEMP that articulates clearing controls and protection measures such as no-go zones and the Tree Protection Plan (EPR EMF2).

#### **Land clearing during construction resulting in the loss or degradation of habitat supporting threatened fauna (risk EC11) or non-threatened fauna (risk EC12)**

Construction of new roads and widening of existing roads would require land to be cleared of its vegetation and fauna habitat and would impact on waterway and wetland habitats (such as Koonung Creek and Banyule Creek). Where habitat was replaced by new road surface, loss would be permanent. Where habitat was lost to create space for the construction process (such as access, laydown, spoil storage, parking, offices) the loss would shorter-term (two to seven years). Outright loss of habitat may be at least partially offset in the long term by re-planting similar habitat in adjacent open space (such as along Koonung Creek in some areas).

Land clearing during construction of the project may also result in indirect loss or degradation of adjacent habitat that is not cleared, but which becomes exposed to new detrimental influences (edge effects). Depending on the severity of the effect, weed invasion, sedimentation and/or erosion, dust, noise, vibration and lighting, shading and surface water or groundwater changes can all contribute to habitat degradation, or even habitat loss.

Loss and degradation of habitat reduces foraging, nesting and dispersal opportunities for fauna in the local area, and confines fauna to the extent of suitable habitat that remains, often increasing con-specific and inter-specific competition. Loss of too much habitat, relative to the original contiguous habitat patch, can threaten the viability of some populations that currently rely on the extent of habitat present. Small proportional losses are less detrimental than large proportional losses. Animals that are unable to seek and obtain resources from alternative sources (closed population) are more disadvantaged by habitat loss than those that can freely move to and use other areas (open population).

Loss or degradation of habitat affects species differently. Some species (such as Red Wattlebird) are mobile and adaptable, and are able to use remaining habitats or even a degraded form of the same habitat. Others (such as Eastern Yellow Robin) are more sensitive to habitat extent and condition, and may decline or disappear as habitat patches get too small or too degraded. Most of the fauna that persist in the Melbourne area are adaptable fauna, already coping with a fragmented and degraded habitat landscape. This applies to common non-threatened fauna and rarer threatened fauna alike.

All habitats along the project corridor support non-threatened terrestrial fauna, and land clearing would impact on those species. Most of the non-threatened native fauna that persist in the Melbourne area (such as Red Wattlebird, Rainbow Lorikeet, Noisy Miner, Crested Pigeon, Common Brushtail Possum, Common Ringtail Possum) are mobile and/or adaptable, and are persisting within a fragmented and degraded habitat landscape. These species are able to use remaining habitats or even a degraded form of the same habitat.

Some of the habitats that would be affected may support threatened fauna also. Habitats along the corridor that support threatened terrestrial fauna are mainly confined to the Yarra River floodplain, including Bolin Bolin Billabong, Banyule Flats and Banyule Swamp. No land clearing would occur in these areas.

Other locations that may be used or visited by threatened terrestrial fauna occasionally include Simpson Barracks (for example, Swift Parrot and Powerful Owl may visit occasionally), Koonung Creek (crakes and rails are likely to visit, and Powerful Owl may forage there occasionally), Macleod railway station (up to 40 Swift Parrots foraged in nearby trees in 2015) and the Yarra River where it is crossed by the Eastern Freeway (which is near to a Grey-headed Flying-fox colony/camp). Habitat loss at these locations is expected to have no more than a minor impact on threatened terrestrial fauna. None of these locations (that is, the specific locations from which habitat would be lost) provides habitat that is critical to the survival or success of a threatened terrestrial fauna species.

At the Yarra River crossing (Eastern Freeway), habitat lost would comprise occasional foraging habitat rather than roosting or breeding habitat for the Grey-headed Flying-fox, and extend no more than 10 metres south of the existing freeway bridges (towards the existing flying-fox camp). As of November 2017, the nearest roosting flying-foxes were approximately 400 metres (straight line distance) downstream from the bridge (700 metres if following meanders of the Yarra River) so impacts of habitat loss at the location would be negligible for the Grey-headed Flying-fox.

The eucalypt trees at and surrounding the Macleod railway station were visited for foraging by up to 40 Swift Parrots for an extended period in 2015 and are therefore considered of high value for Swift Parrots. Most of the trees that the Swift Parrots used lie outside the project boundary, but some trees within the project boundary do or may form part of the habitat patch. Every effort would be made to avoid all impacts on the trees within the project boundary at this location, by confining works to the base of the rail trench, or designing works around these trees. Minor impacts (such as pruning) may be necessary to allow safe access to signal boxes, but the impact is considered unlikely to discourage Swift Parrots from foraging in those trees in future.

No forested habitat planned or at risk of being lost as a result of the project is known breeding habitat for owls or other threatened fauna. Loss of forested habitat from areas other than the Yarra River near Yarra Bend (Simpson Barracks and along Koonung Creek) may result in permanent localised loss of habitat that is used occasionally by owls for foraging. Loss of trees across the suburban area may result in minor and localised loss of occasional foraging habitat for Swift Parrot and Grey-headed Flying-fox. Loss of small areas of habitat that is used occasionally by threatened species, but that is well represented in the surrounding area, would have a minor impact on those species.

Other threatened species that may occasionally use or visit degraded habitats within the study area (such as the Baillon's Crake *Porzana pusilla*, Eastern Great Egret *Ardea modesta* [=alba] or Hardhead *Aythya australis* along Koonung Creek) are not expected to be detrimentally affected by changes to those habitats from the project. Those species tend to be fairly widespread and mobile, and are already making regular or occasional use of degraded habitats within a large urbanised area.

As for loss of vegetation, loss of some fauna habitat is unavoidable. By adhering to the project EPRs, this clearing would be avoided as far as possible through design, and minimised within each site during construction. EPRs would ensure that numerous Environmental Management Plans are prepared and implemented for the project [including a Construction Environmental Management Plan (CEMP) (EPR EMF2), Worksite Environmental Management Plans (WEMPs) and an Operations Environmental Management Plan (OEMP)] in consultation with relevant councils, VicRoads, Melbourne Water, EPA Victoria and other authorities as required by NELP or under any statutory approvals.

Adoption of EPR AR1 (Tree retention and arboriculture assessment) would see that maximum possible tree retention is achieved on both public and private land. This would increase the likelihood of retaining all valuable habitat linkages and wildlife corridors, and minimise the removal of trees and vegetation that provide fauna habitat.

Adoption of EPR AR2 (Tree Protection Plan) would see that trees (fauna habitat) to be retained as part of the works are identified and protected, and where appropriate and practical, options are identified for temporary re-location of significant trees and reinstatement at their former location or another suitable location.

Adherence to EPR LP1 (Minimise design footprint) would see the project is designed and constructed to avoid and minimise temporary and permanent impacts on ecological values, including parks and reserves, and significant landscapes around the Yarra River.

Adoption of EPR FF2 (Native vegetation removal and offsets) would see the project avoid as far as practicable the removal of native vegetation and fauna habitat and impacts on habitat connectivity. The CEMP would include requirements for protection of native vegetation and listed species, including establishment of no-go-zones to protect vegetation and fauna habitat to be retained.

Where the removal of native vegetation (fauna habitat) is unavoidable, the project would meet the assessment and offset requirements of the *Guidelines for the removal destruction and lopping of native vegetation* (DELWP, 2017a).

Most habitat loss that is likely to, or that may, occur as a result of this project, is small and localised, and for fauna is expected to result in the loss or displacement of individuals rather than populations or species.

Habitat degradation (direct or indirect) resulting from nearby land clearing can generally be mitigated, managed and reversed through management actions. Habitat degradation that results from edge effects (where some fauna prefer not to occupy the exposed habitat edge and move deeper into the habitat that remains) is more difficult to mitigate and manage, but is considered unlikely to have anything more than a negligible impact on threatened fauna in the project boundary, given the fragmented nature of habitats within the urbanised area those species visit/use already.

Habitat loss across the corridor is expected to have a minor impact on threatened and non-threatened terrestrial fauna.

### Construction activities resulting in the loss of important habitat for EPBC Act Migratory species (risk EC13)

The potential impact of loss of important habitat for an EPBC Migratory species is assessed here using the criteria outlined for Migratory species in the Impact Significance Guidelines 1.1 under the Commonwealth EPBC Act. The Migratory status of a species is a Commonwealth and international matter rather than a state (Victoria) matter.

The consequence and severity of losing important habitat for a Migratory species would be major, because it could jeopardize the success or recovery of a species internationally. And, unless comparable habitat were replaced nearby, the duration would be long-term, because the habitat would be lost permanently. However, these impacts are not expected to occur during construction, because important habitat is not expected to be lost as a result of construction of this project.

Twenty-six bird species known or predicted to occur within the project boundary are listed as Migratory under the EPBC Act (Appendix D). Some of these may use or visit habitats within the project boundary occasionally (such as White-throated Needletail, Rufous Fantail), but most are seabirds or coastal shorebirds and are unlikely to use the project boundary in large numbers or frequently. One species (Latham's Snipe, *Gallinago hardwickii*) may use parts of the study area regularly enough, and in sufficient numbers, that the study area could constitute 'important habitat' for that species. Latham's Snipe in the study area is described in Section 8.3.3.

Many of the Latham's Snipe records in the area are from the Yarra River floodplain, but only the Banyule Swamp and Banyule Flats area has sufficient historical records to be considered important habitat. There is no indication that any other site along the corridor supports or attracts an ecologically significant proportion of the Latham's Snipe (or other Migratory species) population, or would be considered important habitat.

The Yarra River floodplain area would be avoided by tunnelling, so direct impacts on important habitat would be avoided during construction. Long-term changes to groundwater flow as a result of the construction or presence of the tunnels are considered highly unlikely to lead to changes in migratory species habitat, and this is discussed in Section 12.1.6 and Section 12.2.2.

Direct and indirect impacts on Migratory species and their terrestrial and wetland habitats during construction would be managed and minimised through numerous EPRs (particularly EPR EMF2). Adoption of EPR FF2 (Native vegetation removal and offsets) would see the project minimise the removal of native vegetation and fauna habitat. EPR FF4 (Aquatic habitat protection) would see short- and long-term impacts on riparian, riverbed and aquatic habitat minimised through detailed design and construction, to the extent practicable.

Groundwater and ground movement EPRs would reduce the risk of aquatic habitat degradation or loss. EPR GM1 (Geotechnical model and assessment) and EPR GW1 (Groundwater model) would see that a predictive and numerical groundwater model is used to predict changes in groundwater levels, flow and quality, and develop mitigation strategies. Through EPR GW2 (Groundwater monitoring) a pre-construction, construction and post-construction groundwater monitoring program would be developed and implemented to calibrate the predictive model prior to construction starting, to manage construction activities, to verify the model predictions post-construction, and to monitor during operation.

EPR GW3 (Tunnel drainage design and construction methods) would see that the tunnel drainage design is long-term and construction methods result in minimal changes to groundwater levels during construction and operation, and minimise potential impacts on waterways and groundwater dependent ecosystems, including terrestrial ecosystems. EPR GW3 would also introduce contingency measures and/or controls to maintain base flows to prevent a reduction or loss of groundwater discharge or loss of water availability for terrestrial ecosystems.

Adherence to EPR LP1 (Minimise design footprint) would see the project is designed and constructed to avoid and minimise temporary and permanent impacts on ecological values, including parks and reserves, and significant landscapes around the Yarra River.

Surface water EPRs would serve to manage water volumes and quality. EPR SW1 requires the monitoring and management of discharge and run-off from the project, and through EPR SW5, a management plan would be developed that sets out the Surface Water Management requirements and methods for best practice sediment and erosion control and monitoring, in accordance with EPA Victoria requirements.

With EPR SW8 (Waterway modifications), modifications to all waterways would be designed and undertaken in a way that mitigates the effects of changes to flow, and minimises the potential for erosion, sediment plumes and exposure of contaminated material during construction.

#### **Land clearing during construction resulting in reduced viability of non-threatened native fauna populations (risk EC17)**

Project construction would result in the direct loss of vegetation (habitat) that supports non-threatened terrestrial fauna. Loss of too much habitat, relative to the original contiguous habitat patch, can threaten the viability of some populations that currently rely on the extent of habitat present. For the most part, habitat loss for this project would be localised and mostly comprised of small discrete patches, and unlikely to jeopardise the viability of fauna populations that use those habitats. Mobile fauna that use those patches are likely to use adjacent patches also. One species in one location warrants more detailed discussion: Eastern Grey Kangaroos in Simpson Barracks.

The Simpson Barracks contains a relatively large area of remnant eucalypt woodland in an otherwise urbanised part of Melbourne. This habitat is not accessible to the public and only used occasionally for Defence activities. It is, therefore, in relatively good condition and likely to support or attract fauna that is far less common in surrounding suburbs. Simpson Barracks supports a healthy population of the Eastern Grey Kangaroo. As a defence facility, the site is fenced all around, and the fence for the most part is substantial enough to be kangaroo proof. This effectively makes the kangaroo population at the barracks a closed population, where space and resources are critical to the population's viability. Other fauna that use the barracks (such as possums, birds) are not as constrained as the kangaroos in this way, because they are able to move more freely into and out of the barracks.

The kangaroo population at Simpson Barracks has been assessed numerous times in recent years (Defence 2007 [as cited in Aecom, 2011]; Aecom, 2011; Wilson, 2014; Aecom, 2015). Aecom (2015) reported that approximately 52 hectares of the barracks is grassy woodland vegetation that provides suitable habitat for kangaroos. In addition to the woodland areas, the barracks contains numerous areas around buildings where the grass is mowed, two large grassed sports fields and one large grassed parade ground (Long Green) that is watered during the summer (Wilson, 2014).

The project would permanently remove eight hectares of woodland habitat from Simpson Barracks. If this equates to loss of eight of the 52 hectares, this would increase the kangaroo density estimates by 15.4 per cent. Grazing habitat would be lost as a result of the project, but given the presence of well-watered grassy areas, the habitat lost may not be the habitat that sustains the population within the barracks. Wilson (2014) reported that 80 per cent of kangaroo observations were on the Long Green.

The carrying capacity for EGK at the site is unknown, and whether or not the site is truly 'closed' to EGK migration is uncertain (AECOM, 2015). However, with its reliable water sources and copious and well-watered lawns, the carrying capacity of Simpson Barracks for EGK is likely to be much higher than the current population size. Further, the density of EGK at Simpson Barracks is likely to be far lower than density estimates for other kangaroo populations (for example, of five counts of Eastern Grey Kangaroos in the ACT from 1995 to 1997, the lowest density reported was 2.33 kangaroos per hectare (reported as 233/km<sup>2</sup>; for Tidbinbilla Nature Reserve, ACT; ACT Parks & Conservation Service (1997)). Thus, the proposed habitat loss would be highly unlikely to jeopardise the viability of the current Eastern Grey Kangaroo population in Simpson Barracks.

Density estimates for the barracks assume that the barracks provide the only habitat available to the kangaroo population, and that the population is a closed population. However, there are anecdotal reports of kangaroos being killed by vehicles on nearby roads occasionally. These may be kangaroos from surrounding suburban areas, or they may be kangaroos that get through the fence occasionally, which would suggest that the population is not entirely closed. If it occurs, the most likely direction for immigration and emigration of kangaroos would be to the east, as there is a seemingly safe route that offers continuous suitable habitat and few road crossings between the barracks and the Plenty River at Yallambie.

Implementation of EPRs would ensure that fauna are managed adequately through numerous Environmental Management Plans [including a Construction Environmental Management Plan (CEMP)(EPR EMF2), Worksite Environmental Management Plans (WEMPs) and an Operations Environmental Management Plan (OEMP)]. EPR FF1 (Fauna management measures) would enable appropriate management of fauna that may be displaced due to habitat removal in compliance with the *Wildlife Act 1975 Vic*. Adoption of EPR FF2 (Native vegetation removal and offsets) would see the project avoid as far as practicable the removal of native vegetation and fauna habitat and impacts on habitat connectivity. Adherence to EPR LP1 (Minimise design footprint) would see the project is designed and constructed to avoid and minimise temporary and permanent impacts on ecological values.

#### 12.1.2 Degradation of vegetation and terrestrial habitat through erosion, sedimentation, dust, contamination or soil compaction

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC07, Risk EC08,	Low
Risk EC03, Risk EC04, Risk EC15	Low

#### **Construction activities resulting in erosion/sedimentation, dust, litter or release of contaminants leading to loss or degradation of non-threatened flora and ecological communities (risk EC03)**

Erosion, sedimentation and contamination represent three key risk factors in potential negative impacts to non-threatened native vegetation and habitat. If construction activities, such as access road upgrades and excavation, are not properly managed, this can lead to the mobilisation of sediments and/or contaminants which can have detrimental impacts to the non-threatened native vegetation within the project boundary. To minimise this risk, a CEMP would be prepared to ensure best-practice erosion protection, sedimentation and discharge controls, and management of chemicals, fuels and hazardous materials are in place to reduce the risk of negative impacts on non-threatened vegetation to negligible (EPR EMF2 and EPR CL5).

Prior to construction, discharges, runoff pathways and stockpiles would be designed in a way to reduce the risk of contaminated flows, sediment, and discharges entering local waterways and surrounding areas of non-native vegetation (EPR SW1). In the case of an accidental spill, a best-practice spill contamination procedure would be detailed in the CEMP and spill kits would be present on all construction sites (EPR EMF2). The combination of these protective measures would also combine to protect any aquatic habitat and communities within the vicinity of the construction activities or downstream of these activities (EPR FF4).

Some project activities have the potential to increase dust levels. These activities include the removal, handling and transport of soil and rock, dumping, crushing and processing of material, and increased traffic along existing, newly constructed roads and access tracks, mainly during the project's construction. Dust, depending on its physical and chemical attributes and severity of occurrence, can have a variety of negative effects on vegetation.

Effects that may occur include higher levels of plant stress (Shah *et al.*, 2017; Liang *et al.*, 2016) such as decreased photosynthesis rates, transpiration and respiration capacities, in turn leading to reduced growth and productivity (Shah *et al.*, 2017).

In cases where dust comprises specific chemical compositions (that is, highly alkaline cement production dust, or other calcareous dusts) it can induce changes in soil chemistry and microbial decomposition (Müllerová, *et al.*, 2011). This can potentially lead to impacts ranging from an alteration of the vegetation habitat structure (Paal *et al.*, 2012) to general species effects, including chlorosis, diminished leaf thickness, cellular collapse, obstructed stomata and senescence (Siqueira-Silva *et al.*, 2016).

Particularly native and amenity vegetation, and habitats, both terrestrial and aquatic, occurring adjacent to, or in close proximity to roads and access tracks, could be detrimentally impacted by dust that is generated by project activities.

For fauna, dust that results in substantial changes to vegetation may cause the loss or degradation of habitat.

As such dust control measures need to be put in place, in accordance with the Dust Management Plan. When implementing measures the following implications need to be considered:

- Inadequate dust suppression measures may result in a wider geographical spread of dust contamination
- Excessive dust suppression may result in excess runoff of sediment and/or contaminants.

Additionally, certain construction activities that lead to the generation of high dust levels may need to be avoided during very windy conditions and/or appropriate dust suppression techniques employed.

Measures to control dust would be specified in the Construction Environmental Management Plan (CEMP) (EPR EMF2). Implementation of the EPR CL1 (Spoil Management Plan) would reduce the likelihood of dust being generated to the point that it impacts on ecological values.

EPR SCC4 (Waste management) would enable management measures for waste minimisation during construction and operation in accordance with the *Environment Protection Act 1970* (Vic). Waste excludes soils, but includes litter management, construction and demolition wastes, washing residues, slurries and contaminated water, organic wastes and inert solid wastes.

#### **Construction activities resulting in erosion/sedimentation, dust, litter or release of contaminants leading to loss or degradation of threatened flora and ecological communities (risk EC04)**

Threatened flora species recorded during the current assessment, or assumed to be present, within the project boundary include Matted Flax-lily, River Swamp Wallaby Grass, Arching Flax-lily and Studley Park Gum. Nine other species that have historically been recorded within five kilometres of the project boundary and/or have a moderate or greater likelihood of occurrence are listed in Section 7.3.2. No threatened ecological communities were observed within the project boundary. Erosion, sedimentation and contamination represent three risk factors in potential negative impacts to these threatened flora species and their habitat.

If construction activities, such as access road upgrades and excavation, are not properly managed, this can lead to the mobilisation of sediments and/or contaminants which can have detrimental impacts to the threatened native vegetation within the project boundary. To minimise this risk, a CEMP would be prepared so that best-practice erosion protection, sedimentation and discharge controls, and management of chemicals, fuels and hazardous materials are in place to reduce the risk of negative impacts on threatened vegetation to negligible (EPR EMF2 and EPR CL5). The CEMP would also identify locations of threatened species that have not been managed in another fashion, such as translocation, so these species are clearly marked and no inadvertent removal occurs (EPR EMF2 and EPR AR2).

Prior to construction, discharges, runoff pathways and stockpiles would be designed in a way to reduce the risk of contaminated flows, sediment, and discharges entering local waterways and surrounding areas of non-native vegetation (EPR SW1). In the case of an accidental spill, a best-practice spill contamination procedure would be detailed in the CEMP and spill kits would be present on all construction sites (EPR EMF2). The combination of these protective measures would also combine to protect any aquatic habitat and threatened communities within the vicinity of the construction activities or downstream of these activities (EPR FF4).

EPR SCC4 (Waste management) would enable management measures for waste minimisation during construction and operation in accordance with the Environment Protection Act. Waste excludes soils, but includes litter management, construction and demolition wastes, washing residues, slurries and contaminated water, organic wastes and inert solid wastes.

#### **Construction activity causes soil compaction that leads to the loss or degradation of threatened flora and ecological communities (risk EC07) or non-threatened flora and ecological communities (risk EC08)**

Where construction activity occurs, movement of heavy vehicles, plant and equipment would likely compact soil. Uncontrolled, this would have a significant impact on adjacent threatened and non-threatened flora species and communities to be retained. However, during construction, a CEMP would designate clear access pathways for all heavy traffic as well as sensitive environmental areas (EPR EMF2). Heavy traffic would be required to stay within these designated access areas to reduce the risk of soil compaction in sensitive environmental areas to a negligible level.

Before construction started, planning of appropriate stockpiling and spoil storage sites would also be completed to avoid movement of heavy traffic and storage of construction materials and waste in sensitive environmental areas (EPR EMF2 and EPR CL1). No threatened ecological communities exist within the project boundary or project boundary. Threatened flora species that are likely to be impacted would be protected from soil compaction via translocation (such as Matted Flax-lily), a Tree Protection Plan (for Studley Park Gum) or would be offset in the case of unavoidable loss (EPR AR2 and EPR FF2).

### **Construction activities resulting in erosion/sedimentation, litter or release of contaminants into wetlands and waterways leading to degradation of terrestrial fauna habitat (risk EC15)**

Construction activities involving excavation, transport and stockpiling of soils, create environments that are prone to mobilising contaminants, especially during rainfall events where runoff can transport contaminants. Construction activities without appropriate mitigation preventing transport into waterways can cause risk of water pollution from suspended sediments and chemical contaminants bound within the sediments (eg toxicants and nutrients). The operation of machinery and use of various construction materials also introduces risk that fuels or other chemicals on site may accidentally spill or be inundated during flooding, potentially entering the waterways. Disturbed soils are especially prone to erosion, due to the lack of vegetation or protective ground covering. Eroded soils that enter drainage network alter the quantity and type of sediment entering waterways, which can change physical habitat and alter geomorphological processes. Similarly, litter from construction and associated activities is also susceptible to being transported into the drainage. The risks of erosion/sedimentation, and contaminants on water quality in waterways is addressed in Technical Report P – Surface Water, which considers waterway physical form and surface water quality in accordance with SEPP (Waters) Vic (2018). The risk of existing contamination is addressed in Technical Report O – Contamination, which considers the identification and management of environmental contaminants.

Wetlands and waterways in the project boundary are, or may be, used by a range of threatened and non-threatened terrestrial fauna, including ducks, egrets, cranes and rails, and possibly bitterns. Construction of the project may result in unplanned sedimentation and/or erosion that contribute to degradation of wetland habitats.

Wetland and waterway habitats in the project boundary already receive stormwater from urbanised catchments, so tend to be degraded to some degree already.

Direct and indirect impacts during construction would be managed and minimised through numerous EPRs. Adoption of EPR FF4 (Aquatic habitat protection) would see short- and long-term impacts on riparian, riverbed and aquatic habitat minimised through detailed design and construction, to the extent practicable.

Adherence to EPR LP1 (Minimise design footprint) would see the project is designed and constructed to avoid and minimise temporary and permanent impacts on ecological values, including parks and reserves, and significant landscapes around the Yarra River. Riparian vegetation provides some protection of waterways and wetlands through the prevention of pollutants entering the waterways through overland runoff. Degradation or removal of riparian vegetation may lead to increased pollution of waterways. Minimising design footprint would limit any impacts to riparian vegetation, which helps prevent pollution entering waterways.

Surface water EPRs would serve to manage water quality. EPR SW1 (Design of discharges and runoff) would enable management of discharge and run-off from the project to meet legislated standards for environmental protection, and through EPR SW5 (Surface water management, construction), a management plan would be developed that sets out the Surface Water Management requirements and methods for best practice erosion protection, sediment and erosion control and monitoring, in accordance with EPA Victoria requirements. EPR SW4 (Water quality monitoring) would see a baseline surface water monitoring program developed and implemented before construction started to assess background water quality in all receiving waters. The monitoring and management of surface water quality and flow should include consideration of changed risks due to changes in rainfall and riverflow during wet periods with greater rainfall runoff. With EPR SW8 (Waterway modifications), modifications to all waterways would be designed and undertaken in a way that mitigates the effects of changes to flow, and minimises the potential for erosion, sediment plumes and exposure of contaminated material during construction. With EPR SW9 (Bank stability) appropriate measures would be developed and implemented to maintain bank stability of waterways to the satisfaction of Melbourne Water and in consultation with relevant local councils.

EPR SCC4 (Waste management) would enable management measures for waste minimisation during construction and operation in accordance with the Environment Protection Act. Waste excludes soils, but includes litter management, construction and demolition wastes, washing residues, slurries and contaminated water, organic wastes and inert solid wastes.

EPR CL5 (Management of chemicals, fuels and hazardous materials) would enable minimisation of chemical and fuel storage on site and storage of hazardous materials and dangerous goods in accordance with the relevant guidelines and requirements. This would include development and implementation of management measures for dangerous substances, including appropriate disposing of hazardous materials, installation of bunds and precautions to reduce the risk of spills, and developing contingency and emergency response plans to handle fuel and chemical spills.

Through full implementation of mitigation actions (EPR EMF2), small and localised incidents of erosion, sedimentation or contamination during construction may still occur due to unexpected events (such as particularly heavy rain). However, the likelihood of those localised incidents causing further ecological degradation of wetland habitats is considered very low.

### 12.1.3 Degradation of aquatic habitat through sedimentation or contamination

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC16	Low

#### **Construction activities resulting in erosion/sedimentation, litter or release of contaminants into wetlands and waterways leading to degradation of aquatic fauna habitat (risk EC16)**

Construction activities introduce risks of sediment, chemical and litter pollution to waterways and wetlands that can degrade aquatic habitat. See EC15 for background information (Section 12.1.2).

Aquatic habitats are directly connected to the stormwater network and runoff drainage, which places habitat for aquatic fauna in the direct path of sediments and contaminants that are mobilised and enter the drainage network. Aquatic habitats are the sink for most mobilised contamination, which is generally only removed by transport further downstream to another aquatic habitat. The impacts of pollutant runoff on the aquatic fauna can be significant, with both water and sediment contamination potentially causing toxicity, physical stress and behavioural effects on aquatic fauna. The impacts on aquatic fauna habitat can have greater severity than semi-aquatic or terrestrial fauna, as these species are restricted in capacity to relocate to more suitable habitat in the event of degradation from runoff from construction activities. Through appropriate construction environmental management and monitoring of waterways, the likelihood and extent of such an event is reduced.

The most important method for preventing aquatic habitat degradation is through design of the project to minimise the impacts from connections to the drainage network (EPR SW1 Design of discharges and runoff) and to manage construction to avoid impacts on aquatic habitat (EPR FF4 Aquatic Habitat protection). The use of tunnels under the Yarra River is a good example of this approach, which avoids the need to undertake works in the waterway that could cause direct impacts to the aquatic habitat. In other waterways, the avoidance of works within or adjacent to waterways is also important to minimise the risk of indirect impacts.

Due to the high degree of urbanisation of the catchments, waterways and wetlands in the project boundary support aquatic fauna that have some tolerance to degraded, polluted and contaminated aquatic habitats. Effective controls of site and monitoring of aquatic environmental conditions, particularly during high risk period (such as rainfall events) are critical to minimise impacts to aquatic habitat quality.

EPRs relevant to EC15 (refer Section 12.1.2) are also relevant for managing this impact.

#### 12.1.4 Degradation of aquatic habitat through waterway modification or construction activities in and around waterways

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC18, Risk EC20, Risk EC23	Low

#### **Waterway modification (such as channelisation, piping, bank stabilisation) resulting in loss or degradation of habitat for non-threatened native aquatic fauna (risk EC18)**

For the Eastern Freeway upgrade, a number of sections of Koonung Creek would be enclosed and covered (five sections totalling approximately one kilometre, with covered sections ranging from 100 to 500 metres) (Figure 22). In addition, three sections of the creek (totalling 600 metres in length) would be diverted to a constructed naturalised channel.

Within the M80 Ring Road to Lower Plenty Road section, the upper reaches of Banyule Creek (approximately 850 metres of channel extending within Simpson Barracks and extending down to Lower Plenty Road) would be replaced by two pipes (Figure 23).

Converting sections of a waterway to an enclosed pipe would directly remove structural habitat for aquatic fauna.

No threatened aquatic species inhabit the waterways that would be directly impacted and so no impact to threatened species is likely. The aquatic habitat that would be directly impacted by waterway modification supports non-threatened aquatic fauna that are adapted to a highly modified urban environment.

The headwaters of Banyule Creek are ephemeral and support aquatic ecosystems able to tolerate drying phase or colonise during wetted periods. The loss of natural waterway in this reach of Banyule Creek has a very low risk of impacting the viability of aquatic fauna populations outside the area of direct waterway modification.

The enclosure and covering of sections of Koonung Creek would severely degrade the aquatic habitat in these affected sections, although the condition of the aquatic habitat in this waterway and associated ecological values are already compromised through historical waterway modifications and existing urban stormwater pressures. The effect of waterway modification is considered to be localised, with loss or degradation of habitat likely to be restricted to the immediate area of waterway modification and associated works. Changes to light from shading or proportion of open to shaded areas is known to affect fish behaviour (Jackson, 1996; Jones *et al.*, 2017). Impacts to these sections of the waterway would change their environmental condition which may have impacts downstream from the points of direct impact. The aquatic ecosystem in this waterway is typical of a highly impacted urban stream, containing only tolerant native and invasive exotic species. Downstream impacts on environmental conditions from the covered sections is expected to be similar to existing variability in stream conditions. Koonung Creek already contains a significant enclosed and covered section. The aquatic fauna recorded from Koonung Creek are expected to be tolerant to the changed conditions resulting from the channel modification.

The proposed diversion of the creek to naturalised channel is expected to provide some aquatic habitat (EPR SW8). This is expected to enhance the habitat available for the fauna in Koonung Creek, though the time for naturalisation and colonisation by aquatic fauna may be years.

The management of surface water runoff and bank stability during construction is essential to protect environmental conditions in waterways (EPR SW5, EPR SW9 and EPR EMF2). The implementation of water quality monitoring program would provide some guidance on the effectiveness of stream rehabilitation and identify any environmental degradation that could require remediation (EPR SW4).

#### **Construction activities within/around waterways resulting in loss or degradation of habitat for threatened aquatic and terrestrial fauna (risk EC20)**

Threatened aquatic species are likely to be present in the Yarra River but not in the smaller tributaries in the project boundary. The design of the road tunnels to avoid this major waterway is central to the prevention of impacts to aquatic threatened species through avoidance and minimisation of works in waterways (EPR FF4).

As pollutants and other risks to the aquatic habitats can be transported through the drainage network to waterways, the management of construction activities across the project boundary (overseen by EPR EMF2) should include processes that prevent erosion (EPR SW9), pollutants and sediments (EPR CL5 and EPR SW5). A surface water monitoring program would be required to confirm the effectiveness of waterway protection measures according to SEPP (Waters) objectives and to inform if remediation is required (EPR SW1 and EPR SW4). The monitoring and management of surface water quality and flow should include consideration of changed risks due to changes in rainfall and riverflow during wet periods with greater rainfall runoff.

Existing wetlands within the project boundary and identified as possible locations for WSUD features (such as the southern-most pond in the Freeway Public Golf course) may attract threatened terrestrial fauna, such as Baillon's Crake, which is listed as threatened under the FFG Act and vulnerable under the DELWP advisory list. Construction in those wetlands would impact on those species if they are using the habitat at the time. The resulting impact is expected to be minor, for the following reasons. The wetland changes as a result of WSUD would be temporary, given that the purpose of WSUD is to create wetlands that function hydrologically and ecologically. Those wetlands are relatively small and in an area (the Yarra River floodplain) that supports numerous similar ponds/wetlands. Therefore, mobile wetland species would likely adapt to the temporary loss of small areas of habitat. Habitat values at existing wetlands that are within the project boundary and proposed for WSUD features would be protected as far as practicable (EPR FF9).

**Construction activities within/around waterways resulting in loss or degradation of habitat for non-threatened native aquatic and terrestrial fauna (risk EC23)**

The project would result in the direct loss of aquatic fauna habitat at two locations – Koonung Creek and Banyule Creek. In addition, there is potential for degradation of habitat due to increased sedimentation (risk EC15), groundwater drawdown (risk EC24), and downstream water quality impacts during construction (risk EC16).

The aquatic habitat that would be directly impacted supports non-threatened aquatic fauna that are adapted to a highly modified urban environment. Impacts to these waterways could change their environmental condition which may have impacts downstream from the points of direct impact. To minimise impacts due to erosion, sedimentation or contamination during construction the project would follow the construction EPRs outlined in risk EC20. These mitigation measures would minimise further ecological degradation of these already impacted aquatic habitats and residual risk is therefore considered low.

One existing wetland that is within the project boundary and identified as a possible location for WSUD features (Simpson's Lake in Kew golf course) is known to support a small nesting colony of non-threatened waterbirds, including Australian White Ibis, Little Pied Cormorant, Little Black Cormorant, and Australasian Darter. These birds nest in the dead and alive trees (native and non-native flora species) that line the edge of the lake, particularly on the western, southern and eastern sides. Construction in that wetland would degrade the habitat for those species if the trees are removed. Through EPR FF9 (Protect fauna habitat values in existing waterbodies that are modified for WSUD), habitat values at this and other existing wetlands would be protected as far as practicable.

**12.1.5 Introduction or spread of weeds, pest species or pathogens leading to the reduction of ecological values**

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC05	Low

## Construction activity leading to the introduction or spread of weeds, pest species, or pathogens that leads to the reduction of ecological values (risk EC05)

### Weeds

Construction may spread weeds listed under the *Catchment and Land Protection Act 1994 (Vic)* ('CALP Act') or Weeds of National Significance (WoNS), resulting in the decline in quality of native vegetation within the project boundary and adjacent areas. The seeds of weed species and other pathogens can become lodged in plant and equipment (particularly in the mud of tyre treads) when driven through infested areas. The seeds and/or pathogens may then be carried some distance before being unintentionally deposited in areas free from previous infestations of the species or pathogens. Conversely, plant and/or equipment moving from the project boundary could result in off-site infestations of those species present within the project boundary.

CaLP Act-listed weed species identified within the project boundary are listed in Table 30 in Section 7.3.5 along with their status within the Port Phillip and Westernport Catchment Management Authority (PPWCMA) area. Management requirements for declared noxious weed species are outlined in Table 6 in Section 4.3.7 (EPR FF3). These would be incorporated into the CEMP during construction activities (EPR EMF2). Additionally, a Spoil Management Plan would be developed in conjunction with the CEMP to ensure that potentially contaminated construction spoil is managed in such a way to reduce the risk of spreading weeds and pathogens to other sites (EPR CL1).

### Cinnamon Fungus

Cinnamon Fungus (*Phytophthora cinnamomi*) is a microscopic, soil-borne pathogen that attacks and destroys plant root systems causing plants to die through lack of water and nutrients. Despite the common name, *Phytophthora cinnamomi* is not a true fungus, but actually a soil-borne water mould, more closely related to brown algae. The disease is also known as die back, root rot, PC or Phytophthora.

It is listed in the top 100 of the world's most invasive species and is Victoria's most significant plant pathogen affecting both native ecosystems and the horticultural industry. There is no known cure. The presence of Cinnamon Fungus threatens not only vegetation communities – it can alter the ecology of entire ecosystems.

Heathlands, coastal woodlands and dry eucalypt forests are most at risk. Patches of dead or dying vegetation can indicate the presence of infected vegetation, and infected plants appear drought affected and develop signs of 'dieback'. Within Victoria, the pathogen has had serious impacts in the Brisbane Ranges, Grampians, Great Otway, Lower Glenelg, Point Nepean, Kinglake, Croajingalong and Wilsons Promontory National Parks, in addition to Lerderderg State Park, Lake Tyers, Anglesea Heathlands and the coastal forests of east and south Gippsland.

While the pathogen can spread locally through soil or water via tiny swimming spores, it is more commonly spread through the movement of contaminated soil and gravel carried by vehicle or foot traffic. It can also be spread through infected plant material and potting mix. Without proper soil testing, this microscopic pathogen is difficult to detect. It is more actively spread in moist soils during warm weather and can survive drought. It can be present even if vegetation appears healthy as not all plants are susceptible.

Management measures to reduce the risk of spreading Cinnamon Fungus would be employed by the implementation of a CEMP which would detail and raise awareness of, and compliance with, pathogen management (EPR EMF2 and FF3) and a Spoil Management Plan (EPR CL1) to regulate the movement of spoil and so reduce the risk of infected soil leaving or entering the site.

### **Pest fauna species**

Some non-native terrestrial and aquatic fauna species in the study area are considered pest species, and are likely to be having a detrimental impact on the natural ecology of the Melbourne area. Given the study area is already highly urbanised, the project is considered unlikely to exacerbate the impact of any pest animal or fish species.

Management measures to reduce the risk of exacerbating the impact of terrestrial pest animals would be employed by the implementation of a CEMP (EPR EMF2) and Waste Management (EPR SCC4) to enable management measures for waste (including litter, which may attract pest animals) minimisation during construction and operation in accordance with the Environment Protection Act.

### **Amphibian Chytrid Fungus**

One known pathogen that affects fauna is the Amphibian Chytrid Fungus, which causes the disease chytridiomycosis, which can result in high mortality of frogs. Worldwide, the impact of this fungus has been catastrophic – in numerous locations (including Australia), many species have become extinct or endangered as a result of its inadvertent introduction (such as Schloegel *et al.*, 2006; Skerratt *et al.*, 2007) and it is likely the decline of the Growling Grass Frog across its range is linked to introduction of the fungus into new areas.

*Chytridiomycosis due to the amphibian chytrid fungus* was included on the List of Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)* ('EPBC Act') on 23 July 2002.

The fungus appears to have been spread worldwide by various means from Africa (Weldon *et al.*, 2004). It is highly infectious and can be spread via zoospores on frogs and tadpoles, and potentially in water, on wet equipment and within moist soils (such as on boots, tyres vehicles, equipment) (Murray *et al.*, 2011). There is evidence that different strains of the fungus vary in their impact; some strains are more lethal to frogs than others (Berger *et al.*, 2005).

The typical response pattern of chytrid introduction into a previously uninfected area is for there to be a rapid mass die-off of frogs (epidemic chytrid infection); common and abundant species tend to become rare, while uncommon or rare species may decline to such small population sizes that they become undetectable, extirpated or even extinct (Lips *et al.*, 2006). In the years following the epidemic, the species that persist may build their populations again, now with endemic chytrid infection (Retallick *et al.*, 2004; McDonald *et al.*, 2005). During this phase, there may be a continual or episodic mortality of smaller numbers of frogs, but the mass population-scale die-offs tend not to occur.

Locations where the fungus has had the most catastrophic impacts have been mostly remote locations (such as rugged mountainous areas) where humans rarely visit, rather than urbanised areas that have sustained a high level of human and other disturbance historically.

While little is known of the status or distribution of the fungus in the Melbourne area and across most of Victoria, the Amphibian Chytrid Fungus is known to have been in Australia since 1978 and in Victoria since 1998 (Murray *et al.*, 2010). Recent research has identified the abundant and ubiquitous Common Froglet (*Crinia signifera*) as a likely reservoir host, spreading chytrid spores among frog populations without succumbing greatly to the disease itself (Brannelly *et al.*, 2018). Given the highly infectious nature of the fungus, the long history of disturbance to waterways and landforms in the Melbourne area, the enormous volume of animal and human movements (foot and vehicular) across the area, and the ubiquity of *Crinia signifera* in Melbourne's waterbodies, it is highly unlikely that any wetlands or waterways (habitats for frogs) in the Melbourne area have remained free of chytrid infection to this point. It is likely to be widespread throughout frog habitats within the project boundary already.

Therefore, the likelihood of introducing the fungus to the project boundary (such as through transport of soil, wet or muddy equipment) is low, as is the likelihood of a catastrophic epidemic occurring within the project boundary as a result of this project. However, different strains of the fungus may vary in how lethal they are to frogs, so avoiding continued spread of the fungus is critical to management of this pathogen. If a new strain of the chytrid fungus is introduced to the project boundary, then a larger impact is possible. If infected materials (such as soil, equipment, vehicles) are brought in from elsewhere, there is a chance of a novel and more pathogenic strain becoming established.

Measures can and would be taken to minimise the risk of spreading the Amphibian Chytrid Fungus into, out of or within the project boundary. Management measures to reduce this risk of spreading the chytrid fungus would be employed by the implementation of a CEMP which would detail and raise awareness of, and compliance with, pathogen management (EPR EMF2 and FF3) and a Spoil Management Plan (EPR CL1) to regulate the movement of spoil and so reduce the risk of chytrid-infected soil leaving or entering the site.

Frog species detected in the project boundary are common species (mainly Common Froglet, Southern Brown Treefrog). No threatened species (such as Growling Grass Frog, Brown Toadlet, or Southern Toadlet) were detected.

The risk to the project from the Amphibian Chytrid Fungus is expected to be low.

#### **Epizootic Haematopoietic Necrosis Virus (EHNV)**

Epizootic Haematopoietic Necrosis Virus (EHNV) is an Australian virus that has the potential to negatively impact several native fish species. The EHN Virus enters fish through the body surface or gastrointestinal tract, multiplies in the blood forming organs such as the spleen and kidney and destroys them in the process. The liver is also affected by the virus. Most infected fish are believed to quickly succumb and die.

Native fish species that may be affected by EHNV include Macquarie Perch, Freshwater Catfish, Murray Cod, plus exotic fish species, Eastern Gambusia, Rainbow Trout and Redfin Perch. At present, Australian field studies have only detected EHNV infection in Redfin Perch and farmed Rainbow Trout. It is suspected that illegal movements of Redfin Perch by anglers may have played a part in the distribution of EHNV in the past

Activities that can increase the risk of diseases between waterways include movement of boating, fishing, aquaculture gear and equipment from one waterway to another.

Hygiene of equipment used for instream works (such as barges and floating work platforms) is included in EPR FF3.

#### **12.1.6 Drawdown of groundwater resulting in degradation of terrestrial or aquatic ecosystems**

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC24	Low
Risk EC06	Medium

### Dewatering of groundwater during construction resulting in changes to terrestrial groundwater dependent ecosystems (risk EC06)

Terrestrial GDEs are reliant on the availability of water beneath the surface. Relationships between groundwater and GDEs are described in Section 10. Construction works would likely impact on groundwater conditions within the study area, particularly around the tunnel portals. The extent and magnitude of potential groundwater depressurisation (drawdown) following construction for the project has been determined through groundwater modelling undertaken as part of Technical report N – Groundwater.

Areas outside the project boundary have the potential to be impacted by groundwater changes resulting from the project. There are three main geographic areas of focus in relation to GDEs where indirect effects may occur and have the potential to impact terrestrial ecology: 1) vicinity of the northern portal, including Simpson Barracks and Banyule Creek, 2) vicinity of the southern portal, including the Yarra River Flats, and 3) tunnels section, including Banyule Flats.

Trees outside the project boundary are likely to be accessing groundwater on occasions (10<20-metre groundwater depth zone) and have a moderate to high likelihood of being negatively impacted by groundwater drawdown during construction. These areas comprise Plains Grassy Woodland (dominated by River Red Gum, in association with Studley Park Gum) within Simpson Barracks and adjoining Commonwealth land, Colleen Reserve, Banyule Flats (Main Yarra Trail), River Gum Walk and Mercedes Court. In the 10<20 m groundwater depth zone in these localities, approximately 16 Large Trees (LTs), including one Studley Park Gum, have a reasonable likelihood of suffering a decline in health and/or premature death during construction. Areas outside of this groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

Areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary, which are likely to be accessing groundwater, are unlikely to be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra River floodplain are also unlikely to be negatively impacted, as is the terrestrial vegetation surrounding Bolin Bolin Billabong since drawdown levels are very low. However, the deep pool at the eastern end of Bolin Bolin Billabong is an aquatic GDE and the potential for it to be impacted by drawdown is discussed in the next section.

For the tunnelled section of the project beneath Banyule Flats and the Warringal Parklands (where terrestrial and aquatic habitats occur that are likely to support threatened and migratory fauna), there is negligible predicted change to groundwater levels and flow during and at the end of construction (Figure 16 and Figure 18). A numerical modelling scenario was undertaken to predict mounding beneath the floodplain as a result of boring of the TBM tunnels (Section 8.5.2.5 of Technical report N – Groundwater). The results do not predict mounding beneath the floodplain; groundwater is predicted to flow above and below the tunnels within the bedrock aquifer, without resulting in an increase in water levels in the overlying alluvial sediments. Some mounding, up to 0.2 metres was noted on the eastern side of the TBM tunnels between the floodplain and the northern portal, but within the bedrock aquifer.

Given the variability and uncertainty in dependency of GDEs within the study area (Section 10), potential impacts would be monitored and managed through EPR EMF2 and through:

- Implementation of groundwater monitoring (EPR GW2)
- Implementation of geotechnical modelling and assessment (EPR GM1)
- Implementation of a groundwater dependent ecosystem monitoring and mitigation plan (EPR FF6).

It is particularly important to understand the potential impacts to the Yarra River floodplain environments, and relatively good condition vegetation within Simpson Barracks and nearby reserves. Where vegetation may be significantly impacted by groundwater drawdown, it may be considered lost and would be offset according to the Guidelines (DELWP, 2017a) (EPR reference FF2).

#### **Dewatering of groundwater during construction resulting in changes to aquatic groundwater dependent ecosystems (risk EC24)**

Aquatic GDEs are reliant on the surface expression of groundwater. Changes to groundwater levels during construction have the potential to alter the hydrology of waterways and wetlands that have significant groundwater contribution. Any changes to the hydrology of aquatic habitat has the potential to change the aquatic ecosystem. Aquatic habitat that intersects the areas of groundwater impacts during construction (Figure 16) include Banyule Creek, Banyule Swamp, Bolin Bolin Billabong and the Yarra River.

The hydrological assessment of Banyule Creek (Section 9.3.1) revealed that aquatic habitat is not maintained by groundwater inputs within the area of groundwater drawdown. The source of water in the upper reaches of Banyule Creek is rainfall runoff from overland flow and through the stormwater drainage network. Therefore, dewatering of groundwater during construction is not expected to change the aquatic ecosystems of Banyule Creek.

The Yarra River is modelled as a surface expression of groundwater by the Bureau of Meteorology and DELWP (BoM, 2018; DELWP, 2018a). However, the contribution of local groundwater inputs within the groundwater impact area (Figure 16) is considered insignificant compared with passing flow from the wider catchment upstream. Therefore, any impact of groundwater drawdown from the project construction on the hydrology of the Yarra River would have negligible impact on the aquatic ecosystem in the Yarra River.

The hydrology of Bolin Bolin Billabong has some level of groundwater dependency, with the deep pool located in the eastern extent of the billabong considered to be maintained by alluvial groundwater (Jacobs Group, 2017). There are varying opinions about the degree of permanency of the pool, with some reports suggesting it dries naturally once in ten years (Jacobs, 2017), whereas other anecdotal reports suggesting there is no evidence of it ever having dried out (pers comm. Melbourne Water). Melbourne Water commenced a water quality and water level monitoring program of the billabong in 2017 to inform the management of environmental water delivery, but there is no long-term water monitoring before this date.

Based on the field assessment of wetland aquatic ecosystem undertaken for this assessment (Section 9.3.1) and reported history of Bolin Bolin Billabong (Section 6.5), the ecological condition of this deep pool is highly variable in time, and strongly influenced by antecedent billabong inundation from overbank flooding or environmental flow provision (Jacobs Group, 2017; Leahy, 2005). Nevertheless, the aquatic ecosystem in this billabong is highly valued by the community for both Aboriginal cultural and ecological values, and as a regionally significant example of a Yarra floodplain wetland (Melbourne Water, 2018).

Key aquatic values of the billabong include the presence of native fish, particularly Short-finned eels. Melbourne Water regard this site as having habitat suitable for small-bodied native fish (Australian Smelt, Flatheaded Gudgeon, Common Galaxias and potentially Southern Pygmy Perch). However, these have not been recorded in recent fish surveys undertaken by Melbourne Water or for the assessment of existing conditions. The dominance of exotic fish species (European Carp, Eastern Gambusia and Oriental Weatherloach) are a major threat to the aquatic ecosystem values in the deep pool.

A drop in local groundwater level would be expected to lower the water level in the pool. This wetland is within the area modelled as likely to be impacted by groundwater drawdown during construction, with changes to groundwater levels predicted between 0.1 to 0.5 metres (Figure 11, Figure 16). It is important to note that groundwater change predictions at this fine resolution have considerable uncertainty. Therefore, for the purposes of assessing potential impacts to the aquatic habitat of Bolin Bolin Billabong, this drawdown prediction is interpreted as an indication of risk of groundwater level change. The scale of groundwater impact projected for Bolin Bolin Billabong is the lowest category of change predicted by the drawdown model, and is on the periphery of the modelled groundwater impacts. This site is therefore considered a lower risk of groundwater change. The landscape scale groundwater level model has limited ability to predict the changes to surface water levels in particular floodplain features, such as the billabong, with variability in topography in the billabong (approximately eight-metre drop from upper bank of billabong to base of pool) being considerably greater than the uncertainty in the model across the corresponding distance. Therefore, the influence of the drawdown scenario on groundwater levels, and corresponding changes in surface water level in the pool is uncertain. Thus, this assessment of impact from groundwater drawdown is based on an assumption of moderate to high likelihood projected drawdown of 0.1 to 0.5 metres in this area. As the surface water level in the deep pool is directly linked to groundwater levels, the groundwater drawdown is expected to cause a corresponding lowering of pool water level. The lower water in the pool would shrink the area and reduce the permanency of the deep pool and potentially alter water quality. A bathymetric assessment of the deep pool undertaken by Melbourne Water in 2017 indicates that during the water level in the pool is approximately 1.8 metres during the dry phase.

The ecological impact of changes to the hydrology of this pool includes negative effects on the quantity and potentially quality of remnant aquatic habitat of the deep pool in the billabong. The changes to surface water levels are not expected to affect the aquatic ecosystem condition during or following billabong inundation events (via natural flooding or managed environmental watering). The ecological significance of lowered groundwater levels is uncertain, although there is no evidence this pool provides refuge habitat for any threatened aquatic species. However, the pool does provide habitat for other aquatic species that enter the billabong during the sporadic periods of connectivity with the Yarra River during floodplain inundation, including native and exotic fish. It is also likely to provide important water supply for the native terrestrial fauna. Managed water levels in this wetland may be required to maintain the ecological condition of the billabong.

In addition to a reduction in aquatic habitat available, without mitigation, changes in groundwater behaviour may lead to changes to water quality by increasing salinity or by exposing acid sulfate soils (see Technical report O – Contamination and soil), which may decrease pH. If this is the case, the aquatic habitat in Bolin Bolin Billabong may be impacted for a period of time until the billabong water is refreshed by an inundation event. This is considered highly unlikely since the water level of the pool already fluctuates during wet and dry seasons and dries out every one to 10 years (see Technical report N – Groundwater); therefore, it is unlikely that acid sulfate soil exists immediately surrounding the billabong. In the unlikely scenario that it was present, the ecological impact of these potential changes to the deep pool would not likely be significant, as the aquatic ecosystem present in the pool is generally tolerant of the highly variable water quality conditions that occur during the water level recession of inundated billabong.

The size of the pool is known to vary throughout the flooding/drying cycle, and therefore the fringing vegetation naturally varies correspondingly. Any reduction of pool size resulting from the lowering of groundwater levels would reduce aquatic habitat for native fish. However, under existing conditions, short-finned eels are the only native fish known to occur in this pool. The natural or managed flooding of the billabong provides an opportunity for replenishment of native fish recruits to this pool, and so the fish community can be replenished from the Yarra River community at the frequency of inundation events.

Therefore, any lowering of water levels in the deep pool would reduce the amount of aquatic habitat available, but this would only have a low impact on the aquatic ecosystem, as the ecosystem and fish community is refreshed during overbank flooding or managed inundation events from the Yarra River.

Given the relatively minor ecological impact of changes to surface water levels, and the uncertainty of the degree of change expected, the recommended method for protecting the aquatic ecosystem of Bolin Bolin Billabong is to undertake water level monitoring in the deep pool to confirm the actual changes to surface water. This monitoring can inform the need for mitigation measures, including management of the billabong's environmental water regime to include replenishment of water to maintain water depth in the deep pool. The monitoring program would also be suitable for detecting the impacts of acid sulfate soil (if present), and if detected in the billabong, the maintenance of surface water levels would also mitigate against these impacts.

Therefore, a groundwater and surface water monitoring program would be required to determine the level of change in this ecosystem during the construction of North East Link (EPR GW2 and EPR SW4). A groundwater model (EPR GW1) and acid sulfate soil plan may be required to understand and respond to any changes in environmental condition detected during monitoring.

A reduction in aquatic habitat is not expected to result in loss of significant aquatic ecosystems, or impact habitat for aquatic threatened species, as the billabong ecosystem is naturally dynamic and includes periods of expansion and contraction of aquatic habitat. However, the potential for impacts to salinity and pH in the deep pool may significantly change the wetland ecosystem.

Protection of the aquatic habitat in Bolin Bolin Billabong is required (EPR FF4) to prevent changes to an important wetland aquatic ecosystem.

Potential impacts would be further monitored and managed through implementation of a groundwater dependent ecosystem monitoring and mitigation plan (EPR FF6). To avoid ecosystem changes in the groundwater dependent deep pool in Bolin Bolin Billabong, groundwater levels in this area should be maintained. This would also serve to avoid the activation of acid sulfate soils. Supplemental watering of the billabong by topping up the wetland with inputs from other sources may be suitable. The source and delivery method of supplementary water for the maintenance of deep pool would require integrated planning with the environmental watering plans for the site. The suitability of Yarra River water or alluvial groundwater requires some consideration due to limited knowledge of the interactions and dependency of the deep pool aquatic ecosystem on interactions between hydrogeochemistry and surface water quality. Maintaining surface water levels in the deep pool through supplementation from groundwater is expected to provide the lowest risk method for maintaining the environmental conditions that support this ecosystem. This should be included in the review and planning for maintaining supply to identified groundwater users (EPR GW3) and protection of groundwater quality recharged to the environment (EPR GW4). In particular, the protection of groundwater quality needs to consider any use of recharge activities used to maintain water levels in GDEs (such as Bolin Bolin Billabong) to prevent impacts to groundwater or surface water quality and protect environmental conditions of the GDEs.

### 12.1.7 Death or injury of fauna during construction

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC19	Low

#### Construction activities resulting in the death or injury of native fauna (risk EC19)

The project would occur across a busy urban landscape. Project construction may result in the injuring or killing of fauna, mainly through land clearing (habitat removal) or fauna straying into a construction area. Fauna most at risk are fauna that reside in the habitats to be removed and that have limited mobility (such as frogs, small reptiles, possums), and/or dependent young (such as young birds in a nest), or fauna that stray into a construction area during a quiet time (for example, overnight). Fauna straying into a noisy active construction site during the day is considered unlikely, and would be actively managed by the site environmental officer (via a CEMP) (EPR EMF2 Environmental Management Plans).

In the north-eastern suburbs of Melbourne, fauna most likely to be encountered in a construction site are common species. Presence of uncommon or threatened species is expected to be rare, and death or injury of those species is expected to be extremely rare.

Death or injury of some fauna may occur, but is expected to be infrequent and localised, and most likely to affect individuals rather than populations or species. While killing an individual animal would be permanent, the impact on the population of that species (particularly if that species is common and adaptable) may be only short-term. Its population would be expected to recover relatively quickly (within two years). Therefore, death or injury of common species is not expected to have a long-lasting effect on any of the populations of fauna in the project boundary.

Efforts would be made to minimise harm to fauna during construction. Measures to avoid harming fauna, and to deal with injured fauna if found, would be specified in the CEMP via EPR FF1 (Fauna management measures). This would enable management of fauna displaced or harmed due to habitat removal in compliance with the Wildlife Act, undertaking pre-clearing surveys and inspections to confirm the on-site location of fauna immediately prior to habitat removal, and assisting fauna to safety as necessary. This would also enable the reporting of incidental threatened fauna finds, with any clearing works in the vicinity stopped until an evaluation and approval response could be established.

### 12.1.8 Disturbance of fauna through noise, vibration or lighting

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC09, Risk EC10	Low

#### Construction noise, vibration and/or lighting resulting in elevated disturbance of threatened fauna (risk EC09) or a significant impact on non-threatened fauna (risk EC10)

The construction of North East Link would involve a range of demolition and construction work in numerous locations along the project corridor simultaneously (such as pile driving, tunnel-boring, road widening). Work at some locations would be during daylight hours only, while at other locations it would be at night only, or both during the day and at night. Construction noise has the potential to disturb fauna day or night, while lighting would disturb fauna only at night.

The potential severity of disturbance varies with species and location. Disturbing a threatened species to the point that it abandoned its breeding habitat (such as the Grey-headed Flying-fox camp at Yarra Bend) would be a severe impact, while localised and temporary disturbance of small numbers of individuals of common species (such as the Red Wattlebird, Noisy Miner) from marginal foraging habitat would be relatively inconsequential ecologically.

For this project, impacts on non-threatened terrestrial fauna are expected to be minimal but more widespread than those on threatened fauna, due to the ubiquitous distribution of non-threatened fauna and the localised distribution of threatened fauna along the project corridor.

Disturbance from noise, vibrations and light are not expected to impact on fauna (threatened or non-threatened) through the tunnelled section of the corridor.

## Lighting

Project construction at night would require adequate lighting, which may disturb or displace native or non-native fauna. Lighting during construction would be temporary, moving with the work front. Depending on the nature of the construction changes proposed, some sites would require lighting over a shorter period (weeks or months) than others (months or years).

Artificial light can reduce the success of some nocturnal predators, by giving the potential prey an advantage or favour more tolerant nocturnal predators, potentially changing the composition of both predator and prey species. Artificial light at night can disrupt the typical nocturnal behaviour of fauna (diurnal birds may not roost, nocturnal frogs may not call, insects may be fatally attracted to lights). The effects of lighting may result in some fauna no longer occurring in habitats nearest to the lit areas.

Efforts would be made to minimise the escape of light during the project's construction (for example, lights would be directed downwards rather than outwards, and light screens would be used between roadways and potentially sensitive habitats (such as wetlands). Measures to reduce the effects of light would be specified in the CEMP. EPR LV3 (Lighting – construction) would see measures developed to minimise light spillage during construction to protect significant native fauna habitat to the extent practicable.

Disturbance of some fauna by light is unavoidable, but is expected to be minor and localised. Disturbance of fauna is most likely to affect individuals rather than populations or species, and is not expected to have a long-lasting effect on the populations of fauna in any particular suburb or across Melbourne. Fauna in the urbanised Melbourne area already cope with an environment that is awash with artificial light at night. It is likely, therefore, that the fauna that still occur within the area, or visit the area, have coping mechanisms for persisting in well-lit environments.

## Noise and vibration

Project construction would involve increased noise, and this assessment has investigated the potential for that disturb or displace native or non-native fauna. Displacement of fauna into sub-optimal habitats could increase their susceptibility to predation and competition, or other source of harm in the urban environment. Noisy environments may make it harder for fauna to hear each other and to hear predators moving around.

Noises that disturb fauna tend to be loud, sudden and unexpected noises (such as explosions, pile driving) rather than predictable constant noises (such as loud machinery in continual use). Fauna can become habituated to predictable noises, even if those noises are very loud (for example, birds that use airfields as habitat). Noises generated by the project are expected to vary in intensity and may or may not be accompanied by vibrations that affect terrestrial and aquatic fauna.

During daylight hours, construction noise has the potential to impact on terrestrial fauna in a few ways. It could result in temporary displacement of active diurnal birds – individual birds may choose to forage and roost further from the corridor than they normally do, for the period of disturbance. It could also result in displacement of roosting nocturnal fauna – birds or mammals (such as possums) when disturbed may flee from the corridor and seek a quieter location. Because this would be during daylight hours, it could make the nocturnal fauna more susceptible to predators, competitors and/or temporary harassment (such as mobbing of owls by birds such as noisy miners).

At night, construction noise has the potential to impact on terrestrial fauna through temporary displacement of nocturnal birds and mammals – owls and possums that might forage or roost occasionally near the corridor may abandon a disturbed area for a period of time. It could also result in displacement of roosting diurnal fauna – birds when disturbed may flee from the corridor and seek a quieter location. Because this would be at night, it could make them more susceptible to predators.

Construction noise at night could result in temporary silencing of frogs – frogs may not call during the period of disturbance, or may call but have lower reproductive success due to not being heard. If the construction period lasts longer than the frogs' breeding/calling season, then there is a risk of losing an entire breeding cohort from that location.

Reptiles are not expected to be disturbed greatly by construction noise or vibration, although there may be rare occurrences of localised displacements of individuals (for example, a Tiger Snake moves away from noise or vibration in the area where pile driving occurs).

Persistent noise (such as loud traffic noise near a busy road) has the potential to disrupt acoustic communication by some fauna (such as frogs, birds). The noise may jam frequencies used by some fauna, so those fauna are no longer audible to their conspecifics. There is evidence that some fauna have changed their acoustic signals in response to loud urban noises (Parris *et al.*, 2009; Parris, 2013; Parris, 2015). For species that call at a certain time of year, or at a certain time of day (including frogs that call mainly at dusk during their preferred season and birds that call in Spring), this may be only an occasional problem, but it may reduce their success to the extent that those fauna no longer occur in the habitats nearest to the disturbance source.

Fish use sound in a number of ways, including communication, hunting and predator avoidance. Human-induced noise may impact fish by generating high intensity (acute) or low intensity (chronic) noise (Popper and Hastings, 2009). High intensity noise may kill or damage hearing of fish or lead to a startle response, whereas low intensity noise may pervade the environment and lead to behaviour changes over a long-term period.

For this project, most of the fauna habitats nearest the corridor are not known to support threatened species, other than occasionally. One main exception to this is the Grey-headed Flying-fox colony at Yarra Bend, near the Eastern Freeway where it crosses the Yarra River. Very large numbers of flying-foxes use the colony for daily roosting and for annual breeding.

At this location, impacts from noise are considered unlikely to significantly impact on individual flying-foxes or on the colony. This section of the Eastern Freeway is already very noisy (daily noise from commuting and base-flow traffic) and well-lit at night. Construction is not expected to significantly increase noise or light levels that would disturb the camp. Construction near this location would include bridge strengthening works, road surfacing works and construction of a new bridge for a shared-user path. From information provided by specialists preparing the Technical report C – Surface noise and vibration, the linear noise level is modelled to be 133 dB (119 dB(A)) at the construction site.

Modelling is highly conservative and assumes the continuous and simultaneous operation (which is highly improbable) of the following equipment: Excavator (35T), Concrete Saw, Crane – wheeled (100T), Crane – Franna (20T), Piling Rig (Driven), Concrete Agitator, Truck – Low Loader, and Concrete Pump. On the basis of this, noise levels are predicted to be 65 dB 700 metres downstream of the site (the location where the nearest flying-foxes were observed in November 2017) and 61 dB at a central point of the colony as it currently is. According to a range of online sources (for example, <<http://www.industrialnoisecontrol.com/comparative-noise-examples.htm>>) these levels are slightly more than the level of a conversation in a restaurant, office, or background music, air conditioning unit at 100 feet (~33 metres).

If work at this location is done at night, construction lighting is not expected to disturb the flying-fox camp because there is no line of sight between the works area and the current colony. The risk can be further mitigated using barriers to further reduce the likelihood and severity of disturbance. The implementation of lighting EPRs (EPR LV3) would ensure that measures are developed to minimise light spillage during construction to protect significant native fauna habitat and community facilities to the extent practicable.

For this project, noise during construction would be temporary and short term (actual duration depends on the site and the construction activities required). The implementation of noise and vibration EPRs (NV2, NV3 and NV4) would ensure that a Construction Noise and Vibration Management Plan (CNVMP) is developed and implemented in consultation with EPA Victoria and relevant councils. The CNVMP would identify noise sensitive receptors along the project alignment, and construction noise targets. The CNVMP would also document how construction noise must be minimised, and notification and mitigation measures that would be implemented if noise levels exceed targets. The CNVMP would identify an effective monitoring protocol for noise associated with construction.

Vibrations are considered less likely than noise to disturb terrestrial fauna. Vibrations from high-impact ground disturbance (such as tunnelling, pile driving) tend to be localised and relatively minor in effect to terrestrial fauna. The tunnelling process would generate a constant, quiet, low-pitched hum at surface level, rather than loud noises and ground trembling or quaking (refer to Technical report D – Tunnel vibration). For terrestrial fauna at or near these locations, it is expected to be the noise that disturbs, rather than vibrations.

The sensitive receptors potentially affected by noise or vibration in aquatic ecosystems include resident and migratory aquatic fauna. Vibrations, including sound waves, travel faster and more effectively through liquids than through air, and even more effectively through solids. Thus, the vibration generated through construction activities needs to consider not only construction activity in and around waterways, but also construction at distance from the waterways where enhanced noise/vibration transmission through the substrate has potential to impact on aquatic ecosystems away from the construction site.

For aquatic fauna such as the Australian Grayling, the key area of sensitivity is around the Yarra River in relation to bridge strengthening works and the construction of a new shared use path crossing of the river. The two key activities with the potential to cause impact are:

- Bored piles: Use of bored piling techniques would reduce impact compared with driven piles and this would be beneficial
- Jack hammering: Use of low energy jack-hammers or alternative means (such as saw cutting) would be the preferred construction method. Low energy jackhammering does not transmit high levels of vibration into a major structure such as a bridge, so impacts in the river are likely to be low.

General low-level noise due to plant movement and other activities, including tunnel boring, would also occur during construction.

The published literature contains little directly relevant information about the impact of the expected construction activities on freshwater fish in rivers as most studies are from marine or laboratory conditions. The biology of freshwater and marine fish are similar enough to consider the response to anthropogenic noises would be similar (Vega & Wiens, 2012 in Cox *et al.*, 2016). However, it is not clear what, if any, differences in the physical form and structure of the riverine environment affect the fish species differently compared with marine habitats or laboratory conditions. The acoustic landscape of marine versus freshwater environments differs quite markedly (Mickle and Higgs, 2017). Sound transmission in the open ocean can be effectively modelled as an unbounded medium, but, especially for shallow freshwater environments, such as the Yarra River, acoustic modelling is much more difficult when depth is often very shallow and substrates poorly defined (Kuperman & Ingenito, 1998; Rogers & Cox, 1988 in Mickle & Higgs, 2016).

One experimental study indicated that loud, sudden noise can affect individual and group fish swimming behaviour in laboratory conditions, but continuous loud noise has less effect (Neo *et al.*, 2015). The effects of noise in the natural environment on fish is less clear. The literature refers to increased alarm responses or movement from fishing areas in studies of sudden loud noise from seismic air guns (Fewtrell & McCauley, 2012; Skalski *et al.*, 1992; Engås *et al.*, 1996; Engås & Løkkeborg, 2002 in Wardle *et al.*, 2001). But there is some uncertainty about pile driving, with one study on a coral reef showing little or no effect on overall behaviour and movement patterns of fish (Wardle, 2001). Given the behavioural impacts of loud intermittent noise have been demonstrated experimentally, it is a reasonable precaution to avoid loud, intermittent noise generating activities during periods when changes to fish swimming behaviour could affect important breeding events for the Yarra River Australian Grayling population. Given the Yarra River is located within an environment of considerable human activity (including land based construction, traffic and motorised vessels), the aquatic environment is expected to already have a relatively high background noise level. The impacts of loud constant noise resulting from general construction activities (such as from the TBM, pile boring and heavy truck traffic) is not expected to cause behavioural changes that would impact the viability of native fish populations.

The impacts of intense impact generated noise (such as from pile-driving or jackhammering) on fish in the Yarra River are largely unknown (Popper & Hastings, 2009). However, fish are more likely to elicit an avoidance response before physical damage occurs if they are not constrained (McCauley *et al.*, 2000). In the context of the project, generation of high intensity noise is not expected as the planned construction methods include bored piles, not driven piles. If pile driving or jack hammering was employed during the construction of the project, these would most likely lead to short-term behavioural impacts in fish during these activities. Consequently, EPR FF8 provides the requirement for pile driving or jack hammering to be avoided, and if required these activities should be scheduled to minimise impacts on the Australian Grayling.

Behavioural avoidance of an area that is a key migration corridor during a migratory or spawning period for fish may significantly impact on the breeding success of that species. This is the case for the important population of Australian Grayling in the Yarra River. High intensity noise/vibration generation during construction activity that is transmitted to the Yarra River has the potential to deter spawning fish from descending the river to spawning areas in the estuary, or deter juvenile fish from ascending the river into upstream reaches. Any effects on migration are not expected to persist during periods without noise. Therefore, the best time to undertake construction activities in the vicinity of the Yarra River that involve high intensity noise generation (such as driven piles) is outside the Australian Grayling spawning or upstream migration period. Similar impacts to other fish species are also expected, but the significance of this impact is considerably less for other species with more flexible and/or multiple breeding cycles (such as Macquarie Perch, Common Galaxias) or for species where the Yarra River is not considered an important breeding habitat or contain an important population (such as the Australian Mudfish).

To minimise the likelihood of impacting the breeding cycles of threatened fish species, significant noise generating construction activities would be best undertaken during December, January and February or July and August as summarised in Table 46. This requirement should be included in a Construction Noise and Vibration Management Plan (EPR NV4).

**Table 46 Typical lifecycle and movement patterns of threatened migratory fish – indicating high noise/vibration avoidance periods**

Common name	Life stage	Timing											
		J	F	M	A	M	J	J	A	S	O	N	D
Australian Grayling	Spawning			↓	↓	↓	↓						
	Larvae					↓	↓	↓					
	Juvenile									↑	↑	↑	
	Adult				↓	↓↑	↓↑	↑					
<b>Avoid high intensity noise generation</b>													

Note: arrows indicate upstream or downstream movement

North East Link would be constructed in an already disturbed and urbanised area. Threatened and non-threatened fauna that live in or visit habitats within the project boundary already tolerate substantial disturbance from noise, vibrations and lighting. Construction work similar in nature to that proposed (such as roadworks and bridge works with associated noise and lighting) already occurs within the project boundary on a daily basis, albeit at a smaller scale than this project. It is likely that fauna that still occur within the area, or visit the area, have coping mechanisms for persisting in noisy environments. However, the impact of construction noise may have a disproportionate impact on non-resident or migratory species that have little exposure or are already impacted by the existing acoustic environment. This is notably the case for Australian Grayling, which has a national recovery plan that aims to protect and enhance important life cycle stages.

Through implementation of EPRs, efforts would be made to minimise disturbance to fauna during the construction and operation of the project. With EPR NV4, a Construction Noise and Vibration Management Plan (CNVMP) would be prepared and implemented in consultation with EPA Victoria and relevant councils. The CNVMP would include identification of noise and vibration sensitive receptors along the project alignment, construction noise and vibration targets, identification of key noise and/or vibration generating construction activities that have the potential to generate airborne noise and/or surface vibration impacts on surrounding sensitive receivers, and management actions and notification and mitigation measures to be implemented to minimise noise and vibration associated with construction.

With EPR NV3 (Noise and vibration impacts to sensitive receptors – Construction), construction noise and vibration impacts at sensitive receptors would be managed in accordance with EPA Victoria Guidelines and as specified in the Construction Noise and Vibration Management Plan (CNVMP). Sound barriers can be used to reduce the effects on particularly sensitive fauna (such as near wetlands that support frogs).

Disturbance of some terrestrial and aquatic fauna is unavoidable, but is expected to be minor, localised and short term (in that fauna would most likely return to the habitat when the noise disturbance subsides). Disturbance of fauna is most likely to affect individuals rather than populations or species, and is not expected to have a long-lasting effect on the populations of fauna in any particular suburb or across Melbourne. The impacts of noise and vibration on threatened fish is limited to intermittent impact generated intense vibration transmitted from construction sites to the Yarra River, which is the only waterway in the project boundary likely to support threatened fish.

#### 12.1.9 Fragmentation of terrestrial or aquatic wildlife corridors creating barriers to fauna movement

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC14, Risk EC21, Risk EC22	Low

#### **Habitat fragmentation resulting in reduced effectiveness of terrestrial wildlife corridors and creation of barriers to fauna movement (risk EC14)**

Construction of the project would involve removal of vegetation (habitat) and/or modification of waterways in some areas, which may result in localised fragmentation of some fauna habitats. Loss of a patch of habitat may disrupt or sever habitat connectivity, particularly along waterways and other narrow sections of habitat.

Operation of the project is not expected to result in further habitat fragmentation.

Fragmentation of habitat and isolation of habitat patches reduces the ability of some fauna to disperse across the landscape, and may threaten the viability of some populations that rely on habitat connectivity. Generally, the worst ecological consequences for habitat fragmentation or isolation result when disruption to connectivity is large (such as a broad area of habitat clearing across a wildlife corridor), and/or the habitat fragmented is highly functioning ecologically (such as the Yarra River floodplain).

Habitat fragmentation can affect common non-threatened fauna and rarer threatened fauna alike. Common, mobile and adaptable species (such as the Red Wattlebird, Rainbow Lorikeet) tend to be least affected by fragmentation, as habitat gaps tend not to create barriers to their movement. These species tend to be the ones that persist in the Melbourne area currently. Some mobile threatened species also are able to cope with Melbourne's already fragmented landscape (such as the Swift Parrot and Grey-headed Flying-fox), as determined by their continued use of trees in metropolitan areas. Some common but less mobile fauna appear less inclined or able to bridge habitat gaps (such as the Superb Fairy-wren, White-browed Scrubwren and Sugar Glider) and some of the threatened species tend to be restricted by large habitat barriers (such as the Powerful Owl).

Losing habitat connectivity tends to be long-term or permanent. Permanent loss of connectivity can be at least partially offset by creating or encouraging adjacent habitat patches that can serve the purpose of connecting habitats.

The additional fragmentation that could result from North East Link is not expected to be extensive enough to alter the ecological effectiveness of existing habitat or wildlife corridors, or to create new barriers to fauna movement. The project would be constructed in an already fragmented urban landscape. Species that use habitat patches as movement corridors in the project boundary tend to be highly mobile species already coping with a fragmented and degraded habitat landscape.

The most important habitat and wildlife corridor within the study area is the riparian forests and wetlands associated with the Yarra River floodplain, particularly around the Kew, Bulleen and Banyule area. Threatened wetland and forest fauna, including Powerful Owl, are known or likely to use this area for movement across the landscape. This area would be avoided through tunnelling and the project is not expected to disrupt this area as fauna habitat and as a wildlife corridor.

The fauna movement corridor offered by Koonung Creek is narrow, degraded and already fragmented. While revegetation efforts and wetland creation (mostly for stormwater treatment) in recent decades have improved the condition, amenity and ecological function in some areas along Koonung Creek (such as Koonung Creek Linear Reserve), habitats along the corridor are used predominantly by common and adaptable non-threatened native and non-native fauna. Construction of the Eastern Freeway in earlier decades resulted in an almost unrecoverable loss of ecological function of the corridor along Koonung Creek. North East Link could result in minor additional corridor disruption along Koonung Creek, particularly where new parts of the creek are proposed to be covered and the surface riparian habitat connection would be lost. The impact of this is expected to be minor and not result in further loss of ecological function from Koonung Creek.

North East Link would impact on the upper reaches of Banyule Creek, within Simpson Barracks and south to Lower Plenty Road. This upper section of Banyule Creek offers a very small fauna movement corridor between Simpson Barracks and the Yarra River floodplain. Through this section, the habitat corridor is narrow, degraded, and likely to be used mainly by common and adaptable mobile fauna for local movements only, rather than landscape-scale movements. The absence of mid-storey and under-storey vegetation along the section of Banyule Creek north of Lower Plenty Road, the major barrier to ground-based fauna created by Lower Plenty Road itself, and the busy and urbanised landscape that surrounds Banyule Creek in this local area, means this wildlife corridor is highly compromised in its current form. The project is not expected to result in further loss of ecological function from corridor habitats along Banyule Creek.

Habitat fragmentation would be minimised through project design, and measures to avoid accidental loss of habitat that further disrupts habitat connectivity would be specified in the CEMP (EPR EMF2) and further minimised through the implementation of other EPRs (EPR AR2, EPR LP1, EPR SW8). Reinstatement of vegetation along potential corridors beside the completed roads (such as at Koonung Creek Linear Reserve) would allow continued passage of fauna and help to reduce the long-term effect of additional habitat fragmentation that does occur (EPR AR3). Additional planting of native vegetation (exceeding replacement, resulting in a net habitat gain) along potential corridors may even improve the long-term condition and effectiveness of corridors.

#### **Construction activities within/around waterways resulting in loss of connectivity and impeded passage for threatened aquatic species (risk EC21) or non-threatened native aquatic species (risk EC22)**

Restrictions to movement of native fish have the potential to occur in Koonung Creek and Banyule Creek during construction due to works in waterways that restrict passage (such as the cofferdam placement). Threatened aquatic species are not found in these waterways. The native aquatic species that are found in these waterways are common, widespread and abundant fish species that are not obligate migratory species. The impacts of temporary lack of connectivity would be minor and not cause any impacts to population viability. Construction to divert or cover the waterways would have a severe impact on the physical form and instream habitat of the waterway, but this would not have major impacts on the connectivity to important habitat for these common native species.

The Yarra River contains numerous species of native aquatic fauna, including threatened fish species. The waterway provides passage to large areas of important habitat for many species. To avoid impacts to the aquatic fauna of the Yarra River, works in the Yarra River are not proposed. The construction works in the waterway are therefore not applicable to habitat for threatened species. However, impeded passage in the Yarra River may be caused by noise/vibration near the river (as described in Section 12.1.8 for EC10).

The protection of aquatic habitat through design and avoidance of construction works in and around waterways (EPR FF4) is the key measure to protect aquatic fauna, through minimising the construction of physical barriers to passage. The management of construction activities that can cause behavioural changes in fish are required to minimise the impacts of avoidance. These include noise and vibration controls (EPR NV4), design of drainage structures that could impact habitat quality and prevent spills entering waterways (EPR SW1, EPR SW2 and EPR CL5), management of runoff from construction areas (EPR SW4) and monitoring for any water quality pollution (EPR SW5), modelling and planning to avoiding flow velocities that could prevent fish movement (EPR SW6). Implementation of these across all waterways would minimise the risk to aquatic fauna within the Yarra catchment, including threatened aquatic species.

#### 12.1.10 Detrimental changes to soil, surface water or groundwater conditions as a result of tunnel construction

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC25	Low
Risk EC26	Low

#### **Construction of tunnels causes ground settlement that changes drainage flow and/or hydrology of wetlands (risk EC25)**

Some changes to ground surface levels resulting from ground movement caused by construction of the tunnels are indicated in the ground movement report (Technical report M – Ground movement). Based on this report, the modelled changes to surface levels at Bolin Bolin Billabong are less than two millimetres, which is a negligible change for aquatic or terrestrial ecosystems. There are no ecological impacts expected due to these small ground movements.

Technical report M – Ground movement indicates ground movement modelled at Banyule Swamp could experience minor ground settlement along the alignment of the tunnels. This may change the the level of the shallow constructed levee bank and water level control offtake pipe that drains overflow water to Banyule Creek. Ground movement that affects these structures could cause some change to the hydrology of the swamp, as the water level of this wetland is maintained by the offtake pipe and levee bank. This constructed water level control has created a wetland with relatively stable hydrology, and strongly defined boundary of surface water extent and fringing vegetation controlled by the maximum water levels. However, there is some natural variation below this high water mark; during periods of low rainfall the water levels drops, resulting in natural recession of the wetland's aquatic habitat area.

There is the potential that settlement resulting from construction of the tunnels may lower the height of the levee bank or overflow structure. If this is the case, less water may be retained in the wetland basin, lowering the high water mark, and reducing the potential area of aquatic habitat present. Ground movement analysis suggests that approximately 45 millimetres of settlement could occur at the location of the pipe with a corresponding ground slope of around 1/750. Based on this scenario, it is not expected to be any structural damage to the pipe. The topography of the area shows that Banyule Swamp drains into Banyule creek through a narrow swale that serves as the bypass or spillway.

Ground movement settlement contours indicate that a depression may occur in the vicinity of this swale, which could modify the effective height of the spillway. A height reduction would lower the maximum water level – assuming the observed swale is serving to regulate the maximum lake level. Although the predicted drop in ground level is not large in the landscape context, the bathymetry of the wetland is extremely shallow, with considerable areas of very shallow water. A small lowering of the hydraulic control structures and corresponding drop in water level (<50 millimetres) would significantly change in wetland surface area, including the shallow habitat suitable for wading birds. This range of variation is considered well within the natural range experienced by the swamp on a seasonal or annual basis, but the impact of the lowered high water mark would result in a more permanent recession of aquatic habitat area. To protect the functionality of the lake, the level of the water level control structures (the overflow pipe and levee bank) should be modelled to inform likely ground movement (EPR GM1). A mitigation strategy could increase the height of embankment surrounding the outfall to the swale to offset the settlement.

This risk should be monitored as part of the Ground Movement Management Plan (EPR GM2) and included in the Condition Survey of infrastructure that could be impacted by ground movement (EPR GM3), with a structural level monitoring program. Lake water surface levels would need to be included in the monitoring program and Condition Survey to ensure the impact acceptability criteria applied for this asset (as included in EPR GM 2) is appropriate to protect aquatic habitat extent. Any observed changes to water level control structures would be identified for repair works if required (EPR GM4).

#### **Construction of tunnels causes ground settlement that causes changes in vegetation quality or resilience of native vegetation (risk EC26)**

The construction of the North East Link tunnels has the potential to cause minor levels of ground settlement in areas supporting native vegetation or scattered native trees. In particular, settlement of 10 millimetres in a small area of Floodplain Riparian Woodland between Bolin Bolin Billabong and Bulleen Road, 10 to 14 millimetres in a small area of Floodplain Riparian Woodland west of the southern tunnel portal, and two to 45 millimetres through the Banyule Swamp area. Modelled settlement of this magnitude is regarded as a negligible impact and is unlikely to cause premature death of native trees, or cause degradation of vegetation quality.

In addition to the settlement in areas of Floodplain Riparian Woodland, modelled settlement of two to six millimetres is predicted in Plains Grassy Woodland within Simpson Barracks. This degree of settlement is regarded as a negligible impact on native vegetation.

## **12.2 Operation impacts**

This section describes the potential impacts on ecological assets, values and uses from activities and consequences that occur during operation of North East Link. Risk pathways (Table 44 in Section 11) relevant to each impact category are indicated.

### **12.2.1 Loss or degradation of terrestrial or aquatic habitat through shading**

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC30, Risk EC39	Medium
Risk EC27, Risk EC28	Low

**Shading from structures causing the loss or degradation of non-threatened flora and ecological communities (risk EC27) or shading from structures causing the loss or degradation of threatened flora and ecological communities (risk EC28)**

The effects of reduced lighting and increased shading on vegetation, ultimately representing a reduction in photosynthetically active radiation (PAR) are manifold, both growth promoting and limiting. In general, effects are dependent on the percentage of PAR reduction and the species affected.

At the basic level, a reduction of PAR can lead to a reduction in photosynthesis, which in turn reduces available energy, plant growth and vigour. As such, there is a range of adverse and avoidance effects observed in plants, which occur and relate to the PAR levels and a plant's physiological limit for leaf survival. Each species has different tolerance levels and as such whole plant vegetative growth, and the level of flowering (as an indication of reproduction) are dependent on respective PAR levels (Tan & Ismail, 2014).

In general, adverse effects include:

- Decline in plant growth
- Decline in reproductive growth
- Decline in flowering
- Shade avoidance response (excessive growth).

Research indicates that a decreasing ability of plants to utilise carbon, through less utilisable PAR, can reduce root mass and leaf production, decreasing overall biomass production (Mikola *et al.*, 2000). In general, non-tolerant or adaptive plants, experiencing significant PAR reductions, show decreasing seedling biomass and growth (Mikola *et al.*, 2000), as well as reduced flowering (Tan & Ismail, 2014). This means that even though many plants can tolerate low PAR conditions, not all plants can effectively reproduce under such conditions (Valladares & Niinemets, 2008).

One of the most common plant avoidance reactions to low PAR is excessive shoot growth. This is reflected through above average stem height/DBH size (Tan & Ismail, 2014). These avoidance reactions themselves represent a potential cause for further flow-on effects to the surrounding flora through changes in competition between species, such as through fast-growing taller species suppressing slower growing shorter species (Norton & Young, 2016).

As such, significant shading can be harmful to terrestrial and aquatic ecosystems, as it can result in streams that are barren of aquatic flora. Similarly, growth of canopy vegetation declines as a function of shade, as well as crowding (Poulson & Platt, 1989). Given this, there is the potential of shading from structures to cause decline of some canopy species of trees. However, in some circumstances shading can be beneficial, such as where some species benefit from partial shading (50 per cent shade) (Sari, Triadiati & Ratnadewi, 2017).

Shading is also known to affect the physical and chemical properties of small and moderate sized watercourses by reducing incident radiation and temperature. As such, shading has been found to be an effective tool in improving water quality and reducing the risk of eutrophication (Ghermandi *et al.*, 2009).

In unaltered ecosystems, this shading function would normally be provided by riparian canopy trees, but in a disturbed waterway artificial shading may play a similar functional role to those pre-existing riparian canopy trees and so improve water and habitat quality.

Literature suggests that the ecological impact of shading is varied and unclear and it is likely to depend on the pre-existing conditions of the ecosystem. Within the context of North East Link, shading may have a negative impact on retained native and planted vegetation.

While it may have a negative impact on the growth of canopy vegetation, it may also improve soil conditions. Nevertheless, within this impact assessment it is assumed that where >50 per cent average annual shading occurs as a result of new structures, loss to vegetation (remnant or amenity) would be assumed.

For fauna, shading that results in substantial changes to vegetation may result in localised loss or degradation of habitat (see Section 12.1.2).

Vegetation areas potentially affected by shading would include those located in the immediate vicinity of noise walls (particularly on the south side) and those under elevated structures.

Shade modelling has not been completed for elevated structures and noise walls, as total native vegetation loss is currently assumed for vegetation within the project boundary. For the purpose of this assessment it is assumed that 100 per cent of native vegetation that exists below proposed elevated structures would be considered lost and so this is included in offset calculations (EPR FF2). Vegetation immediately south of noise walls where shading would increase may be affected to some degree. The extent of the impact would vary by species. However, as a conservative assessment these have also been considered lost and have been included in offset calculations. To minimise impacts of shading, during the design phase, overhead structures and noise walls should be designed to maximise penetration of light under structures (EPR LV1).

Through the implementation of these EPRs, the risk rating for non-threatened native flora (EC27) is expected to be low (local scale, long-term duration [8+ years] and still possible). The residual risk rating for threatened flora or communities (EC28) is also expected to be low (local scale, medium severity, long-term duration [8+ years] and moderate consequence overall, but unlikely to occur).

Shading of waterways from structures causing the loss or degradation of aquatic and riparian vegetation that degrades aquatic habitat quality (risk EC30); or resulting in reduced nutrient processing, leading to increased nutrient transport that degrades downstream aquatic ecosystems (risk EC39)

Vegetation in waterways provides important ecosystem functions that contributes to the quality of aquatic habitat. Vegetation provides habitat for aquatic fauna, and epiphytic microbiome, stabilises sediments, provides food source for aquatic and terrestrial fauna and contributes to nutrient processing and organic cycling. The ecosystem services provided by instream vegetation can be substantial, and are often replicated in WSUD features for the management of nutrient, sediment and other contaminant transport in waterways. Thus, changes to aquatic vegetation from shading can impact aquatic habitat quality and reduce the ecosystem services provided by the waterway. This assessment has considered the potential for shading caused by North East Link structures to impact aquatic habitat and ecosystems.

The impact of shading from new or modified bridges on light availability for aquatic vegetation is not considered significant, as the width and elevation of these structures would allow for ample light penetration to the waterway beneath. Any increase in shading of the Yarra River at these locations is negligible, compared with the natural shading from riparian vegetation and channel topography.

Areas of waterways where shading from the project would be significant are the reaches of Koonung Creek, where the waterway would be modified to a covered channel (causing complete shading) or where the existing channel would be located to the south of proposed noise walls (partial shading) along the southern edge of the Eastern Freeway. The assessment of instream vegetation in Koonung Creek adjacent to existing noise walls on Eastern Freeway indicated that these reaches do not contain abundant aquatic plants or algal biofilm. Although the riparian vegetation alongside noise walls can support tall canopy trees, these areas contain little understorey, compared with areas not shaded by noise walls.

Therefore, for the purposes of assessing the impact of shading on aquatic habitat or ecosystems function, the impacts of shading from covered waterway and noise wall shading are expected to reduce the viability of aquatic vegetation. Changes to the presence of aquatic vegetation can affect the suitability of habitat for aquatic fauna. This vegetation includes submerged plants, emergent reeds and rushes, fringing vegetation, filamentous algae and benthic algae. The presence of vegetation in a waterway is dependent on numerous factors, including flow, water depth, substrate and light. Most waterways are shaded to some extent by riparian vegetation. However, sections of streams in the project boundary are also impacted by urban structures, such as noise walls or bridges. These affect the suitability for the waterway to support aquatic plants, and the aquatic habitat in these sites is compromised. For background information see EC27.

Although partially shaded sites can resemble naturally shaded riparian vegetation, waterways that are totally covered would contain no vegetation, and are considered as heavily degraded aquatic habitat. The addition of increased shading of waterways from the project would limit aquatic vegetation, and the degree of habitat degradation would likely be proportional to the degree of shading. Areas where Koonung Creek would be covered would not support any aquatic vegetation, and lose both aquatic habitat quality and ecosystem services provided by instream vegetation. Areas of the creek on the south of noise walls would have partial shading, which might retain some aquatic habitat, but depleted ecosystem services from a reduction of instream vegetation.

The ecosystem services provided by aquatic plants in urban waterways include nutrient processing, which results in a reduction in nutrient loads to downstream systems. The aquatic plants also provide sediment stabilisation, which reduces erosion, improves water clarity and supports habitat and natural biological processes in the interface between anaerobic and aerobic zones. Many of these services are those which are replicated in WSUD features, such as sediment capture ponds and water quality polishing wetlands. Loss or degradation of instream vegetation from shading by noise walls, or covering the waterway would reduce the existing water treatment services provided by the aquatic ecosystem of Koonung Creek. These services impact the transport of contaminants to downstream locations, and so the impacts of any change to naturally occurring instream water treatment services would be observed in downstream ecosystems.

Minimising direct impacts to aquatic habitats should be part of the project design, by minimising the footprint that requires structures that could impact light levels on aquatic habitat (EPR FF4). The modifications to waterways, including the containment and covering of waterways should be minimised, with any diversion of waterway to be designed as open and naturalised wherever possible (EPR SW8). The placement and design of noise walls should consider the shading footprint over waterways, and aim to minimise the impacts to aquatic vegetation (EPR LV1). Opportunities to expand the use WSUD to offset any loss of specific ecosystem services resulting from changes to aquatic habitat, specifically nutrient and sediment management, could be explored where practicable during detailed design. Through the implementation of these EPRs, the residual risk rating for shading causing the loss or degradation of aquatic and riparian vegetation that degrades aquatic habitat quality (EC30) is expected to be medium (local scale, low severity, minor consequence overall, but long-term duration [8+ years] and almost certain).

The residual risk rating for shading resulting in reduced nutrient processing (EC39) is also expected to be medium (wider region, low severity, but moderate consequence overall, long-term duration [8+ years] and possible).

### 12.2.2 Groundwater changes during operation resulting in degradation of terrestrial or aquatic ecosystems

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC35	Low
Risk EC29	Medium

#### Groundwater changes during operation resulting in degradation of terrestrial groundwater dependent ecosystems (risk EC29)

Terrestrial GDEs are reliant on the availability of water beneath the surface. Relationships between groundwater and GDEs are described in Section 10. Groundwater extraction would occur around the tunnel portal areas during North East Link's construction (Section 12.1.6) but would then cease. From that point on, groundwater levels would gradually re-adjust (increasing or decreasing) during the project's operation to new levels, flowing around the tunnels and portals. In some areas, depth to water is predicted to remain below the original level during operation. In other areas, it is predicted to mound (a rise in water table depth) over an extended period. Mounding is expected to stabilise after 50 years (2075) (refer to Technical report N – Groundwater).

The extent and magnitude of potential groundwater depressurisation (drawdown) after 50 years of operation of this project (year 2075) has been determined through groundwater modelling and is presented in Figure 17.

For the tunnelled section beneath Banyule Flats and Warringal Parklands (where terrestrial and aquatic habitats occur that are likely to support threatened and migratory fauna), there is negligible predicted change to groundwater levels and flow at year 2075 (Figure 17) (Section 8.5.2.5 of Technical report N – Groundwater).

Terrestrial and aquatic habitats for flora and fauna in the tunnelled section are not expected to be directly or indirectly impacted by the project.

Areas outside the project boundary have the potential to be impacted by groundwater changes resulting from the project. There are three main geographic areas of focus in relation to GDEs where indirect effects on terrestrial GDEs may occur: 1) vicinity of the northern portal, including Simpson Barracks and Banyule Creek; 2) vicinity of the southern portal, including the Yarra River Flats; and 3) tunnels section, including Banyule Flats.

Trees outside the project boundary are likely to be accessing groundwater on occasions (10<20-metre groundwater depth zone) and have a moderate to high likelihood of being negatively impacted by groundwater drawdown during construction. These areas comprise Plains Grassy Woodland (dominated by River Red Gum, in association with Studley Park Gum) within Simpson Barracks and adjoining Commonwealth land, Colleen Reserve, Banyule Flats (Main Yarra Trail), River Gum Walk and Mercedes Court. In the 10<20 m groundwater depth zone in these localities, approximately 32 Large Trees (LTs), including three Studley Park Gum, have a reasonable likelihood of suffering a decline in health and/or premature death during operation of the project (ie to 2075). It should be noted that these numbers incorporate all trees identified in Section 12.1.6. Areas outside this groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

Although a number of large trees within Simpson Barracks have the potential (moderate to high likelihood) to suffer premature mortality over the long term, there are currently thousands of other younger trees approximately 10 to 20 metres in height (with diameter at breast height (DBH) ranging from 20 to 70 centimetres) within the moderate to high risk zones at Simpson Barracks. From 2024 to 2075, these trees are expected to grow and self-thin (due to density-dependent mortality) with many trees likely to move through the ranks into the LT category by 2075.

While groundwater levels may be slightly lower over the long-term, most of these trees are likely to have never accessed groundwater during their development, owing to their relatively smaller size (and shallower root systems) at the time of North East Link's construction, and subsequently, are unlikely to be affected by the projected drawdown as they are unlikely to be dependent on groundwater.

It should be noted that it is possible, even likely, that any LT losses due to groundwater drawdown may be countered by other trees growing and moving into the LT cohort over time. For example, it is estimated that more than 200 trees ranging in size from 50 to 79 centimetres DBH occur in the moderate to high risk zones at Simpson Barracks. While some of these trees may suffer premature mortality due to groundwater drawdown, many are likely to have root systems that do not penetrate deep enough to access groundwater, and by inference, drawdown would not impact these individuals. Consequently, over the 50-year timespan from 2024 to 2075, many of these trees are likely to become LTs (conservatively adding girth of c. 0.5 centimetres per year (for example, Bennetts & Jolly 2017 reported 0.44 centimetres year<sup>-1</sup> growth in River Red Gum in floodplain forests)), resulting in a scenario where it is quite probable there would be no net loss of LTs from Simpson Barracks.

Areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary, which are likely to be accessing groundwater, are unlikely to be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra floodplain are also unlikely to be negatively impacted.

The deep pool at the eastern end of Bolin Bolin Billabong is likely to reduce in size. Under current conditions, as the billabong recedes from a fully inundated condition to the remnant deep pool, water quality deteriorates to the point that it only supports tolerant aquatic fauna. Therefore, the ecological significance of the lowered water levels is uncertain, although there is no evidence this pool provides refuge habitat for any threatened aquatic species. However, it is likely to provide water supply for the native terrestrial fauna. Managed water levels in this wetland may be required to maintain the ecological condition of the billabong.

Groundwater dependent ecosystems are modelled extensively across the Banyule Flats area. However, as groundwater drawdown resulting from North East Link's construction is modelled to be less than 0.1 metres throughout ecological values mapped within the main tunnelled section of the project boundary, including the Banyule Flats, the potential for negative ecological impacts is considered negligible in this area.

Given the variability and uncertainty in dependency of GDEs within the study area (Section 10), potential impacts would be monitored and managed through:

- Implementation of groundwater monitoring (EPR GW2)
- Implementation of a groundwater dependent ecosystem monitoring and mitigation plan (EPR FF6).

It is particularly important to understand the potential impacts to the Yarra River and relatively good condition vegetation within Simpson Barracks and nearby reserves. Where vegetation may be significantly impacted by groundwater drawdown, it would be considered removed and would need to be offset according to the Guidelines (DELWP, 2017a) (EPR reference FF2).

### Groundwater changes during operation resulting in changes to aquatic groundwater dependent ecosystems (risk EC35)

Aquatic GDEs are surface GDEs. Relationships between groundwater and GDEs are described in Section 10.

The key aquatic habitat that would likely be impacted by changes to the levels of groundwater are the groundwater dependent deep pool wetland with limited catchment inflows (that is, Bolin Bolin Billabong). Waterways with larger catchments and more permanent baseflow (such as the Yarra River and Koonung Creek) or intermittent streams that are not impacted by groundwater changes (such as Banyule Creek) are not expected to have significant groundwater impacts of hydrology or aquatic habitat quality.

The modelled groundwater drawdown in the northern portal indicates the impacts to groundwater levels are not expected to affect reaches of Banyule Creek that are maintained by groundwater fed baseflows. The field assessment of Banyule Creek revealed that groundwater supplemented baseflows in Banyule Creek occur more than one kilometre south of Lower Plenty Road, which is well outside the drawdown area. This suggests that Banyule Creek flows and water level in Banyule Swamp would not be impacted by dewatering in the northern portal.

The modelled groundwater drawdown for the southern portal indicates that the extent of dewatering may reach the edges of Bolin Bolin Billabong. The eastern extent of Bolin Bolin Billabong contains the deepest pool that is thought to be permanent, and maintained by alluvial groundwater (Jacobs, 2017). Thus, there is some uncertainty about the impact of groundwater changes on the aquatic habitat in Bolin Bolin Billabong. The ecological assessment of this aquatic habitat indicated the site has little modification from expected natural conditions, apart from altered hydrological connection from the Yarra River overbank flows. The management of the billabong now includes an environmental water regime that aims to replicate natural conditions. Natural flooding of the billabong occurs occasionally, although less frequently than previously due to the regulation of flows in the Yarra River. Melbourne Water's planned environmental watering regime is focused on supplementing the natural flooding phase of the billabong, to provide inundation events two of every three years (pers. Comm. Melbourne Water). Some management intervention is thus already being undertaken to support this high value, natural ecosystem. The flooding or inundation of the billabong is the dominant hydrological feature affecting the aquatic ecology of Bolin Bolin Billabong. This inundation effectively 'resets' the aquatic habitat conditions, including water level, water quality, aquatic species present. Antecedent surface water conditions of the deep pool under dry phase conditions are considered to have relatively negligible influence on the flooded phase or subsequent dry phase. Therefore changes to surface water level resulting groundwater drawdown is not expected to affect the aquatic ecology of the billabong, if the change is within the range of natural interannual variability. The modelled groundwater drawdown of 0.1 to 0.5 metres is well within the range of water level change experienced in the deep pool during the dry phase.

The protection of ecological values at this site is likely to be dependent on maintaining the hydrological regime – flooded phase alternating with dry phase. Aquatic habitat during the dry phase is believed to be maintained by groundwater. However, the details of the reliance on groundwater is unclear (see discussion in Section 10.3.2). A detailed groundwater and surface water monitoring program would be required to monitor any changes to conditions that could degrade aquatic ecosystems (EPR FF6, EPR GW2, EPR SW4). This would also need to consider the potential for exposure of acid sulfate soils that may be present in the organic rich quaternary alluvial sediments of the Yarra floodplain (Technical report O – Contamination and soil) that could cause additional ecological impacts (EPR CL2). Groundwater management measures may be required to supplement surface water levels of the deep pool in the billabong (EPR GW5). This would need to include protection of groundwater quality and surface water quality, and prevention of contamination of groundwater that could impact GDEs.

It is important to note that artificial supplementation of the pool from surface water or other sources may or may not be appropriate for this ecosystem, as the aquatic ecological conditions of billabongs are dynamic through time and the effects of water source or watering mechanism may have significant ecological differences. The water quality conditions of the deep pool of Bolin Bolin Billabong is vastly different during the flooded/inundated phase compared with the dry phase where the aquatic habitat has receded to the deep pool. Managing the hydrology and environmental condition of the isolated deep pool should be considered as a distinct phase of the billabong wetting and drying cycle, separate but connected to the natural or managed flooding events. Any design of surface water or groundwater management systems should consider aquatic habitat protection (EPR FF4).

### 12.2.3 Disturbance of fauna through noise, vibration or lighting

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC31, Risk EC32	Low

#### **Operational noise, vibration and/or lighting resulting in elevated disturbance to threatened fauna (risk EC31) or significant impact on non-threatened native fauna (risk EC32)**

Operation and use of the roads would generate noise (engines, engine braking, tyres, horns) and require lighting at night (overhead lights to enable better visibility for motorists) that may disturb or displace native or non-native fauna. Disturbance from noise and light are not expected to impact on fauna through the tunnelled section of the corridor.

Vibrations are not expected to impact on threatened fauna during the project's operation.

See Section 12.1.8 for background information on this impact and applicable EPRs.

Along sections of road that would abut fauna habitat (such as along parts of Koonung Creek, the Yarra River and Simpson Barracks) and in the absence of noise walls, operational noise may establish a 'noise impact zone' adjacent to the roads, particularly during noisy periods. In this zone, fauna may not be able to hear each other (or potential predators) due to the noise, which could result in a number of responses. Vocal fauna that cannot hear each other may alter their vocal behaviour – they may abandon calling in that zone and focus on other aspects of life (such as foraging), or with time some species may alter the characteristics of their calls to be more audible to others with the background noise (Parris *et al.*, 2009; Parris 2013; Parris, 2015). Alternatively, they may abandon the area and seek a habitat patch where they can call and hear each other.

Other fauna (such as the Eastern Grey Kangaroo at Simpson Barracks) may move away from the roadway during noise periods, to better hear their surroundings (for potential predators).

The width of this zone would likely vary with location and time, depending on the prevailing noise levels. At times of less noise, fauna would be expected to re-enter the impacts zone and use them as normal habitat.

Noise impacts on individuals or on species (such as impacts on their social structure) in already noisy environments is poorly known. For common and adaptable species that reside in or regularly visit urbanised areas, the impact is expected to be minor. It may lead to gradual changes in fauna composition (in noisy areas, bolder species less susceptible to noise may dominate over species more sensitive to noise), but that type of change is likely to have occurred already across much of the Melbourne area, including the project boundary.

Additional lighting from North East Link once it was operating would increase light levels in some areas, but because the area is already well-lit with street lights, it is not expected to result in broad scale increases across the entire project corridor. As for noise, fauna in the urbanised Melbourne area already live with and cope with an artificially lit environment at night. Nocturnal and diurnal fauna that occur within or visit the area are likely to have coping mechanisms for light. Lighting across the area is not even, and fauna are likely to seek the light conditions that best suit their requirements and tolerances.

Impacts on non-threatened terrestrial fauna are expected to be minimal but more widespread than those on threatened fauna, due to the ubiquitous distribution of non-threatened fauna and the localised distribution of threatened fauna along the project corridor.

Because habitat for threatened species is localised along the corridor (such as at Yarra Bend Park), disturbance impacts of noise and lighting on threatened species would be localised. With mitigation and the implementation of design EPRs (EPR EMF2, EPR LV4, EPR NV2), impacts from operational noise and light on the Grey-headed Flying-fox colony at Yarra Bend are expected to be minimal. This section of the Eastern Freeway is already very noisy (daily noise from commuting and base-flow traffic) and well-lit at night. Given the distance from the road to the colony, and sound/distance relationship (sound level decreases by 6 dB per doubling the distance), the level of additional noise reaching the colony is expected to be relatively low. Given the already restricted line of sight between the roadway and the current colony, operational lighting is not expected to increase greatly on existing levels of road lighting.

Noise walls added to the completed roads for social and amenity purposes (screens and vegetation) are expected to effectively reduce the impacts of noise on local fauna. Measures to reduce the effects of operational noise would be specified in the OEMP and noise EPRs.

The implementation of noise and vibration EPRs during construction (EPR NV3 and EPR NV4) would ensure that noise sensitive receptors along the project alignment are identified, through a Construction Noise and Vibration Management Plan (CNVMP). With EPR NV2 (Traffic noise monitoring), traffic noise would be measured prior to and upon opening, and during operation of North East Link, in accordance with VicRoads requirements. Remedial action would be taken in the event that measured traffic noise levels exceeded the noise performance requirements.

Design features would help reduce the escape of light during operation (for example, lights can be directed downwards rather than outwards, and light screens and planted vegetation can be used between roadways and potentially sensitive habitats, such as wetlands) (EPR AR3). Measures to reduce the effects of light would be specified in the OEMP and lighting EPRs. EPR LV4 (Lighting – operation) would see that lighting used during operation is designed in accordance with local council requirements and relevant standards.

#### 12.2.4 Degradation of aquatic habitat through waterway modification

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC36	Medium
Risk EC33, Risk EC37	Low

##### **Enclosing waterways resulting in reduced viability of native aquatic species (risk EC33)**

For background information see risk EC18 (Section 12.1.4). This risk addresses the localised effects of enclosing a waterway on the existing fauna that inhabit the modified segment of waterway. The extent of impact is localised, which keeps the risk level low.

The aquatic fauna likely to be present in waterways impacted by habitat modification are either dominated by exotic species (Koonung Creek) or there is very little available habitat or passage under existing conditions to support native fish (Banyule Creek). Covering of waterways indefinitely would likely impact on native aquatic species that inhabit Koonung Creek and Banyule Creek. However, the potential impacts in Koonung Creek are also considered in the context of the existing conditions, with approximately three kilometres of the 11-kilometre creek already comprised of a continuous enclosed waterway. Along with a less productive ecosystem within the enclosed waterway, there would likely be a behavioural response by fish.

Fish may avoid entering the poorly illuminated pipes during daylight hours, due to the light intensity itself or to the sharp transition from light to dark (Jackson, 1996; Jones *et al.*, 2017). In addition, featureless pipes are likely to offer little in the way of refuge under flowing conditions, which may cause a physical barrier to passage.

##### **Changed waterway form resulting in loss of connectivity and impeded passage for native aquatic species (risk EC36)**

See EC18 for background information (Section 12.1.4). This risk addresses the effects that impeded passage can have on aquatic species across the stream network, beyond the extent of physical modifications to the waterway. The wider extent of impact raises the risk level to medium.

The long-term changes to Koonung and Banyule Creeks would reduce connectivity in these waterways. In Banyule Creek, the headwaters affected by channel modification do not currently provide important aquatic habitat, and the loss of connectivity at this site is not significant for aquatic species. However, Koonung Creek contains native fish species that do require connectivity between habitats. The change of waterway form, especially the containment and covering of the channel may result in impeded passage for these species (Jackson, 1996; Jones *et al.*, 2017). However, the current form of Koonung Creek (which is approximately 11 kilometres long) contains constructed channels, drop structures (between Thompsons Road and Doncaster Road) and approximately three kilometres of covered sections. Each of these existing waterway structures could potentially act as physical or behavioural barriers to fish passage.

Fish surveys undertaken in Koonung Creek indicated that few species of native fish were present, and the occurrence of mostly large mature individuals in upstream reaches indicates the absence of young recruits. As such, the fish species present are able to find passage at least occasionally. This suggests the existing fish passage in Koonung Creek is possible but the viability of the population is potentially affected by limited recruitment in reaches upstream. The construction of further covered sections and other changes to waterway forms may create additional barriers that could impede passage.

The creation of a naturalised channel where channel modification occurs would likely support the return of some aquatic ecosystem values and improve waterway health by re-creating suitable habitat for native aquatic fauna at these locations (EPR SW8). Design of waterways could include the removal of existing drop structures or other physical barriers to fish passage in Koonung Creek. If this can be achieved, a net improvement in connectivity in Koonung Creek may result.

The impacts of the project on fish passage could be minimised by reducing design impacts on aquatic habitats, including appropriate flow and water velocities (EPR FF4). For the covered waterway sections, this might include low-flow channel containing natural substrates (such as boulders and cobbles) to provide suitable refuge and flow diversity. The management of surface water from the project requires consideration of the potential barriers to aquatic fauna due to stream flow velocity and structures and inclusion of measures to avoid the creation of new barriers (EPR SW6).

#### **Changes to stormwater drainage resulting in hydraulic impact to waterways that degrades aquatic ecosystems (risk EC37)**

An increase in paved surface is planned as part of the new roads, with consequential increase in stormwater drainage that needs to be discharged to urban waterways in and around the project boundary. The implementation of water sensitive urban and road drainage design (EPR SW11) would need to include the prevention of stormwater surges that could degrade aquatic ecosystems. Urban stormwater is regarded as one of the two most threatening processes to aquatic ecosystems in the urban environment (Walsh & Webb, 2016), with the major mechanisms of impact from flow velocity and scouring of aquatic habitats. WSUD features should be designed to prevent flooding and water quality impacts as well as maintain or improve the hydrology of waterways to reduce the impacts of stormwater runoff from new directly connected impervious surfaces.

Design of drainage should minimise impact to aquatic habitats (EPR FF4). Modelling of flow velocity in waterway should be undertaken (EPR SW6). Where drainage inputs to waterway are likely to ecologically significantly change the magnitude or duration of peak flows, waterway channel modifications may be required to ameliorate the hydrological impacts (EPR SW8). This may include bank stabilisation works at drainage outfalls, channel and/or floodplain storage capacity and engagement modifications to minimise the impacts of high flows on aquatic habitat, and provision of refuges for aquatic fauna.

#### **12.2.5 Death or injury of fauna during road operation**

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC34	Low

#### **Increased volumes of traffic resulting in death or injury of native fauna (risk EC34)**

Operation of the roads may result in death or injury to fauna as they attempt to cross roads with large volumes of fast-moving traffic. Fauna most at risk are fauna that readily cross substantial barriers such as main roads to get to other habitat patches, including possums, birds, foxes, rabbits and kangaroos. In the eastern suburbs of Melbourne, these tend to be common species, and death or injury of uncommon or threatened species is expected to be rare.

The project setting is an already busy urban landscape. Death or injury of some fauna may occur, but is expected to be infrequent and localised, and most likely to affect individuals rather than populations or species. Fencing along the roadways would be required for safety and security purposes and would deter most fauna, greatly reducing the risk of injury and harm. Birds would still be able to fly across the roads at low elevation, and those birds would be at greatest risk of collisions. These include Sulphur-crested Cockatoos, Galahs, Long-billed Corellas and ravens, all of which are common to abundant in the Melbourne area.

Measures to avoid harming fauna, and to deal with injured fauna if found, would be specified in the OEMP (EPR EMF2).

#### 12.2.6 Degradation of aquatic habitat through contaminated runoff

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC38	Low

##### **Increased road traffic resulting in increased pollutants (metals, hydrocarbons) in stormwater runoff to waterways that degrades aquatic ecosystems (risk EC38)**

Increased traffic from the project is expected to increase the generation of road-borne pollution, such as hydrocarbons and metals. The transport of these to aquatic ecosystems by stormwater runoff has the potential to lead to a degradation of water and sediment quality in receiving aquatic environments. This process would result in an accumulation of pollutants over the longer term and a degradation of aquatic ecosystems due to increased toxicity in sediments and water. The use of WSUD would mitigate against this risk by capturing run-off before it reaches waterways within the study area (EPR SW11). WSUD features would be required to manage pollutants load so there was no net increase of load to waterways or natural wetlands. In addition, spill containment would be provided for new and upgraded roads (EPR SW2) and runoff would be required to meet State Environmental Protection Policy requirements (EPR SW1).

The design of the road and drainage network should avoid impacts to aquatic habitats (EPR FF4) through placement of drainage inputs to waterways at locations that avoid input of pollutants to aquatic ecosystems. Any works on the drainage network and waterways should include elements that enhance the ecosystem services to build resilience to degradation from pollutants (EPR SW8).

#### 12.2.7 Detrimental changes to groundwater, soil and terrestrial vegetation and habitat as a result of tunnel presence

The following risk pathways are discussed under this impact category:

Risk pathways	Risk rating
Risk EC40	Low

##### **Groundwater changes in the vicinity of the tunnel causing long-term detrimental changes in terrestrial and aquatic ecosystems (risk EC40)**

The placement of road tunnels underground has the potential to modify the movement of groundwater in the immediate location of the tunnel across a wider area. These changes may raise or lower the groundwater level at various locations. Lowering of the groundwater could impact on terrestrial or aquatic groundwater dependent ecosystems, whereas raising of the groundwater could impact on ecosystems not previously reliant on groundwater, but sensitive to greater levels of inundation, saturation or salinity.

Groundwater modelling (EPR GW1), groundwater monitoring (EPR GW2) and groundwater dependent ecosystem (GDE) monitoring (EPR FF6) are required to forecast and confirm any changes of groundwater level across areas containing ecological values. Specifically, the monitoring of water levels in areas of vegetation and wetlands potentially impacted by groundwater changes (Banyule Flats and Banyule Swamp). Monitoring should include changes to hydrology and habitat types suitable for threatened species (such as snipe, bitterns, owls, ducks and egrets) that use those habitats. A mitigation plan for any impacts to GDEs is also required.

The design of the tunnel should consider the location of these ecological values to minimise impacts to aquatic ecosystems (EPR FF4). The drainage and construction design for the tunnels should include the requirements to avoid and minimise groundwater changes that could impact ecological values (EPR GW3) and the management of groundwater during the project's operation would require protection of ecological values to be included in the management measures (EPR GW5).

The extent and magnitude of potential groundwater changes are presented in Figure 11. For the tunnelled section between the portals (where terrestrial and aquatic habitats occur that are likely to support threatened and migratory fauna) there is negligible predicted change to groundwater levels and flow at the end of construction and by 2075 (Figure 9 and Figure 10). A numerical modelling scenario was undertaken to predict mounding beneath the floodplain as a result of the TBM tunnel (Section 8.5.2.5 of Technical report N – Groundwater). The results do not predict mounding beneath the floodplain—groundwater is predicted to flow above and below the tunnel within the bedrock aquifer, without resulting in an increase in water levels in the overlying alluvial sediments. Some mounding of up to 0.2 metres was noted on the eastern side of the TBM between the floodplain and the northern portal, but within the bedrock aquifer.

Terrestrial and aquatic habitats for flora and fauna in the tunnelled section are not expected to be directly or indirectly impacted by the project.

### 12.3 Alternative design options

Although the reference design for North East Link has been adopted for the purposes of the EES, there are currently two design options being considered for the arrangement of the Manningham Road interchange, and two locations for the launch of the tunnel boring machine (TBM). For information on the design options, refer to EES Chapter 8 – Project description.

This section explains how the potential impacts associated with the alternative design options would differ from the impacts associated with the reference design assessed in Section 12.1 and Section 12.2.

#### 12.3.1 Manningham Road interchange alternative design

The potential ecological impacts of the alternative design for the Manningham Road interchange have been reviewed. With specific reference to ecological matters, the alternative design includes the following:

- A smaller and narrower (compared with the reference design) area of surface impact within the former Bulleen Drive-in site (west of Bulleen Road, south of Manningham Road), which is currently cleared of its native vegetation and dominated by non-native grasses (so no additional impact)
- A slightly broader (~30 metre) area of surface impact and loss of habitat in the Yarra Flats habitats north of the former Bulleen Drive-in site, which may result in the loss of additional trees.

This alternative would not change impacts to aquatic ecosystems.

### 12.3.2 Northern tunnel boring machine (TBM) alternative launch site

The potential ecological impacts of the alternative TBM launch site have been reviewed.

Launching the TBM from the northern portal would not be expected to change the assessment provided in Section 12.1 and Section 12.2 above, since the option does not change the project footprint and it assumed that all vegetation within the footprint would be removed. Therefore, the same EPRs would be effective at minimising the impacts.

Modelling of the drawdown associated with the TBM retrieval shaft is shown in Technical Report N – Groundwater. The drawdown would not have impacts on any additional native vegetation, considered large trees or scattered trees.

# 13. Environmental Performance Requirements

Table 47 lists the Environmental Performance Requirements relevant to ecology.

Table 47 Environmental Performance Requirements

EPR ID	Environmental Performance Requirement
EPR FF1	<p><b>Minimise impacts on fauna and flora</b></p> <p>The CEMP must include requirements and methods for:</p> <ul style="list-style-type: none"> <li>Managing fauna that may be displaced due to vegetation removal or encountered on site during construction works in compliance with the <i>Wildlife Act 1975</i> and in consultation with public land managers where relevant</li> <li>Complying with the <i>Fisheries Act 1995</i></li> <li>Undertaking pre-clearing surveys and inspections to confirm the on-site location of fauna immediately prior to tree removal or, where relevant, works on waterways, and to assist fauna to safety as necessary</li> <li>Contingency and reporting procedures for the event that a listed threatened species is identified in order to mitigate any potential for significant impacts on the listed threatened species</li> </ul> <p>Surveys, inspections and management actions must be undertaken by a qualified wildlife ecologist or aquatic ecologist with all necessary authorisations obtained prior to removal of fauna habitat.</p>
EPR FF2	<p><b>Minimise and offset native vegetation removal</b></p> <p>Through detailed design, minimise the removal of native vegetation and fauna habitat and impacts on habitat connectivity, in particular in relation to <i>Environment Protection and Biodiversity Conservation Act 1999 (Cth)</i> or <i>Flora and Fauna Guarantee Act 1988</i> listed threatened species. This must include minimising removal of Matted Flax Lily, the locally endemic Studley Park Gum and the loss of potential foraging habitat for the Powerful Owl, Swift Parrot and Grey-headed Flying Fox. Key areas for minimisation efforts must include Simpson Barracks, Yarra Bend, Trinity Grammar wetlands and the Koonung Creek valley.</p> <p>The CEMP must include requirements for protection of native vegetation and listed species, including establishment of no-go-zones to protect vegetation to be retained and Tree Protection Plan(s) as required by EPR AR2. No-go-zones must also be established for:</p> <ul style="list-style-type: none"> <li>The Grey-headed Flying fox Campsite within the Yarra Bend Park</li> <li>Bolin Bolin Billabong</li> <li>The Plains Grassy Woodland community between Enterprise Drive and the M80 Ring Road in Bundoora</li> <li>The portion of 49 Greenaway Street, Bulleen (former Drive-in) heavy vegetated with trees along the Yarra River</li> <li>Surface impacts in the Banyule Flats and Warringal Parklands and the Heide Museum of Modern Art.</li> </ul> <p>Every effort must be made to avoid ecological impacts in other locations that are known to provide high habitat value for significant fauna species.</p> <p>Where the removal of native vegetation is unavoidable the project must meet the offset requirements of the Guidelines for the removal, destruction or lopping of native vegetation, DELWP December 2017 except as otherwise agreed to by the Secretary to DELWP.</p> <p>Where appropriate for the landscape and project location, tree replacement (as required by EPR AR3) and landscaping is to use locally indigenous species (utilising seed collected from species within the project boundary where appropriate and practical), which are suited to the landscape profile and setting being revegetated, and seek to maximise habitat value and connectivity for native fauna. Where practicable and appropriate for the landscape and project location, best practice measures must be applied to retain and reinstate topsoil to support growing conditions for native species. Where topsoil cannot be retained or reused for North East Link, alternative opportunities for reuse must be explored.</p>

EPR ID	Environmental Performance Requirement
EPR FF3	<p><b>Avoid introduction or spread of weeds and pathogens</b></p> <p>The CEMP must include measures to avoid the spread or introduction of weeds and pathogens during construction, including vehicle and equipment hygiene.</p>
EPR FF4	<p><b>Protect aquatic habitat</b></p> <p>Design, locate and construct structures to minimise short and long term adverse impacts on riparian, riverbed and aquatic habitat in waterways and wetlands, including billabongs. The CEMP must contain and require implementation of measures to minimise adverse impacts from construction activities on riparian, riverbed and aquatic habitat and aquatic fauna connectivity.</p>
EPR FF5	<p><b>Obtain <i>Flora and Fauna Guarantee Act 1988</i> permits</b></p> <p>A permit must be obtained to take and destroy flora species protected under <i>the Flora and Fauna Guarantee Act 1988</i>.</p>
EPR FF6	<p><b>Implement a groundwater dependent ecosystem monitoring and mitigation plan</b></p> <p>Prepare and implement a Groundwater Dependent Ecosystem Monitoring and Mitigation Plan. The Groundwater Dependent Ecosystem Monitoring and Mitigation Plan must be informed by the groundwater modelling and groundwater monitoring required by EPR GW1 and EPR GW2. Where the survival of Groundwater Dependent Large Trees is predicted to be affected based on groundwater modelling outputs, offsets must be obtained in accordance with EPR FF2.</p>
EPR FF7	<p><b>Implement a salvage and translocation plan for Matted Flax-lily</b></p> <p>Where direct impacts on Matted Flax-lily occur, a salvage and translocation plan must be developed and implemented to the satisfaction of the Department of Environment, Land, Water and Planning and the Commonwealth Department of Environment and Energy.</p>
EPR FF8	<p><b>Minimise intense noise and vibration impacts on Australian Grayling</b></p> <p>The CEMP must include and require implementation of reasonable measures to avoid and mitigate intense noise and vibration impacts in or near the Yarra River (eg from activities such as pile driving and similar activities). This must include, to the extent practicable:</p> <ul style="list-style-type: none"> <li>• Selection of work methods to minimise noise and vibration</li> <li>• Avoiding activities that may generate intense noise and vibration and impact on the Australian Grayling during critical migration or breeding periods (March to June, September to November) as defined within the National Recovery Plan for the Australian Grayling <i>Prototroctes maraena</i> (Backhouse, G, Jackson, J &amp; O'Connor, J 2008).</li> <li>• Management and monitoring of noise and vibration in accordance with the CNVMP (EPR NV4).</li> </ul>
EPR FF9	<p><b>Protect fauna habitat values in existing waterbodies that are modified for drainage purposes</b></p> <p>Where existing waterbodies within or near the project boundary are to be modified for drainage purposes (for example Simpson's Lake, billabongs, and the southernmost waterbody in the Freeway golf course), the CEMP must include and require implementation of measures to minimise impacts on waterbirds that use the wetlands including:</p> <ul style="list-style-type: none"> <li>• Retain dead and alive standing trees in and surrounding the waterbody</li> <li>• As far as practicable, undertake activities outside the typical nesting period for waterbirds (typically Sept to Jan)</li> <li>• Minimise the construction period to the extent practicable and refill the wetlands post construction if they have been drained.</li> </ul>
EPR EMF2	<p><b>Deliver project in accordance with an Environmental Strategy and Management Plans</b></p> <p>Prepare and implement an Environmental Strategy, Construction Environmental Management Plan (CEMP), Worksite Environmental Management Plans (WEMPs), Operation Environmental Management Plan (OEMP) (operator only) and other plans as required by the Environmental Performance Requirements (EPRs) and in accordance with the Environmental Management Framework (EMF).</p> <p>The Environmental Strategy, CEMP, WEMPs and OEMP must be developed in consultation with relevant stakeholders as listed in the EMF and as required by NELP or under any statutory approvals.</p> <p>The CEMP must be prepared with reference to EPA Victoria Publication 480 Best Practice Environmental Management: Environmental Guidelines for Major Construction Sites.</p>

EPR ID	Environmental Performance Requirement
EPR AR1	<p><b>Develop and implement a Tree Removal Plan</b></p> <p>Develop and implement a Tree Removal Plan, as part of the CEMP, that identifies all trees within the project boundary and specifies:</p> <ul style="list-style-type: none"> <li>• Trees to be removed or retained as part of the works</li> <li>• The condition and arboricultural value of the trees to be removed</li> <li>• A protocol for tree removal that addresses the requirements of EPR FF1, EPR FF2 and EPR FF5.</li> </ul> <p>Tree retention must be maximised to the extent practicable through detailed design and selection of construction methods to minimise canopy loss, and in accordance with EPR FF1, including by retaining trees where practicable and minimising potential impacts to trees.</p> <p>Arboricultural assessments are to inform the detailed design, Tree Removal Plan and Tree Canopy Replacement Plan (required by EPR AR3) in order to maximise tree retention and long-term viability of amenity plantings in accordance with Australian Standard AS4970:2009 Protection of Trees on Development Sites.</p> <p>The Tree Removal Plan must be informed by a pre-construction site assessment to confirm the area and number of trees and other vegetation proposed to be impacted. Trees to be retained must be protected in accordance with EPR AR2. Vegetation removal is to occur in a staged manner with removal only occurring once necessary for the current stage of works.</p> <p>The area and number of trees and other vegetation actually removed is to be confirmed through a post-construction assessment.</p>
EPR AR2	<p><b>Implement a Tree Protection Plan(s) to protect trees to be retained</b></p> <p>The CEMP must include a Tree Protection Plan(s), which is to be developed and implemented in accordance with Australian Standard AS4970-2009 Protection of Trees on Development Sites. The Tree Protection Plan(s) must provide details of any tree protection actions that will ensure that trees proposed to be retained are adequately protected from the impact of construction or related activities, prior to those works being undertaken.</p> <p>Tree Protection Plans must be prepared based on detailed construction drawings and surveyed tree locations.</p> <p>Trees subject to protection must be monitored for a two-year period following completion of construction works in that location to assess ongoing viability, with maintenance or replacement of stressed or damaged specimens to be undertaken.</p>
EPR AR3	<p><b>Implement a Tree Canopy Replacement Plan</b></p> <p>Develop and implement a Tree Canopy Replacement Plan to replace the loss of canopy cover and achieve a net gain in tree canopy cover by 2045. The plan must show the location, size and species of replacement trees, in consultation with relevant land managers. The plan must specify requirements to support the long-term viability of replacement plantings including appropriate soil requirements, establishment works and ongoing maintenance.</p>

EPR ID	Environmental Performance Requirement
EPR CL1	<p><b>Implement a Spoil Management Plan</b></p> <ul style="list-style-type: none"> <li>• Prepare and implement a Spoil Management Plan (SMP) in accordance with relevant regulations, standards and best practice guidelines. The SMP must be developed in consultation with the EPA Victoria and include processes and measures to manage spoil. The SMP must define roles and responsibilities and include requirements and methods for:</li> <li>• Complying with applicable regulatory requirements</li> <li>• Completing a detailed site investigation (in accordance with Australian Standard AS 4482.1:2005 Guide to the investigation and sampling of sites with potentially contaminated soil and the EPA Victoria Industrial Waste Resource Guidelines) prior to any excavation of potentially contaminated areas to identify location, types and extent of impacts and to characterise spoil to inform spoil and waste management.</li> <li>• Identifying the nature and extent of spoil (clean fill and contaminated spoil)</li> <li>• Storage, handling, transport and disposal of spoil in a manner that protects human health and the environment and is consistent with the transport management plan(s) required by EPR T2. This includes requirements and methods for the appropriate treatment/remediation of any contaminated excavated spoil and contaminated residual material left on site</li> <li>• Design and management of temporary stockpile areas</li> <li>• Minimising impacts and risks from disturbance of acid sulfate soils (as per EPR CL2), odour (as per EPR CL3) and vapour and ground gas intrusion (as per EPR CL4)</li> <li>• Management of hazardous substances, including health, safety and environment procedures that address risks associated with exposure to hazardous substances for visitors and general public; contain measures to control exposure in accordance with relevant regulations, standards and best practice guidance and to the requirements of WorkSafe and EPA Victoria; and include method statements detailing monitoring and reporting requirements</li> <li>• Identifying where any contaminated or hazardous material is exposed during construction (notably through former landfills, service stations and industrial land) and how it will be made safe for the public and the environment. Beneficial uses of land and National Environment Protection (Assessment of Site Contamination) Measures 2013 guidance on criteria protective of those beneficial uses must be considered for the land uses in these areas. This must include methods for: <ul style="list-style-type: none"> <li>– Construction of appropriate cover (soil, concrete, geofabric etc.) such that no contamination is left exposed at the surface or where it may be readily accessed by the public and such that it cannot generate runoff or leachate during rain events.</li> <li>– Maintenance of the cover</li> <li>– Identification of the nature and depth of the contaminants</li> <li>– Mitigating impacts during sub-surface works in those areas, eg drilling and excavation</li> </ul> </li> <li>• Monitoring and reporting</li> <li>• Identifying locations and extent of any prescribed industrial waste (PIW), other waste, and the method for characterising PIW and other waste prior to excavation</li> <li>• Identifying and managing potential sites for re-use, management or disposal of any spoil in accordance with the Environment Protection Act 1970 waste management hierarchy</li> <li>• Identifying suitable sites for disposal of any waste. This includes identifying contingency arrangements for management of waste, where required, to address any identified capacity issues associated with the licensed landfills' ability to receive PIW and other waste.</li> </ul>
EPR CL2	<p><b>Minimise impacts from disturbance of acid sulfate soil</b></p> <p>The SMP referenced in EPR CL1 must include requirements and methods to minimise impacts from disturbance of acid sulfate soil, including but not limited to:</p> <ul style="list-style-type: none"> <li>• Characterising acid sulfate soil and rock prior to excavation</li> <li>• Developing appropriate stockpile areas including lining, covering and runoff collection to prevent release of acid to the environment</li> <li>• Identifying suitable sites for re-use management or disposal of acid sulfate soil and rock</li> <li>• Preventing oxidation that could lead to acid formation if possible through cover and/or scheduling practices, ie ensuring acid sulfate soil and rock is not left in stockpiles for any length of time and/or addition of neutralising compounds</li> </ul> <p>Requirements and methods must be in accordance with the Industrial Waste Management Policy (Waste Acid Sulfate Soils), EPA Victoria Publication 655.1 Acid Sulfate Soil and Rock, and the Department of Sustainability and Environment's Victorian Best Practice Guidelines for Assessing and Managing Coastal Acid Sulfate Soil.</p>

EPR ID	Environmental Performance Requirement
EPR CL5	<p><b>Manage chemicals, fuels and hazardous materials</b></p> <p>The CEMP and OEMP must include requirements for management of chemicals, fuels and hazardous materials including:</p> <ul style="list-style-type: none"> <li>Minimise chemical and fuel storage on site and store hazardous materials and dangerous goods in accordance with the relevant guidelines and requirements.</li> <li>Comply with the Victorian WorkCover Authority and Australian Standard AS1940 Storage Handling of Flammable and Combustible Liquids and EPA Victoria publications 480 Environmental Guidelines for Major Construction Sites and 347 Bunding Guidelines</li> <li>Develop and implement management measures for hazardous materials and dangerous substances, including: <ul style="list-style-type: none"> <li>Creating and maintaining a dangerous goods register</li> <li>Disposing of any hazardous materials, including asbestos, in accordance with Industrial Waste Management Policies, regulations and relevant guidelines</li> <li>Implementing requirements for the installation of bunds and precautions to reduce the risk of spills</li> </ul> </li> <li>Contingency and emergency response procedures to handle fuel and chemical spills, including availability of on-site hydrocarbon spill kits.</li> </ul>
EPR GM1	<p><b>Design and construction to be informed by a geotechnical model and assessment</b></p> <p>Develop and maintain geological and groundwater model(s) (as per EPR GW1) to inform tunnel and trench design and the construction techniques to be applied for the various geological and groundwater conditions. The model(s) are to:</p> <ul style="list-style-type: none"> <li>Identify sensitive receptors that may be impacted by ground movement</li> <li>Inform monitoring of ground movement and ground water levels prior to construction to identify pre-existing movement</li> <li>Inform tunnel design and the construction techniques to be applied for the various geological and groundwater conditions</li> <li>Assess potential drawdown and identify trigger levels for implementing additional mitigation measures to minimise potential primary consolidation settlement</li> <li>Assess potential ground movement from excavation and identify trigger levels for implementing additional mitigation measures to minimise potential ground movement.</li> </ul>
EPR GM2	<p><b>Implement a Ground Movement Plan to manage ground movement impacts</b></p> <p>Develop and implement a Ground Movement Plan(s). The Ground Movement Plan must be informed by EPR GM1 and EPR GW1 (predictive model) and:</p> <ul style="list-style-type: none"> <li>Address the location of structures/assets which may be susceptible to damage by ground movement</li> <li>Identify baseline ground movement monitoring prior to construction</li> <li>Identify appropriate ground movement impact acceptability criteria</li> <li>Identify appropriate mitigation measures should the geotechnical model (EPR GM1), predictive groundwater model (EPR GW1), or subsequent monitoring program indicate acceptability criteria may not be met</li> <li>Establish ground movement monitoring requirements for the area surrounding proposed project works to measure ground movement consistency with the anticipated ground movement in the predictive model.</li> </ul>

EPR ID	Environmental Performance Requirement
EPR GM3	<p><b>Carry out Condition surveys for potentially affected property and infrastructure</b></p> <p>Conduct condition survey(s) of property and infrastructure predicted to be affected by ground movement based on the results of the geological and groundwater model (EPR GM1) or, where a property owner reasonably expects to be potentially affected and has requested a pre-construction condition survey. Develop and maintain a database of pre-construction and as-built condition information for each potentially affected structure identified as being in an area susceptible to damage (see EPR GM1) or where a property owner has requested a pre-construction condition survey, specifically including:</p> <ul style="list-style-type: none"> <li>• A list of identified structures/assets which may be susceptible to damage resulting from ground movement resulting from project works</li> <li>• Results of pre-construction condition surveys of structures, pavements, significant utilities and parklands to establish baseline conditions and potential vulnerabilities</li> <li>• Records of consultation with land owners in relation to the condition surveys</li> <li>• Post-construction stage condition surveys conducted, where required, to ascertain if any damage has been caused as a result of project works.</li> </ul> <p>Pre- and post-condition assessments must be proactively shared with the property owner.</p> <p>All stakeholder engagement activities must be undertaken in accordance with the Communications and Community Engagement Plan (see EPR SC2).</p>
EPR GM4	<p><b>Rectify damage to properties and assets impacted by ground movement or settlement</b></p> <p>For properties and assets affected by ground movement caused by the project, undertake required repair works or other actions as agreed with the property or asset owner. For places listed on the Victorian Heritage Register, consultation with Heritage Victoria must be undertaken.</p> <p>Establish an independent mediation process for the assessment of claims for property and asset damage that cannot be agreed between the Project and the property or asset owner.</p>
EPR GW1	<p><b>Design and construction to be informed by a groundwater model</b></p> <p>Develop a predictive and numerical groundwater model, informed by field investigations, to predict changes in groundwater levels and flow and quality, as they are affected by construction, and develop mitigation strategies, as per EPR GM1. The groundwater model must be updated to take account of any changes to construction techniques or operational design features.</p>
EPR GW2	<p><b>Monitor groundwater</b></p> <p>Develop and implement a pre-construction, and construction groundwater monitoring program to:</p> <ul style="list-style-type: none"> <li>• Establish baseline water level and quality conditions throughout the study area</li> <li>• Calibrate the predictive model prior to commencement of construction, manage construction activities, and verify the model predictions</li> <li>• Assess the adequacy of proposed design and construction methods, and where required, identify and implement any additional measures required to mitigate impacts from changes in groundwater levels, flow and quality.</li> </ul> <p>A post-construction groundwater monitoring program must be developed and implemented to:</p> <ul style="list-style-type: none"> <li>• Confirm the acceptability of resultant water quality and water level recovery (and potential mounding) as predicted by the numerical groundwater model. Acceptability is to be assessed with consideration to the Groundwater Dependent Ecosystem Monitoring and Mitigation Plan (as required by EPR FF6) and other identified beneficial uses of groundwater</li> <li>• Confirm the effectiveness of applied measures as identified in the Groundwater Management Plan (refer EPR GW4) and if required, identify and implement contingency measures to restore groundwater to an acceptable level.</li> </ul> <p>The duration of post-construction monitoring must be a minimum of two years or until acceptable restoration of groundwater has been confirmed. The monitoring program must be developed in consultation with EPA Victoria and be consistent with EPA Victoria Publication 668 Hydrogeological assessment groundwater quality guidelines, EPA Victoria Publication 669 Groundwater Sampling Guidelines, and the State Environment Protection Policy (Waters).</p>

EPR ID	Environmental Performance Requirement
EPR GW3	<p><b>Minimise changes to groundwater levels through tunnel and trench drainage design and construction methods</b></p> <p>Design long term tunnel and trench drainage and adopt construction methods which minimise changes to groundwater levels during construction and operation to manage, mitigate and/or minimise to the extent practicable:</p> <ul style="list-style-type: none"> <li>• Requirements for groundwater management and disposal</li> <li>• Mobilisation of contaminated groundwater</li> <li>• Dewatering and potential impacts of acid sulfate soils, including both unconsolidated sediments and lithified sedimentary rock</li> <li>• Potential impacts on waterways and potential groundwater dependent ecosystems, including terrestrial ecosystems</li> <li>• Any other adverse impacts of groundwater level changes such as subsidence.</li> </ul> <p>Design and implement engineering control measures and/or ground treatment to limit to the extent practicable groundwater inflow and groundwater drawdown during excavation, construction and operation of tunnels and trenches, cross passages and subsurface excavations.</p> <p>The Groundwater Management Plan (as required by EPR GW4) must contain measures and/or controls to minimise groundwater inflow during construction to excavations and groundwater drawdown, including contingency measures should monitoring indicate adverse impacts are occurring. These must include measures to:</p> <ul style="list-style-type: none"> <li>• Minimise to the extent practicable reduction or loss of groundwater discharge to waterways or loss of water availability for terrestrial ecosystems</li> <li>• Manage, mitigate and minimise the oxidation of acid sulfate soil materials and acidification of groundwater</li> <li>• Manage, mitigate and minimise any movement of contamination that is identified</li> <li>• Manage, mitigate and minimise impacts on beneficial uses and risk of vapour intrusion</li> </ul> <p>Ensure that groundwater seepage is collected, treated and disposed during construction in accordance with the <i>Environment Protection Act 1970</i> waste management hierarchy and EPA Victoria requirements. Obtain a trade waste agreement from the relevant water authority where disposal to sewer is required or approval from EPA and the relevant water authority (as required) if discharge to waterways is determined to be appropriate.</p>

EPR ID	Environmental Performance Requirement
EPR GW4	<p><b>Implement a Groundwater Management Plan to Protect groundwater quality and manage groundwater interception</b></p> <p>A Groundwater Management Plan must be developed in consultation with EPA Victoria and implemented to protect groundwater quality and manage interception of groundwater including documenting the measures required to achieve EPR GW2 and EPR GW3. The Groundwater Management Plan must be informed by the groundwater modelling required by EPR GW1 and updated where required in response to modelling results and assessment of the adequacy or effectiveness of controls</p> <p>The Groundwater Management Plan must include requirements and construction methods to protect groundwater quality including where appropriate, but not limited to:</p> <ul style="list-style-type: none"> <li>• Selection and use of sealing products, caulking products, lubricating products and chemical grouts during construction that will not diminish the groundwater quality</li> <li>• Selection and use of fluids for artificial recharge activities that will not diminish the groundwater quality</li> <li>• Requirements to ensure compatibility of construction material with groundwater quality to provide long term durability for infrastructure design life</li> <li>• Design and development of drainage infrastructure that minimises clogging and maintenance risks from dissolved constituents in groundwater precipitating out of solution</li> <li>• Measures to assess, remove and dispose of contaminated groundwater and impacted soils associated with excavation and construction</li> <li>• Reinjection borefields for hydraulic control of drawdowns (or contaminated groundwater plumes)</li> <li>• Remedial grouting.</li> </ul> <p>The Groundwater Management Plan must include requirements and methods for management of groundwater interception during construction including where appropriate, but not limited to:</p> <ul style="list-style-type: none"> <li>• Identification, treatment, disposal and handling of contaminated seepage water and/or slurries including vapours in accordance with relevant legislation and guidelines</li> <li>• Assessment of barrier/damming effects</li> <li>• Subsidence management</li> <li>• Dewatering and potential impacts on acid sulfate soils, including both unconsolidated sediments and lithified sedimentary rock</li> <li>• Protection of waterways and potential groundwater dependent ecosystems</li> <li>• Management of unexpected contaminated groundwater eg using treatments, hydraulic controls, grouting and exclusion methods.</li> <li>• Contingency actions when interventions are required.</li> </ul> <p>The Groundwater Management Plan must also include a review to confirm the status of potential use of extraction bores within the estimated construction drawdown area. Where required, measures must be developed and implemented, to the satisfaction of Southern Rural Water, to maintain water supply to identified, impacted groundwater users.</p>
EPR GW5	<p><b>Manage groundwater during operation</b></p> <p>Prepare as part of the OEMP and implement measures for management, monitoring, reuse where possible and disposal of groundwater inflows during operation that comply with relevant legislation and guidelines, including but not limited to:</p> <ul style="list-style-type: none"> <li>• State Environment Protection Policy (Waters)</li> <li>• State Environment Protection Policy (Prevention and Management of Contaminated Land)</li> <li>• Water Industry Regulations 2006</li> <li>• <i>Occupational Health and Safety Act 2004</i> and Occupational Health and Safety Regulations 2017.</li> </ul> <p>The OEMP must include contingency measures and emergency response plans if unexpected groundwater contamination is encountered and requires disposal.</p>

EPR ID	Environmental Performance Requirement
EPR LP1	<p><b>Minimise land use impacts</b></p> <p>The project must be designed and constructed to:</p> <ul style="list-style-type: none"> <li>Minimise the design footprint and avoid, to the extent practicable, any temporary and permanent impacts on the following land uses: <ul style="list-style-type: none"> <li>Parks and reserves</li> <li>Significant landscapes around the Yarra River</li> <li>Other sensitive land uses such as educational facilities</li> <li>Recreational and community facilities</li> <li>Residential properties</li> <li>Commercial and industrial sites.</li> </ul> </li> <li>Consolidate or minimise the fragmentation of, and provide access to, residual land parcels to support future viable land use to the extent practicable.</li> </ul>
EPR LV1	<p><b>Design to be generally in accordance with the Urban Design Strategy</b></p> <p>Urban Design and Landscape Plans must be developed and implemented for permanent above-ground buildings or structures (excluding preparatory buildings and works) in accordance with the North East Link Project – Incorporated Document. The design response must be generally in accordance with the North East Link Urban Design Strategy and, to the extent practicable:</p> <ul style="list-style-type: none"> <li>Avoid or minimise landscape and visual, overlooking, and shading (with reference to EPR LP4) impacts in extent, duration and intensity</li> <li>Maximise opportunities for enhancement of public and private receptors including public amenity, open space and facilities, and heritage places resulting from the project.</li> </ul>
EPR LV3	<p><b>Minimise construction lighting impacts</b></p> <p>Develop and implement measures to minimise light spillage during construction to protect the amenity of adjacent neighbourhoods, parks, community facilities and any known significant native fauna habitat to the extent practicable.</p>
EPR LV4	<p><b>Minimise operation lighting impacts</b></p> <p>Design and install lighting used during operation of permanent structures in accordance with relevant standards, including but not limited to AS 4282 -1997 Control of the obtrusive effects of outdoor lighting.</p> <p>Design and install lighting to minimise spill and disturbance to significant fauna sites (eg, Grey-headed Flying-fox colony at Yarra Bend, wetlands and waterways immediately adjacent to roadways).</p>
EPR NV2	<p><b>Monitor traffic noise</b></p> <p>Traffic noise monitoring must be carried out for at least the following time periods:</p> <ul style="list-style-type: none"> <li>Baseline traffic noise must be re-verified after project award and prior to construction works</li> <li>Traffic noise must be re-measured within six months of project opening during normal traffic flows (outside school or public holidays). For the purpose of determining compliance, the measurements conducted after project opening must be adjusted to the 10 year traffic flows.</li> <li>Traffic noise must be re-measured 10 years after project opening</li> </ul> <p>All traffic noise monitoring must be undertaken in accordance with the VicRoads Traffic Noise Measurement Requirements for Acoustic Consultants – September 2011, to verify conformance with the external traffic noise objectives set out in EPR NV1.</p> <p>Remedial action must be taken as soon as practicable in the event that the measured traffic noise levels demonstrate that the external traffic noise objectives set out in EPR NV1 are not met.</p>

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EPR NV3	<p><b>Minimise construction noise impacts to sensitive receptors</b></p> <p>Construction noise and vibration must be managed in accordance with the Construction Noise and Vibration Management Plan (CNVMP) required by EPR NV4.</p> <p><u>Non-residential sensitive receptors</u></p> <p>For sensitive land uses (based on AS/NZS 2107:2016) implement management actions as per EPR NV4 if construction noise is predicted to or does exceed the internal and external noise levels below, and a noise sensitive receptor is adversely impacted. If construction exceeds the noise levels below:</p> <ul style="list-style-type: none"> <li>Consider the duration of construction noise</li> <li>Consider the existing ambient noise levels</li> <li>Consult with the owner or operator of the noise sensitive receptor</li> <li>Consider any specific acoustic requirements of land uses listed below to determine whether a noise sensitive receptor is adversely impacted.</li> </ul> <table> <tr> <th>Land use</th><th>Construction noise management level, <math>L_{Aeq}</math> (15 min) applies when properties are in use</th></tr> <tr> <td>Classrooms in schools and other educational institutions</td><td>Internal noise level 45 dB(A)</td></tr> <tr> <td>Hospital wards and operating theatres</td><td>Internal noise level 45 dB(A)</td></tr> <tr> <td>Places of worship</td><td>Internal noise level 45 dB(A)</td></tr> <tr> <td>Active recreation areas characterised by sporting activities and activities which generate their own noise, making them less sensitive to external noise intrusion</td><td>External noise level 65 dB(A)</td></tr> <tr> <td>Passive recreation areas characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example reading, meditation</td><td>External noise level 60 dB(A)</td></tr> <tr> <td>Community centres</td><td>Depends on the intended use of the centre. Refer to the recommended maximum internal levels in AS/NZS 2107:2016 for specific uses</td></tr> <tr> <td>Industrial premises</td><td>External noise level 75 dB(A)</td></tr> <tr> <td>Offices, retail outlets</td><td>External noise level 70 dB(A)</td></tr> <tr> <td>Other noise sensitive land uses as identified in AS/NZS 2107:2016</td><td>Refer to the noise levels in AS/NZS 2107:2016</td></tr> </table> <ul style="list-style-type: none"> <li></li> </ul>	Land use	Construction noise management level, $L_{Aeq}$ (15 min) applies when properties are in use	Classrooms in schools and other educational institutions	Internal noise level 45 dB(A)	Hospital wards and operating theatres	Internal noise level 45 dB(A)	Places of worship	Internal noise level 45 dB(A)	Active recreation areas characterised by sporting activities and activities which generate their own noise, making them less sensitive to external noise intrusion	External noise level 65 dB(A)	Passive recreation areas characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example reading, meditation	External noise level 60 dB(A)	Community centres	Depends on the intended use of the centre. Refer to the recommended maximum internal levels in AS/NZS 2107:2016 for specific uses	Industrial premises	External noise level 75 dB(A)	Offices, retail outlets	External noise level 70 dB(A)	Other noise sensitive land uses as identified in AS/NZS 2107:2016	Refer to the noise levels in AS/NZS 2107:2016
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Other noise sensitive land uses as identified in AS/NZS 2107:2016	Refer to the noise levels in AS/NZS 2107:2016																				

EPR ID	Environmental Performance Requirement								
	<p><b><u>Residential receptors</u></b></p> <p>For residential dwellings, management actions must be implemented as per EPR NV4 if noise from construction works during normal working hours is predicted to or does exceed the noise management levels for normal working hours below.</p> <p>Noise from construction works during weekend/evening work hours and the night period must meet the weekend/evening and night period noise guideline targets in the table below unless they are Unavoidable Works.</p> <table> <tr> <th>Time of day</th><th>Construction noise guideline targets</th></tr> <tr> <td>           Normal working hours:            7am – 6pm Monday to Friday            7am – 1pm Saturday         </td><td>           Noise affected: Background <math>L_{A90}+10</math> dB            Highly noise affected: 75 dB(A)            Source: NSW Interim Construction Noise Guideline (ICNG) Chapter 4.1.1 Table 2.            The noise affected level represents the point above which there may be some community reaction to noise. The highly noise affected level represents the point above which there may be strong community reaction to noise.         </td></tr> <tr> <td>           Weekend/evening work hours:            6pm – 10pm Monday to Friday            1pm – 10pm Saturday            7am – 10pm Sunday and public holidays         </td><td>           Noise level at any residential premises not to exceed background noise (<math>L_{A90}</math>) by:            10 dB(A) or more for up to 18 months            5 dB(A) or more after 18 months            Source: EPA Publication 1254 Section 2         </td></tr> <tr> <td>           Night period:            10pm – 7am Monday to Sunday         </td><td>           Noise inaudible within a habitable room of any residential premises            Source: EPA Publication 1254 Section 2 and EPA Publication 480 Section 5         </td></tr> </table> <p>Note: Where any reference is made to the rating background level (RBL) or background <math>L_{A90}</math>; the 'average background' over the assessment period as per Victorian noise policy practices is to be used. This applies to all receptors and all time periods.</p> <p><b><u>Unavoidable Works</u></b></p> <p>Unavoidable Works may include:</p> <ul style="list-style-type: none"> <li>• The delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads</li> <li>• Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm</li> <li>• Maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours</li> <li>• Tunnelling works including mined excavation elements and the activities that are required to support tunnelling works (ie spoil treatment facilities)</li> <li>• Road and rail occupations or works that would cause a major traffic hazard</li> </ul> <p>Other works where a contractor demonstrates and justifies a need to operate outside normal working hours and exceed the noise guideline targets such as work that once started cannot practically be stopped.</p>	Time of day	Construction noise guideline targets	Normal working hours: 7am – 6pm Monday to Friday 7am – 1pm Saturday	Noise affected: Background $L_{A90}+10$ dB Highly noise affected: 75 dB(A) Source: NSW Interim Construction Noise Guideline (ICNG) Chapter 4.1.1 Table 2. The noise affected level represents the point above which there may be some community reaction to noise. The highly noise affected level represents the point above which there may be strong community reaction to noise.	Weekend/evening work hours: 6pm – 10pm Monday to Friday 1pm – 10pm Saturday 7am – 10pm Sunday and public holidays	Noise level at any residential premises not to exceed background noise ( $L_{A90}$ ) by: 10 dB(A) or more for up to 18 months 5 dB(A) or more after 18 months Source: EPA Publication 1254 Section 2	Night period: 10pm – 7am Monday to Sunday	Noise inaudible within a habitable room of any residential premises Source: EPA Publication 1254 Section 2 and EPA Publication 480 Section 5
Time of day	Construction noise guideline targets								
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Night period: 10pm – 7am Monday to Sunday	Noise inaudible within a habitable room of any residential premises Source: EPA Publication 1254 Section 2 and EPA Publication 480 Section 5								

EPR ID	Environmental Performance Requirement
EPR NV4	<p><b>Implement a Construction Noise and Vibration Management Plan (CNVMP) to manage noise and vibration impacts</b></p> <p>Prepare, implement and maintain a Construction Noise and Vibration Management Plan (CNVMP) in consultation with EPA Victoria and relevant councils. The CNVMP must comply with and address the Noise and Vibration EPRs, be informed by the noise modelling and monitoring results and must include (but not be limited to):</p> <ul style="list-style-type: none"> <li>• Identification of noise and vibration sensitive receptors along the project alignment, including habitat for listed threatened fauna, likely to be impacted by the project</li> <li>• Construction noise and vibration targets as per EPRs NV3, NV5, NV8, NV9, NV10, NV11 and NV12, including any details of conversions between alternative metrics</li> <li>• Details of construction activities and an indicative schedule for construction works, including the identification of key noise and/or vibration generating construction activities that have the potential to generate airborne noise and/or surface vibration impacts on surrounding sensitive receivers</li> <li>• How construction noise (including truck haulage) and vibration would be minimised (see EPR T2)</li> <li>• A requirement for preliminary tests using the actual equipment to validate modelling for vibration and regenerated noise and review, with predictions to be remodelled as necessary and confirm prevention/mitigation/remediation measures confirmed</li> <li>• Management actions and notification and mitigation measures to be implemented with reference to the Appendix B and Appendix C of the New South Wales Roads and Maritime Services Construction Noise and Vibration Guideline 2016 (CNVG)</li> <li>• Any processes and measures to be implemented as part of the Communications and Community Engagement Plan including measures concerning complaints management (see EPR SC2)</li> <li>• Requirements to assess and manage vibration impacts to scientific or medical establishments to the higher of ambient levels or ASHRAE VC Standards (as defined in the 2015 handbook), or manufacturers equipment levels (unless by agreement with occupant)</li> <li>• Measures to ensure effective monitoring of noise and vibration associated with construction with consideration to the construction noise and vibration targets</li> <li>• Measures to minimise noise and vibration impacts from temporary traffic diversions and altered access to parking facilities</li> <li>• The Unavoidable Works that would be undertaken, including their location, timing and duration. The CNVMP must either include a clear rationale for defining works or a list of the type of planned works that constitute Unavoidable Works and response strategies to mitigate the impacts of these Unavoidable Works, with reference to EPA Victoria Publication 1254 Noise Control Guidelines and Appendix B and Appendix C of the CNVG. The Independent Environmental Auditor must verify that the proposed Unavoidable Works meet the definition of Unavoidable Works for each instance they are undertaken. Details of Unavoidable Works must be made publicly available. For emergency Unavoidable Work, a rationale must be provided to the satisfaction of the Independent Environmental Auditor as soon as practicable.</li> </ul>
EPR SW1	<p><b>Discharges and runoff to meet State Environment Protection Policy (Waters)</b></p> <p>Meet the State Environment Protection Policy (Waters) requirements for discharge and run-off from the project, including by complying with the Victorian Stormwater Committee's Best Practice Environmental Management Guidelines for Urban Stormwater (as published by CSIRO in 1999 with assistance from EPA Victoria and others).</p>
EPR SW2	<p><b>Design to include spill containment</b></p> <p>Design and construct the spill containment capacity of the stormwater drainage system for all freeway pavements (including ramps) to manage the risk of hazardous spills from traffic accidents at or prior to every stormwater outlet, to meet AustRoads requirements. The design and location of spill containment must consider the risk and potential impact of a spill, as well as the effectiveness in reducing the risks associated with a spill on the environment. Develop procedures for freeway roads and ramps to be implemented in response to a hazardous spill.</p>

EPR ID	Environmental Performance Requirement
EPR SW4	<p><b>Monitor water quality</b></p> <p>Develop and implement a surface water monitoring program prior to commencement of and during construction to assess surface water quality a suitable distance upstream and downstream of works to establish baseline conditions and enable assessment of construction impacts on receiving waters. This monitoring program must be developed in consultation with EPA Victoria and the asset owner/manager and as appropriate with reference to EPA Victoria Publication 596 Point source discharges to streams: protocol for in-stream monitoring and assessment and Industrial Waste Resource Guideline 701 Sampling and analysis of waters, wastewaters, soils and wastes. The surface water monitoring program is to be used to inform the development and refinement of the Surface Water Management Plan (EPR SW5).</p>
EPR SW5	<p><b>Implement a Surface Water Management Plan during construction</b></p> <p>Develop and implement a Surface Water Management Plan for construction that sets out requirements and methods for:</p> <ul style="list-style-type: none"> <li>• Best practice sediment and erosion control and monitoring, in general accordance with EPA Victoria publications 275 Construction techniques for sediment pollution control, 347.1 Bunding Guidelines, 480 Best Practice Environmental Management Environmental Guidelines for Major Construction Sites, 960 Temporary Environmental Protection Measures for Subdivision Construction Sites, and Industrial Waste Resource Guideline 701 Sampling and analysis of waters, wastewaters, soils and wastes</li> <li>• Maintaining the key hydrologic and hydraulic functionality and reliability of existing flow paths, drainage lines and floodplain storage</li> <li>• Retain existing flow characteristics to maintain waterway stability downstream of construction</li> <li>• Location and bunding of any contaminated material (including tunnel spoil and stockpiled soil) to the 1% AEP flood level and to the requirements of EPA Victoria and the relevant drainage authority</li> <li>• Works scheduling to reduce flood related risks</li> <li>• Bunding of significant excavations including tunnel portals and interchanges to an appropriate level during the construction phase</li> <li>• Protecting against the risk of contaminated discharge to waterways when working in close proximity to potential pollutant sources (eg landfill or sewer infrastructure)</li> <li>• Documenting the existing condition of all drainage assets potentially affected by the works (including their immediate surrounds) to enable baseline conditions to be established and potential construction impacts on these assets to be assessed and managed.</li> </ul>
EPR SW6	<p><b>Minimise risk from changes to flood levels, flows and velocities</b></p> <p>Permanent works and associated temporary construction works must not increase overall flood risk or modify the flow regime of waterways without the acceptance of the relevant drainage authority or asset owner (typically Melbourne Water) and in consultation with other relevant authorities (eg Council, VicRoads, Parks Victoria, SES, emergency services).</p> <p>To assess overall flood risk, undertake modelling of the design of permanent and temporary works to demonstrate the resultant flood levels and risk profile. This modelling analysis is to include sufficient events (at least up to and including the 1% AEP event) and scenarios (eg with and without blockage) to support the estimation of tangible (eg average annual damages) and intangible flood damages. If significant increases in flood risk are predicted for any events analysed, an assessment of overall flood risk considering tangible and intangible flood damages must be prepared and presented with appropriate mitigation measures for the acceptance of the relevant drainage authority or asset owner.</p>
EPR SW8	<p><b>Minimise impacts from waterway modifications</b></p> <p>Where waterway or flow regime modification is necessary, modifications will be designed and undertaken in a way that mitigates to the extent practicable the effects of changes to flow and minimises, to the extent practicable, the potential for erosion, sediment plumes, impacts on bed or bank stability and exposure or mobilisation of contaminated material during construction and operation to the requirements of Melbourne Water or the relevant drainage authority.</p> <p>Waterway modifications are to be designed and undertaken in a way that maximises the visual and aesthetic amenity and environmental conditions (including habitat, connectivity, refuge and hydraulic conditions) to support aquatic ecosystems of the waterways having regard to relevant strategies, policies and plans for that waterway and in consultation with Melbourne Water or the relevant drainage authority.</p>

EPR ID	Environmental Performance Requirement
EPR SW9	<p><b>Maintain bank stability</b></p> <p>Develop and implement appropriate measures to minimise erosion and protect bank stability of waterways affected by construction or operation activities both directly or indirectly (for example as a result of site access), to the requirements of Melbourne Water or the relevant drainage authority.</p>
EPR SW11	<p><b>Adopt Water Sensitive Urban and Road Design</b></p> <p>Adopt and implement water sensitive urban design and integrated water management principles in the stormwater treatment design, in general accordance with the Urban Design Strategy, the specifications of the relevant local council as applicable, and VicRoads Integrated Water Management Guidelines (June 2013), the Victorian Stormwater Committee's Victoria Best Practice Environmental Management Guidelines for Urban Stormwater (as published by CSIRO in 1999 with assistance from EPA Victoria and others) and the DELWP Integrated Water Management Framework for Victoria (September 2017).</p>
EPR SCC4	<p><b>Minimise and appropriately manage waste</b></p> <p>Develop and implement management measures for waste (excluding soils) minimisation during construction and operation in accordance with the <i>Environment Protection Act 1970</i> waste management hierarchy and management options, to address:</p> <ul style="list-style-type: none"> <li>• Litter management</li> <li>• Construction and demolition wastes including, but not limited to, washing residues, slurries and contaminated water</li> <li>• Organic wastes</li> <li>• Inert solid wastes.</li> </ul>

## 14. Conclusion

The purpose of this report is to assess the potential ecological impacts associated with North East Link to inform the preparation of the EES required for the project.

Impacts to significant ecological values and the application of the legislation, frameworks and policies that relate to their protection are a key consideration of the EES process. Accordingly, an understanding of existing ecological values within the North East Link study area is critical to determine the likelihood and extent of project-related impacts on significant ecological values.

A summary of the key assets, values or uses potentially affected by the project, and an associated assessment of ecological impacts, is provided below.

### Existing conditions

#### Flora and vegetation

The project boundary intersects 14 EVCs across three bioregions: Gippsland Plain, Victorian Volcanic Plain and Highlands–Southern Fall. The majority of the project boundary falls within the Gippsland Plain bioregion. Landforms within the Gippsland Plain generally consist of low-lying floodplains including oxbow lakes associated with the Yarra River and flat to undulating plains. The northern part of the project boundary is characterised by undulating hills within the Highlands–Southern Fall bioregion which drain to the Plenty River, and flat basaltic plains within the Victorian Volcanic Plain, west of the M80 Ring Road intersection and at the western end of the Eastern Freeway (west of the Yarra River).

The quality of native vegetation within the project boundary is generally poor, with the ecological values present largely reflecting the long history of urban land use in the surrounding landscape. There is continuing pressure from weed infestation and regular disturbance through urban management. Vegetation mapped within the project boundary predominantly consists of vegetation planted for amenity purposes along public road and recreation reserves.

Despite the highly urbanised landscape, the project boundary does contain substantial ecological values. Key areas of remnant vegetation within the project boundary generally consist of riparian and floodplain vegetation (Floodplain Riparian Woodland, Swampy Riparian Woodland) associated with the Yarra River and its tributaries. Consistent with the low-lying landforms of the Gippsland Plain bioregion, several swamps and billabongs, including man-made wetlands, are located within and adjacent to the project boundary. These areas include Bolin Bolin Billabong (designated no-go zone, see Figure 2 in Section 3.5), wetlands adjacent to the Eastern Freeway and wetlands associated with the Banyule Flats.

Several areas of remnant vegetation contained good quality Plains Grassy Woodland (EVC 55) and Grassy Dry Forest (EVC 22), which were characterised by a mixed-eucalypt canopy over a grassy and herb-rich understorey. In several of these locations, occurrences of the EPBC Act and FFG Act-listed Matted Flax-lily were observed and recorded. This includes areas within Simpson Barracks adjacent to Banyule Creek, Hurstbridge rail corridor and areas adjacent to the M80 Ring Road bike path at the northern end of the project boundary.

Within the project boundary, approximately 52.109 hectares of native vegetation patches from 14 EVCs, 92 large trees within patches, 55 large scattered trees and 115 small scattered trees are expected to be directly impacted. In addition, 32 large scattered trees rooted outside the project boundary may potentially be impacted by groundwater drawdown associated with the northern tunnel portal construction. The current design has avoided direct impacts on a significant area of non-threatened yet significant vegetation throughout the Banyule Flats and Warringal Parklands by tunnelling through this area. It is anticipated that with further refinement of the design at the detailed design stage, the actual footprint of the project would be reduced, and as a result, removal of patches of native vegetation and scattered trees would be further minimised. Unavoidable vegetation losses would be mitigated through offsets in accordance with the Guidelines (DELWP, 2017a) and secured in accordance with those Guidelines.

Within the study area, 48 species of rare or threatened flora have been recorded historically (VBA). Three of these species were recorded within the project boundary during the assessment:

- Matted Flax-lily (95 individuals) listed as threatened under the EPBC Act and FFG Act
- Arching Flax-lily (five individuals) listed as vulnerable under the DELWP Advisory List
- Studley Park Gum (10 individuals recorded but many more likely to occur at Simpson Barracks) listed as endangered under the DELWP Advisory List.

One additional species, River Swamp Wallaby-grass, listed as vulnerable under the EPBC Act, has been previously recorded within the project boundary; however, was not recorded during the current assessment.

Impacts to Matted Flax-lily and Arching Flax-lily would be mitigated through the implementation of a salvage and translocation plan.

After discussions with DELWP, NELP has committed to undertaking further field surveys to better understand the prevalence of Studley Park Gum at Simpson Barracks and to estimate the number of individuals potentially impacted by the project. Unavoidable loss of large trees within patches and scattered small trees of Studley Park Gum would be managed through an offsetting arrangement as per the Guidelines (DELWP, 2017a). To further mitigate impacts on Studley Park Gum, seed would be collected from individuals within the project boundary and propagated in a nursery. Propagated plants would then be incorporated into project landscaping.

Most rare or threatened flora species that were considered for the project are not expected to make substantial use of the project boundary. No threatened communities were found to be present within the project boundary.

Nine weeds classified as Weeds of National Significance (WoNS) were observed within the project boundary and there is potential for the pathogen Cinnamon Fungus (*Phytophthora cinnamomi*) to be present within the study area.

### **Terrestrial fauna**

The study area is considerably urbanised and fragmented, but still supports habitats for native fauna. Habitats for terrestrial fauna include forests and woodlands (riparian and non-riparian), scattered trees and shrubs, waterways and wetlands.

Areas of highest ecological value occur particularly near the Yarra River and its associated floodplain in the Banyule and Bulleen area. This waterway provides the most significant wildlife corridor within the study area and within the eastern suburbs of Melbourne.

Other areas of notable value to terrestrial fauna include eucalypt woodland in Simpson Barracks and along Koonung Creek, where habitats are mostly degraded and disturbed, but are likely to function as a local wildlife corridor.

Most of the threatened fauna identified for the study area are considered unlikely to occur within the area. Species that have a moderate or high likelihood of using or visiting parts of the study area that would be impacted by the project include:

- Powerful Owl, *Ninox strenua*
- Swift Parrot, *Lathamus discolor*
- Grey-headed Flying-fox, *Pteropus poliocephalus*.

The project is expected to have negligible impacts on these species. Numerous other species are likely to occur within the study area, but are not considered likely to make considerable use of areas that would be impacted by the project. Many of these are most likely to occur in habitats above the tunnelled section (species include crakes and rails, egrets, ducks, bitterns, snipe and the Grey Goshawk).

### **Aquatic ecosystems and aquatic fauna**

The Yarra River provides very high value aquatic habitat, and supports an abundant and diverse assemblage of aquatic fauna, including native fish, turtles and platypus. The other waterways within the study area (Koonung Creek, Merri Creek, Banyule Creek and Plenty River) are generally more degraded, with heavy impacts due to channel modification, urban stormwater and riparian zone modification. These existing impacts have affected aquatic habitat condition and reduced aquatic biodiversity.

The floodplain wetlands of the Yarra River contain some high quality aquatic habitat, including the billabongs, although these are somewhat degraded, with altered hydrological regime disrupting the ecological conditions of these dynamic systems.

Within the study area, 32 species of fish, three species of turtle and two aquatic mammals have been recorded or are predicted to occur or have suitable habitat occurring. Ten species identified for the search area are classified as threatened fauna. These include five species listed as threatened under the EPBC Act, eight species listed as threatened under the FFG Act and seven species listed as threatened on the DELWP Advisory Lists (DSE, 2009; DEPI, 2013a).

Of the threatened species recorded in the study area, the following are considered to have a moderate or high likelihood of occurrence in waterways within the study area:

- Australian Grayling, *Prototroctes maraena*
- Australian Mudfish, *Neochanna cleaver*
- Macquarie Perch, *Macquaria australasica*
- Murray Cod, *Maccullochella peelii*
- Murray River Turtle, *Emydura macquarii*
- Broad Shelled Turtle, *Chelodina expansa*.

These species are considered likely to occur in the Yarra River, although there is low likelihood that the other urban waterways within the project boundary support these threatened species.

There are no Ramsar listed or internationally significant wetlands within the study area, and the project is not expected to impact on the Ramsar-listed Port Phillip Bay (western shoreline) wetlands which are over 20 kilometres from the project boundary.

### **Groundwater dependent ecosystems (GDEs)**

Areas adjacent to the project boundary have the potential to be impacted by groundwater changes resulting from the project. There are three main geographic areas of focus in relation to GDEs where indirect effects may occur: 1) vicinity of the northern portal, including Simpson Barracks and Banyule Creek; 2) vicinity of the southern portal, including the Yarra River Flats; and 3) tunnel section, including Banyule Flats.

Some large trees outside the project boundary are likely to be accessing groundwater on occasions (10<20-metre groundwater depth zone) and have a moderate to high likelihood of being negatively impacted by groundwater drawdown during construction and operation of the project. These areas comprise Plains Grassy Woodland (dominated by River Red Gum, in association with Studley Park Gum) within Simpson Barracks and adjoining Commonwealth land, Colleen Reserve, Banyule Flats (Main Yarra Trail), River Gum Walk and Mercedes Court. In the 10<20 m groundwater depth zone in these localities, 16 LTs have a moderate or high risk of being negatively impacted by groundwater drawdown by 2024 at the end of construction, while under the 2075 long-term scenario, 32 LTs would have a moderate to high chance of being negatively impacted (this number incorporates all trees affected under the 2024 scenario). Areas outside this groundwater depth zone are unlikely to be negatively impacted by groundwater changes.

Areas of Floodplain Woodland (dominated by River Red Gum) on the Yarra River floodplain but outside the project boundary which are likely to be accessing groundwater are unlikely to be negatively impacted by groundwater drawdown. Similarly, ephemeral billabongs of the Yarra River floodplain are also unlikely to be negatively impacted.

Without mitigation controls, groundwater drawdown during North East Link's construction is expected to result in some minor lowering of water levels in the deep pool of Bolin Bolin Billabong. This aquatic habitat is highly dynamic, and major changes to environmental and ecological condition occurs during each hydrological inundation cycle (flooding or environmental flow provision, and subsequent decline in water level and retraction of aquatic habitat).

Under current conditions, as the billabong recedes from a fully inundated condition to the remnant deep pool, water quality deteriorates to the point that it only supports tolerant aquatic fauna. Therefore, the ecological significance of the lowered water levels is uncertain, although there is no evidence this pool provides refuge habitat for any threatened aquatic species. However, it is likely to provide important water supply for the native terrestrial fauna. Managed water levels in this wetland may be required to maintain the ecological condition of the billabong.

Groundwater dependent ecosystems are modelled extensively across the Banyule Flats area. However, as groundwater drawdown resulting from the project is not predicted throughout these ecologically sensitive areas, including the Banyule Flats, the potential for negative impacts is considered negligible in this area.

### **Risk and impact assessment**

Forty risk pathways relating to ecology were identified for the project. Of these, three are planned, none are High risk, five are Medium risk and the remaining 32 are considered Low risk.

## Planned

Planned risks include those that involve direct and indirect loss of vegetation and habitat (risks EC01, EC02 and EC12).

These risks are expected to result in the largest impacts of the project, with total direct vegetation loss within the project boundary expected to include up to 52.109 hectares of native vegetation patches, 92 large trees within patches, 202 scattered trees (87 large, 115 small) and removal of wetland and waterway habitats along Koonung Creek and Banyule Creek. Furthermore, known populations of Matted Flax-lily are proposed to be impacted by the project. To minimise these impacts, a Matted Flax-lily salvage and translocation plan would be prepared and implemented. NELP is currently investigating potential recipient sites for Matted Flax-lily within the City of Whittlesea, City of Banyule and/or in the eastern section of Simpson Barracks (EPR FF7). These sites are still being assessed for feasibility and are therefore not confirmed at this stage of the project. All sites would be subject to review as documented within a salvage and translocation plan (Appendix K) to assess their suitability for the success of the translocation (EPR FF7).

Vegetation and habitat removal would be managed and minimised through the implementation of tree retention where possible and further minimisation of the footprint (EPR AR1 and EPR LP1), adherence to the *Guidelines* (DELWP, 2017a) and establishment of no-go zones (EPR FF2 and EPR EMF2), preparation of a Tree Protection Plan (EPR AR2) and obtaining necessary permits (EPR FF5).

## High risks

None of the risk pathways relating to ecology are considered to be high risk.

## Medium risks

Medium risks include the groundwater dewatering resulting in changes to terrestrial GDEs during construction (risk EC06) and operation (risk EC29), the shading of waterways degrading aquatic habitat quality (risk EC30), and the loss of connectivity and impeded passage for native aquatic species due to changed waterway form (risk EC36).

Generally, these pathways are reduced from high to medium risk through the implementation of EPRs. These risks tend to be geographically confined, with extent of impacts at either the local (risks EC06, EC29, EC30) or municipal risk (EC36) level.

For risk EC06 (construction) and risk EC29 (operation), there are three main areas where effects may occur and impact terrestrial ecology: 1) vicinity of the northern portal, including Simpson Barracks and Banyule Creek, 2) vicinity of the southern portal, including the Yarra River Flats, and 3) tunnel section, including Banyule Flats. Within Simpson Barracks and other areas near the northern portal, there is a moderate to high likelihood of approximately 32 LTs being negatively impacted by groundwater drawdown over the long term. In the Yarra River Flats area, Floodplain Riparian Woodland (dominated by River Red Gum) and ephemeral billabongs are unlikely to be negatively impacted, since drawdown levels are predicted to be very minor. The deep pool at the eastern end of Bolin Bolin Billabong is an aquatic (rather than terrestrial) GDE and the risk of it being ecologically impacted by drawdown is considered to be low. For the tunnelled section, groundwater changes as a result of the portals or TBM are predicted to be negligible.

The shading of waterways from structures resulting in degradation of aquatic habitat quality (risk EC30) is almost certain, but it is expected to be local and of low severity. The loss or degradation of aquatic vegetation resulting from sections of shaded or covered channel in Koonung Creek would also reduce the existing instream ecosystem services of nutrient and sediment transport (risk EC39). The potential impact of this would be degraded surface water quality in downstream waterways. Although separate outcomes, the impacts of shading waterways would be managed to a degree by minimising a footprint that requires structures that could impact light levels on aquatic habitat (EPR FF4), minimising modifications to waterways such as containment, covering and diversion (EPR SW8) and consideration of noise wall locations (EPR LV1).

The modification of Koonung Creek includes approximately one kilometre of covered channel. Although Koonung Creek is already a highly modified waterway with existing sections of covered waterway and other barriers to fish passage, native fish do inhabit this waterway, although there is evidence that fish passage is presently impeded. Further modifications to the waterway are considered likely to create additional barriers (risk EC36). To minimise the impact of waterway modification, waterway design needs to protect (EPR FF4) and provide (EPR SW8) aquatic habitat and hydraulic requirements suitable for these aquatic species.

### Offset strategy

The construction of roads, tunnels and ancillary infrastructure would require the removal of surface vegetation including threatened flora and fauna habitat. Within the project boundary, 95 Matted Flax-lily, five Arching Flax-lily, and greater than 10 (population size/area of impacted habitat to be confirmed) Studley Park Gum occur within the area that would be impacted. Unavoidable loss of Matted Flax-lily and Arching Flax-lily would be managed through a salvage and translocation plan (EPR FF2), while the removal of large trees of Studley Park Gum would be managed through an offsetting arrangement as per the Guidelines (DELWP, 2017a) (EPR FF2). An NVR report has been completed (Appendix J) that identifies the general offset units and species-specific offsets required for the estimated unavoidable native vegetation removals.

This assessment considered total impact across the whole of the project boundary (including Simpson Barracks) and potential impacts due to drawdown. An offset strategy has been developed in order to document a process how these offsets would be secured and managed (Appendix L).

## 15. References

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