MAJOR ROAD PROJECTS AUTHORITY

OCTOBER 2018

MORDIALLOC BYPASS

FLORA AND FAUNA IMPACT ASSESSMENT

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Mordialloc Bypass
Flora and Fauna Impact Assessment

Major Road Projects Authority

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All landholders for access to their land.

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GLOSSARY

Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: — Genetic diversity — the variety of genes (or units of heredity) in any population. — Species diversity — the variety of species. — Ecosystem diversity — the variety of communities or ecosystems.
Bioregion (region)	A bioregion defined in a national system of bioregionalisation. The project area is located within the Gippsland Plain Bioregion.
Braeside Park wetlands	The wetlands in the southwestern part of Braeside Park.
Canopy Tree	Defined under Guidelines 2017 as a native mature tree (i.e. it can flower) that is greater than 3 metres in height and is normally found in the upper layer of the relevant EVC. It can be a Scattered Tree or a tree in a patch (Refer to 'Scattered Tree' and 'Remnant Patch').
Department of Environment, Land, Water and Planning (DELWP)	This department was formerly known as: — Department of Environment and Primary Industries (DEPI) — Department of Planning, Local Government, and Property and Land Titles (DTPLI).
Department of the Environment and Energy (DoEE)	The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the EPBC Act. The Commonwealth Department of the Environment and Energy was previously known as: — Department of the Environment (DoE) — Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) — Department of the Environment, Water, Heritage and the Arts (DEWHA) — Department of Environment and Heritage (DEH) — Department of the Environment and Water Resources (DEWR).
Ecological community	An assemblage of species occupying a particular area.
Ecological Vegetation Class (EVC)	A type of native vegetation classification that is described through a combination of its floristics, life form and ecological characteristics, and through an inferred fidelity to particular environmental attributes. Each EVC includes a collection of floristic communities (i.e. lower level in the classification that is based solely on groups in the same species) that occur across a biogeographic range, and although differing in species, have similar habitat and ecological processes operating.
Edithvale wetlands	The Edithvale component of the Edithvale-Seaford Ramsar site, comprising northern and southern sections which are separated by Edithvale Road.
Environmental weed	Any plant that invades native ecosystems and reduce the diversity and/or abundance of native flora or fauna.
Exotic	Introduced from outside the area. Used in the context of this report to refer to species introduced from overseas.

Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community, including any biotic or abiotic components.
Impact Area	For the purpose of this assessment, this is assumed to be the entire project area minus any No-go Zones.
Indigenous	Native to the area: not introduced.
Introduced	Not native to the area: not indigenous. Refers to both exotic and non-indigenous Australian native species of plants and animals.
Large Tree	Defined under Guidelines 2017 as a native canopy tree with a Diameter at Breast Height (DBH) greater than or equal to the large tree benchmark for the relevant bioregional EVC. A large tree can be either a large scattered tree or a large tree contained within a patch.
Likely	Taken to be a real chance or possibility.
Local population	The population that occurs within the site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated. The local population of migratory or nomadic fauna species comprises those individuals likely to occur in the study area from time to time or return year to year.
Locality	The area within a 5 km radius of the project area.
Migratory species	Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The listing of these species relates to international agreements to which Australia is a signatory. These include Japan-Australia Migratory Bird Agreement, China-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and the Bonn Convention on the Conservation of Migratory Species of Wild Animals.
Matters of National Environmental Significance (MNES)	Matters listed pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*. These include: listed threatened species and ecological communities, Migratory species protected under international agreements, wetlands of international importance (listed under the Ramsar Convention), Commonwealth marine environment, World Heritage Properties, National Heritage Places, the Great Barrier Reef Marine Park, Commonwealth marine areas, nuclear actions, and a water resource (in relation to coal seam gas development and large coal mining development).
Nocturnal call playback	A survey technique undertaken (at night) which attempts to stimulate fauna species to call by imitating or playing their call at probable breeding sites.
No-go Zones	Areas of native vegetation which will be retained and are excluded from the calculation of impacts.
Noxious weed	An introduced species listed under the Noxious Weeds Act 1993. Under the Act, noxious weeds have specific control measure and reporting requirements.
Potentially Threatening Processes	The state equivalents of Key Threatening Processes, Potentially Threatening Processes are listed under Section 10 of the *Flora and Fauna Guarantee Act 1988* (FFG Act).

Project area	Defined as the entire extended footprint of the project works. This includes areas of land that are outside the proposed Right of Way where works are expected to be completed.
Protected flora (Victoria)	Protected flora are: — Plants that have been declared to be protected under section 46 of the FFG Act. — Plants that are listed as threatened under section 10 of the FFG Act — Plants that belong to communities that are listed as threatened under section 10 of the FFG Act.
Recovery plan	A plan prepared under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 to assist the recovery of a Threatened species, population or ecological community.
Region	A bioregion defined in the state system of bioregionalisation (DELWP 2017b). For this study the relevant bioregion is the Gippsland Plain.
Patch	Defined under Guidelines 2017 as an area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native, or any area with three or more native trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy, or any mapped wetland included in the Current Wetlands map, available in DELWP systems and tools.
Revegetation	Establishment of native vegetation to a minimum standard in formerly cleared areas, outside of a Remnant Patch
Scattered tree	Defined under Guidelines 2017 as a Canopy Tree that does not form part of a remnant patch.
Significant species	Important, weighty or more than ordinary; typically used to describe the importance of a species or community at local, regional, state or federal levels.
Significant impact	A ‘significant impact’ is an impact which is important, notable, or of consequence, having regard to its context or intensity.
Small Tree	Defined under Guidelines 2017 as a native canopy tree with a Diameter at Breast Height (DBH) less than the large tree benchmark for the relevant bioregional EVC.
Species richness	Species richness is simply the number of species present in a sample, community, or taxonomic group. Species richness is one component of the concept of species diversity, which also incorporates evenness, that is, the relative abundance of species.
Study area	The study area is the project area plus a buffer of 20+ metres. This is to ensure sufficient data collection to provide context to the project area and allow more accurate impact assessment to occur.
The project	The Mordialloc Bypass project.
Threatened species, populations and ecological communities	Species, populations and ecological communities listed as Vulnerable, Endangered or Critically Endangered (collectively referred to as Threatened) under state and/or Commonwealth legislation (including TSC Act, FM Act or the EPBC Act). Capitalisation of the terms ‘Threatened’, ‘Vulnerable’, ‘Endangered’ or ‘Critically Endangered’ in this report refers to listing under the relevant state and/or Commonwealth legislation.

Waterways wetlands	The wetlands constructed as part of the development of Waterways (suburb) along Mordialloc Creek.
Weed	A plant growing out of place or where it is not wanted: often characterized by high seed production and the ability to colonise disturbed ground quickly. Weeds include both exotic and Australian native species of plant naturalised outside of their natural range.
Woodlands Industrial Estate wetlands ('Woodlands wetlands')	The Melbourne Water retention ponds and associated wetland vegetation/shallow wetlands within the same block.

ABBREVIATIONS

CaLP	*Catchment and Land Protection Act 1994*
CMA	Catchment Management Area
DELWP	Victorian Department of Environment, Land, Water and Planning
DoEE	Commonwealth Department of the Environment and Energy
EPA	Environment Protection Authority Victoria
EPR	Environmental Performance Requirement
EVC	Ecological Vegetation Class
EES	Environment Effects Statement
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FFG Act	Victorian *Flora and Fauna Guarantee Act 1988*
GIS	Geographic Information System. a system for storing and manipulating geographical information on computer
GPS	Global Positioning System- a navigational tool which uses radio receivers to pick up signals from four or more special satellites to provide precise determination of location
Guidelines 2017	*Guidelines for the removal, destruction or lopping of native vegetation* (DELWP 2017c)
IBA	Important Bird and Biodiversity Area (defined by (BirdLife International 2018) and also included on the World Database of Key Biodiversity Areas)
MNES	Matters of National Environmental Significance - Matters listed pursuant to the *Environment Protection and Biodiversity Conservation Act 1999*
P&E Act	*Planning and Environment Act 1987*
sp.	Abbreviation of species (single)
spp.	Abbreviation of species (multiple)
subsp.	Abbreviation of subspecies
TPZ	Tree Protection Zone
WoNS	Weed of National Significance – weed listed by the Commonwealth of Australia based on invasiveness, potential for spread and environmental, social and/or economic impacts
WVC	Wildlife-vehicle collisions

EXECUTIVE SUMMARY

INTRODUCTION

WSP Australia Pty Limited (WSP) was engaged by VicRoads to prepare the Environment Effects Statement (EES) and associated technical reports for the proposed Mordialloc Bypass (the 'project'), located in outer Melbourne, Victoria. The Mordialloc Bypass is a proposed new freeway within Melbourne's southern movement corridor, located within an existing road reservation. The project corridor is approximately 9.7 km in length, comprising 7.5 km of greenfield dedicated road corridor and 2.2 kilometres of roadworks required to integrate the project with the Mornington Peninsula Freeway.

The objective of this study was to address the EES Scoping Requirements (Draft) through detailing the ecological values of the project area (including significant values), assessing the ecological impacts of the current design, and outlining a mitigation strategy for the Project. The significant ecological values include those listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Flora and Fauna Guarantee Act 1988* (FFG Act) and the Victorian Rare or Threatened Species Advisory Lists (DEPI 2013a, 2014; DSE 2009).

This report does not yet include an assessment of the Thames Promenade addition to the Project. This will be added for the final version.

PROJECT AREA

The project area is located 25 km south east of the Melbourne CBD and 5 km east of Mordialloc. The proposed road extends north-west from the Mornington Peninsula Freeway's existing terminus at Springvale Road in Aspendale Gardens and links to the Dingley Bypass, providing connections to Governor Road, Lower Dandenong Road and Centre Dandenong Road. The project area occurs within the municipalities of Kingston and partly within Greater Dandenong and is located within the Gippsland Plain Bioregion.

The Mordialloc Bypass project area is a long-established reserved road corridor and much of the project area has been cleared of native vegetation. However, the project area includes patches of native vegetation and scattered trees and it bisects the 48 ha award-winning ecological restoration project, The Waterways Wetlands. In addition, the area surrounding the project area includes sensitive and high-value environments including Braeside Park, Edithvale-Seaford wetlands and the wetlands at Woodlands Industrial Estate.

METHODS

To determine the ecological values (existing conditions) of the project area, a database and literature review, and field surveys were undertaken. This built upon the work completed for the Preliminary flora and fauna assessment for the Mordialloc Bypass (WSP 2017). These works then informed a detailed assessment of likely impacts, and provision of a recommended biodiversity mitigation strategy for the project.

Specifically, the following were completed:

- A database and literature review used to prepare a list of threatened flora and fauna species, ecological communities, listed migratory species and any significant habitat previously recorded or predicted to occur in the project area and the broader locality (Section 3.4.1). This included:
  - Government databases and mapping
  - Birdlife Australia records
  - Review of the previous ecological assessments of relevance to the Project
  - Other data sources (detailed in the report).

- Field surveys to determine the significant values present including:
  - Targeted flora survey (Section 3.4.3)
  - Vegetation mapping and categorisation, including Habitat Hectare assessments and verification of previous mapping (Section 3.4.2)
  - Targeted fauna survey and habitat mapping, including detail wetland bird surveys and waterbird habitat mapping, sound recorder surveys and owl surveys (Section 3.4.4).
- Assessment of existing conditions including consolidation of records and likelihood of occurrence and habitat assessment (Section 3.4.5).
- Risk assessment, identifying risks to biodiversity values and controls to minimise risk where possible (Section 3.5).
- Detailed assessment of impacts upon ecological values, including native vegetation, significant species, threatening processes, and ecological character, with reference to relevant legislation and policy. This also included assessment of the potential for cumulative impacts. Likely impacts of the Project upon native vegetation were determined based on a buffer of the Project design (8-10 metres), in consultation with VicRoads and Project designers. Any remnant native vegetation that could potentially be avoided was either mapped as No-go Zones or identified as 'avoid if possible areas (Section 3.6).
- Development of a recommended impact avoidance and mitigation strategy for the Project, based on the outcomes of the risk assessment and impact assessment, and identification of the required mitigation measures for significant species (Section 3.6.2).

RESULTS: EXISTING CONDITIONS

VEGETATION

Most of the project area supports exotic vegetation (including exotic roadside vegetation and modified agricultural land) and constructed features such as roads. However, remnant vegetation occurs within the project area and includes 12 Ecological Vegetation Classes (EVCs). Ten of these EVCs are considered 'endangered' within the Gippsland Plain Bioregion, and two are 'vulnerable'.

Two EPBC Act listed threatened ecological communities were recorded, both listed as critically endangered:

- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
- Natural Damp Grassland of the Victorian Coastal Plains.

There are two listed FFG Act threatened communities which partly correspond to the above EPBC Act communities:

- Herb-rich Plains Grassy Wetland (West Gippsland) Community
- Plains Grassland (South Gippsland) Community.

A total of 3341 trees were recorded in the study area, including 784 indigenous trees (including understorey trees), 1618 planted native trees, and 939 exotic or invasive trees. Under the *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP 2017c) (Guidelines 2017), 703 Canopy Trees were recorded.

FLORA

A total of 245 vascular plant species have been recorded within the vegetation assessment study area (project area plus a 20 m buffer), of which 103 (42%) are native, 8 are planted street trees/shrubs (3%), and 134 (55%) are introduced species. Many species were planted as part of the creation of the Waterways wetlands, which contributes significantly to the diversity of native plant species recorded.

Over a series of targeted surveys, five significant species were detected, including Matted Flax-lily *Dianella amoena* (EPBC Act endangered, FFG Act Listed, Advisory List endangered), Leafy Twig-sedge *Cladium procerum* (rare in

Victoria), Pale Swamp Everlasting *Coronidium gunnianum* (Advisory List vulnerable), Large River Buttercup *Ranunculus papulentus* (not threatened but considered poorly known in Victoria) and Swamp Everlasting *Xerochrysum palustre* (EPBC and FFG listed, Advisory List vulnerable). These species were recorded in the Waterways Wetlands and all except Large River Buttercup occurred within revegetated areas. One additional species, Swamp Fireweed *Senecio psilocarpus* (EPBC Act and Advisory List vulnerable) was considered to have the potential to occur in the project area in the Waterways Wetlands and therefore to be impacted by the project.

FAUNA

A combined total of 210 vertebrate fauna species have been recorded within 500 metres of the project area from several sources (including this study and associated targeted surveys – refer Appendix C). This included 166 native birds, one vagrant bird, nine native frogs, five native mammals, and six native fish. A total of 40 species of conservation significance have been recorded, 13 of which are EPBC Act listed migratory bird species.

A total of 23 exotic fauna species have been recorded, including 12 birds, six mammals and five fish species.

A total of 102 fauna species of state and/or national significance were assessed for the potential to occur within 5 km of the study area. Of these species, 44 species are considered to have greater than a 'low' likelihood of occurrence within or nearby the project area. Most (40) of the significant species likely to occur are birds.

Fauna habitat values within the project area include:

- The constructed wetlands at the Waterways, immediately south of Governor Road, which includes some permanent aquatic habitat at Mordialloc Creek and fringing swamp vegetation. The wetlands provide habitat for a diverse range of aquatic and terrestrial species.
- Agricultural grassland (predominantly highly modified with some small patches of remnant vegetation) occurring adjacent to Braeside park and Woodlands Industrial Estate.
- Roadside weedy grassland and small drains/drainage lines, some of which provide foraging habitat for wetland birds (particularly after rain) and habitat for frogs.
- Some remnant and planted trees which provide foraging and nesting habitat for woodland birds.

Higher quality habitat for threatened and migratory fauna occurs in the locality of the project area. This includes the 'Carrum Swamp Important Bird Area' (BirdLife International 2018), which is comprised of a number of wetlands, including areas adjacent or nearby to the project area: Woodlands Industrial Estate wetlands, Braeside Park wetlands and Edithvale wetlands.

Nine different waterbird habitat types were mapped in the study area (which included the wetlands immediately adjacent to the project area). This mapping allowed calculation of the loss of different habitat types and assessment of the potential for impact on particular species which rely on specific habitat types.

Waterbird species move between wetlands in the area depending on the local conditions. The grassland in the project area that occurs between wetlands is likely to be utilised for the movement of fauna, including woodland and wetland birds, as well as reptiles such as turtles, and mammals including rodents, echidnas and possums.

IMPACT ASSESSMENT

PROJECT IMPACTS

Relevant potential or likely impacts from the Project are:

- Habitat loss
- Mortality and injury of wildlife due to collision with vehicles
- Reduced connectivity of habitat/barrier effects
- Habitat degradation from increased disturbance due to:
  - Noise impacts
  - Light impacts
  - Visual disturbance
- Habitat degradation from physical changes including:
  - Weed invasion
  - Rubbish
  - Erosion, sedimentation, and water pollutants
  - Hydrological changes.

The main impacts at the project area are likely to be habitat loss, as well as less direct effects from road noise, reduced habitat connectivity and vehicle lighting.

NATIVE VEGETATION AND TREES

Likely impacts of the Project upon native vegetation were determined based on a buffer off the Project design, in consultation with VicRoads and Project designers. No-go Zones have been identified for the Project, as well as areas and tree TPZs that should be avoided if possible (but are considered lost for calculation of impacts). Note: Minor changes to these No-go Zones may be required, however the maximum anticipated loss of EVCs, threatened communities, and Guidelines 2017 trees, will not be exceeded.

Up to 10.56 ha of native vegetation (patches) is currently proposed to be lost from ten EVCs. All these EVCs are considered ‘endangered’ or ‘vulnerable’ within the Gippsland Plain Bioregion. With scattered tree buffers added, the total native vegetation loss for offset calculations is 12.10 ha.

For the tree impacts under Guidelines 2017, a total of 24 large trees comprised of 14 Trees in patches and 10 Scattered Trees are proposed to be impacted (including direct removal and those with greater than 10% Tree Protection Zone impacts). There are also 43 Small Scattered Trees and 227 Small Trees in patches proposed for removal. This is a total of 294 Canopy Trees proposed to be affected by the Project. When understorey trees are considered, the total will be up to 331 trees. The remaining remnant trees occurring within the project area will be protected with No-go zones.

As well as the above, the Project is likely to result in the loss of 491 (of total 939) exotic or invasive trees and 730 (of total 1618) planted native trees. These numbers are approximate, as No-go Zones have not yet been determined for planted trees. This will be completed by the contractor with the aim of retaining as many high value trees as possible, particularly large trees and trees with hollows.

It is likely that the number of trees (and extent of EVCs) impacted can be reduced further as construction methods are better known. Focus should be on minimising impacts to large trees.

THREATENED COMMUNITIES

For the EPBC Act critically endangered communities:

- 0.24 ha maximum anticipated loss of Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (excluding area previously assessed as the community)
- 0.04 ha maximum anticipated loss of Natural Damp Grassland of the Victorian Coastal Plains.

For the FFG Act listed communities:

- 0.35 ha maximum anticipated loss of Herb-rich Plains Grassy Wetland (West Gippsland) Community
- 0.04 ha maximum anticipated loss of Plains Grassland (South Gippsland) Community.

These impacts are not considered to be significant.

SIGNIFICANT SPECIES

The potential for the Project to impact significant species was assessed. Results are summarised below:

- No significant flora species are expected to be substantially affected by the Project
- 44 significant fauna species (i.e. every significant fauna species with a likelihood of occurrence greater than 'low') were assessed for their potential to be impacted by the Project. With the incorporation of at least the minimum required mitigation measures (refer Mitigation below), residual impacts upon threatened and migratory fauna are unlikely to be significant. Note: usually only species with a likelihood of 'moderate' and above are assessed, however the 'low-moderate' category was included to address species identified in the scoping requirements.

ECOLOGICAL CHARACTER

The project may lead to changes in ecological character at environments at and adjacent to the project area. This may constitute changes in species composition/loss of species due to fragmentation and reduction in habitat quality from noise and light impacts. The mitigation measures and guidelines proposed are likely to substantially reduce negative effects upon ecological character. Ecological character of Edithvale wetlands is highly unlikely to be affected.

EDITHVALE WETLANDS

Impacts upon the ecological values of the Edithvale wetlands (part of the Edithvale-Seaford Ramsar site) are highly unlikely, based on groundwater and surface water studies completed for the Project.

THREATENING PROCESSES

The Project has the potential to exacerbate several threatening processes listed under the EPBC Act or FFG Act. Most of these will be managed through standard controls. Some vegetation clearing is unavoidable.

CUMULATIVE IMPACTS

Based on currently-available information regarding relevant nearby projects, the Project is unlikely to result in significant cumulative impacts.

MITIGATION

AVOID AND MINIMISE

A key tenet of the Guidelines 2017 is the requirement to *avoid and minimise* impacts to native vegetation; this principal is also common to relevant legislative instruments such as the EPBC Act and the FFG Act. The principal is that preference should be given to avoidance, then minimisation, then mitigation, and lastly offsetting, and that this process should be considered early in the design of the project. The process to avoid and minimise impacts through the conceptual design process, preliminary planning and developing processes to further avoid and minimise impacts is developed and outlined in the body of the report in Section 7.1.

MITIGATION MEASURES

There is limited scope to move the road within the project area, and there are no alternative corridor options available. Therefore, emphasis has been placed on developing minimisation strategies/guidelines and mitigation measures to reduce both the direct and indirect impacts associated with the construction and operation of the road. There are opportunities for a range of solutions (informed by current research and expert opinion), to mitigate the indirect impacts of the Project (light, noise, etc.). Mitigation strategies include barrier structures, wildlife crossing structures, fauna-sensitive lighting, landscaping and revegetation, and measures during construction.

The impact assessment and risk assessment has identified the requirement for mitigation of four main impacts for the operational phase of the project, namely road noise, reduced connectivity, vehicle lighting, and wildlife mortality due to collision with vehicles.

The following measures from the mitigation section (Section 7) are assumed for the assessment of residual impacts on significant fauna (Provided in Section 6.4):

- Culverts for fauna passage with associated revegetation/landscaping between the ranger station at Braeside and Bowen Parkway.
- Multi-function fauna barrier as described in Section 7.4.1, for the key wetland areas (between the ranger station at Braeside Park and the bridge over Mordialloc Creek).
- Construction guidelines detailed in Section 7.5, including No-go zones for all habitat within the project area that is not proposed to be impacted.
- Wetland vegetation clearance under bridge is minimised and revegetated to the extent possible.
- Fauna-sensitive lighting design guidelines followed for key wetland areas.

The remaining mitigation measures in Section 7.4 (including additional fauna barriers and crossings) address other impacts identified in the impact assessment and risks identified in the risk assessment, to provide a best practice strategy for the project.

Mitigation from impacts relating to hydrological changes (flow and quality of surface water and groundwater) are provided in the relevant specialist reports. Residual impacts from hydrological changes are expected to be negligible.

Recommended monitoring of the mitigation is provided at the end of the mitigation section and includes monitoring of weeds, rehabilitation, fauna connectivity (i.e. use of culverts but target species), and bird habitat use. There is the potential for a before/after – control/impact (BACI) study, which could contribute substantially to the scientific understanding of road impacts on birds. This should be further developed through a monitoring plan, with associated contingency measures in place.

The key mitigation measures and outcomes of the risk assessment have been used to develop Environmental Performance Requirements (EPRs) for the Project. There are six EPRs specifically for biodiversity, which outline the major biodiversity requirements and objectives for the Project.

LEGISLATION AND POLICY

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (EPBC ACT)

Several Matters of National Environmental Significance (MNES) have been recorded within or near the project area. Several MNES with at least a moderate likelihood of occurrence and with the potential to be impacted by the Project have been assessed, which includes migratory bird species including Latham's Snipe and Sharp-tailed Sandpiper, two critically endangered EPBC Act communities, one threatened bird species (Australasian Bittern) and one threatened flora species (Swamp Everlasting). Studies by WSP, including the preliminary flora and fauna impact assessment (WSP 2017d) and groundwater impact assessment (WSP 2017a), indicated that a significant impact was unlikely but that a referral should be completed for certainty. An EPBC Act referral was submitted on 31 October 2017. A determination by the Commonwealth was provided on 30 January 2018, stipulating that the Project was a controlled action. The referral decision identified several MNES of concern. Potential impacts on MNES have been addressed in this study (summarised in Table ES.1) along with more detailed mitigation measures to minimise impacts.

This assessment determined that significant impacts upon MNES are unlikely. With the mitigation proposed, EPBC Act Offsets are not considered warranted for the Project.

Table ES.1 Matters of National Environmental Significance identified in referral letter

MNES	HOW IT HAS BEEN ADDRESSED
Edithvale-Seaford Ramsar wetland	Revised impact assessment based on new surface and groundwater modelling. Ramsar wetland and constituent species unlikely to be impacted. Significant impacts unlikely.
Australian Fairy-tern (Vulnerable)	Species is predominantly estuarine and has a low likelihood of occurrence. No recent nearby records and no potential habitat at the project area. Significant impacts unlikely.
Eastern Curlew (Critically Endangered and Migratory)	No longer considered to have the potential to be impacted. Subsequent investigation and habitat mapping has indicated that the species has a low likelihood of occurrence in the area, and that the habitat near the project area is sub-optimal (the species is predominantly estuarine). Significant impacts unlikely.
Curlew Sandpiper (Critically Endangered and Migratory)	Further bird surveys and detailed habitat mapping was completed. Species was recorded at Braeside Park wetlands during survey in 2018. The impact assessment addresses the potential for impacts upon this species. Species unlikely to be significantly impacted with mitigation.
Australasian Bittern (Endangered)	Further bird surveys and detailed habitat mapping was completed. The impact assessment addresses the potential for impacts upon this species. Species unlikely to be significantly impacted with mitigation.
Sharp-tailed Sandpiper (Migratory)	Further bird surveys and detailed habitat mapping was completed. Species was recorded at Braeside Park wetlands during survey in 2018. The impact assessment addresses the potential for impacts upon this species. Species unlikely to be significantly impacted with mitigation.
Latham's Snipe (Migratory)	Further bird surveys and detailed habitat mapping was completed. The impact assessment addresses the potential for impacts upon this species. Species considered unlikely to be significantly impacted.
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (Critically Endangered)	Further field assessment was completed for this community and area of extent revised based on assessments of marginal condition areas during a 'wet phase'. The impact assessment addresses the potential for impacts upon this community. Impacts unavoidable however considered not significant.

ENVIRONMENT EFFECTS ACT 1978

A self-assessment against the criteria was completed (WSP 2017e). This assessment, based on the information available at the time, identified that one or more individual effects may be triggered. Subsequently, the Mordialloc Bypass project was the subject of an EES Referral, and a determination was made by the Minister that an EES was required. This report will be an attachment to the EES document.

FLORA AND FAUNA GUARANTEE ACT 1988 (FFG ACT)

As FFG Act listed species and communities are proposed to be impacted by the project, an FFG Act permit to remove threatened species/communities is required. The impact assessment is provided in Section 6. Based on this assessment, several FFG Act values may require permits. These are listed below and the relevant species are detailed in the report:

- Listed flora species:
  - No listed threatened flora are likely to be impacted.
- Listed fauna species:
  - 13 threatened fauna species may incur some direct and indirect impacts on foraging habitat.
- Communities:
  - Plains Grassland (South Gippsland) Community
  - Herb-rich Plains Grassy Wetland (West Gippsland) Community
- Protected flora:
  - Three flora species are listed on the Protected flora list and a further 22 flora species are protected as part of threatened communities. These are detailed in the report.

GUIDELINES FOR THE REMOVAL, DESTRUCTION OR LOPPING OF NATIVE VEGETATION

The total native vegetation loss for offset calculations is 12.096 ha. The native vegetation removal report from DELWP's Native Vegetation Team (dated 3 September 2018), returned an offset amount of 4.426 general units and 24 large trees, with a minimum strategic biodiversity value score of 0.422. No specific species offset units are required.

It is likely that the number of trees (and extent of EVCs) impacted can be reduced further as construction methods are better known. Focus should be on minimising impacts to large trees.

WILDLIFE ACT 1975

A considerable number of native and exotic trees are likely to require removal for the Project. This includes up to 24 large remnant trees. Trees, as well as other areas of fauna habitat such as wetland vegetation, provide habitat for local fauna. A permit for removing fauna habitat will be required under the *Wildlife Act 1975*. Any persons involved in fauna removal, salvage, capture or relocation of fauna must hold a current Management Authorisation under the Act.

CATCHMENT AND LAND PROTECTION ACT 1994 (CALP ACT)

The field surveys identified that the project area supports eleven regionally controlled (C), five restricted (R) and one regionally prohibited (P) weed, pursuant to the CaLP Act. It is the responsibility of the landowner to control these weeds on their property and on adjacent roadside reserves. Six of these weed species are also listed as Weeds of National Significance (WoNS) by the Australian Government.

Most of the significant weeds were recorded along roadsides and private land in the north of the project area. Very few noxious weeds were recorded from within the Waterways.

PLANNING AND ENVIRONMENT ACT 1987

The project will require approval under the Kingston Planning Scheme for works within the Public Use Zone, Land Subject to Inundation Overlay and the Special Building Overlay. Approvals for vegetation removal will be required under both the Kingston and Greater Dandenong Planning Schemes.

There are a number of areas with planted Victorian and other Australian native species (e.g. Giant Honey-myrtle, Spotted Gum) along the Mornington Peninsula Freeway and other areas. Under Section 52.17 under all Victorian Planning Schemes, there is an exemption to obtaining a planning permit for planted vegetation, unless the vegetation was planted with government funding. The vegetation must have been planted or managed for conservation for a permit to be required. DELWP interprets vegetation planted along a roadside by a road authority not to be for conservation purposes, and therefore exempt from a planning permit and offsets. The exemption applies to the vegetation that was planted, not vegetation generated from the planted vegetation.

This exemption would not apply to native vegetation planted throughout The Waterways, as this area was planted for conservation purposes using (in part) public funds and is located on public land (mostly owned by Melbourne Water).

1 INTRODUCTION

1.1 PROJECT OVERVIEW

WSP Australia Pty Limited (WSP) was engaged by VicRoads to prepare the Environment Effects Statement (EES) and associated technical reports for the proposed Mordialloc Bypass (the 'project'), located in outer Melbourne, Victoria.

The Mordialloc Bypass project (the project) is the proposed construction of a new freeway connecting the Dingley Bypass with the Mornington Peninsula Freeway; and is predominately to be constructed within an existing road reservation. The project passes between the western boundary of Braeside Park and the eastern boundary of the Woodlands Estate (constructed) wetlands, traverses constructed wetlands at Waterways and approaches to within one kilometre of the Ramsar-listed Edithvale-Seaford Wetlands. The northern and southern ends of the project pass through or border the South East Green Wedge.

The project corridor is approximately 9.7 kilometres in length, comprising two, two-lane 7.5 kilometre long carriageways (with a path for walking and cycling) along the greenfield alignment, and 2.2 kilometres of roadworks required to integrate the project with the Mornington Peninsula Freeway. It is expected that each carriageway will provide for two 3.5 metre wide lanes, with a 3.0 metre wide outside shoulder and 1.0 metre wide inside shoulder. The Mordialloc Bypass will also provide connections from the freeway onto the Dingley Bypass, Centre Dandenong Road, Lower Dandenong Road, Governor Road, Springvale Road and new north facing ramps at Thames Promenade. There will also be an overpass at Old Dandenong Road. Mordialloc Creek and the associated Waterways Wetlands will be spanned by twin 400 metre long bridges.

The proposed alignment allows for a future upgrade of the project to a six-lane freeway standard road within the construction footprint.

The proposed alignment is generally located within the existing road reservation, most of which is already covered by Public Acquisition Overlay, and some of which is already in VicRoads' ownership.

The proposed project consists of:

- Four-lane freeway standard cross-section (two lanes in each direction), divided by a centre median.
- 100 km/hr posted speed limit.
- Full diamond interchanges at Springvale Road, Governor Road and Lower Dandenong Road whereby Mordialloc Bypass is elevated over the arterial roadway with northbound and southbound entry and exit ramps providing access for all directions of travel.
- Half single point urban interchange at Centre Dandenong Road whereby Mordialloc Bypass is elevated over Centre Dandenong Road and southbound entry and northbound exit ramps provide accessibility to and from the south.
- Addition of northbound entry and southbound exit ramps at the existing Mornington Peninsula Freeway interchange at Thames Promenade to provide access to and from Mordialloc Bypass. The existing interchange provides ramps to and from Mornington Peninsula Freeway to the south only. The proposed entry and exit ramps will create a full diamond interchange at Thames Promenade.
- An at-grade T-signalised intersection at Dingley Bypass.
- Elevation of the bypass over Old Dandenong Road and Bowen Parkway to maintain existing connectivity on these routes.
- Shared use path running north-south along the length of the Mordialloc Bypass and connecting existing paths along the north side of Dingley Bypass and the south side of Springvale Road adjacent to Chelsea Heights Hotel.

- Bus queue jump lanes provided in intersection configurations at the proposed Springvale Road and Centre Dandenong Road interchanges.

The project area for the Mordialloc Bypass is shown on Figure 1.1 and the current design is shown on Figure 1.2.

1.2 PROJECT AREA

The project area for Mordialloc Bypass (Figure 1.1) was set aside as a road reservation in the 1950s. It traverses the suburbs of Clayton South, Dingley Village, Braeside, Waterways, Aspley Gardens, Chelsea Heights and Bangholme in the City of Kingston, with small components of work proposed in the City of Greater Dandenong. It is situated approximately 25 km south east of the Melbourne CBD and 5 km east of Mordialloc. The project area occurs within the Gippsland Plain Bioregion.

The topography of the project area is relatively flat, with only gentle rises in the landscape. The lowest lying section of project area is in the south around the Waterways Wetlands, at approximately 4 m above sea level. The topography rises gradually to the north, to around 30 m elevation.

The project will occur partly within the designated Braeside West and Mordialloc Creek Wetlands/Waterways Wetlands catchment areas. Both these catchments contribute tributary runoff flow to the larger Mordialloc Creek drainage system.

Several wetland areas of high ecological value occur adjacent or nearby to the project area. A description of the habitats and values of the surrounding environment is provided in Section 4.1.

The design includes space within the road footprint for an additional two lanes to allow for the expansion of the road in future.

1.3 STUDY SUMMARY

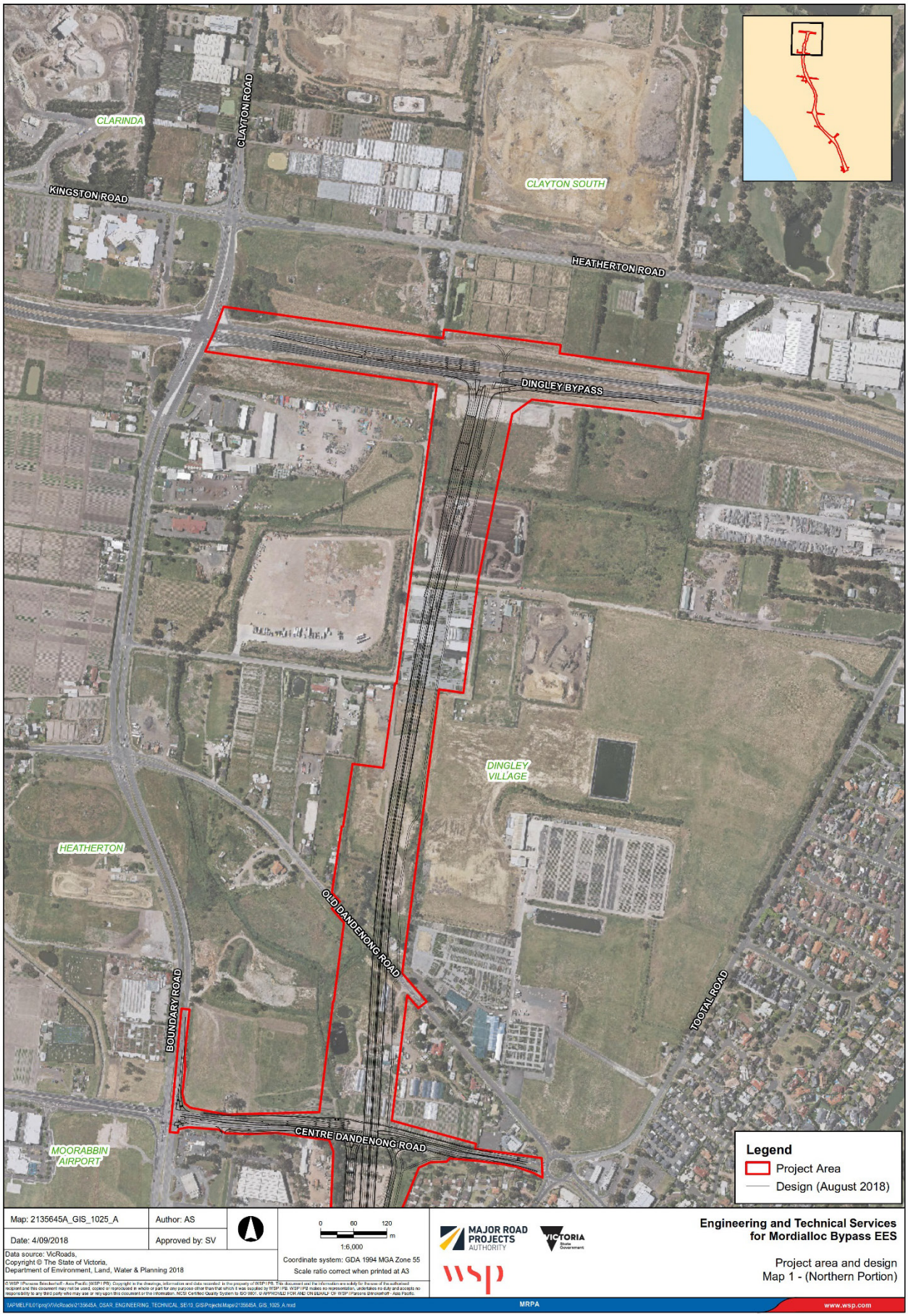
The objectives of this study were to detail the biodiversity values of the project area and surrounds, assess the risks and likely impacts of the Project based on the current design, and provide a recommended mitigation strategy for the Project. This has been done to address the EES Scoping Requirements [Draft] (refer Section 2) and comments by the Project Technical Reference Group (TRG).

This report builds upon the work completed to date, including the preliminary flora and fauna assessment (WSP 2017d).

The following scope of works has been undertaken by WSP for this study:

- Desktop review of flora and fauna databases and relevant biodiversity strategies, policies and legislation
- Review of Habitat Hectare assessments and verification of previous mapping (Biosis 2013, 2015)
- Mapping and Habitat Hectare assessments of additional areas
- Targeted flora survey
- Fauna habitat assessment and targeted surveys
- Likelihood of occurrence assessment of threatened flora, fauna and communities listed under *the Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) the *Flora and Fauna Guarantee Act 1988* (FFG Act) and/or listed on the Victorian Rare or Threatened Species Advisory Lists (DEPI 2013a, 2014; DSE 2009)
- Risk assessment for biodiversity/habitat and wetlands/waterways values
- Detailed assessment of impacts upon ecological values, including native vegetation, significant species, threatening processes, and ecological character, with reference to relevant legislation and policy
- Development of a recommended impact avoidance and mitigation strategy for the Project, and identification of required mitigation measures for significant species.

Figure 1.1 Location of the project area


CLARINDA
CLAYTON ROAD
KINGSTON ROAD
CLAYTON SOUTH
HEATHERTON ROAD
DINGLEY BYPASS
DINGLEY VILLAGE
HEATHERTON
OLD DANDENONG ROAD
BOUNDARY ROAD
TOOTAL ROAD
CENTRE DANDENONG ROAD
MOORABBIN AIRPORT
Legend
Project Area
Design (August 2018)
Map: 2135645A_GIS_1025_A
Author: AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads,
Copyright © The State of Victoria,
Department of Environment, Land, Water & Planning 2018
0 60 120 m
1:6,000
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Project area and design
Map 1 - (Northern Portion)
MRPA
www.wsp.com


HEATHERTON
CENTRE DANDENONG ROAD
TOOTAL ROAD
SPRING ROAD
HOWARD ROAD
MOORABBIN AIRPORT
DINGLEY VILLAGE
ROWAN ROAD
BOUNDARY ROAD
LOWER DANDENONG ROAD
WOODLANDS DRIVE
MORDIALLOC
BRAESIDE
WHITE STREET
GOVERNOR ROAD
SPRINGVALE ROAD
WATERWAYS
ASPENDALE
ASPENDALE GARDENS
WELLS ROAD
Legend
Project Area
Design (August 2018)
Map: 2135645A_GIS_1025_A
Author: AS
Date: 4/09/2018
Approved by: SV
0 150 300 m
1:15,000
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
Data source: VicRoads,
Copyright © The State of Victoria,
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VICTORIA
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Project area and design
Map 2 - (Central Portion)
MRPA
www.wsp.com

Figure 1.2 Project area and current design

2 EES SCOPING REQUIREMENTS

The following EES objectives, issues and requirements relating to flora and fauna have been extracted from the Scoping Requirements for the Mordialloc Bypass EES (May 2018).

This study has been designed to meet these objectives.

2.1 DRAFT EVALUATION OBJECTIVE

To avoid, minimise or offset potential adverse effects on native vegetation, listed migratory and threatened species and communities, as well as habitat for other protected species.

2.2 KEY ISSUES AND SCOPING REQUIREMENTS

Table 2.1 provides the EES Key Issues and Scoping Requirements relating to biodiversity, and the relevant sections of this report where they are addressed.

Table 2.1 EES Key Issues and Scoping Requirements

EES KEY ISSUES AND SCOPING REQUIRMENTS	SECTION
KEY ISSUES	
Direct loss of native vegetation and any associated listed threatened flora and fauna species and communities known or likely to occur in the project site, such as Plains Grassy Woodland, Damp Sands Herb-rich Woodland/Heathy Woodland Mosaic, Plains Grassy Wetlands, Creekline Grassy Woodland and Swamp Scrub Plains Grassy Woodland.	Section 6.1.1 Section 6.2 Section 6.3 Section 6.4
Loss of, degradation, modification or hydrological alteration to any ecological communities listed as threatened under the FFG Act and EPBC Act, including revegetated areas, and including but not limited to: — *Herb-rich Plains Grassy Wetland (West Gippsland) Community (FFG Act)/critically endangered Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (EPBC Act); and* — *Plains Grassland (South Gippsland) Community (FFG Act).*	Section 6.1.1 Section 6.1.5.4 Section 6.2
Direct loss of, or degradation to, habitat for flora and fauna species listed as threatened or migratory under the EPBC Act, the FFG Act and/or DELWP Advisory Lists, including but not limited to avifauna species, in particular: — *Australian Fairy Tern (Sternula nereis nereis)* — *Eastern Curlew (Numenius madagascariensis)* — *Curlew Sandpiper (Calidris ferruginea)* — *Australasian Bittern (Botaurus poiciloptilus)* — *Sharp-tailed Sandpiper (Calidris acuminata)* — *Latham's Snipe (Gallinago hardwickii); and* — *Australian Painted Snipe (Rostratula australis).*	Section 6.1.1 Section 6.3 Section 6.4

EES KEY ISSUES AND SCOPING REQUIRMENTS	SECTION
Indirect loss of vegetation or habitat quality, that may support any listed species or other protected fauna, resulting from hydrological or hydrogeological change, edge effects, overshadowing, habitat fragmentation, loss of connectivity, or other disturbance impacts including noise from haul trucks during construction and from potential increased traffic along Springvale Road through the Edithvale Wetland.	Section 6.1.2 Section 6.1.4 Section 6.1.5.4 Section 6.1.6 Section 6.7
Potential for adverse effects on the ecological character and biodiversity values of the listed Edithvale-Seaford Wetlands Ramsar site including, but not limited to, the bird species mentioned above.	Section 6.5 Section 6.6 Appendix G
Potential for indirect effects on biodiversity values including but not limited to those effects associated with changes in hydrology (including surface and groundwater changes), water quality (i.e. on water dependent ecosystems), contaminants and pollutants, weed, pathogen and pest animal.	Section 6.1.5.1 Section 6.1.5.3 Section 6.1.5.4 Section 6.7
Potential for impacts on FFG Act and EPBC Act listed species and other protected species resulting from construction and operation activities, including but not limited to significantly increasing mortality due to road traffic, and disturbance to foraging, roosting and breeding of listed threatened species and listed migratory species due to increased lighting, noise and traffic;	Section 6.1.3 Section 6.1.4 Section 6.4
Potential for indirect significant impacts due to shading of vegetation because of the project including but not limited to elevated structures, such as the proposed bridges over Mordialloc Creek and the Waterways wetlands.	Section 6.1.1 Section 6.3 Appendix G
The availability of suitable offsets for the loss of native vegetation and habitat for relevant listed threatened species, ecological communities and migratory species under the EPBC Act and /or FFG Act.	Section 7.2
EES SCOPING REQUIREMENTS	
Priorities for characterising the existing environment	
Characterise the distribution and quality of native vegetation, terrestrial and aquatic habitat and any wildlife movement in the area that could be impacted by the project or associated works. This must include the quality and type of habitat impacted and quantification (in hectares) of the total impact area and areas indirectly impacted from the proposed action.	Section 4.3 Section 4.5 Section 6.2 Section 6.3 Section 6.4
Identify the existing or likely presence of any protected species, and especially species listed under the EPBC Act, FFG Act and DELWP Advisory Lists, as well as declared weeds, pathogens and pest animals.	Section 4.3 Section 4.4 Section 4.5 Appendix D

EES KEY ISSUES AND SCOPING REQUIRMENTS	SECTION
Characterise the listed threatened and migratory species, other protected species, ecological communities and potentially threatening processes that are likely to be present in the nearby wetlands, including wetlands that are part of the Edithvale-Seaford Wetlands Ramsar site. This characterisation is to be informed by the literature and recent available data (especially data <5 years old) and supported by seasonal or targeted surveys where necessary. Details of the scope, timing and method for studies or surveys used to provide information on the ecological values at the site (and in other areas that may be impacted by the project) should be outlined.	Section 3.4 Section 4.1 Section 4.2 Section 4.3 Section 4.4 Section 4.5 Section 6.7
Identify and characterise any groundwater dependant ecosystems that may be affected by the project works. This characterisation is to be informed by relevant data, literature and appropriate surveys.	GDEs assessed in Groundwater Impact Assessment
Identify flora and fauna that could be affected by the project's potential effects on air quality, noise or vibration levels.	Section 6.1.5.5 – air quality Section 6.1.4.2 – noise and vibration Section 6.3 – flora Section 6.4 – fauna
Describe the biodiversity values that could be affected by the project, including: — *Native vegetation and any ecological communities listed under the EPBC Act and FFG Act* — *Presence of, or suitable habitats for, native flora and fauna species, especially those listed under the EPBC Act, FFG Act, and DELWP Advisory List; and* — *Use of the site and its environs for movement by the EPBC Act, FFG Act, and DELWP Advisory List listed fauna species and other protected species.*	Section 4.3 Section 4.4 Section 4.5
Describe the existing threats present to biodiversity values, including: — *Direct removal of individuals or destruction of habitat* — *Disturbance or alteration of habitat conditions (e.g. habitat fragmentation, changes to water quantity or quality, fire hazards, etc.);* — *Threats of mortality of listed threatened fauna;* — *Presence of any declared weeds, pathogens and pest animals within and near the project area; and* — *Initiating or exacerbating potentially threatening processes under the FFG Act.*	Section 4.6 Section 6.7
Design and mitigation measures	
Identify potential and proposed design options and measures that could avoid or minimise significant direct and indirect effects on native vegetation and any listed ecological communities or flora and fauna species and their habitat including the ecological character of the Edithvale-Seaford Wetlands and habitat connectivity values between the Waterways wetlands, Braeside Park and Woodland Industrial Estate wetlands.	Section 7.1
Assessment of likely effects	
Assess likely direct and indirect effects of the project and relevant alternatives on native vegetation, ecological communities and flora species, in particular any species listed under the FFG Act and EPBC Act.	Section 6.2 Section 6.3 Appendix G

EES KEY ISSUES AND SCOPING REQUIRMENTS	SECTION
Assess likely indirect effects of the project on the ecological character and habitat values of the Edithvale-Seaford Wetlands, Braeside Park, the Waterways Wetlands and Woodland Industrial Estate wetlands.	Section 6.5 Section 6.6 Appendix G
Assess likely direct and indirect effects of the project and relevant alternatives on protected fauna and their habitat, including listed (FFG Act/EPBC Act) threatened and migratory species, relative to existing hazards and risks where relevant.	Section 6.4 Appendix G
Assess likely effects of the project and relevant alternatives on any groundwater dependant ecosystems and EPBC Act listed ecological communities, in particular due to project dewatering activities.	Section 6.2.4 Section 6.6 Appendix G – significant impact criteria assessments GDEs addressed in Groundwater Impact Assessment (WSP 2018b) Project dewatering activities are not anticipated.
Assess likely cumulative effects on biodiversity-related values that might result from the project in combination with other projects or actions taking place or proposed nearby.	Section 6.8
Approach to manage performance	
Describe and evaluate proposed measures to further mitigate and manage residual effects of the project on biodiversity values, including an outline of an offset strategy that sets out and includes evidence of the offsets that have been secured or are proposed to satisfy offset policy requirements and the relevant provisions of planning schemes.	Section 7.2 Section 7.3 Section 7.4
Describe and evaluate the approach to monitoring and the proposed contingency measures to be implemented in the event of adverse residual effects on flora, fauna and ecological community values requiring further management.	Section 7.6 Section 7.7
Identify any further methods proposed to manage risks and effects on other biodiversity values and native vegetation, including as part of the EMF (see section 5).	Addressed in Chapter 23 of the Mordialloc Bypass EES
Commonwealth offsets	
Describe and evaluate proposed measures to manage residual effects of the project on biodiversity values, including an outline of an offset strategy and Offset Management Plan that sets out proposed environmental offsets to satisfy Commonwealth offset policy requirements.	Section 7.2 Commonwealth EPBC Act offsets are not currently proposed, as the Project aims to avoid, minimise, and mitigate impacts such that the residual impact upon all EPBC Act listed matters is not significant.
Describe how the offset will be secured, managed and monitored, including management actions, responsibility, timing, performance measures and the specific environmental outcomes to be achieved.	
Outline the key commitments and management actions for delivering and implementing a proposed offset through an Offset Management Plan.	
Proposed offsets must meet the requirements of the EPBC Act Environmental Offsets Policy (Oct, 2012): www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy.	

3 METHODOLOGY

This chapter provides the methodology of this study.

3.1 DEFINITIONS

For this report the following definitions apply:

- **Project area** is the entire extended footprint of the project works. This includes areas of land that are outside the proposed Right of Way where works are expected to be completed. This is shown on Figure 1.2.
- **Study area** is the project area plus a variable buffer. For the targeted bids surveys, the study area included part of the adjacent wetlands, for flora it was a 20 m buffer on the project area, for vegetation mapping it was a 20 m buffer on the project area, plus the Mordialloc Creek wetlands.
- **Impact Area** is assumed to be the entire Project Area minus No-go Zones – see Section 3.6.1.
- **Locality** is defined as an approximate 5 km radius around the project area.
- **No-go Zones** are areas of native vegetation which are recommended for retention and are excluded from the calculation of impacts. See Section 3.6.1 for more detail.
- **Region** is a bioregion defined in the state system of bioregionalisation (DELWP 2017b). For this study the relevant bioregion is the Gippsland Plain.
- **Waterways wetlands:** the wetlands constructed as part of the development of Waterways (suburb) along Mordialloc Creek (refer Section 4.1).
- **Woodlands Industrial Estate wetlands ('Woodlands wetlands')**: The Melbourne Water retention ponds and associated wetland vegetation/shallow wetlands within the same block (refer Section 4.1).
- **Braeside Park wetlands**: the wetlands in the southwestern part of Braeside Park (refer Section 4.1).
- **Edithvale wetlands**: the Edithvale component of the Edithvale-Seaford Ramsar site, comprising northern and southern sections which are separated by Edithvale Road.

Additional definitions are provided in the glossary at the beginning of this report.

3.2 PERSONNEL

The contributors to this study, their qualifications and Project roles are provided in Table 3.1.

Table 3.1 Contributors and their roles

NAME	QUALIFICATIONS	POSITION AND ROLE/S ON PROJECT
Samantha Vertucci	BSc (Hons)	Ecologist – Project manager/coordinator Field survey, lead report preparation
Nic McCaffrey	BSc	Principal Ecologist – Ecology project director/botanical lead Field survey, report preparation
Mark Shepherd	BEnvSc	Senior Ecologist Field survey, report preparation
Allan Richardson	BEnv (Hons)	Senior Ecologist — Avifauna specialist Bird survey, habitat mapping, and impact assessment review

NAME	QUALIFICATIONS	POSITION AND ROLE/S ON PROJECT
Jake Urlus	BEnvSc Hons	Principal Zoologist – terrestrial fauna Reporting – fauna habitat, impact assessment and mitigation
Rob Gration	M. Wildlife Mgmt (Habitat), GradCertApSc (Wildlife Ecology/Mgmt), DipApSc (NRM)	Principal Ecologist (subconsultant) Terrestrial fauna survey (songmeters) and data analysis
Rodney van der Ree	PhD	Principal Ecologist (subconsultant – Ecology and Infrastructure International Pty Ltd) Inputs and preliminary review of impacts and mitigation.
Peter Gannon	BSc, GradDippEnvSci., MEnvSci.	Principal Ecologist Technical Review
John McGuckin		Principal Ecologist (subconsultant – Streamline Research) Aquatic ecology surveys
Ed McNabb		Wildlife ecologist (subconsultant – Ninox Pursuits) Owl habitat assessment and surveys
Danelle Scicluna	BEnvSc	Graduate Ecologist Data management, mapping, report preparation
Matt Brown	BEnvSc	Senior GIS Technician Mapping and data management
Angela Sun	BEnvSc	GIS Technician Mapping and data management

3.3 TAXONOMY

Fauna taxonomy in this report predominantly follows the Australian Faunal Directory (AFD), a Commonwealth DoEE database maintained and updated by the Australian Biological Resources Study (ABRS 2009).

Flora taxonomy follows the Victorian Biodiversity Atlas (DELWP 2018d).

Plant and animal species in this report are initially cited by both common and scientific name, with scientific name in italics. Subsequent references to a species cite the common name only. Introduced species are identified within text with an asterisk '*' mark, for example **Briza maxima*.

3.4 EXISTING CONDITIONS

3.4.1 DATABASE AND LITERATURE REVIEW

A database search and literature review was undertaken to inform our initial understanding on the ecological values of the project area and surrounds. Relevant and available documents were reviewed for information on past land uses, vegetation communities, and flora and fauna. Relevant databases were searched for records of threatened species within 5 km of the project area.

This review was used to prepare a list of threatened flora and fauna species, ecological communities, migratory species and any significant habitat previously recorded or predicted to occur in the study area and the broader locality (listed and preliminary listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Flora and Fauna Guarantee Act 1988* (FFG Act). The following sources of information were consulted:

- The Victorian Department of Environment, Land, Water and Planning (DELWP) Biodiversity Interactive Map (now NatureKit) (DELWP 2018c)
- The Victorian Biodiversity Atlas (DELWP 2017d) – 5 km radius of the study area
- The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Protected Matters Search Tool – 5 km radius of the study area (DoEE 2018)
- The Commonwealth Department of the Environment Species Profile and Threats Database
- Victorian Rare or Threatened Species Advisory Lists (DEPI 2013a, 2014; DSE 2009)
- Biodiversity Information Tools used in Victoria's Native Vegetation Permitted Clearing Regulations and the Native Vegetation Information Management System (DELWP 2018b)
- BioSite maps (DELWP 2014), wetlands and any significant roadside studies
- Publicly available reports
- Reports provided by VicRoads, Melbourne Water and Parks Victoria
- Aerial imagery to determine habitat extents and linkages
- Relevant legislation, government policy and strategies
- Publicly available geospatial datasets.

The background reports of most relevance to ecological values of the project area (and reviewed in the Section 4.2 Literature Review) are:

- Edithvale and Bonbeach Level Crossing Removal Projects – Environment Effects Statement: EES Technical Report A – Groundwater Impact Assessment (AECOM-GHD JV 2018a)
- Edithvale and Bonbeach Level Crossing Removal Projects – Environment Effects Statement: EES Technical Report B – Ecological Impact Assessment; Wetlands and Groundwater Dependent Ecosystems (AECOM-GHD JV 2018b)
- Edithvale and Bonbeach Level Crossing Removal Projects – Environment Effects Statement: EES Technical Report D – Ecological Impact Assessment; Project Areas (AECOM-GHD JV 2018c)
- Establishment of Indigenous Flora and Fauna in Revegetated Areas at "The Waterways" (Australian Ecosystems 2017)
- Flora and Fauna Investigation: Northern Extension of the Mornington Peninsula Freeway (Biosis 2013)
- Mordialloc Bypass: Flora and Fauna Investigation Including Habitat Hectare Assessment (Draft Report) (Biosis 2015)
- Preliminary Ecological Assessment for 12km of proposed roadway between the South Gippsland Freeway and Warrigal Road (Biosis Research 2008)
- Outer Suburban Arterial Road Program – Preliminary Biodiversity Assessment (Brett Lane & Associates 2016)
- Vegetation of Braeside Metropolitan Park, Braeside, Victoria and its Management (Carr 1985)
- Flora and Fauna Lists of "The Waterways" (Cook, D undated)
- List of Indigenous Plants for the Braeside Region (Dunn 1988)
- Edithvale-Seaford Wetlands Ramsar Site Management Plan (Ecology Australia 2016)

- Entomology Society of Victoria, 2016. Moths of the Braeside Park Heathland (Entomological Society of Victoria 2017)
- Field Naturalists Club of Victoria, 2016 – Braeside Park Frog Recording Data (The Field Naturalists Club of Victoria 2016)
- Field Naturalists Club of Victoria, 2017, Fauna Survey at Braeside Park (The Field Naturalists Club of Victoria 2017)
- Melbourne Water Regional Bird Monitoring Project, Annual Report: July 2015-June 2016 (Herman & Purnell 2016)
- Edithvale and Seaford Wetlands Bird Survey Project 2014-15 (Silcocks 2016).

3.4.2 VEGETATION ASSESSMENT

3.4.2.1 SUMMARY

Biosis conducted detailed flora and fauna investigations and habitat hectare assessments for the project in 2015 (Biosis 2015). They were unable to access several properties at the time of that study. The project area has also changed since these investigations were completed. For these reasons, WSP conducted additional surveys of the project area in 2016 and 2017 to inform this assessment. This included additional habitat hectare assessments and the application of wetland EVCs (as defined under the Index of Wetland Condition) to the vegetation in the project area.

The initial WSP field assessments (for the preliminary flora and fauna assessment) were conducted over a series of days between November 2016 and May 2017.

Follow up surveys were completed for this study to further ground-truth and improve upon the previous mapping, and to assess new parts of the project area. The study area for the vegetation assessment and mapping was the Project area plus a 20 m buffer.

The following techniques were utilised for the current study:

- Field validation of vegetation communities – the extent and condition of mapped EVCs were verified and re-mapped as required. Any additions to the project area (i.e. not included in the Biosis assessment) were mapped. Our procedure for classifying vegetation is provided in Section 3.4.2.3.
- Assessment of ecological communities against EPBC Act criteria – plots/quadrats were used to assess patches of native vegetation against determination criteria for the EPBC Act listed ecological communities. Plot/quadrat assessments were conducted in accordance with the Braun-Blanquet methodology (Specht 1981).
- Habitat hectare assessment – completed for all habitat zones identified within the study area in accordance with the '*Vegetation Quality Assessment Manual – Guidelines for applying the habitat hectares scoring method Version 1.3*' (DSE 2004). The previous habitat hectare assessments were verified and updated where required. More information about our methods for completing habitat hectare assessments is provided in Section 3.4.2.5.
- Any other incidental observations or evidence of flora or fauna were recorded including any records of threatened flora or fauna taxa observed during any of the site assessments.

3.4.2.2 PLANT IDENTIFICATION

Flora species that could not be identified in the field were recorded to the nearest possible family or genus. These were then collected and identified where possible as per protocols of the Flora and Fauna Guarantee permit (10007800) for the collection of plant material.

3.4.2.3 DETERMINATION OF ECOLOGICAL VEGETATION CLASSES

An Ecological Vegetation Class (EVC) is a unit of consistent vegetation displaying broadly similar botanical characteristics reflecting consistent environmental and structural conditions (Oates & Taranto 2001). Field validation (or ground-truthing) of the DELWP modelled vegetation layer NV2005_EXTANT (DELWP 2018c) was undertaken to determine the site specific classification of the vegetation structure, floristics, wetland formations, dominant canopy

species, native diversity and condition. NV2005_EXTANT was mapped with a focus on terrestrial vegetation and broader wetland types and has not been updated to include published wetland EVCs. Specific wetland EVCs were assessed using EVCs developed for the Index of Wetland Condition by (Frood 2009) and (DELWP 2016).

Terrestrial and wetland EVCs were mapped where the vegetation met the requirements for a remnant patch or scattered tree under the *Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017c):*

A *patch* of native vegetation is either:

- An area of vegetation where at least 25 per cent of the total perennial understorey plant cover is native
- Any area with three or more native trees where the drip line of each tree touches the drip line of at least one other tree, forming a continuous canopy, or
- Any mapped wetland included in the Current wetlands map, available in DELWP systems and tools.

A *scattered tree* is:

- A native tree that does not form part of a remnant patch. Where they did not meet the criteria for remnant patches, scattered trees were recorded with a handheld GPS.

3.4.2.4 REVEGETATION CATEGORISATION

Revegetation is extensive at some sites and can have different implications and exemptions under planning laws and other biodiversity legislation. Categories detailed in Table 3.2 were used for the purposes of categorising vegetation in the study area. Flora that has been planted for aesthetic purposes was deemed to be exempt of requiring a planning permit. Please note however that indigenous flora that has naturally regenerated from planted areas, indigenous flora which is regrowth greater than 10 years in age, or indigenous flora planted for conservation, was determined to be **not exempt** from requiring a planning permit and was subsequently mapped as a remnant patch and subject to habitat hectare assessment (i.e. revegetation at the Waterways wetlands). Relevant patches were assessed against the criteria for FFG Act and EPBC Act communities (see Section 3.4.2.7).

Where possible, groups or rows of planted trees were lumped into revegetation polygons. Where planted trees occurred as individual trees, the location of individual planted trees were mapped and diameter at breast height (DBH) was recorded for each tree. The planning implications for native vegetation recorded in the project area are provided in Section 8.2.3

Table 3.2 Revegetation categories used for mapping

REVEGETATION/PLANTING MAPPING CATEGORY	DESCRIPTION	PLANNING IMPLICATIONS
Site indigenous	Indigenous to a local area. Described by (Pyšek, Richardson & Williamson 2004) and adopted by (Royal Botanic Gardens Melbourne 2016), defined as 'taxa that have originated in a given area without human involvement or that have arrived there without intentional or unintentional intervention of humans from an area in which they are native'.	There are exemptions under Victorian Planning Schemes, Clause 52.17 'planted vegetation', particularly if the vegetation has been planted for aesthetic or amenity purposes. The clause states *'this exemption does not apply if public funding was provided to assist in planting or managing the native vegetation and the terms of the funding did not anticipate removal or harvesting of the vegetation'*. Therefore, there may be circumstances where planted vegetation is not exempt from requiring a planning permit (e.g. where revegetation has been planted for conservation, such as along creeks).

REVEGETATION/PLANTING MAPPING CATEGORY	DESCRIPTION	PLANNING IMPLICATIONS
		If the vegetation is also covered by an overlay such as 'Environment Significance Overlay', it will likely require a permit to remove any vegetation. Revegetation can also meet criteria for FFG Act and/or EPBC Act communities – see Section 3.4.2.7.
Native to Victoria	Non-indigenous to the local area but native to Victoria (e.g. Mahogany Gums, Giant Honey-myrtle). Defined in Victorian Planning Provisions – Definitions – Clause 72 as *'Plants that are indigenous to Victoria, including trees, shrubs, herbs, and grasses'*.	If vegetation is not exempt as above, it may require a permit for removal.
Native to Australia	Non-indigenous Australian native plants or vegetation (non-indigenous to Victoria) (e.g. Sugar Gums)	Usually do not require a permit for removal but are identified to show these have not been overlooked.

3.4.2.5 HABITAT HECTARE ASSESSMENTS

Habitat hectare assessments were undertaken to determine the condition of the vegetation in the context of the local area and the relevant bioregions. This methodology is outlined in *Vegetation Quality Assessment Manual-Guidelines for applying the habitat hectares scoring method* (DSE 2004). The habitat hectare method involves making visual and quantitative assessments on various characteristics of native vegetation according to established criteria that are set against an optimum benchmark. This process aims to establish the significance of native vegetation through an objective and repeatable methodology using working documents (benchmark data and field assessment score sheets) that are uniformly applied across Victoria.

In summary, this process begins with the identification of the EVC. Each EVC, found on DELWP's website (DELWP 2018a), has a benchmark of optimal values. Site assessments are undertaken using the *Vegetation Quality Field Assessment Sheet* (Version 1.3 October 2004) from (DSE 2004). Further to the site condition criteria, the habitat hectare process also requires an assessment of the site in a landscape context (DSE 2004).

If a site meets or exceeds all benchmark criteria it will receive a total score of 100, which is a total of the above condition and landscape scores in pristine undisturbed condition. However, in many cases in the urban-influenced ecosystems in the Melbourne area, sites receive a score less than 60, due to their relatively high level of modification, and modified surrounds. The final habitat score is presented as a percentage and then converted to a score out of 1.00. Areas defined as a 'patch' were subject to habitat hectare assessments. According to the Native vegetation location risk 2013 (DELWP 2018c).

For some wetland EVCs there was no habitat hectare EVC benchmark, therefore the most similar available EVC benchmark for the bioregion was used – see Table 3.3.

Typically Bioregion Conservation Status is derived from (DELWP 2018a). However, several EVCs did not have a published conservation status, therefore a status in a nearby bioregion was used. Where this wasn't available, the conservation status from Frood and Papas (2016) was used.

Table 3.3 EVC Benchmark availability

EVC NUMBER	ECOLOGICAL VEGETATION CLASS	WETLAND EVC	EVC BENCHMARK AVAILABLE?	MOST SIMILAR EVC BENCHMARK USED
653	Aquatic Herbland	Yes	Yes	n/a
308	Aquatic Sedgeland	Yes	No	Sedge Wetland (EVC 136)
68	Creekline Grassy Woodland	No	Yes	
3	Damp Sands Herb-rich Woodland	No	Yes	
55	Plains Grassy Woodland	No	Yes	
125	Plains Grassy Wetland	Yes	Yes	n/a
647	Plains Sedgy Wetland	Yes	No	Sedge Wetland (EVC 136)
132_62	*South Gippsland* Plains Grassland	No	Yes	n/a
918	Submerged Aquatic Herbland	Yes	No	Aquatic Herbland (EVC 653)
937	Swampy Woodland	Yes	Yes	n/a
53	Swamp Scrub	Yes	Yes	n/a
821	Tall Marsh	Yes	Yes	n/a

3.4.2.6 TREE SURVEYS

Tree surveys were conducted by the project arborist and data were provided in GIS shapefile and the *Preliminary tree assessment report* (Ryder 2018). All living and dead trees 3 m and taller were assessed, and locations from the Project feature survey were used for maximum accuracy. For the Thames Promenade component of the Project, added after the tree assessment had been completed, tree data were collected by an ecologist using high accuracy DGPS. A number of metrics were used to measure and record tree data including those consistent with *Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017c)* ('Guidelines 2017') including Diameter at Breast Height (DBH) (diameter in centimetres measured at 1.3 metres above ground level). The Tree Protection Zone (TPZ) was calculated by the arborist for most of the Project, and for the Thames Promenade component, was calculated by an ecologist (12 x DBH up to a maximum of 15 m).

Tree data was used to determine the location and size class of all Canopy Trees (indigenous trees >3 m which are canopy species for the relevant EVC) as per the Guidelines 2017. This included 'Scattered Trees' and 'Trees in patches'. Large trees were determined as Canopy Trees which met or exceeded the DBH benchmark for the relevant EVC.

For trees with >10% TPZ impact, loss was assumed for calculating offsets. The buffer for impact calculations (i.e. the area required to compensate for tree removal) was determined as per the Guidelines 2017 (10 m for a small tree, 15 for a large).

3.4.2.7 THREATENED VEGETATION COMMUNITIES

Several EPBC Act and FFG Act listed communities identified from the database and literature review were considered to have the potential to occur within the study area. There are no specific criteria which determine the presence of FFG Act communities except for an informal method of comparing site characteristics and floristics with community descriptions in *Characteristics of Threatened Communities – Flora and Fauna Guarantee Act 1988 – Threatened List* (DELWP undated). For EPBC Act communities, vegetation patches must meet the scientific determination criteria including

certain condition thresholds to constitute the community. For the relevant communities, these criteria are described in Approved Conservation Advice (including listing advice) for the Natural Damp Grassland of the Victorian Coastal Plains (TSSC 2015) and Commonwealth Listing Advice on Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (TSSC 2012).

Flora quadrats (usually 20 x 20 m) were undertaken in patches with the potential to be FFG Act and/or EPBC Act communities, and the data were compared against the community descriptions (FFG Act) or criteria (EPBC Act) to determine the presence/absence of threatened communities. Patches assessed in this way included remnant vegetation, and areas of revegetation (discussed further below).

REVEGETATION

It is important to know when revegetation should be considered against the criteria for threatened communities under the FFG Act and/or EPBC Act. This is particularly the case at the study area, which supports large areas of high quality revegetation at The Waterways wetlands, planted to recreate natural ecosystems. There has been a high level of natural recruitment of indigenous flora which is appropriate to this sites' aquatic ecosystems and EVC structures. These now naturally recruiting and functioning sites have been assessed and mapped as *remnant patch* vegetation, despite their planted sources. The justification for the consideration of patches at The Waterways wetlands against criteria for threatened communities under the relevant legislation, is detailed below.

FLORA AND FAUNA GUARANTEE ACT 1988

There is no clear guidance under the FFG Act regarding whether revegetation can be considered part of a listed threatened community under the FFG Act. Therefore, we have assumed that if the community has the attributes which are consistent with the *Characteristics of Threatened Communities* (DELWP undated), then the community is present. This approach has been supported by DELWP's TRG.

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The EPBC Act community Natural Damp Grassland of the Victorian Coastal Plains contains a provision in (TSSC 2015):

> *"Revegetated or replanted sites are not excluded from the listed ecological community so long as the patch meets the key diagnostic characteristics plus condition thresholds above. It is recognised that revegetation often requires longer-term effort and commitment and it may take some time for a degraded patch to reach a high quality condition".*

For the Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains, the principle of including revegetated wetlands in the community listing is alluded to in (TSSC 2012):

> *"The following indicators should be considered when assessing the impacts of actions or proposed actions under the EPBC Act, or when considering recovery, management and funding priorities for a particular wetland….connectivity or proximity to other natural features (e.g. native vegetation remnants, other water bodies) or restoration works. In particular, a wetland in an important position between (or linking) other wetlands in the landscape".*

To further clarify, staff from the Department of the Environment and Energy, Ecological Communities section were consulted. The following advice was received:

> *"Yes, I would accept that revegetated wetlands that can be improved to the point they meet the key diagnostic and condition criteria of the listing advice are included as part of the listed ecological community".*

3.4.3 TARGETED FLORA SURVEY

The likely presence of threatened species was initially determined through an assessment of suitable habitat in the study area. A precautionary approach was adopted and a species was assumed to be present if suitable habitat was observed in the study area, and if that species was known to occur regionally. Targeted surveys were completed to refine this assessment. Surveys were completed between January and May 2017, with follow-up targeted surveys completed in

November and December 2017 to ensure that some survey effort overlapped with the most appropriate survey season for each of the target species (as defined in relevant literature or survey guidelines).

Figure 3.1 shows the area targeted for threatened flora survey.

Field surveys for threatened flora were undertaken using a combination of random meander searches of preferred habitats and parallel line searches. The random meander technique involves targeting a particular or several, threatened plant species and traversing areas of suitable habitat in no set pattern (Cropper 1993). Parallel line traverses involve one or more observers surveying in parallel lines, as outlined by Cropper (Cropper 1993).

When a significant flora species was detected, population information was collected (either patch size or estimated number of plants) where this data might be relevant for impact assessment, or where it may have management implications.

Only those species with a moderate or high likelihood of occurrence (prior to survey) were targeted during surveys.

The survey design was based on relevant state and Commonwealth survey guidelines. The following guidelines are considered to be *'best practice'* and formed the basis for the surveys undertaken:

- Biodiversity Precinct Structure Planning Kit (Department of Sustainability and Environment 2010)
- Management of Endangered Plants (Cropper 1993)
- Pest Plant Mapping & Monitoring Protocol (Parks Victoria 2007)
- Survey Guidelines For Australia's Threatened Orchids (Department of Environment 2013)
- Site examination for threatened and endangered plant species – for timed meander technique (Goff, Dawson & Rochow 1982)
- Monitoring Plant and Animal Populations (Elzinga et al. 2001).

3.4.4 TARGETED FAUNA SURVEY AND HABITAT ASSESSMENT

Detailed surveys and habitat assessment was undertaken in 2012/2013 (Biosis 2013) and 2014/2015 (Biosis 2015) for threatened fauna, including Growling Grass Frog *Litoria raniformis*, wetland birds (plus targeted survey for Latham's Snipe *Gallinago hardwickii* and Australasian Bittern *Botaurus poiciloptilus)*, and threatened fish. Opportunistic bird surveys were undertaken by WSP in December 2016 for the preliminary flora and fauna assessment (WSP 2017d).

The above survey effort, as well as record data from other sources (refer to Section 4.1), was added to by WSP for this impact assessment through additional targeted assessment, detailed below.

WATERBIRD SURVEY AND HABITAT MAPPING

The wetlands adjacent to the study area are popular birding hotspots and therefore there are considerable occurrence data available in publicly-accessible databases for birds, examined during database review and utilised for the likelihood of occurrence assessment (refer Section 3.4.5).

The aims of the survey were to:

- Improve upon our understanding of the value of the habitats within the project area and the adjacent wetlands to bird species of conservation significance
- To improve upon our understanding of the way in which common and significant species move around the area
- To revise the habitat mapping for the project area and vicinity.

As such, targeted bird surveys were conducted within the project area, and at the wetlands immediately adjacent to the project area, in spring 2017/summer 2018 by a WSP avifauna specialist (Allan Richardson). These surveys involved a combination of walked transects and point surveys conducted twice per month in November 2017, and January and March 2018. On each occasion, two 20-minute point surveys and four walked transects were completed. Each transect took up to two hours to complete. Data collected included species, number, and behaviour (if noteworthy). Bird flight trajectory information (height, direction of flight, etc.) was also recorded for bird sightings during March surveys to

improve our understanding of bird movement across and within the project area. The locations of the transects and point surveys are shown on Figure 3.1 and Table 3.4 provides dates and survey effort.

Detailed bird habitat mapping was completed for the habitat of significance to wetland birds in conjunction with the targeted surveys. Examination of aerial imagery and on-ground survey was used to map bird habitat types within the bird survey study area (refer Figure 3.1). The likely use of the habitat types under low and high water conditions were documented by the WSP avifauna specialist for several key bird species, including species of conservation significance. This was a different approach to the previous mapping (Biosis 2015) which involved mapping of habitat for species only. As the previous mapping was approximately five years old, and was completed at a broader scale, the mapping completed for this study should be seen to supersede the previous mapping.

Table 3.4 Bird survey effort

DATE		SURVEY EFFORT
NOV	14/11/2017	All sites surveyed **(not including the Braeside Park bird hide)**
	15/11/2017	All transects and Woodlands/Braeside point survey 1 No Waterways Quadrat
JAN	30/01/2018	All transects and point surveys **(including the Braeside Park bird hide)**
	31/01/2018	All transects and point surveys **(including the Braeside Park bird hide)**
MAR	14/03/2018	All transects and point surveys **(including the Braeside Park bird hide)**
	15/03/2018	All transects and point surveys **(including the Braeside Park bird hide)**
	16/03/2018	Transect 4 (Braeside Park) only

SONGMETER RECORDINGS

Songmeter (sound recorder) surveys were completed over several months in 2017 by a WSP subconsultant, EcoAerial (Rob Gration) (EcoAerial 2018). The objective of these surveys was to detect the presence of Growling Grass Frog *Litoria raniformis* and threatened birds (Lewin's Rail *Lewinia pectoralis pectoralis*, Baillon's Crake *Porzana pusilla palustris*, Little Bittern *Ixobrychus minutus dubius* and Australasian Bittern *Botaurus poiciloptilus*) at the project area. The surveys involved installing one songmeter at Woodlands Industrial Estate Wetlands, and another at the Waterways wetlands. A total of 1,207 sound files (603.5 hours) were analysed against reference calls using Wildlife Acoustics™ Song Scope Version No: 4.1.3A. Survey effort was consistent with Melbourne Water's sound recorder survey guidelines (Symbolix & EcoAerial 2017). Refer to Figure 3.1 for survey locations and Table 3.5 for a breakdown of survey periods and the number of sound files which were analysed for each period.

Table 3.5 Songmeter survey effort for Growling Grass Frog and threatened waterbirds

START	FINISH	FAUNA	LOCATION	NUMBER OF SOUND FILES ANALYSED
9/02/2017	15/02/2017	Growling Grass Frog	Woodlands wetlands	147
24/03/2017	28/03/2017	Growling Grass Frog	Waterways wetlands	109
5/10/2017	17/10/2017	Waterbirds	Waterways wetlands	294
17/10/2017	27/10/2017	Waterbirds	Waterways wetlands	253
14/11/2017	26/11/2017	Growling Grass Frog	Waterways wetlands	276
26/11/2017	1/12/2017	Growling Grass Frog	Waterways wetlands	128

OWL HABITAT ASSESSMENT AND TARGETED SURVEY

Owl habitat assessment and targeted survey was conducted on the 8th and 9th February 2018 by Ninox Pursuits Environmental Services (Ninox Pursuits Environmental Services 2018). Habitat assessments for the Project were completed as part of a broader study of sites across outer Melbourne to identify habitat for owl species of conservation significance, specifically Masked Owl *Tyto novaehollandiae*, Barking Owl *Ninox connivens* and Powerful Owl *Ninox strenua*. Habitat assessments included preliminary desktop analysis and field inspection. Whilst the Project was determined to have a low impact on the aforementioned owl species, Braeside Park was identified as potential habitat for owl foraging and roosting. As such, call playback and spotlighting surveys (<1ha) were conducted at two locations within Braeside Park. One site was located 600 m from the project boundary and the other was located 450 m from the project boundary within Braeside Park. Playback surveys were conducted as per DELWP protocol (Loyn, McNabb & Machunter 2011a, 2011b, 2011c)

AQUATIC FAUNA SURVEY

An aquatic fauna field assessment was initiated on 29 November 2016 and concluded on 15 March 2017 by a WSP subconsultant, Streamline Research (McGuckin 2017). The methodology and results were reported on in the preliminary flora and fauna impact assessment (WSP 2017d) and have been considered for the likelihood of occurrence assessment in this report.

3.4.5 LIKELIHOOD OF OCCURRENCE

As with most biological assessments, the presence or absence of a particular species cannot be definitively determined during a relative short survey timeline. For this study, the likelihood of occurrence of threatened and migratory species and populations was determined based on the criteria shown in Table 3.6 below. This method utilises the known habitat requirements of the species, outcomes of a habitat assessment, and habitat connectivity at the project area, in conjunction with Victorian Biodiversity Atlas (and other database) records, and Protected Matters Search Tool habitat modelling.

The likelihood of occurrence assessment was initially used to determine which targeted surveys were required and has been continually revised/updated as new surveys are completed. Usually only species with a likelihood of 'moderate' and above are assessed in the impact assessment component of an ecological assessment report. However, the 'low-moderate' category was included in the impact assessment component of this report to address species identified in the scoping requirements.

Table 3.6 Likelihood of occurrence criteria for threatened flora and fauna species

LIKELIHOOD	DESCRIPTION
Low	Species considered to have a low likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: — Have not been recorded previously in the study area and surrounds and for which the study area is beyond the current distribution range — Rely on specific habitat types or resources that are not present in the study area — Are considered locally extinct — Are a non-cryptic perennial flora species that were specifically targeted by surveys and not recorded — Are fauna species that have been specifically targeted by appropriate survey and have not been recorded.

LIKELIHOOD	DESCRIPTION
Moderate	Species considered to have a moderate likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: — Have infrequently been recorded previously in the study area and surrounds — Use habitat types or resources that are present in the study area, although generally in a poor or modified condition — Are unlikely to maintain sedentary populations, however, may seasonally use resources within the study area opportunistically during variable seasons or migration — Are cryptically flowering flora species that were not seasonally targeted by surveys and that have not been recorded — Are cryptic fauna species that have not been seasonally targeted by surveys and have not been recorded — May periodically visit the site during seasonal movements or migration.
High	Species considered to have a high likelihood of occurrence include species not recorded during the field surveys that fit one or more of the following criteria: — Have frequently been recorded previously in the study area and surrounds — Use habitat types or resources that are present in the study area, and that are abundant and/or in good condition within the study area — Are known to, or considered likely to, maintain resident populations surrounding the study area — Are known or likely to regularly visit the site during regular seasonal movements or migration.
Recorded (flora only)	Any threatened species recorded during field surveys. This category is used for flora only in this report, as many of the relevant significant fauna species are known to periodically occur in the area, and the regularity and number of past records are more important than presence in any one survey in determining the likelihood of the species to occur, and/or the importance of the habitat present.

3.4.6 LIMITATIONS

A common limitation of ecological surveys is the short period over which they are undertaken and the lack of multi-seasonal sampling, which can lead to lack of detection of some species. Fieldwork for the vegetation component of this study was undertaken in late summer and autumn which is suboptimal for detection of some plant species in the region. Nevertheless, this study does not rely solely on one survey, drawing on previous survey work to help inform the assessment.

The potential for threatened species was determined primarily through habitat assessment, targeted survey and a detailed examination of the high number of common and threatened species records from the locality. This assessment contains some results which vary from the preliminary flora and fauna assessment. This is a standard process, to update the likelihood of occurrence assessment based on further research and new information. It should be seen to supersede the preliminary assessment. Where possible, we have explained why the determination has been revised.

Survey results are indicative of the environmental conditions at the time of assessment. Site conditions, including the presence of threatened species, can change with time.

3.4.7 PERMITS

All relevant WSP staff are covered under the Victorian *Flora and Fauna Guarantee Act 1988* Permit to take/keep protected flora purposes of identification and lodging herbarium specimens (permit no. 10007800). Also, all relevant WSP staff are covered under the Standard Operating Procedures approved by the Department of Economic Development, Jobs, Transport and Resources, Wildlife and Small Institutions Animal Ethics Committee approval (08.17) and Victorian *Wildlife Act 1975* Research Permit (permit no. 10007800).

3.4.8 SURVEY SUMMARY

Table 3.7 provides a summary of the various surveys and assessments completed by WSP and others for the Project.

Table 3.7 Summary of surveys and assessments conducted for the project

ACTIVITY / SPECIES	COMPLETED BY / PRESENTED IN	DATE COMPLETED	SEASON
Vegetation and habitat assessments			
Initial vegetation mapping and habitat hectare assessment	Completed by Biosis and presented in *Flora and Fauna Investigation: Northern Extension of the Mornington Peninsula Freeway (Biosis 2013)*	April 2013	Autumn
Initial detailed flora investigations and further vegetation mapping and habitat hectare assessments	Completed by Biosis and presented in *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment (Biosis 2015)*	November – December 2014	Spring –Summer
Wetland EVC mapping	Completed by WSP and presented in *Preliminary Flora and Fauna Impact Assessment (WSP 2017d)* and this report.	February – March 2017	Summer-Autumn
Field validation of vegetation communities, additional habitat hectare assessment, and additional assessment of threatened ecological communities	Completed by WSP and presented in *Preliminary Flora and Fauna Impact Assessment (WSP 2017d)*	January – May 2017	Summer – Autumn
Further field validation of vegetation communities, additional habitat hectare assessments, and additional assessment of threatened ecological communities.	WSP – this report	November – December 2017	Spring – Summer
Recording of additional trees (Thames Promenade)	WSP – this report	March 2018	Autumn
Targeted flora survey			
Targeted flora surveys for: — Swamp Everlasting — Matted Flax-lily — River Swamp Wallaby-grass	Completed by Biosis and presented in *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment (Biosis 2015)*	December 2014	Summer

ACTIVITY / SPECIES	COMPLETED BY / PRESENTED IN	DATE COMPLETED	SEASON
Numerous flora species with a moderate or high likelihood of occurrence (prior to survey). Survey designs were based on relevant state and Commonwealth survey guidelines.	Completed by WSP and presented in *Preliminary flora and fauna impact assessment (WSP 2017d)* and this report	January - May 2017	Summer – Autumn
Follow up surveys to ensure sufficient effort during the most appropriate survey season for each of the target species	Completed by WSP and presented in this report	November - December 2017	Spring – Summer
Targeted fauna survey and habitat assessment			
Targeted surveys for: — Growling Grass Frog	Completed by Biosis and presented in *Flora and Fauna Investigation: Northern Extension of the Mornington Peninsula Freeway (Biosis 2013)* and *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment (Biosis 2015)*	December 2012 – January 2013 December 2014 – January 2015	Summer Summer
Surveys for threatened waterbird and migratory shorebirds	Completed by Biosis and presented in *Flora and Fauna Investigation: Northern Extension of the Mornington Peninsula Freeway(Biosis 2013)* and *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment (Biosis 2015)*	March 2013 December 2014 – January 2015	Autumn Summer
Targeted survey for: — Latham's Snipe — Australasian Bittern	Completed by Biosis and presented in *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment (Biosis 2015)*	December 2014 – January 2015	Summer
Opportunistic bird survey	Completed by WSP and presented in *Preliminary flora and fauna impact assessment (WSP 2017d)*	December 2016	Summer
Sound recorder surveys for: — Growling Grass Frog	Completed by WSP subconsultant EcoAerial and presented in this report.	February – March 2017 (not optimum survey period) November – December 2017 (optimum survey period)	Summer – Autumn Spring – Summer

ACTIVITY / SPECIES	COMPLETED BY / PRESENTED IN	DATE COMPLETED	SEASON
Sound recorder surveys for: — Lewin's Rail — Baillon's Crake — Little Bittern — Australasian Bittern	Completed by WSP subconsultant EcoAerial and presented in this report.	October 2017	Spring
Detailed wetland bird surveys including observations of activity (behaviour, flight height, and flight direction)	Completed by WSP and presented in this report.	November 2017 - March 2018	Spring – Autumn
Detailed wetland bird habitat mapping	Completed by WSP and presented in this report.	November 2017 - March 2018	Spring – Autumn
Owl habitat assessment and targeted owl survey	Completed by WSP subconsultant Ninox Pursuits Environmental Services and presented in this report.	February 2018	Summer
Aquatic fauna survey			
Aquatic habitat assessment and targeted surveys for: — Yarra Pygmy-perch — Dwarf Galaxias	Completed by Biosis and presented in *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment (Biosis 2015)*	December 2014 – January 2015	Summer
Aquatic fauna field assessment and surveys for: — Dwarf Galaxias	Completed by WSP subconsultant Streamline Research and presented in *Preliminary flora and fauna impact assessment (WSP 2017d)*	November 2016 - March 2017	Spring – Autumn

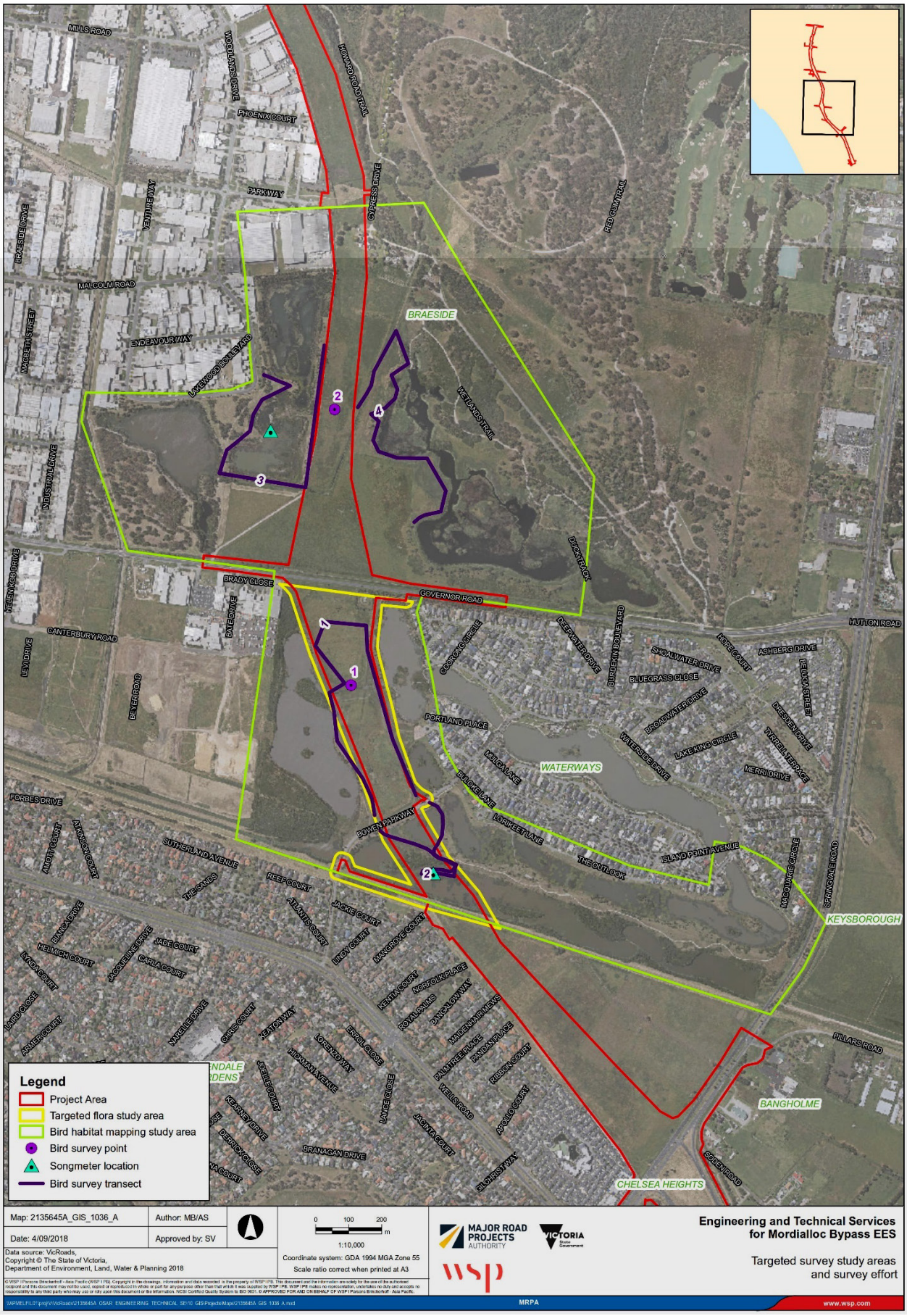


Figure 3.1 Targeted survey study areas and survey effort

3.5 RISK ASSESSMENT

3.5.1 INTRODUCTION

As outlined in the Ministerial Guidelines for Assessment of Environmental Effects (2006) and the Scoping Requirements for the Mordialloc Bypass Project EES (2018), a risk-based approach was adopted for the EES studies to direct a greater level of effort at investigating matters that pose relatively higher risk of adverse environmental effects. The following definitions were adopted for the assessment:

- *Environmental impact:* is described as any change to the environment as a result of a project activities.
- *Environmental risk:* As defined by the Ministerial Guidelines for Assessment of Environmental Effects Under the Environment Effects Act 1978 (DSE, 2006), *"Environmental risk reflects the potential for negative change, injury or loss with respect to environmental assets"*.

The purpose of the risk assessment is to provide a systematic approach to identifying and assessing the environmental risks, including heritage, cultural, social, health, safety and economic aspects as a result of the project. It articulates the likelihood of an incident with environmental effects occurring and the consequential impact to the environment.

The impact assessment and risk assessment processes were integrated throughout the development of the EES. The environmental risk assessment (ERA) process allowed the project team to identify as many environmental risks as a result of the project as possible and refine and target impact assessments accordingly. The impact assessments ensured the project team has a robust understanding of the nature and significance of impacts and the mitigation measures developed to minimise and control those impacts.

The risk and impact assessment processes were essential components of the project design process and in the formulation of construction and additional mitigation measures to minimise environmental impacts. These assessments also underpin the establishment of the Environmental Performance Requirements (EPRs), which set out the desired environmental outcomes for the project.

The below methodology was developed to assess the potential impacts of the Mordialloc Bypass on biodiversity (divided into "Biodiversity and Habitat" and "Wetlands and Waterways") and sets out the process, methods and tools used to complete the impact and risk assessments.

3.5.2 RISK ASSESSMENT METHODOLOGY

The risk assessment is a critical part of the EES process as it guided the level and extent of impact assessment work required and facilitated a consistent approach to risk assessment across the various technical disciplines. The risk assessment process was based on the approach defined in *ISO 31000:2018 Risk Management – Principles and Guidelines*, which describes an environmental risk management process which is iterative and supported by ongoing communication and consultation with project stakeholders. The ERA process incorporated VicRoads key risk management requirements, specifically from the VicRoads Environmental Risk Management Guidelines (VicRoads 2012a) and the VicRoads Environmental Sustainability Toolkit (VicRoads 2017).

3.5.2.1 SCOPE AND BOUNDARIES

The ERA assessed all project phases, namely: Initial Phase (the current approvals and concept design stage); Construction Phase; and Operations and maintenance Phase. The risk process evaluated environmental risks that would result from the development of the project based on the concept designs for the project, the draft construction methodology and the existing conditions of the study area, as well as the draft environmental impact assessment reports which were in development during the ERA.

3.5.2.2 RISK IDENTIFICATION

To effectively and comprehensively recognise all potential environmental risks that may result from the project, it was necessary to identify impact pathways for all project activities during all its project phases. An impact pathway is the cause and effect pathway or causal relationship that exists between a project activity and an asset, value or use of the environment.

Environmental impact pathways were identified under two categories:

- Primary environmental impacts: The impacts to environmental values that are directly attributable to project activities within a cause and effect paradigm. Project activities cause environmental impacts (effects) on environmental values through an environmental impact pathway such as construction activities. The assessment of these impacts and their associated risks assumes that all standard mitigation measures are in place and working as intended.
- Cumulative impacts: The potential cumulative impacts to environmental values that may result from the implementation of the project. This allowed for the identification of:
  - Secondary environmental risks which may result from the implementation of a risk response in mitigating a primary environmental risk
  - On-site aggregate risks resulting from multiple on-site project activities on an environmental asset (risks were assessed in two ways, as a single project phase and as a whole project risk)
  - Off-site cumulative environmental risks which accounted for potential off-site cumulative impacts of the Mordialloc Bypass project in conjunction with surrounding off-site projects in the local area.

3.5.2.3 RISK ANALYSIS

With risks identified for each discipline, VicRoads and industry best practice and standard mitigation controls that are considered intrinsic to a project of this nature were identified, including requirements under relevant sections of the VicRoads Standard Specifications, Environment Protection Authority (EPA) guidelines and Government environmental management policies.

3.5.2.4 RISK EVALUATION

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar VicRoads projects, as presented in Table 3.8. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

Table 3.8 Risk analysis matrix

			LIKELIHOOD				
CONSEQUENCE	**Risk Categories**		**Rare**	**Unlikely**	**Possible**	**Likely**	**Almost Certain**
			A	**B**	**C**	**D**	**E**
	Catastrophic	**5**	Medium	High	High	Extreme	Extreme
	Major	**4**	Medium	Medium	High	High	Extreme
	Moderate	**3**	Low	Medium	Medium	High	High
	Minor	**2**	Negligible	Low	Low	Medium	Medium
	Insignificant	**1**	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate likelihood and consequence criteria were developed in consultation with VicRoads, the TRG and technical specialists [Table 3.9, Table 3.10 and Table 3.11].

Table 3.9 Likelihood categories

LIKELIHOOD				
Less than once in 12 months OR 5% chance of occurrence during course of the project	Once to twice in 12 months OR 5 - 10% chance of occurrence during course of the project	3 to 4 times in 12 months OR 30% chance of occurrence during course of the project	5 to 6 times in 12 months OR 50% chance of occurrence during course of the project	More than 6 times in 12 months OR 100% chance of occurrence during course of the project
The event may occur only in exceptional circumstances	The event could occur but is not expected	The event could occur	The event will probably occur in most circumstances	The event is expected to occur in most circumstances
It has not happened in Victoria but has occurred on other road projects in Australia.	It has not happened in metropolitan Melbourne but has occurred on other road projects in Victoria	It has happened in metropolitan Melbourne	It has happened on a road project in metropolitan Melbourne in the last 5 years	It has happened on a road project of similar size and nature in metropolitan Melbourne within the last 2 years. OR It has happened multiple times on a road project in the region within the last 5 years.
Rare	Unlikely	Possible	Likely	Almost Certain
A	B	C	D	E

Table 3.10 Biodiversity and habitat environmental risk assessment consequences descriptors

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATESTROPHIC
Project impacts EPBC Act listed *Critically Endangered* fauna species (Note: The local population of nomadic fauna species comprises those individuals likely to occur in the study area from time to time or return year to year.)	Population change not detectable or Negligible impact upon habitat	Population change not detectable or Minor impact upon habitat	Loss of <1% of the local area population or habitat for a listed species.	Loss of 1-10% of the local area population or habitat for a listed species	Loss of >10% of the local area population or habitat for a listed species
Project impacts EPBC Act listed *Vulnerable or Endangered* fauna species	Population change not detectable or Negligible impact upon habitat	Loss of <1% of the local area population or habitat for a listed species	Loss of 1-5% of the local area population or habitat for a listed species	Loss of 6-15% of the local area population or habitat for a listed species	Loss of >15% of the local area population or habitat for a listed species
Project impacts *EPBC Act* listed *Migratory* fauna species (Note: The local population of migratory species comprises those individuals likely to occur in the study area from time to time or return year to year.)	Population change not detectable Negligible impact to habitat	Loss of <1% of the local area population or habitat for a listed species No impact to important habitat	Loss of 1-5% of the local area population or habitat for a listed species None or minor impact to important habitat	Loss of 6-15% of the local area population or habitat for a listed species Impact to important habitat	Loss of >15% of the local area population or habitat for a listed species Impact to important habitat
Project impacts FFG Act listed or DELWP Advisory List *Critically Endangered* fauna species	Negligible population change	Loss of <1% of the local area population or habitat	Loss of 1-5% of the local area population or habitat	Loss of 6-15% of the local area population or habitat	Loss of >15% of the local area population or habitat

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATESTROPHIC
Project impacts DELWP Advisory List *(Rare, Vulnerable or Threatened)* fauna species	Loss of <1% of the local area population or habitat	Loss of <5% of the local area population or habitat	Loss of 5-20% of the local area population or habitat	Loss of 21-40% of the local area population or habitat	Loss of >40% of the local area population or habitat
Project impacts fauna protected under the *Wildlife Act 1975*	Minor temporary increase in mortality of protected fauna.	Moderate temporary or minor long term increase in mortality of protected fauna.	Substantial temporary or moderate long term increase in mortality of protected fauna.	High long term increase in mortality of protected fauna.	Very high long term increase in mortality of protected fauna.
Project impacts *EPBC Critically Endangered* flora species	Negligible population change	Population change not detectable	Loss of <1% of the local area population	Loss of 1-10% of the local area population	Loss of >10% of the local area population
Project impacts *EPBC Vulnerable or Endangered* flora species	Negligible population change	Loss of <1% of the local area population for a listed species	Loss of 1-5% of the local area population for a listed species	Loss of 6-15% of the local area population for a listed species	Loss of >15% of the local area population for a listed species
Project impacts *FFG listed* or *DELWP Critically Endangered* flora species	Negligible population change	Loss of <1% of the local area population for a listed species	Loss of 1-5% of the local area population for a listed species	Loss of 6-15% of the local area population for a listed species	Loss of >15% of the local area population for a listed species
Project impacts *DELWP Advisory List (Rare, Vulnerable or Threatened)* flora species	Loss of <1% of the local area population for a listed species	Loss of <5% of the local area population for a listed species	Loss of 5-20% of the local area population for a listed species	Loss of 21-40% of the local area population for a listed species	Loss of >40% of the local area population for a listed species
Project impacts EVCs / native vegetation	Negligible impacts on the extent of an EVC	Loss of <0.1% of an EVC of High or Very High conservation significance from the region (based on the total area of an EVC from the bioregion) Or total native vegetation loss <5 ha	Loss of 0.1- 1% of an EVC of High or Very High conservation significance from the region (based on the total area of an EVC from the bioregion) Or total native vegetation loss 5-10 ha	Loss of >1-5% of an EVC of High or Very High conservation significance from the region (based on the total area of an EVC from the bioregion) Or total native vegetation loss 10-15 ha	Loss of >5% of an EVC of High or Very High conservation significance from the region (based on the total area of an EVC from the bioregion) Or total native vegetation loss >15 ha

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATESTROPHIC
Project impacts EPBC Act listed community	No measurable impacts on the extent of a community listed under the EPBC Act	Loss of <0.1% of the EPBC Act listed community.	Loss of 0.1-1% of the EPBC Act listed community. Residual significant impacts can be Offset.	Loss of 1-5% of the EPBC Act listed community. Residual significant impacts can be Offset.	Loss of >5% of the EPBC Act listed community. Or residual significant impacts cannot be Offset
Project impacts FFG Act listed community	No measurable impacts on the extent of a community listed under the FFG Act	Loss of <1 ha of an FFG Act listed community.	Loss of 1-5 ha of an FFG Act listed community.	Loss of 5-10 ha of an FFG Act listed community.	Loss of >10 ha of an FFG Act listed community.
Project impacts large remnant native trees	Loss of 1 or 2 large trees.	Loss of <10 large trees.	Loss of 10-25 large trees.	Loss of 26-50 large trees.	Loss of >50 large trees.
Project impacts Wildlife corridors	No measurable impact on the quantity and extent of wildlife corridors. Alignment does not intercept or reduce any existing wildlife corridors or habitat linkages.	Alignment reduces the width of a wildlife corridor by up to 10%. OR Alignment intercepts 1 - 2 habitat linkages.	Alignment reduces the width of a wildlife corridor by 10-50%. OR Alignment intercepts 3 - 4 habitat linkages.	Alignment reduces the width of the wildlife corridor by 50-75% OR Alignment intercepts 5 habitat linkages.	Alignment reduces the width of the wildlife corridor by >75% OR Alignment intercepts 6 or more habitat linkages.

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATESTROPHIC
Cumulative Effects	Scope and Boundaries: — Projects which occur in the immediate area of the project area (i.e. approx. 1 km) which could increase noise, light and other indirect impacts, or lead to additional direct loss of local habitat. or — Projects in the broader locality (<10 km) which have, may, or will reduce the quality or size of valuable wetland habitat (i.e. known to support the significant species which also occur at the project area). and — Projects which have already been approved, are being constructed, or which have been constructed within the last five years. Future unapproved projects (i.e. without defined impact areas and without detailed assessments available) would require too much guesswork to consider and are beyond the scope of this assessment unless reasonably foreseeable. Projects which occurred prior to five years ago are generally too old to be accurately considered. They have been considered part of the existing conditions of the site only, unless recent (<5 years) and with assessments publicly available. Note: the impact assessment has already considered the impact of the project with consideration of the built-up nature of the area (industrial, residential, green wedge etc.), historical change, and the sensitivity and population numbers/extents of the species and communities to be impacted. This examination of cumulative effects is for recent specific known projects only. — Projects which have or may negatively impact ecology. i.e. wetland creation projects or other ecological improvement projects such as those listed under regional/local plans in Section 3.3 in the area are not considered. This is because it is difficult to foresee what positive outcomes may result for any particular significant ecological value from a project.				

Table 3.11 Wetlands and waterways environmental risk assessment consequences descriptors

ASPECT	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATESTROPHIC
Impacts on significant species and communities as per Biodiversity and Habitat consequence descriptors	As per Biodiversity and Habitat consequence descriptors	As per Biodiversity and Habitat consequence descriptors	As per Biodiversity and Habitat consequence descriptors	As per Biodiversity and Habitat consequence descriptors	As per Biodiversity and Habitat consequence descriptors
Project impedes fauna passage	Fish passage not affected	Fish passage restricted during construction period	Fish passage obstructed during construction period	Fish passage permanently restricted	Fish passage permanently obstructed
Project impacts on aquatic habitats	No detectable changes in aquatic habitats	Short-term (i.e. construction only) isolated detectable changes in aquatic habitats in the study area	Short-term localised detectable changes in aquatic habitats in the study area	Long-term detectable changes in aquatic habitats that are significant in the study area, OR Short-term detectable changes in aquatic habitats that are significant regionally	Long-term detectable changes in aquatic habitats that are significant regionally
Project impacts RAMSAR wetland	No measurable change in ecological character. Under the limits of acceptable change for the Ramsar wetland.	Minor change in ecological character. Under the limits of acceptable change for the Ramsar wetland.	Moderate change in ecological character. Under the limits of acceptable change for the Ramsar wetland.	Major change in ecological character. Limits of acceptable change exceeded.	Extreme change in ecological character. Limits of acceptable change exceeded.
Project impacts floodplain habitat & ecological function	No detectable changes in floodplain habitat for aquatic species or ecological function	Short-term (i.e. construction only) isolated changes to floodplain habitat for aquatic species within the study area	Short-term (<1 year) localised changes to floodplain habitat for aquatic species within the study area, OR Detectable impacts to ecological function of floodplain within the study area	Long-term changes to floodplain habitat for aquatic species within the study area, OR Detectable impacts to ecological function of floodplain within the region	Long-term changes to floodplain habitat for aquatic species beyond the study area, AND detectable impacts to ecological function of floodplain within the region
Cumulative Effects	Scope and Boundaries: As for terrestrial ecology.				

For all risks rated medium, high or extreme in the initial risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to perform the residual risk rating. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk has been effectively avoided or mitigated to as low as reasonably practicable.

Where risks could not be eliminated or sufficiently reduced (e.g. by engineering controls or re-design), these will typically be addressed by specific conditions in a site Environmental Management Plan (EMP), or be the subject of a separate management plan, including adaptive management plans based on ongoing studies or monitoring.

3.5.2.5 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

Following the evaluation of risk and through consultation with VicRoads, EPRs were developed to define relevant, achievable, and measurable environmental outcomes for the project. The mitigation measures identified during the risk assessment process were used to inform the EPRs and also specify the means by which the EPRs are to be satisfied. The EPRs for Biodiversity are provided in Table 7.12 referenced in the risk assessment tables (Table 5.1, Table 5.2 and Table 5.3).

3.6 IMPACT ASSESSMENT

Preliminary impact assessment was undertaken by WSP (WSP 2017d) based on preliminary design.

This impact assessment provides a more detailed assessment of likely impacts from the road, based on the current (freeway) design and the latest research on road impacts and ecology. It includes an examination of likely impacts upon each listed species/community as well as upon ecological character of nearby wetlands. Importantly, it also examines potential impacts upon the movement of threatened and non-threatened species in the area. It addresses all potential impacts in context with remaining and local populations and includes assessment of the potential for the Project to exacerbate threatening processes. A cumulative impact assessment provides the Project impacts in context with recent and foreseeable future projects.

3.6.1 CONSTRUCTION IMPACT DETERMINATION

To determine the likely impacts of the Project, it was assumed that the entire Project Area will be available for the construction of the road and associated infrastructure minus any areas of native vegetation or habitat identified as important to be retained.

Any native vegetation and habitat which was possible to avoid was mapped as No-go Zones. This included trees with <10% impact upon their tree protection zones, and some native groundcover vegetation, such as native drainage lines, and all native vegetation outside of the 8 m bridge buffer. Impacts upon trees was generally calculated based on a conservative buffer of 10 metres off the project earthworks (or up to 3 metres off the surface water design, where the surface water design protruded).

For some (but not all) groundstorey vegetation, such as native patches immediately north and south of Governor Road, impacts were extended to the project boundary. This was because these patches were considered unlikely to persist, due to changes in local conditions (surface water changes from swales etc.) and from landscaping and maintenance of the project area after construction.

For the bridge over Mordialloc Creek, impacts were calculated based on 8 metres off the bridge design, based upon advice from VicRoads that the bridge can be construction from the centre. All areas within the 8 metre bridge buffer and under the bridge were considered impacted for the purpose of native vegetation removal calculations.

The Viva gas pipeline, which was installed in the 1970s through what is now the Waterways wetlands, will require re-capping work in the sections under the proposed bridge prior to bridge construction. As such it has been included in the impacts from this Project. An impact area along the pipeline of approximately 12 metres wide on either side of the bridge was calculated for these works. Although works will be completed by a separate contractor to the remainder of the Project, the controls of the Project (particularly No-go Zones) will be relevant.

The designation of No-go Zones and the calculated impact area has been undertaken in consultation with VicRoads staff and the road design team. The No-go Zone map is shown on Supplementary Figure 6, Appendix A.

Planted native trees are also recommended to be retained wherever possible, however the determination of No-go Zones for planted native trees (and other planted trees) have not been marked on Supplementary Figure 6 and will be made in consultation with landscape designers on the Project. It is expected that all planted native trees that will do not need to be impacted (i.e. impacts from required works would be <10% of the TPZ), or at least the vast majority, could be retained.

We note that there is value in the retention of dead trees or trees with >10% TPZ impacts. This is included in clearing and construction guidelines (Section 7.5).

3.6.2 MITIGATION

The preliminary impact assessment by WSP (WSP 2017d) identified mitigation measures likely to be required. This has been further developed and updated in this report based on revised project design and impact assessment to provide a strategy for mitigation for the Project. Mitigation measures address specific impacts identified in the impact assessment chapter. Standard VicRoads measures are not included in this report.

4 EXISTING CONDITIONS

This chapter describes the current condition of the project area and surrounds with regard to ecological values.

4.1 LANDSCAPE CONTEXT

The project area, being an established road easement passing through urban and industrial environments, is predominantly cleared and highly modified. Despite this, it passes through and nearby to areas of high ecological significance. It also supports patches of remnant vegetation, scattered remnant trees, drainage lines, and roadside revegetation, all of which provide habitat and connectivity for fauna.

Figure 4.1 identifies nearby ecological environments of significance and their proximity to the project area. They are broadly described below.

4.1.1 WOODLANDS INDUSTRIAL ESTATE WETLANDS 'WOODLANDS WETLANDS'

Woodlands wetlands is located immediately west of the project area, north of Governor Road. It is a constructed area of Melbourne Water retention ponds, consisting of three deep ponds and some associated shallow wetlands. Construction of the wetlands commenced in 1992 and was completed in 2003.

Parts of the wetlands are shallow and draw down in summer, and large numbers of migratory waders are occasionally recorded, however this is rare.

This site is recognised as a component of the Carrum Swamp 'Important Bird and Biodiversity Area' (IBA) (BirdLife International 2018), also included on the World Database of Key Biodiversity Areas (KBA) (refer Figure 4.1). This IBA/KBA includes Edithvale, Seaford, Peninsula Aeronautical Remote Control Society (PARCS), Braeside and Woodland Estate Wetlands, Boundary Road Swamp and the Eastern Treatment Plant. These wetlands are known to be important as a coastal refuge for waterbirds during drought periods (Clarke et al. 2015) and key bird species will move between them depending on their conditions (water levels etc.) (BirdLife International 2018).

4.1.2 WATERWAYS WETLANDS

Waterways wetlands is a 48 ha area planned and revegetated by Australian Ecosystems which commenced in 2000 and is now known for its significant values (Australian Ecosystems 2017; Cook, D. 2016). It occurs along Mordialloc Creek within the Waterways suburb and was partly funded by Melbourne Water and partly by the Haines Family, a developer. Waterways wetlands consists of constructed and rehabilitated wetlands and fringing grassland. As the deep pools were designed to contain permanent water, the wetlands provide minimal mudflat foraging habitat for migratory waders, although threatened and migratory species are regularly recorded. The site supports high quality revegetated grassy wetland, with threatened species and revegetated threatened ecological communities.

In 2016, Waterways wetlands was the recipient of the Award for Excellence in Restoration Practice by The Society for Ecological Restoration Australasia (http://www.seraustralasia.com/pages/SERAawards.html).

The bypass corridor bisects the Waterways wetlands, and a bridge is proposed over part of the Waterways wetlands and Mordialloc Creek (refer Figure 1.2).

4.1.3 EDITHVALE-SEAFORD RAMSAR WETLANDS

The Edithvale component of the Ramsar site ('Edithvale wetlands') is located approximately 700 metres west of the project boundary, in the southern extent of the alignment. It consists of a northern section of predominantly deep constructed pools and some shallow areas, separated by Edithvale road from a southern section of predominantly shallow wetland. It has a history of grazing however is no maintained for water storage and as a wildlife sanctuary.

The Edithvale-Seaford Ramsar wetlands are internationally recognised for their significance to threatened and migratory birds. They regularly support over 1% of the flyway population of the migratory shorebird Sharp-tailed Sandpiper (DSE 2012), as well as numerous other migratory, nomadic, and resident birds.

These Ramsar listed wetlands offer high-value seasonal mudflat foraging habitat for migratory waders, as demonstrated in the records for these threatened taxa, which is not generally available within the permanent wetland habitat provided within the Project Area or regional WSUD treatment systems.

Most migratory shorebirds which visit Australia are present during the non-breeding period, from as early as August to as late as April/May each year. Numbers at Edithvale generally peak in the summer months. Breeding of these birds primarily occurs elsewhere in Asia (DoEE 2017). Their summer habitat is important for replenishing their condition prior to their onward migration and breeding season.

This site is recognised as a component of the Carrum Swamp IBA/KBA (refer to Section 4.1.1). It is also part of the Melbourne Water Biosite. Biosites are areas of biological significance, previously used in state level planning and conservation.

4.1.4 BRAESIDE PARK INCLUDING WETLANDS

Braeside Park, managed by Parks Victoria, is located immediately east of the project area between Lower Dandenong Road and Governor Road. It was opened in 1987 in an area of former farmland and water treatment. Extensive revegetation and improvement works have resulted in a large parkland area of rehabilitated woodland and some areas of rehabilitated, constructed wetlands. The largest and most significant area of wetlands, located in the southwest of the park, supports various wetland habitat types, including large areas of shallow water marsh habitat which is valuable to wading birds. The woodland and heathland areas potentially support habitat for numerous native fauna species, some of which are likely to periodically or regularly utilise the project area, including woodland birds, reptiles, small/arboreal mammals and terrestrial-breeding frogs.

This site is recognised as a component of the Carrum Swamp IBA/KBA (refer Section 4.1.1). Braeside Park is also part of the Melbourne Water Biosite.

4.1.5 OTHER WETLANDS

Other valuable wetland habitat occurs in the wider locality, although more distant and unlikely to be affected by the proposed development. For example, the Eastern Treatment Plant is a high value bird area located approximately 1.5 km southeast of the study area.

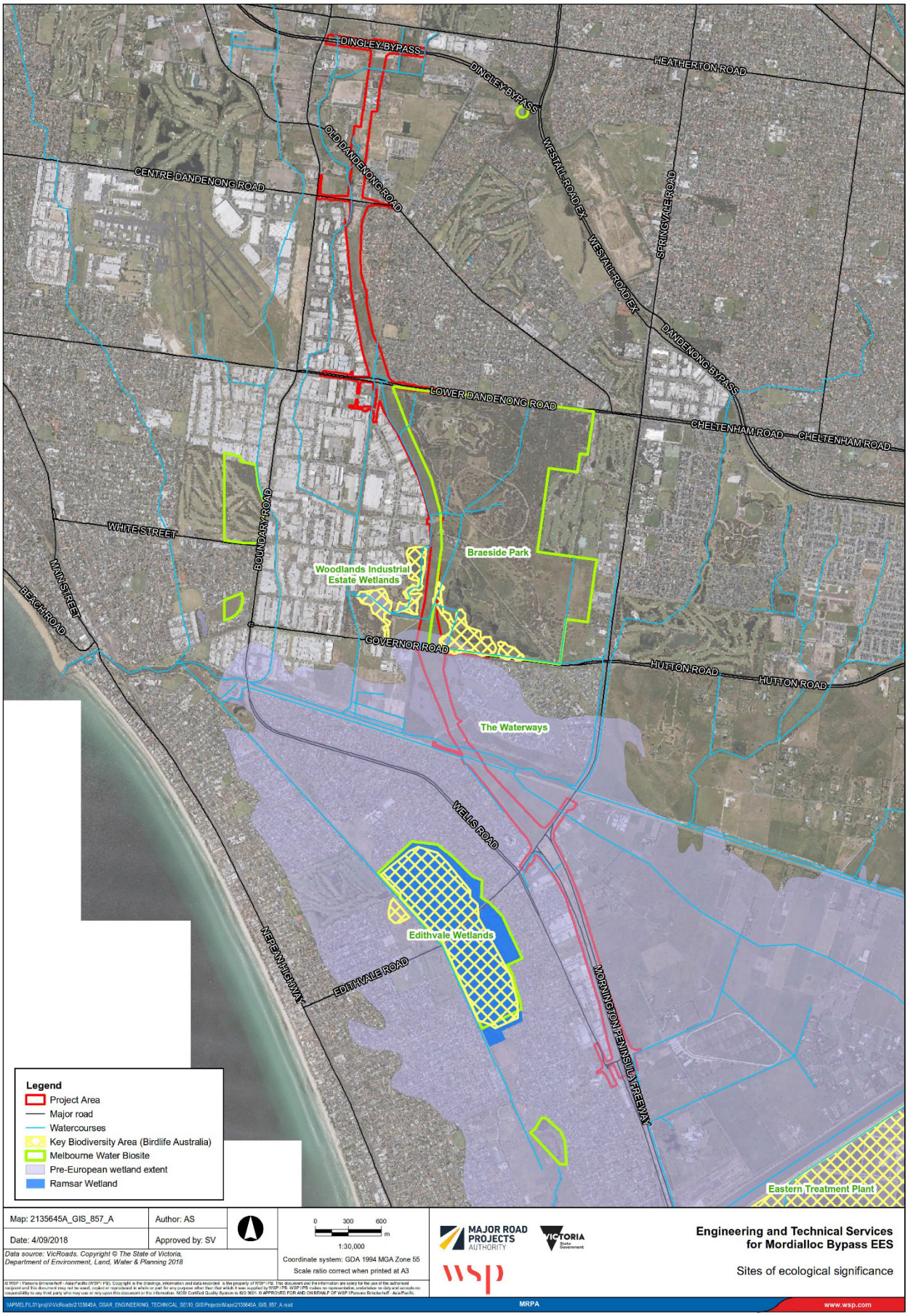


Figure 4.1 Nearby sites of ecological significance

4.2 LITERATURE REVIEW

Previous ecological assessment of the project area and locality were reviewed to provide an overview of the known ecological values and systems of the area. The assessments are summarised below. The species recorded in these assessments were considered when assessing the likelihood of occurrence of threatened species within the study area.

Flora and Fauna investigation: Northern extension of the Mornington Peninsula Freeway (Biosis 2013)

In 2013, Biosis completed the *Flora and Fauna Investigation: Northern Extension of the Mornington Peninsula Freeway* for VicRoads. The assessment was undertaken to inform a feasibility study of the Mornington Peninsula Freeway extension. The scope of the assessment included (but was not limited to): a review of relevant databases and literature; EVC mapping; a vegetation quality assessment; and identification of threatened species, noxious weeds, project constraints and potential effects. The assessment study area was located between Edithvale and Dingley Village southeast of the Melbourne CBD encompassing 206.9 ha within the Gippsland Plain Bioregion and Bunyip River Basin. The assessment recommended further targeted studies and identified that the most effective measure to reduce effects to biodiversity will be to limit the removal of native vegetation and habitat.

Mordialloc Bypass: Flora and Fauna investigation including habitat hectare assessment (Biosis 2015)

In 2015, Biosis completed the *Mordialloc Bypass: Flora and Fauna Investigation including habitat hectare assessment* for VicRoads. The assessment was undertaken to inform VicRoads of flora and fauna related project constraints associated with the Mordialloc Bypass. The scope of the assessment included (but was not limited to) a review of relevant databases and literature, identification and mapping EVCs and species of management concern, conducting a Vegetation and Quality Assessment, conducting targeted surveys (including for flora, general waterbird survey, Latham's Snipe, Australasian Bittern, Growling Grass Frog, and threatened fish), review application legislation, assess potential effects and make recommendations for further assessment. The assessment study area was located between Edithvale and Dingley Village southeast of the Melbourne CBD encompassing 206.9 ha within the Gippsland Plain Bioregion and Bunyip River Basin. The assessment identified that the study area supports approximately 10 ha of native vegetation (~2 habitat hectares) and includes 28 scattered trees. Native vegetation was comprised of eight EVCs across 44 habitat zones, all of which are either endangered or considered vulnerable within the Gippsland Plain bioregion. The assessment also notes that the study area includes approximately 7 ha of EPBC Act/FFG Act listed ecological communities.

Outer Suburban Arterial Road Program – Preliminary Biodiversity Assessment (Brett Lane & Associates 2016)

Brett Lane and Associates Pty. Ltd. completed the *Outer Suburban Arterial Road Program – Preliminary Biodiversity Assessment* in 2016 for VicRoads. The Assessment focussed on 25 proposed road upgrade projects across Melbourne. The assessment was undertaken to provide VicRoads with a high-level understanding of native vegetation including potential effects on species of management concern within the 25 project areas. The assessment notes that the majority of the project areas were comprised of heavily altered landscapes with inclusions of remnant patch native vegetation and scattered trees. The report further identifies project areas with the potential to support threatened species listed under the FFG Act and EPBC Act. The report provides further detail on offset requirements and a review of legislation and their potential implications on the various projects.

Establishment of Indigenous Flora and Fauna in Revegetated Areas at "The Waterways" (Australian Ecosystems 2017)

In 2017, Australian Ecosystems completed the *Establishment of Indigenous Flora and Fauna in Revegetated Areas at "The Waterways"* case study. The case study involves a review of the acclaimed restoration efforts at "The Waterways" located on Mordialloc Creek. Restoration efforts were designed to restore habitats to those associated with the Carrum Carrum Swamp. The successful establishment of the desired habitats has resulted in the observations of 19 threated fauna species including Australasian Bittern. The case study further describes the habitat types and the observations of flora and fauna located within The Waterways.

Melbourne Water Regional Bird Monitoring Project. Annual report: July 2015 – June 2016 (Herman & Purnell 2016)

Herman and Pernell completed the *Melbourne Water Regional Bird Monitoring Project. Annual report: July 2015 – June 2016* for Melbourne Water. The monitoring program and reports are a requirement for Melbourne Water to complete for rivers, estuaries, wetlands and floodplains that may be affected by water management activities. The 2015-16 monitoring report summaries the results of 2373 targeted surveys from 177 sites across Melbourne and the outer suburbs. Monitoring observations included 250 species, 23 listed as *endangered/threatened* on the Victorian Advisory List, 4 EPBC Act listed threated species, and 22 migratory species protected under international agreements, including 13 shorebird species.

Flora and fauna lists of "The Waterways" (Cook, D undated)

Damien Cook (Rakali Ecological Consulting Pty Ltd) provided detailed lists of flora and fauna species observed at the Waterways. The fauna list includes presence (including nests) of species at the Waterways from 2001 to 2007, while the flora list shows species observed at the Waterways. The fauna species recorded are included in the species list in Appendix C. The flora species are not included in the flora list however they were used to inform the Likelihood of Occurrence Assessment, as well as to determine which species required targeting during surveys.

Preliminary Ecological Assessment for 12 kilometres of proposed roadway between the South Gippsland Freeway and Warrigal Road (Biosis Research 2008)

Biosis was retained by Maunsell Pty. Ltd. on behalf of the Eastern Integrated Transport Authority to complete a preliminary ecological assessment along a proposed freeway easement between the South Gippsland Freeway, Dandenong South and Warrigal Road, Oakleigh South, Victoria. This study area is situated within the Gippsland Plain Bioregion and the Bunyip River Basin. The preliminary ecological assessment was informed by a combination of field assessments (completed in October 2008) and various relevant databases and literature sources. The report summarizes the results of the database and literature review noting historical records of numerous flora and fauna species of national and state significance across the various databases. The field assessments provide insight of the existing vegetation conditions at the time of the study and note the presence of small patches of native vegetation comprising five EVCs.

Edithvale and Seaford Wetlands Bird Survey Project 2014-15 (Silcocks 2016)

Silcocks provides a summary of fauna survey data at the Edithvale and Seaford Wetlands for the 2014-15 monitoring year in this document. The report notes that 110 and 114 species were recorded at Edithvale and Seaford respectively, during the July 2014 to June 2015 monitoring period. The report indicates that these species counts exceed the annual averages recorded since 1989 (Edithvale) and 1994 (Seaford). The report outlines that numerous significant species were recorded at Edithvale and Seaford wetlands, and that the Edithvale wetlands provides habitat for at least 1% of the estimated world population of Sharp-tailed Sandpiper. The monitoring report explains that the value of Edithvale and Seaford wetlands centres on the wetland and associated remnant/revegetated upland habitat it provides birds. It provides management recommendations highlighting the importance of controlling invasive flora and fauna species.

Edithvale-Seaford Wetlands Ramsar Site Management Plan (Ecology Australia 2016)

In 2016, Ecology Australia prepared the *Edithvale-Seaford Wetlands Ramsar Site Management Plan* for Melbourne Water. The report explains that Melbourne Water, owner/manager of Edithvale Wetlands and joint manager of Seaford Wetlands is required to complete management plans for the wetlands every 7 years. This management plan will guide management efforts at the Edithvale-Seaford wetlands through until 2023 when a new management plan is drafted. The management plan provides a detailed assessment of ecological components, processes and services of the wetlands including a detailed explanation of the various EVCs present and the flora and fauna the wetlands support. The management plan outlines various strategies to maintain and improve the ecological character of the wetlands. It includes monitoring of birds (monthly surveys by Birdlife Australia), Common Reed height and coverage, water quality, water levels, kangaroos, and pest animals.

Edithvale and Bonbeach Level Crossing removal projects – Environment Effects statement: EES Technical Report A – Groundwater Impact Assessment (AECOM-GHD JV 2018a)

In 2018, AECOM-GHD Joint Venture delivered a *Groundwater Impact Assessment* report for the Level Crossing Removal Authority (LXRA). The project areas consisted of the Edithvale Road level crossing and the Bonbeach level crossing. However, due to the complex and influential nature of groundwater systems, the study area is much larger and encompasses the broader area bound by Port Phillip Bay and Edithvale-Seaford wetlands. The aim of the assessment was to identify and assess potential groundwater impacts that may result from the level crossing removal projects. The initial assessment identified some impacts to groundwater levels. Risks from changes to groundwater level at Bonbeach were predicted to be low and no additional mitigation was required. In comparison, the risks at Edithvale were predicted to be greater, leading to modifications to the construction design to reduce the impacts. This allowed groundwater impacts to be maintained as close as practicable to background levels. With the implementation of mitigation and EPR's, all groundwater related residual risks at both Bonbeach and Edithvale are expected to be minor or negligible.

Edithvale and Bonbeach Level Crossing removal projects – Environment Effects statement: EES Technical Report B – Ecological Impact Assessment; Wetlands and Groundwater Dependent Ecosystems (AECOM-GHD JV 2018b)

In 2018, AECOM-GHD Joint Venture delivered an Ecological Impact Assessment for the Level Crossing Removal Authority (LXRA) to inform the proposed Edithvale and Bonbeach Level Crossings Removal Projects. The detailed ecological assessment presented within this report occurred in response to groundwater impacts being predicted at the Edithvale Wetland by early groundwater models. The report assesses the potential impacts to wetlands and Groundwater Dependent Ecosystems (GDEs) from groundwater changes associated with removal of the level crossings. The GDEs identified within this report included Edithvale Wetland section of the Edithvale-Seaford Wetlands Ramsar site, Wannarkladdin Wetlands and Aspendale to Carrum Foreshore Reserve. The assessment determined that the Edithvale project would have no impact to the function or character of Edithvale Wetland. Similarly, it is expected that the Bonbeach project will not impact Wannarkladdin Wetland. The assessment did identify a risk of groundwater drawdown impacting on the native vegetation of the Aspendale to Carrum Foreshore Reserve. This is predicted to be negligible at Edithvale and minor at Bonbeach based on the extent of vegetation which could be affected.

Edithvale and Bonbeach Level Crossing removal projects – Environment Effects statement: EES Technical Report D – Ecological Impact Assessment; Project AREAS (AECOM-GHD JV 2018c)

In 2018, AECOM-GHD Joint Venture delivered an Ecological Impact Assessment for the Level Crossing Removal Authority (LXRA) to inform the proposed Edithvale and Bonbeach Level Crossings Removal Projects. The purpose of this assessment was to identify the ecological impacts that may occur within the project areas as a result of the two projects. The assessment identified that Edithvale would involve the removal of 21 patches of native vegetation (1.147 ha) and three scattered trees while Bonbeach would result in removal of 17 patches of native vegetation (1.053 ha) and one scattered tree. Both sites would result in some loss of native flora listed as "protected" under the FFG Act, some loss of habitat resulting in displacement, injury or death of non-threatened native wildlife and could exacerbate habitat fragmentation and the spread of weeds. These impacts are expected to be managed through offsets, permits and the implementation of mitigation measures. The report concluded that the projects were not expected to result in impacts to Matters of National Environmental Significance (MNES) or to flora and fauna listed as threatened under the FFG Act.

Braeside Park Flora and Fauna Survey Reports

Fauna survey at Braeside Park (The Field Naturalists Club of Victoria 2017)

Fauna surveys were completed at Braeside Park using ground-based remote cameras, hair tubes, spotlighting, harp traps, tiles and acoustic frog surveys. The surveys recorded 46 different species including 2 amphibians, 29 birds, eight mammals and seven reptiles. Three species of conservation significance were located during the surveys and in incidental sightings: the endangered Blue Billed Duck *Oxyura australis* (FFG Act listed and Advisory List endangered), Common Long-Necked Turtle *Chelodina longicollis* (Advisory List data deficient) and the Grey-headed Flying Fox *Pteropus*

poliocephalus (EPBC Act vulnerable, FFG Act listed and Advisory List vulnerable). The survey failed to detect any Growling Grass Frogs which were translocated to Braeside Park in 2002 but have not been recorded since 2006.

Braeside Park Frog Recording Data (The Field Naturalists Club of Victoria 2016)

Eight species of frogs were recorded at Braeside Park in a 2016 survey, however no species of conservation significance (including Growling Grass Frog) were detected.

Moths of the Braeside Park Heathland (Entomological Society of Victoria 2017)

The Entomological Society Victoria conducted a moth survey at Braeside Park on 26 November, 2016. The survey revealed a highly diverse range of moth species at the park but none of conservation significance.

Vegetation of Braeside Metropolitan Park, Braeside, Victoria, and its management (Carr 1985)

A study was completed of the vegetation within Braeside Park. The vegetation was classified into communities based on analysis of data from 37 10 x 10 m quadrats. A total of 343 vascular plant species were recorded, with 203 of these being native species. Four vegetation communities were recognised: *Eucalyptus viminalis* heathy woodland, *Eucalyptus camaldulensis* grassy woodland, *Melaleuca ericifolia* scrub, and Wetland complex.

The wetland vegetation was considered significant despite the wetland being "artificial", and the authors stated that the vegetation was likely to increase in significance over time as the wetland matures (it would have been less than 5 years old at the time of this survey). The authors note that the wetlands at Braeside Park are highly suitable for Phragmites colonisation – this is evident now, with the species occurring in dense swards around the wetlands.

Species recorded which were considered significant by the authors included: *Acacia brownii, Diuris punctata, Eryngium vesiculosum, Eucalyptus pauciflora, Leptospermum myrsinoides x L. laevigatum, Monotoca scorparia, Ricinocarpus pinifolius* and *Trachymene anisocarpa*. Several other species had also been recorded in the past however may have become extinct at the site by the time of this study.

Recommendations for management are made for the preservation (and improvement) of the flora values at the park.

List of indigenous plants for the Braeside Region (Dunn 1988)

This is a list compiled from several different sources, including (Carr 1985), of flora species which would have occurred in the Braeside region. It was developed as a regional list from which species can be selected for planting in the park.

4.3 VEGETATION

Much of the project area has been cleared, with the remaining native vegetation predominantly highly modified. High quality native vegetation, including threatened communities, occurs at the Waterways, where it was planted as part of a large-scale habitat creation project. The remaining mapped native vegetation occurs as planted roadside vegetation (mapped as revegetation), scattered remnant trees, and small patches of EVCs including remnant native wetland vegetation. A detailed overview of the vegetation within the project area is provided in this section.

4.3.1 ECOLOGICAL VEGETATION CLASSES PRESENT

Twelve EVCs were mapped within the study area. The EVCs recorded, and their corresponding conservation significance ratings are summarised in Table 4.1. Brief descriptions are provided in Section 4.3.3. Mapping of the wetland EVCs (IWC mapping) is provided on Figure 4.2, and the total extent of native vegetation is provided on Figure 4.3. Detailed mapping of all terrestrial EVCs (i.e. showing the benchmark EVCs used) is provided in the Supplementary Figure 4 series in Appendix A.

Most of these EVCs are considered 'endangered' within the Gippsland Plain Bioregion. The remainder of the project area (approximately 125 ha) consists of exotic vegetation and constructed features such as roads.

Table 4.1 Ecological vegetation classes

EVC NO.	ECOLOGICAL VEGETATION CLASS	BIOREGION CONSERVATION STATUS (DELWP 2018A)	WETLAND EVC BIOREGION CONSERVATION STATUS (FROOD & PAPAS 2016)	ACCEPTED BIOREGION CONSERVATION STATUS	FFG ACT COMMUNITY EQUIVALENT*	EPBC ACT COMMUNITY EQUIVALENT*
653	Aquatic Herbland	EVC not listed in Gippsland Plain Bioregion (GipP). Aquatic Herbland is 'endangered' in most bioregions	Endangered	Endangered	Herb-rich Plains Grassy Wetland (West Gippsland) Community	Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
308	Aquatic Sedgeland	EVC not listed	Vulnerable	Vulnerable	Drier edges consistent with Herb-rich Plains Grassy Wetland (West Gippsland) Community	None Contra-indicated from Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
68	Creekline Grassy Woodland	Endangered	None	Endangered	None	None
3	Damp Sands Herb-rich Woodland	Vulnerable	None	Vulnerable	None	None
125	Plains Grassy Wetland	Endangered	Endangered	Endangered	Herb-rich Plains Grassy Wetland (West Gippsland) Community	Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
55	Plains Grassy Woodland	Endangered	None	Endangered	No	No

EVC NO.	ECOLOGICAL VEGETATION CLASS	BIOREGION CONSERVATION STATUS (DELWP 2018A)	WETLAND EVC BIOREGION CONSERVATION STATUS (FROOD & PAPAS 2016)	ACCEPTED BIOREGION CONSERVATION STATUS	FFG ACT COMMUNITY EQUIVALENT*	EPBC ACT COMMUNITY EQUIVALENT*
647	Plains Sedgy Wetland	No status in GipP. Listed as 'endangered' in most bioregions	Endangered	Endangered	Herb-rich Plains Grassy Wetland (West Gippsland) Community	Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
132_62	*South Gippsland* Plains Grassland	Endangered	None	Endangered	Plains Grassland (South Gippsland) Community	Natural Damp Grassland of the Victorian Coastal Plains
918	Submerged Aquatic Herbland	EVC not listed Most similar EVC Aquatic Herbland is 'endangered' in most bioregions	Endangered	Endangered	No	No
53	Swamp Scrub	Endangered	Endangered	Endangered	No	No
937	Swampy Woodland	Endangered	Endangered	Endangered	No	No
821	Tall Marsh	No status in GipP. Most similar EVC Floodplain Reedbed is 'endangered' in GipP	Endangered	Endangered	No	No Contra-indicated from Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains
990	Unvegetated (open water/bare soil/mud – 'Non Vegetation'	n/a	n/a	n/a	No	No

*Equivalence to FFG Act and EPBC Act communities as assessed by criteria in the following section (Threatened vegetation communities)

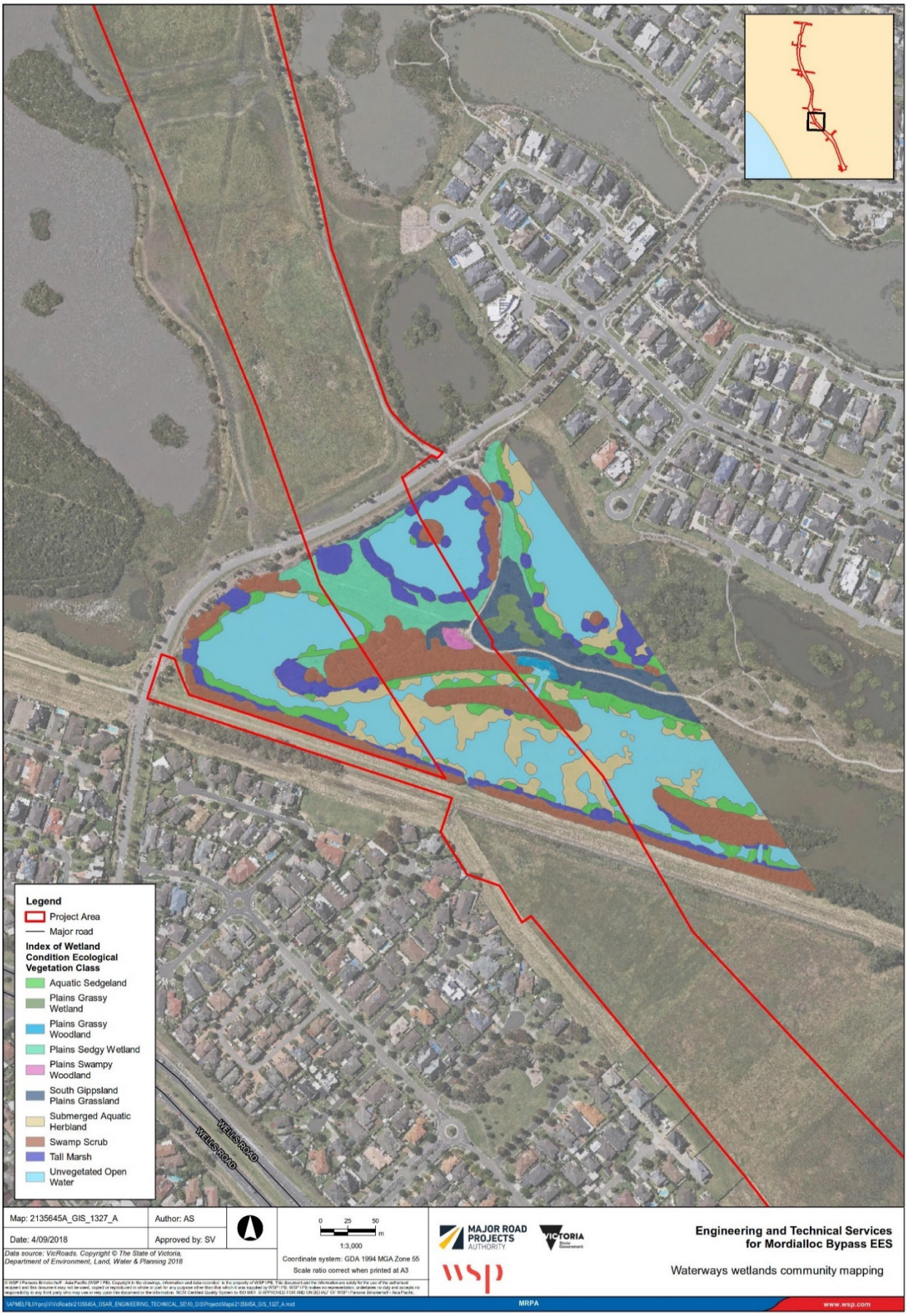
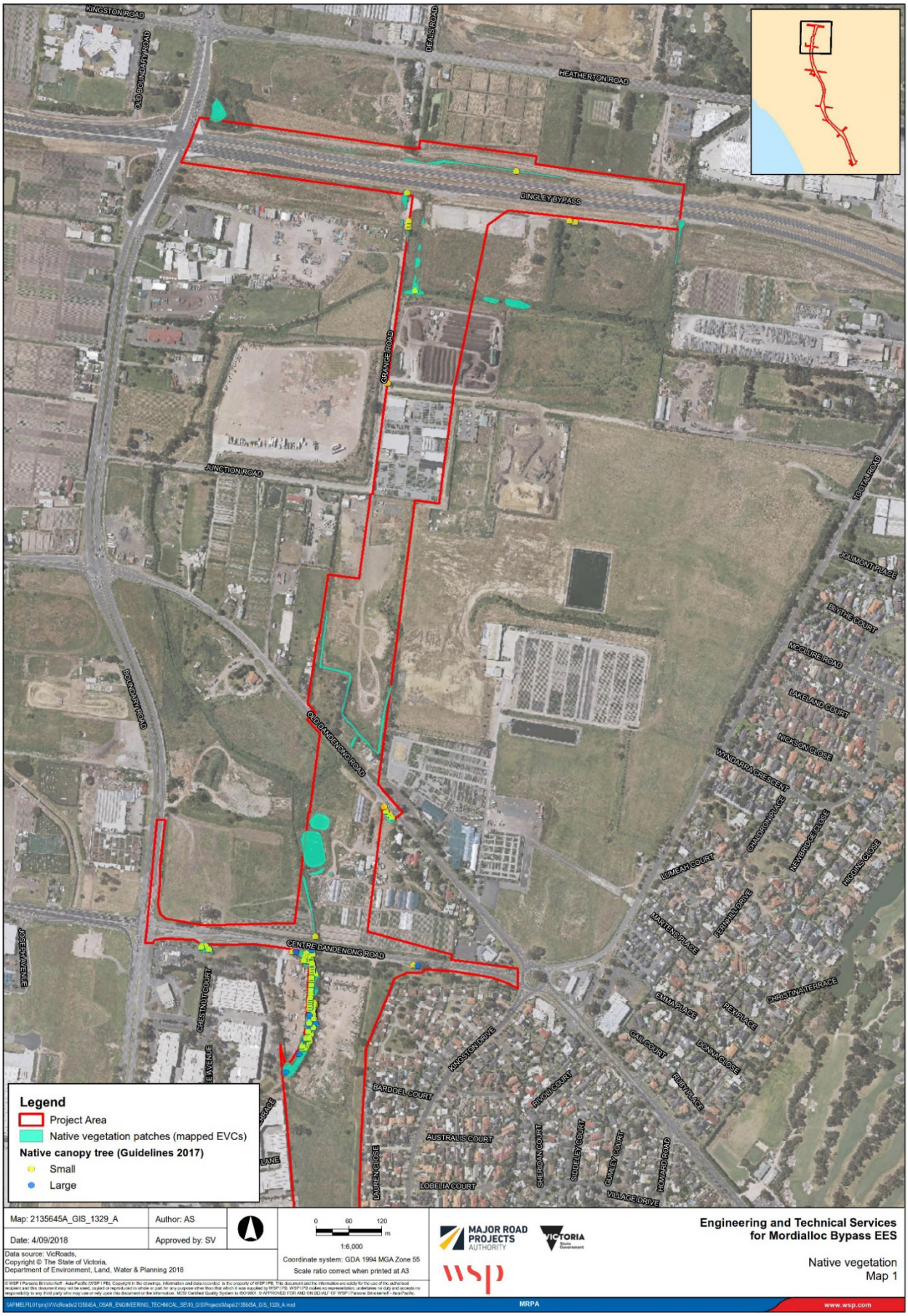


Figure 4.2 Wetland community mapping at Waterways Wetlands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DEANS ROAD
HEATHERTON ROAD
DINGLEY BYPASS
ORANGE ROAD
JUNCTION ROAD
BOUNDARY ROAD
OLD DANDENONG ROAD
CENTRE DANDENONG ROAD
JOSEPH AVENUE
CHESTNUT COURT
TOMTAL ROAD
JOUMONT PLACE
BLYTHE COURT
MCCLURE ROAD
LAKELAND COURT
NICKSON CLOSE
WYNDARRA CRESCENT
CHILDRONI PLACE
NEWBRIDGE CLOSE
HIGGINS CLOSE
LUMEAH COURT
FERNHILL DRIVE
MAYENS PLACE
EMMA PLACE
REX PLACE
CHRISTINA TERRACE
GAIL COURT
DONNA CLOSE
RUBY PLACE
KINGSTON RESERVE
BARDOEL COURT
RIVOLI COURT
AUSTRALIS COURT
SHERIDAN COURT
SIDDELEY COURT
OAKLEY COURT
HOWARD ROAD
VILLAGE DRIVE
LOBELIA COURT
LAUREN CLOSE
Legend
Project Area
Native vegetation patches (mapped EVCs)
Native canopy tree (Guidelines 2017)
Small
Large
Map: 2135645A_GIS_1329_A
Author: AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads,
Copyright © The State of Victoria,
Department of Environment, Land, Water & Planning 2018
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MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
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Engineering and Technical Services for Mordialloc Bypass EES
Native vegetation
Map 1
MRPA
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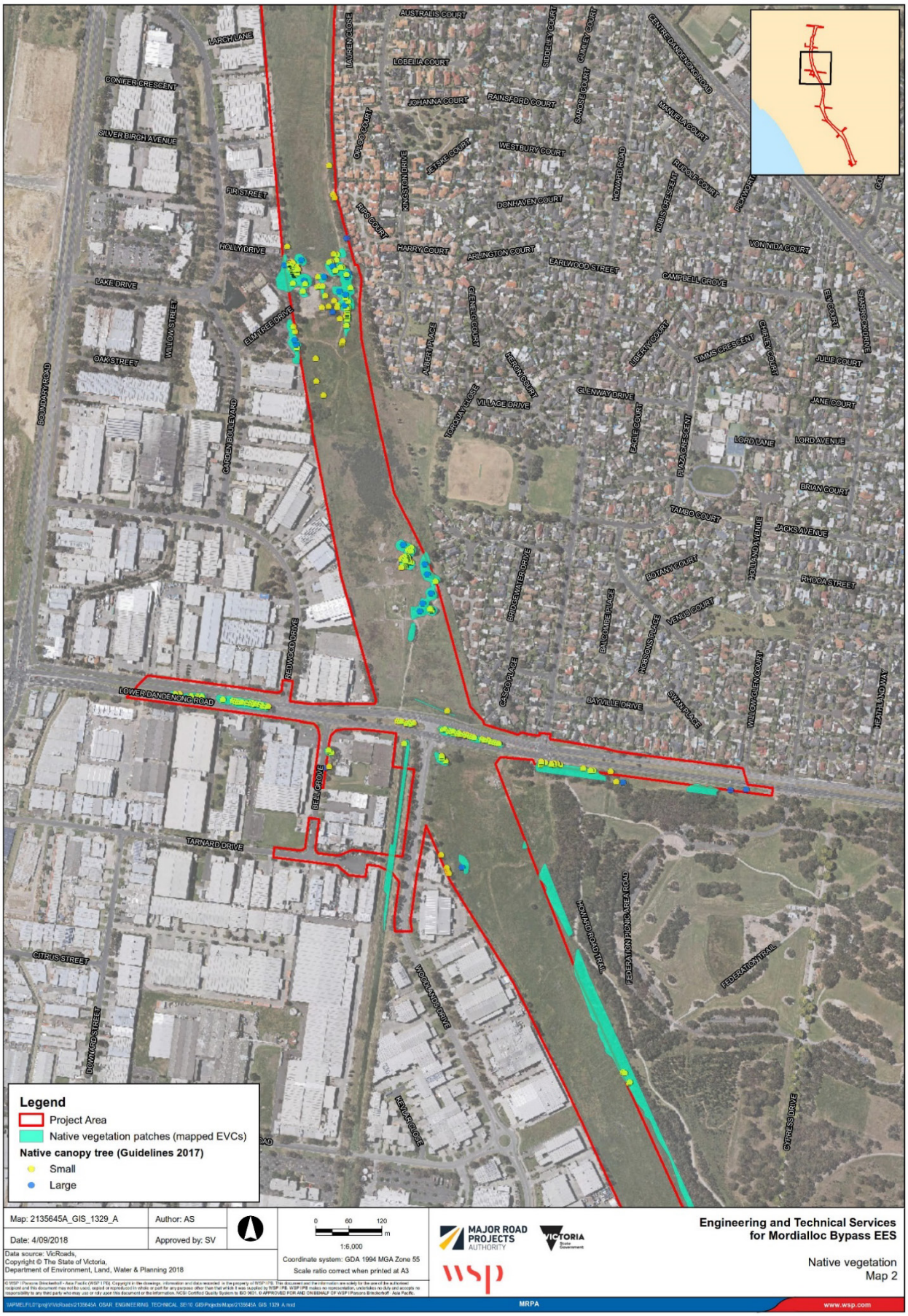
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LARCH LANE
LAUREN CLOSE
LOBELIA COURT
SILBERLEY COURT
GIMLEY COURT
CENTRE DANDENONG ROAD
CONIFER CRESCENT
JOHANNA COURT
RAINSFORD COURT
SABRINA COURT
MANUELA COURT
SILVER BIRCH AVENUE
OPTICO COURT
JESSAE COURT
WESTBURY COURT
KINGSTON DRIVE
HOWARD ROAD
RUDOLF COURT
FIR STREET
DONHAVEN COURT
IBIS CRESCENT
PELSWORTH
RUS COURT
HOLLY DRIVE
HARRY COURT
ARLINGTON COURT
EARLWOOD STREET
VON NIDA COURT
CAMPBELL GROVE
LAKE DRIVE
ELM TREE DRIVE
WILLOW STREET
GLENELG COURT
ALBERT PLACE
LIBERTY COURT
TIMMS CRESCENT
CHELSEY COURT
JULIE COURT
OAK STREET
BOUNDARY ROAD
HERON COURT
GLENWAY DRIVE
VILLAGE DRIVE
TORQUAY CLOSE
EAGLE COURT
PIAZZA CRESCENT
JANE COURT
LORD LANE
LORD AVENUE
GARDEN BOULEVARD
BRIAN COURT
TAMBO COURT
JACKS AVENUE
HOLLAND AVENUE
BOTANY COURT
RHODA STREET
BIRDSMARSH DRIVE
VENUS COURT
BALCOMBE PLACE
HOBSONS PLACE
REDWOOD DRIVE
LOWER DANDENONG ROAD
CASSIOPEA PLACE
BAYVILLE DRIVE
SHANY PLACE
WILLOW GLEN COURT
BELL GROVE
TARNARD DRIVE
HOWARD ROAD TRAIL
FEDERATION PICNIC AREA ROAD
FEDERATION TRAIL
CITRUS STREET
WOODLANDS GROVE
DOWLAND STREET
KEW RIDGE
CYPRESS DRIVE
Legend
Project Area
Native vegetation patches (mapped EVCs)
Native canopy tree (Guidelines 2017)
Small
Large
Map: 2135645A_GIS_1329_A
Author: AS
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Engineering and Technical Services for Mordialloc Bypass EES
Native vegetation
Map 2
MRPA
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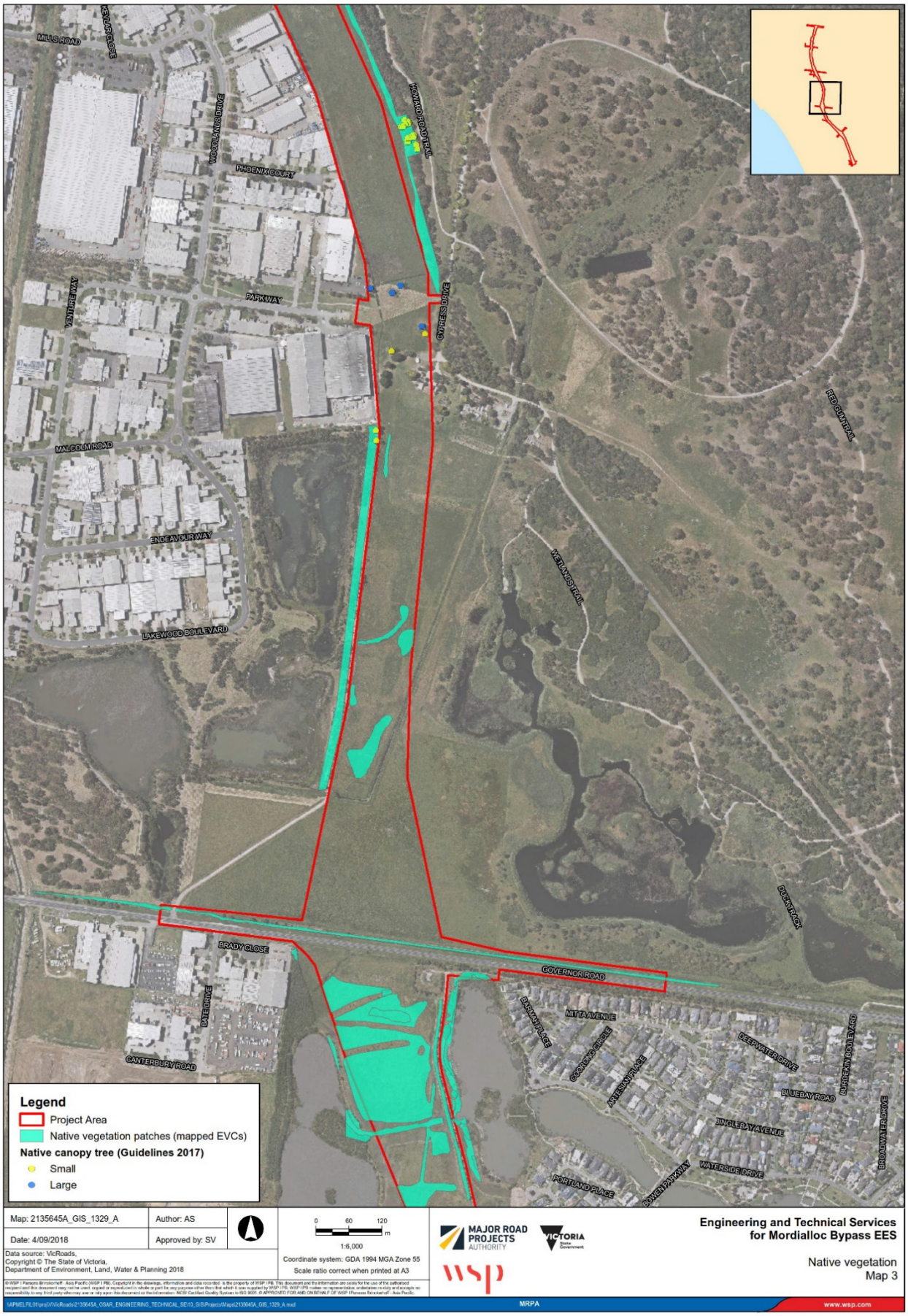
MILLS ROAD
KENYA CLOSE
WOODLANDS DRIVE
PHOENIX COURT
HOWARD ROAD TRAIL
CYPRESS DRIVE
VENTURE WAY
PARKWAY
MALCOLM ROAD
ENDEAVOUR WAY
LAKEWOOD BOULEVARD
WETLANDS TRAIL
RED GUM TRAIL
DUCK TRACK
BRADY CLOSE
GOVERNOR ROAD
BATE DRIVE
CANTERBURY ROAD
BARWAN PLACE
MITTA AVENUE
COOROOC CIRCLE
ARTEMIS PLACE
DEEPWATER DRIVE
BLUEBAY ROAD
BINGLE BAY AVENUE
WATERSIDE DRIVE
PORTLAND PLACE
BOWEN PARKWAY
BROOMWATER PARK
Legend
Project Area
Native vegetation patches (mapped EVCs)
Native canopy tree (Guidelines 2017)
Small
Large
Map: 2135645A_GIS_1329_A
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MAJOR ROAD PROJECTS AUTHORITY
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Engineering and Technical Services for Mordialloc Bypass EES
Native vegetation
Map 3
MRPA
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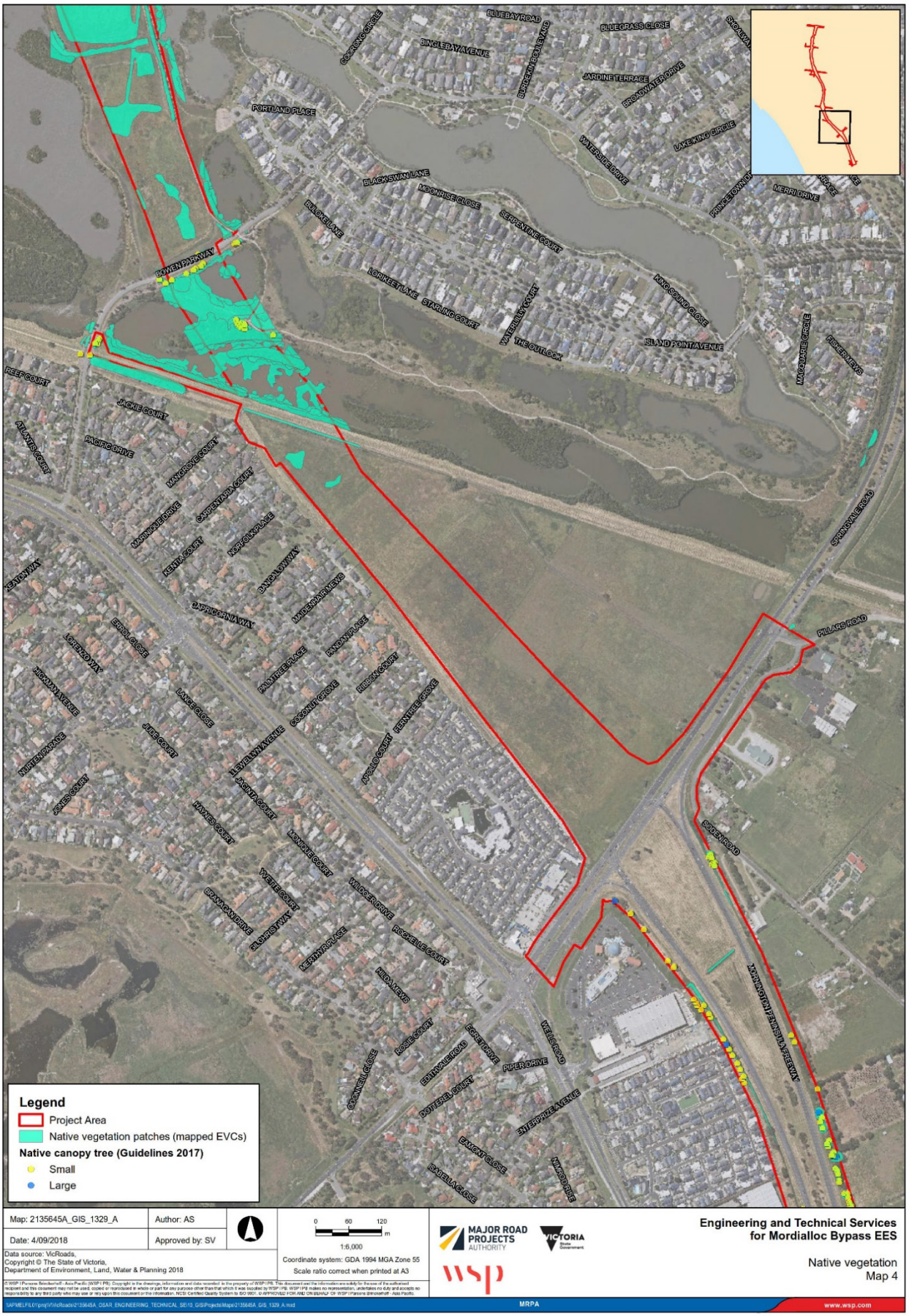
Legend
Project Area
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Native vegetation
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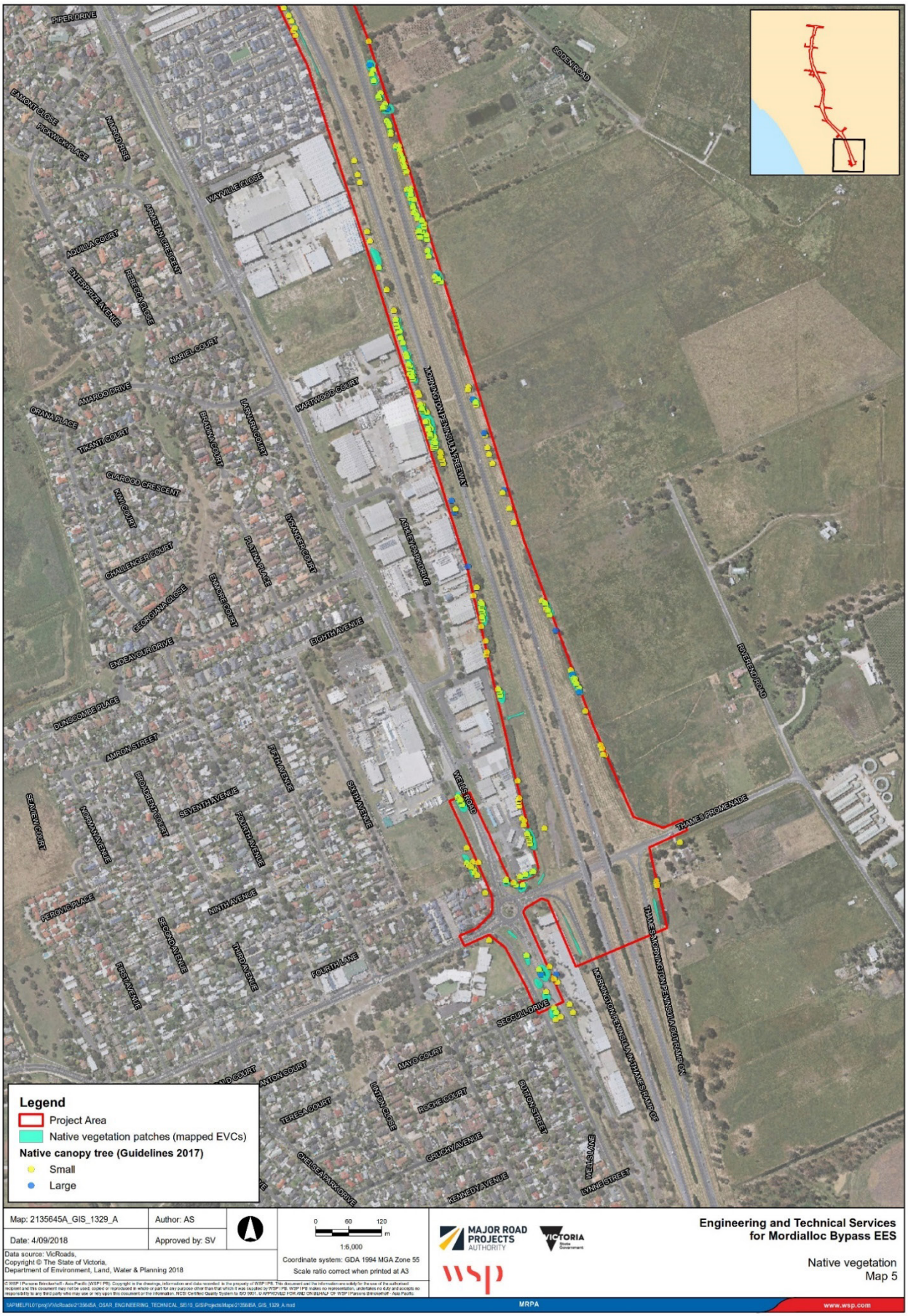


Figure 4.3 Native vegetation

4.3.2 THREATENED VEGETATION COMMUNITIES

Two EPBC Act listed threatened ecological communities occur in the project area. These are:

- Natural Damp Grassland of the Victorian Coastal Plains
- Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains.

There are two largely corresponding FFG Act listed communities:

- Plains Grassland (South Gippsland) Community.
- Herb-rich Plains Grassy Wetland (West Gippsland) Community

The EVCs which correspond (or may correspond) to the above listed communities are detailed in Table 4.1. The locations of threatened communities are shown on Figure 4.4.

More information about the extent of the communities and changes following recent survey is provided below.

4.3.2.1 EPBC ACT COMMUNITIES

Cover abundance surveys were undertaken using quadrats (plot data provided in Appendix B, plot locations shown on Figure 4.4). Patches were then assessed against the EPBC Act criteria and condition thresholds in the listing advice and conservation advice documents for the communities (Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (TSSC 2012), and Natural Damp Grassland of the Victorian Coastal Plains (DoE 2014; TSSC 2015)). The assessments against the EPBC Act threatened ecological community criteria are provided in Appendix E.

All planted areas (i.e. at the Waterways south of Bowen Parkway) mapped as either of the two EPBC communities meet the condition thresholds based on the plot data. Since the Preliminary Flora and Fauna Assessment (WSP 2017d), there has been an update to the area of Seasonal Herbaceous Wetland mapped within the project area. The reasons behind this change are discussed below.

SEASONAL HERBACEOUS WETLANDS MAPPING REVISIONS

Biosis mapped several patches between Bowen Parkway and Governor Road as potential Seasonal Herbaceous Wetlands. Biosis' surveys, in March 2013, December 2014, and January 2015 were undertaken when these ephemeral wetlands were dry (Biosis 2015). Subsequently, WSP resurveyed these areas when undertaking vegetation assessment at the Waterways for the preliminary assessment (WSP 2017d).

Most vegetation surveys by WSP for the preliminary assessment were undertaken in late summer and autumn (2017), which are suboptimal times to identify wetlands. Also, Seasonal Herbaceous Wetlands can be difficult to identify during a 'dry phase' and some may only be evident irregularly from higher rainfall events as opposed to an annual filling phase. During a 'dry phase', most plants remain dormant as seeds or underground as propagules (such as tubers), thus making identification of this community difficult (Goulburn Broken CMA 2015). Therefore, although the patches were mostly dry and predominantly exotic at the time of the assessment, WSP adopted the areas of Seasonal Herbaceous Wetlands mapped by Biosis for the preliminary flora and fauna assessment (WSP 2017d). It was not known however whether these areas are now too highly modified to hold sufficient water to enter a 'wet phase', or, if they can enter a wet phase, whether they would still meet the criteria for Seasonal Herbaceous Wetlands.

To determine whether these remnant patches would meet the criteria for Seasonal Herbaceous Wetland in wet phase, the area was re-visited in winter, spring and summer 2017, and flood modelling was examined for the area. Two additional vegetation plots (plots 8 and 9, Figure 4.4) were completed in the best quality vegetation on 23 November 2017, at a time where nearby wetlands (e.g. Edithvale wetlands) supported moderate water levels. The motivation to reassess these patches in a wet phase was provided by communication with staff from the Department of the Environment and Energy, Ecological Communities section (via email 17 May 2017). They stated it may be necessary to reassess some plots during the wet phase of the seasonal cycle, notably, the remnant native vegetation patches, to have greater certainty about the presence of Seasonal Herbaceous Wetland.

Although the plots still supported approximately 25% native vegetation cover (the minimum required to be mapped as an EVC patch), they did not support the native cover required to meet the EPBC Act criteria for Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. The entire area between Bowen Parkway and Governor Road is regularly mown and weed-dominated. The patches did not appear to be retaining sufficient water after rainfall to cause exotic vegetation to die off and native wetland vegetation to flourish. A site visit was conducted on 7 December 2017, after heavy rainfall the previous week (19 mm on 2/12 and 44.6 mm on 3/12, as per the Commonwealth Bureau of Meteorology records for Moorabbin Airport). No change in vegetation or water levels was evident from the 23 November survey. Flood modelling by the WSP surface water team indicated that although the area would still be inundated (particularly when high rainfall is combined with a king tide), it does not retain water for long. This is likely due to the significant modifications to the surface topography and the artificial drainage channels and weirs needed to regulate flooding in the area. It is now considered unlikely that these patches retain sufficient natural values to be considered part of Seasonal Herbaceous Wetlands, according to the Scientific Determination Criteria. The assessments against the EPBC Act threatened ecological community criteria are provided in Appendix E.

4.3.2.2 FFG ACT COMMUNITIES

The patches of previously mapped FFG Act communities were compared against the community descriptions under the FFG Act. Generally, mapping of FFG Act communities remained consistent with the Preliminary assessment (WSP 2017d); however, consistent with the assessment of Seasonal Herbaceous Wetlands (Section 4.3.2.1), areas of Herb-rich Plains Grassy Wetland (West Gippsland) between Governor Road and Bowen Parkway were removed from the mapping as they no longer constitute wetland of sufficient quality to meet the community description.

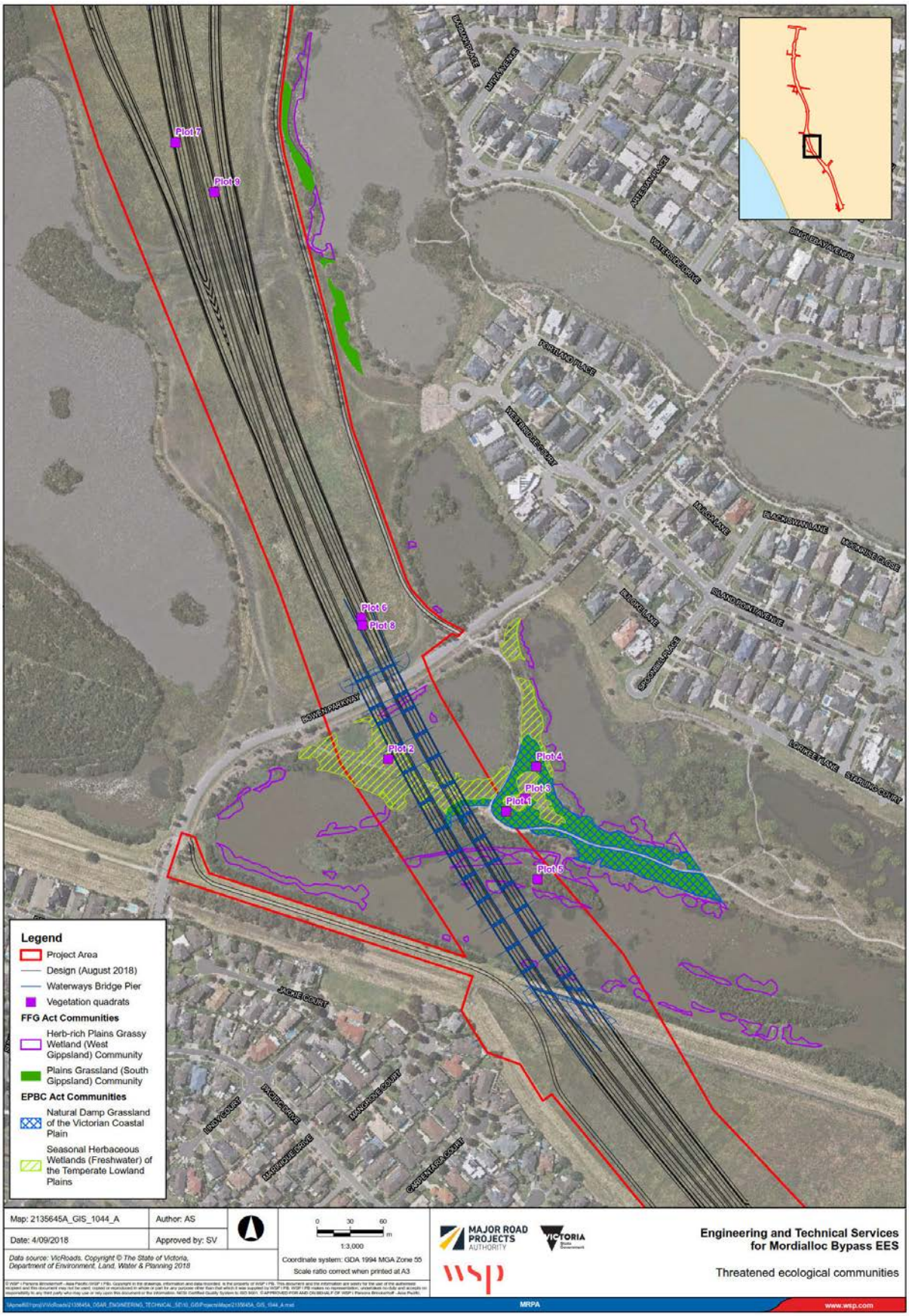


Figure 4.4 Threatened ecological communities

4.3.3 ECOLOGICAL VEGETATION CLASS DESCRIPTIONS

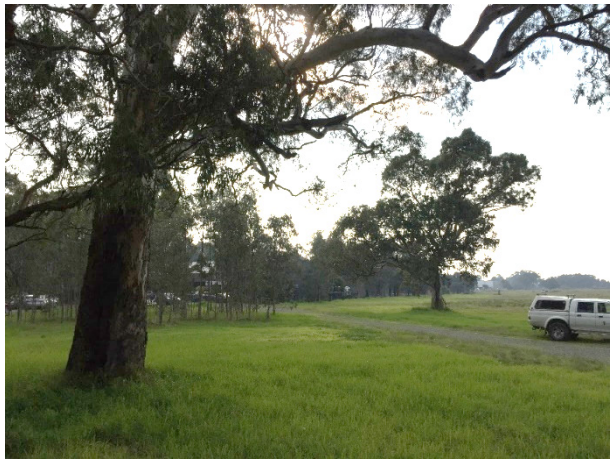
The twelve EVCs recorded within the study area are described in the following table.

Table 4.2 Ecological vegetation class descriptions

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
Aquatic Herbland (EVC653)		Herbland of permanent to semi-permanent wetlands, dominated by sedges (especially on shallower verges) and/or aquatic herbs. Occurs on fertile paludal soils, typically heavy clays beneath organic accumulations. Typical species include native plants Slender Knotweed *Persicaria decipiens*, Pale Knotweed *Persicaria lapathifolia*, Common Spike-sedge *Eleocharis acuta*, Common Water-ribbons *Cycnogeton procerum* (broad erect leaf variant), Broom Rush *Juncus sarophorus* and Water Plantain *Alisma plantago-aquatica.* Introduced species typically include Water Couch **Paspalum distichum*, Aster-weed **Aster subulatus*, Curled Dock **Rumex crispus and* Drain Flat-sedge **Cyperus eragrostis.* Found throughout the project area in drains, dams and low lying depressions.
Aquatic Sedgeland (EVC 308)		Typically species-poor vegetation dominated by robust inundation-tolerant rhizomatous sedges including *Eleocharis sphacelata* and *Baumea articulata* occasionally in deeper areas. Widespread on deeper wetland edges, often adjacent to Plains Sedgy Wetland, Wet Verge Sedgeland and Swamp Scrub. Few weeds in this EVC except Parrot's Feather **Myriophyllum aquaticum* in some areas. Areas of this EVC merging into Plains Sedgy Wetland contain weeds such as Water Couch **Paspalum distichum*, Aster-weed **Aster subulatus*, Curled Dock **Rumex crispus* and Drain Flat-sedge **Cyperus eragrostis.* Only found in The Waterways.

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
Creekline Grassy Woodland (EVC 68)		Eucalypt dominated woodland to 15 m tall with occasional scattered shrub layer over a mostly grassy/sedgy to herbaceous ground-layer. Occurs on low-gradient ephemeral to intermittent drainage lines, typically on fertile colluvial/alluvial soils, on a wide range of suitably fertile geological gradients. Dominated by River Red-gum *Eucalyptus camaldulensis* canopy with mid-storey shrubs including Swamp Paperbark *Melaleuca ericifolia* and Hedge Wattle *Acacia paradoxa* (Biosis 2015). The understorey is highly modified with majority of areas dominated by weeds including Flax-leaf Broom **Genista linifolia*, Blackberry **Rubus fruticosus* spp. agg. and Gorse **Ulex europaeus*. Scattered remnants of this EVC occur in the northern parts of the project area.
Damp Sands Herb-rich Woodland (EVC 3)		A low, grassy or bracken-dominated eucalypt forest or open woodland to 15 m tall with a large shrub layer and ground layer rich in herbs, grasses, and orchids. Occurs mainly on flat or undulating areas on moderately fertile, relatively well-drained, deep sandy or loamy topsoils over heavier subsoils. Canopy species include Coast Manna-gum *Eucalyptus viminalis* subsp. *pryoriana*, with a modified understorey dominated by Spiny-headed Mat-rush *Lomandra longifolia*, Hedge Wattle *Acacia paradoxa* and introduced species Great Brome **Bromus diandrus*, Pampas Lily-of-the-Valley **Salpichroa origanifolia*, Gorse **Ulex europaeus* and Galenia **Galenia pubescens* var. *pubescens.* Scattered remnants in the northern parts of the project area.

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
Plains Grassy Wetland (EVC 125)		Grassy-herbaceous, shallow seasonal wetlands which are typically species-rich. Throughout revegetated areas of The Waterways, this EVC is 'very high quality' according to the Scientific Determination Criteria for Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. Characteristic species in drier zones of this EVC include Brown-back Wallaby-grass *Rytidosperma duttonianum*, Prickfoot *Eryngium vesiculosum*, Common Tussock-grass *Poa labillardierei*, Wetland Wallaby-grass *Rytidosperma semiannulare*, Pale Swamp Everlasting *Coronidium gunnianum*, Varied Raspwort *Haloragis heterophylla*, Milky Beauty-heads *Calocephalus lacteus* and Reed Bent-grass *Deyeuxia quadriseta*. In wetter zones, species typically include Running Marsh-flower *Ornduffia reniformis*, Common Swamp Wallaby-grass *Amphibromus nervosus*, Common Spike-sedge *Eleocharis acuta*, Small Spike-sedge *Eleocharis pusilla*, Upright Water-milfoil *Myriophyllum crispatum* and Swamp Everlasting *Xerochrysum palustre*. Some areas contain localised dominance of Fine Twig-sedge *Baumea arthrophylla* and Poong'ort *Carex tereticaulis*, however where these sedges become structurally dominant, this merges into Plains Sedgy Wetland. In high quality areas, typical weeds comprise <5%, which include Aster-weed **Aster subulatus*, Paspalum **Paspalum dilatatum*, Toowoomba Canary-grass **Phalaris aquatica*, Hairy Hawkbit **Leontodon saxatilis subsp. saxatilis* and Ribwort **Plantago lanceolata*. See Plot 3 (flora plot data is provided in Appendix B and is assessed against EPBC Act Community Criteria in Appendix E). In remnant areas (i.e. not the parts of the Waterways which were revegetated), these patches are in much poorer condition, dominated by the weed Toowoomba Canary-grass **Phalaris aquatica*.

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
Plains Grassy Woodland (EVC 55)		An open, eucalypt dominated woodland to 15 m tall occurring on several geologies and soil types. Occupies poorly drained, fertile soils on flat or gently undulating plains at low elevations. The understorey consists of a few sparse shrubs over a species-rich grassy and herbaceous ground layer. Dominated by River Red-gum *Eucalyptus camaldulensis* canopy over a highly modified understorey dominated by several introduced grasses and herbs including Perennial Rye-grass **Lolium perenne*, Paterson's Curse **Echium plantagineum* and Chickweed **Stellaria media*. Scattered remnants in the northern parts of the project area.
Plains Sedgy Wetland (EVC 647)		Sedge dominated wetland vegetation in areas where moisture supply is more reliable. Found mostly in the revegetated areas of Waterways. Occurs throughout low-lying areas, often between Plains Grassy Wetland (in drier zones) and Aquatic Sedgeland or Wet Verge Sedgeland in the wetter zones. Indicator species include Poong'ort *Carex tereticaulis* and sometimes Fine Twig-sedge *Baumea arthrophylla* along with Common Spike-sedge *Eleocharis acuta*, Lesser Joyweed *Alternanthera denticulata* s.l., Tassel Sedge *Carex fascicularis*, Broom Rush *Juncus sarophorus*, Water Pepper *Persicaria hydropiper* and Slender Knotweed *Persicaria decipiens*. Weeds typically comprise 10% cover, which include Water Couch **Paspalum distichum*, Aster-weed **Aster subulatus*, Curled Dock **Rumex crispus*, Marsh Yellow-cress **Rorippa palustris* and Drain Flat-sedge **Cyperus eragrostis*. See Plot 2 (flora plot data is provided in Appendix B and is assessed against EPBC Act Community Criteria in Appendix E).

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
South Gippsland Plains Grassland (EVC 132_62)		Treeless vegetation dominated by grasses and herbs. High quality patches are typically dominated by Common Tussock-grass *Poa labillardierei*, Kangaroo Grass *Themeda triandra*, Wetland Wallaby-grass *Rytidosperma semiannulare*, Prickfoot *Eryngium vesiculosum*, Milky Beauty-heads *Calocephalus lacteus* and occasional Blackwood *Acacia melanoxylon*. Weeds typically comprise 5% cover and include Tall Fleabane **Erigeron sumatrensis*, Narrow-leaf Clover **Trifolium angustifolium var. angustifolium*, Ox-tongue **Helminthotheca echioides* and Hairy Hawkbit **Leontodon saxatilis subsp. saxatilis*. See Plot 1 and Plot 4 (flora plot data is provided in Appendix B and is assessed against EPBC Act Community Criteria in Appendix E). Only found in The Waterways.
Submerged Aquatic Herbland (EVC 918)		Submerged aquatic grass dominated beds of Eel Grass *Vallisneria australis* found throughout deeper areas of the Waterways lake and wetland systems. Typically, only Eel Grass *Vallisneria australis* tolerates deeper, permanent inundation but in shallower areas Tall Spike-sedge *Eleocharis sphacelata* and Jointed Twig-sedge *Baumea articulata* can be present. No weeds are typically found in this vegetation. Only found in The Waterways.

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
Swamp Scrub (EVC 53)		Dense shrubby vegetation dominated by Swamp Paperbark *Melaleuca ericifolia* with occasional emergent Blackwood *Acacia melanoxylon*. High quality patches of Swamp Scrub are found throughout revegetated sections of Waterways, with poorer quality remnant and regrowth elsewhere in the study area. Understorey species often include Weeping Grass *Microlaena stipoides* var. *stipoides*, Common Tussock-grass *Poa labillardierei*, Common Grass-sedge *Carex breviculmis*, Hollow Rush *Juncus amabilis*, Annual Fireweed *Senecio glomeratus* and in damper areas, Poong'ort *Carex tereticaulis* and Common Reed *Phragmites australis.* Weeds throughout Waterways typically comprise 10% cover, which include Blackberry **Rubus fruticosus spp. agg.*, Aster-weed **Aster subulatus*, Spear Thistle **Cirsium vulgare*, Black Nightshade **Solanum nigrum s.l.* and Prickly Lettuce **Lactuca serriola.* See Plot 5 (flora plot data is provided in Appendix B and is assessed against EPBC Act Community Criteria in Appendix E).
Swampy Woodland (EVC 937)		Open eucalypt woodland dominated by Swamp Gum *Eucalyptus ovata* with an understorey dominated by Common Tussock-grass *Poa labillardierei*, Kangaroo Grass *Themeda triandra*, Cotton Fireweed *Senecio quadridentatus* and occasional Swamp Paperbark *Melaleuca ericifolia*. Small patches mapped in close association with Swamp Scrub. Weeds typically comprise 10% cover, which include Water Couch **Paspalum distichum*, Prairie Grass **Bromus catharticus*, Couch **Cynodon dactylon* var. *dactylon* and Glandular Willow-herb **Epilobium ciliatum*.

EVC	INDICATIVE PHOTOGRAPH	DESCRIPTION
Tall Marsh (EVC 821)		Wetland dominated by tall emergent grass Common Reed *Phragmites australis* with very few other species present. More species-rich on the edges which merge into Plains Sedgy Wetland with species such as Broom Rush *Juncus sarophorus*, Poong'ort *Carex tereticaulis* Common Spike-sedge *Eleocharis acuta*, Lesser Joyweed *Alternanthera denticulata s.l. and* Slender Knotweed *Persicaria decipiens.* Widespread on wetland edges. Sometimes mono-dominant swards of Leafy Twig-sedge *Cladium procerum*.

4.3.4 HABITAT HECTARE ASSESSMENT DATA

Native vegetation within the project area comprises:

- High quality planted wetland and terrestrial vegetation within and adjacent to Waterways Estate
- Low quality planted and remnant terrestrial vegetation throughout the remainder of the project area
- Remnant scattered trees throughout the project area, some of which are classified as Large Trees
- Generally low quality (and occasionally high quality) recolonising wetland vegetation within constructed drains throughout the project area
- Large areas of low quality recolonising wetland vegetation located within exotic grass dominated paddocks between Braeside Parkland Springvale Road.

Habitat Hectare scores range between 0.06 to 0.72 and the results are provided in Appendix H. The assessment of the quality of native vegetation present is included in the EES Scoping Requirements. The lowest-scoring vegetation is wetland vegetation colonising exotic pasture (generally between Braeside Park and Springvale Road) and wetland vegetation colonising constructed drainage-lines throughout the project area. This vegetation generally is of low floristic and structural diversity and in many locations supports only 2-3 indigenous species. Other low scoring vegetation includes stands of small and medium sized remnant trees on roadsides, where logs have been removed and the understorey consists of mown grass.

Moderate scoring vegetation comprises some constructed drainage-line vegetation, in addition to stands of older trees which include Large Trees and modified understorey vegetation.

The highest scoring vegetation at the study area is generally located within Waterways wetlands, primarily consisting of planted wetland and terrestrial vegetation. This vegetation has been planted with a highly diverse understorey and is subject to regular weed management.

4.3.5 TREES

There are a total of 3157 trees and shrubs in the arboricultural dataset (Ryder 2018), of which 2284 are located inside the project area. The remaining 873 are located outside the project area, included to allow TPZ impacts to be assessed. With trees recorded by ecologists for Thames Promenade, the total number of trees is 3341.

Of importance are the trees which are considered under the Guidelines 2017 for impact assessment and offsetting purposes. These are ‘Canopy Trees’, defined under Guidelines 2017 as remnant native trees over 3m of canopy genera for the EVC. A summary of Canopy Trees recorded is provided in Table 4.3. A total of 703 Canopy Trees were recorded. This includes Canopy Trees recorded by ecologists near Thames Promenade after the project area was extended, not included in the arborist dataset. Sixty ‘large trees’ (scattered and within patches) were recorded in the study area. Large trees are defined (as per the Guidelines 2017) as Canopy Trees which meet or exceed the benchmark DBH for the EVC.

Eighty-one remnant trees of understorey species were also recorded, as well as 1618 planted native and indigenous trees, and 939 exotic and invasive trees. As understorey trees, planted trees, and exotic trees are not considered for offsetting, they are not addressed in detail in this report. However, they are considered in the assessment of impacts upon fauna habitat. Note that any planted trees that are considered to be Canopy Trees and require offsetting (such as trees in the revegetated waterways wetlands) are included in the Canopy Tree category and not the planted tree category.

Table 4.3 Canopy trees (Guidelines 2017) recorded at the project area

TREE CATEGORY (GUIDELINES 2017)	LARGE	SMALL	TOTAL
Tree in Patch	37	510	547
Scattered Tree	23	133	156
Canopy Tree Project total	**60**	**643**	**703**

Refer to Supplementary Figure 4 in Appendix A for the location of all trees recorded in the project area. Appendix F provides an extract of all Canopy Trees, both scattered and in patches). The full list of all trees and shrubs recorded in the project area (aside from the trees near the intersection with Thames Promenade) is provided in the arborist assessment (Ryder 2018).

4.3.6 WEEDS

The field surveys identified that the project area supports eleven regionally controlled (C), five restricted (R) and one regionally prohibited (P) weed, pursuant to the CaLP Act. These weeds are listed in Table 4.4. It is the responsibility of the landowner to control these weeds on their property and on adjacent roadside reserves. Six of these weed species are also listed as Weeds of National Significance (WoNS) by the Australian Government.

Most of the significant weeds were recorded along roadsides and private land in the north of the project area. Very few noxious weeds were recorded from within the Waterways.

Table 4.4 Noxious weeds in the project area

SCIENTIFIC NAME	COMMON NAME	CALP ACT STATUS	WONS STATUS
Allium triquetrum	Angled Onion	R	
Asphodelus fistulosus	Onion Weed	R	
Cirsium vulgare	Spear Thistle	C	
Cytisus scoparius	English Broom	C	Yes
Datura ferox	Long-spine Thorn-apple	C	
Dittrichia graveolens	Stinkwort	C	
Echium plantagineum	Paterson's Curse	C	
Foeniculum vulgare	Fennel	R	
Genista linifolia	Flax-leaf Broom	P	Yes
Genista monspessulana	Montpellier Broom	C	Yes
Lycium ferocissimum	African Box-thorn	C	Yes
Oxalis pes-caprae	Soursob	R	
Rubus fruticosus spp. agg.	Blackberry	C	Yes
Salix babylonica s.l.	Weeping Willow	R	
Salpichroa origanifolia	Pampas Lily-of-the-Valley	C	
Silybum marianum	Variegated Thistle	C	
Ulex europaeus	Gorse	C	Yes

4.4 FLORA

A total of 245 vascular plant species have been recorded within the vegetation assessment study area (project area plus a 20 m buffer), of which 103 (42%) are native, 8 are planted street trees/shrubs (3%), and 134 (55%) are introduced species. Numerous species have also been planted throughout The Waterways, which significantly contributes to the diversity of native plant species recorded. The full list of flora species recorded from multiple sources is included as Appendix B.

VBA records were examined for the likelihood of occurrence assessment. VBA records within 5 km of the project area are provided as Supplementary Figure 3, Appendix A.

4.4.1 TARGETED SURVEY RESULTS

Five significant species were detected during field surveys, as detailed in Table 4.5. These species were mostly planted as part of the creation/revegetation of the Waterways wetlands although all are considered remnant for the purpose of this assessment. The locations of significant flora recorded are provided on Figure 4.5.

Table 4.5 Significant flora species recorded (shown on Figure 4.5)

ID (LABEL ON FIGURE 4.5)	SPECIES	COMMON NAME	DATE	OBSERVER	APPROXIMATE PATCH SIZE / OTHER NOTES
Mapped as polygons	*Cladium procerum*	Leafy Twig-sedge	Several	NM and MS	Grows in dense swards where present
1	*Ranunculus papulentus*	Large River Buttercup	23/11/2017	NM	in flower. 2x1 m
2	*Xerochrysum palustre*	Swamp Everlasting	24/03/2017	NM	2x2 m
3	*Coronidium gunnianum*	Pale Swamp Everlasting	24/03/2017	NM	Grown from planted material
4	*Coronidium gunnianum*	Pale Swamp Everlasting	24/03/2017	NM	2x3 m
5	*Coronidium gunnianum*	Pale Swamp Everlasting	24/03/2017	NM	2x1.5 m
6	*Xerochrysum palustre*	Swamp Everlasting	24/03/2017	NM	6x5
7	*Dianella amoena*	Matted Flax-lily	23/11/2017	NM	1x1
8	*Ranunculus papulentus*	Large River Buttercup	23/11/2017	NM	1x1
9	*Coronidium gunnianum*	Pale Swamp Everlasting	6/12/2017	MS SV	2x2.5 m
10	*Coronidium gunnianum*	Pale Swamp Everlasting	8/12/2017	MS SV	2x1.5 m
11	*Coronidium gunnianum*	Pale Swamp Everlasting	8/12/2017	MS SV	1x1
12	*Coronidium gunnianum*	Pale Swamp Everlasting	8/12/2017	MS SV	1x2
13	*Coronidium gunnianum*	Pale Swamp Everlasting	8/12/2017	MS SV	1x1
14	*Xerochrysum palustre*	Swamp Everlasting	8/12/2017	MS SV	1x1
15	*Coronidium gunnianum*	Pale Swamp Everlasting	8/12/2017	MS SV	2x1
16	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1
17	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	2x4

ID (LABEL ON FIGURE 4.5)	SPECIES	COMMON NAME	DATE	OBSERVER	APPROXIMATE PATCH SIZE / OTHER NOTES
18	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	4x2 m
19	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
20	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
21	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
22	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
23	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
24	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
25	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
26	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
27	*Ranunculus papulentus*	Large River Buttercup	8/12/2017	MS SV	1x1 m
28	*Ranunculus papulentus*	Large River Buttercup	9/04/2018	MS	1 x 2 m
29	*Ranunculus papulentus*	Large River Buttercup	9/04/2018	MS	1 x 5 m

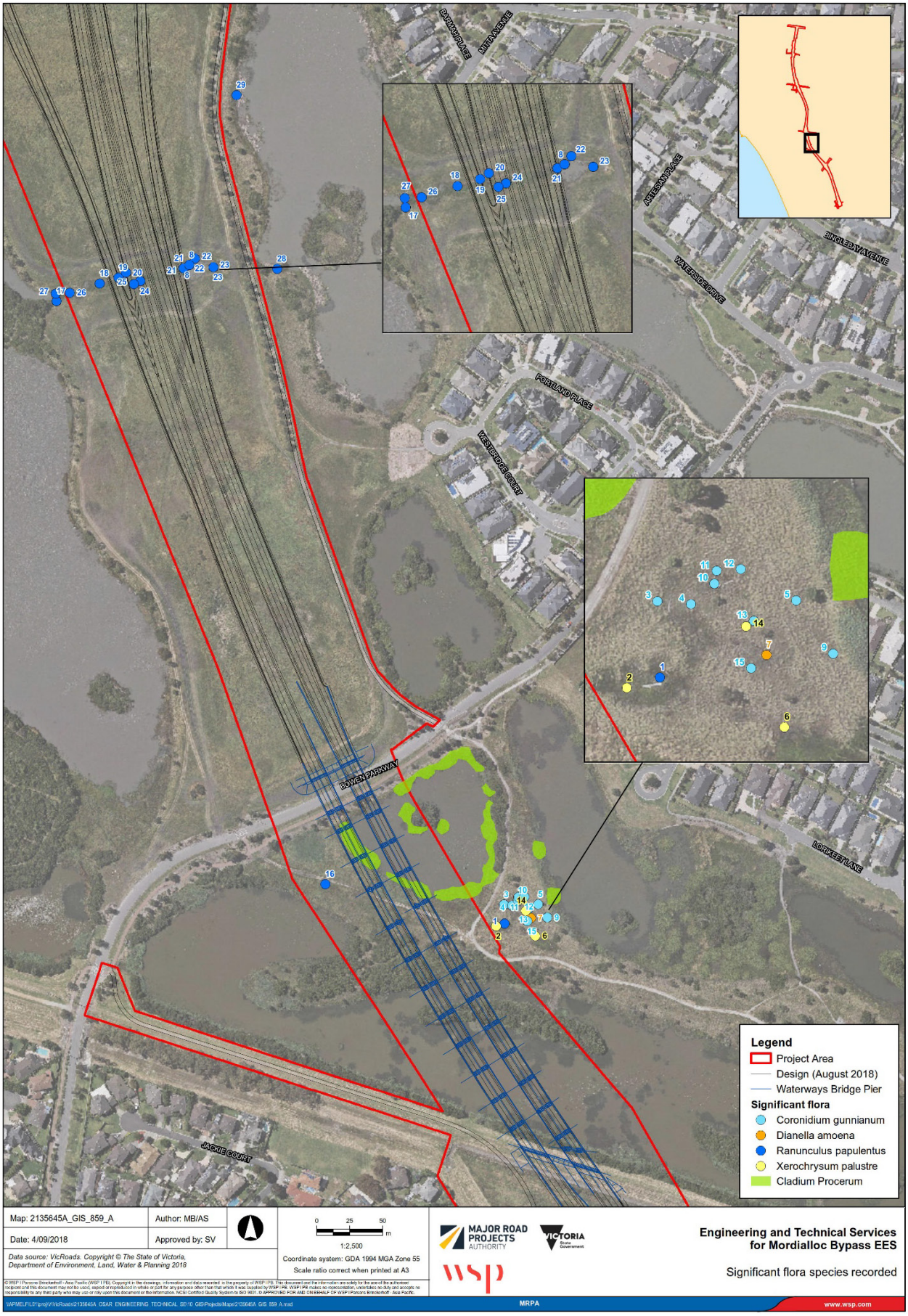


Figure 4.5 Significant flora species recorded

4.4.2 LIKELIHOOD OF OCCURRENCE

Forty-eight (48) species of state and/or national significance were assessed for their potential to occur at the project area. These species were either recorded within 5 km of the project area and are recorded on DELWP's Victorian Biodiversity Atlas (VBA), are predicted to occur by the DoEE Protected Matters Search Tool or were planted in Waterways wetlands. The significant flora species determined to have a moderate or higher likelihood of occurrence within the project area based on the desktop assessment and on the results of all targeted surveys to date are provided in Table 4.6. The full likelihood of occurrence assessment is provided in Appendix D.

VBA records from within 5 km of the project area are shown in Supplementary Figure 3 Appendix A. We note that several of the VBA records are low accuracy or are quite old and do not reflect the actual locations of the species. The targeted flora survey results (Figure 4.5) provides the locations of recorded significant species.

Table 4.6 Significant flora species with the potential to occur

SPECIES	COMMON NAME	CONSERVATION STATUS			VBA RECORD (5 KM BUFFER)	LIKELIHOOD OF OCCURRENCE AND HABITAT
		EPBC ACT	FFG ACT	VIC ADV LIST		
Cladium procerum	Leafy Twig-sedge	–	–	Rare		**Recorded** Occurs as revegetation at Waterways wetlands.
Coronidium gunnianum	Pale Swamp Everlasting	–	–	Vulnerable	2	**Recorded** Planted, recorded during surveys in numerous patches at the Waterways wetlands.
Dianella amoena	Matted Flax-lily	Endangered	Listed	Endangered		**Recorded** Recorded in this study; planted at Waterways wetlands outside of the project area.
Ranunculus amplus	Lacey River Buttercup	–	–	Rare	1	**Moderate** Planted but not recorded during field surveys.
Ranunculus papulentus	Large River Buttercup	–	–	Poorly known	9	**Recorded** Recorded by Biosis (Biosis 2015) and WSP at Waterways wetlands. Several naturally-occurring or naturalised occurrences within the project area, mostly outside of the revegetated areas.
Senecio psilocarpus	Swamp Fireweed / Smooth-fruited Groundsel	Vulnerable	–	Vulnerable		**Moderate** Planted but not recorded during field surveys.
Xerochrysum palustre	Swamp Everlasting	Vulnerable	Listed	Vulnerable	1	**Recorded** Planted, recorded during surveys.

4.5 FAUNA

4.5.1 FAUNA HABITAT

Fauna habitat values within the project area include:

- The constructed wetlands at the Waterways, immediately south of Governor Road, which includes some permanent aquatic habitat at Mordialloc Creek and fringing swamp vegetation. The wetlands provide habitat for a diverse range of species with aquatic and terrestrial habits, and support areas with dense understorey cover and some Trees in patches for nesting. There is potential roosting and foraging sites for wetland and migratory birds, as well as potential habitat for bats, frogs, turtles and other reptiles.
- Agricultural grassland (predominantly highly modified with some small patches of remnant vegetation) occurring adjacent to Braeside park and Woodlands Industrial Estate.
- Roadside weedy grassland and small drains/drainage lines, some of which provide foraging habitat for wetland birds (particularly after rain) and habitat for frogs.
- Some remnant and planted trees which provide foraging and nesting habitat for woodland birds.

There is abundant fauna habitat nearby the project area within the broader Waterways area, Woodlands wetlands, Braeside Park wetlands, Edithvale wetlands, and other more distant wetlands including Seaford wetlands and the Eastern Treatment Plant (see Figure 4.1). These areas are described in Section 4.1.

The significant wetland habitat within and adjacent to the project area was mapped for this study to inform the impact assessment, particularly for threatened and migratory wetland birds. The results are provided below.

4.5.1.1 WATERBIRD HABITAT ASSESSMENT AND MAPPING

The bird habitat present within key areas for significant birds was re-mapped in January-March 2018 by a WSP avifauna expert. The habitat types mapped are described in Table 4.7 and the mapping of key habitat types for wetland birds is provided on Figure 4.6. The likely use of the various habitats by a range of bird species is provided in a table after the figure (Table 4.8). This table includes both high and low water-level conditions, as suitability of habitat changes with changing water levels. Not all species which may occur are included, however this provides an indication of habitat importance for various bird guilds. For example, migratory shorebirds will generally use open areas of the shallow water and emergent vegetation habitat types, although they will use this habitat in different ways (foraging strategy, depth, etc.).

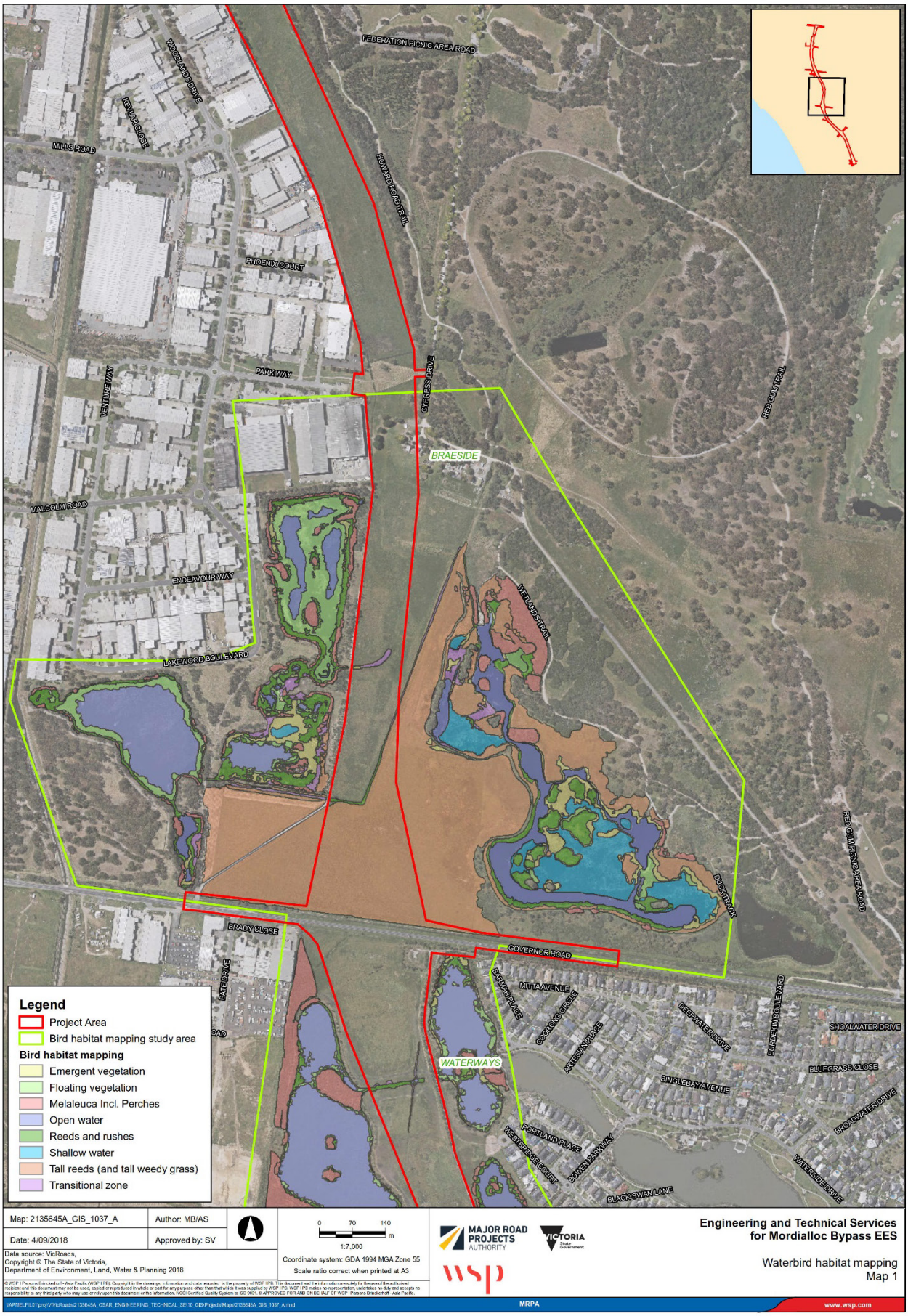
Note that this mapping varies from the Biosis mapping referred to in the preliminary flora and fauna report (Biosis 2015). This is discussed further in the Methodology Section 3.4.4.

Table 4.7 Wetland bird habitat types mapped for the Project

HABITAT NAME (FIGURE 4.6)	DESCRIPTION	VALUES
Terrestrial habitats	In the context of the project, terrestrial habitats are those that are essentially dry apart from periods of high rainfall when temporary puddles may form or excessive inundations temporarily extend the boundaries of wetland margins. They can be separated from Transitional Zone habitats by their inability to support wetland plants species because of very low inundation return rates. These habitats are not shown on the mapping since terrestrial habitats include all habitat not mapped in other categories. Note: terrestrial habitat nearby to wetlands is likely to be of highest value to wetland birds.	May provide foraging opportunities to waterbirds, due to temporary availability of food resources, such as floating seeds, amphibian breeding events or the flushing of subterranean invertebrates. Terrestrial habitats also occur within or at the edges of wetlands as potential perching sites utilised for roosting or breeding purposes and represented by fallen timber, wetland trees, dead stags or islands.
Melaleuca	Some of the wetlands associated with the project have stands of fringing Swamp Paperbark *Melaleuca ericifolia* or stands located on higher ground within the wetlands themselves.	For the most part melaleuca stands offer little foraging opportunities for wetland bird species, but they may be used as cover by rails. At Braeside Park wetlands, stands of melaleuca provide breeding sites for cormorants and darters.
Tall Reeds	The majority of this habitat is represented by Common Reed *Phragmites australis*. Although this species also occurs in inundated areas and sometimes through Transitional Zone habitats, there are large areas where this species occurs that are bordering on terrestrial habitats. There is often some thinning and stunted form away from more reliable water, but still sufficient water for the rhizomatous habit of this plant to extend away from more reliably watered areas. There are expanses of areas just north of Governor Road which is mapped as Tall Reeds but is dominated by tall weedy grasses such as Toowoomba Canary-grass **Phalaris aquatica.*	The dense cover it represents offers foraging and breeding habitats for Swamp Harriers and small passerines such as Golden-headed Cisticola and may be used by rails, crakes and bitterns as cover during movements between more suitable habitats or as foraging habitat during high water levels. These sites of dense reed cover also provide important nesting opportunities for waterfowl (in particular for Blue-billed Duck, Hardhead and a range of wading species).
Transitional Zone	Transitional Zones occur at the margins of wetland habitat and are generally not sufficiently inundated to represent standing water for most water birds to utilise. They occur above the average water levels of a wetland interfacing with terrestrial habitats but are occasionally inundated during high rainfall events. These sites are usually subject to high water tables and so support a range of sedges, grasses, reeds and herbs that prefer wet substrates.	Although a general high density of vegetation in these areas often prevent waterfowl from utilising them during lower water levels, their transitional nature makes them suitable for a wide range of waterbirds, particularly during periods of high water levels. Their moist nature and often dense vegetation cover attract invertebrates and amphibians, which are potential prey groups for herons, egrets, bitterns and rails.

HABITAT NAME (FIGURE 4.6)	DESCRIPTION	VALUES
Reeds and rushes	Reeds and Rushes habitat is represented by stands of tall emergent water plants at the margins of deeper water. This habitat type may extend over large areas if water levels are sufficient to allow colonisation. Such habitats blend naturally with the Emergent Vegetation habitat zone with thinned sections of Reeds and Rushes habitat extending into this neighbouring habitat. Reeds and Rushes, especially the Common Reed also extends into areas of less reliable water where sufficient moisture is present in underlying substrates.	Relatively dense habit make this habitat desirable shelter, foraging and breeding habitats for secretive species such as bitterns, rails and small wetland passerines such as Australian Reed-Warbler and Little Grassbird.
Emergent vegetation	Emergent Vegetation habitats, as described here, represent a relatively broad zone around the edges of a wetland. Like the Transitional Zone habitat, the Emergent Vegetation zones are highly dynamic with fluctuations in water depth. They are often the interface between dense Reed and Rush habitats and deeper water adjacent to Shallow Water. Their key characteristic is occurring in water columns low enough to allow vegetation to grow from the wetland's benthic substrates and still extend to the surface to photosynthesise.	They are often used as foraging or loafing areas for waterfowl and swamp hens. Due to the often more open vegetated structure they provide foraging habitat for long-legged waterbirds such as stilts, egrets and herons. They provide excellent hunting habitats for freshwater foraging cormorants, darters and grebes. Crakes, rails, bitterns, Australian Reed-Warblers and Little Grassbirds will sometimes leave the cover of their dense reed bed habitats to forage out amongst the sparser vegetation of this habitat type, particularly when water levels expose its substrates. During periods of low water levels their exposed benthic zone also provides foraging areas for snipe. The interface with deep water also supports floating vegetation that provides foraging habitats for Eurasian Coots, Dusky Moorhens and ducks.
Shallow water	Shallow Water here denotes habitat that is usually seasonally inundated at average wetland water levels but does not remain present for sufficient periods of time for wetland plants to colonise it.	During average to low water levels it provides roosting sites for waterfowl and more terrestrial waterbirds such as Masked Lapwing, but as the water levels fall its very shallow water columns and substrates are exposed providing access to benthic invertebrates for resident and migratory waders such as dotterels, stints, stilts, sandpipers and plovers. Teal and other waterfowl species forage in the shallow water columns around its perimeter.

HABITAT NAME (FIGURE 4.6)	DESCRIPTION	VALUES
Floating vegetation	Around the shallower edges of the Open Water habitats there are tracts of floating vegetation in water too deep to support Emergent vegetation. In this habitat, true floating vegetation occurs as well as submerged plants, which grow in dense patches that reach the surface.	Offers foraging opportunities for coots, moorhens, grebes, cormorants, darters, swans and ducks. Together with Open Water habitats, the distance from shorelines adds security to swimming birds by possessing a deep water buffer and a more unimpeded view of surroundings than areas adjacent to tall reed beds and surrounding trees.
Open water	Open Water habitats, as described here, represent those habitats where the water is of sufficient depth and/or distant from established vegetation to allow emergent vegetation types to establish. They generally occupy the centre of wetlands away from the shallow edges.	Open water habitats are utilised by cormorants, darters and grebes to forage for aquatic fauna, and the diving ducks, such as the Hardhead, Blue-billed Duck and Musk Duck use this habitat to dive for submerged vegetation. Other species of waterfowl use Open Water habitats as a refuge to shelter away from terrestrial threats.


FEDERATION PICNIC AREA ROAD
WOODLANDS DRIVE
KENYA CLOSE
MILLS ROAD
HOWARD ROAD TRAIL
PHOENIX COURT
PARKWAY
VENTURE WAY
CYPRESS DRIVE
RED GUM TRAIL
BRAESIDE
MALCOLM ROAD
ENDEAVOUR WAY
WETLANDS TRAIL
LAKEWOOD BOULEVARD
RED GUM PICNIC AREA ROAD
DYSONS AVENUE
BRADY CLOSE
GOVERNOR ROAD
BATE DRIVE
BARMAH PLACE
MITTA AVENUE
GOORONG CIRCLE
DEEPWATER DRIVE
BURDEKIN BOULEVARD
SHOALWATER DRIVE
ARTESIAN PLACE
WATERWAYS
BLUEGRASS CLOSE
SINGLEBAY AVENUE
BROADWATER DRIVE
PORTLAND PLACE
WESTBRIDGE COURT
BOWEN PARKWAY
WATERSIDE DRIVE
BLACK SWAN LANE
Legend
Project Area
Bird habitat mapping study area
Bird habitat mapping
Emergent vegetation
Floating vegetation
Melaleuca Incl. Perches
Open water
Reeds and rushes
Shallow water
Tall reeds (and tall weedy grass)
Transitional zone
Map: 2135645A_GIS_1037_A
Author: MB/AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads,
Copyright © The State of Victoria,
Department of Environment, Land, Water & Planning 2018
0 70 140 m
1:7,000
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
MAJOR ROAD PROJECTS AUTHORITY
VICTORIA State Government
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Waterbird habitat mapping
Map 1
MRPA
www.wsp.com

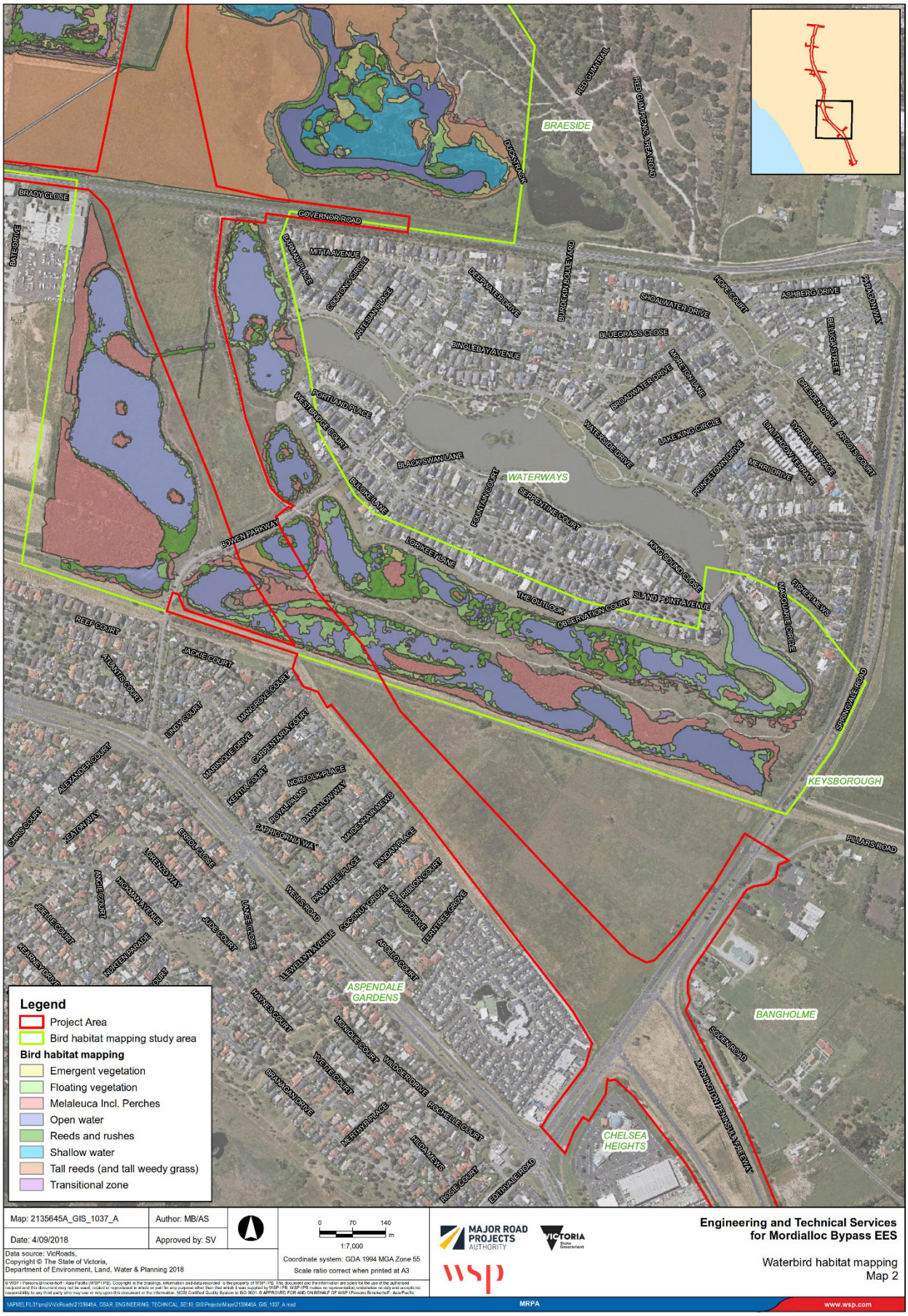


Figure 4.6 Waterbird habitat mapping

Table 4.8 Wetland bird habitat use (refer Figure 4.6)

SELECTION OF WATERBIRD SPECIES	STATUS	TERRESTRIAL INCL. PERCHES		MELALEUCA INCL. PERCHES		TALL REEDS		TRANSITIONAL ZONE		REEDS AND RUSHES		EMERGENT VEGETATION		SHALLOW WATER		FLOATING VEGETATION		OPEN WATER	
		POTENTIAL HABITAT USAGE UNDER LOW AND HIGH WATER LEVELS																	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Australasian Bittern	en L EN								F	RF	RF	RF	F		F				
Australasian Darter		R	R	RB	RB								FR		F	FS	FS	FS	FS
Australasian Grebe													FSRB		FSR	FSR	FSR	FSR	FSR
Australasian Shoveler	vu								F				FR	R	FSR	FSR	FSR	FSR	FSR
Australian Painted Snipe	cr L EN							FR				FR		FR					
Australian Pelican																		F	SR
Australian Shelduck													FR	R	FSR	FSR	FSR	FSR	FSR
Australian Spotted Crake							FS		FS	FRBS	FRBS	FRBS	FRBS	F					
Australian White Ibis		R	R						F			F			F				
Australian Wood Duck		F	F										FR	R	FSR	FSR	FSR	FSR	FSR
Baillon's Crake	vu L						FS		FS	FRBS	FRBS	FRBS	FRBS	F					
Black Swan													FR	R	FSR	FSR	FSR	FSR	FSR
Black-fronted Dotterel														FR					
Black-winged Stilt												FR		FR	FR				
Blue-billed Duck	en L												R			SR	SR	FSR	FSR
Cattle Egret		FR	FR	R	R				F			F							
Chestnut Teal			F						F				FR	R	FSR	FSR	FSR	FSR	FSR
Curlew Sandpiper	en L CR M											FR		FR					
Dusky Moorhen										FRBS	FRBS	FRBS	FRBS			FS	FS		
Eurasian Coot										FRBS	FRBS	FRBS	FRBS		F	FS	FS	FS	FS
Freckled Duck	en L												FR	R	FSR	FSR	FSR	FSR	FSR

SELECTION OF WATERBIRD SPECIES	STATUS	TERRESTRIAL INCL. PERCHES		MELALEUCA INCL. PERCHES		TALL REEDS		TRANSITIONAL ZONE		REEDS AND RUSHES		EMERGENT VEGETATION		SHALLOW WATER		FLOATING VEGETATION		OPEN WATER	
		POTENTIAL HABITAT USAGE UNDER LOW AND HIGH WATER LEVELS																	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Great Cormorant		R	R	R	R											FS	FS		
Great Egret	vu L	R	R	R	R				F			F			F				
Grey Teal			FS						F				FR	R	FSR	FSR	FSR	FSR	FSR
Hardhead	vu												R	R	S	SR	SR	FSR	FSR
Hoary-headed Grebe													FSRB		FSR	FSR	FSR	FSR	FSR
Intermediate Egret	en L	R	R	R	R				F			F			F				
Latham's Snipe	nt M							FR				FR		FR					
Lewin's Rail	vu L						FS		FS	FRBS	FRBS	FRBS	FRBS	F					
Little Bittern/ Black-backed Bittern	en L								F	RFB	RFB	F	F						
Little Black Cormorant		R	R	RB	RB								FR		F	FS	FS	FS	FS
Little Egret	en L	R	R	R	R				F			F			F				
Little Pied Cormorant		R	R	RB	RB								FR		F	FS	FS	FS	FS
Marsh Sandpiper	vu M											FR		FR	FR				
Masked Lapwing		F	F											FR	RS				
Musk Duck	vu															SR	SR	FSR	FSR
Nankeen Night Heron				R	R				F			F			F				
Pacific Black Duck			F						F				FR	R	FSR	FSR	FSR	FSR	FSR
Pied Cormorant	nt	R	R	R	R											FS	FS		
Pink-eared Duck									F				FR	R	FSR	FSR	FSR	FSR	FSR
Purple Swamphen										FRBS	FRBS	FRBS	FRBS					S	S
Red-capped Plover														FR					

SELECTION OF WATERBIRD SPECIES	STATUS	TERRESTRIAL INCL. PERCHES		MELALEUCA INCL. PERCHES		TALL REEDS		TRANSITIONAL ZONE		REEDS AND RUSHES		EMERGENT VEGETATION		SHALLOW WATER		FLOATING VEGETATION		OPEN WATER	
		POTENTIAL HABITAT USAGE UNDER LOW AND HIGH WATER LEVELS																	
		LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH
Red-kneed Dotterel														FR					
Red-necked Stint	M													FR					
Royal Spoonbill	nt	R	R						F			F			F				
Sharp-tailed Sandpiper	M											FR		FR					
Silver Gull														FR					
Spotless Crake							FS		FS	FRBS	FRBS	FRBS	FRBS	F					
Straw-necked Ibis		FR	FR																
Swamp Harrier		FRB	FR	FR	FR	FRB	FRB	F	F	F	F	F	F	F	F	F	F	F	F
Whiskered Tern	nt													FR		F	F	F	F
White-faced Heron		R	FR	R	R				F			F			F				
White-necked Heron		R	FR	R	R	A			F			F			F				
White-winged Black Tern	nt													FR		F	F	F	F
Yellow-billed Spoonbill		R	R						F			F			F				
TOTAL AREA		Not calculated		16.49 ha		26.13 ha		1.81 ha		10.50 ha		3.29 ha		3.97 ha		10.94 ha		29.00 ha	
PROJECT AREA		Not calculated		0.73 ha		6.34 ha		0.26 ha		0.47 ha		0.02 ha		0 ha		0.78 ha		0.80 ha	
ANTICIPATED LOSS		**Not calculated**		**0.38 ha**		**6.12 ha**		**0.21 ha**		**0.34 ha**		**0.02 ha**		**0 ha**		**0.45 ha**		**0.79 ha**	

Key to the table:

- **Victorian Advisory List** (DEPI 2013a): Shown as ex = extinct, rx = regionally extinct, ew = extinct in the wild, cr = critically endangered, en = Endangered, vu = Vulnerable, nt = Near Threatened, dd = Data Deficient
- **Victorian FFG Act:** Shown as D = Delisted as threatened, I = Rejected for listing as threatened; taxon invalid, L = Listed as threatened, N = Nominated for listing as threatened, X = Rejected for listing as threatened; taxon ineligible
- **Commonwealth EPBC Act:** Shown as EX = Extinct, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, M = Migratory
- **Habitat Usage:** F = Foraging; R = Roosting; B = Breeding; S = Shelter

4.5.2 FAUNA SPECIES RECORDED

A combined total of 210 vertebrate fauna species have been recorded at or adjacent to the project area from the following sources:

- WSP (waterbird survey – this study)
- WSP incidentals and surveys for the preliminary assessment (WSP 2017d).
- Biosis targeted survey and incidentals (Biosis 2013, 2015)
- Species counts at Waterways wetlands (Cook, D undated)
- Birdlife Australia surveys (Birdlife Australia 2017) - data clipped to 500 m buffer of the project area to approximate the study area of the other sources by excluding Edithvale wetland records from the results. This was to ensure that the birds recorded are relevant to the habitats at or near the project area (note: there are over 27,000 bird records in the Birdlife Australia database from within 500 m of the Project. These data have helped inform our likelihood of occurrence assessment)
- Aquatic survey completed for the preliminary assessment (McGuckin 2017).

This included 167 native birds, one vagrant bird, eight native frogs, five native mammals, and six native fish. A total of 41 species of conservation significance have been recorded, 13 of which are EPBC Act listed migratory bird species.

A total of 23 exotic fauna species have been recorded, including 12 birds, six mammals and five fish species. These included species such as the Red Fox *Vulpes vulpes*, European Rabbit *Oryctolagus cuniculus*, Brown Hare *Lepus capensis*, Gambusia *Gambusia holbrooki* and European Carp *Cyprinus carpio*.

The full species list, tabulated by source, is provided in Appendix C. VBA records were examined for the likelihood of occurrence assessment but not included in the table, as the low accuracy of many of the records can be misleading. VBA records within 5 km of the project area are provided as Supplementary Figures 1 and 2, Appendix A.

The results of the targeted surveys completed for this study are presented below.

OWL HABITAT ASSESSMENT AND SURVEY RESULTS

No threatened owls were recorded at or nearby the project area. Potential foraging and roosting habitat for owls including Powerful Owls was recorded at Braeside Park, however no suitable habitat was observed in the project area itself, and there is only one record of the species within 5 km of the project area. The study determined that the potential for the Project to impact any significant owl species is low. The results have been considered in the likelihood of occurrence assessment (Appendix D).

SONGMETER SURVEY RESULTS

No Growling Grass Frog calls were detected at Woodlands wetlands, and no threatened bird (Little Bittern, Australasian Bittern, Baillon's Crake, Lewin's Rail) calls were detected at Waterways wetlands. One call that could have been a Growling Grass Frog was recorded on 28/03/2017 at Waterways wetlands. However, this was outside of the breeding season for this species and a truck reversing horn was recorded at the same time. As such, the likelihood that this was a true Growling Grass Frog call is low. Subsequent sound recorders deployed during November 2017 (during the species' optimal survey season) did not record any calls that could be attributed to the species.

WATERBIRD SURVEY RESULTS

Bird surveys undertaken by the WSP ornithologist over November-March 2017-18 resulted in a total 4,123 individual birds recorded over the course of the surveys (refer Table 4.9). This included 14 significant species (i.e. species of conservation significance and listed migratory species) amounting to 199 individuals. These records are detailed in Table 4.10 and the full results will be provided as an appendix for the final version of this report. Of note is the observation of Little Bittern at Woodlands wetlands, which is likely to have bred at the wetlands in 2017. However, the most significant species were recorded at Braeside Park. This includes 59 Sharp-tailed Sandpiper (EPBC Act migratory), and three Curlew Sandpipers (EPBC Act critically endangered and migratory, FFG Act Listed, Advisory List

endangered), as well as other migratory birds were recorded at the shallow water habitat at Braeside. Threatened ducks including Blue-billed Ducks (FFG Act listed and Advisory list endangered), Australasian Shoveler (Advisory List vulnerable), and Hardheads (Advisory List vulnerable), were recorded in reasonable numbers, and one Musk Duck (Advisory List vulnerable) and one Freckled Duck (FFG Act listed and Advisory List endangered) were recorded.

These data have been reviewed and taken into consideration for the likelihood of occurrence assessment.

Table 4.9 Summary of targeted bird survey results

	NOV 2017		JAN 2018		MAR 2018	
Total Records	988		1330		1923	
	No. Sp	**Recordings**	**No. Sp**	**Recordings**	**No. Sp**	**Recordings**
Avifauna	62	981	67	1220	76	1922
Amphibians	2	5	4	97	0	0
Mammal	2	2	1	13	1	1
Significant Species	2	7	6	24	10	169

Table 4.10 Significant fauna species recorded during 2017-18 bird surveys

LOCATION NAME	COMMON NAME	SCIENTIFIC NAME	QUANTITY	DATE, TIME
January				
Waterways Wetlands Transect 1	Great Egret	*Ardea alba*	1	30/01/2018 2:15
Woodlands Wetlands Transect 3	Great Egret	*Ardea alba*	1	30/01/2018 3:52
Braeside Park Transect 4	Great Egret	*Ardea alba*	1	31/01/2018 7:10
Braeside Park Bird Hide	Great Egret	*Ardea alba*	1	31/01/2018 7:45
Woodlands Wetlands Transect 3	Great Egret	*Ardea alba*	1	31/01/2018 9:58
Waterways Wetlands Quadrat 1	Great Egret	*Ardea alba*	2	31/01/2018 11:59
Braeside Park Bird Hide	Hardhead	*Aythya australis*	2	30/01/2018 5:09
Braeside Park Bird Hide	Hardhead	*Aythya australis*	3	31/01/2018 7:34
Woodlands Wetlands Transect 3	Australian Little Bittern	*Ixobrychus dubius*	1	31/01/2018 9:07
Braeside Park Bird Hide	Blue-billed Duck	*Oxyura australis*	5	30/01/2018 5:01
Braeside Park Bird Hide	Blue-billed Duck	*Oxyura australis*	3	31/01/2018 7:34
Braeside Park Bird Hide	Freckled Duck	*Stictonetta naevosa*	1	31/01/2018 7:51
Braeside Park Transect 4	Pacific Gull	*Larus pacificus*	2	31/01/2018 6:57
November				
Braeside Park Transect 4	Blue-billed Duck	*Oxyura australis*	2	15/11/2017 10:29
Braeside Park Transect 4	Great Egret	*Ardea alba*	1	14/11/2017 2:50
Braeside Park Transect 4	Hardhead	*Aythya australis*	2	15/11/2017 10:35
Braeside Park Transect 4	Royal Spoonbill	*Platalea regia*	2	15/11/2017 10:58

LOCATION NAME	COMMON NAME	SCIENTIFIC NAME	QUANTITY	DATE, TIME
March				
Braeside Park Transect 4	Australasian Shoveler	*Anas rhynchotis*	9	14/03/2018 4:22
Braeside Park Transect 4	Blue-billed Duck	*Oxyura australis*	6	14/03/2018 4:12
Braeside Park Transect 4	Curlew Sandpiper	*Calidris ferruginea*	3	16/03/2018 5:05
Braeside Park Bird Hide	Great Egret	*Ardea alba*	1	14/03/2018 3:31
Braeside Park Transect 4	Great Egret	*Ardea alba*	1	14/03/2018 4:09
Waterways Wetlands Transect 2	Great Egret	*Ardea alba*	1	15/03/2018 3:26
Braeside Park Bird Hide	Great Egret	*Ardea alba*	1	15/03/2018 10:23
Braeside Park Transect 4	Hardhead	*Aythya australis*	28	14/03/2018 4:03
Braeside Park Transect 4	Hardhead	*Aythya australis*	6	14/03/2018 4:23
Braeside Park Transect 4	Hardhead	*Aythya australis*	25	14/03/2018 4:44
Waterways Wetlands Transect 1	Hardhead	*Aythya australis*	2	15/03/2018 2:56
Braeside Park Bird Hide	Hardhead	*Aythya australis*	2	15/03/2018 10:28
Braeside Park Transect 4	Musk Duck	*Biziura lobata*	1	14/03/2018 4:26
Braeside Park Transect 4	Red-necked Stint	*Calidris ruficollis*	1	16/03/2018 5:12
Braeside Park Transect 4	Royal Spoonbill	*Platalea regia*	12	14/03/2018 4:50
Waterways Wetlands Transect 2	Royal Spoonbill	*Platalea regia*	1	15/03/2018 3:41
Braeside Park Transect 4	Sharp-tailed Sandpiper	*Calidris acuminata*	59	16/03/2018 4:51

4.5.3 LIKELIHOOD AND HABITAT ASSESSMENT

The 102 fauna species of state and/or national significance, identified in the desktop assessment as potentially occurring within 5 km of the study area, are detailed in Appendix D Table 4.11. Of these species, 44 are considered to have a likelihood greater than 'low' of occurring within or nearby the project area on a permanent or intermittent basis. These species are detailed in Table 4.11. Note, as detailed in the Methodology, the likelihood of occurrence for fauna should be considered more of a 'likelihood of regular occurrence'. This provides a more meaningful indication of the value of the habitat to the species, particularly for migratory and nomadic bird fauna. Several migratory shorebirds are known to periodically occur in the shallow water and emergent vegetation habitats at Braeside Park wetlands and occasionally at Woodlands wetlands, when water levels are low. This habitat near the project area is part of the local area of habitat for these species when present in Australia over the summer months. Similarly, several nomadic bird species are known to periodically occur, and the regularity, time of year, and number of records indicate the potential value of the habitat present.

Species reliant solely upon pelagic/oceanic habitat were excluded from the likelihood of occurrence assessment; this includes pelagic birds, whales, sharks and marine turtles.

Table 4.11 Fauna with a likelihood of occurrence greater than 'low'

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
BIRDS								
Australasian Bittern	*Botaurus poiciloptilus*	Endangered	Listed	Endangered	175	45 records, over 19 years. Recorded at Woodlands wetlands and Braeside wetlands. No breeding was observed. Where counts were recorded, results were typically 1 but did reach as high as 3 on three occasions.	**High**	Well-vegetated freshwater wetlands, particularly those with shallow water areas and dense emergent vegetation and reedbeds. Movement can occur through dense low vegetation surrounding wetlands. Habitat occurs at Braeside wetlands, Woodlands wetlands and, to a lesser extent, Waterways wetlands, as well as well-vegetated drainage lines in the area. Australasian Bittern has not been recorded/observed breeding in the area however is known to be a regular winter visitor in low numbers.
Australasian Shoveler	*Anas rhynchotis*			Vulnerable	400	Over 150 recordings, most of which occurred at Braeside Park. No breeding has been recorded. Where counts were recorded, they typically ranged between 1 and 20 although higher counts between 30-40 were also recorded (the highest being 81 in 1994).	**High**	Permanent, densely vegetated wetlands with deep, open areas for foraging, and areas of reed beds or other emergent vegetation for shelter and nesting. Foraging habitat occurs at Braeside Park, Woodlands and Waterways and species was recorded during surveys.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Australian Little Bittern	*Ixobrychus dubius*		Listed	Endangered	28	Only 4 entries for this species, all from Woodlands Estate Wetlands/Woodlands Industrial Estate. One entry was from December 2007, another from January 2014 and the last two from the same day in June 2014. Breeding was not observed.	**Moderate-high**	Cryptic species utilising freshwater wetlands with dense emergent and fringing vegetation, particularly reedbeds. Potential wetland habitat in the study area occurs in Braeside Park wetlands, Woodlands wetlands and Waterways wetlands and the species was recorded at Woodlands wetlands during surveys. Species considered likely to breed at Woodlands wetlands, based on timing of records and observations of breeding plumage.
Australian Painted Snipe	*Rostratula australis*	Endangered	Listed	Critically endangered	6	2 entries, both at Braeside. One was recorded in November 1986 and the other in February 1994. No breeding has been observed.	**Low-moderate**	Habitat consists primarily of ephemeral freshwater wetlands, particularly following flooding events, that support areas of exposed mud, shallow water and low vegetation. Within the study area, potential habitat is largely limited to Braeside Park wetlands. The species is not regularly recorded and habitat is unlikely to generally be of high value, however it may become more valuable when inland Australia is in drought.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Baillon's Crake	*Porzana pusilla palustris*		Listed	Vulnerable	86	15 entries in total over 19 years recorded at Mordialloc Creek, Woodlands and Braeside Park. No breeding was recorded and where counts were recorded, numbers ranged between 1-3.	**High**	Freshwater wetlands supporting some dense fringing and emergent vegetation cover. Suitable habitat exists within Braeside Park wetlands, Woodlands wetlands and Waterways wetlands.
Black Falcon	*Falco subniger*			Vulnerable	4	Only two entries, both from the same day in May 2014 at Woodlands Industrial Estate. No breeding was observed.	**Moderate**	Foraging habitat of relatively low value occurs within the project area, mainly consisting of treed areas near water courses and wetlands.
Blue-billed Duck	*Oxyura australis*		Listed	Endangered	390	Breeding observed on two separate occasions, both at Braeside Park in January 2014. Most of the 177 records were from Braeside Park. Where counts were recorded, they were typically small (15 and under) but reached as high as 25 and 26 (Braeside Park, 2014 and 1994 respectively).	**High**	Highly aquatic duck utilising deep freshwater wetlands with submerged vegetation to forage in, particularly those with dense fringing and emergent vegetation for roosting and nesting. Suitable habitat occurs at Braeside Park, Woodlands and Waterways. Species has been recorded breeding at Braeside Park wetlands.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Caspian Tern	*Hydroprogne caspia*		Listed	Near threatened	47	10 records, 9 of which came from Mordialloc Creek, the other from Woodlands Estate Wetlands. Recordings were captured over 5 consecutive years (2007-2011). Recorded counts were between 1-2 and there was no observation of breeding.	**High**	Typically recorded in sheltered coastal waters and large inland waterbodies, including temporary and flooded wetlands. May forage periodically to regularly in large wetlands in Braeside Park, Woodlands and Waterways.
Common Greenshank	*Tringa nebularia*	Migratory		Vulnerable	78	4 entries recorded for this species. Two were from Braeside in 1999, one from Braeside in 2000 and the last from Waterways in 2002. No breeding was observed on any occasion.	**Moderate**	Preferred habitat of shallow fresh to brackish wetlands and mudflats is largely limited in the study area to wetlands in the south of Braeside Park.
Common Sandpiper	*Actitis hypoleucos*			Vulnerable	57	1 entry recorded at Braeside Park in 2006.	**Low - Moderate**	Occurs in fresh to saline wetlands, typically supporting mudflats, rocky shores and/or areas of shallow water. The project area itself is unlikely to support important habitat for this species. Potential foraging habitat occurs nearby at Braeside Park; however, the species appears to utilise this habitat infrequently.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Curlew Sandpiper	*Calidris ferruginea*	Critically endangered, Migratory	Listed	Endangered	71	4 records only. Three of the records came from Braeside park in January 1995 (three separate days of surveys) and the last was recorded in Woodlands wetlands in November 2004. Counts were recorded they ranged between 3-8.	**Moderate**	Shallow fresh to saline wetlands, typically supporting mudflats and low emergent or fringing vegetation. The project area itself is unlikely to support important habitat for this species, however, foraging habitat occurs nearby at Braeside Park wetlands and Woodlands wetlands. The species was recorded at Braeside Park wetlands during targeted surveys completed for this study.
Diamond Dove	*Geopelia cuneata*		Listed	Near threatened	3	N/A	**Low-moderate**	Typically occurs in arid and semi-arid grassland and grassy woodland areas, generally near water. The study area may provide some foraging habitat at Braeside and potentially Woodlands, however, these areas only appear to be visited rarely.
Eastern Great Egret	*Ardea modesta*		Listed	Vulnerable	206	Just over 250 records over 25 years (half of which came from Braeside Park). Recorded counts were no higher than 8 and no breeding was observed.	**High**	A variety of wetlands, typically favouring areas of shallow, fresh water, flowing or still, including flooded grasslands. Roosting often occurs in trees, including paperbarks, surrounding wetlands. Potentially suitable habitat includes small wetlands and flooded grasslands within the project area, and adjacent wetlands at Braeside Park, Woodlands and Waterways.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Fork-tailed Swift	*Apus pacificus*	Migratory				1 record from Mordialloc creek in 2008.	**Moderate**	A predominantly aerial species which feeds on the wing, occurs across many different habitat types and is considered secure. The project area is highly unlikely to support important habitat for this species.
Freckled Duck	*Stictonetta naevosa*		Listed	Endangered	19	44 records of this species, most of which came from Woodlands Industrial Estate/Woodlands Estate Wetlands. No breeding was recorded. Where counts were recorded, numbers varied greatly ranging from 1-85.	**High**	Suitable habitat, of freshwater wetlands with shallow areas and generally some dense fringing and emergent vegetation, occurs in Braeside Park, Woodlands and Waterways.
Glossy Ibis	*Plegadis falcinellus*	Migratory		Near threatened	49	2 records of this species, both at Braeside. One was in March 1999 and the second in November 2006.	**High**	Habitat consists of shallow freshwater wetlands, particularly where there are trees for roosting surrounding the wetland. Such wetland habitat occurs in Braeside Park, Woodlands and Waterways.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Hardhead	*Aythya australis*			Vulnerable	362	Breeding recorded on one occasion at Braeside park in 2010. Recorded counts were typically below 30 except for one instance in 2015 at Woodlands where 770 counts of the species were recorded.	**High**	Permanent, densely vegetated wetlands with deep, open areas for foraging, and areas of reed beds or other emergent vegetation for shelter and nesting. Habitat occurs at Braeside Park, Woodlands and Waterways and species was recorded during surveys. Braeside Park wetlands are known to have supported breeding of this species in low numbers. Species is considered less likely to breed at the Waterways wetlands or at Woodlands wetlands.
Intermediate Egret	*Ardea intermedia*		Listed	Endangered	15	12 records, most from Braeside Park. Records for this species start in 1990 with the most recent record being from 2014. No breeding was observed and where counts were recorded, they were consistently low (1-4) except for one count of 14 in 2009.	**Moderate**	A variety of freshwater wetlands, typically favouring areas with dense aquatic vegetation. Roosting often occurs in trees within or fringing wetlands. Habitat locally includes wetlands at Braeside Park, Woodlands and Waterways.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Latham's Snipe	*Gallinago hardwickii*	Migratory		Near threatened	259	Over 70 recorded entries. Almost half of the entries were observed at Braeside Park while Woodlands and Mordialloc Creek made up the rest. No breeding was observed and recorded counts ranged between 1-8.	**High**	Typically recorded in well-vegetated waterbodies or wet areas, including flooded grasslands and marshes. Suitable habitat occurs in and around waterbodies and low-lying areas at Braeside Park, Woodlands and Waterways. Vegetated drainage lines and associated riparian areas may also support suitable habitat, including Dingley Drain (e.g. within Braeside Park) and Mordialloc Creek.
Lewin's Rail	*Lewinia pectoralis pectoralis*		Listed	Vulnerable	7	N/A	**Moderate**	Cryptic species utilising dense vegetation surrounding coastal and inland wetlands, foraging in shallow water and bare mud/exposed ground. Potentially suitable wetland habitat occurs at Braeside Park, as well as Woodlands and Waterways.
Little Egret	*Egretta garzetta nigripes*		Listed	Endangered	16	11 records, across Braeside Park, Woodlands and Mordialloc Creek. No breeding was observed and where counts were recorded, they were consistently low (always less than 10).	**Moderate**	Potential habitat for this species consists primarily of areas of shallow water and emergent vegetation around the margins of wetlands at Braeside Park, Woodlands and Waterways, as well as watercourses. The species may also roost in trees and Swamp Paperbark surrounding these areas.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			COUNT OF SIGHTINGS (5 KM VBA)	SUMMARY OF BIRDLIFE RECORDS WITHIN 500 M OF PROJECT AREA	LIKELIHOOD OF OCCURRENCE	HABITAT WITHIN OR NEARBY THE PROJECT AREA
		EPBC ACT	FFG	ADVISORY LIST				
Long-toed Stint	*Calidris subminuta*	Migratory		Near threatened	4	N/A	**Low-Moderate**	Freshwater to brackish wetlands, particularly shallow water areas with mudflats and/or some low vegetation. The very low number of records indicate that the locality is unlikely to support important habitat for this species, however the species may visit shallow water habitat at Braeside Park wetlands and Woodlands wetlands in appropriate conditions.
Magpie Goose	*Anseranas semipalmata*		Listed	Near threatened	149	94 records with about two thirds coming from Braeside Park and the other third of records coming from Woodlands and Mordialloc Creek. No breeding was observed at any of the sites. Where counts were recorded, numbers ranged from 1-2.	**Moderate**	Foraging habitat typically comprises vegetated wetlands and margins, as well as wet or flooded grasslands. Habitat occurs within and adjacent the project area, and includes wet grasslands and an area of wetland around the proposed bridge at Waterways, as well as Braeside Park wetlands and Woodlands wetlands.
Marsh Sandpiper	*Tringa stagnatilis*	Migratory		Vulnerable	46	6 records, all from Braeside, between 1994 and 2012. No breeding was observed.	**Moderate**	Preferred habitat of shallow fresh to brackish wetlands and tidal flats is largely limited in the study area to wetlands in the south of Braeside Park.

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		EPBC ACT	FFG	ADVISORY LIST				
Musk Duck	*Biziura lobata*			Vulnerable	265	37 records, most from Woodlands Estate Wetlands/Woodlands Industrial Estate and Braeside. Most of the recorded counts were 1 except for two occasions where a count of 2 was recorded. No breeding was observed.	**High**	Permanent wetlands with open areas and floating vegetation, generally with areas of reed beds or other emergent vegetation for shelter and nesting. Habitat occurs at Braeside Park, Woodlands and Waterways, and species was recorded during surveys.
Nankeen Night Heron	*Nycticorax caledonicus hillii*			Near threatened	44	N/A	**High**	Forages in shallow freshwater to brackish wetlands and wet grassy areas, and roosts in nearby leafy trees. Potentially suitable wetland habitat at Braeside Park, Woodlands and Waterways.

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Pacific Gull	*Larus pacificus pacificus*			Near threatened	158	Records for this species have been collected over 24 years. Most entries were recorded at Kingston Road, Heatherton. No breeding was observed. Where counts were recorded this species typically had low counts except for one entry in 2011 at Kingston Road (71) and another in 2012 at the same location (300).	**Moderate**	Primarily recorded on sheltered sandy shores, ocean beaches and rocky shores in coastal areas, foraging mainly on shellfish and crabs; sometimes roosts around near-coastal wetlands. May periodically roost in wetlands in Braeside Park, Woodlands or Waterways.
Pectoral Sandpiper	*Calidris melanotos*	Migratory		Near threatened	34	1 entry of this species recorded in 2013 at Braeside wetlands.	**Moderate**	Shallow fresh to saline wetlands, generally with mudflats and low emergent or fringing vegetation. The project area itself is unlikely to support important habitat for this species, however, foraging habitat occurs nearby at Braeside wetlands and Woodlands wetlands.
Pied Cormorant	*Phalacro-corax varius*			Near threatened	113	N/A	**High**	Uses a variety of large, deep marine and freshwater wetlands, with roosting occurring in trees and bushes in or around water. Foraging habitat and some roosting habitat in Braeside Park, Woodlands and Waterways.

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		EPBC ACT	FFG	ADVISORY LIST				
Red-necked Stint	*Calidris ruficollis*	Migratory			98	5 entries recorded at Woodlands wetlands and Braeside wetlands. Earliest record was from 1994 and the most recent was in 2005. Recorded counts were 1 or 2.	**Moderate**	Freshwater to brackish wetlands, particularly shallow water areas and mudflats. The project area itself is unlikely to support important habitat for this species, however, foraging habitat occurs nearby at Braeside wetlands and Woodlands wetlands.
Royal Spoonbill	*Platalea regia*			Near threatened	227	Over 150 entries recorded over 26 years, most from Mordialloc Creek and Braeside Park. No breeding was observed and where counts were recorded they ranged from 1-11.	**High**	Utilises fresh to brackish wetlands, particularly large, permanent wetlands with areas of shallow water; this habitat occurs in Braeside Park, Woodlands and Waterways.
Ruff	*Philomachus pugnax*	Migratory				N/A	**Low - moderate**	Suitable habitat consists of freshwater wetlands with shallow areas, including mudflats, as well as flooded grasslands. While some potential habitat occurs in Braeside Park and low-lying parts of the alignment, the species is a rare visitor to the area.
Rufous Fantail	*Rhipidura rufifrons*	Migratory				1 entry recorded at Braeside Park in March 2011.	**Low - moderate**	Typical habitat consists of moist forest with a shaded understorey, and riparian areas in drier woodlands. Potential habitat within the area would be limited to Braeside Park.

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		EPBC ACT	FFG	ADVISORY LIST				
Sharp-tailed Sandpiper	*Calidris acuminata*	Migratory			197 (under-reported)	Most records are from Braeside Park. Recorded counts varied considerably from 1-277. In 2004 the count was 3,105 for a single day of surveying at Woodlands wetlands.	**High**	Shallow fresh to saline wetlands, typically supporting mudflats and low emergent or fringing vegetation. The project area itself is unlikely to support habitat for this species, however, foraging habitat occurs nearby at Braeside Park wetlands and Woodlands wetlands.
Spotted Harrier	*Circus assimilis*			Near threatened	5	11 records of this species in relatively recent years (2001, 2013, 2014 and 2015). No breeding was observed.	**Moderate**	Habitat for this species locally largely consists of grasslands within and adjacent to the alignment and open woodlands at Braeside Park and Woodlands.
Whiskered Tern	*Chlidonias hybridus javanicus*			Near threatened	162	43 entries of this species recorded over 20 years. Recordings came from a good mix across all sites (Mordialloc Creek, Woodlands wetlands and Braeside Park wetlands). No breeding was observed and recorded counts were typically under 7 except for one entry in 2004 which recorded a count of 28.	**High**	Habitat for this species consists of fresh to brackish wetlands and swampy areas, where they forage for a variety of invertebrate and small vertebrate aquatic prey. Foraging habitat occurs largely outside of the project area, except for the area around the proposed bridge at Waterways.

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		EPBC ACT	FFG	ADVISORY LIST				
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		Listed	Vulnerable	8	6 recorded entries of this species, observed at Braeside Park and Woodlands Industrial Estate. No breeding was observed.	**Moderate**	Forages over wide areas in coastal and in-shore habitats, including lowland reaches of rivers and large inland wetlands. The study area is likely to provide some foraging habitat, although breeding in the area is unlikely.
White-throated Needletail	*Hirundapus caudacutus*	Migratory	Listed	Vulnerable	28	N/A	**Moderate**	An aerial species occurring over many different habitat types, rarely directly utilising vegetation. Likely to forage above the study area regularly, but not be directly reliant upon vegetation.
White-winged Black Tern	*Chlidonias leucopterus*			Near threatened	22	N/A	**Moderate**	Foraging habitat consists of wetlands and swampy areas surrounding the project area; the project area itself is unlikely to support important habitat for this species.
Wood Sandpiper	*Tringa glareola*	Migratory		Vulnerable	52	7 entries, all recorded at Braeside in 1993, 1994, 1995, 1999 and 2014. No breeding was observed and all recorded counts ranged between 1-3.	**Moderate**	Potential habitat of shallow freshwater wetlands with some emergent and fringing vegetation occurs in Braeside Park and Woodlands, and potentially Waterways.

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MAMMALS								
Grey-headed Flying-fox	*Pteropus poliocephalus*	Vulnerable	Listed	Vulnerable	13	N/A	**Moderate**	Limited foraging habitat (i.e. eucalypts and related genera) occurs within the road alignment. The species is unlikely to roost or regularly forage within the study area itself, although potential habitat occurs at adjacent Braeside and Woodlands.
REPTILES								
Eastern Snake-necked Turtle	*Chelodina longicollis*			Data deficient	9	N/A	**High**	Suitable wetland habitat exists in at Woodlands, Braeside Park and Waterways; periodic movements are likely between these wetlands and into surrounding areas. Species also likely to occur in/move through larger waterways, such as Dingley Drain and Old Dandenong Drain in the north of the study area.
Glossy Grass Skink	*Pseudemoia rawlinsoni*			Vulnerable		N/A	**Moderate**	Potentially suitable swampy and wet margins habitat in the south of Braeside Park, and at Waterways Estate where it has previously been recorded.

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AMPHIBIANS								
Southern Toadlet	*Pseudophryne semimar-morata*			Vulnerable	2	N/A	**Moderate**	Potentially suitable habitat in Braeside Park, most notably in heathy vegetation in the northeast, and in and around Dingley Drain and scattered ephemeral wetlands and depressions.

Several significant fauna species are known to have once occurred within or adjacent to the project area, however are now considered unlikely to occur. These are detailed in Table 4.12 below.

Table 4.12 Fauna species which previously occurred within or nearby the project area

SPECIES	CONSERVATION STATUS	HABITAT	ASSESSMENT OF LIKELIHOOD
Eastern Dwarf Galaxias *Galaxiella pusilla*	Vulnerable (EPBC Act) Listed (FFG Act) Endangered (Advisory list)	Slow flowing and still, shallow, permanent and temporary freshwater habitats such as swamps, drains and the backwaters of streams and creeks, often (but not always) containing dense aquatic macrophytes and emergent plants.	Potential habitat occurs within Mordialloc Creek and associated wetlands. Targeted surveys undertaken by Biosis (Biosis 2015) failed to detect this species. In addition to this study, Streamline Research has undertaken extensive sampling for Melbourne Water throughout the length of the Mordialloc Bypass over the past decade without detecting the species. A study undertaken during the current assessment (McGuckin 2017) determined that the species is unlikely to occur. In a large flood event, there is the slight possibility that the species could be flushed into the Mordialloc Creek. However, the high degree of modification (including presence of exotic fish species), and the lack of connectivity with high quality known habitat means that it is unlikely that the Mordialloc Creek could support an ongoing population of the species. **Low likelihood of occurrence** **No further assessment required**
Growling Grass Frog *Litoria raniformis*	Vulnerable (EPBC Act) Listed (FFG Act) Endangered (Advisory list)	Still or slow moving water such as lagoons, swamps, lakes and ponds, with emergent vegetation included reeds, rushes and sedges. Also known to occur in artificial waterbodies such as farm dams, irrigation channels and disused quarries.	A translocated population of the species was introduced to the Waterways Estate in January 2002, and have since been regularly monitored, however there have been no records of the species in that location or elsewhere in the locality since 2006. Surveys were completed in 2012-2013 (Biosis 2013), and 2014-2015 (Biosis 2015). Areas surveyed included Waterways Estate, Melbourne Water wetlands to the north of Waterways, and wetlands within Braeside Park. Songmeter surveys conducted for this study did not detect any definite Growling Grass Frog calls. The species is considered unlikely to currently occur within the project area or vicinity. **Low likelihood of occurrence** **No further assessment required**

SPECIES	CONSERVATION STATUS	HABITAT	ASSESSMENT OF LIKELIHOOD
Southern Brown Bandicoot *Isoodon obesulus obesulus*	Endangered (EPBC Act) Listed (FFG Act) Near threatened (Advisory list)	Inhabit a variety of habitats including heathland, shrubland, sedgeland, heathy open forest and woodland and are usually associated with infertile, sandy and well drained soils, but can be found in a range of soil types. Within these vegetation communities they typically inhabit areas of dense ground cover.	The species was known to occur in the Braeside area but is now considered locally extinct, with no recent records of the species in the locality. The closest known extant population is in Cranbourne. **Low likelihood of occurrence** **No further assessment required.**

4.5.4 CONNECTIVITY AND FAUNA MOVEMENT

The present-day suburbs of Mordialloc through to Frankston once comprised a large wetland area known as Carrum Carrum Swamp, covering approximately 5,260 hectares (Victorian Places, 2015). The swamp was drained in 1879, creating agricultural land, and few remnants now remain. The estimated pre-draining swamp extent is shown on Figure 4.1. One such remnant is the Wetland of International Importance, Edithvale-Seaford Wetlands. Braeside Park, Woodlands Industrial Estate, and the Waterways also all occur partly within or nearby the historic extent of Carrum Carrum Swamp (although all are created wetlands).

The Waterways, the Woodlands Industrial Estate wetland, and Braeside Park form almost continuous habitat for migratory and wetland bird species. These wetlands are also within easy flying distance from the Edithvale-Seaford Wetlands, with the Edithvale component of this wetland approximately 1 km from the Waterways Estate wetland and the Seaford component approximately 9 km away. Most migratory or nomadic waterbird species are likely to move freely between all wetlands in the area depending on the local conditions. The grassland area between Woodlands Industrial Estate and the southern part of Braeside Park is likely to be utilised for the movement of fauna between the two areas, including woodland and wetland birds, as well as reptiles such as turtles.

Present connectivity and likely/known habitat use by fauna is discussed in the following sections. It is important to understand how fauna are likely to be moving across the project area, to assess the impacts of the Project upon individual species, and to design effective mitigation. Characterisation of movement of significant fauna was identified in the EES Scoping Requirements. This section focuses native species, although many exotic fauna species, including cats, foxes, starlings, and Indian Mynas, occur in the area.

4.5.4.1 AVIFAUNA

This section provides a summary of the results of bird surveys completed in November 2017, February 2018 and March 2018 as they relate to bird movement within and across the project area. The data and observations summarised below were used to inform our assessment of impacts upon bird species and bird movement, and helped in the determination of mitigation recommendations for the Project.

Take-off patterns for wetland birds vary for different wetland bird species. Those species that require relatively long periods of low flight before having sufficient speed to gain elevation, such as swans and cormorants, are largely unable to take off from a low position in a direction toward close high barriers such as emergent wetland vegetation stands and high terrestrial vegetation barriers. This makes them more likely to select open areas in which to approach and leave wetland habitats. Other species, such as ducks, egrets, ibis, spoonbill, and wader bird species can take off almost

vertically over surrounding barriers if needed. In both cases the barriers force birds to gain elevation if they need to fly over them. Those species that use flight less regularly, such as crakes and rails, generally walk or fly low at ground level to move between habitat areas when they are relatively close to each other.

BIRD MOVEMENT AND FLIGHT PATTERNS

WOODLANDS WETLANDS AND BRAESIDE PARK WETLANDS CORRIDOR

The Woodlands-Braeside corridor is the broad grassy corridor separating the two areas of wetland habitats. The two wetland areas are linked by ephemeral depressions that would hold water during wet periods, and the Dingley Drain, which is colonised by wetland plants and rank grasses. Both wetlands are separated from the project corridor by tree plantings which form a variable 3 m to 6 m barrier between the open corridor and both wetlands. There are open edges along the southern extent of the Braeside Park wetlands that allow a low take-off angle for higher flying waterbirds, but they largely require a more southern path to avoid tall vegetation along the western wetland boundary.

Wetland birds

Wetland birds noted crossing during surveys included Little Pied Cormorant, Pacific Black Duck and Royal Spoonbill. Little Pied Cormorant were the most frequent corridor crossing species, due to the presence of at least fifteen (15) active nests at the Braeside Reserve wetland, which were visible from the Braeside Bird Hide. Cormorants were observed to fly across the corridor in both an east or west direction between the breeding area in front of the Braeside Bird Hide and the large Lakewood Boulevarde Pond. The cormorants less frequently visited the two north and south Woodlands wetlands adjacent to the project corridor. The birds were recorded as flying at varying elevations between 3 m and 25 m. Although cormorants are usually relatively high flying species, they sometimes flew at low elevations under windy conditions to avoid the strongest wind speeds higher up, as did many other species. Pacific Black Ducks were observed to do the same, although their lower altitude flight paths extended down to almost grass-top height when the birds were flying into the wind. As prevailing wind conditions are more often from the west, birds flew lower when crossing from Braeside Park to Woodlands Industrial Estate. A single flight noted for a pair of Royal Spoonbills was toward the east away from the corridor from Braeside at elevations between 8 m and 12 m. Spoonbills, like ibis, herons and egrets can quickly gain height from a standing start before adopting a travelling-mode flight pattern.

Other waterbirds that are generally more terrestrial in habit and movement, such as rails and crakes, are more likely to walk between the wetlands via low areas in the corridor, through grassland under cover of darkness, or along through the Dingley Drain. These species generally fly as a last resort to avoid danger so would likely walk across the corridor or fly low across open spaces when they feel threatened.

Terrestrial birds

Other bird species noted as flying across the corridor between Woodlands and Braeside Reserve were varied, from larger open country passerines, such as ravens and magpies to small birds of cover, such as Red-browed Finches. In comparison to many of the wetland species that generally fly long distances between suitable habitat, many of the non-wetland dependent terrestrial bird species are resident at the locations and exhibit average flight paths that are generally lower in elevation. Many smaller species keep low for the added cover the ground affords, but many larger species also flew excessively low to avoid competition with the wind as did the wetland birds. Lorikeets, which usually fly high between locations often flew down to 3 m into wind across the corridor.

Several small grassland bird species, including Golden-headed Cisticolas and Australian Pipit, use the grassland habitats of the corridor for foraging and breeding purposes. Their flight patterns consist of generally low movement between vegetation with high nuptial flights during courtship.

WATERWAYS WETLANDS

The Waterways wetland areas were divided into two separate sections; the area north of Bowen Parkway, which exhibits a broad grassy corridor between wetland areas, and a mosaic of wetland ponds that occur to the south of Bowen Parkway. In the north, the east and west wetland areas are linked by a shallow channel colonised by wetland plants with water

levels maintained by water levels in the wetlands it links. The northern corridor section varies in elevation, with an elevated mound along the eastern corridor edge and ephemeral depressions across the grassy habitats.

In the south, the mosaic of wetlands are separated by relatively narrow corridors of grassy habitats with stands of shrubby vegetation plantings. The most southerly pond represents a section of Mordialloc Creek with culverts maintaining continuity of creek water column exchange.

Wetland birds

The Waterways Wetlands' corridor exhibited a lower number of bird crossings over the same survey time-period than did the Braeside to Woodlands wetlands corridor to the north. A single wetland bird species, the Little Black Cormorant was observed crossing the northern corridor section from a west to east direction at an elevation of 25 m. Stands of taller emergent and planted vegetation on the margins of the wetlands to the north of Bowen Parkway were patchy on the western wetland boundary, but almost complete in the east due to a planted row of trees. North of Bowen Parkway, waterbirds that are generally more terrestrial in habit and movement, such as rails and crakes, are likely to walk between the wetlands via the wetland channel.

Terrestrial birds

Terrestrial birds crossing the corridor were less diverse than those at the Woodlands-Braeside corridor to the north. The highest-flying species were Rainbow Lorikeets and Australian Magpies, which were observed flying at 40 m and 25 m respectively. Swamp Harrier and New Holland Honeyeater were the lowest flying species at 1-5-6 m and 2-8 m respectively. Little Ravens, Australian Magpies, and Straw-necked Ibis were observed foraging across the corridor as well as two introduced species, Eurasian Skylark and Common Myna.

4.5.4.2 TERRESTRIAL NON-AVIFAUNA

A range of terrestrial (i.e. non-avian) vertebrate fauna species occur in and surrounding the project area, including both native and exotic species.

Native terrestrial fauna that occur, or are likely to occur, in and adjacent to the project area include the following:

- Arboreal mammals, including the Common Ringtail Possum, Common Brushtail Possum and Sugar Glider, and small ground-dwelling mammals including the Swamp Rat, Water Rat, and Echidna
- A range of common native frogs
- Reptiles, including snakes, small scincids and the Eastern Long-necked Turtle.

GENERAL FAUNA MOVEMENT PATTERNS

Movement patterns throughout the project area will vary substantially based on the taxa involved and the location. Typically, movement of smaller mammals and herpetofauna between habitat patches will be limited to those areas that are relatively well connected by vegetation cover, waterbodies or drainage lines. Arboreal mammals, particularly Common Ringtail Possums and Common Brushtail Possums, are likely widespread throughout the project area, and will move more readily and further through highly urbanised areas. The home ranges of individuals of these possum species may also occur wholly or partly within urban areas, unlike most other native fauna species.

The existing level of connectivity and potential movement through the key areas of Woodlands wetlands, Braeside Park and Waterways is discussed briefly below. Other notable areas that native fauna may regularly utilise or move through include drainage lines in the north of the alignment, particularly Old Dandenong Road Drain, and grassy and treed vegetation within the road alignment itself (i.e. movements to the north or south within the corridor).

WOODLANDS INDUSTRIAL ESTATE AND BRAESIDE PARK CORRIDOR

The project area between the Woodlands wetlands and Braeside Park largely comprises exotic grassland vegetation, with some scattered remnant patches of native vegetation, and the Dingley drainage line. This vegetation is likely to be periodically to regularly utilised by a range of native terrestrial fauna, primarily relatively common (i.e. non-listed) species.

Arboreal mammals such as possums and Sugar Gliders are likely to make occasional movements into and across the project area as they forage and during dispersal. These movements would be most frequent where the distance between treed habitat is smallest, such as in the north near the Ranger's Station. Larger reptiles, such as snakes, large skinks and the Eastern Long-necked Turtle, considered 'data-deficient' in Victoria, would be likely to move from wetland and woodland habitat from one side to the other. These movements would be more frequent for snakes and turtles—the latter of which are known to make substantial overland movements—and may include dispersal to new habitat as well as more regular foraging trips. For scincids and other small reptiles, given the small spatial scale at which they operate, movements across the alignment would likely largely be restricted to the periodic dispersal of individuals. A range of frog species are likely to make occasional movements, both foraging and dispersal, into the project area, from wetland habitat on either side. The distance between the nearest wetlands on either side of the alignment is approximately 200 m; recent data suggests that most frog species occurring in the region are able to make semi-regular or occasional movements beyond this distance, and up to 1 km or more over land (Ecology Australia 2017). Such periodic movements are likely to be important in maintaining the occupancy of wetland habitat over time, as many frog species appear to operate under a 'metapopulation' paradigm, where 'populations' at a wetland go extinct and are then recolonised from surrounding wetlands, in response to fluctuating wetland conditions (*sensu* (Heard, Scroggie & Malone 2012)).

Movements across the alignment to the north of the Woodlands wetlands (i.e. from Braeside Park) are likely to be much less frequent for terrestrial fauna, given the highly urbanised nature of the industrial land to the west.

WATERWAYS ESTATE CORRIDOR

The project area within Waterways primarily comprises grassland and low, swampy vegetation; approximately half of this vegetation has been assessed as remnant patches of native vegetation. The area includes a relatively large drainage line connecting wetlands on the east and west of the alignment. The vegetation in the project area at Waterways is likely to be periodically to regularly utilised by a range of relatively common (i.e. non-listed) terrestrial fauna species, for both foraging and/or dispersal movements.

Movement of most terrestrial fauna groups through the project area at the Waterways is likely to be similar to that between Braeside Park and Woodlands wetlands, as outlined above. Given the expansive areas of wetland habitat on either side of the alignment and their relative proximity, movement by terrestrial species associated with aquatic habitats is likely to be somewhat more frequent than at Braeside Park/Woodlands wetlands.

Currently there appears to be limited opportunities for terrestrial fauna to cross between Waterways and Braeside Park to the north; such movements would likely require a direct crossing of Governor Road.

4.6 EXISTING THREATS

The project area is heavily modified and there are numerous existing threats to ecological values. Existing threats to the ecological values within and nearby the project area are detailed in the assessment of threatening processes, in Section 6.7.

5 RISK ASSESSMENT

5.1 KEY FINDINGS – PROJECT RISKS

Impacts to Biodiversity have been assessed via 31 “Biodiversity and Habitat” risks, and five “Wetlands and Waterways” risks (note: there is considerable overlap between these risk categories).

The Biodiversity risks are provided in Table 5.1. The initial risk ratings presented below consider standard inherent controls as listed in the Environmental Risk Assessment Report. The additional controls listed in the tables below are those recommended to further mitigate and minimise the primary environmental risks which were risk rated as medium or above. Primary environmental risks which were scored as low did not require additional controls to be applied.

It should be noted that, in the risk assessment process, the likelihood rating is provided for the most relevant consequence applied to the risk. It is generally preferred that, when additional controls are applied, the consequence remains the same but the likelihood is reduced (if applicable). For this reason, for a risk such as removal of large trees (R-BH5), although large trees will be removed for the Project, the likelihood of the consequence level is reduced through mitigation such that the residual likelihood is ‘likely’, not ‘certain’. The consequence level selected for this risk is ‘moderate’. Up to 24 large trees are currently proposed to be removed (a low number for a large road project), however they are in an area where there are few large trees remaining. The consequence guide (refer Section 3.5.2) was developed to consider these site-specific factors. moderate.

Also included in the table below are any identified on-site project related cumulative risks, including: secondary risks (resulting from the implementation of a risk response in mitigating a primary environmental risk) and on-site aggregate cumulative risks (the aggregate/combined primary environmental risks resulting from diverse project activities having an impact on the same environmental asset.

The highest residual risks (i.e. medium and above) relate to:

- Clearing of EVCs (unavoidable)
- Clearing of threatened communities (unavoidable although extent is minor)
- Direct loss of some habitat likely to be occasionally utilised by threatened species (unavoidable)
- Fragmentation of habitat (mitigation measures cannot completely ameliorate this risk)
- Mortality of protected and significant fauna (mitigation measures cannot completely ameliorate this risk)
- Traffic noise (uncertainty regarding the level of impact the Project may have, even with mitigation, upon the significant bird species).

Residual risks to Edithvale wetland are low.

A detailed impact assessment, providing information on the predicted types and magnitudes of the impacts assessed in the risk assessment, is provided in Section 6.

Table 5.1 Biodiversity and habitat environmental risk assessment register

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH1	Clearing impacts significant vegetation or ecological communities	Clearing results in loss of EVCs		Major	Almost Certain	Extreme	Refinement of design / impact footprint to further reduce vegetation to be removed and add to No-go Zones. Incentives to contractors to further minimise vegetation loss. Revegetation and landscaping to use site-indigenous species from the relevant EVCs. Offsets utilised to compensate for their loss (not considered a mitigation measure).	B1 B3 B5	Major	Likely	High
R-BH2	Clearing impacts significant vegetation or ecological communities	Clearing results in loss or fragmentation of an EPBC Act and/or FFG Act listed community		Minor	Almost Certain	Medium	Refinement of impact footprint to further reduce vegetation to be removed and add to No-go Zones. Minimisation of impacts at the Waterways and revegetation under the bridge to maintain the connectivity of seasonal herbaceous wetlands. Restoration of substrate and landform under the bridge to allow revegetation and regeneration.	B1 B3 B5	Minor	Likely	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH3	Clearing impacts fauna habitat values	Clearing results in direct loss of habitat for threatened fauna species including MNES, State-listed and advisory list fauna		Minor	Almost Certain	Medium	Refinement of impact footprint to further reduce vegetation to be removed and add to No-go Zones. Minimisation of impacts at the Waterways and revegetation under the bridge. Restoration of substrate and landform under the bridge to allow revegetation of appropriate EVCs.	B1 B3 B5	Minor	Likely	Medium
R-BH4	Clearing impacts significant flora species	Vegetation clearing results in impacts upon significant flora including MNES, State listed and advisory listed flora.		Moderate	Unlikely	Medium	Pre-clearing survey within the project area at Waterways wetlands for any additional significant flora. Salvage and relocation of EPBC Act and FFG Act listed species if required. No go zones at Mordialloc Creek and Waterways wetlands	B3 B5	Moderate	Rare	Low
R-BH5	Clearing impacts fauna habitat values	Clearing impacts large remnant native trees (Large trees under Guidelines 2017)		Moderate	Almost Certain	High	Refinement of design / impact footprint to reduce the number of trees, particularly large remnant trees, to be removed. Retain large trees for habitat, even if there are TPZ impacts.	B3 B5	Moderate	Likely	High

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH6	Design impacts on MNES	Clearing results in loss or fragmentation of habitat for a migratory species.		Minor	Possible	Low	Not required	B1	Minor	Possible	Low
R-BH7	Design impacts fauna habitat values	Design results in altered surface water flow/movement or quality which impacts fauna habitat, including threatened or migratory species habitat, adjacent to the project area (Woodlands wetlands and Waterways wetlands/Mordialloc Creek).		Moderate	Unlikely	Medium	Swale design (e.g. bio-retention systems) to minimise changes to existing surface flow and quality conditions at important habitat areas (specifically Woodlands and Waterways). Water off the bridge over Mordialloc creek to be diverted for treatment.	B3, W2	Moderate	Rare	Low
R-BH8	Design Impacts significant fauna species	Road lighting design leads to impacts on fauna: — Seriously disrupts the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. — Leads to reduction in area of occupancy of a threatened species, or modification of habitat quality leading to decline of the species.	Potential reduction in connectivity caused by barriers	Major	Possible	High	Implement lighting design guidelines as recommended in Biodiversity Impact Assessment Barriers and/or plantings to prevent light spill across habitat/sites of ecological value.	B1 B2, LV1, LV4, LV5	Major	Rare	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH9	Design impacts fauna habitat values	Design fragments fauna habitat / wildlife corridors (Woodlands - Braeside corridor and the Waterways corridor)	Potential reduction in connectivity caused by barriers	Moderate	Almost Certain	High	Fauna crossing structures (at least the high/very high structures between Woodlands/Braeside and at the Waterways) Barriers to funnel fauna into culverts Landscaping to maximise connectivity Revegetation under bridge at Mordialloc Creek (to all extent possible) to encourage use. Use of 'furniture' in culverts and under bridge.	B1, B6, LV1	Moderate	Possible	Medium
R-BH10	Design impacts significant flora species	Design results in altered surface water flow/movement, volumes, or drainage which impacts threatened flora species by decreasing the quality of habitat (specifically at the Waterways where they are known to occur). Sediment-laden run-off from the road may lead to a decrease in the quality of habitat for significant flora.		Moderate	Unlikely	Medium	Design to divert run-off from bridge and treat on site. Design to ensure that there are minimal changes to water volume at Waterways wetlands and Mordialloc Creek during both construction and operation of road.	B3, W1, W2	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH11	Design impacts on MNES	Design leads to impact on Seasonal Herbaceous Wetlands of the Temperate Lowland Plains due to modification of abiotic factors necessary for community's survival: surface water drainage, groundwater systems, or increased pollution.		Moderate	Possible	Medium	Design to divert run-off from bridge and treat on site. Design to ensure that there are minimal changes to water volume at Waterways wetlands and Mordialloc Creek during both construction and operation of road.	B3, W1, W2	Moderate	Unlikely	Medium
R-BH12	Construction results in unauthorised clearing	Clearing or construction impacts on vegetation outside approved area. E.g.: — Clearing within No-go Zones or outside of the project area — Dust generated by construction impacting vegetation		Moderate	Rare	Low	Not required	B5, AQ2	Moderate	Rare	Low
R-BH13	Construction impacts on MNES	Construction noise impacts on wetland habitat such that dependent species are seriously affected including MNES and State significant species.		Moderate	Possible	Medium	Edithvale Road (through the Edithvale wetlands) not used for hauling equipment and materials. Noise management plan to include consideration of ecological values.	B4, NV2	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH14	Construction impacts on MNES	Light from construction activities impacts on wetland habitat such that locally occurring species are significantly affected, including MNES and State significant species.		Moderate	Possible	Medium	Lighting is located away from sites of ecological value or areas of retained habitat wherever practicable. Lighting is directed to works areas only and away from sites of ecological value. Install shields or fittings to minimise light spill and direct light to where it is needed. Temporary lighting is removed promptly from site once not required. Include in CEMP	B4, LV5	Moderate	Rare	Low
R-BH15	Construction impacts on MNES	Earthworks and construction result in erosion and/or sedimentation of habitat which impacts threatened flora, fauna or ecological communities. Sediment-laden run-off from the road may lead to a decrease in the quality of habitat in downstream environments.		Moderate	Rare	Low	Not required	B4, B5, W3	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH16	Clearing impacts on MNES	Clearing/construction directly impacts a threatened community beyond what has been proposed (and approved) in the design of the Project.		Moderate	Rare	Low	Not required	B5	Moderate	Rare	Low
R-BH17	Clearing impacts on MNES	Clearing/construction directly impacts a threatened species/habitat beyond what has been proposed (and approved) in the design of the Project		Moderate	Rare	Low	Not required	B4, B5	Moderate	Rare	Low
R-BH18	Clearing impacts significant fauna species	Clearing and construction results in mortality of fauna protected under the Wildlife Act 1975 (or otherwise listed).		Minor	Possible	Low	Not required	B4	Minor	Possible	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH19	Construction impacts on MNES	Construction of road results in introduction or spread of an invasive species impacting habitat for significant species and reducing the quality of threatened communities.		Moderate	Unlikely	Medium	Comprehensive weed and disease hygiene measures in the CEMP should include additional monitoring and control following works to protect threatened flora. CEMP should include specific provision for threatened species and ecological communities. Additional monitoring and management is required where the Project occurs adjacent to the Waterways wetlands, Braeside Park wetlands, and Woodlands wetlands.	B5, B6	Moderate	Rare	Low
R-BH20	Operation impacts significant fauna species	Operation of the road (traffic noise) impacts fauna species/habitat, including listed migratory or threatened fauna.	Connectivity	Major	Possible	High	Multi-function fauna barrier to reduce noise impact on the key wetland habitats.	B1	Major	Unlikely	Medium
R-BH21	Operation impacts on MNES	Operation of the road (Headlights) impacts fauna species/habitat, including listed migratory or threatened fauna.	Connectivity	Moderate	Possible	Medium	Multi-function fauna barrier to help shield the key wetland habitats from headlights. Landscaping to shield wetlands from vehicle headlights.	B1, B2, LV1	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH22	Operation impacts on MNES	Operation of the shared user path (SUP) impacts migratory species or leads to reduction in area of occupancy of a threatened species.		Moderate	Possible	Medium	Wildlife-friendly farm fence, landscaping, and/or consideration of path placement to limit access to Braeside wetlands from people and dogs. Minimal or no lighting on SUP to reduce light impacts.	B1, B2, LV1, LV4	Moderate	Rare	Low
R-BH23	Operation impacts significant fauna species	Operation of road results in increased mortality of fauna protected under the Wildlife Act 1975 (or otherwise listed).	Potential reduction in connectivity caused by barriers	Major	Likely	High	Fauna connectivity culverts and multi-function fauna barrier to reduce road mortality in key wetland areas. Identified in the flora and fauna impact assessment.	B1, B6	Major	Unlikely	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH24	Maintenance impacts significant vegetation or ecological communities	Operation and maintenance of road results in introduction or spread of an invasive species potentially impacting habitat for significant species and reducing the quality of threatened communities.		Moderate	Possible	Medium	Additional monitoring and management is required for the 5 year maintenance period, where the Project occurs adjacent to the Waterways wetlands, Braeside wetlands, and Woodlands wetlands. This should include comprehensive weed and disease hygiene measures. Where the Project occurs adjacent to the Waterways, Braeside Park, and Woodlands Industrial Estate, slashers to be clean of weed seed/propagules before entering site.	B5, B6	Moderate	Unlikely	Medium
R-BH25	Maintenance results in unauthorised clearing	Road maintenance activities such as slashing the roadsides cause accidental damage or removal of protected vegetation.		Minor	Unlikely	Low	Not required	Contract Specification Section 750 - Routine maintenance	Minor	Unlikely	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH26	Maintenance results in unauthorised clearing	Road maintenance activities such as slashing the roadsides can cause dust and dirt building up on neighbouring vegetation preventing plant respiration causing indirect vegetation loss (clearing).		Minor	Unlikely	Low	Not required	Contract Specification Section 750 - Routine maintenance	Minor	Unlikely	Low
CUMULATIVE IMPACTS – ON-SITE AGGREGATE											
R-BH27	Multiple impacts from unauthorised clearing	Multiple project activities result in native vegetation loss. Multiple risks include clearing, increased dust, changes in surface water flows and quality, changes in groundwater, spills and leaks and contamination.		Moderate	Likely	High	Refinement of design / impact footprint to further reduce vegetation to be removed and add to No-go Zones. Incentives to contractors to further minimise vegetation loss. Revegetation and landscaping to use site-indigenous species from the relevant EVCs. Offsets utilised to compensate for their loss (not considered a mitigation measure).	B3, W2, AQ1, LV1, CL1	Moderate	Possible	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH28	Multiple impacts to significant flora species	Multiple project activities result in impact to significant flora species. Multiple risks include increased dust, changes in surface water flows and quality, changes in groundwater, spills and leaks and contamination.		Moderate	Unlikely	Medium	Refining of alignment and construction footprint. Pre-clearing survey within the project area at the Waterways. Design to divert run-off from bridge and treat on site. Design to ensure that there are minimal changes to water volume at Waterways wetlands and Mordialloc Creek during both construction and operation of road.	B5, W2, AQ1, LV1, CL1	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH29	Multiple impacts to significant fauna species	Multiple project activities result in impact to protected and significant fauna species (mortality). Multiple risks include vegetation clearing, collisions with vehicle associates with clearing and earthworks, construction and during operation and maintenance.	Potential reduction in connectivity caused by barriers	Moderate	Possible	Medium	Modified culverts and barriers to reduce road mortality in key areas. Identified in the flora and fauna impact assessment. Refinement of design / impact footprint to reduce the number of trees, particularly large remnant trees, to be removed. Landscaping to maximise connectivity Revegetation under bridge at Mordialloc Creek (to all extent possible) to encourage use. Use of 'furniture' in culverts and under bridge.	B1, B4, B6, LV1	Moderate	Unlikely	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH30	Multiple impacts to fauna habitat values	Multiple project activities result in impacts to fauna habitat. Multiple risks include clearing, increased dust, noise and light, changes in surface water flows and quality, changes in groundwater, spills and leaks and contamination	Potential reduction in connectivity caused by barriers	Major	Possible	High	No-go Zones mapped to protect potential/known habitat. No storage of materials, driving and other disturbance to occur within No-go Zones or outside of the project area. No direct impacts to occur outside of the project area. Follow lighting design guidelines as recommended in Biodiversity Impact Assessment Barriers and/or plantings to prevent light spill across habitat/sites of ecological value. Barrier Type 1 to minimise noise impacts and light spill at wetland habitat. Spill mitigation as per the Surface Water Impact Assessment.	B1, B2, B3, B4, B6, LV1, AQ1, AQ2, NV1, NV2, W1, W3, W4, CL1	Major	Unlikely	Medium

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-BH31	Multiple impacts to significant vegetation or ecological communities	Multiple project activities result in impacts upon significant vegetation or ecological communities. Multiple risks result include increased dust, changes in surface water flows and quality, changes in groundwater, spills and leaks and contamination		Minor	Almost Certain	Medium	Design to divert run-off from bridge and treat on site. Design to ensure that there are minimal changes to water volume at Waterways wetlands and Mordialloc Creek during both construction and operation of road. Additional weed monitoring and management is required where the Project occurs adjacent to the Waterways, Braeside Park, and Woodlands Industrial Estate.	B1, B3, B4, B5, B6, LV1, AQ1, AQ2, NV1, NV2, W1, W3, W4, CL1	Minor	Likely	Medium

Table 5.2 Wetlands and waterways environmental risk assessment register

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-WW1	Design impacts on MNES	Design results in a substantial and measurable change in the hydrological regime of the Ramsar wetland/important habitat for Sharp-tailed Sandpiper.		Moderate	Rare	Low	Not required	W1, W2, B1	Moderate	Rare	Low
R-WW2	Earthworks impacts on MNES	Development causes a substantial and measurable change in the water quality of the wetland resulting in an adverse impact on biodiversity, ecological integrity, social amenity or human health.		Moderate	Rare	Low	Not required	W1	Moderate	Rare	Low
R-WW3	Operation impacts on MNES	Operation of the road results in change in the water quality of the wetland resulting in an adverse impact on biodiversity, ecological integrity, social amenity or human health.		Moderate	Unlikely	Medium	Bio-retention systems and spill containment as detailed in the Surface Water Impact Assessment.	W1	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	PRIMARY ENVIRONMENTAL RISK DESCRIPTION	SECONDARY ENV. RISK	INITIAL RISK			ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
				CONSEQUENCE	LIKELIHOOD	RATING			CONSEQUENCE	LIKELIHOOD	RATING
R-WW4	Construction impacts on MNES	Construction results in the introduction and/or spread of invasive species in the wetland that are harmful to the ecological character of the wetland.		Moderate	Rare	Low	Not required	B5, B6	Moderate	Rare	Low
CUMULATIVE IMPACTS – ON-SITE AGGREGATE											
R-WW5	Project impacts on MNES	Project activities including clearing, earthworks, construction, operation and maintenance impact the Ramsar Wetland MNES or other waterways or wetlands.		Moderate	Unlikely	Medium	Bio-retention systems and spill containment as per the those detailed in the Surface Water Impact Assessment.	W1, W3, B1, B3, B4, B5, B6	Moderate	Rare	Low

5.2 KEY FINDINGS – CUMULATIVE RISKS

The assessment of cumulative impacts was competed in two stages, namely the assessment of aggregate project impacts and the assessment of the cumulative impact of multiple off-site projects in addition to the Mordialloc Bypass project for Biodiversity. For most of the identified risks, cumulative effects were considered and were not deemed to be applicable. The risks for which cumulative effects were deemed applicable are provided in Table 5.3.

A cumulative impact assessment is provided in Section 6.8.

Table 5.3 Biodiversity cumulative effects environmental risk assessment

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION/ CONTROLS	EPR	RESIDUAL RISK		
						CONSEQUENCE	LIKELIHOOD	RATING
R-BH1	Project impacts significant vegetation or ecological communities	— LXRA Edithvale and BonBeach — Monash Freeway Upgrade — Westall Road extension — Chadwick Reserve development — Moorabbin Airport Master Plan — Kingswood Dingley Village	Native vegetation (incorporating both scattered trees and patches) was recorded within the level crossing removal project areas. LXRA (1.123 ha - BonBeach, 1.315 ha - Edithvale) **Higher impact when cumulative impacts are considered however offsets should compensate for this.**	Refinement of design / impact footprint to further reduce vegetation to be removed and add to No-go Zones. Incentives to contractors to further minimise vegetation loss. Revegetation and landscaping to use site-indigenous species from the relevant EVCs. Offsets utilised to compensate for their loss (not considered a mitigation measure).	B5	Major	Almost Certain	Extreme
R-BH5	Project impacts fauna habitat values	— LXRA Edithvale and BonBeach — Monash Freeway Upgrade — Westall Road extension — Chadwick Reserve development — Moorabbin Airport Master Plan — Kingswood Dingley Village	Native vegetation (incorporating both scattered trees and patches) was recorded within the level crossing removal project areas. Thirteen (13) large trees are proposed for removal for the Edithvale - BonBeach LXRA projects. **Higher risk when cumulative impacts are considered. Offsets (including for large trees) will be obtained for the relevant projects.**	Refinement of design / impact footprint to reduce the number of trees, particularly large remnant trees, to be removed. Retain large trees for habitat, even if there are TPZ impacts.	B5	Moderate	Likely	High

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION/ CONTROLS	EPR	RESIDUAL RISK		
						CONSEQUENCE	LIKELIHOOD	RATING
R-BH18	Clearing impacts significant fauna species	— LXRA Edithvale and BonBeach — Monash Freeway Upgrade — Westall Road extension — Chadwick Reserve development — Moorabbin Airport Master Plan — Kingswood Dingley Village	Some mortality of protected fauna is likely to results from the identified projects including LXRA (note: equivalent risk from LXRA project determined to be minor.). This is unlikely to result in a substantial cumulative effect upon protected species, provided that each project has the standard controls (fauna management). in place to minimise mortality	Not required	B4	Minor	Likely	Medium
R-BH23	Operation impacts significant fauna species	— LXRA Edithvale and BonBeach — Monash Freeway Upgrade — Westall Road extension — Chadwick Reserve development — Moorabbin Airport Master Plan — Kingswood Dingley Village	Cumulative impacts from multiple road projects upon protected fauna in the area are likely, although with the mitigation in place are unlikely to substantially affect the protected species.	Fauna connectivity culverts and multi-function fauna barrier to reduce road mortality in key wetland areas. Identified in the flora and fauna impact assessment.	B1, B6	Minor	Likely	Medium

6 IMPACT ASSESSMENT

The types of impacts likely to be associated with this development are discussed in Section 6.1 in the context of current literature. The magnitude of impacts with and without mitigation for specific ecological values at the project area is assessed in the subsequent sections (6.2 to 6.6) threatening processes are addressed in Section 6.7, and cumulative impacts in Section 6.8. Mitigation recommended for the project is provided as Section 7 of this report.

6.1 ROAD IMPACTS AND ECOLOGY AT THE PROJECT AREA

The proposed Mordialloc Bypass is likely to have a myriad of direct and indirect ecological impacts that potentially impact the local landscape and beyond (Figure 6.1). The impacts may be temporary, predominantly occurring during the construction phase, or ongoing for the operational phase of the bypass. The direct impacts of the road are typically the most obvious, and include the clearing of vegetation, barrier effects to animal movement and mortality of wildlife due to collision with vehicles. Indirect impacts include loss of habitat through degradation from changes such as weed incursion or pollution, and changes to behaviour from noise and light. It is important to also note that the ecological impacts of a road can extend for hundreds or thousands of metres from the road itself, a phenomenon known as the road-effect zone, which is discussed in more detail in Section 6.1.4 (Benítez-López, Alkemade & Verweij 2010; Forman, R.T.T. & Deblinger 2000).

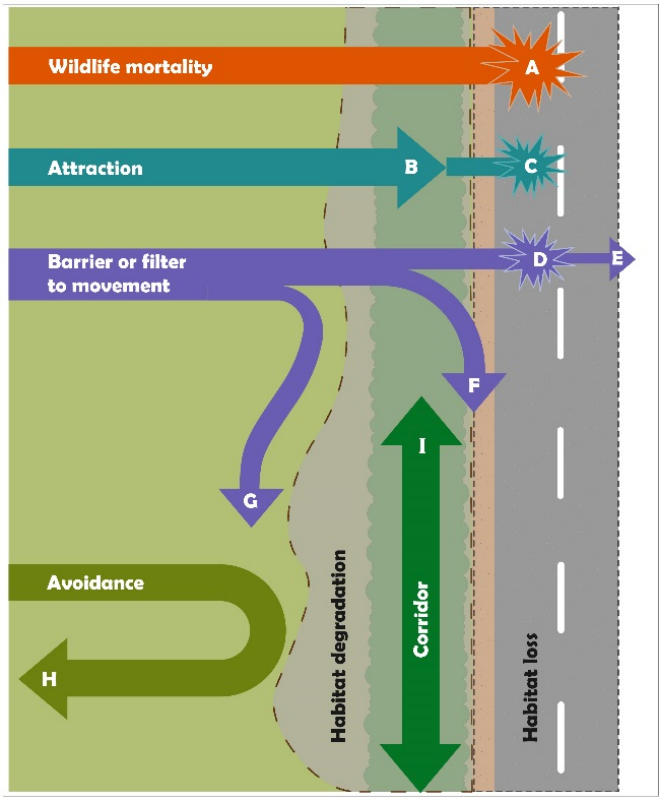


Figure 6.1 The numerous potential impacts of roads on wildlife

Habitat is lost to build the road and habitat adjacent to the road is degraded. The most obvious impact of roads and traffic on wildlife is mortality due to wildlife vehicle collision (WVC) (A). Some species are attracted to resources (e.g. carrion, or heat for basking) on the road or roadside (B) which, depending on the animal's ability to avoid traffic, may result in death due to WVC (C). The barrier or filter effect reduces the movement of animals across the road and a proportion of individuals attempt to cross are killed due to WVC (D) and some make it across (E), while others are deterred from crossing by the road (F) or degraded roadside habitat (G). Other species actively avoid the road or degraded habitat (H). In contrast, some species use the roadside vegetation as habitat and/or corridor for movement (I). Source:(van der Ree, R., Smith, D. J. & Grilo, C. 2015)

6.1.1 LOSS OF VEGETATION AND HABITAT (DIRECT REMOVAL AND SHADING)

Loss of habitat, together with habitat degradation and fragmentation, is one of the most critical impacts to native wildlife in Australia (Gleeson & Gleeson 2012) and remains so globally (Watson et al. 2016). These processes reduce the amount and quality of habitat that provides critical resources required by wildlife for foraging, roosting and breeding. Inter- and intra-specific competition increases concomitantly as the abundance and quality of resources declines. Clearing also typically results in habitat fragmentation and the creation of barriers to movement, discussed further in the following Section.

The Project will require clearing of native and non-native vegetation within the alignment that provides habitat for a range of wildlife species, and Section 6.2.2 details the area of each EVC proposed to be cleared. Clearing of trees is detailed in Section 6.2.3. The bridge over Mordialloc Creek will result in the shading of some native vegetation and habitat, including some threatened vegetation communities. Shading can result in significant changes in vegetation structure and composition through the loss of some plant species and the proliferation of others. This can, in turn, affect the suitability of vegetation as habitat for wildlife, including for threatened species.

For this assessment (and all associated calculations of impact), vegetation and habitat with the potential to be substantially shaded by the bridge (i.e. with a majority of the 10am to 3pm sun hours shaded) is considered lost. This is included within the 8 metre buffer of the bridge design for impact calculations (construction footprint). As the bridge runs roughly north-south and is comprised of two split carriages, some light penetration under the bridge is anticipated, expected to be sufficient for revegetation with shade-tolerant native vegetation.

There may also be some minor shading of other vegetation within the project area such as planted and remnant roadside trees near proposed overpasses; however, this is considered unlikely to result in additional vegetation loss. A buffer to the road design to allow for construction is already included in impact calculations, and this buffer is expected to include any vegetation likely to be affected by shading. Further constraining the construction footprint to retain vegetation, at the Waterways wetlands and elsewhere, may require an assessment by the contractor to ensure the long-term viability of any vegetation immediately adjacent to the road.

Other indirect changes, such as increased levels of noise and light, weed invasion, etc., can also result in the loss of useable habitat along the edge of the road, because some species of wildlife avoid such disturbed areas. Known as ‘edge effects’ these impacts are greater at the edge of the patch of habitat than towards the middle (Gleeson & Gleeson 2012). Noise and light impacts are discussed in more detail in Section 6.1.4. Edge effects are discussed further in Section 6.1.5.5.

6.1.2 LOSS OF CONNECTIVITY

The movement of animals, plants and ecosystem processes is critical to species survival and healthy ecosystem functioning. Wildlife need to move across a range of spatial and temporal scales, which vary from short-distance daily movements to access food, shelter and mates, to annual migrations which for some species are across the globe and once-in-a-lifetime dispersal movements. Clearing and construction of roads can result in habitat fragmentation, thereby limiting or preventing animal movements, creating smaller populations and increasing the risk of extinction. Populations are at a greater risk of local extinction when they are sub-divided into smaller and more isolated sub-populations because of smaller population size, inbreeding depression, inability to access sufficient resources and greater susceptibility to environmental variation. Consequently, habitat fragmentation is listed under the FFG Act as ‘…a threatening process for fauna in Victoria’. Roads and traffic can form a barrier or filter to movement for certain species, particularly those that are sensitive to the noise, light and disturbance by vehicles, are slow moving (and suffer high mortality – discussed in Section 6.1.3), or require protective cover to move around.

The fauna habitat in the locality of the project area, particularly the wetland habitat (i.e. the remnants of the original Carrum Carrum Swamp, now the Carrum IBA/KBA) is already somewhat fragmented, and the species utilising the habitat appear to be tolerant of the current level of fragmentation. Nevertheless, the connectivity which currently exists between the wetlands at Woodlands Industrial Estate and Braeside Park and between wetlands at Waterways will be affected by the proposed road. Given the context of the landscape in the study area, specifically the very limited amount

of remnant habitat in the surrounding area, the maintenance of functional connectivity between Braeside Park, Woodlands wetlands and the Waterways is likely to be important in the local long-term viability of a number of 'common' native fauna species that occur in the area. Losses of connectivity that effectively isolate these populations from each other may lead to decreased resilience, a loss of genetic diversity, and hence likely a loss of 'fitness', and a reduced ability to recolonise vacant areas of habitat. In effect, it may substantially increase the risk of the extirpation of some, or all, of the populations of a species that are no longer functionally connected. Species most likely to be impacted by a loss of connectivity at the project area are small or less mobile fauna such as turtles and frogs, terrestrial mammals such as echidnas, as well as secretive (reliant on vegetative cover) bird species. The construction of the road may lead to road avoidance or road mortality for these taxa. Some of the species likely to be affected by a reduction in connectivity are of conservation significance.

The Project does not involve the clearing of any vegetation that comprises a regionally significant movement corridor for small woodland birds, however it is likely to reduce connectivity for small woodland birds on a local scale.

Flora species at the study area are considered unlikely to be affected by the road, as pollen flow (usually driven by wind, invertebrates, and/or birds) is unlikely to be substantially hindered. However, there has been little research on this topic to fully address this potential impact.

6.1.3 FAUNA INJURY AND MORTALITY

The proposed bypass has the potential to increase the rate of fauna injury and mortality during both the construction and the operational phase of the project, as discussed in the following sections.

6.1.3.1 CONSTRUCTION PHASE

Mortality of wildlife during construction may occur during clearing, or from collisions when wildlife strays into the construction zone (van der Ree, R., Smith, D. J. & Grilo, C. 2015). The potential for injury and mortality of wildlife from the Project is summarised in Table 6.1.

Table 6.1 Summary of potential for increased injury and mortality from Construction Phase

ACTIVITY WITH POTENTIAL TO CAUSE MORTALITY	NATIVE ANIMALS WITH POTENTIAL TO BE AFFECTED	NATURE AND MAGNITUDE OF THE IMPACT OF THE PROJECT
Vegetation/habitat removal during construction: — Removal of mature trees with hollows and dead standing trees	— Hollow-dependent bats — Hollow-nesting and canopy-nesting birds — Arboreal mammals — Arboreal reptiles — Arboreal frogs — Invertebrates	The level of mortality and injury of both non-threatened and threatened species of birds, bats and arboreal mammals is likely to be low. With regard to potential fauna habitat trees, 24 large remnant trees are likely to require removal for the Project, including several with hollows. Additional small trees and both small and large planted native and exotic trees will also require removal for the Project. Mortality of species of native reptiles and frogs is likely to occur in higher numbers from vegetation (groundcover) clearance.
— Removal of understorey, groundcover, topsoil and debris (wood, rocks, rubbish etc.)	— Small woodland birds — Ground-dwelling reptiles — Frogs — Invertebrates	
Machinery/plant and vehicle collisions with fauna during construction	— Terrestrial, semi-aquatic and arboreal reptiles, frogs and mammals — Birds, especially waterbirds	Occasional mortality of native animals may occur during vehicle movements within the project area. This is unlikely to be a substantial risk as construction speed limits are low. It is more likely that fauna may fall into trenches or shelter in materials.

6.1.3.2 OPERATIONAL PHASE (ONGOING IMPACTS)

One of the most obvious impacts of traffic on wildlife is injury and mortality due to wildlife vehicle collision (WVC). Studies of the scale and severity of bird mortality due to collision with vehicles estimate that 80–340 million birds die annually in the USA (Loss, Will & Marra 2014) and up to 27 million birds die annually in some European countries (Erritzoe, Mazgajski & Rejt 2003). The exact rates of WVC are difficult to estimate, especially for smaller-bodied species of wildlife, because most collision would remain unreported, unlike collisions with large-bodied animals that also result in human injury or death and significant vehicle damage. Nevertheless, mortality of wildlife due to collision with vehicles is one of the leading causes of anthropogenic mortality, with significant implications in the decline and extinction of many species of wildlife. A recent review of the scientific literature found that the number of studies which reported a negative effect of roads and traffic on animal abundance outnumbered positive effects by a factor of 5 (Fahrig & Rytwinski 2009). However, it should be noted that many of the sources of data (79 discrete published studies) that were used for the review were incidental and were not explicitly focused on quantifying road impacts on wildlife. Thus, the number and extent of impacts of roads and traffic on wildlife are probably greater than what their review suggests.

All roads have the potential to result in the mortality (roadkill) of native animals. The risk of roadkill is generally higher where roads:

- Dissect locations or habitats with naturally high rates of movement by wildlife, such as between foraging and resting habitats, or between seasonally occupied habitats
- Traverse areas of substantial animal habitat which support high-density populations of wildlife
- Are near natural or artificial water bodies, which typically support high-density populations of wildlife, principally birds
- Contain food sources (e.g. Mown grass verges, nectar-producing shrubs) which attract animals to the road edge
- Have high speed limits
- Provide poor visibility of wildlife (e.g. Due to bends, crests and poor lighting).

In addition, the susceptibility of different taxa to collision with vehicles is species- or group-specific and varies depending on their ecological traits, such as their speed of movement, their ability to move out of the way of oncoming vehicles, the extent to which the species is attracted to the road, and if a bird, bat or gliding mammal, the height at which it flies or glides above the road (Fahrig & Rytwinski 2009). In their extensive review of the published scientific literature, Fahrig and Rytwinski (Fahrig & Rytwinski 2009) found that amphibians and reptiles showed the greatest negative effect from roads due to their relative lack of mobility and low car avoidance behaviour compared to other taxonomic groups. Similarly, birds showed mostly negative or neutral effects, probably because of the wide-diversity of species-specific traits displayed by birds. For example, some raptor species are attracted to the carrion left on roadsides, and if sufficiently mobile and able to detect and avoid oncoming vehicles, they may experience a net benefit from increased food availability (Fahrig & Rytwinski 2009). Small mammals generally show positive or no effects, with impacts increasing with size in mammals and size of movement range, and depending on whether their predators have been affected (Fahrig & Rytwinski 2009).

The risk of wildlife-vehicle collision is of course related to the presence of both wildlife and vehicles on the road surface (Visintin, McCarthy & van der Ree 2016). The presence of wetlands which support high abundance and species-richness of birds on both sides of the proposed bypass, combined with the high-traffic volume of the road, results in a high-risk location for bird mortality. The extent of wetland-bird movement across the proposed bypass is difficult to quantify, however based on records and observations (refer to Section 4.5.4), it can be assumed that wetland birds currently fly between IBA wetlands in the local area, including between Braeside and Woodlands wetlands and The Waterways.

The primary method of movement among wetlands by EPBC Act listed threatened and migratory birds is by flight. Nevertheless, we can assume that some wetland birds, particularly secretive species that use flight less regularly and birds with young (i.e. species for which terrestrial connectivity is important), will occasionally move through (or forage within) tall exotic grass that occurs between Braeside Park and Woodlands wetlands. This includes species such as Australasian Bittern, Baillon's Crake and Lewin's Rail, all of conservation significance, and known to periodically or regularly occur in the area.

It is therefore likely that without physical barriers (i.e. flight diverters, see mitigation Section 7.4), wetland birds will be affected by WVC, particularly due to the propensity for some wetland birds to walk or fly low at ground level to move between habitat areas when they are relatively close to each other. Birds with a low take-off trajectory such as swans and cormorants may also be affected to a lesser extent. Numerous common fauna including turtles, frogs, echidnas, etc., are also likely to regularly move between wetlands, and vehicle strike is therefore likely to be high without mitigation.

The rates of WVC and wildlife mortality in the project area is expected to be highest near and between wetlands, where the road is at grade or above, and where there are no other barriers. Rates of WVC at the bridge are likely to be comparatively lower because there is space underneath for birds to cross.

6.1.4 HABITAT DEGRADATION FROM DISTURBANCE

The road effect zone is the distance over which the ecological effects of the road and traffic can be measured or detected (Benítez-López, Alkemade & Verweij 2010; Forman, R.T.T. & Deblinger 2000). The causes of the road effect zone are numerous and difficult to disentangle, but include a combination of noise, light and chemical pollution, disturbance effects from vehicles, and changes to the vegetation due to microclimatic effects or altered hydrology (van der Ree, Grilo & Smith 2015).The size and severity of the road effect zone is influenced by: the width and surface of the road; the type, volume and speed of traffic; the adjacent landscape (e.g. topography, hydrology vegetation type); the speed and direction of the wind; and, the traits of the impacted species (van der Ree, R, Gagnon, J.W & Smith, D.J 2015). Importantly, wetlands facilitate the propagation of noise and light and thus the road effect zone extends further in these habitats than many others. These impacts, including reduced occurrence or abundance of species, reduced breeding success, etc. are measurable for hundreds to thousands of metres from the road itself (Benítez-López, Alkemade & Verweij 2010; Eigenbrod, Hecnar & Fahrig 2009). One example of the significance of the road effect zones was conducted using a before-during-after study design that focussed on the effect of a 4-lane highway to Madrid in Spain that was built through a steppe-bird hotspot (Torres et al. 2011). Using a 12-year dataset on the occurrence of the Great Bustard *Otis tarda*, they found that the distribution of the birds changed significantly after construction, with an active avoidance of the first 500 m. Importantly, this reduction in use was attributed to a reduction in the quality of the habitat, probably due to disturbance and noise, rather than increased mortality due to collisions with vehicles, as no road-killed birds were ever detected. This change in use represents a significant reduction in suitable habitat, far more than that lost to the actual road itself. Other studies (Jack et al. 2015; Summers, Cunnington & Fahrig 2011) have attributed the presence of a road-effect zone in birds to increased rates of mortality, indicating that it is likely to be a combination of causes contributing and that both impacts should be addressed.

The easement for the proposed Mordialloc Bypass passes through already extensively modified habitats, including major roads, walking paths, and industrial and residential land-uses. Therefore, species currently utilising the area around the proposed road appear to be habituated or tolerant of the current level of disturbance. However, the threshold in disturbance and the likely presence of an extinction debt (where species are declining and likely to go extinct due to past disturbance or habitat clearing) do not make it a foregone conclusion that an existing road or an additional road in the landscape is unlikely to have significant impacts on wildlife (Roger, Laffan & Ramp 2011). Furthermore, many studies have demonstrated that some impacts of the road are not immediately obvious, such as increased stress levels, reduced breeding or reduced survival rates of resident animals. Other studies have also shown that subordinate individuals, such as certain age or sex-classes of wildlife, are relegated to the poorer quality habitat along roads, with dominant individuals occupying better quality habitat further away.

6.1.4.1 ROAD EFFECT ZONE DISTANCES

A recent review of the published scientific literature found that the road effect zone for 201 different species of bird can extend up to 2580 m from the road itself (Benítez-López, Alkemade & Verweij 2010), with a reduction in abundance of 28–36% within that distance. Importantly, they also concluded that most effects were within 1 km of the road, and the road effect zone is larger in more open areas than forested areas, presumably because the road is more visible in such landscapes and there are fewer obstacles to mask or ameliorate the disturbance.

Although the road effect zone has not been well-studied for Australian waterbirds, some examples of road effect zone research are detailed below. These may provide some insight into the potential for effects at the project area, although some of the research was conducted in areas which was not already affected to the same extent by existing development.

- A 40% reduction in the density of Ovenbirds *Seiurus aurocapillus* within 150 m of roads through forested landscapes in Vermont, USA (Ortega & Capen 1999).
- A statistically significant reduction in the abundance of the Great Bustard within 500 m of a 4-lane Highway in Spain (Torres et al. 2011).
- An experimental study of the effect of broadcast traffic noise in a road-less area in southern Idaho, USA, found an almost ¼ reduction in bird abundance and almost complete avoidance by some species between noise-on and noise-off time periods (McClure, Christopher J. W. et al. 2013). This affect was recorded at sampling points 30–50 m from the speakers playing the recorded traffic noise, and would likely extend further than 50 m, however no surveys were undertaken beyond 50 m.
- A study of grassland birds adjacent to a number of roads of varying traffic volume near Boston, USA, found that moderate-volume roads (8000–15,000 vehicles per day/vpd) reduced bird-breeding, and high-traffic volume roads (>15,000 vpd) affected both bird presence and breeding. These effects were measurable from 400 m for moderate volume roads and over 1200 m for multi-lane highways with more than 30,000 vpd (Forman, R.T.T, Reineking & Hersperger 2002).
- A series of landmark studies in The Netherlands in the 1990s showed that proximity to major highways with over 50,000 vpd had a significant impact on bird abundance, bird diversity, movement distances and breeding success (Foppen & Reijnen 1994; Reijnen & Foppen 1994; Reijnen, Foppen & Meeuwsen 1996; Reijnen et al. 1995; Reijnen, R, Foppen, R & Veenbaas, G 1997), with significant implications for species persistence.
- Nests of Pied flycatchers *Ficedula hypoleuca* in Finland were more likely to fail at the chick stage when located close (10–20 m) to high traffic-volume roads compared to nests located further away (60–130 m) (Kuitunen et al. 2003). This failure was attributed to the mortality of parent birds while chicks were still dependent on adults for food.
- A statistically significant distance of 300 m to the nearest road was identified as the threshold for the most significant negative impacts on the abundance and richness of birds in central Spain (Palomino & Carrascal 2007).

6.1.4.2 NOISE AND VIBRATION

NOISE

Noise is defined as unwanted or background sound within an environment. Road construction noise often occurs at a high intensity but for relatively short periods of time, while road-traffic noise typically occurs at lower intensities and is more persistent over time (Parris, K M 2015). There are two main components to noise which is relevant here: frequency, or pitch, which is measured in hertz (Hz); and, amplitude (also referred to as loudness), which is measured in pressure or intensity, and is expressed in decibels (dB). The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. A logarithmic scale is used in acoustic assessments because the human ear has a vast sound-sensitivity range of over a thousand billion to one.

The noise from road construction and traffic can be stressful, eliciting a physiological stress response, with some animals temporarily or permanently moving away from the noise. A permanent move away from the noise is one mechanism that causes the road effect zone and a permanent reduction in the area of suitable habitat, and hence reduction in local population size. Species that remain exposed to the noise have reportedly experienced a range of responses, including reduced breeding success (Halfwerk et al. 2011; Reijnen & Foppen 1994) and lower survival rates, potentially such that otherwise suitable habitat is no longer occupied (Slabbekoorn & Ripmeester 2008).

There is also an increasing body of evidence demonstrating a variety of responses to anthropogenic noise in frogs, birds and other species that rely on acoustic signals (Brumm 2004; Hoskin & Goosem 2010; Parris, Kirsten M & Schneider

2008; Slabbekoorn & Ripmeester 2008). One of these impacts is masking, or where the noise interferes with the use of the acoustic signals critical to many animal species (Halfwerk et al. 2011), including calling to attract mates, territory defence, and warning of predators. The negative effect of traffic noise on birds depends on the temporal and frequency (Hz) overlap with relevant acoustic sounds, such as their own song or calls of predators (Brumm & Slabbekoorn 2005). Most birds call to defend territory and attract mates, with much of this occurring around dawn. The impacts of traffic noise on birds can be particularly acute if this dawn 'chorus' of their calling coincides with morning peaks in traffic.

Similarly, some species of bats that rely on acoustic signals to locate their insect prey are disadvantaged close to noisy roads (Schaub, Ostwald & Siemers 2008; Siemers & Schaub 2011). A recent synthesis of the effects of traffic noise on birds suggested that masking typically occurs with noise levels between 50 and 60 dB (Dooling & Popper 2007).

One study of the effect of traffic noise on birdsong was conducted on the Mornington Peninsula, where the calls of the Grey Fantail *Rhipidura fuliginosa* and Grey Shrike Thrush *Colluricincla harmonica* were recorded adjacent to 58 roads of varying size and traffic volume. The lower-singing Grey Shrike Thrush sang at a higher frequency in traffic noise, while the higher-singing Grey Fantail did not appear to alter its call (Parris, K. M. & Schneider 2009). However, the authors reported that this increased pitch was still unlikely to fully compensate for the acoustic interference experienced, thereby causing a reduction in the active space of an individual's song. Some species of frog will also attempt to call louder or change their pitch in areas with lots of anthropogenic noise (Parris, K M, Velik-Lord & North 2009). These changes may come with additional costs, such as increased energetic demands associated with changes in call volume or pitch.

The most compelling evidence demonstrating an impact of traffic noise on birds is from some recent studies in the USA where road noise was propagated from speakers set up in areas without a road (McClure, C J W et al. 2013; Ware, H E et al. 2015). Using a stop-over site for birds on their annual migration through southern Idaho, the authors played recorded traffic noise through a series of 15 speakers for four days-on and four days-off. The overwhelming response was a >25% reduction in bird abundance overall within the study area and an almost complete avoidance of the area by some species of birds (McClure, C J W et al. 2013). This was the first study to experimentally prove that the reduction in the number of birds occupying habitat close to roads was largely due to traffic noise, and not roadkill, chemical pollution or visual or physical disturbance.

There are three significant challenges to quantifying the specific impacts of noise on wildlife and identifying the thresholds at where these effects become evident and significant.

Alarm calls, such as those warning conspecifics of the presence of danger, can occur at any time of day or night and individuals will be impacted if they are unable to detect or comprehend the intended message. The first challenge in trying to identify thresholds in noise levels that cause significant impacts to wildlife relates to variability in hearing sensitivity among species. There is 'considerable variability' in the hearing efficiency and sensitivity of different species of birds, and there is no way to tell from a birds vocalisations, physical appearance or behaviour how well it hears (Dooling & Popper 2007).

The second is the variation in results of field and lab-based studies that assessed the impacts of traffic noise on wildlife. Whilst there is compelling evidence that traffic noise has a generally negative impact on many species studied, there have been several recent studies of road-effects on birds from Canada that failed to find evidence that supported the hypothesis that traffic noise is the primary factor affecting bird abundance or richness in areas adjacent to roads (Jack et al. 2015; Summers, Cunnington & Fahrig 2011). In contrast, they concluded that in their studies, traffic mortality was the major impact and that mitigation should focus on reducing mortality, rather than solely noise.

In addition, it is still difficult to identify consistent thresholds in sound pressure and pitch where impacts begin to occur for specific species or groups of taxa, such as wetland birds or frogs. This difficulty is probably due to the nascent status of much ecological traffic-noise research and the significant challenges in isolating the effects of traffic noise from other confounding variables, such as mortality, chemical and light pollution, disturbance, etc.

The final challenge is the considerable variation in the metrics and analytical approaches used in the different studies to describe the acoustic landscape. Many field-based ecological studies simply report the maximum volumes of road noise at each site or averaged across treatments or site types (i.e. dB) for varying periods of time (ranging from 5 mins to

continuously for multiple days), while others have presented their noise levels using metrics that are also used in studies of noise impacts to humans, such as dB(A), Leq and L10 18 h dB(A) (see Table 6.2). Other metrics used in human studies include Daily L10, 18hr, dB(A), ambient noise levels such as Leq, day / Leq, night, and background noise levels such as L90 dB(A).

Despite these challenges in quantifying traffic-noise impacts on wildlife, it is clear that traffic noise can have significant impacts on many species of wildlife, especially including those that communicate aurally.

NOISE IMPACT THRESHOLD

There have been several attempts to identify a threshold level in traffic noise above which negative impacts occur. As mentioned earlier, Dooling & Popper (2007) suggested limits of 93–110 dB(A) for continuous traffic noise to prevent temporary hearing loss in birds and pulses (presumably equivalent to Lmax) to not exceed 125 dB(A) to prevent permanent damage to hearing. Dooling and Popper (2007) also tentatively suggested that noise levels from roads should not exceed 50–60 dB(A) to prevent masking and other similar effects while a more recent study suggested the threshold was 49 dB(A) (Wiacek et al. 2015). Importantly, McClure et al (2013) and Ware et al. (2015) both found a significant effect to propagated road noise at 55 dB(A)Leq within a road-free landscape with a background noise level of 41 dB(A), demonstrating a maximum threshold (i.e. 55 dB(A)) that should be avoided. Unfortunately, no studies have evaluated a range of noise levels to identify where thresholds might occur, and thus the 55 dBA Leq should be considered a maximum threshold. Much lower thresholds in acceptable noise levels for all species of breeding birds in woodland (42–52 dB(A)) and open grassland (47 dB(A)) in The Netherlands were suggested by Reijnen et al. (1997). Numerous studies that compared noisy environments with quieter ones had quiet environments around the 31 L10 18 h dB(A) SPL (Parris, K. M. & Schneider 2009), and 42 dB(A) (Wiacek & Polak 2015) levels. A study of wetland birds in Finland found a negative effect where noise levels exceeded 56dB, implying that this SPL may represent a threshold in that study (Hirvonen, Heikki 2001). From this body of evidence, and relying largely on the comprehensive review by Dooling and Popper (2007), traffic noise should ideally be kept below 55–60 dBA (18 hr exposure), especially during the morning chorus.

There are several locations along the alignment where significant bird species are known to periodically or regularly occur and are also likely to experience a considerable increase in noise exposure. These sensitive locations are:

- Where the project area occurs adjacent to Braeside Park wetlands
- Where the project area occurs adjacent to Woodlands wetlands
- Where the project bisects The Waterways (noise likely to travel across the water, particularly at the location of the bridge).

Based on noise measurements at nine parkland locations within these areas (WSP 2018c), they currently experience typical levels of approximately 49–57 dBA ($L_{10, 18hr}$). In peak times, the noise level generally remains below 60 dBA, except at the Waterways monitoring location where 60 dBA was briefly exceeded twice. These noise levels are predicted to increase to approximately 59–70 dBA ($L_{10, 18hr}$) during peak hours in the absence of any form of mitigation. This represents a potential increase in noise levels of up to 18 dBA ($L_{10, 18hr}$) at the parkland areas which are key habitat areas for wetland birds. This material increase in noise levels exceeds the apparent threshold identified in the scientific literature. Refer to Section 7.4.1.2 for noise modelling with and without the currently proposed mitigation.

Table 6.2 Summary of studies relating to noise impacts on birds

SPECIES	HABITAT TYPE AND LOCATION	CALL FREQUENCY OF BIRD SPECIES	INFORMATION ABOUT NOISE LEVEL, ROAD SIZE, STUDY DESIGN	RESULTS	REFERENCE
Great Tit *Parus major*	Patchy woodland landscape in The Netherlands	Hole-nesting passerine, calling in 2–9 khz range	Studied the effect of traffic noise on breeding success in a population of Great Tit alongside a 'busy' motorway with 46.5–67.8 dB SPL, A-weighted. Traffic volume not given. Traffic noise levels recorded for 30 seconds at 30 min intervals, in four octave bands at 76 locations, averaged across 30 min or 24 hr intervals, depending on the type of analysis.	Traffic noise had a negative effect on reproductive success with females laying smaller clutches in noisier areas. Variation in traffic noise in the frequency band that overlaps most with the lower frequency part of great tit song best explained the observed variation.	(Halfwerk et al. 2011)
Migrating songbirds	Idaho, USA	Not given	Recorded traffic noise was played from 15 pairs of speakers arranged as a 500 m line-source of noise in a road-free landscape, in a noise-on, noise-off study design. Noise level at the three bird survey plots during the playback phases was 55–60 dB(A) hourly Leq.	Documented a >25% decline in overall bird abundance and almost complete avoidance by some species during noise-on periods, and no-such decline at the control sites.	(McClure, Christopher J. W. et al. 2013)
Migrating songbirds	Idaho, USA	Not given	A follow-up study to McClure et al. (2013) using the same study design plus an experimental laboratory experiment of foraging and vigilance behaviour. Noise levels were measured continuously throughout the study and reported as hourly level equivalent or LEQ). The noise-on LEQ at bird-survey locations was 55 dBA, and was 11 dBA louder than during the noise-off survey periods. Noise levels at the control sites during the noise on phase was 41 dBA.	31% decrease in bird capture rate when road noise 'turned on' during 4-day blocks of treatment. Birds that stayed experienced reduction in body condition index. Forging vigilance behaviour given as one explanatory mechanism. Also found a reduction in stop-over efficiency, where animals that stayed during the noisy periods were less able to accumulate weight, probably because more time was spent being vigilant, rather than foraging.	(Ware, Heidi.E et al. 2015)

SPECIES	HABITAT TYPE AND LOCATION	CALL FREQUENCY OF BIRD SPECIES	INFORMATION ABOUT NOISE LEVEL, ROAD SIZE, STUDY DESIGN	RESULTS	REFERENCE
Grey Fantail *Rhipidura fuliginosa*, a common, sedentary species, dependent on forest, woodland, or shrubland	Roadside habitats, Mornington peninsula, Vic, Australia	A complex and variable sequence of high-pitched tones and frequency-modulated cheeps, mostly between 4000 and 7500 Hz.	Roadsides studied varied from <25 vpd to 32,000 vpd. Traffic noise levels were estimated using the calculation of road traffic noise (CoRTN) model, which gave traffic-noise levels at the study sites between 31 and 75 L_{10} 18 h dB(A) SPL. The CoRTN model estimates noise levels based on the hearing range, or audibility curve of humans, which is similar to the average audibility curve observed for birds.	The frequency of this species call did not appear to change in traffic noise	(Parris, Kirsten M & Schneider 2008)
Grey Shrike Thrush *Colluricincla harmonica*, a common, sedentary species, dependent on forest, woodland, or shrubland	Roadside habitats, Mornington Peninsula, Vic, Australia	A melodious and highly variable song, containing pure tones, trills, and whistles, mostly between 1500 and 4000 Hz.	Roadsides studied varied from <25 vpd to 32,000 vpd. Traffic noise levels were estimated using the calculation of road traffic noise (CoRTN) model, which gave traffic-noise levels at the study sites between 31 and 75 L_{10} 18 h dB(A) SPL. The CoRTN model estimates noise levels based on the hearing range, or audibility curve of humans, which is similar to the average audibility curve observed for birds	Increased dominant frequency of its song by 5.8Hz/dB in noisy traffic areas	(Parris, Kirsten M & Schneider 2008)

SPECIES	HABITAT TYPE AND LOCATION	CALL FREQUENCY OF BIRD SPECIES	INFORMATION ABOUT NOISE LEVEL, ROAD SIZE, STUDY DESIGN	RESULTS	REFERENCE
25 species of European migratory birds	Stop-over habitats in closed-canopy forest dominated by pine, birch and oak species of tree in eastern Poland	Not given	Did bird surveys in forest at 60 m, 310 m and 560 m from the road during the autumn migration period. A 'relatively wide' 2-lane national road, 90 $kmhr^{-1}$ speed limit and ~9000 vpd. Noise levels at each plot were recorded three times, for 5 min each, from morning through to afternoon. Mean noise levels were 72.1 ±4.5 db (range 61.2 – 81.4 db) at 60m from road edge, 48.6 ±5.4 db (40.1 – 60.6db) at 310 m from road edge and 42.1 ±6.1 db (31.7 – 52.4 db). A second study using the same sites and design was conducted during the non-breeding winter period.	The abundance of birds and species richness of birds was lowest at 60 m, highest at 310 m and intermediate at 560 m. Traffic noise was the only variable that explained variation in bird abundance and species richness. Birds that foraged on insects were the only group that was most abundant near the road. A primary conclusion was that noise levels above 49 db significantly reduced bird abundance and species richness. The results from the winter, non-breeding study were mixed, with no effect of traffic noise during December, but reductions in abundance and species richness close to the road in January and February.	Non-breeding Winter study:(Wiącek & Polak 2015); Autumn migration study: (Wiącek et al. 2015)
Wetland birds	South coast of Finland	Not given	Studied the abundance of birds in two wetlands, before and after road construction, with one wetland impacted by a new highway and the other not. Noise levels in the affected wetland was 56 dB. No description of the methods used to record or calculate noise levels is given.	The conservation value of the impacted wetland (based on species rarity, abundance and degree of endangerment) declined by 25% after road construction, with most of this decline due to reductions in the density of several wetland specialist species of bird, including the European Bittern *Botaurus stellaris*, Marsh harrier *Circus aeruginosus*, Ruff *Philomachus pugnax* and gull *Larus minutus*. Abundance of these species within 200 m of a road declined by 50% during construction and by 80% after construction. Reductions levelled off at 800 m from the road.	(Hirvonen, H. 2001)

SPECIES	HABITAT TYPE AND LOCATION	CALL FREQUENCY OF BIRD SPECIES	INFORMATION ABOUT NOISE LEVEL, ROAD SIZE, STUDY DESIGN	RESULTS	REFERENCE
Forest bird community in Ontario, Canada	20 forest sites	Not given	Birds were surveyed in 20 forest sites along numerous 4-lane highways with average AADT from 24,000–27,000. Sites were classified as 'small gap', with forest immediately on both sides of highway or 'large gaps' with gaps between forest of 175–1000 m across the road. Birds were surveyed in 50 m radius point counts at 50 m, 150 m, 250 m and 350 m from the road edge. Sites were surveyed throughout the breeding period, to test the hypothesis that bird abundance would decline during breeding season faster at small gap sites because birds were more willing to cross the road, compared to large gap sites where birds were less willing to cross the gap. Traffic noise was measured at each site on the morning of the survey (04:30 – 09:00 hrs), and ranged between 90.0 – 102 dB at survey points located 50 m from the road and 75.3 – 92.2 dB at 350 m from the road. Average dB levels at small gap sites was 89.3 db (S.E. ± 1.04) and 88.4 (±1.09) at large gap sites. The index of traffic noise was measured as the average power of noise, in unweighted dB, of each second of sound across 0.3 – 2.0 kHz, recorded during the single recording per site for the period between 5am and 9am.	The abundance of birds at small gap sites (i.e. those with higher risk of collision) declined during the breeding season at a faster rate than at large gap sites (i.e. those with lower risk of collision), demonstrating that road mortality had a bigger apparent impact on the abundance of birds than traffic noise or other disturbance effects. Authors concluded that traffic mortality is an important contributor of negative road effects, and that mitigation should also focus on reducing traffic mortality, and not just to reduce traffic noise.	(Jack et al. 2015)

CONSTRUCTION VIBRATION AND NOISE

Vibration is predominantly expected to be short term (construction phase) as it is generally associated with earthworks only. The bridge over Mordialloc Creek is proposed to sit on pier bearings for expansion, which may offer isolation from vibration at the Waterways. Advice from noise specialists is that impacts from vibration at ground level will be minimal. Vibration may disturb species which climb on or reside under the bridge structures, however this is not a concern for the significant species at the project area are surrounding areas.

A small number of studies have shown that exposure to high-intensity construction and traffic noise can result in temporary or permanent hearing loss in animals (Brattstrom & Bondello 1983; Dooling & Popper 2007). The sound pressure level of continuous noise that induces temporary hearing loss in birds is 93–110 dB(A) and higher levels are required to potentially cause permanent loss, while levels of pulses need to exceed 125 dB(A) to permanently damage hearing in birds (Dooling & Popper 2007). This is highly unlikely to be of relevance to the Project, as noise-generating activity will be controlled due to proximity to human residences. The noise from construction can be stressful and lead to animals moving away from the source, however given the short-term nature of any high noise-generating activities the impacts of construction noise are expected to be minor.

6.1.4.3 ECOLOGICAL LIGHT POLLUTION

Artificial light that alters the natural patterns of light and dark in ecosystems is referred to as ‘ecological light pollution’ (Longcore & Rich 2004). Types of ecological light pollution include chronic or periodically increased illumination, unexpected changes in illumination, and direct glare (Longcore & Rich 2004). Lights from headlights and street lighting has the potential to impact fauna utilising habitat nearby the project area.

Artificial light affects species in different ways but the main responses are either:

- Disorientation – Artificial light sources may disorient night flying species including birds and bats, as well as other species such as turtles (Gleeson & Gleeson 2012). Conversely, artificial lighting may increase orientation, providing a benefit to some species.
- Attraction – Predator species such as Magpies and Kookaburras are attracted to the lights due to the increased insect activity (Patriarca 2010). Wading birds have also shown increased foraging success under artificial lighting (Santos et al. 2010), however this may lead to increased predation.
- Avoidance – Some species may avoid well-lit areas due to an increased risk of predation (Longcore & Rich 2004), however it can be difficult to separate any avoidance behaviour shown by fauna as being the result of the lighting compared to noise or a physical barrier (Gleeson & Gleeson 2012).

The above responses may affect foraging, reproduction, communication, and other critical behaviours (Longcore & Rich 2004). One of the most notable implications of light pollution is alteration of interspecific interactions (e.g. predator-prey and competitive interactions) (Longcore & Rich 2004).

Under present conditions much of the project area and surrounds is likely to be affected by a low to moderate level of light pollution. A Preliminary Landscape Visual Impact Assessment completed for the Project (Tract 2017) determined that the major change in light levels from the Project is likely to be at the southern end of the road where the road passes over wetlands and beside residential areas.

The ecological values most at risk of impact from artificial lighting and headlights (without sufficient mitigation) are:

- Fauna occurring at the Waterways on either side of the project area (likely to be habituated to a low-moderate level of light)
- Fauna occurring within Braeside Park immediately east of the project area (wetland habitat currently dark except for light spill from Governor Road)
- Fauna occurring at Woodlands Industrial Estate wetlands (habitat currently dark)

- Migratory and nomadic birds visiting the Edithvale component of the Edithvale-Seaford Wetlands Ramsar site (although the lighting is proposed to be located >700 m from the wetlands and these fauna already regularly fly over numerous other light sources in the local area).

With regard to permanent lighting for the Project, the following is currently anticipated:

- Road lighting will be achieved using directional lighting that minimises light spill onto surrounding areas. It is expected that the bypass will have street lighting 200 m on the approach and departure of intersections with Governor Road, Lower Dandenong Road, Centre Dandenong Road and the Dingley Bypass. The dual outreach light poles will be spaced approximately 50 m apart and be approximately 15 m high. There will be additional poles required at the intersections to increase lighting levels. Subject to further assessment each pole will have 2 luminaries, each being 250w if incandescent is used, or less if LED is used. There will be no lighting on the Bypass between these intersections.
- Under structure lighting will be provided over Springvale Road (typically 250w), and over Bowen Parkway (typically 150w). No lighting is currently proposed on the bridge over the Waterways wetlands.
- No lighting is proposed for the Shared User Path – this may require revision in some locations for safety.

With regard to construction lighting, any night work would be at intersecting roads and would be short-term (i.e. approximately two nights per bridge) utilising focused directional lighting only. Work is not expected to occur early enough that lights are required for morning work. As such, impacts from temporary construction lighting are expected to be negligible.

6.1.5 PHYSICAL HABITAT DEGRADATION

Potential indirect impacts leading to degradation of habitat surrounding the bypass are discussed below.

6.1.5.1 WEED INVASION AND DISEASE

The type of disturbance associated with the construction of roads, batters, paths etc. can result in a window of opportunity for weeds and soil pathogens such as Phytophthora *Phytophthora cinnamomi* to establish. Clearing vegetation, stockpiling of materials and driving on site leaves bare ground that is particularly susceptible to colonisation by weeds or introduction of disease. Weed seeds and pathogens contained within material being used for construction or within mud from vehicles may be deposited into disturbed areas. Without effective weed and disease hygiene control protocols, contaminants from construction material and un-clean vehicles have the potential to introduce a suite of avoidable impacts to ecological values on site.

In addition, construction of the road will fragment patches of vegetation, creating additional edges from which weed invasion may occur. After completion of the road weed seed and pathogens may be carried on vehicles to colonise the road edges and spread into nearby vegetation.

The part of the project area which bisects the Waterways currently supports a low cover of weeds due to the high density of planting (when the wetlands were established) and follow up weed control and maintenance. The remainder of the project area is moderately-highly affected by weeds, particularly introduced pasture grasses, however the cover of *Catchment and Land Protection Act 1994* (CaLP Act) listed species, Weeds of National Significance, or other species regarded as highly invasive is currently generally low.

Pathogens are not currently known to be affecting the project area or vicinity. They are unlikely to be introduced or substantially worsened by the Project, as there is minimal earthworks and trenching required, and topsoil will only be moved locally on site.

With VicRoads standard controls, including reuse of topsoil on site and use of sterile fill only, substantial spread or introduction of weeds from construction of the Project are unlikely. Nevertheless, additional measures are recommended beyond standard to reduce the likelihood that weed introduction or spread leads to degradation/loss of threatened ecological communities and reduction in the value of the habitat for threatened and migratory species.

6.1.5.2 RUBBISH

The Project is expected to result in an increase in rubbish in terrestrial and aquatic habitats adjacent to the construction footprint. As well as reducing visual amenity, this may have a negative impact upon habitat quality, for example, by blocking light to sensitive vegetation.

6.1.5.3 SEDIMENT AND WATER POLLUTANTS DURING CONSTRUCTION

There is the potential for sediment-laden run-off and other pollutants entering nearby waterways during the clearing and construction phase of the Project.

The consequence of any erosion, sedimentation, and increased water pollution is highest near Woodlands Industrial Estate, the Waterways, Mordialloc Creek, and Edithvale Wetlands. Standard erosion and sedimentation control will largely ameliorate this risk during construction. Refer to the relevant specialist report for more information.

6.1.5.4 CHANGES IN HYDROLOGY

The Project was preliminarily determined to have the potential to impact groundwater and surface hydrology (volume, flow and quality) at the Waterways and nearby wetlands, including the Edithvale component of the Edithvale-Seaford Ramsar site. Any changes may have flow-on effects upon migratory waders and other waterbirds relying on seasonally inundated wetlands, and other wetland or aquatic flora and fauna in the area. Further investigation has been completed since the Preliminary flora and fauna impact assessment was completed, and the results and potential for impact on ecology are summarised below.

GROUNDWATER

Several groundwater dependant ecosystems were identified within 2 km of the project area in the preliminary groundwater assessment (WSP 2017b). These include the Edithvale Wetlands Ramsar site, which are connected to groundwater in the northern excavated ponds.

As determined through the Groundwater Impact Assessment (WSP 2017a), the project (particularly, compaction associated with fill, and driving of bridge pylons) will have a negligible impact upon groundwater volumes and flows in the area, including at Edithvale Wetlands. No impacts upon ecological values at Edithvale are anticipated.

The assessment determined that none of the other wetlands associated with the project have the potential to be impacted. The method of bridge footing construction, driving of pylons which does not involve removal of material, will ensure that groundwater does not enter the Waterways wetlands and influence water quality.

SURFACE WATER

Preliminary surface water investigations by WSP (WSP 2017c) indicated that one drainage outfall from the Project area contributes runoff into the southern section of Edithvale wetlands. The catchment area to this outfall extends from Springvale Road to approximately 800 metres south of Springvale Road and discharges to the Melbourne Water Carrum Lowlands North Drainage Scheme drainage system just south of Edithvale Road.

Preliminary flora and fauna assessment also identified the potential for surface water flow and quality changes from the road to negatively impact Woodlands wetlands and the Waterways wetlands, parts of which rely on seasonal wetting and drying to provide habitat, leading to potential loss of habitat for threatened flora and fauna.

Specifically, potential surface water impacts include:

- Impacts on vegetation and wetland habitat from a change in volume at Waterways wetlands/Mordialloc Creek by directing water off the bridge (or increase in pollutants/risk from spills if water is not directed off bridge and into WSRD structures).
- Impacts on vegetation and wetland habitat from a change in volume off the road at Woodland wetlands and Waterways wetlands related to a loss of floodplain storage.
- Water quality impacts from general use of the road (Waterways wetlands, Woodlands wetlands, Edithvale wetlands).

- Water quality impacts from spills on the road (Waterways wetlands, Woodlands wetlands, Edithvale wetlands). The potential for spills during operation of the road (such as from petrol trucks) is being assessed by the surface water team. Depending upon where a spill occurred along the road, it could have significant and long-lasting impacts upon the downstream wetlands and waterways (including Edithvale wetlands). However, roads already occur within the catchment areas of these wetlands, and the Project may not substantially increase the likelihood of a spill. A safer road may lower spill risk (although this should not be assumed). Assessment and mitigation for this risk are provided in the surface water report and are not repeated Section 7 of this report.
- Impacts on vegetation and wetland habitat from change in water flow/volume at Woodlands wetlands.
- Although not strictly an ecological impact, vegetation loss from the bridge may lead to an inability for Waterways wetlands to meet WSUD requirements.

The above impacts are addressed in the Surface Water Impact Assessment (WSP 2018d) which provides modelled results for the WSRD (i.e. swales and cross-drainage) proposed. The WSRD bio-retention systems have been designed ensure that there will be no increase in nutrient levels in the downstream sensitive receptors (Woodlands wetlands, Waterways/Mordialloc Creek, and Edithvale wetlands) during operation of the road. Impacts from changes in water quality are therefore highly unlikely. Changes to hydrology are expected to be minimal, based on the surface water impact assessment for the current design (WSP 2018d). These changes may constitute an approximately 40 mm increase in maximum flood level at Woodlands wetlands in a one in five-year flood event or 33mm in a one in 100-year event. Braeside Park wetlands may experience an approximately 43 mm increase in maximum flood level in a one in one hundred-year flood event. The increase at both wetlands would rapidly drain away, and seasonal wetting and drying of the valuable shallow wetland habitat would not be affected. This is considered highly unlikely to affect biodiversity values of the wetlands. Grassland on either side of the Project will also experience a slight increase in water level in large flood events although this is unlikely to negatively affect fauna.

Water balance modelling has been completed to model hydrological changes at Edithvale wetlands and is provided as part of the Groundwater Impact Assessment (WSP 2017a). The results indicate that any changes are likely to be from slightly increased surface water input (i.e. from an increase in impervious road surface in the catchment), not changes in groundwater, however that the overall impact upon the wetland is negligible.

Based on these assessments, the scale of any changes is anticipated to be negligible. As such, ecological impact from hydrological changes is considered unlikely.

6.1.5.5 AIR QUALITY

An Air Quality Impact Assessment was completed for the Project, including both construction and operation impacts, and is summarised in EES Chapter 13: Air Quality and Greenhouse Gas.

Without mitigation, dust and particulates during construction were predicted to be elevated above EPA 1 hour limits up to 60 m from the project area under a worst-case scenario (hottest and windiest weather). With standard CEMP measures, however, dust during construction is expected to be managed such that nearby sensitive receptors, including flora and fauna, are not substantially impacted.

The operational impacts on air quality are expected to be negligible for carbon monoxide, PM_{10} and for $PM_{2.5}$. For nitrogen dioxide, beyond 20 m of the roadway the peak levels are predicted to be under the EPA design criteria for one hour exposure, however this limit may not be appropriate for ecological values. High or long term nitrogen dioxide can impact vegetation growth and potentially affect resident fauna, although there is limited research on acceptable levels for flora and fauna, and no set standards or limits in Victoria as there are for humans. The World Health Organisation provide guidelines for nitrogen dioxide limits for vegetation. They propose critical levels for NO_x ($NO + NO_2$, expressed as NO_2 in µg/m3) as 30 µg/m3 for an annual mean and 75 µg/m3 as a 24-hour mean (World Health Organisation 2000). These are levels under which no impact is expected. There are no equivalent critical levels for fauna, however the WHO guideline levels for humans are 40 µg/m3 annual mean and 200 µg/m3 1-hour mean (World Health Organisation 2006). For generally highly mobile fauna species with shorter lifespans, these may not be applicable to the fauna at the project area.

The above guidelines have not been directly compared against predictions from the road. Air pollution impacts on flora and fauna are not regularly considered in ecological assessments. Although some impacts upon vegetation adjacent to the roadway from elevated nitrogen dioxide and other airborne pollutants are possible, it is unlikely that air pollutants are a substantial factor in comparison to many of the other likely effects of the road. Studies have shown that noise walls, and sometimes vegetative buffers, can reduce downwind pollutant concentrations near roads (Hagler et al. 2012; World Health Organisation 2000). As such, the barriers proposed to minimise disturbance impacts on wetland areas (refer Section 7.4.1) are likely to provide some mitigation of air pollution near the road, although the degree of mitigation has not been assessed. Substantial air quality impacts on the high value habitat at Braeside Park wetlands and Woodlands wetlands, and the constituent threatened and migratory fauna, are unlikely.

The WHO also provide critical loads for atmospheric nitrogen deposition, which can have substantial impacts on ecosystems (World Health Organisation 2000). The WHO study into European ecosystems suggests a critical load for atmospheric nitrogen deposition in wetlands of about 20 kg/ha per year and for most forests, 15–20 kg/ha per year. Although this impact has not been modelled, in the highly modified study area, and associated urban wetlands, atmospheric nitrogen deposition from the Project is unlikely to impact ecological values. Further assessment of this potential impact is not considered warranted.

Air quality mitigation, monitoring, and management, with the relevant EPRs are provided in EES Chapter 13: Air Quality and Greenhouse Gas.

6.1.6 EDGE EFFECTS

Edge effects are caused by a range of biotic and abiotic factors, which lead to creation of a modified edge when vegetation is cleared. Edge effects are often pronounced along linear infrastructure such as roads. Specialist species of plants and animals are often outcompeted by generalist species which are better adapted to the edge conditions (van der Ree, R., Smith, D. J. & Grilo, C. 2015). Much of the study area is already highly modified, and no areas contain large unmodified areas of native vegetation (i.e. all vegetation within the study area may be affected by edge effects to some degree), However, where the road occurs close to larger areas of habitat (Braeside Park, Woodlands wetlands, and Waterways wetlands) edge effects may be more pronounced. Controlling the individual impacts (noise, light, weeds etc.), including a buffer in fenced No-go Zones where possible, and revegetating/planting within the road corridor to create a visual and habitat buffer to the adjacent retained habitat will assist in reducing edge effects in these areas.

6.2 IMPACTS UPON NATIVE VEGETATION AND THREATENED COMMUNITIES

6.2.1 CONSTRUCTION IMPACT DETERMINATION

The methods for calculating the likely impact area for construction are provided in Section 3.6.1. The areas proposed for retention marked as No-go Zones are shown on Supplementary Figure 6, Appendix A. Guidelines for additional vegetation retention during construction are provided in Section 7.

6.2.2 ECOLOGICAL VEGETATION CLASSES

Based on the vegetation assessments completed for the Project, the project area supports 12 EVCs. Up to 10.56 ha of native vegetation (patches) is currently proposed to be lost from ten EVCs, all of which are considered either ‘endangered’ or ‘vulnerable’ within the Gippsland Plain Bioregion. This includes 0.64 ha of DELWP modelled wetland. With scattered tree buffers added, the total native vegetation loss for offset calculations is 12.10 ha. The breakdown of areas (in hectares) of maximum anticipated EVC losses provided in Table 6.3.

Offset calculations and details of proposed sourcing of offsets is provided in Section 7.2.1.

Options to create or improve areas of wetlands through the State offset process within the local area (City of Kingston council area nearby the project area) should be further explored, and would be well-received by stakeholders.

Anticipated impacts and proposed No-go Zones are shown on Supplementary Figure 5 of Appendix A.

Table 6.3 Breakdown of anticipated Ecological Vegetation Class impacts

EVC (BENCHMARK) NAME	EVC CODE	EVC CONSERVATION STATUS	MAXIMUM ANTICIPATED LOSS (HA) †
Aquatic Herbland††	GIPP0653	Endangered	0.81
Creekline Grassy Woodland	GIPP0068	Endangered	0.22
Damp Sands Herb-rich Woodland	GIPP0003	Vulnerable	0.01
Plains Grassy Wetland	GIPP0125	Endangered	4.53
Plains Grassy Woodland	GIPP0055	Endangered	2.02
Sedge Wetland††	GIPP0136	Vulnerable	0.47
South Gippsland Plains Grassland	GIPP0132_62	Endangered	0.05
Swamp Scrub	GIPP0053	Endangered	0.53
Swampy Woodland	GIPP0937	Endangered	0.04
Tall Marsh	GIPP0821	Endangered	1.23
DELWP modelled wetland	WET_0000	Not applicable	0.64
Total			**10.56**
Total including scattered tree buffers			**12.10**

† Rounded to two decimal places

†† Refer to Table 3.3. Total figures for Aquatic Herbland is comprised of Aquatic Herbland and the EVC without benchmarks Submerged Aquatic Herbland. Sedge Wetland represents Plains Sedgy Wetland and Aquatic Sedgeland as there are no benchmarks available for the Bioregion. There is no Sedge Wetland in the study area.

6.2.3 TREE IMPACTS

A total of 24 large trees comprising 14 Trees in patches and 10 Scattered Trees are proposed to be impacted (including direct removal and trees with greater than 10% Tree Protection Zone impacts). There are also 43 Small Scattered Trees and 227 Small Trees in patches proposed to be impacted. This is a total of 294 Canopy Trees proposed to be affected by the Project. When understorey trees are included (not considered under Guidelines 2017), the total will be up to 331 trees. See Table 6.4 for the summary of trees proposed for removal and retention. Also, refer to Supplementary Figure 5 in Appendix A for the location of all trees recorded in the project area. Appendix F provides an extract of all large and small Canopy Trees and their impact status (no impact, <10% TPZ impact, >10% TPZ impact, or physically removed).

No-go Zones have not yet been developed for planted or exotic trees, however it is anticipated that approximately 491 (of total 939) exotic or invasive trees and 730 (of total 1618) planted native trees will be removed or otherwise impacted by the Project.

Table 6.4 Summary of Canopy Trees (Guidelines 2017) and anticipated impacts

	LARGE	SMALL	TOTAL
Tree in Patch	**37**	**510**	**547**
— Retained	23	283	306
— Impacted	14	227	241
Scattered Tree	**23**	**133**	**156**
— Retained	13	90	103
— Impacted	10	43	53
Total retained	**36**	**373**	**409**
Total impacted*	**24**	**270**	**294**
Canopy Tree Project total	**60**	**643**	**703**

* Considered lost for impact calculations and offsets, however a number of trees may be able to be retained through design changes, further constraining the construction footprint/expanding No-go Zones, or after assessment by an arborist. Dead trees and trees likely to die from TPZ impacts should be retained as habitat wherever possible. Refer to Section 7.5.

6.2.4 LISTED COMMUNITIES

Several EVCs are also consistent with up threatened vegetation communities under the EPBC Act and FFG Act. The breakdown of areas (in hectares) of threatened vegetation communities within the project area and the construction footprint is provided in Table 6.5 below.

For EPBC Act communities, an assessment under the significant impact criteria was completed and is provided in Appendix G. Based on this assessment, the impacts upon the communities are not considered significant. EPBC Act Offsets are not currently proposed.

Table 6.5 Breakdown of Threatened Vegetation Communities

COMMUNITY	STATUS	ANTICIPATED LOSS (HA)
EPBC Act		
Natural Damp Grassland of the Victorian Coastal Plain	Critically endangered	0.04
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically endangered	0.24 (Note: this extent excludes the area north of Bowen Parkway which was previously mapped as this community but has since been reassessed. If this area were included, the anticipated loss would be approximately 4 ha. Refer to Section 4.3.2.1 for more information)
Total		0.28

COMMUNITY	STATUS	ANTICIPATED LOSS (HA)
FFG Act		
Plains Grassland (South Gippsland) Community	Listed	0.04
Herb-rich Plains Grassy Wetland (West Gippsland) Community	Listed	0.35 (Note: this extent excludes the area north of Bowen Parkway which was previously mapped as this community but has since been reassessed. If this area were included, the anticipated loss would be approximately 4 ha)
Total		0.39

6.3 IMPACTS UPON SIGNIFICANT FLORA

Impacts upon flora species with a moderate or higher likelihood of occurrence are assessed in detail in Table 6.6. The use of No-go Zones to protect known areas of threatened flora outside of the construction footprint will be implemented. These minimum No-go Zones are provided on Supplementary Figure 6 of Appendix A.

Two significant species will be impacted by the Project: Leafy Twig-sedge and Large River Buttercup. Neither of these species are listed under the EPBC Act or the FFG Act and the impacts upon these species will be relatively minor. No known locations of any other species will be impacted by the Project and no significant flora species are likely to be significantly impacted by the Project.

Table 6.6 Assessment of likely impacts upon significant flora species

SPECIES	CONSERVATION STATUS			LIKELY IMPACT	MITIGATION REQUIRED	RESIDUAL IMPACT
	EPBC ACT	FFG ACT	ADV LIST			
Cladium procerum Leafy Twig-sedge	-	-	Rare	Although rare in Victoria, this species is relatively common in the region and is quite common at the project area. It occurs in dense swards at the edges of ponds at the Waterways wetlands. Up to 0.071 ha of this species of a total recorded 0.325 ha (more likely to occur outside of the surveyed area) at the Waterways is proposed to be cleared for the Project. This is a minor impact upon the species. No specific mitigation is considered warranted for this species.	None	0.071 ha of at least 0.325 ha proposed to be cleared. This is a minor impact upon this species.
Coronidium gunnianum Pale Swamp Everlasting	-	-	Vulnerable	This species occurs in numerous patches at the Waterways wetlands. The known locations at the Waterways are not currently proposed to be impacted by the Project.	None	Species unlikely to be impacted.
Dianella amoena Matted Flax-lily	Endangered	Listed	Endangered	This species was recorded outside of the project area during targeted flora surveys completed for this study. The known location at the Waterways is not currently proposed to be impacted by the Project. An assessment under the significant impact criteria was completed and is provided in Appendix G. The species is unlikely to be impacted based on the current construction footprint.	None	**Species unlikely to be impacted**

SPECIES	CONSERVATION STATUS			LIKELY IMPACT	MITIGATION REQUIRED	RESIDUAL IMPACT
	EPBC ACT	FFG ACT	ADV LIST			
Lachnagrostis punicea subsp. *filifolia* Purple Blown-grass	-	Listed	Rare	The species, which occurs in brackish to saline depressions in grassland or woodland, was not recorded within the project area. As it is known to have been planted at the Waterways, there is a chance that this species may be impacted by the Project, if it occurs within the project area. Given it was not recorded in multiple surveys, it would only occur in low numbers. Any impacts are unlikely to significantly impact the species as a whole.	**None**	**Minor, if present**
Ranunculus amplus Lacey River Buttercup	-	-	Rare	The species is known to have been planted as part of revegetation at the Waterways although was not recorded during field surveys. If it occurs, the species as a whole is unlikely to be significantly impacted by any loss of individual plants from the Project.	**None**	**Minor, if present**
Ranunculus papulentus Large River Buttercup	-	-	Poorly known	This species has been recorded in several locations within the project area. The Project will result in the removal of several of these occurrences. The species is uncommon, however it is not considered threatened. Despite the proposed impact, the species is unlikely to be substantially affected by the Project.	**None**	**Minor – loss of several occurrences of a species which is not considered threatened.**

SPECIES	CONSERVATION STATUS			LIKELY IMPACT	MITIGATION REQUIRED	RESIDUAL IMPACT
	EPBC ACT	FFG ACT	ADV LIST			
Senecio psilocarpus Swamp Fireweed / Smooth-fruited Groundsel	Vulnerable	-	Vulnerable	The species was not recorded within the project area during targeted flora survey completed for this study, however it is known to have been planted at the Waterways wetlands. An assessment was completed under the significant impact guidelines and is provided as Appendix G. If present, it is unlikely to be substantially affected by the Project.	**None**	**Minor, if present**
Xerochrysum palustre Swamp Everlasting	Vulnerable	Listed	Vulnerable	This species was recorded immediately outside the project area during targeted flora surveys completed for this study. These known locations at the Waterways are not proposed to be impacted by the Project. An assessment under the significant impact criteria was completed and is provided in Appendix G. The species is unlikely to be impacted by the Project.	**Pre-clearing survey (and relocation if required). Additional weed management at Waterways wetlands.**	**None**

6.4 IMPACTS UPON SIGNIFICANT FAUNA

The likelihood of impacts to significant species which occur or have a 'low-moderate' or greater likelihood of occurring (intermittently or regularly) at the project area and adjacent wetlands are provided in Table 6.7 below.

The mitigation measures in the table, relied upon to varying degrees for the assessment of residual impacts, are outlined below. These are consistent with the measures resulting from the risk assessment (Section 4.6). This can therefore be seen as the minimum mitigation scenario for significant fauna species. More detail on the measures, plus additional measures (to provide a best practice strategy, not solely for the significant fauna) is provided in Section 7.

a No-go Zones for retained habitat at the Waterways wetlands (see Supplementary Figure 6 of Appendix A).
b Barriers to minimise road mortality at wetland areas (Recommended design is Type 1: Multi-function fauna barrier as per Section 7.4.1)
c Fauna connectivity culverts between key wetland areas (at least the current design, provided in Table 7.6 and Figure 7.2). (Note: some species are unlikely to regularly move through culverts but may occasionally utilise them provided there is sufficient vegetation at entrances/exits)
d Revegetation of disturbed areas to/from fauna passages (see Section 7.4.5.1)
e Fauna-sensitive lighting (as per Section 7.4.3)
f Noise attenuation in and around wetland areas (Noise mitigation recommended is the fauna barrier Type 1: Multi-function fauna barrier as per Section 7.4.1)
g Minimise wetland vegetation clearance under bridge, and revegetate to all extent possible (see Section 7.4.5.2).
h Landscape plan to include some revegetation and maintenance of wet and grassy habitat post-works (including on swales and water storage areas) in areas behind fauna barriers (see Section 7.4.5.1)

Areas of impact upon habitat for birds are calculated from the habitat mapping completed for this study (Figure 4.6), and the likely use of each habitat type by the relevant bird species (e.g. some of the key species provided in Table 4.8). Some small areas of additional wetland habitat occur elsewhere within the alignment (i.e. outside of the wetland mapping study area) and have not been mapped as habitat in this study. The significant species are less likely to utilise habitat away from the key wetland areas mapped.

Table 6.7 Impact assessment for significant fauna with a moderate or higher likelihood of occurrence

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Birds							
Australasian Bittern	*Botaurus poiciloptilus*	Endangered	Listed	Endangered	Some minor loss of foraging and roosting habitat, up to approximately 0.6 ha, is likely. The proposed development may also impact the species through fragmentation of wetland habitat, increased mortality from road collisions, and disturbance through increased noise and lighting. The Significant Impact Criteria assessment (Appendix G) provides further information regarding impacts and mitigation for this species. This assessment gave the likelihood of a significant impact occurring, in lieu of any mitigation, as 'moderate' for this species.	A, B, C, D, E, F, G, H	Loss of a small amount of foraging, non-breeding habitat up to approximately 0.6 ha is unavoidable. Residual impacts may occur from disturbance and loss of connectivity; however, with the mitigation proposed, these are considered unlikely to result in a material decrease in the size of the population or the use of local habitat. The Significant Impact Criteria assessment (Appendix G) gave the likelihood of a residual significant impact occurring for this species as 'low'.
Australasian Shoveler	*Anas rhynchotis*			Vulnerable	Some fragmentation of species habitat is likely, as well as some disturbance-related impacts, including impacts from noise and light. Loss or degradation of a small area of the species' wetland habitat, of approximately 1.008 ha, is likely during and following bridge construction.	A, B, C, F, G	A small area of wetland habitat, which the species may utilise for foraging, roosting and shelter, will be directly impacted. The mitigation measures proposed will likely materially reduce other types of impacts.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Australian Little Bittern	*Ixobrychus dubius*		Listed	Endangered	Some direct loss of foraging and roosting habitat (approximately 0.553 ha) is likely. The species is known to breed within Woodlands wetlands, although not at the Waterways wetlands where direct impacts on habitat are proposed. Noise and light impacts may reduce the value of the habitat at Woodlands wetlands for breeding. The proposed development may affect the species through direct loss of habitat and/or indirect impacts such as increased mortality through road collisions. Fragmentation of the wetland network may affect the suitability of nearby habitat for the species.	A, B, C, D, E, F, G, H	Some direct loss of foraging habitat is unavoidable. Residual impacts may occur from disturbance and loss of connectivity; however, these are considered unlikely to result in a material decrease in the size of the population, with the mitigation measures proposed.
Australian Painted Snipe	*Rostratula australis*	Endangered	Listed	Critically endangered	The project area itself is unlikely to support important habitat for this species. However, there is the potential for impacts such as increased noise and lighting disturbance upon potential habitat at Braeside Park and possibly Woodlands. The Significant Impact Criteria assessment (Appendix G) provides further information regarding impacts and mitigation for this species.	A, B, F, G	Direct loss of foraging habitat is unlikely. Residual impacts may occur relating to disturbance of nearby habitat; however, these residual impacts are considered to be minor. The Significant Impact Criteria assessment (Appendix G) gave the likelihood of a residual significant impact occurring for this species as 'low'.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Baillon's Crake	*Porzana pusilla palustris*		Listed	Vulnerable	Approximately 6.667 ha of habitat (some of it potential breeding habitat) for this species may be lost or degraded during and following construction. Much of this is poor quality exotic weedy grassland (i.e. the area immediately north of Governor Road) and is unlikely to be regularly utilised. Loss of connectivity is likely, as well as potential increased mortality from road collisions. Remaining habitat may be reduced in quality by an increase in noise and light.	A, B, C, D, E, F, G, H	Some habitat is proposed to be lost. The mitigation measures proposed will likely materially reduce other types of impacts.
Black Falcon	*Falco subniger*			Vulnerable	Loss of a small amount of low value foraging habitat. Small increase in mortality possible.	No specific mitigation proposed.	Impacts upon this species are likely to be minor.
Blue-billed Duck	*Oxyura australis*		Listed	Endangered	Some fragmentation of species habitat is likely, as well as some disturbance-related impacts. Loss or degradation of a small area of habitat will occur during and following bridge construction; this is likely to comprise less than 0.804 ha (including open water, much of which may remain unaffected). Indirect impacts upon Braeside Park wetlands, where the species is known to breed, could potentially result in reduced breeding success.	A, B, C, F, G	A minor area of habitat, which the species may use for foraging, will be directly impacted; some of these impacts will be temporary. The mitigation measures proposed will likely materially reduce other types of impacts.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Caspian Tern	*Hydroprogne caspia*		Listed	Near threatened	Minor impacts on foraging habitat for this species are likely, and there is the potential for indirect impacts, (e.g. increased noise) upon nearby foraging habitat.	A, B, F, G	Minor loss of potential foraging habitat around the bridge is unavoidable. The mitigation measures proposed will likely materially reduce other types of impacts.
Common Greenshank	*Tringa nebularia*	Migratory		Vulnerable	The study area and surrounds are unlikely to support habitat of significance to this species. Mudflats and shallow water areas where the species may periodically forage (e.g. Braeside Park and Woodlands) will not be directly impacted.	No specific mitigation proposed.	Potential impacts to this species are likely to be indirect and minor.
Common Sandpiper	*Actitis hypoleucos*			Vulnerable	The project area is considered unlikely to support important habitat for the species, although potential foraging habitat may occur at Braeside Park. Possible impacts to this potential habitat relate primarily to disturbance from noise and light spill.	B, E, F	Noise and light impacts to potential foraging habitat at Braeside Park will be reduced such that any residual impacts are likely to be minor.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Curlew Sandpiper	*Calidris ferruginea*	Critically endangered, Migratory	Listed	Endangered	The project area itself is unlikely to support valuable foraging habitat for this species. However, there is the potential for indirect impacts such as increased noise and lighting disturbance upon adjacent and nearby wetland habitat at Braeside Park and potentially Woodlands. The Significant Impact Criteria assessment (Appendix G) provides further information regarding impacts and mitigation for this species.	A, B, F, G, H	Direct loss of foraging habitat is unlikely. Residual impacts may occur relating to disturbance of nearby habitat; however, these residual impacts are considered to be minor. The Significant Impact Criteria assessment (Appendix G) gave the likelihood of a residual significant impact occurring for this species as 'low'.
Diamond Dove	*Geopelia cuneata*		Listed	Near threatened	The project area is considered very unlikely to support important habitat for the species, although individuals may occasionally occur in the area and potentially forage in low, open grassy areas near waterbodies. When present in the area, the primary risk to this species, known to forage on roadsides, is likely mortality from traffic collisions.	B, F, H	Potential mortality and noise impacts will be reduced, and the loss of open grassy vegetation for foraging will be reduced, such that the residual impact on this species is likely to be minor
Eastern Great Egret	*Ardea modesta*		Listed	Vulnerable	Some loss of regular foraging and breeding habitat is likely, including wet grasslands within and adjacent to the alignment; this loss is likely to consist of less than 0.604 ha. Potential fragmentation and disturbance of adjacent wetland and grassland habitat is likely.	A, B, C, F, G, H	Some loss of foraging habitat is unavoidable. The mitigation measures proposed will likely materially reduce other types of impacts.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Fork-tailed Swift	*Apus pacificus*	Migratory			This aerial species may occur in the airspaces over the study area intermittently during seasonal movements to the local region, but is unlikely to use terrestrial habitats within the study area. Therefore, the study area does not represent important habitat for this species. The Significant Impact Criteria assessment (Appendix G) provides further information regarding the potential for impacts on this species.	No specific mitigation proposed.	Any potential impacts to this species are likely to be indirect and minor. Project will not impact this species.
Freckled Duck	*Stictonetta naevosa*		Listed	Endangered	Some fragmentation of species habitat is likely, as well as some disturbance-related impacts. Loss or degradation of a small area of habitat of approximately 0.804 ha is likely.	A, B, C, F, G	A small area of wetland habitat around the bridge will be directly impacted; some of these impacts will be temporary. The mitigation measures proposed will likely materially reduce other types of impacts. Residual impact considered to be minor.
Glossy Ibis	*Plegadis falcinellus*	Migratory		Near threatened	Some loss, fragmentation and disturbance of species foraging habitat is likely, including periodically flooded grasslands within and adjacent to the alignment. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding the potential for impacts on this species.	A, B, C, F, G, H	Some loss of foraging habitat, including grasslands, is unavoidable. Noise disturbance and habitat degradation reduced in remaining areas of habitat. A 'significant impact' to this species is considered unlikely (Appendix G).

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Hardhead	*Aythya australis*			Vulnerable	Some fragmentation of species habitat is likely, as well as some disturbance-related impacts. Loss or degradation of a small area of habitat at the Waterways wetlands/Mordialloc Creek is likely. Indirect impacts upon Braeside Park wetlands could potentially result in reduced breeding success.	A, B, C, F, G	A minor area of habitat of up to approximately 0.804 ha, which the species may use for foraging, roosting and shelter will be directly impacted although some of these impacts will be temporary. The mitigation measures proposed will likely materially reduce other types of impacts.
Intermediate Egret	*Ardea intermedia*		Listed	Endangered	Some loss, fragmentation and disturbance of species foraging habitat is likely, including periodically flooded grasslands within and adjacent to the alignment.	A, B, C, F, G, H	Some loss of foraging habitat is unavoidable. Noise disturbance and habitat degradation reduced in remaining areas of habitat.
Latham's Snipe	*Gallinago hardwickii*	Migratory		Near threatened	Some loss and fragmentation of foraging habitat, of up to 0.219 ha, is likely. Potential for indirect impacts upon adjacent and nearby habitat, as well as possible increased mortality from road collisions. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding impacts and mitigation for this species.	A, B, F, G, H	Some loss of foraging habitat, particularly grasslands and hydric vegetation within the alignment, is unavoidable. Noise disturbance and habitat degradation will likely be reduced in remaining areas of habitat. The Significant Impact Criteria assessment for migratory species (Appendix G) gave the likelihood of a significant residual impact occurring as 'low' for this species.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Lewin's Rail	*Lewinia pectoralis pectoralis*		Listed	Vulnerable	Some loss of species foraging and breeding habitat may occur, as well as potentially increased mortality from road collisions. The secretive nature of this species may partly explain the low numbers of previous records near the project area; however, given this low number and the generally low quality of habitat within the project area, the habitat which may be lost is unlikely to be important for the species.	A, B, C, D, E, F, G, H	Some loss of foraging habitat, particularly dense ground vegetation, is unavoidable. Indirect impacts are likely to be substantially reduced in remaining areas of habitat by the mitigation proposed.
Little Egret	*Egretta garzetta nigripes*		Listed	Endangered	Some loss, fragmentation and/or disturbance of species foraging habitat is likely.	A, B, C, F, G, H	Minor loss or disturbance of foraging habitat is likely. Indirect impacts are likely to be substantially reduced in remaining areas of habitat by the mitigation proposed.
Long-toed Stint	*Calidris subminuta*	Migratory		Near threatened	The project area is considered unlikely to support important habitat for the species, although potential foraging habitat may occur at Braeside Park and Woodlands. Possible impacts to this potential habitat relate primarily to disturbance from noise and light spill. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding the potential for impacts on this species.	B, E, F	Noise and light impacts to foraging habitat at Braeside Park and Woodlands wetlands will be minimised. Residual impacts upon this species are likely to be minor. Significant impact is highly unlikely (Appendix G).

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Magpie Goose	*Anseranas semipalmata*		Listed	Near threatened	Some loss, fragmentation and disturbance of species foraging habitat is likely, including flooded and dry grasslands within and adjacent to the alignment.	A, B, C, F, G, H	Some loss of foraging habitat, particularly grasslands, is unavoidable. Disturbance and habitat degradation will likely be reduced in remaining areas of habitat.
Marsh Sandpiper	*Tringa stagnatilis*	Migratory		Vulnerable	The project area itself is unlikely to support important habitat for this species. However, there is the potential for indirect impacts upon adjacent and nearby habitat. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding the potential for impacts on this species.	A, B, F, G, H	Some loss of low quality foraging habitat may occur. Indirect impacts are likely to be substantially minimised in remaining areas of habitat by the mitigation proposed. Significant impact is highly unlikely (Appendix G).
Musk Duck	*Biziura lobata*			Vulnerable	Some fragmentation of habitat is likely, as well as some disturbance-related impacts. Loss or degradation of a minor area of wetland habitat, of approximately 0.789 ha, during and following bridge construction is likely.	A, B, C, F, G	A minor area of wetland habitat, which the species likely uses for foraging, will be directly impacted; some of these impacts will be temporary. The mitigation measures proposed will likely materially reduce other types of impacts.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Nankeen Night Heron	*Nycticorax caledonicus hillii*			Near threatened	Some loss of species foraging and potential breeding habitat is likely within and adjacent to the alignment. Fragmentation and disturbance of adjacent wetland and grassland habitat may also occur.	A, B, C, F, G, H	Some loss of foraging habitat, including wet grassland, is unavoidable. Noise disturbance and habitat degradation will be minimised in remaining areas of habitat. Some residual impact is expected however this will be relatively minor with the mitigation proposed.
Pacific Gull	*Larus pacificus pacificus*			Near threatened	The habitat within the study area and vicinity is unlikely to be of high value to the species, for which there is a large amount of habitat in the locality.	No specific mitigation proposed.	There is unlikely to be a material residual impact on the species.
Pectoral Sandpiper	*Calidris melanotos*	Migratory		Near threatened	The project area itself is unlikely to support important habitat for this species. However, there is the potential for indirect impacts upon adjacent and nearby habitat. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further information regarding impacts and mitigation for this species.	A, B, F, G, H	Some potential foraging habitat, namely grassland adjacent to wetlands, may be lost. Noise disturbance and habitat degradation will be reduced through mitigation in remaining areas of habitat. A 'significant impact' to this species is considered unlikely (Appendix G). Residual impact is expected to be minor.
Pied Cormorant	*Phalacrocorax varius*			Near threatened	Some foraging and roosting habitat for the species will be lost, although some of these impacts will be temporary. Potential fragmentation and disturbance of adjacent wetland habitat.	A, B, F, G	The great majority of wetland habitat will be retained. Indirect impacts of noise disturbance and potential habitat degradation will be reduced through mitigation and residual impact upon this species is expected to be minor.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Red-necked Stint	*Calidris ruficollis*	Migratory			The project area itself is unlikely to support important habitat for this species. However, there is the potential for indirect impacts upon adjacent and nearby foraging habitat. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding the potential for impacts on this species.	A, B, F, G	Shallow water and drawn-down wetland habitat areas will not be removed. Indirect impacts of noise disturbance and habitat degradation will be reduced through mitigation. A 'significant impact' to this species is considered highly unlikely (Appendix G). Residual impact is expected to be minor.
Royal Spoonbill	*Platalea regia*			Near threatened	Some loss of species foraging habitat is likely, including wet grasslands within and adjacent to the alignment. Potential fragmentation and disturbance of adjacent wetland habitat.	A, B, C, F, G, H	Some loss of foraging habitat, including wet grasslands, is unavoidable. Noise disturbance and habitat degradation will be reduced through mitigation in remaining areas of habitat. Residual impact is expected to be minor.
Ruff	*Philomachus pugnax*	Migratory			This species is a rare visitor to the area; potential impacts to this species may include disturbance (e.g. noise and light) of mudflat and shallow wetland habitat, and potentially collisions with traffic.	B, E, F	Potential noise and light impacts to potential foraging habitat at Braeside Park and Woodlands will be reduced, as will potential collision impacts. Residual impact is expected to be minor.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Rufous Fantail	*Rhipidura rufifrons*	Migratory			Potential habitat within the project area is limited to wooded vegetation in Braeside Park. This habitat will not be physically disturbed; hence possible impacts to this species are likely to consist of potential noise and light disturbance. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding the potential for impacts on this species	E, F	Potential noise and light impacts to potential foraging habitat at Braeside Park will be minimised. A 'significant impact' to this species is considered highly unlikely (Appendix G).
Sharp-tailed Sandpiper	*Calidris acuminata*	Migratory			Some loss of potential foraging habitat is possible, including grassy areas fringing shallow water. Potential disturbance of adjacent wetland habitat, including shallow water (mudflat) habitat at Braeside park, known to occasionally support the species. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further information regarding impacts and mitigation for this species. This assessment gave the likelihood of a significant impact occurring, in lieu of any mitigation, as 'moderate' for this species. This was based on potential impacts on feeding and resting behaviour from noise and lighting disturbance.	A, B, F, G, H	Loss of a small amount of foraging, non-breeding habitat may occur; much of this habitat is degraded and considered to be of relatively low quality for the species. Noise and light disturbance and habitat degradation will be reduced in remaining areas of habitat. The Significant Impact Criteria assessment (Appendix G) gave the likelihood of a residual significant impact occurring for this species as 'low'.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Spotted Harrier	*Circus assimilis*			Near threatened	The most important habitat for this species locally will be grasslands associated with the bypass corridor. As such, the road will remove some suitable foraging habitat for this species. However, given the wide foraging range of this species and the intermittent and small number of records, this is unlikely to materially impact the species.		The road will remove some suitable foraging habitat for this species. However, given the wide foraging range of this species and the intermittent and small number of records, this is unlikely to materially impact the species.
Whiskered Tern	*Chlidonias hybridus javanicus*			Near threatened	Some loss of species foraging habitat is likely. Potential fragmentation and disturbance of habitat adjacent to the alignment.	A, B, F, G, H	Some loss of species habitat will be unavoidable. Potential indirect impacts upon surrounding wetland habitat likely to be reduced.
White-bellied Sea-Eagle	*Haliaeetus leucogaster*		Listed	Vulnerable	The loss of a small amount of hunting habitat is unlikely to impact this species.		The loss of a small amount of hunting habitat is unlikely to impact this species.
White-throated Needletail	*Hirundapus caudacutus*	Migratory	Listed	Vulnerable	Predominantly an aerial species which is only likely to occur over the study area intermittently during seasonal movements within the region including many different habitat types. As such the works are unlikely to impact the species. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding the potential for impacts on this species		The proposed works are unlikely to impact upon the species. A 'significant impact' to this species is considered highly unlikely (Appendix G).

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
White-winged Black Tern	*Chlidonias leucopterus*			Near threatened	The project area itself is unlikely to support important habitat for this species. However, there is the potential for indirect impacts upon adjacent and nearby habitat.	A, B, F, G, H	Some minor loss of grassland foraging habitat may be unavoidable. Potential indirect impacts upon surrounding habitat likely to be reduced.
Wood Sandpiper	*Tringa glareola*	Migratory		Vulnerable	Loss of species foraging habitat unlikely. Potential for indirect impacts upon adjacent and nearby wetland habitat. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further information regarding the potential for impacts on this species.	A, B, F, G, H	Potential indirect impacts upon wetland habitat likely to be reduced. A 'significant impact' to this species is considered unlikely (Appendix G).
Mammals							
Grey-headed Flying-fox	*Pteropus poliocephalus*	Vulnerable	Listed	Vulnerable	The vegetation at the project area is predominantly grassland which does not constitute foraging habitat for the species. A small amount of potential foraging habitat (i.e. treed areas) may be lost; however, this is considered highly unlikely to impact upon the species. Indirect impacts are unlikely to affect this species given the large area over which it forages. The Significant Impact Criteria assessment for migratory species (Appendix G) provides further detail regarding impacts and mitigation for this species.		A small amount of potential foraging habitat may be lost; however, this is considered highly unlikely to materially impact upon the species. The Significant Impact Criteria assessment (Appendix G) gave the likelihood of a residual significant impact occurring for this species as 'low'.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Reptiles							
Eastern Snake-necked Turtle	*Chelodina longicollis*			Data deficient	Wetland habitat surrounding the study area will be retained; however, some terrestrial habitat around and between wetlands will be lost. Terrestrial habitats are utilised regularly by the species for movement between wetlands, while suitable areas of sand or soil near wetlands can be used for egg-laying. Impacts relating to loss of connectivity and increased road mortality are likely.	A, B, C, D, E, F, G, H	Residual impacts relate to the loss of some terrestrial habitat around and between wetlands, and some residual loss of connectivity.
Glossy Grass Skink	*Pseudemoia rawlinsoni*			Vulnerable	Some habitat for this species, namely dense ground-layer vegetation in low-lying areas and around waterbodies, and in vegetated drainage lines, may be lost; this is most pertinent in Waterways, where the species has previously been recorded. Connectivity between areas of potentially suitable habitat will be reduced, and the risk of road mortality during dispersal may increase.	A, B, C, G, H	A small amount of potential habitat may be lost; this predominantly comprises vegetated drainage lines and low-lying areas within the alignment.

COMMON NAME	SCIENTIFIC NAME	CONSERVATION STATUS			LIKELY IMPACT	KEY MITIGATION MEASURES	RESIDUAL IMPACT
		EPBC ACT	FFG	VICTORIAN ADVISORY LIST			
Amphibians							
Southern Toadlet	*Pseudophryne semimarmorata*			Vulnerable	Some potential habitat for this species may be lost. Increased noise levels may potentially disturb individuals and/or affect detection of auditory cues. Connectivity between populations may be reduced; however, given the general lack of suitable habitat outside of Braeside Park, functional connectivity may not be materially affected.	A, F, H	Some potential habitat for this species may be lost. Fauna sensitive design and noise barriers will reduce noise-related impacts to Southern Toadlet.

6.5 IMPACTS UPON ECOLOGICAL CHARACTER

Ecological character is defined under the Ramsar convention (Department of the Environment Water Heritage and the Arts 2008) as:

> *the combination of the ecosystem components, processes, benefits and services that characterise the wetland at a given point in time*

Although only one nearby wetland is protected under the Ramsar convention (Edithvale-Seaford Wetlands), it is important to consider ecological character (i.e. considering the whole of the ecosystem, not just particular listed species) when assessing impacts of development upon all nearby environments of significance. We summarise the potential for impacts upon ecological character for the project area itself, as well as for identified significant sites (Woodlands wetlands, Braeside Park and wetlands, Waterways wetlands, and Edithvale wetlands) nearby the project area in Table 6.8.

Table 6.8 Anticipated impacts upon ecological character

SITE	IMPACTS TO ECOLOGICAL CHARACTER
Project Area	Within the project area itself the Project will lead to a loss of open space, within which numerous non-threatened bird species, in addition to some threatened species, can regularly be seen foraging. These areas are also likely to periodically facilitate the foraging and/or dispersal of small terrestrial vertebrates, including mammals such as native rats, and reptiles including the Eastern Long-necked Turtle. The ecological character of this corridor, although generally in poor condition and put aside as a road reserve, will be permanently altered. The parts of the project area not included within the construction footprint or otherwise not proposed to be permanently lost are likely to be affected by noise and other indirect effects. Landscaping, fencing, and other measures will partially mitigate these impacts.
Woodlands Industrial Estate Wetlands	Although direct or indirect impacts upon vegetation are not anticipated, the habitat value is likely to be impacted by noise and light from the Project. Although effects upon vegetation, hydrology and water quality are anticipated to be negligible, there may be potential disturbance impacts upon the native vertebrate species occurring in this area resulting from increased noise and light. Connectivity within the landscape will also be impacted; this will particularly be relevant for non-avian vertebrates such as possums, rats and echidnas, reptiles (e.g. snakes, skinks etc.), and frogs.
Braeside Park	The ecological character of Braeside Park is likely to be affected by increased edge effects, specifically from light and noise, even with mitigation proposed in Section 7. This may lead to increased fauna disturbance and changes in the species composition at the wetlands. Roadkill and disturbance from the road (noise, light, visual impact) is likely to also increase edge effects along the remaining boundary between Braeside Park and the Project. This is likely to change ecological character of the park along that edge, predominantly impacting common species. Connectivity within the landscape will also be impacted; this will particularly be relevant for non-avian vertebrates such as possums, rats and echidnas, reptiles (e.g. snakes, skinks etc.), and frogs. Although this report does not address social impacts, the Project may affect birdwatching and other nature-based activities in the Park.

SITE	IMPACTS TO ECOLOGICAL CHARACTER
Waterways wetlands	Increased noise and light, and the fragmentation of habitat may lead to minor changes in ecological character at the Waterways wetlands. Vegetation communities and health outside of the project area are unlikely to be affected.
Edithvale-Seaford Ramsar site	The Project is sufficiently distant from the Edithvale-Seaford Ramsar site (>700 m to the Edithvale wetlands) that no impacts upon ecological character are anticipated. Changes in hydrology are expected to be negligible, as are impacts from noise and light.

6.6 IMPACTS UPON EDITHVALE-SEAFORD RAMSAR SITE

An assessment under the significant impact criteria was completed for the Edithvale-Seaford Ramsar site and is provided in Appendix G. Based on this assessment, no impacts upon the wetland habitat values of the site are anticipated, and the Project is unlikely to significantly impact this MNES. Exceedance of the Limits of Acceptable Change (LAC) for the Ramsar site (Hale & Butcher 2017) is highly unlikely to result from the Project.

Notwithstanding the above, many of the wetland birds which visit this site, including migratory and threatened species, also visit wetlands associated with the Project depending on local conditions (specifically, Woodlands wetlands, Braeside Park wetlands, and Waterways wetlands). As such, mitigation of impacts upon these smaller patches of habitat will be important to ensure that the network of local habitat is retained. This is particularly the case for the shallow water/mudflat habitat of which there is little remaining in the Melbourne region.

6.7 THREATENING PROCESSES

6.7.1 FLORA AND FAUNA GUARANTEE ACT 1988

There are 43 threatening processes listed under the FFG Act. An assessment was undertaken to identify which threatening processes were relevant to the Project and which processes may be exacerbated by the Project. The assessment is provided in Table 6.9. Several of these FFG Act listed threatening processes may be exacerbated by the Project without sufficient controls. Standard VicRoads controls in conjunction with the mitigation measures provided in Section 7 will assist in managing these risks such that the overall impact of threatening processes is minimal.

Table 6.9 Threatening Processes (FFG Act) relevant to project area

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Alteration to the natural flow regimes of rivers and streams.	There have been extensive changes to the natural flow regimes of rivers and streams in the locality, with natural water movement modified around existing roads, residential development, and industrial development. The southern part of the project area would have been part of a large swamp (Carrum Carrum Swamp) which was largely drained in the 1980s. Although artificial wetlands have been created, flows into these wetlands are controlled, leading to an alteration in seasonal wetting and drying.	The project will have negligible impact upon natural flow regimes of rivers and streams (e.g. Mordialloc Creek, Dingly Drain etc.) which are already substantially modified. **The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Alteration to the natural temperature regimes of rivers and streams.	Likely to already be affecting the project area and surrounds due to modification of drainage, wetland construction, and alterations to vegetation and landform upstream of the relevant creeks/drainage lines.	**The project is unlikely to exacerbate this threatening process.**
Collection of native orchids.	Not relevant to the project area.	**The project is unlikely to exacerbate this threatening process.**
Degradation and loss of habitats caused by feral Horses (Equus caballus).	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Degradation of native riparian vegetation along Victorian rivers and streams.	Most of the native vegetation that exists along current rivers, streams and drainage lines within the project area is degraded. Where culverts have been constructed, the condition of the native vegetation is typically poor. Vegetation along Mordialloc Creek has been rehabilitated and is in generally good condition.	The project has the potential to exacerbate this threatening process at Mordialloc Creek through bridge construction however controls will be in place to minimise impacts from construction. Disturbed vegetation will be rehabilitated. The project is unlikely to lead to degradation of native riparian vegetation elsewhere within or adjacent to the project area. **It is possible that the project may exacerbate this threatening process.**
Habitat fragmentation as a threatening process for fauna in Victoria.	The area is heavily modified through land clearing, residential and industrial development, and road networks. This threatening process has had a severe impact upon local fauna.	Habitat fragmentation is anticipated through bisection of the Woodland wetlands/Braeside Park wetlands corridor as a result of this project. Some fragmentation is also expected at the Waterways Wetlands, particularly in the area immediately south of Governor Road. Fragmentation of other minor movement corridors may also occur. **The project is likely to exacerbate this threatening process.**
High frequency fire resulting in disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.	Fires are unlikely to occur frequently due to the built-up nature of the area and the control of biomass in the project area and nearby parks through other means (slashing and grazing). Therefore, this threatening process is unlikely to be of relevance to the project area.	**The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Human activity which results in artificially elevated or epidemic levels of Myrtle Wilt within Nothofagus-dominated Cool Temperate Rainforest.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Inappropriate fire regimes causing disruption to sustainable ecosystem processes and resultant loss of biodiversity.	Due to the built-up nature of the area, fire is no longer a viable management strategy. A change in fire regime may already have affected the biodiversity of remnant vegetation in the area.	**The project is unlikely to exacerbate this threatening process.**
Incidental catch (or bycatch) of seabirds during longline fishing operations.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Increase in sediment input into Victorian rivers and streams due to human activities.	The project area exists within a highly urbanised and modified landscape and the creeks that pass through the project area pass through urban environments. Thus, it is likely that some waterways in the area experience an increase in sediment input.	This project will require areas to be cleared which will expose bare ground. This has the potential to increase sediment input into nearby rivers and creeks, such as Mordialloc Creek, via different dispersal methods including run-off. This would be of most concern during the construction phase. **The project has the potential to exacerbate this threatening process without sufficient controls.**
Infection of amphibians with Chytrid Fungus, resulting in chytridiomycosis	It is likely that the chytrid fungus is present in the project area – this explain why Growling Grass Frogs are no longer found in the wetlands associated with the project area despite them being reintroduced to the area in 2002.	The project is unlikely to affect the incidence of Chytrid in the environments at or nearby the project area.
Input of organotins to Victorian marine and estuarine waters.	There are no marine or estuarine environments in the project area however Mordialloc Creek flows west to the ocean. This threatening process may already be relevant to the area.	Input of organotins is unlikely to be increased during either the construction or operational phase of the Project. **The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Input of petroleum and related products into Victorian marine and estuarine environment.	There are no marine or estuarine environments in the project area. However, where roads bisect the project area, there is a chance that petroleum and related products may enter the marine and estuarine environment via spills and run off.	The construction of an additional road in the area means that there is an increased chance of petroleum and related products entering nearby waterways that lead to marine and estuarine environments. This risk has been addressed in the surface water impact assessment for the Project (WSP 2018d). **The project has the potential to exacerbate this threatening process.**
Input of toxic substances into Victorian rivers and streams.	Parts of Braeside were previously a water treatment pond, and landfills occur in the north of the project area. Thus, toxic substances may have entered rivers and streams at some point in time. It is also possible that toxic substances from sources upstream have entered rivers and streams which flow through the project area.	The Project has the potential to lead to increased input of toxic substances into waterways associated with the project area. However, the catchments are already heavily bisected by roads and the increased risk to them from an additional freeway would be slight. **The project has the potential to exacerbate this threatening process.**
Introduction and spread of Spartina to Victorian estuarine environments.	There are no estuarine environments in the project area. Spartina does not occur at the project area.	**The project is unlikely to exacerbate this threatening process.**
Introduction of live fish into waters outside their natural range within a Victorian river catchment after 1770.	There are several exotic fish species that occur in the wetlands and creeks associated with the project area. These include: Goldfish, European Carp, Gambusia, Oriental Weatherloach and Redfin (Refer to list in Appendix C).	**The project is unlikely to exacerbate this threatening process.**
Invasion of native vegetation by Blackberry Rubus fruticosus L. agg.	This species was recorded across the project area and poses a significant threat to native vegetation. Invasion by the species may be worsened by future developments.	Where Blackberry is removed for the construction of the project, the invasive weed may be unintentionally dispersed via machinery and other dispersal methods. The species may also colonise bare ground caused by clearing and construction. **The project may exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Invasion of native vegetation by 'environmental weeds'.	Several weed species have been recorded in the project area, the most severe of which are listed in Section 4.3.6. Weeds are most prevalent in disturbed drainage lines, roadsides and paddocks with a history of grazing. They include six weeds listed as Weeds of National Environmental Significance. The revegetated/rehabilitated wetlands at the Waterways display minimal invasion by environmental weeds, likely due to the density of native plantings combined with follow-up management.	This project will require areas to be cleared which will expose bare ground, thus giving exotic (and non-local native) weed species an opportunity to colonise new areas. Construction and maintenance vehicles/plant may unintentionally introduce or disperse weeds at the project area and nearby vegetation. **The project may exacerbate this threatening process.**
Invasion of native vegetation communities by Tall Wheat-grass Lophopyrum ponticum.	Whilst the species has been recorded near the project area in the past, it is unlikely that it is currently having a significant impact on native vegetation communities at the site.	**The project is unlikely to exacerbate this threatening process.**
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.	Coast wattle has been identified within the project area (see Appendix B). Both species have also been identified in a VBA search of the project area which states that they are native but notes that some stands may be alien. It is possible that these species may have caused some loss of biodiversity in the area.	**The project is unlikely to exacerbate this threatening process.**
Loss of biodiversity in native ant populations and potential ecosystem integrity following invasion by Argentine Ants (Linepithema humile).	The extent of impact of this exotic species upon the integrity of the ecosystems associated with the project area is not known.	**The project is unlikely to exacerbate this threatening process.**
Loss of coarse woody debris from Victorian native forests and woodlands.	The project site is a highly modified area which has been cleared in the past for urbanisation including residential development and road construction. This clearing is likely to have resulted in the loss of coarse woody debris from Victorian native forests and woodlands.	The project would result in minimal loss of woodland habitat. It may result in the loss of a small amount of woody debris but this would be negligible. **The project is unlikely to exacerbate this threatening process.**
Loss of hollow-bearing trees from Victorian native forests.	Given that clearing has occurred, it is highly likely that the project area has suffered a loss of hollow-bearing trees over time.	The project is expected to result in the loss of some hollow-bearing trees. **The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases.	It is unlikely that anthropogenic emissions of greenhouse gases have resulted in measurable habitat loss at the project area.	**The project is unlikely to exacerbate this threatening process.**
Predation of native wildlife by the cat, Felis catus.	A VBA search returned multiple counts of feral cat sightings within a 10 km radius form the project area. Feral cats and roaming domestic cats are highly likely to prey upon native fauna in the area. Cats are prohibited to residents at the Waterways which may reduce predation pressure on birds in this area relative to other urban wetlands.	**The project is unlikely to exacerbate this threatening process.**
Predation of native wildlife by the introduced Red Fox Vulpes vulpes.	The Red Fox is known to occur in the project area and associated/nearby environments, particularly within Braeside Park. It is highly likely that predation by this species occurs in the area.	**The project is unlikely to exacerbate this threatening process.**
Prevention of passage of aquatic biota as a result of the presence of instream structures.	Weirs and culverts are likely to have resulted in barriers to movement of aquatic biota in the region.	Several culverts are expected to be constructed under the road as part of the project design. These will be designed to not restrict passage by aquatic biota. **It is possible that the project may exacerbate this threatening process.**
Reduction in biodiversity of native vegetation by Sambar (Cervus unicolor).	Does not currently affect the project area.	**The project will not exacerbate this threatening process.**
Reduction in biodiversity resulting from Noisy Miner (Manorina melanocephala) populations in Victoria.	This species is known to occur in the project area (large groups, particularly at the Waterways, were recorded during field surveys) and is likely to be benefited by the modified nature of the vegetation in the area. It is possible they are causing a loss of biodiversity at this site.	The current environment within the Landscaping has the potential to create additional habitat that preferences this species (i.e. plantings with open/no midstorey), although this is unlikely to noticeably increase this threatening process in the area, given the degree of modification currently present. **The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Reduction in biomass and biodiversity of native vegetation through grazing by the Rabbit Oryctolagus cuniculus.	Rabbits are known to occur in the project area, with high numbers occurring at Braeside Park. Therefore, reduction in biomass and biodiversity of native vegetation through their grazing is a relevant threatening process.	**The project is unlikely to exacerbate this threatening process.**
Removal of wood debris from Victorian streams.	Given the history of clearing that has occurred in the project area, it is likely that wood debris has, at some point in time, been removed from streams.	It is possible that some woody debris will be removed from streams where bridges and culverts are constructed. However, these waterways are already highly modified and this impact is expected to be minor. **The Project is unlikely to exacerbate this threatening process.**
Soil and vegetation disturbance resulting from marble mining.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Soil degradation and reduction of biodiversity through browsing and competition by feral goats (Capra hircus).	Does not currently affect the project area.	**The project will not exacerbate this threatening process.**
Soil erosion and vegetation damage and disturbance in the alpine regions of Victoria caused by cattle grazing.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Spread of Pittosporum undulatum *in areas outside its natural distribution.*	The species is known to occur in the area (and is considered native to the broader region). It was not recorded in the project area.	**The Project is unlikely to exacerbate this threatening process.**
The discharge of human-generated marine debris into Victorian marine or estuarine waters.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
The introduction and spread of the Large Earth Bumblebee Bombus terrestris into Victorian terrestrial environments.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
The introduction of exotic organisms into Victorian marine waters.	Not relevant to the project area.	**The project will not exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
The spread of Phytophthora cinnamomi from infected sites into parks and reserves, including roadsides, under the control of a state or local government authority.	Phytophthora is not known to currently affect the project area or surrounds however it may be present.	Insufficient clearing and construction hygiene, or use of infected gravel or soil, may lead to introduction or spread of this pathogen. **The project has the potential to exacerbate this threatening process without appropriate controls.**
Threats to native flora and fauna arising from the use by the feral honeybee Apis mellifera of nesting hollows and floral resources.	The feral honeybee is an existing threat in the project area as it displaces native wildlife by competing for nesting hollows and floral resources.	**The project is unlikely to exacerbate this threatening process.**
Use of Phytophthora-infected gravel in construction of roads, bridges and reservoirs.	Phytophthora is not known to currently affect the project area or surrounds however it may be present.	Insufficient clearing and construction hygiene, or use of infected gravel or soil, may lead to introduction or spread of this pathogen. The inclusion of standard disease hygiene measures in the CEMP as per VicRoads 177 Environmental Management (Major) should sufficiently manage this risk. **The project has the potential to exacerbate this threatening process without appropriate controls.**
Wetland loss and degradation as a result of change in water regime, dredging, draining, filling and grazing.	The southern part of the project area occurs within the historical extent of the Carrum Carrum Swamp (refer Figure 4.1). This swamp has undergone significant changes, having been almost completely drained in the late 1800s. Edithvale wetlands is the only remnant of this ecosystem, retaining some natural landform, particularly in the southern section. The other wetlands associated with the project area have been created. These created wetlands are predominantly deep pools with steep edges. They support very little shallow marsh habitat, reliant on seasonal wetting and drying cycles, and valuable to migratory and other shorebirds. Some shallow wetland habitat is present at Braeside Park wetlands and Woodlands wetlands.	Where the proposed project intersects the Mordialloc Creek, bridges will be constructed to avoid wetland loss. The project will result in a small area of wetland loss; however, this wetland habitat is low quality and not a natural existence in the area. Loss or physical degradation of valuable areas of shallow wetland habitat is not expected. **The project is unlikely to exacerbate this threatening process.**

6.7.2 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

There are 21 threatening processes listed under the EPBC Act. An assessment was undertaken to identify which threatening processes were currently relevant to the Mordialloc Bypass project area and whether the project could increase or exacerbate those threatening processes. Only one EPBC Act listed threatening process, 'Land clearing' is unable to be mitigated via the controls proposed for the project. The assessment is provided in Table 6.10.

Table 6.10 Threatening processes (EPBC Act) relevant to project area

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (Manorina melanocephala)	This species is known to occur in the project area (large groups, particularly at the Waterways, were recorded during field surveys) and is likely to be benefited by the modified nature of the vegetation in the area. It is possible they are causing a loss of biodiversity at this site.	Landscaping has the potential to create additional habitat that preferences this species (i.e. plantings with open/no midstorey). However, this is unlikely to result in increased Noisy Miner activity, given the project area is already highly modified. **The project is unlikely to exacerbate this threatening process.**
Competition and land degradation by rabbits	Rabbits are known to occur in the project area, with high numbers occurring at Braeside Park. Therefore, reduction in biomass and biodiversity of native vegetation through their grazing is a relevant threatening process.	**The project is unlikely to exacerbate this threatening process.**
Competition and land degradation by unmanaged goats	Does not currently affect the project area.	**The project will not exacerbate this threatening process.**
Dieback caused by the root-rot fungus (Phytophthora cinnamomi)	Phytophthora is not known to currently affect the project area or surrounds however it may be present.	Insufficient clearing and construction hygiene, or use of infected gravel or soil, may lead to introduction or spread of this pathogen. However, standard VicRoads controls should sufficiently reduce this risk. **The project is unlikely to exacerbate this threatening process.**
Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations	Not relevant to the project area.	**The project will not exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	It is likely that the chytrid fungus is present in the project area – this explain why Growling Grass Frogs are no longer found in the wetlands associated with the project area despite them being reintroduced to the area in 2002.	The project is unlikely to affect the incidence of chytrid in the environments at or nearby the project area. **The Project is unlikely to exacerbate this threatening process.**
Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Invasion of northern Australia by Gamba Grass and other introduced grasses	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Land clearance	The project area is situated within a highly modified landscape that has been cleared in the past for agriculture and multiple urban developments including roads, residential housing, and industry.	The project will involve some land clearance and the above ground biomass will be replaced with non-natural materials. However, the area is situated within an already highly modified landscape and the native vegetation present is generally degraded and patchy. The impact on native vegetation is assessed in Section 6. **The project will exacerbate this threatening process.**
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	The project area is surrounded by residential development. It is highly likely that there has been a loss of native plant and animal habitat by invasion of escaped garden plants.	**The Project is unlikely to exacerbate this threatening process.**
Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (Anoplolepis gracilipes) on Christmas Island, Indian Ocean	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	It is unlikely that anthropogenic emissions of greenhouse gases have resulted in measurable habitat loss at the project area.	**The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Novel biota and their impact on biodiversity	This threatening process is relevant to the project area due to the highly modified nature of the surrounding land. Novel biota recorded or considered likely to impact the project area includes (but is not limited to) weeds (refer Section 4.3.6) and exotic pest fauna such as cats and foxes.	This project will require areas to be cleared which will expose bare ground, thus giving exotic weed species an opportunity to colonise new areas. The use of machinery may also add to the issue by unintentionally dispersing weeds throughout the study area. Vehicles using the freeway may also introduce new weeds. A weed control program for the Project should sufficiently reduce this risk. The Project is unlikely to increase the impact of exotic pest fauna. **The project is unlikely to exacerbate this threatening process.**
Predation by European red fox	The Red Fox is known to occur in the project area and associated/nearby environments, particularly within Braeside Park. It is highly likely that predation by this species occurs in the area.	Although fauna culverts create opportunities for predators such as Red Foxes to prey on native fauna, there is little-to-no-evidence that such predation occurs systematically at all crossing structures, nor reduces the rate of use by the target native fauna (Little, Harcourt & Clevenger 2002; Mata et al. 2015). However, this will be managed by increasing the number of culvert crossings and ensuring there is sufficient cover present. Refer to Section 7.4.2. **The project is unlikely to exacerbate this threatening process.**
Predation by exotic rats on Australian offshore islands of less than 1000 km^2 (100,000 ha)	Not relevant to the project area.	**The project will not exacerbate this threatening process.**
Predation by feral cats	A VBA search returned multiple counts of feral cat sightings within a 5 km radius of the project area. Feral cats and roaming domestic cats are highly likely to prey upon native fauna in the area. Cats are prohibited to residents at the Waterways which may reduce predation pressure on birds in this area relative to other urban wetlands.	**The project is unlikely to exacerbate this threatening process.**

THREATENING PROCESS	CURRENT RELEVANCE	POTENTIAL PROJECT IMPACT
Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs	It is highly unlikely that this threatening process is relevant in the area. The last recorded sighting of a feral pig was in 1979 and over 10 km away from the project area (VBA search).	**The project is unlikely to exacerbate this threatening process.**
Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species	Whilst there are Psittacine species in the area, endangered Psittacine species are unlikely to occur within the project area. Therefore, psittacine circoviral disease is not considered a relevant threatening process.	**Not relevant to the project area.**
The biological effects, including lethal toxic ingestion, caused by Cane Toads (Bufo marinus)	Does not currently affect the project area.	**The project will not exacerbate this threatening process.**
The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, Solenopsis invicta (fire ant)	Not known to currently affect the project area or surrounds.	**The project is unlikely to exacerbate this threatening process.**

6.8 CUMULATIVE IMPACTS

It is important to consider cumulative impacts when assessing project impacts, to avoid the 'death by a thousand cuts' approach which leads to gradual loss of habitat and significant impacts through numerous individual projects.

From the (The Cumulative Effects Assessment Working Group et al. 1999), a cumulative effects assessment is expected to:

- *assess effects over a larger (i.e., "regional") area that may cross jurisdictional boundaries;*
- *assess effects during a longer period of time into the past and future;*
- *consider effects on Valued Ecosystem Components (VECs) due to interactions with other actions, and not just the effects of the single action under review;*
- *include other past, existing and future (e.g., reasonably foreseeable) actions; and*
- *evaluate significance in consideration of other than just local, direct effects.*

For the assessment of cumulative impacts for this Project, we have considered:

- Projects which occur in the immediate area of the project area (i.e. approx. 1 km) which could increase noise, light and other indirect impacts, or lead to additional direct loss of local habitat.

or

- Projects in the broader locality (<10 km) which have, may, or will reduce the quality or size of valuable wetland habitat (i.e. known to support the significant species which also occur at the project area).

and

- Projects which have already been approved, are being constructed, or which have been constructed within the last five years. Future unapproved projects (i.e. without defined impact areas and without detailed assessments available) would require too much guesswork to consider and are beyond the scope of this assessment unless reasonably foreseeable. Projects which occurred prior to five years ago are generally too old to be accurately considered. They

have been considered part of the existing conditions of the site only, unless recent (<5 years) and with assessments publicly available. Note: the impact assessment has already considered the impact of the project with consideration of the built-up nature of the area (industrial, residential, green wedge etc.), historical change, and the sensitivity and population numbers/extents of the species and communities to be impacted. This examination of cumulative effects is for recent specific known projects only.

- Projects which have or may positively impact ecology, i.e. wetland creation projects or other ecological improvement projects such as those listed under regional/local plans in Section 8.3, are not considered. This is because it is difficult to foresee what positive outcomes may result for any particular significant ecological value from a project.

Outlined below in Table 6.11 is a summary of projects that have been considered for the potential to contribute to cumulative impacts associated with this project, and the results of the assessment.

Table 6.11 Cumulative impact assessment

PROJECT AND DESCRIPTION	PROJECT IMPACT SUMMARY	CUMULATIVE IMPACT
LXRA Bonbeach and Edithvale Removal of level crossings involving some vegetation removal and some local changes to groundwater	This project will have relatively minor local ecological impacts and local impacts on groundwater. No impacts on Edithvale wetland and no impacts on migratory birds are anticipated. The works for this project (including haulage) may occur during construction of the Mordialloc Bypass, however they will be brief/short-term only.	Some cumulative vegetation and tree loss (although no threatened communities are proposed to be impacted by LXRA). As haulage along Edithvale Road will be avoided for this Project, no cumulative impacts upon the Ramsar wetland are anticipated. No other cumulative impacts anticipated
Monash Freeway Upgrade (construction phase) Upgrade between Chadstone and Pakenham	Although several of the relevant significant species (including Australasian Bittern and Latham's Snipe) were recorded or assessed as being likely to occur in the study area in the referral submitted for the project it is unlikely that any habitat for these species has been or will be impacted, as the Monash Freeway Upgrade project requires minimal vegetation clearance (mostly infilling lanes). The only patch of native vegetation that may potentially be affected by the development is the Wet Verge Sedgeland to the north of the Monash Freeway bridge over Dandenong Creek.	Cumulative impacts are not anticipated.
Westall Road Extension (planning phase only) – extension from Westall Road/Princes Highway to the Monash Freeway	No assessments currently available. The extension may pass through or nearby water retention ponds however from an examination of E-Bird, no waterbird hotspots are present in the area.	Unknown however considered unlikely.

PROJECT AND DESCRIPTION	PROJECT IMPACT SUMMARY	CUMULATIVE IMPACT
City of Kingston development of Chadwick Reserve (project phase unknown)	No information available	Unknown, although (based on preliminary assessments) considered unlikely.
Moorabbin Airport Master Plan (planning phase only)	Not available but likely to be minor and not involve impacts to wetlands. Unlikely to increase noise and light impacts although no assessment is yet available.	None anticipated although as the projects are still in the planning phase this would need to be assessed by Moorabbin Airport.
Kingswood Dingley Village (planning phase only) Proposed residential development approximately 700 m east of project area in the north	Not available, likely to involve tree and some wetland removal (unlikely to support significant species). Wetland creation unlikely to be designed to support species of significance.	Unknown, although (based on preliminary assessments) considered unlikely.
Cumulative impact summary		
No projects have been identified which are likely to lead to significant cumulative impacts upon the species and communities identified in this assessment.		

7 MITIGATION

This chapter provides avoidance, minimisation, mitigation, and offsetting for the project. It is expected that the relevant final mitigation measures will be incorporated into any Construction Environmental Management Plan (CEMP) for the project by the construction contractor. Key measures are likely to become conditions of approval by State and Commonwealth regulators. The measures and guidelines in this chapter are based on best practice, considering the ecological values likely to be affected by the Project.

Key measures have been incorporated into project EPRs.

VicRoads standard controls are an assumed baseline and are not documented.

7.1 AVOID AND MINIMISE

A key tenet of the *Guidelines (DELWP 2017c)* is the requirement to *avoid and minimise* impacts to native vegetation; this principle is also common to relevant legislative instruments such as the EPBC Act and the FFG Act. The principal is that preference should be given to avoidance, then minimisation, and lastly offsetting, and that this process should be considered early in the design of the project.

The biodiversity impact avoidance and minimisation process that has been completed to date includes:

- The dual-structure design of the bridge over Mordialloc Creek, developed to ensure there is a sufficient gap to allow light penetration. This was incorporated into the reference design to facilitate vegetation growth between the carriageways to improve the quality of this habitat and its value as a movement passage for fauna.
- Micro-alignment of the shared user path to avoid impacts on existing native vegetation at various sections of the Project. Further micro-alignment and examination of construction techniques to minimise impacts on tree TPZs should be undertaken during detailed design.
- There has been/is limited scope to adjust the alignment of the road to avoid large trees and other vegetation. This is because the speed of the freeway constrains the flexibility of the design. However, avoidance of trees where possible was considered early in the design process.
- Development of the minimum No-go Zones to minimise impact on native vegetation, to minimise tree loss, and to constrain construction activity near areas of important bird habitat. This approach was developed over a series of workshops with WSP road designers and VicRoads/MRPA. The No-go Zones have focused on areas with higher retention value such as large trees and the wetlands at the Waterways. These areas been mapped based on a conservative buffer of 10 metres off the project earthworks. Some trees for which this buffer impacts >10% of the Tree Protection Zone (TPZ) are likely to be able to be retained, however as the impact has not yet been assessed by an arborist, loss is currently assumed. It is highly likely that vegetation loss can be further reduced as the design is finalised and construction methods are known. However, for vegetation loss and offset calculations, a more conservative approach allows for flexibility at this stage and ensures that all possible impacts are appropriately considered. Areas identified as 'Avoid if possible' on Supplementary Figure 6 of Appendix A will be used as target areas to further avoid and minimise impacts.
- For large trees, detailed assessment of individual trees was completed, to retain them where possible. This has resulted in an additional 14 large trees added to No-go Zones. Efforts to avoid and minimise impacts to large trees are documented in Appendix F.2.
- For seasonal wetland community types, localised changes in surface water (due to construction of swales etc.) may lead to loss of some of the EVCs over time, whether or not the patches are retained as No-go Zones. As such, small patches of these EVCs are not a focus of the guidelines for vegetation retention during construction, and in some cases, have been removed from the 'avoid if possible category'. These EVCs are assumed lost for vegetation impact calculations.

- Biodiversity impact minimisation will be a key criterion for contractor selection and VicRoads will put contractually binding financial incentives in place for the contractor to further reduce vegetation loss. Tenderers have been provided will the locations of all trees, with the prerogative to further minimise tree impacts (through design changes, retaining walls, consideration of construction techniques, arborist assessment etc. as relevant), particularly for large trees. This is an important step in a landscape with few large old trees remaining, and will be a high priority.
- The Project is to be rated under the Infrastructure Sustainability Council of Australia (ISCA) rating scheme under which ecology is a category. This may not result in any additional minimisation or mitigation however provides some assurance that ecological outcomes are being taken seriously by the Project.
- For most of the Project, specifics regarding construction techniques are yet to be determined (to be finalised by contractor, meeting VicRoads standards) within the constraints of the No-go Zones determined in this study. The exception is the bridge over Mordialloc Creek where construction will be undertaken from the centre (or otherwise, with no impacts upon No-go Zones or outside of the project area). This allows the footprint to be constrained and minimises impacts upon sensitive vegetation. In this location, the No-go Zones were calculated on an eight-metre buffer off the bridge design.
- Woodlands Industrial Estate Wetlands, Waterways Wetlands, and Edithvale Wetlands were identified as sensitive receptors (water quality) for design of WSRD. This means that instead of the required maximum limit of acceptable change in nutrient levels, the surface water design (swales including bio-retention systems) will lead to no increase in nutrient levels in these waterways as a consequence of the Project. (Note: as Braeside Park wetlands is upstream of the project, this was not considered to be required for this wetland).

7.2 RESIDUAL IMPACTS AND OFFSETTING

7.2.1 NATIVE VEGETATION (GUIDELINES 2017)

A total area of 12.096 hectares of native vegetation was identified as *remnant patches* or *scattered trees* on site that cannot be avoided, and which will therefore be Offset in accordance with the *Guidelines 2017* policy. This includes 24 large trees. These losses have been determined and assessed by WSP ecologists, all of whom are registered with DELWP as competent to conduct *Vegetation Quality Assessments*. They have been processed by DELWP's Native Vegetation Team and the resulting native vegetation removal report (dated 3 September 2018) is provided as Appendix I.

Table 7.1 summarises the native vegetation removal report, outlines the extent of native vegetation clearance associated with this project, and identifies the commensurate Offset target required to secure a 'no net loss' of biodiversity values at this site. These Offset targets will be purchased from a third-party Offset Credit supplier registered on the DELWP Native Vegetation Credit Register and transferred to the project with an Allocated Credit Extract. The Allocated Credit Extract is to be secured *prior* to the clearance of any native vegetation on site.

Preliminary negotiations have been instigated with several Offset Credit suppliers and brokers listed on the DELWP Native Vegetation Credit Register and it has been confirmed that the requisite Offset Credits listed in Table 7.1 are readily available from covenanted Offset Sites. These Offset Credits will therefore be purchased prior to the commencement of native vegetation clearance works and secured with an Allocated Credit Extract to the Planning Scheme Amendment.

Offset Credits will be sourced from sites local to the Project wherever practicable. Options to create or improve areas of wetlands through the State offset process within the local area (City of Kingston council area nearby the project area) should be further explored, and would be well-received by stakeholders.

Table 7.1 Vegetation clearance and offset requirements

VEGETATION CLEARANCE	
Assessment pathway	Detailed assessment pathway
Extent including past and proposed	12.096 hectares
Extent of past removal	0.000 ha
Extent of proposed removal	12.096 hectares
No. Large trees proposed to be removed	24
Location category	Location 2 The native vegetation is in an area mapped as an endangered EVC.
OFFSET REQUIREMENTS	
General offset amount	4.426 general habitat units
Vicinity	Port Phillip and Westernport Catchment Management Authority (CMA), Greater Dandenong City or Kingston City Council.
Minimum strategic biodiversity value score	0.422
Large trees	24 large trees

7.2.2 COMMONWEALTH OFFSETS

The project is a controlled action under the EPBC Act and the associated referral decision letter identified several MNES with the potential to be significantly impacted. It also stated the requirement for further survey and assessment for these values to determine the likely impacts. Impact assessment completed in accordance with the relevant Commonwealth guidelines (Appendix G) concluded that without specific mitigation (i.e. beyond MRPA standards) there was a potential for MNES to be significantly affected. Through design of a comprehensive strategy of mitigation for the project, residual impacts upon MNES are expected to be minor and not significant. This assessment was supported by several recent surveys, detailed habitat mapping, and a wealth of local records.

As such, Commonwealth Offsets in accordance with the Offsets Policy (DSEWPaC 2012) are not proposed. However, communication with the Commonwealth will be required to ensure they are satisfied with the extent of mitigation that is proposed with the final design. Further investigation during detailed design is recommended to ensure that the final design meets or exceeds expectations for mitigation of impacts, particularly upon EPBC Act listed fauna.

7.3 MITIGATION CONCEPTS

The negative effects of many of the ecological impacts of roads and traffic can be mitigated through careful planning, design, construction and maintenance (van der Ree, R, Smith, D J & Grilo, Clara 2015). Some of the more frequently applied treatments with proven effectiveness include under-and over-passes to facilitate the movement of wildlife (i.e. wildlife crossing structures) (Smith, van der Ree & Rosell 2015), fencing or other barriers to prevent animals from accessing the roadway and to funnel them towards crossings structures (van der Ree, R, Gagnon, J W & Smith, D J 2015), and shielding or other strategies to reduce light and noise pollution (Blackwell, DeVault & Seamans 2015; Parris, K M 2015).

It is important to clearly identify the impact of the proposed project and design specific mitigation strategies. Relevant potential or likely impacts for the Project are:

- Mortality and injury of wildlife due to collision with vehicles
- Reduced connectivity of habitat/barrier effects
- Habitat loss
- Habitat degradation from increased disturbance due to:
  - Noise impacts
  - Light impacts
  - Visual disturbance
- Habitat degradation from physical changes including:
  - Weed invasion
  - Rubbish
  - Erosion, sedimentation, and water pollutants
  - Hydrological changes.

It is also important to consider unintended consequences of different mitigation strategies as well as the interactions amongst them because they can exacerbate certain impacts if they are not carefully designed. For example, the use of noise walls can simultaneously reduce noise impacts and reduce mortality for birds willing to fly up and over, but may increase the barrier effect for small low-flying birds.

From our impact assessment, it is clear that the greatest impacts of the bypass are upon birds, however, there is also a range of terrestrial and aquatic fauna that are likely to be impacted by the project.

Efforts to mitigate the negative effects of roads and traffic on birds are much less developed internationally than for terrestrial species, such as large mammals, reptiles and amphibians. Most mitigation internationally has been to improve driver safety by providing crossing structures for large mammals (i.e. deer, boar etc.) and similarly in Australia for kangaroos and wallabies (Smith, van der Ree & Rosell 2015). In contrast, there has only been a handful of studies that have tested or evaluated the effectiveness of measures to reduce mortality of birds due to collision with vehicles and facilitate the movement of birds across roads (Kociolek, Grilo & Jacobson 2015; Zuberogoitia et al. 2015). It is critical therefore to consider that the diversity of birds and their ecological requirements and behaviours means that one strategy may work for one species and not another.

The mitigation strategies for this project have been developed after identifying the potential impacts of the proposed bypass and developing the following three broad goals:

1. Minimise rates of wildlife mortality due to wildlife-vehicle collision
2. Maintain landscape connectivity across and along the bypass for wildlife
3. Minimise the extent and severity of direct (i.e. clearing) and indirect (i.e. noise, light, disturbance etc.) habitat loss and degradation.

Mitigation strategies with known levels of use and effectiveness were selected from relevant publications, including VicRoads guidelines (VicRoads 2012b), guidelines from other states (NSW and Queensland), from published peer-reviewed articles, and from grey literature.

7.4 DESIGN FEATURES AND LANDSCAPING

A recommended fauna mitigation plan for the project is provided as Figure 7.3. This is broken down in the following sections (7.4.1 to 7.4.5) which presents guidelines for the design, installation and maintenance of each mitigation measure. Full specifications and final locations of each mitigation measure will be determined in the detailed design stage of the project.

The impact assessment has identified the requirement for mitigation of four main impacts, namely road noise, reduced habitat connectivity, vehicle lighting, and wildlife mortality due to collision with vehicles. WSRD design and water

quality mitigation are covered in the relevant specialist reports. The risk of spills from the road entering sensitive receptors may also require mitigation. This is addressed in the Surface Water Impact Assessment (WSP 2018d).

Given there is limited ability to move the alignment away from key habitat, and that the road will pass between areas of habitat, options for mitigation are mostly limited to road design and landscape treatments.

The landscape along (within or adjacent to) the project alignment can be categorised into four main habitat zones, based on broad vegetation categories, land-use and habitat quality, namely:

1. Wetland habitats (and the movement corridors including grassland and drainage lines between them)
2. Mordialloc Creek
3. Boundary with terrestrial habitat at Braeside Park
4. Mixed Land-use Areas (with occasional drainage lines).

Table 7.2 Project habitat zones and primary aims of mitigation

HABITAT ZONES	DESCRIPTION	AIM OF MITIGATION
Wetland habitats	Areas between key wildlife habitat, namely between Woodlands and Braeside Park and at the Waterways. Key areas for threatened species (and project area provides movement corridor)	— Minimise rates of fauna mortality — Minimise habitat degradation from noise and light — Maintain landscape connectivity for fauna — Minimise habitat loss — Minimise loss of water quality or WSUD wetland function
Mordialloc Creek	Mordialloc Creek (bridge over creek and wetland). Habitat for threatened and common species.	— Minimise rates of fauna mortality — Minimise impacts on habitat from noise and light — Maintain landscape connectivity for fauna — Minimise loss of water quality or WSUD wetland function
Braeside Park Boundary	The boundary between the project area and terrestrial areas of Braeside Park (i.e. approximately between the Rangers station and Lower Dandenong Road) This area is less important for threatened species.	— Minimise rates of wildlife mortality — To a lesser extent, minimise habitat degradation along the edge of Braeside Park from noise and light
Mixed Land-use Areas	Areas dominated by a mixture of hobby farms, residential and industrial land uses. These areas are not important for threatened species however, drainage lines, including the Old Dandenong Road drain, may be important movement corridors for non-listed species.	— Minimise rates of wildlife mortality — Maintain landscape connectivity, particularly along drainage lines

Outlined below is a summary of recommended mitigation measures which can be implemented for the impacts identified above.

Table 7.3 Summary table of recommended mitigation measures for the identified impacts

IMPACT	RECOMMENDED MITIGATION MEASURES
Bird mortality	Flight diverters encourage birds flying across the road to fly above the height of vehicles to avoid collision (Kociolek, Grilo & Jacobson 2015) and can include physical walls, dense plantings of vegetation, and earth mounds (Pons 2000). Physical walls and landscaping are suitable for use for the Project.
General / all fauna mortality	Wildlife fencing prevents or reduces the rate of wildlife accessing the roadway, thereby reducing rates of wildlife vehicle collision (recommendations in Section 8.3.1). Wildlife barriers can also funnel animals to wildlife crossing structures (van der Ree, R., Smith, D. J. & Grilo, C. 2015). Wildlife crossing structures recommended to facilitate safe movement (including modified culverts) are detailed in Section 8.3.2.
Vehicle noise	Acoustic barriers, such as physical noise walls or berms, reduce the sound pressure level of noise in adjacent landscapes. As a simple rule of thumb, effective noise mitigation structures should be tall enough to break the line of sight between vehicles and sensitive habitat or species (The Centre for Urban Design 2016).
Vehicle lighting	Fencing and landscaping can effectively prevent or reduce the spill of light from vehicle headlights and streetlights. Densely planted vegetation on the roadsides can prevent light spill into the adjacent environment (VicRoads 2012b)
Road / intersection lighting	Lighting should be designed by a lighting designer experienced in minimising impacts on sensitive ecological areas, based on the guidelines provided in Section 7.3.3. Densely planted vegetation on the roadsides can prevent light spill into the adjacent environment and may prevent light attracted species such as bats from being drawn to the lights to feed off insects (VicRoads 2012b).
Habitat fragmentation / barrier effect	Wildlife crossing structures, such as under- and over-passes can facilitate the safe movement of wildlife across the road. Underpasses include culverts and bridges, and overpasses include rope ladders that connect tree canopies, and land bridges with vegetation that connect opposite sides of the road. The use of fauna fencing to funnel wildlife towards the crossing structure can significantly improve rates of crossing by wildlife. Rope ladders can connect tree canopies for arboreal species. Landscaping and strategic revegetation (including appropriate maintenance) is extremely important in facilitating the use wildlife crossing structures, by encouraging animals to approach the entrances to the crossing structures.

7.4.1 BARRIER STRUCTURES

Mitigation measures that limit or prevent (1) noise, (2) light spill and (3) wildlife from accessing the roadway (including the diversion of bird flight paths) are collectively termed ‘barrier structures’ in this assessment. If mitigation measures for noise, light and wildlife movement are implemented individually, there is a high likelihood that there will be unnecessary redundancy in the strategies and may potentially lead to perverse outcomes where some strategies will counteract each other. Hence, we recommend an integrated approach to mitigate impacts and maximise effectiveness and efficiencies.

The optimal approach for barrier structures in the different ‘habitat zones’ of the Project is detailed in Table 7.4. The currently proposed locations of barriers are shown on Figure 7.2 in Section 7.4.2.2.

Table 7.4 Optimal barrier structure approach for habitat zones identified at the project area

HABITAT ZONE/S	BARRIER STRUCTURE TYPE	LOCATION
Wetland habitat areas and Mordialloc Creek	**Multi-function fauna barrier (Barrier Type 1)** See Barrier Type 1 on Figure 7.3. Barrier features: — The recommended approach for this zone is a multi-function fauna barrier, i.e. fencing or walls that are sufficiently tall to act as a flight diverter (a height of 2 m above the batter would force birds to fly above light vehicles), solid at the base to prevent wildlife passing through and funnel wildlife to culverts, and opaque to prevent light spill. — The aim of this barrier is to mitigate the effects of light, noise, and mortality. — The value of the barrier for noise mitigation would depend upon the height and materials of the barrier. Although there are no VicRoads or other guidelines regarding noise mitigation for fauna, mitigation is recommended based on the literature review and impact assessment provided in Section 7.1.4.2. The threshold that is both feasible for the Project and reduces the residual impact to an acceptable level needs to be determined through modelling and consultation with regulators.	— Both sides of the bypass, from approximately the pedestrian underpass to the levy (southern side of Mordialloc Creek) This is the extent shown on Figure 7.3 for barrier Type 1. — The current noise wall design (i.e. noise attenuation for people) for the Project partly overlaps with the recommended locations of barrier Type 1 – it is expected that noise walls for residences can fulfil the requirements for barrier Type 1 in these locations. — The precise extent can be determined during detailed design — It is important that the ends of the barrier are designed to minimise the likelihood of fauna entering the roadway corridor and becoming trapped. — We note that the most important location for noise mitigation for the significant species at the project area is between Woodlands wetlands and Braeside Park wetlands. If prioritisation must occur, this area should be prioritised and the extent between Governor Road and Bowen Parkway could become a Type 2 barrier (Low fauna barrier – see below). — Wherever Barrier Type 1 is installed, Barrier Type 2 (see below) is not required as well.
Braeside Park Boundary (terrestrial)	**Low fauna barrier (Barrier Type 2)** See barrier Type 2 on Figure 7.3. Barrier features: — Low (~1 m high) barrier (solid opaque fence or fine mesh fencing) to prevent small mammals, amphibians and reptiles from accessing the road.	From approximately the pedestrian underpass / ranger station (to be determined during detailed design) to Lower Dandenong Rd on the eastern side of the Project. See barrier Type 2 on Figure 7.3.

HABITAT ZONE/S	BARRIER STRUCTURE TYPE	LOCATION
Mixed Land-use areas	**Low fauna barrier (Barrier Type 2)** Barrier Type 2 as for the Braeside Park Boundary (above). Not shown on Figure 7.3 for the 'mixed land-use areas' zone. Barrier features: — Low (~1 m high) barrier (a solid opaque fence or fine mesh fencing) to prevent small mammals, amphibians and reptiles from accessing the road.	Short sections of fence (approximately 50 m either side of culvert entrances) to funnel fauna towards underpasses/culverts, in areas outside the wetland habitats, Mordialloc creek and Braeside Park Boundary.

Alternative barrier structures that are considered sub-optimal for the key wildlife areas (the wetland areas) are:

- Solid fencing that forms a barrier to force birds to fly over the road, and other fauna to use culverts, that would also provide light mitigation but be ineffective at reducing noise for the key wetland areas.
- Chain mesh fencing that would form a barrier to force larger-sized birds to fly over the road. This would not provide noise or light mitigation. Mesh fencing would need to incorporate a solid material or fine rabbit-proof mesh at the base, to prevent small fauna moving through it. The top wire should be marked to prevent bird collisions.
- Several studies have suggested that rows of vertical poles along the road edge may cause birds to fly up and over, without the same visual or wind capture issues as noise walls (Bard et al. 2002; Kociolek, Grilo & Jacobson 2015). However, a major advantage of solid structures, such as walls, berms and dense vegetation, is that they can also act as noise and light barriers, reducing light and noise impacts for people and wildlife. Vertical poles do not prevent ground-dwelling project from entering the road, which is an important consideration for the Project.
- Dense vegetation, which can act as a flight diverter for larger species. Vegetation can also be used to screen sensitive habitat from light from the road. Observations of fights across the project area showed that larger birds flew up, over and above the plantings along the edge of wetlands. However, vegetation plantings alone will not prevent ground-based fauna from moving onto the road, nor will they provide sufficient noise reduction.

7.4.1.1 BARRIER STRUCTURE DESIGN PRINCIPLES

- Ensure target species are unable to pass through, squeeze under or climb over.
- Ensure structure is integrated with culverts and Shared User Path (SUP), to ensure access to roadway is prevented. If structures are attached to culvert end walls, ensure wildlife are unable to squeeze in between or access the roadside corridor.
- Opaque barrier structures are superior to mesh because animals are unable to see through them, thereby discouraging them from attempting to force their way through. Transparent structures are not appropriate; however, semi-transparent structures may be suitable in conjunction with landscaping to limit light.
- Solid structures are better than mesh because maintenance is easier.
- Place structures as close as possible to the source of road noise.

7.4.1.2 MULTI-FUNCTION FAUNA BARRIER – CURRENT DESIGN

The current design and landscape plan incorporates a multi-function fauna barrier in key locations, where noise walls are not already proposed for residences. This effectively results in a continuous fauna barrier between the wetland areas, providing noise, light, and mortality mitigation and allowing passage under the road where possible through culverts or the Mordialloc Creek bridge. It is expected to encourage birds to fly up over the road, as well as providing a visual barrier between birds and traffic. The location of the barrier is shown on Figure 7.4, Section 7.4.3.

The current design is a 2 metre high barrier (multi-function fauna barrier component only, where noise walls for residences are proposed they may be lower or higher), A comparison between existing noise levels and predicted noise levels, with and without multifunctional fauna barriers and noise walls for residences, is shown in Table 7.5, with the locations examined shown on Figure 7.1 and Figure 7.2. Noise levels are calculated at the height of 1.5 m from terrain. It is important to note that, in this instance, the noise modelling has been expressed in $L_{10\ 18hr}$, a standard measurement used for noise contour modelling regarding roads to represent the upper limit of noise levels. Therefore, the results are representative of a worst-case scenario and noise levels are generally expected to be lower. Should the road be upgraded to a 6-lane freeway in future, the potential increase in noise from higher traffic is likely to require additional assessment.

As can been seen from this modelling, the barriers will reduce the upper limit of noise (L10) by between 3 and 5 dBA in key areas for wetland birds (note: given dBA is a logarithmic scale, this is a substantial reduction). This puts mitigated noise levels within or close to the range of maximums suggested by current literature (refer Section 6.1.4.2). We note, however, that the impact of nearby arterial roads on noise levels may be considerable for some of the key habitats. The contribution of arterial roads is not included in the modelling of existing or predicted levels.

Although a higher barrier would further reduce noise levels, a 2 metre barrier was considered appropriate by the Project, considering:

- As barrier height increases, the amount of noise reduction it provides becomes increasingly small
- Other conflicting priorities of the project, including aesthetics/visual impact of a high barrier, and increasing cost and footprint required to support a higher barrier.

Table 7.5 Existing and predicted upper noise levels with and without mitigation

LOCATION ID (FIGURE 7.1 AND FIGURE 7.2)	X COORDINATE	Y COORDINATE	EXISTING LEVELS[1] ($L_{10,18HR}$ dBA)	PREDICTED LEVELS (2031) WITHOUT MITIGATION ($L_{10,18HR}$ dBA)$_2$	PREDICTED LEVELS (2031) WITH MULTI-FUNCTION FAUNA BARRIER AND NOISE WALLS FOR RESIDENCES ($L_{10,18HR}$ dBA)[2]
1	335027.64	5791887.15	51	66	61
2	335376.36	5791872.43	51	65	61
3	335554.11	5791588.25	57	61	57
4	335207.97	5790725.54	50	64	60
5	335636.34	5790638.03	49	65	62
6	335418.80	5792139.50	50	63	60
7	334896.60	5791764.30	53	64	61
8	335772.60	5791698.30	55	59	56
9	335183.60	5790969.30	52	70	63

(1) Estimated based on noise monitoring and adjustments based on proximity to arterial roads

(2) Predicted levels are based on contributions from the proposed freeway only. Arterial roads are excluded for predictions

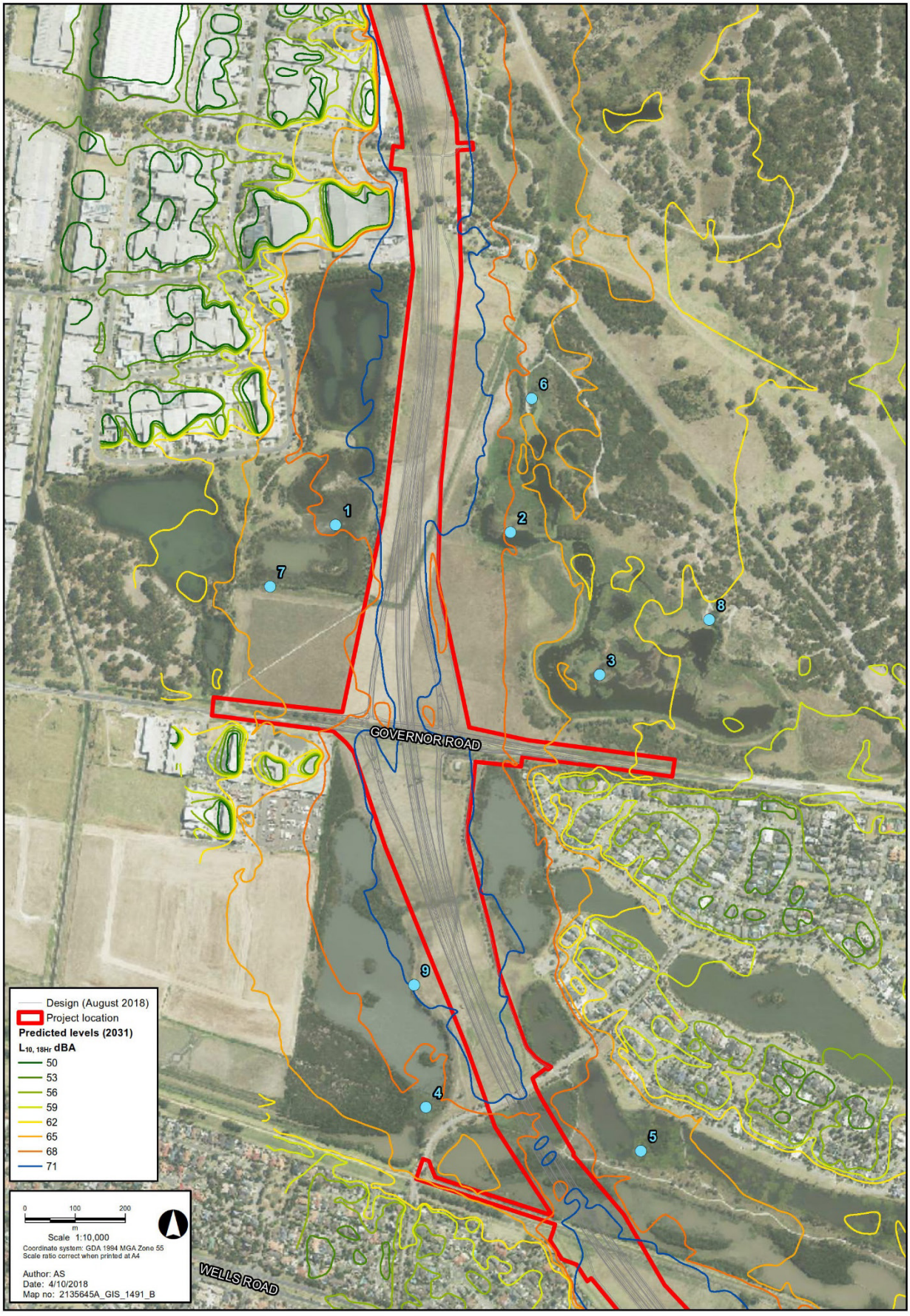


Figure 7.1 Noise monitoring locations (Table 7.5) and predicted noise levels (2031) without mitigation

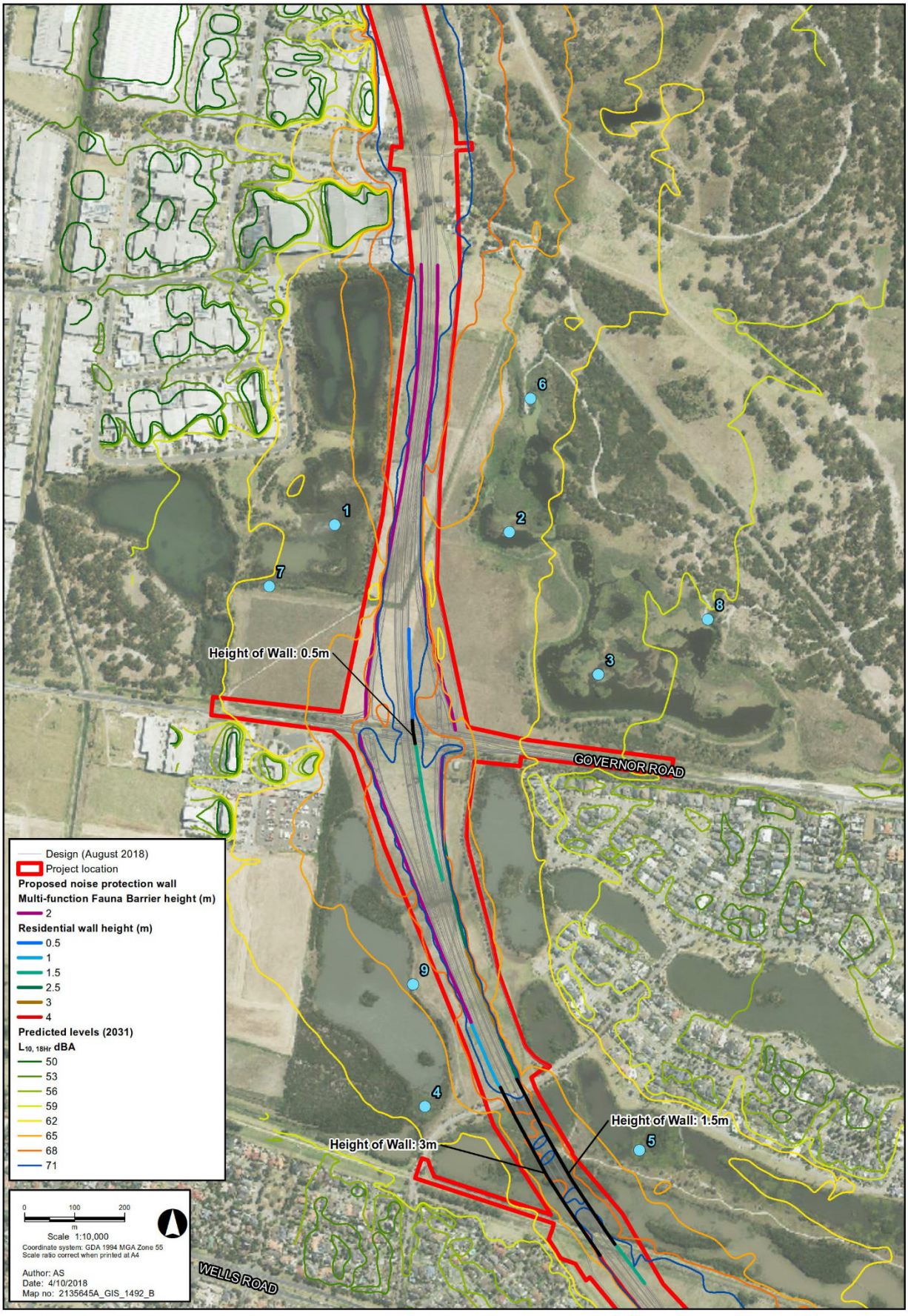


Figure 7.2 Noise monitoring locations (Table 7.5) and predicted noise levels (2031) with multi-function fauna barriers and noise walls for residences

7.4.2 WILDLIFE CROSSING STRUCTURES

7.4.2.1 DESIGN PRINCIPLES AND GUIDELINES

BRIDGES, SPANS AND CULVERTS

To facilitate the movement of wildlife underneath roads it is always preferable to use bridges, rather than pipe or box culverts. Larger underpasses, such as bridges, are almost always used at higher rates by a greater diversity of species than smaller underpasses (van der Ree, pers comm). Standard bridge designs can be easily modified to accommodate the movement of wildlife. The key considerations are: (1) ensuring sufficient height clearance under the bridge for the target species; (2) providing a sufficiently wide and dry bank on both sides of the waterway/wetland to enable dry passage at all (or most) times of the year; (3) allowing natural substrate and vegetation growth to continue under the bridge as much as possible, thereby providing a minimal break in natural conditions; and (4) allowing sufficient height for the safe movement of birds in flight. Where two bridges are planned to be constructed side by side, consider separating them to allow sufficient sunlight and rainfall to penetrate underneath the bridge, which will encourage natural vegetation growth and promote use by wildlife.

Smaller bridges (i.e. 'spans' across drainage lines) are also preferable to culverts for fauna passage. Where possible, drainage lines within key habitat areas (i.e. Braeside Park, Woodlands and Waterways) within the project area should be spanned by a small bridge, versus the removal of the drainage line and installation of culverts.

With regard to combined-use culverts, the optimal approach is to keep wildlife passage and drainage requirements separate. When this is not feasible, combined drainage and wildlife culverts are possible. However, extra planning is required in these circumstances, as wildlife movement may be compromised when the focus of the design is primarily drainage. For example, culverts which have a concrete floor, required to prevent scour, are generally less preferred by wildlife than underpasses with a natural-substrate floor. Keeping some cells dry in multi cell culverts can be easily achieved by raising the floor height of the first and last culvert by 10 or 20 cm (or whatever is required relative to typical water heights). This will ensure dry passage for wildlife during all times of the year apart from during flood events. If the drainage structure is a single culvert, a shelf or concrete platform can be installed to provide dry passage for wildlife.

The provision of 'fauna furniture' within crossing structures is an important consideration to maximise the rate of use by wildlife and minimise the risk of predation during use. For example, many species of wildlife, particularly smaller-bodied species, attempt to avoid being in open areas because of the increased risk of being preyed upon. Therefore, the provision of logs or piles of branches that wildlife can hide under or within may increase the acceptance of crossing structures and rate of use, and minimise predation rates. It should be noted that while predation may occur while prey-species are crossing under or over roads, there is little-to-no-evidence that such predation occurs systematically at all crossing structures, nor reduces the rate of use by the target native fauna (Little, Harcourt & Clevenger 2002; Mata et al. 2015).

It is generally well-recognised that rock beaching made of large, sharp and 'wobbly' rocks within a wildlife crossing structure can be a deterrent to the passage of wildlife. For example, turtles may fall in the gaps and be trapped. Therefore, where possible, the use of such rock beaching to prevent scour under bridges and at the entrances and exits of culverts should be avoided. If scour protection is required, use alternatives such as smaller-sized rocks, poured concrete, or replacement of a 2 m-wide strip of beaching with natural substrate (or poured concrete if scour is an issue). This should be implemented at all underpasses designed to accommodate the movement of wildlife, and the specific alternative treatment (i.e. use of natural substrate or poured concrete) to be adopted will vary depending on the risk of erosion at each location. Table 7.6 provides a list of design principles for both dedicated fauna culverts and dual-purpose fauna/surface water culverts within the project area.

We note that some of the species likely to be affected by reduction in connectivity, particularly Baillon's Crake, Lewin's Rail, Australasian Bittern, and Australian Little Bittern, generally move through vegetation. These species are unlikely to regularly use a culvert to move. However, culverts may support occasional movement, particularly if the entrances/exits are densely vegetated with tall reeds or other wetland vegetation, and if culverts are wet and have natural substrate. Although generally larger culverts are preferable, providing a range of culvert sizes allows for species which may feel more secure in a smaller culvert to select that option. Waterbirds have been recorded using culverts, including herons

(Queensland Department of Transport and Main Roads 2000; Sparks & Gates 2012) and ducks (Sparks & Gates 2012), and there have been records overseas of White-breasted Rails utilising culverts (reference unavailable).

Table 7.6 Culvert design principles for the Project

CULVERT DESIGN PRINCIPLES	
Dimensions and features	— The height of fauna culverts should be maximised relative to available space - i.e. a minimal amount of fill above the culvert. — Minimum height for fauna connectivity culverts is 1200 mm. — Preferred minimum height for fauna connectivity culverts in key areas is 1800 mm. — The floor of the culverts should be flush with the surrounding terrain. — The length of culverts should be the minimum necessary to meet drainage requirements (i.e. as short as possible). Although light wells would be preferable given the width of the road, it is understood that they may not be feasible for the project given the current design. Should this become possible, they should be incorporated into the design.
Box / pipe	— Box culverts are preferred to pipe culverts, at a similar height (i.e. at or above the minimum culvert height for fauna of 1200 mm). For example, for fauna passage and combined culverts, replace 1800 mm pipe culvert with 1800 mm box culvert.
Distance	— As a general approach, the distance between culverts supporting fauna passage should be minimised, with consideration to other design and functional considerations and requirements. — Because most reptiles, small mammals, and amphibians have small home ranges, as little as tens of square meters for small scincid reptiles, culverts should be installed at intervals of 150-300 m (Clevenger, Chruszcz & Gunson 2001). — We recommend a maximum distance between fauna culverts of approximately 150 m for the key areas between Woodlands wetlands and Braeside Park wetlands, and at the Waterways. This forms the basis for the locations of our recommended additional fauna culverts (i.e. additional to those in the surface water design) in these areas.
Pipe	— Where pipe culverts are required, for fauna passage culverts these should be sufficiently sized to maintain a horizontal section across the bottom of the culvert (i.e. addition of a natural substrate)
Two-way	— All fauna connectivity culverts should be two-way (i.e. not one-way water flow culverts).
Substrate	— Culverts should have natural substrates wherever possible (i.e. earthen floor with embedded small rocks instead of concrete). Where this is not feasible, sediment / natural substrate should be added to the floor of the culvert, including gravel or small pebbles.
Wet / dry	— Fauna culverts in the project area should be both wet and dry, due to the preferences of the different fauna species likely to make use of them. ‘Wet’ refers to maintaining water in the culvert most, but not necessarily all, days of the year. 'Dry' refers to the opposite, with the culvert, or part thereof, only being inundated during high flows (i.e. small portion of the year) — The 'wet' and 'dry' portions could be within a single culvert - i.e. a wet channel within a dry culvert, or conversely a raised dry section within a wet culvert. If only a single wet culvert is possible, dry cells/ledges should be incorporated into the culvert.
Furniture	— Dry fauna culverts or dry portions of wet culverts should have furniture installed, such as logs, rocks and/or artificial structures (e.g. wooden rails, ledges or trawler ropes).

CULVERT DESIGN PRINCIPLES	
Fencing	— Fauna culverts will generally require fencing (Barrier Type 2) to direct movement into the culverts, and restrict movement onto roads; these fences may be able to be incorporated into noise walls, flight diverters/barriers, or other fencing.
Revegetation	— Most or all fauna culverts (particularly those of 'high' and 'very high' priority) will require revegetation corridors to nearby vegetation. Landscaping should be carefully considered for all culverts modified or considered to be fauna crossings (refer to Section 7.4.5.1). — The area leading to culvert entrances should generally support dense, ground-layer, wet-adapted vegetation; this should extend as close to the entrance as possible. Vegetation can also be used to discourage human exploration of culverts (tall wetland vegetation, shrubs etc.). — Existing culverts that will not be upgraded/modified can be improved as fauna crossing points through weed control and landscaping/revegetation works (e.g. Dingley Bypass culverts).
North-south connectivity	— Although east-west connectivity is important for the key habitat areas (Braeside/Woodlands and Waterways), as a principle, the maintenance of north-south connectivity along the alignment is also important. Hence, fauna crossings of perpendicular (i.e. east-west) roads should be incorporated wherever possible, particularly on the west side which supports the Dandenong Drain channel in the northern portion.
Key supporting references	(Queensland Department of Transport and Main Roads 2010) (Hayes & Goldingay 2009) (Practical Ecology 2012) (VicRoads 2012b)

CANOPY ROPE BRIDGES

The species targeted by rope bridges are arboreal mammals, including Common Ringtail Possums, Common Brushtail Possums and Sugar Gliders. The height of the rope ladder above the road surface will need to be at least 7.5 m, to allow several metres or more of clearance between the tallest trucks and the rope ladder itself.

The design of the rope bridge, being two steel cables between two timber support poles, with a rope-ladder style rope bridge attached, is an appropriate and proven method to restore connectivity for the target species (R. van der Ree pers. comm. 2018). A key consideration for longevity of the bridge is to use marine-grade UV-stabilised rope. An additional important consideration for the effectiveness of rope bridges is to tie-off the ends of each rope bridge to two to three adjacent trees. This style bridge has been used extensively in Victoria, NSW and Queensland, with previous monitoring demonstrating its widespread use by the target species (R. van der Ree pers. comm. 2018).

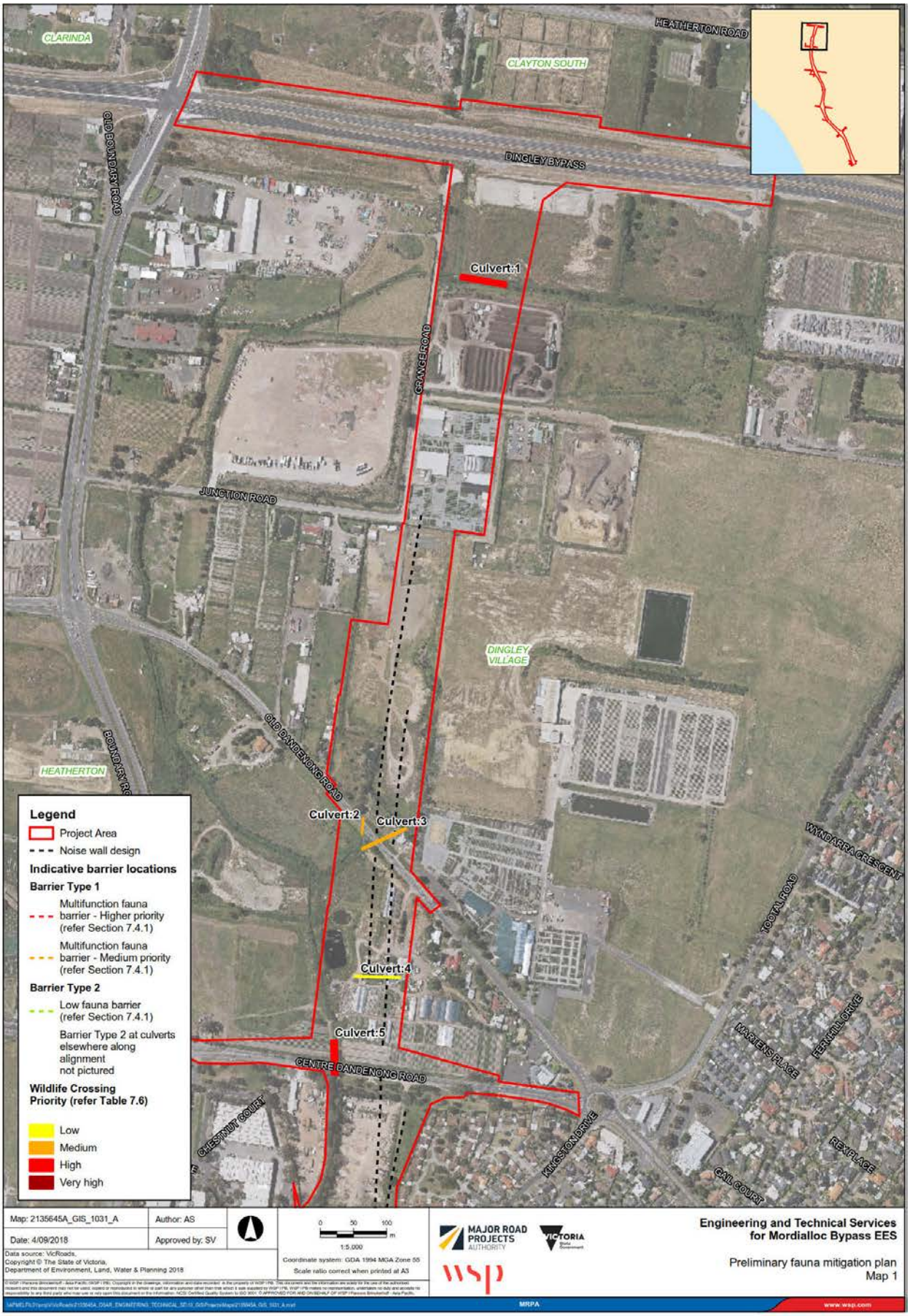
There is a widely-held misconception that wildlife crossing structures, such as underpasses and overpasses, including canopy rope bridges, are prey-traps for wildlife because predators learn that they can get an 'easy feed' at those locations. Despite this assertion, there is little to no evidence that predators systematically use crossing structures in this way (Little, Harcourt & Clevenger 2002; Mata et al. 2015). Furthermore, studies on rope bridge use and effectiveness along the Hume Freeway in southern NSW (R. van der Ree pers. comm. 2018) have shown that the same individual possums and gliders used rope bridges over multiple years, demonstrating that individuals were able to use the bridges successfully over multiple years without being taken by owls. Nevertheless, predation and attempted predation does occur and simple strategies such as the inclusion of refuge pipes (short lengths of 100 – 150 mm diameter PVC pipes) along the rope bridge may provide shelter if an owl attempts to predate on an animal using the bridge.

7.4.2.2 CROSSING POINT ASSESSMENT

Several potential or known crossing points were assessed. The locations of these crossing points are provided on Figure 7.3. Most of the culverts with the potential to facilitate fauna passage are already required for surface water drainage, and many would require minimal modification to be effective for fauna movement. Several additional passages for fauna were assessed (see Table 7.7) with two added to the current Project design. The 'priority' on the figures and in the table indicates the relative importance of the fauna crossing point, taking into account the habitat being connected, the nearest other culverts/crossing points, the types of fauna likely to use the culvert, the likely effectiveness of the crossing point, and the conservation significance of fauna likely to use the crossing point. Priority is somewhat dependent upon which culverts are installed/upgraded as fauna crossing points. I.e. should the additional fauna crossings be installed, the 'very high' priority culverts nearby may be able to be downgraded to 'high', as they become less important for the resident fauna.

All details regarding final locations and design of culverts and rope bridges (if the latter are incorporated) for the project are yet to be determined, however, it is expected the decision-making process will include consideration of the crossing structure priority, the listed species for which culverts may be useful, and other considerations (design constraints, cost, etc.).

The currently proposed crossing points (i.e. right-most column of Table 7.7) are presented in the following section.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CLAYTON SOUTH
OLD BOUNDARY ROAD
DINGLEY BYPASS
Culvert:1
GRANGE ROAD
JUNCTION ROAD
DINGLEY VILLAGE
OLD DANDENONG ROAD
HEATHERTON
Culvert:2
Culvert:3
Culvert:4
Culvert:5
CENTRE DANDENONG ROAD
WYNDARRA CRESCENT
TOOTAL ROAD
FERNHILL DRIVE
MARLENS PLACE
REX PLACE
CAIL COURT
KINGSTON DRIVE
CHESTNUT COURT
Legend
Project Area
Noise wall design
Indicative barrier locations
Barrier Type 1
Multifunction fauna barrier - Higher priority (refer Section 7.4.1)
Multifunction fauna barrier - Medium priority (refer Section 7.4.1)
Barrier Type 2
Low fauna barrier (refer Section 7.4.1)
Barrier Type 2 at culverts elsewhere along alignment not pictured
Wildlife Crossing Priority (refer Table 7.6)
Low
Medium
High
Very high
Map: 2135645A_GIS_1031_A
Author: AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads,
Copyright © The State of Victoria,
Department of Environment, Land, Water & Planning 2018
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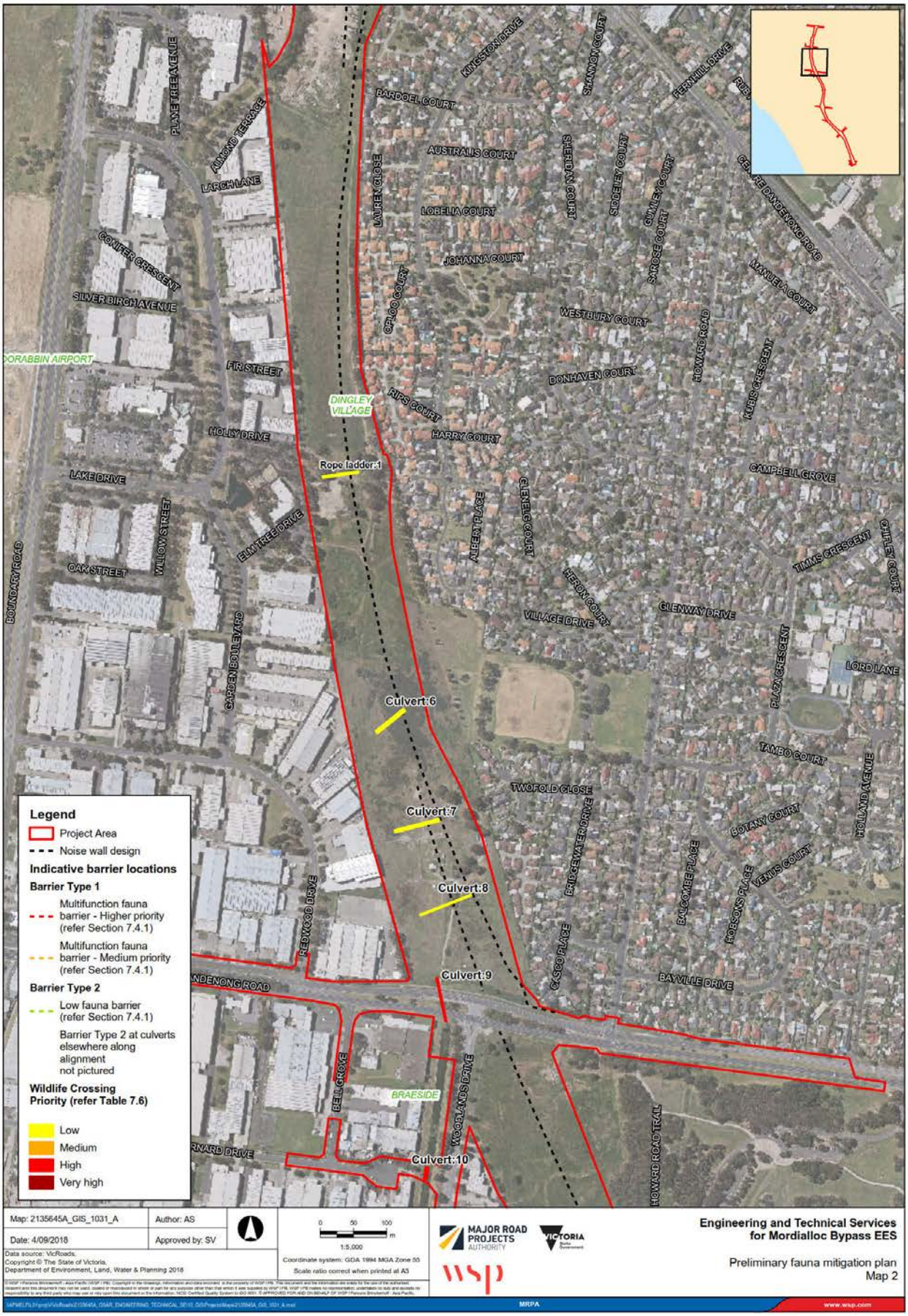
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Preliminary fauna mitigation plan
Map 1
MRPA
www.wsp.com


Legend
Project Area
Noise wall design
Indicative barrier locations
Barrier Type 1
Multifunction fauna barrier - Higher priority (refer Section 7.4.1)
Multifunction fauna barrier - Medium priority (refer Section 7.4.1)
Barrier Type 2
Low fauna barrier (refer Section 7.4.1)
Barrier Type 2 at culverts elsewhere along alignment not pictured
Wildlife Crossing Priority (refer Table 7.6)
Low
Medium
High
Very high
Rope ladder:1
Culvert:6
Culvert:7
Culvert:8
Culvert:9
Culvert:10
DINGLEY VILLAGE
BRAESIDE
KINGSTON DRIVE
BARDOEL COURT
AUSTRALIS COURT
LOBELIA COURT
JOHANNA COURT
WESTBURY COURT
DONHAVEN COURT
HARRY COURT
CAMPBELL GROVE
GLENWAY DRIVE
VILLAGE DRIVE
TIMMS CRESCENT
LORD LANE
TAMBO COURT
TWOFOLD CLOSE
BOTANY COURT
BAYVILLE DRIVE
HOWARD ROAD TRAIL
PLANE TREE AVENUE
ALMOND TERRACE
LARCH LANE
CONIFER CRESCENT
SILVER BIRCH AVENUE
FIR STREET
HOLLY DRIVE
LAKE DRIVE
OAK STREET
WILLOW STREET
ELM TREE DRIVE
BOUNDARY ROAD
GARDEN BOULEVARD
REDWOOD DRIVE
BELL GROVE
WOODLANDS DRIVE
FERNHILL DRIVE
SHANNON COURT
SHERIDAN COURT
SIDDELEY COURT
GINNEY COURT
SAROSE COURT
LAUREN CLOSE
OPLOO COURT
HOWARD ROAD
KUBIS CRESCENT
MANUELA COURT
GLENELG COURT
ALBERT PLACE
HERON COURT
BRIDGEWATER DRIVE
BALCOMBE PLACE
HOBSONS PLACE
VENTIS COURT
HOLLAND AVENUE
PLAZA CRESCENT
CHILEY COURT
Map: 2135645A_GIS_1031_A
Author: AS
Date: 4/09/2018
Approved by: SV
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Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
Data source: VicRoads.
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MAJOR ROAD PROJECTS AUTHORITY
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Preliminary fauna mitigation plan
Map 2
MRPA
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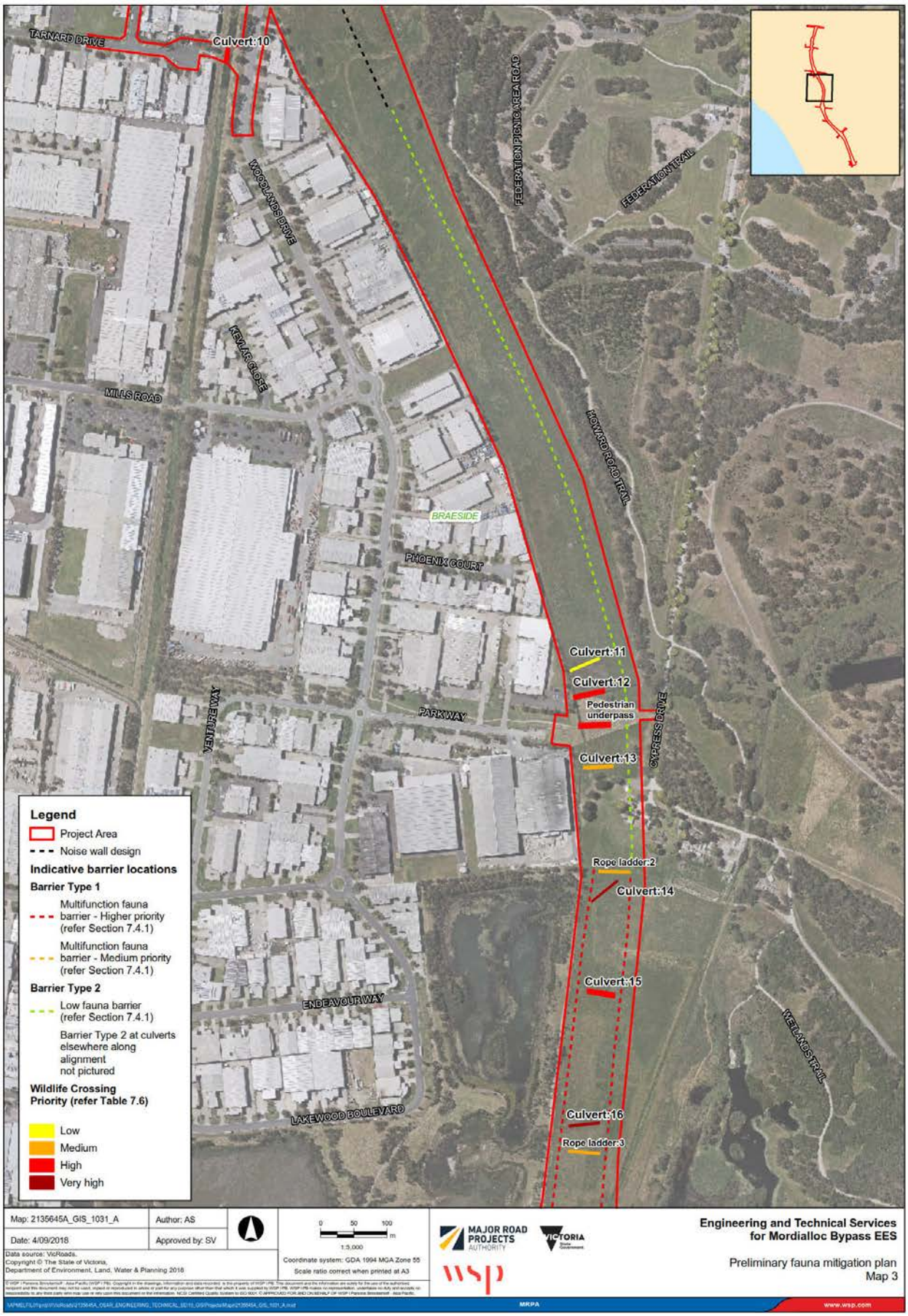
TARNARD DRIVE
Culvert:10
WOODLANDS DRIVE
FEDERATION PICNIC AREA ROAD
FEDERATION TRAIL
KEVLAR CLOSE
MILLS ROAD
HOWARD ROAD TRAIL
BRAESIDE
PHOENIX COURT
Culvert:11
Culvert:12
Pedestrian underpass
PARKWAY
VENTURE WAY
CYPRESS DRIVE
Culvert:13
Rope ladder:2
Culvert:14
Culvert:15
ENDEAVOUR WAY
WETLANDS TRAIL
LAKEWOOD BOULEVARD
Culvert:16
Rope ladder:3
Legend
Project Area
Noise wall design
Indicative barrier locations
Barrier Type 1
Multifunction fauna barrier - Higher priority (refer Section 7.4.1)
Multifunction fauna barrier - Medium priority (refer Section 7.4.1)
Barrier Type 2
Low fauna barrier (refer Section 7.4.1)
Barrier Type 2 at culverts elsewhere along alignment not pictured
Wildlife Crossing Priority (refer Table 7.6)
Low
Medium
High
Very high
Map: 2135645A_GIS_1031_A
Author: AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads.
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0 50 100 m
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MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
wsp
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Preliminary fauna mitigation plan
Map 3
MRPA
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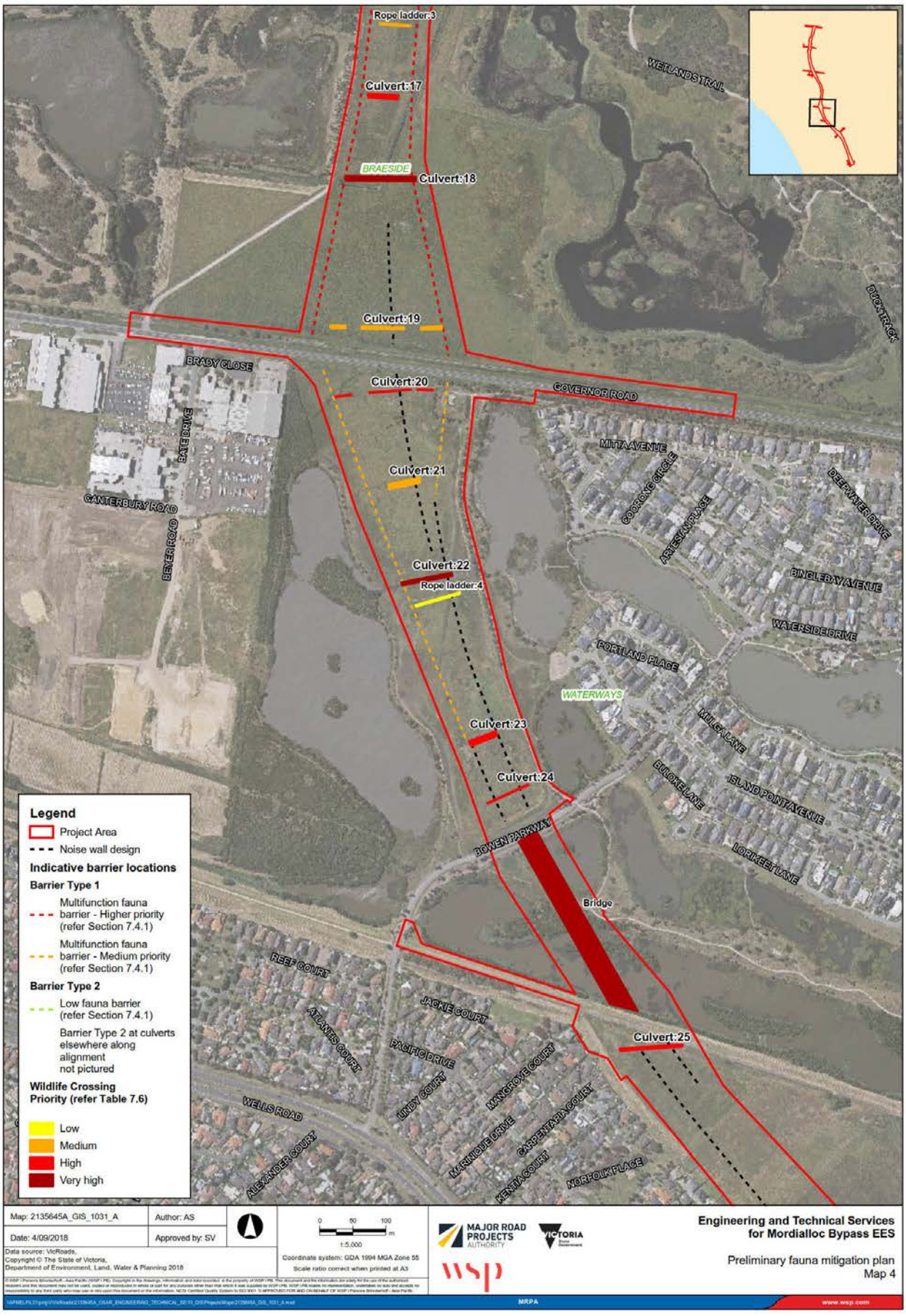


Figure 7.3 Preliminary fauna mitigation plan

Table 7.7 Assessment of potential fauna crossing structures

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
Culverts							
1 High	Yes, culvert CD A1 Ø(2x) 3600x2700	23000	One wet and one 'dry' culvert.	Old Dandenong Rd Drain (upper). Drain currently provides habitat and connectivity through the landscape for a range of native fauna, and potentially some listed fauna species. Post-construction, the drain would be one of few potential crossing points in the surrounding area; nearest crossing to S would be c. 900 m away.	Some waterbirds, including cryptic species that typically walk rather than fly, and those with young (e.g. ducks). Amphibians. Eastern Long-necked Turtle. Some small mammals, including potentially Water Rat.	No change to dimensions. Wet and dry culvert incorporated in design. Ø(2x) 3600x2700	YES
2 Moderate	CD C2 Ø600	23870	Increase height to 1200 mm if possible.	Minor drainage line crossing of Old Dandenong Rd. Constrained by Old Dandenong Road height	Usage likely limited to more generalist native fauna, such as common amphibian species.	Not incorporated	Unlikely
3 Moderate	CD C1 Ø(2x) 1200x600	23900	Increase height to 1200 mm if possible. One wet and one dry	Culvert crosses Old Dandenong Rd. Constrained by Old Dandenong Road height. Drainage line connection, across two barriers (i.e. 2 roads); nearest other crossing point would be c. 200m to S or c. 900m to N (i.e. 1 km separation)	Usage likely limited to more generalist native fauna, such as common amphibian species	Not incorporated	Unlikely
4 Low	CD D1 Ø1050	24100		Limited habitat to east. As such, this culvert would require revegetation to be of value to native fauna.	Usage likely limited to more generalist native fauna, such as common amphibian species.	Not incorporated	Unlikely

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
5 High	CD D2 Ø(3x) 3000x1500	24200	Increase height for one or more to 1800 mm+. At least one wet and one dry.	Dandenong Drain, running parallel to alignment. Constrained by road height. Drainage line crossing of Centre Dandenong Road, providing N-S connectivity within and outside of the alignment. Likely to be utilised by a range of native fauna species, potentially including periodic use by listed species.	Some waterbirds, including cryptic species that typically walk rather than fly, and those with young (e.g. ducks). Amphibians. Eastern Long-necked Turtle. Small mammals, including potentially Water Rat.	Not incorporated, however height already sufficient for most fauna. Include wet and dry portions. Ø(3x) 3000x1500	YES
6 Low	CD E1 Ø(3x) 1200x750	25450	1200 mm height	Unlikely to connect habitat of value	Usage likely limited to more generalist native fauna, such as common amphibian species.	Not incorporated	Unlikely
7 Low	CD E2 Ø(3x) 1200x750	25650	1200 mm height	Unlikely to connect habitat of value	Usage likely limited to more generalist native fauna, such as common amphibian species.	Not incorporated	Unlikely
8 Low	CD E3.1 Ø1200x600	25740	1200 mm height	Considered too long to facilitate periodic successful crossings.	Usage likely limited to more generalist native fauna, such as common amphibian species; passage may be too long.	Not incorporated	Unlikely

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
9 High	CD E3 (however refer to Brief Rationale column) Ø1650	25850	Box culvert design. Minimum 1800 mm. Wet and dry portions within culvert.	West side of alignment. Current pipe is underground so fauna connectivity not possible. However, the is the potential for additional of a separate dedicated fauna crossing culvert to improve north-south connectivity. This may be constrained by the existing road height and may not be feasible for the Project. Perpendicular road crossing - connects drainage line, and potentially Braeside, to alignment and landscape to N. Maintains N-S connectivity of wet habitat along the alignment (i.e. from Dandenong Drain to north, plus swales)	Some waterbirds, including cryptic species that typically walk rather than fly, and those with young (e.g. ducks). Amphibians. Eastern Long-necked Turtle. Small mammals, including potentially Water Rat.	Afflux issues so fauna passage not added.	NO

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
10 High	CDE5 Ø(3x) 1500x1500	26100	Span over drainage line. Otherwise, box culverts to maintain minimum height of 1200 mm. One dry culvert (or dry portion of wet culvert).	Small bridge span would retain much of the existing connectivity along the drainage line, for a range of species using the wet habitat. Otherwise, culverts likely to partially mitigate lost connectivity.	Some waterbirds, amphibians and some small mammals, including potentially Water and Swamp Rat.	Culverts, not span. Ø(3x) 1500x1500	YES
11 Low	CDF5 Ø1200x1200	27160	Leave at current height	Not a key fauna connectivity culvert, under the assumption that 27200 would be, and potentially the pedestrian underpass. This should be considered higher priority if these structures cannot be utilised and modified for fauna connectivity.	Primarily terrestrial fauna, including reptiles, amphibians and small mammals.	No change required (not a key culvert)	YES

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
12 High	CD F1 Ø(4x) 1200x1200	27200	Increase size of one or more culverts to 1800 mm. Wet and dry culverts.	The 'high' priority is contingent on revegetation and connectivity south through to Woodlands. High priority due to location with Braeside on east and Woodlands wetlands to south. Use by fauna would be contingent on the west side of alignment being appropriately revegetated. Potential for tree plantings on Parkway to enhance connectivity to west.	Primarily terrestrial fauna, including reptiles, amphibians and small mammals. Potentially arboreal mammals also, moving between Braeside and west side of alignment/urban tree areas.	Incorporated in design (one cell to become 1800 high) Recommend that a rail for arboreal mammals be included in this one. At least: Ø(3x) 1200x1200 (1x) 1200x1800	YES
13 Moderate	CD F4 Ø(2x) 1200x1200	27330	Maintain height of minimum 1200 mm; one wet and dry.	Braeside on east and Woodlands within 150 m to south on west side.	Primarily terrestrial fauna, including reptiles, amphibians and small mammals. Potentially arboreal mammals also, moving between Braeside and west side of alignment/urban tree areas.	No modification required. (at least some dry passage ideal – can be all dry) Ø(2x) 1200x1200	YES

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
14 Very high	CD F2 Ø600	27500	Increase to 1800 mm+, and duplicate. Straighten. One wet, one dry. Provision for arboreal species also (reveg corridor to east; canopy connection (e.g. rope bridge)?).	Will require revegetation corridor on east to Braeside. Very high priority due to presence of a range of fauna habitats at either side in Braeside and Woodlands, including habitat for arboreal and terrestrial mammals, reptiles, frogs and waterbirds (i.e. those spp. that rarely fly or have young, and hence require terrestrial connectivity). Likely to be utilised by threatened species.	Arboreal mammals moving between treed areas in Woodlands to Braeside. A range of common and threatened waterbirds, particularly those with a skulking preference or with young. A range of amphibians and reptiles including Eastern Long-necked Turtle. Water rats.	Not incorporated	NO
15 High	No	27680	Add fauna box culvert(s), min. 1200 mm height	Current hydrological design has three proposed culverts between Woodlands and Braeside, resulting in alignment interfaces of up to 300 m without a crossing structure. Crossings at c. 27680 and 28030 will reduce this distance to approximately 150 m; this will likely materially reduce fragmentation for fauna populations at Braeside and Woodlands (particularly species operating at small spatial scales e.g. small reptiles and amphibians).	Arboreal mammals moving between treed areas in Woodlands to Braeside. A range of common and threatened waterbirds, particularly those with a skulking preference or with young. A range of amphibians and reptiles including Eastern Long-necked Turtle.	Added into design 2 x 1200x1200 Location is approximate. Size is minimum.	YES

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
16 Very high	CD F3 Ø1200	27870	Increase to 1800 mm+, and duplicate. Straighten. One wet, one dry. Provision for arboreal species also (reveg corridor to east; canopy connection (e.g. rope bridge)?).	Will require revegetation corridor on east to Braeside. Very high priority due to presence of a range of fauna habitats at either side in Braeside and Woodlands, including habitat for arboreal and terrestrial mammals, reptiles, frogs and waterbirds (i.e. those spp. that rarely fly or have young, and hence require terrestrial connectivity). Likely to be utilised by threatened species.	Arboreal mammals moving between treed areas in Woodlands to Braeside. A range of common and threatened waterbirds, particularly those with a skulking preference or with young. A range of amphibians and reptiles including Eastern Long-necked Turtle.	Incorporated in design 2 x 1800 x 1800 Some wet, some dry passage	YES
17 High	No	28030	Add fauna box culvert(s), min. 1200 mm height	Current hydrological design has three proposed culverts between Woodlands and Braeside, resulting in alignment interfaces of up to 300 m without a crossing structure. Crossings at c. 27680 and 28030 will reduce this distance to approximately 150 m; this will likely materially reduce fragmentation for fauna populations at Braeside and Woodlands (particularly species operating at small spatial scales e.g. small reptiles and amphibians).	Arboreal mammals moving between treed areas in Woodlands to Braeside. A range of common and threatened waterbirds, particularly those with a skulking preference or with young. A range of amphibians and reptiles including Eastern Long-necked Turtle.	No additional passage proposed. See below.	NO. See below

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
18 Very high	CD G1 Ø(3x) 2400x2100	28150	Wet and dry culvert.	Will require revegetation corridor on east to Braeside. Very high priority due to presence of a range of fauna habitats at either side in Braeside and Woodlands, including habitat for arboreal and terrestrial mammals, reptiles, frogs and waterbirds (i.e. those spp. that rarely fly or have young, and hence require terrestrial connectivity). Likely to be utilised by threatened species.	Arboreal mammals moving between treed areas in Woodlands to Braeside. A range of common and threatened waterbirds, particularly those with a skulking preference or with young. A range of amphibians and reptiles including Eastern Long-necked Turtle.	Will now be located roughly where Culvert 17 was proposed. This is potentially a better outcome for fauna. No change to SW design for ecology – proposed size is sufficient. Ø(3x) 2400x2100	YES
19 Moderate	CD H1 Ø(2x) 1800x1800	28400	One wet, one dry.	Current culvert size considered sufficient to facilitate fauna passage.		No change required Fencing between carriageways to prevent fauna getting on to the road. Ø(2x) 1800x1800	YES but requires fencing between carriageways to prevent fauna getting stuck on road

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
20 High	CD I1 Ø750	28470	Increase size to 1800 mm (1200 mm minimum). Duplicate. One wet and one dry (or a dry portion within a culvert).	Suitable culvert(s) would provide connectivity between the northern sections of the wetlands on either side of the alignment.	A range of waterbirds, including some threatened species - particularly skulking species or those with young. Reptiles, including Eastern Long-necked Turtle and Glossy Grass Skink. A range of common amphibian species. Small mammals, including potentially Water Rat and Swamp Rat.	No changes incorporated, not possible due to ramps/road height. Potentially too long to be used by fauna. May still be used by some small species. Fencing between carriageways to prevent fauna getting on to the road.	Unlikely (but if it is used, fauna could become trapped if no fencing between carriageways)

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
21 Moderate	No	c. 28620	Add fauna box culvert(s), min. 1200 mm height	Early hydrological design has three areas of culverts between wetlands in Waterways, resulting in alignment interfaces of over 300 m without a crossing structure. Crossings at c. 28620 and 28950 will reduce this distance to c. 150 m; this will likely materially reduce fragmentation for fauna populations at Waterways. A culvert at c. 28600 would be long, or a series of culverts; hence a lower priority than crossing at c. 28950.	A range of waterbirds, including some threatened species - particularly skulking species or those with young. Reptiles, including Eastern Long-necked Turtle and Glossy Grass Skink. A range of common amphibian species. Small mammals, including potentially Water Rat and Swamp Rat.	Not incorporated, not enough fill/road height not amenable to addition.	NO
22 Very high	CD J1 Ø(2x) 2400x1200	28760	Span drainage line. Otherwise, increase height to 1800 mm+. Wet and dry.	Currently an existing drainage line connecting Waterways wetlands, and likely to be utilised by a range of fauna groups, including threatened species. Retention of natural drainage line (i.e. by spanning) would retain much of this connectivity.	A range of waterbirds, including some threatened species - particularly skulking species or those with young. Reptiles, including Eastern Long-necked Turtle and Glossy Grass Skink. A range of common amphibian species. Small mammals, including potentially Water Rat and Swamp Rat.	Culverts not span. 2x 2400x1800	YES

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
23 High	No	c. 28950	Add fauna box culvert(s), min. 1200 mm height	Current hydrological design has three proposed culverts between wetlands in Waterways, resulting in alignment interfaces of over 300 m without a crossing structure. Crossings at c. 28620 and 28950 will reduce this distance to c. 150 m; this will likely materially reduce fragmentation for fauna populations at Waterways.	A range of waterbirds, including some threatened species - particularly skulking species or those with young. Reptiles, including Eastern Long-necked Turtle and Glossy Grass Skink. A range of common amphibian species. Small mammals, including potentially Water Rat and Swamp Rat.	Fauna passage added to design One 1200x1200 Location is approximate, size is minimum	YES

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
24 High	CD J2 Ø600	29100	Bridge extension (5-10 m). Otherwise, add box culverts, 1200 mm+, wet and dry.	Bridge extension to N preferred, to create a terrestrial underpass (i.e. a non-culvert crossing) of c. 5-10 m width. If bridge can be extended north of Bowen Parkway (i.e. c. 5-10 m) this would provide a terrestrial underpass for fauna within the alignment. Terrestrial underpasses are more effective at facilitating crossings for most fauna species. An effective crossing is considered important here; particularly if there is no crossing provided at c. 28950. In the absence of an effective crossing, non-flying fauna in and around the wetland to the west may need to cross a culvert under Bowen Parkway, cross the alignment (i.e. under bridge), and then cross a second culvert under Bowen Parkway to access the wetland to the east (and vice versa).	A range of waterbirds, including some threatened species - particularly skulking species or those with young. Reptiles, including Eastern Long-necked Turtle and Glossy Grass Skink. A range of common amphibian species. Small mammals, including potentially Water Rat and Swamp Rat.	Not incorporated	Unlikely

NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
25 High	CD K1 Ø(2x) 1500x1200	29580	Wet and dry culvert.	Culvert at Smythes Drain. High priority assigned partly due to consideration of future open space and connectivity in this area. Likely large enough to facilitate fauna passage.	Some waterbirds, including cryptic species that typically walk rather than fly, and those with young (e.g. ducks). Amphibians. Reptiles, including Eastern Long-necked Turtle and potentially Glossy Grass Skink. Some small mammals, including potentially Water Rat.	No change necessary Ø(2x) 1500x1200	YES
Rope bridges							
1 Low	No		Rope bridge or similar. Requires tree planting	Common fauna mortality reduction only	Common possum species	No, although potential future option.	
2 Medium	No		Rope bridge or similar. Requires tree planting	Mortality reduction and connectivity for a less common (although not threatened) species. Connects wildlife-rich areas.	Potentially Sugar Gliders, as well as common possum species	Identified as future option	YES – if incorporated
3 Medium	No		Rope bridge or similar. Requires tree planting	Mortality reduction and connectivity for a less common (although not threatened) species. Connects wildlife-rich areas.	Potentially Sugar Gliders, as well as common possum species	No, although potential future option.	

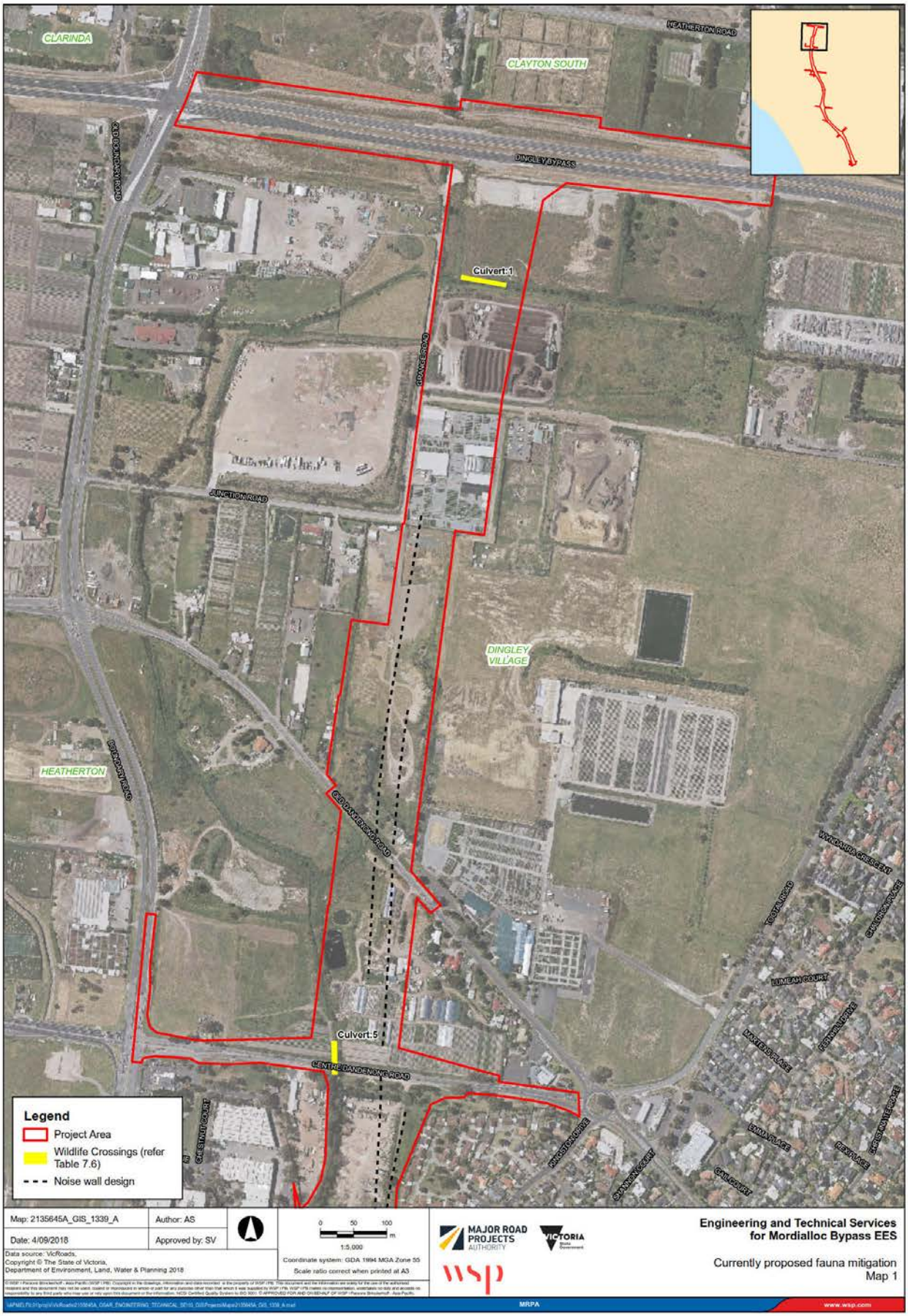
NUMBER (FIGURE 7.3) AND INITIAL PRIORITY	CULVERT NUMBER AND INITIAL DESIGN	APPROX CHAINAGE	ECOLOGY DESIGN RECOMMENDATIONS	RATIONALE	TARGET FAUNA	DECISION (AS OF AUGUST 2018) AND CURRENT DESIGN	WILL DESIGN ALLOW FAUNA PASSAGE?
4 Medium	No		Rope bridge or similar. Requires tree planting	Common fauna mortality reduction only	Common possum species	No, although potential future option.	
Other Potential Crossing Points							
Pedestrian underpass Medium	Yes Pedestrian underpass	27250	Would require vegetation connectivity and/or natural substrate. Or a rail could be added for possums.	Pedestrian underpass would provide a high passage and would likely enhance fauna connectivity.	Terrestrial fauna, including reptiles, amphibians and small mammals. Potentially arboreal mammals also, moving between Braeside and west side of alignment/urban tree areas and to Woodlands wetlands. Depending on height of underpass it may also be used by a range of bird species.	No. Dual purpose not suitable for safety. Underpass may need to be lit. Also, modification not considered necessary due to proximity to suitable culverts.	NO
Bridge Very high	Yes 400 m long bridge	29300	Refer revegetation section	Bridge over Mordialloc Creek.	A range of waterbirds, including some migratory birds and threatened species. Reptiles, including Eastern Long-necked Turtle and Glossy Grass Skink. A range of common amphibian species. Small mammals, including Water Rat and Swamp Rat.	Revegetation incorporated into landscape plan. Guidelines provided in Section 7.4.4.	YES

7.4.3 CURRENT CROSSING STRUCTURE AND BARRIER LOCATIONS

The currently proposed crossing points (Project design as of August 2018) are all culverts assessed to have the potential to facilitate fauna passage (right-most column of Table 7.7). This is a total of 13 culverts, including two designed solely for fauna (i.e. not dual purpose surface water/fauna).

The currently proposed barriers (Project landscape plan as of August 2018) include a multi-function fauna barrier between the key wetland areas, and a low fauna barrier north of the ranger station on the eastern side of the Project at Braeside Park. Fauna fencing at culverts elsewhere in the Project area is not currently included in the design, but should be considered for all culverts likely to facilitate fauna passage (where a barrier is not already present).

The above is shown on Figure 7.4.


CLARINDA
CLAYTON SOUTH
HEATHERTON ROAD
DINGLEY BYPASS
CLARINDA ROAD
Culvert:1
ORANGE ROAD
JUNCTION ROAD
DINGLEY VILLAGE
HEATHERTON
CENTRE DANDENONG ROAD
Culvert:5
Legend
Project Area
Wildlife Crossings (refer Table 7.6)
Noise wall design
Map: 2135645A_GIS_1339_A
Author: AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads,
Copyright © The State of Victoria,
Department of Environment, Land, Water & Planning 2018
0 50 100 m
1:5,000
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Currently proposed fauna mitigation
Map 1
MRPA
www.wsp.com


Legend
Project Area
Wildlife Crossings (refer Table 7.6)
Noise wall design
Culvert 10
DINGLEY VILLAGE
BRAESIDE
DORABBIN AIRPORT
LOWER DANDENONG ROAD
TARNARD DRIVE
Map: 2135645A_GIS_1339_A
Author: AS
Date: 4/09/2018
Approved by: SV
Data source: VicRoads,
Copyright © The State of Victoria,
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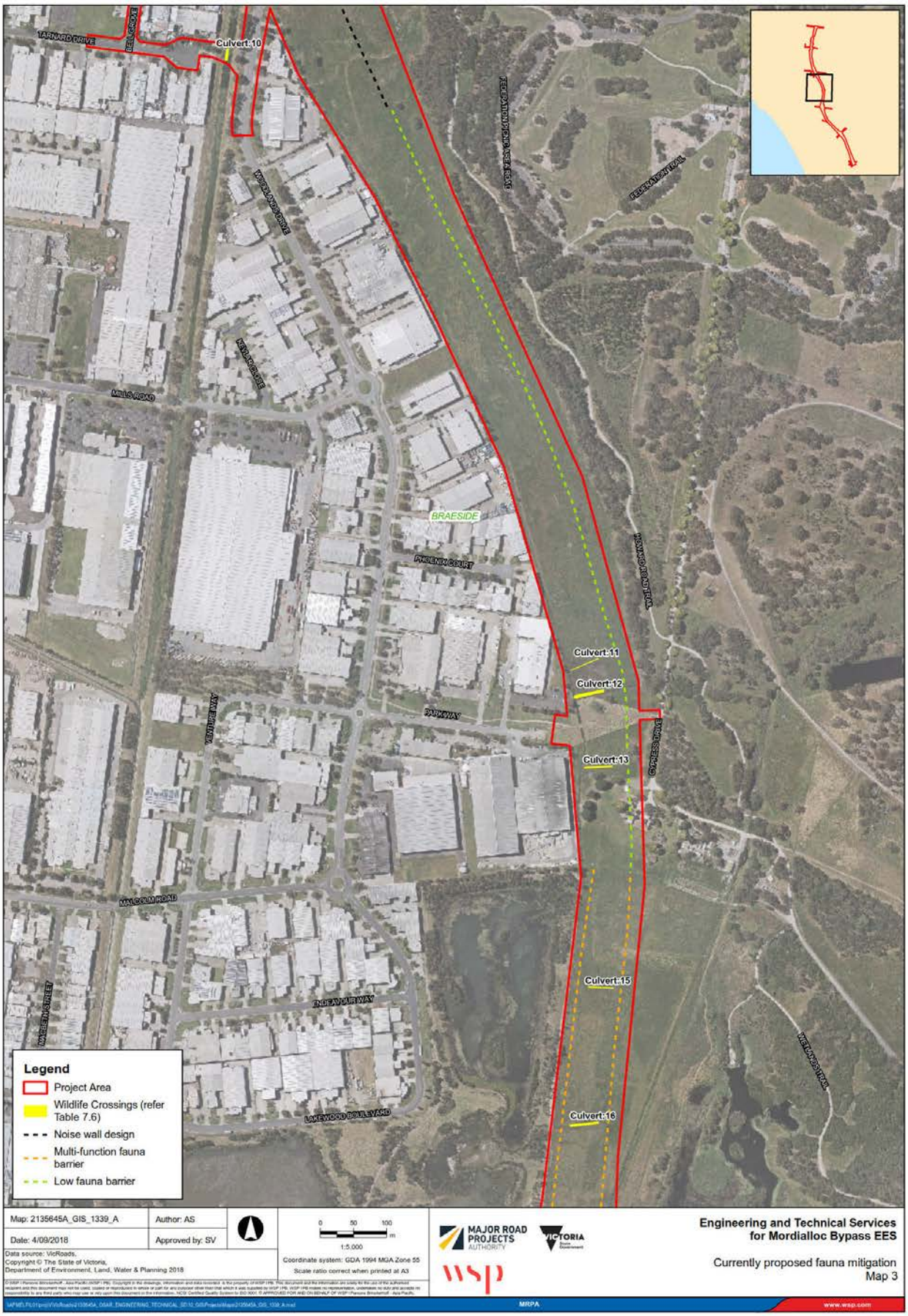
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Currently proposed fauna mitigation
Map 2
MRPA
www.wsp.com


BARNARD DRIVE
BELL GROVE
Culvert-10
WOOLWORKS DRIVE
MEWLA CLOSE
MILLS ROAD
FEDERATION TRAIL
BRAESIDE
PHOENIX COURT
HOWARD ROAD TRAIL
Culvert-11
Culvert-12
PARKWAY
KESTLE WAY
Culvert-13
CYPRESS DRIVE
MALCOLM ROAD
MAGEE STREET
ENDEAVOUR WAY
Culvert-15
WOLAMAI TRAIL
LAKEWOOD BOULEVARD
Culvert-16
Legend
Project Area
Wildlife Crossings (refer Table 7.6)
Noise wall design
Multi-function fauna barrier
Low fauna barrier
Map: 2135645A_GIS_1339_A
Author: AS
Date: 4/09/2018
Approved by: SV
0 50 100 m
1:5,000
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
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MAJOR ROAD PROJECTS AUTHORITY
VICTORIA
wsp
Engineering and Technical Services for Mordialloc Bypass EES
Currently proposed fauna mitigation
Map 3
MRPA
www.wsp.com

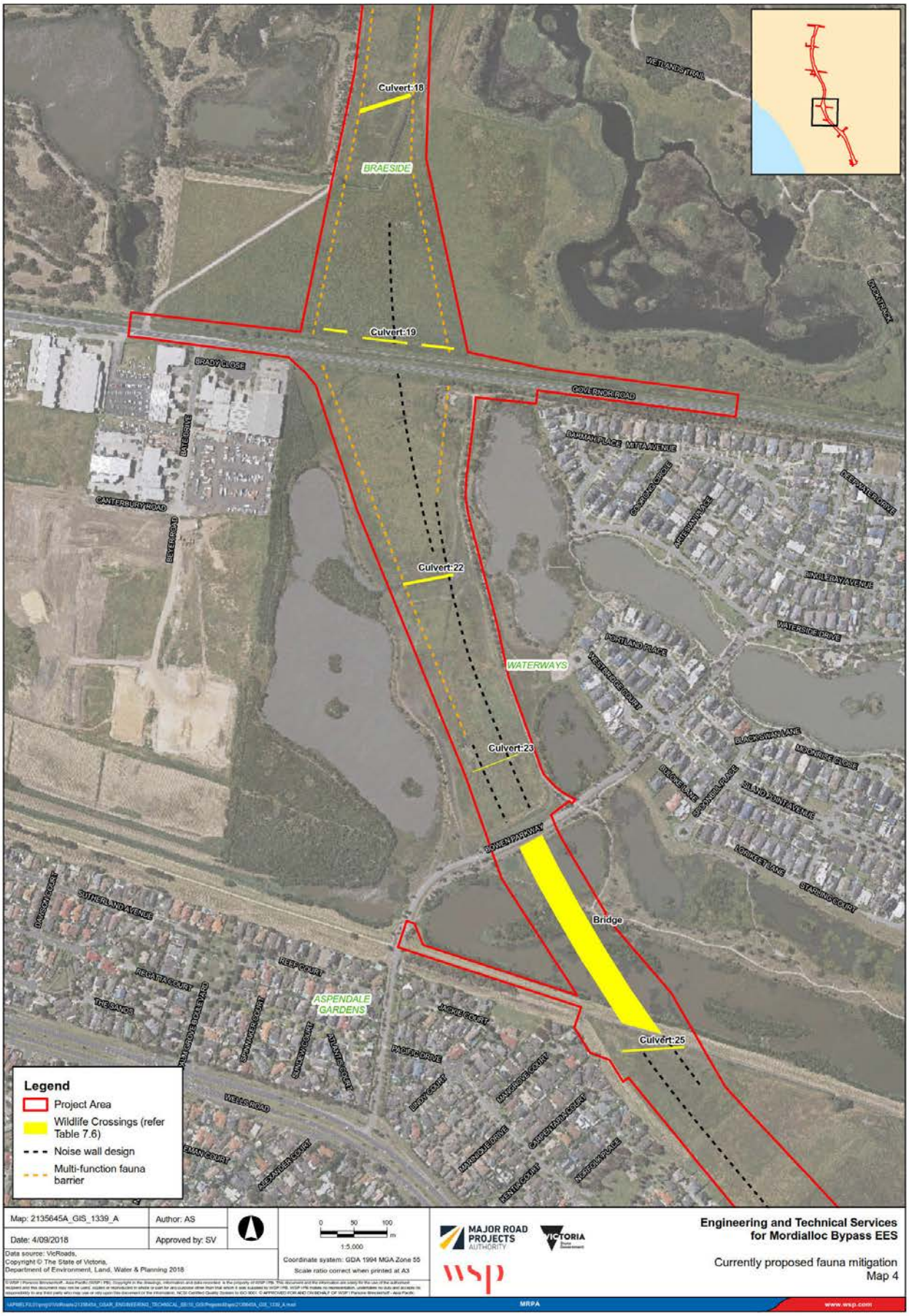

Figure 7.4 Currently proposed fauna mitigation

7.4.4 FAUNA-SENSITIVE LIGHTING

Design principles for road (and other) lighting are detailed in Table 7.8. These principles should be followed for the entire road alignment. The final detailed lighting design for the Project should be developed by a professional lighting designer with experience in minimising impacts on ecology. The table does not address vehicle lights. Screening will be required to shield light, particularly headlights, from wetlands in key locations. This can be achieved through barriers and/or landscaping.

Table 7.8 Lighting principles for the Mordialloc Bypass

	LIGHTING DESIGN PRINCIPLES	KEY REFERENCES
Siting of lights	— Utilise lighting only where necessary – consider white lining and 'cats' eyes' in other location. Use the minimum amount of light (lumens) required (Note: current design incorporates lighting at intersections only) — Site lighting columns away from sites of ecological value to all extent possible. — Consider the height of lighting. Generally, a lower mounting height is preferred (although not always, this should be determined by a lighting designer with experience minimising impact on sensitive receptors).	— Interim Guidance: Artificial lighting and wildlife - Recommendations to help minimise the impact of artificial lighting (Bat Conservation Trust Undated). — VicRoads fauna sensitive road design guidelines (VicRoads 2012b). — Florida Fish and Wildlife Conservation Commission – Wildlife Lighting Criteria (Florida Fish and Wildlife Conservation Undated). — International Dark-sky Association website (International Dark-Sky Association Undated).
Fixtures	— Install full cut-off or fully shielded lights or fixtures to direct light down to where it is needed only, and to minimise light spill onto sites of ecological value. — Fixture must fully shield the bulb/lens from important wildlife habitat. — Avoid using reflective surfaces under lights.	
Wavelengths	— Use narrow-spectrum light sources to lower the range of species affected by lighting — Avoid white or blue wavelengths – where white light sources are required they should be of a warm colour temperature (definitely <4,200 kelvin, preferably <3,000 kelvin). — Minimise emission of ultra-violet light. — Utilise long wavelength bulbs.	
Temporary fencing	— Should vegetation be utilised as a screening measure, install temporary fencing until vegetation is sufficiently mature.	
Specific recommendations for Shared User Path (in addition to above guidelines).	No lighting on the SUP is currently proposed or expected. However, these guidelines are relevant for pedestrian underpass lighting or other situations where some lighting may be required for safety. — Utilise long-wavelength low-luminance solutions such as amber or red solar in-path lighting, directed along the path. — Alternatively, low, shielded, long-wavelength lamps could be utilised in some locations.	

7.4.5 LANDSCAPING AND PLANTING

7.4.5.1 LANDSCAPING GUIDELINES

The Project landscape plan should incorporate revegetation of habitat temporarily disturbed for the Project. Alternatively, a targeted revegetation plan could be developed. The principles for landscaping for ecological values are provided in Table 7.9.

Although not required to mitigate any of the identified project risks, there are opportunities for community involvement in revegetation and habitat creation/improvement such as community planting days. This could be of benefit, particularly in the Braeside Park/Woodlands/Waterways area, to maintain a sense of community ownership and encourage enjoyment of these public spaces.

Seed collection from plants at the project area is unlikely to be of substantial benefit to the project or the ecological values of the area. Sourcing of local provenance plants where possible is recommended, however the time and effort which would be required raising seedlings from the area is unlikely to be justified. This is due to the degree of planting which has already occurred in the area, and the general availability of local provenance plants at local nurseries. Overtures with local nurseries should be made to ensure this, as it would be prudent to ensure plants are sufficiently well-established, preferably prior to completion of the Project.

Table 7.9 Ecological landscaping guidelines for the Project

	PRINCIPLE
Culverts	— Habitat to be created for wetland fauna on either side of culverts. This should link up with nearby areas of habitat where possible. Created habitat should not be mown (unless periodically required to sustain habitat heterogeneity). — Tree planting should not occur within 20 m of wetland vegetation or water storage areas to avoid crowding out waders and other wetlands birds from habitat.
Rope bridges	— Should rope bridges be incorporated, planting of suitable trees will be required to create or improve habitat linkages to nearby vegetation. Trees can be planted now with the aim to eventually link them with rope bridges in future, should it not be a current priority for the Project. Rope bridges will only be beneficial for common fauna species, as no threatened fauna species occur which will utilise them.
General landscaping	— Local provenance trees (particularly River Red Gums, Swamp Gums and Coast Manna-gums) and shrubs can be planted outside barriers/noise walls on either side of road (i.e. on and beyond batters). This would encourage waterbirds to fly above trees to get across the road, provide some buffering of headlights, and assist in maintaining connectivity for woodland birds. — Only native indigenous vegetation should be planted, and aim to utilise species of the most appropriate local/nearby EVC. — Tree planting should not occur within 20 m of culvert entrances or water storage areas to avoid crowding out waders and other wetlands birds from habitat. Existing trees can be retained. — Planting should not occur within close proximity of the road edge if no barrier is present. Plantings can extend above the barrier. — Road verges (i.e. inside of barriers or otherwise on the outer edges of carriageways) should not be planted or grassed. This will reduce the potential for roadkill. — The Project landscape design should include some revegetation and maintenance of hydric and grassy habitat (without trees), including on swales, in areas behind fauna barriers. At a minimum, this should occur at the key wetland areas near Braeside/Woodlands corridor and at the Waterways between Governor Road and Bowen Parkway. This may constitute planting of native, tussock-forming, wet-adapted species on swales and other areas likely to occasionally be wet. It may link up with revegetation at culvert entrances. The maintenance schedule should allow for a greater vegetation height to maintain some suitability for fauna.

7.4.5.2 BRIDGE REVEGETATION

Much of the area under the bridge, aside from pylon locations, has the potential to be revegetated post construction. Vegetation within areas receiving minimal shading are expected to be reinstated to approximate pre-construction cover and composition, which will be achieved by planting wetland species and by natural re-colonisation/regeneration processes. Areas receiving extended shading because of the bridge will be planted with wetland species that are more tolerant of shade, with the aim of maintaining maximum vegetative continuity beneath the bridge. It is anticipated that most of the area directly beneath each 12.5 metre carriageway can be re-instated with vegetation of varying density, within terrestrial or semi-aquatic environments. Areas which cannot be revegetated should be left as natural substrate, with some logs and other furniture to provide some shelter (without impeding fauna movement).

If the above mitigation measures are implemented, it is likely that there will be sufficient terrestrial and aquatic connectivity for the significant species likely to move beneath the bridge (including Australasian Bittern and Latham's Snipe). Revegetation will also mitigate risks associated with failure of wetland function and water treatment processes.

The species composition and planting density should be determined as part of a landscape plan or through a revegetation program, however, species which may be suitable for slightly lower light situations under the bridge include *Melaleuca ericifolia, Poa labillardierei, Carex apressa,* and *Lachnagrostis filiformis*. Heterogeneity between under-bridge corridors should be aimed for, to encourage use by different species. Any revegetation program should incorporate follow-up weed monitoring and control.

7.5 CLEARING AND CONSTRUCTION

As the detailed design is yet to be completed, we have identified No-go Zones (NGZs) for the Project based upon a conservative buffer from the current Project design for important native vegetation. This has informed our impact calculations for the Project, including calculation of native vegetation offset requirements. It is expected that this can be further refined by the contractor, who will be incentivised to further reduce impacts upon native vegetation. The guidelines for this, and for other measures to minimise or mitigate impacts upon ecological values during construction, are provided in Table 7.10. The proposed NGZs and areas to avoid if possible are shown on Supplementary Figure 6 in Appendix A.

Table 7.10 Guidelines for ecological impact management during clearing and construction (beyond VicRoads' standards)

CATEGORY	GUIDELINES / MEASURES
Minimising impacts to native vegetation (i.e. adding to NGZs) where possible	— Add to NGZs where possible, by constraining construction to avoid impacts to individual trees and other patches identified on Supplementary Figure 6 as 'Avoid if possible'. **Large trees and trees with hollows should be prioritised.** — Minimise impacts to patches of revegetation where possible. Revegetation has not been incorporated into NGZs at this stage of the Project however it is assumed that the vast majority of native planted vegetation can (and will) be retained. Minimisation of impacts to exotic trees is not required. — Should tree death from TPZ impacts be anticipated, large or hollow-bearing trees should be retained for their habitat values to all extent practicable.

CATEGORY	GUIDELINES / MEASURES
NGZ management	— Minor changes to the proposed NGZs may be required, however the maximum anticipated loss of EVCs (Table 6.3, Section 6) and the maximum loss of 'trees within patches' and 'scattered trees' (Table 6.4, Section 6) will not be exceeded. The maximum loss of remnant 'large trees' (Table 6.4, Section 6) will also not be exceeded. — All NGZs should be fenced prior to works occurring in the vicinity. Fencing should incorporate an additional buffer of at least one metre wherever possible. — Any works proposed near patches of native vegetation with trees should consider how the impact might affect the critical root zone of tree species by following the *Assessor's handbook – Applications to remove, destroy or lop native vegetation* (DELWP 2017a). This specifies the way in which impacts upon trees should be assessed and Tree Protection Zones should be demarcated to prevent losses of native vegetation during construction activities. — Note: the Project's Shared User Path route is not final and can be further modified to avoid/minimise impacts. Works for the SUP within NGZs will be minor and restricted to the path plus approximately one metre on either side. This has been factored into vegetation losses, however it is likely that impacts, particularly on tree roots, will be minimal.).
Further constraining construction footprint where possible to minimise indirect impacts	— No haulage route along the western side of road near the boundary with Woodlands (or, constrain construction footprint in this area). This will keep the most significant noise impacts further from the wetland. It will also minimise the risk of weed introduction and spread to the wetland and terrestrial vegetation at Woodlands. — Constrain construction footprint along the eastern boundary with Braeside Park, north of the ranger station. Minimising impacts along this boundary will reduce indirect impacts upon vegetation and fauna, as well as reduce effects upon park users.
Sediment	— Construction of swales early in the construction process where practicable may further assist in minimising sediment run-off from the Project, and will contribute to maintenance of water quality within the wetlands and waterways.
Fauna mortality management	— Conduct pre-clearing survey and supervision of vegetation clearing by an experienced ecologist. Areas requiring the above are all hollow-bearing trees, and all vegetation between Bowen Parkway and the levy (southern side of Mordialloc Creek). — Avoid pits and trenches being left open overnight to all extent practicable; incorporate regular inspection of pits and trenches with fauna salvage and relocation by an ecologist if necessary.
Flora management at the Waterways	— Conduct pre-clearing survey between Bowen Parkway and the levy (southern side of Mordialloc Creek). Relocate significant species where practicable. — Fence the key habitat for threatened flora at the Waterways wetlands (i.e. the No-go Zones east of the proposed bridge), should driving of light vehicles on the track outside of the construction footprint be required.
Impacts on Edithvale Wetlands	— Do not use Edithvale Road as a haulage route during construction.

CATEGORY	GUIDELINES / MEASURES
Temporary disturbance impacts	— Avoidance of loud works near wetland areas, particularly Braeside Park wetlands and Woodlands wetlands is recommended during peak season for migratory shorebirds, and breeding season for other listed birds (i.e. total window approx. September-February); however, this may not be feasible for the Project.
Reduction of weed risk	— Avoid the use of exotic (fertile) pasture grasses as soil stabilisers to minimise weed risk. — Undertake follow-up weed control within the project area, targeting areas of native vegetation or adjacent to native vegetation, particularly at the Waterways. It will be important to minimise weed establishment in rehabilitated and planted areas of habitat, including culvert entrances, swales, and communities re-established under the proposed bridge.
Re-establishment of landform and substrate at the bridge location	— It is important that the landform and substrate under the proposed Mordialloc Creek bridge is rehabilitated to its present state following completion of bridge works. This will ensure that the existing vegetation communities can be re-established to all extent possible. — Re-establishment should include removal of all fill/hardstand materials. Matting over the existing substrate (i.e. instead of removing topsoil or adding fill directly onto substrate) could be used to reduce the work required to re-establish substrate type and landform. — Fill should be removed from waterways to all extent practicable following works. No impacts upon water volume or flow at the Waterways wetlands/Mordialloc Creek should occur during or following construction.

7.6 MONITORING

The ecological monitoring recommended for the Project is broadly described in Table 7.11 below. A monitoring plan to address each item should be developed with performance indicators and detailed management and contingency measures. Based on the scoping requirements and comments from the TRG, this is likely to be expected and to require DELWP approval prior to clearing or construction works commencing. We note that this does not include monitoring and management of impacts (noise, light, sedimentation/run-off, and vegetation clearing) which should occur during clearing and construction.

No fauna or groundwater-dependent ecosystem monitoring at Edithvale wetlands is currently recommended. The fauna and ecosystems are already well characterised (i.e. (DSE 2012)), and bird monitoring is regularly undertaken by Birdlife Australia. Given the extremely low likelihood of ecological impacts at Edithvale Wetlands, and the natural variability in the relevant ecosystems and fauna numbers, monitoring to detect ecological/biological differences caused by the project is unlikely to be effective or useful. Groundwater and surface water monitoring (detailed in the relevant reports) will be undertaken, and the results from this monitoring are expected to provide assurance of the results of these assessments (i.e. negligible impacts).

Table 7.11 Recommended environmental monitoring

PROGRAM	DESCRIPTION/PURPOSE	TIMING/DURATION
Weed management	— Post construction weed survey of all areas impacted by clearing and construction works — Targeted control of noxious weeds — Follow-up monitoring and control within road reserve and immediately adjacent, with focus on areas near sensitive vegetation and habitat (wetland areas and Braeside Park boundary). — Baseline survey can be completed; however, target should be control of all noxious and environmental weeds based on advice from an ecologist.	Annual monitoring for 5 years
Rehabilitation	— Regime for planting and follow-up monitoring for the vegetation under the bridge — Monitoring and contingency measures for NGZs, including rehabilitation should any NGZs be impacted — Baseline: the current condition which was determined through habitat hectare assessments.	Annual monitoring for 5 years
Fauna connectivity	— Monitoring of fauna use of culverts for movement under the road — Monitoring of habitat connection quality (i.e. wetland habitat at entrance to culverts, or tree plantings near rope bridges) — Contingencies may include modifications to culvert furniture or associated landscaping. — Performance indicators should be developed. Collection of baseline data unlikely to be feasible. — No monitoring of rope bridge use (if installed) is proposed, as the use of rope bridges by the arboreal fauna relevant to the project area is already well studied.	Annual monitoring for 5 years
Bird use of habitat	— Bird surveys (walking of similar transects to those conducted for this study) to determine use of wetlands immediately adjacent to project area. A before/after – control/impact (BACI) study to monitor the changes prior and post road construction is recommended to better understand the indirect impacts on bird populations. A partnership with research institutes including universities and other organisations could be used to develop such a study. — Baseline data from surveys conducted for this study (and/or publicly-available bird record data) may be sufficient, however this would need to be determined through survey design. Collection of baseline data consistent with the monitoring methodology may be required prior to construction.	Monitoring during construction, monitoring 5 years post-construction.

7.7 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

The EPRs outlined in Table 7.12 set out the desired environmental outcomes for the project with regard to biodiversity. The EPRs are applicable to all project phases and provide certainty regarding the Project's environmental performance.

The EPRs relating to environmental management are provided in the Environmental Management Framework (WSP 2018).

Table 7.12 Biodiversity environmental performance requirements

EPR NUMBER	EPR	PROJECT PHASE

B1	**Fauna habitat**
	Direct and indirect impacts on fauna must be minimised by preserving and enhancing habitat and facilitating habitat connectivity where practicable. This will be achieved through implementation of (as a minimum):
	— Fauna crossings, including culverts modified for fauna movement between the Braeside Park wetlands and Woodlands Industrial Estate wetlands (minimum of 3 culverts), and between the Waterways wetland waterbodies south of Governor Road (minimum of 2 culverts)
	— Multi-function fauna barriers to limit fauna mortality, limit disturbance to surrounding habitat areas and encourage culvert use by fauna between Braeside Wetlands and Woodlands Wetlands, and between the Waterways Wetland waterbodies south of Governor Road
	— A low fauna barrier to limit fauna mortality and encourage culvert use on the eastern side of the new roadway, north of the Parks Victoria office and adjacent to Braeside Park
	— Wildlife friendly fencing to control human and dog access to Braeside Wetlands and Braeside Park from the shared user path or roadway
	— Landscaping including:
	  — The use of site-specific indigenous species
	  — Creating or revegetating habitat that maximises connectivity at fauna crossing points and under the constructed bridge over Waterways wetlands
	  — Open wetland and grassy habitat where appropriate, including swales adjacent to fauna barriers
	— A dual bridge structure at Mordialloc Creek/Waterways wetland to allow light penetration and facilitate fauna movement.
		All

EPR NUMBER	EPR	PROJECT PHASE
B2	**Lighting design** Fauna sensitive lighting design principles must be incorporated into lighting design in sensitive areas around wetlands and Braeside Park. The design principles are: — Siting of lights — Use lights only where necessary and use the minimum brightness (lumens) possible — Site lighting columns away sites of ecological value to the extent possible — Minimise the height of lighting where possible. — Fixtures: — Use shielding to fully shield bulbs and lenses and to minimise light spill onto sites of ecological value — Avoid reflective surfaces under lights. — Wavelengths: — Use narrow-spectrum light sources to lower the range of species affected by lighting, and avoid blue and white wavelengths (4200 kelvin, ideally <3000 kelvin) — Use long wavelength bulbs to minimise the emission of UV light.	Design, Construction
B3	**Native vegetation and habitat** Native vegetation removal must be avoided, minimised and managed in accordance with the *Guidelines for the removal, destruction or lopping of native vegetation 2017 (*Guidelines 2017*)*. Native vegetation offsets will be required for the removal of native vegetation, with the area (in hectares) to be calculated and approved in accordance with these guidelines. No-go zones will be established to protect sensitive vegetation, trees and habitat areas that are not removed in accordance with the Guidelines 2017. No-go zones will be specified in the project EMF.	Design, Construction
B4	**Fauna (construction)** Minimise, monitor and document impacts on fauna during construction works, including: — Obtaining all relevant permits under the *Wildlife Act 1975* — Pre-clearing fauna surveys and relocation of fauna by qualified fauna handlers to nearby suitable habitat — Directional temporary construction lighting to minimise lighting impact on sensitive fauna habitat — Noise and vibration impacts on sensitive fauna — If construction works near wetlands occur between September and March, monitoring of birds before and at regular intervals during construction to assess disturbance impacts, with minimisation of noisy and high disturbance works where practicable — Regular inspections of excavations/trenches — Avoiding heavy construction vehicles along Edithvale Road — Adding high value habitat trees (including hollow-bearing and large trees) into no-go zones where suitable — Closure of all excavations/trenches at the end of each day — Installation of fauna movement devices — Enforced speed limits of 40 km per hour within construction areas, outside of existing arterial roads.	Construction

EPR NUMBER	EPR	PROJECT PHASE
B5	**Native vegetation (construction)** Monitor, minimise and document impacts on retained/adjacent native vegetation, including: — Pre-clearing surveys for threatened flora in the Mordialloc Creek/Waterways wetland impact area are to be conducted by a suitably qualified ecologist, and plants are to be relocated to a suitable recipient site where considered practicable by the ecologist — Mapping and fencing of no-go zones and tree protection zones — No site compound, temporary offices, hardstand, plant storage facility or stockpiles will be established within no-go zones, nor will any works be conducted in such areas — Environmental induction/training for construction personnel — Development and implementation of weed hygiene measures to avoid the spread or introduction of weeds during construction, including vehicle and equipment hygiene measures — As far as practicable, re-establishing the landform and substrate under the Mordialloc Creek bridge following bridge construction.	Construction
B6	**Flora and Fauna (operation)** Prior to opening the project to the public, a Flora and Fauna Monitoring and Management Plan must be prepared in consultation with Department of Environment and Energy (DoEE), Department of Environment, Land, Water and Planning (DELWP), Melbourne Water, Parks Victoria, VicRoads and any other relevant land manager. The plan must include: — Flora and fauna monitoring by ecologists for 5 years after opening, including bird use of nearby wetlands (Woodlands Wetlands, Braeside Park Wetlands, and Waterways Wetlands) and threatened flora and weeds at the Waterways, to include at least one monitoring event prior to opening — Measures to be implemented to manage any flora and fauna impacts resulting from the operation of the freeway, including: — Ecological rehabilitation measures developed by a suitably qualified ecologist — Measures to reinstate sensitive habitat to the extent practicable under the Waterways bridge — Weed management — Monitoring of measures to improve habitat connectivity for threatened fauna including Waterways bridge, fauna culverts, and revegetation.	Operation

8 LEGISLATION AND POLICY

This chapter details the Commonwealth, State, and regional/local environmental legislation, policy, and strategies relevant to the project. It details the way in which the Project is or is not consistent with these, and the implications for the Project.

8.1 COMMONWEALTH

8.1.1 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined in the Act as matters of national environmental significance (MNES). There are nine matters of national environmental significance to which the EPBC Act applies, these are:

- World heritage sites
- National heritage places
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- Nationally threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions
- The Great Barrier Reef Marine Park, and
- A water resource, in relation to coal seam gas development and large coal mining development.

A 'significant impact' is defined under the EPBC Act as 'an impact that is important, notable, or of consequence, having regard to its context or intensity' (Department of the Environment 2013). If a project is likely to have a significant impact on one of the nine MNES, the 'action' must be referred to the Commonwealth Department of the Environment and Energy (DoEE). This 'referral' is then released to the public for comment.

Three out of the nine matters are relevant to the project area: wetlands of international importance, nationally threatened species and ecological communities, and migratory species.

To assess whether an impact is significant or not, the following policy documents and guidelines should be used:

- Significant Impact Guidelines 1.1 - Matters of National Environmental Significance for EPBC Act listed biodiversity (Department of the Environment 2013) (the 'significant impact guidelines').
- EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE 2017).
- Referral guidelines for individual species listed under the EPBC Act, if available.

Studies by WSP, including the preliminary flora and fauna impact assessment (WSP 2017d), recommended referring the Project for legal certainty. An EPBC Act referral was submitted on 31 October 2017. A determination by the Commonwealth was provided on 30 January 2018, stipulating that the Project was a controlled action.

The referral decision letter identified several MNES of concern to DoEE as requiring further survey and assessment. Other Commonwealth-listed species and communities, not identified in the Referral decision letter, have been included in the impact assessment section of this report (Section 6). This provides a complete assessment based on the current design (which differs from that proposed at the time of the referral), and is required as per the EES Scoping Requirements.

Table 8.1 provides a summary of the assessment work completed for all MNES with the potential to occur or which have previously been identified as having the potential to occur or be impacted by the Project.

The way in which these MNES have been addressed in this study is detailed in Table 8.1. Based on this assessment, residual impacts upon MNES are expected to be minor and not significant. As such, Commonwealth Offsets in accordance with the Offsets Policy (DSEWPaC 2012) are not proposed. However, communication with the Commonwealth will be necessary to ensure they are satisfied with the extent of mitigation that is proposed with the final design, and the Project EPRs. Further investigation during detailed design is recommended to ensure that the final design meets or exceeds expectations for mitigation of impacts upon EPBC Act listed fauna.

Table 8.1 Summary of assessment of Matters of National Environmental Significance

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
Wetlands of international importance (listed under the Ramsar Convention)								
Edithvale-Seaford Ramsar wetland		Edithvale component occurs approximately 700 m southwest of the project. Survey guidelines not applicable.	Yes. Using Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	Recovery Plan not available but relevant plans include: Edithvale-Seaford Wetlands Ramsar Site Management Plan (Ecology Australia, 2016)	Yes Additional work completed since referral include further groundwater and surface water modelling.	Edithvale Road not used for haulage Spill containment and bio-retention systems	No impact to ecological values anticipated. No significant impact.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment (Section 6.6).
Nationally threatened species and ecological communities								
FLORA	Matted Flax-lily	No survey guidelines. Species recorded just east of the project area at the Waterways wetlands.	Yes, using Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	National Recovery Plan for the Matted Flax-lily *Dianella amoena* (Carter, 2010)	No Additional work completed since referral includes further targeted flora survey	Not required	Species occurs near the project area however no significant impact is anticipated.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant flora (Section 6.3)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
	River Swamp Wallaby Grass	No survey guidelines. Several surveys conducted, species not detected.	Although given a 'moderate' likelihood of occurrence in the Preliminary flora and fauna assessment (WSP 2017), species now considered unlikely to occur following repeated surveys of wetland areas. No impact assessment required.	Not relevant.	No Additional work completed since referral includes further targeted flora survey	Not required	Species unlikely to occur. Assessment not required.	Likelihood of Occurrence Assessment (Appendix D)
	Swamp Everlasting	No survey guidelines. Species recorded just east of the project area at the Waterways wetlands.	Yes, using Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	National Recovery Plan for the Swamp Everlasting *Xerochrysum palustre* (Carter & Walsh 2011).	No Additional work completed since referral includes further targeted flora survey	Weed monitoring and control at Waterways wetlands (CEMP) Pre-clearing survey and relocation if required (CEMP)	Species occurs near the project area however no impact is anticipated.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant flora (Section 6.3)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
	Swamp Fireweed	No survey guidelines. Species not detected however still given a 'moderate' likelihood of occurrence.	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	No recovery plan	No Additional work completed since referral includes further targeted flora survey	Not required	If present, species unlikely to be significantly impacted.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant flora (Section 6.3)
	All other EPBC Act listed flora	Not relevant	Other EPBC Act listed flora species considered unlikely to occur. This is based on habitat assessment and repeated surveys and visits to the project area. No impact assessment required.	Not relevant	No Additional work completed since referral includes further targeted flora survey	Not required.	No other EPBC Act listed flora species with the potential to be impacted.	Likelihood of Occurrence Assessment (Appendix D)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
FAUNA	Australasian Bittern	Survey Guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010) Species known to occur.	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	No recovery plan	Yes Additional work completed since referral include further bird surveys and detailed habitat mapping.	Multi-function fauna barrier (disturbance and mortality) Revegetation (including swales and under the bridge) to buffer habitat and/or maximise connectivity Fauna-sensitive lighting design Culverts not relied upon as a key measure but may occasionally be used so revegetation of culvert entrances important to maximise this. Noise management plan in CEMP to include consideration of ecological values, including migratory and threatened birds.	Minor residual impact expected however this is not considered to constitute a significant impact upon the species.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant fauna (Section 6.4)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
	Australian Fairy Tern	Survey Guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010) Species is predominantly estuarine and is unlikely to visit the study area.	Considered low likelihood of occurrence. Significant impact criteria assessment not required.	No recovery plan	Yes Additional work completed since referral include further bird surveys and detailed habitat mapping.	Not required.	Species unlikely to occur. Impact assessment not required.	Likelihood of Occurrence Assessment (Appendix D)
	Australian Painted Snipe	Survey Guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010)	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	No recovery plan	No	Not required.	Significant impact not anticipated, species unlikely to be affected by Project. No significant impact.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant fauna (Section 6.4)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
	Curlew Sandpiper	Survey Guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010) EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE 2017)	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	No recovery plan	Yes Additional work completed since referral include further bird surveys and detailed habitat mapping. Species was recorded at Braeside Park wetlands during surveys in 2018.	Multi-function fauna barrier (operational disturbance impacts) Fauna-sensitive lighting design Noise management plan in CEMP to include consideration of ecological values, including migratory and threatened birds.	Any residual impact would be minor. Significant impact upon the species not anticipated.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant fauna (Section 6.4)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
	Eastern Curlew	Survey Guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010) EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE 2017) Habitat not present at the project area.	Significant impact criteria not required. Species unlikely to occur.	Not relevant.	Yes Further investigation and habitat mapping completed after referral submission has indicated that the species has a low likelihood of occurrence in the area, and that the habitat near the project area is sub-optimal (the species is predominantly estuarine).		No impact anticipated as species is unlikely to occur.	Likelihood of Occurrence Assessment (Appendix D)
	Eastern Dwarf Galaxias	Survey guidelines for Australia's threatened fish: Guidelines for detecting fish listed as threatened under the EPBC Act (DEWHA 2011).	Species not present despite several repeated surveys. Considered low likelihood of occurrence. Significant impact criteria assessment not required.	National recovery plan for the Dwarf Galaxias *(Galaxiella pusilla)* (Saddlier, Jackson and Hammer 2010)	No		Species unlikely to occur. Impact assessment not required.	Likelihood of Occurrence Assessment (Appendix D)

MNES		RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
	Grey-headed Flying-fox	Surveys were not considered necessary as Grey-headed Flying-foxes are likely to forage on trees within the study area intermittently, but also forage widely across the Port Philip and Westernport Catchment area and beyond. There are no impacts on breeding or roosting areas along the Yarra River.	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	Draft Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (Commonwealth of Australia 2017)	No		Significant impact not anticipated, species unlikely to be affected by Project.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant fauna (Section 6.4)
	Growling Grass Frog	Survey guidelines for Australia's threatened frogs: Guidelines for detecting frogs listed as threatened under the EPBC Act (DEWHA 2010).	Species not present despite several repeated surveys. Considered low likelihood of occurrence. No impact assessment required.	National Recovery Plan for the Southern Bell Frog *Litoria raniformis* (Clemann & Gillespie 2012)	No		Species unlikely to occur. Impact assessment not required.	Likelihood of Occurrence Assessment (Appendix D)

MNES	RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
Ecological communities							
Natural Damp Grassland of the Victorian Coastal Plains	Approved Conservation Advice (including listing advice) for the Natural Damp Grassland of the Victorian Coastal Plains (TSSC 2015)	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	Non-existent	No		Minor residual impact on this community is anticipated (0.04 ha). Not considered a significant impact.	Significant impact criteria assessment (Appendix G) summarised in the impact assessment for listed communities (Section 6.2.4)
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Commonwealth Listing Advice on Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains (TSSC 2012).	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013)	Not yet undertaken, proposed.	Yes Additional work completed since referral include revised survey and assessment against community criteria. Less vegetation meets the criteria for this community than previously assumed and presented in the referral.	Reinstation of landform and substrate at bridge after construction (managed in CEMP) Incentives to contractor to minimise impacts during construction (beyond assessed impacts) at Waterways where possible Revegetate under bridge to maximise connectivity at the Waterways wetlands.	Minor residual impact on this community is anticipated (0.24 ha). Not considered a significant impact.	Significant impact criteria assessment (Appendix G) summarised in the impact assessment for listed communities (Section 6.2.4). Revised mapping of the community is discussed and presented in Section 4.3.2.1.

MNES	RELEVANT SURVEY GUIDELINES	SIGNIFICANT IMPACT CRITERIA ASSESSMENT COMPLETED (APPENDIX G)	RELEVANT RECOVERY PLAN	IDENTIFIED IN REFERRAL LETTER BY DOEE?	SUMMARY OF KEY MITIGATION	SUMMARY OF ASSESSMENT (RESIDUAL IMPACT)	RELEVANT SECTIONS OF REPORT
Migratory species							
Migratory Birds	EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE 2017) Draft referral guideline for 14 birds listed as migratory species under the EPBC Act (DotE 2015) Survey Guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010)	Significant Impact Guidelines 1.1 Matters of National Environmental Significance (Department of the Environment 2013) EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE 2017) Draft referral guideline for 14 birds listed as migratory species under the EPBC Act (DotE 2015)	Non-existent for all relevant migratory bird species	Yes – Sharp-tailed Sandpiper, Latham's Snipe and Curlew Sandpiper Additional work completed since referral include further bird surveys and detailed habitat mapping. Sharp-tailed Sandpiper was recorded at Braeside Park wetlands during surveys in March 2018.	Multi-function fauna barrier (operational disturbance) Fauna sensitive lighting design Noise management plan in CEMP to include consideration of ecological values, including migratory and threatened birds.	Minor residual impact anticipated. Not considered a significant impact.	Significant impact criteria assessment (Appendix G) Summarised in the impact assessment for significant fauna (Section 6.4)

8.2 STATE

8.2.1 ENVIRONMENT EFFECTS ACT 1978

Under Victoria's *Environment Effects Act 1978* (EE Act), projects that could have a 'significant effect' on Victoria's environment can potentially require an Environment Effects Statement (EES). This Act applies to any public works 'reasonably considered to have or be capable of having a significant effect on the environment'. The Minister for Planning and Environment is the responsible person for assessing whether this Act applies.

Before commencing any public works to which this Act applies, the proponent must initiate an EES to be prepared and submit it to the Minister for the Minister's assessment of the environmental effects of the works.

The criteria for the types of potential effects on the environment that might be of significance are provided in the Ministerial Guidelines for Assessment of Environmental Effects under the Environment Effects Act 1978 (DSE 2006). They include impacts to native vegetation, matters listed under the FFG Act, and wetlands. The criteria come under two categories:

- Individual potential environmental effects (one or more effects indicates potential significance of the impacts)
- A combination of potential environmental effects (two or more effects indicate potential significance of the impacts).

A self-assessment against the criteria was completed (WSP 2017e). This assessment, based on the information available at the time, identified that one or more individual effects may be triggered. Subsequently, the Mordialloc Bypass project was the subject of an EES Referral, and a determination was made by the Minister that an EES was required. This report will be an attachment to the EES document.

8.2.2 FLORA AND FAUNA GUARANTEE ACT 1988

The Victorian *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 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.

A permit from the DELWP is required to 'take' protected flora from public land. A permit is not required under the FFG Act for private land, unless listed species are present and the land is declared 'critical habitat' for the species. Protected flora are all FFG Act listed species, species which belong to listed communities, and other species which have been included on the protected flora list, managed by the DELWP. A permit is also required for removal of FFG Act listed fauna habitat or ecological communities.

As FFG Act listed species and communities are proposed to be impacted by the project, an FFG Act permit to remove threatened species/communities is required. The impact assessment is provided in Section 6. Based on this assessment, the following FFG Act values may require permits.

Listed flora species:

- No listed threatened flora are likely to be impacted.

Listed fauna species:

- Several listed threatened fauna species may incur some minor direct and indirect impacts on foraging habitat including the following species: Australasian Bittern, Australian Little Bittern, Baillon's Crake, Blue Billed Duck, Caspian Tern, Diamond Dove, Curlew Sandpiper, Eastern Great Egret, Freckled Duck, Intermediate Egret, Lewin's Rail, Little Egret, Magpie Goose.

Although other listed fauna species may periodically occur, these are not likely to be materially affected by the project.

Communities:

- Plains Grassland (South Gippsland) Community
- Herb-rich Plains Grassy Wetland (West Gippsland) Community

Protected flora:

Some flora species recorded at the project area are listed on the protected flora list. The species which may need a permit (excluding species recorded but not proposed to be impacted) are:

- *Acacia longifolia subsp. Sophorae*
- *Acacia mearnsii*
- *Acacia pycnantha*

In addition, there are several flora species protected as part of threatened communities that are likely to also require a permit (although not all species will occur within the extent of the communities proposed to be cleared):

- *Acacia melanoxylon*
- *Amphibromus nervosus*
- *Baumea arthrophylla*
- *Calocephalus lacteus*
- *Carex tereticaulis*
- *Eleocharis acuta*
- *Eleocharis pusilla*
- *Eryngium vesiculosum*
- *Eucalyptus camaldulensis*
- *Eucalyptus ovata*
- *Eucalyptus viminalis*
- *Hemarthria uncinata var. uncinate*
- *Juncus holoschoenus*
- *Lachnagrostis filiformis s.l.*
- *Lythrum hyssopifolia*
- *Melaleuca ericifolia*
- *Myriophyllum crispatum*
- *Myriophyllum verrucosum*
- *Poa labillardierei*
- *Potamogeton tricarinatus s.l.*
- *Rytidosperma duttonianum*
- *Rytidosperma semiannulare.*

8.2.3 THE GUIDELINES FOR THE REMOVAL, DESTRUCTION OR LOPPING OF NATIVE VEGETATION

The *Guidelines for the removal, destruction or lopping of native vegetation* (DELWP 2017c) (the Guidelines) are designed to manage the risk to Victoria's biodiversity associated with the removal of native vegetation. They provide the mechanism for offsetting residual native vegetation and habitat loss, with emphasis on avoiding and minimising impacts prior to offsetting. The guidelines are incorporated into the Victoria Planning Provisions and all planning schemes in Victoria.

The Project was preliminarily assessed using the *Permitted Clearing of Native Vegetation – Biodiversity Assessment Guidelines* (DEPI 2013c), based on the construction footprint for an arterial road design. These guidelines were updated in December 2017 and the impact of the Project is different under the current freeway design. As such, this report provides an updated assessment, using the 2017 guidelines only.

The risk to biodiversity from vegetation/habitat loss, and therefore the pathway that the project will be assessed under, is determined via an assessment of the 'location risk' and the 'extent risk':

- 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. The native vegetation location risk map is available from the Native Vegetation Information Management tool (DELWP 2018b).
- Extent risk is determined by the amount of the native vegetation that is proposed to be removed.

Together, these two risk types are used to determine the risk-based pathway for assessing a permit application to remove native vegetation. The pathway determines the process to be followed for the assessment of planning permit applications and dictates the types of offsets that are required for the vegetation removal.

Under the guidelines, the Project should be considered under the 'Detailed' assessment pathway as it requires the clearance of greater than 0.5 ha of native vegetation.

The offsets required under the guidelines, based on the current design of the Project, are provided in Section7.2.1.

8.2.4 WILDLIFE ACT 1975

The *Wildlife Act 1975* is the primary legislation in Victoria for the protection of wildlife. All native fauna in Victoria are protected under this Act. The Act requires that wildlife research (including fauna salvage and translocation) is regulated through a permit system, which is managed by the DELWP.

Authorisation for habitat removal must be obtained under the *Wildlife Act 1975* through a licence granted by the DELWP. Any persons involved in fauna removal, salvage, capture or relocation of fauna for the Project must hold a current Management Authorisation under the Act.

8.2.5 CATCHMENT AND LAND PROTECTION ACT 1994

Plants declared noxious under the *Catchment and Land Protection Act 1994* (CaLP Act) are known to or have the potential to result in detrimental environmental and / or economic effects.

Under the CaLP Act, declared noxious weeds are categorised into four groups depending on their known and potential impact and specific circumstances for each region. These categories are:

- State Prohibited Weeds (S) – Plants that do not occur in Victoria but would pose a significant threat if they did invade. If found they are to be eradicated with responsibility falling on the Victorian Government.
- Regionally Prohibited Weeds (P) – Weeds that are not widely distributed in a region but are capable of spreading further. Land owners, including public authorities responsible for managing land must take all reasonable steps to eradicate Regionally Prohibited weeds on their land.
- Regionally Controlled Weeds (C) – Invasive plants that are usually widespread in a region. Ongoing control measures are required to prevent their spread. Land owners, including public authorities responsible for managing land, must take all reasonable steps to prevent growth and spread of Regionally Controlled weeds on their land.
- Restricted Weeds (R) – Plants that pose an unacceptable risk of spreading in this state and are a serious threat to another State or Territory. Trade in these weeds and their propagules, either as plants, seeds or contaminants in other materials is prohibited.

It is the responsibility of the landowner to control these weeds on their property and on adjacent roadside reserves.

8.2.6 VICTORIAN WATERWAY MANAGEMENT STRATEGY

In 2013, the Department of Environment and Primary Industries (DEPI) finalised the Victorian Waterway Management Strategy (DEPI 2013b). The Strategy provides an integrated and adaptive framework that outlines a vision, guiding principles and management approach to maintaining and improving environmental conditions that support waterway values within the state of Victoria. The vision for Victoria's waterways is:

> *Victoria's rivers, estuaries and wetlands are healthy and well-managed; supporting environmental, social, cultural and economic values that are able to be enjoyed by all communities (DEPI 2013b)*

Waterway management is implemented through the Victorian Waterway Management Program, an eight-year adaptive management cycle that is overseen by DEPI and led by catchment management authorities and Melbourne Water. The program consists of planning, implementation and evaluation stages with ongoing research and input from the community. In addition, development and implementation of regional Waterway Strategies for each catchment will further help to deliver key elements of the Victorian Waterway Management Strategy.

Mordialloc is located within the Bunyip Basin. Data collected by DEPI has indicated that <10% of river length within this basin is in good or excellent condition. The Strategy aims to improve this by focusing on a range of management issues related to environmental water, riparian vegetation, wetlands, estuaries and waterways in urban areas. Whilst the Mordialloc Bypass is not aimed at enhancing waterway management, it has considered the various impacts to waterway quality and related environmental values and will implement measures to ensure any impacts will be minimised to all extent practicable.

A key element of the Victorian Waterways Strategy, from its planning to implementation and monitoring, is community involvement. The Mordialloc Bypass project will endeavour to promote community involvement through tree planting or similar community events. This will help to rehabilitate cleared areas near waterways and provide habitat for native fauna and flora.

8.3 REGIONAL AND LOCAL

8.3.1 KINGSTON AND GREATER DANDENONG PLANNING SCHEMES

The *Planning and Environment Act 1987* (P&A Act) provides the legal framework for the operation of Victoria's planning system, commonly referred to as the Planning Scheme. The project will require approval under the Kingston Planning Scheme for works within the Public Use Zone, Land Subject to Inundation Overlay and the Special Building Overlay. Approvals for vegetation removal will be required under both the Kingston and Greater Dandenong Planning Schemes.

All vegetation within the project area that is not exempt from the requirement to obtain a permit has been mapped as EVCs or scattered trees. All exempt planted vegetation has been mapped as revegetation. More information about how this was mapped is provided in Section 3.4.2.

8.3.2 KINGSTON CITY COUNCIL GREEN WEDGE

"Green Wedges" are the non-urban areas of the metropolitan Melbourne that are located outside of the Urban Growth Boundary (UGB). They were created with the purpose of preserving locations for service industries and protecting areas for different land uses including, but not limited to, agriculture, biodiversity, recreation, and natural resources. There are 12 Green Wedge areas in Melbourne that collectively form a ring around the Melbourne metropolitan area. The Kingston City Council Green Wedge includes all land outside the UGB within the City of Kingston.

The Kingston City Council Green Wedge covers an area of 2070 hectares and includes more than 400 land parcels/allotments (City of Kingston 2012). It extends from Karkarook Park to Braeside Park with an additional two small areas of land in Aspendale Gardens/Waterways and Patterson Lakes (Figure 8.1).

The Kingston Green Wedge Plan was developed in 2012 and addresses several key issues specific to the Kingston City Council including managing existing landfills, protecting and improving environmental qualities and retaining a predominately open and semi-rural feel. The plan also identifies a vision, objectives and actions for the sustainable use and development of the Kingston Green Wedge which focuses on environmental qualities, land use and activities, public spaces, movement systems, buildings, and governance models. Objectives most relevant to biodiversity values of the region and the ways in which the Mordialloc Bypass project fits in with the Green Wedge objectives are outlined in Table 8.2.

Table 8.2 Kingston City Council Green Wedge Objectives and their relevance to the Mordialloc project

RELEVANT KINGSTON CITY COUNCIL GREEN WEDGE OBJECTIVES (CITY OF KINGSTON 2012)	PROJECT RELEVANCE
Watercourses in good condition, including in-stream and riparian habitat, stream bed and bank stability, water quality and flow connectivity.	A small amount of in-stream and riparian habitat will be lost for the bridge over Mordialloc Creek (pylons, shading under the bridge, and construction access), however this will be constrained as much as practicable and largely revegetated/rehabilitated after the works are complete. There will also be loss of some riparian habitat from drains that the Project bisects. Aside from this, watercourses will be maintained in current condition, including in-stream and riparian habitat, stream bed and bank stability, water quality and stream connectivity. Refer to Sections 6.1.5.3 and 6.1.5.4. Landscaping/revegetation of riparian habitat is addressed in Section 7.4.
Watercourses that support the community's desired ecological, aesthetic and recreational values.	The project will have some impact upon the ecological, aesthetic and recreational values of the Mordialloc Creek area. Impacts at Mordialloc Creek will be limited to slightly reduced connectivity for birds and terrestrial fauna (largely mitigated by the bridge), and some loss of wetland and riparian vegetation. Aesthetic and recreational values are not addressed in this assessment.
Water security in flood and drought for agricultural and ecological purposes.	The project will not affect water security.
A resilient environment that is adaptive to climatic change.	Environment resilience is unlikely to be affected by the project.
Water resource data that informs decision making within the context of the Green Wedge Plan.	Data has been collected to inform the groundwater and surface water impact assessments for the Mordialloc Bypass. This may help inform decision making for these water resources.
Land development that enhances environmental and water resources values.	The project is unlikely to enhance environmental and water resource values. Landscaping for the Project will aim to maintain or enhance environmental values where possible. Refer to Section 7.4.
A community that is aware of water management issues and values water resources.	This objective is not relevant to the project.

RELEVANT KINGSTON CITY COUNCIL GREEN WEDGE OBJECTIVES (CITY OF KINGSTON 2012)	PROJECT RELEVANCE
An improvement in the ecological values of water bodies and waterways.	The waterways and waterbodies within the Kingston Green Wedge that occur within or adjacent to the project area are: Mordialloc Creek, Braeside Park wetlands, Old Dandenong Road Drain, Dingley Drain, Smythes Drain, and other small drainage lines. Direct impacts are proposed so improvement of ecological values is unlikely, however the Project will largely aim to maintain the ecological values of these waterways and waterbodies. The likely impacts upon ecological values within and nearby the project area are assessed in Section 6 and proposed mitigation of impacts is provided in Section 7.
An improvement in the capacity of native fauna species to respond to the threat of climate change (through improved connectivity between resources and habitat).	The Project will aim to maintain important fauna connectivity. Refer to Section 7.
Protection and enhancement of existing ecological values and communities.	The project will have some impact upon ecological values and communities within Kingston City Council Green Wedge areas. Refer to Section 6. Strategies for mitigation is provided in Section 7.
Re-created habitat, habitat links and buffers for native fauna.	The way in which the Project proposes to maintain or improve habitat links is provided in Section 7.
Re-established populations of conservation significant species that have declined or no longer occur in the area	Not currently proposed.
Conservation areas that safeguard the environmental values of the area and provide passive open space opportunities.	The important conservation areas within the Kingston City Council Green Wedge are not proposed to be directly impacted. See Section 6 for the impact assessment.
A linked open space system realising and expanding upon the 'Chain of Parks' concept	Maintenance or improvement of habitat linkages specific to fauna and flora are addressed in Section 7.
Parks, reserves and wetlands that are linked by paths, and protect and provide refuge for indigenous flora and fauna	The Project will improve connectivity for people through development of the shared user path, whilst aiming to maintain the condition of nearby refuges for fauna and flora.
The use of indigenous vegetation and substantial trees that blend with the roadside treatments	This is a core component of landscaping aims for the project. Refer to report on landscape and visual impacts (ASPECT Studios 2018).

Figure 8.1 City of Kingston Green Wedge Map, taken from City of Kingston Green Wedge website (City of Kingston 2018)

8.3.3 LIVING LINKS

Living Links is an urban nature project aimed at retaining and protecting the natural values within the Port Phillip and Westernport catchment. In the face of continuing development, the project intends to create a web of green spaces across Melbourne's south-east, resulting in a world-class urban ecosystem. Living Links projects highlight significant strategic region-wide links of biodiversity and open space, valued by the community and integral to sustainable development. The program identifies key cycling, pedestrian, ecological and open space corridors, and highlights the desire for more strategic connection of these four elements across the broader area.

Seventeen (17) inter-connecting corridors have been identified as offering the opportunity for new and improved links across the region. Projects have been identified/proposed along these corridors, through which habitat and connectivity will be improved for wildlife and people (Port Phillip and Westernport Catchment Management Authority 2017).

Ecological Strategic Living Links corridors or projects nearby the Mordialloc Bypass project area include:

- Corridor: Dandenong Creek to Port Philip Bay along Mordialloc Creek. This corridor connects the Dandenong Creek Corridor at Bangholme and Port Philip Bay at Mordialloc via the Mordialloc Creek. It also connects several other Living Links corridors. This corridor supports environmental values including endangered vegetation communities, threatened flora and fauna and significant waterbodies. The Project bisects this link at the Waterways. The proposed bridge over Mordialloc Creek will maintain connectivity along this corridor for fauna and flora.
- Project: Mordialloc Creek Wetlands between Waterways Estate and Wells Road - Development of wetlands along Mordialloc Creek to improve and enhance environmental values (in planning phase). This site occurs west of the project area, downstream of the proposed bridge over Mordialloc Creek.
- Project: Mortim Lands Wetlands creation (concept only, no progress). This potential project occurs immediately to the east of the project area, south of Mordialloc Creek.

The Mordialloc Bypass is unlikely to sever any of the links or substantially affect any of the identified projects.

8.3.4 CITY OF KINGSTON BIODIVERSITY STRATEGY

The City of Kingston Biodiversity Strategy sets out goals, outlines strategic objectives and incorporates a management plan for protecting and preserving Kingston's terrestrial biodiversity. The overarching goal is to protect and enhance local biodiversity across the City of Kingston and to support wider biodiversity initiatives. In addition, the Strategy aims to increase awareness, appreciation and understanding of biodiversity among its residents and to encourage active participation in managing biodiversity within the community (City of Kingston 2008).

The City of Kingston Biodiversity Strategy objectives and the ways in which the Mordialloc Bypass project fit within these objectives are outlined below in Table 8.3.

Table 8.3 City of Kingston Biodiversity Strategy objectives and their relevance to the Mordialloc project

CITY OF KINGSTON BIODIVERISTY STRATEGY OBJECTIVES (CITY OF KINGSTON 2008)	PROJECT RELEVANCE
Identify, protect and manage remnant indigenous vegetation.	Although the project will involve some removal of remnant vegetation, measures have been taken to ensure the impact will be minimised to all extent possible. Refer to Sections 7.1 and 7.4 for more information.
Identify, protect and enhance sites of habitat significance and other significant vegetation.	The project is unlikely to enhance sites of habitat significance and other significant vegetation. Some loss of vegetation and habitat is proposed (refer to Section 6 for the impact assessment). Where possible, measures will be taken to ensure that habitat values and significant vegetation is either maintained at current condition or where appropriate, mitigation implemented to minimise impacts.

CITY OF KINGSTON BIODIVERISTY STRATEGY OBJECTIVES (CITY OF KINGSTON 2008)	PROJECT RELEVANCE
Undertake and encourage re-vegetation using local indigenous species.	Revegetation with local indigenous species will be undertaken as part of the Project's mitigation measures.
Reduce negative impacts on biodiversity within and beyond Kingston's boundaries that arise from activities within the municipality.	Refer to Section 7 for the mitigation measures proposed to reduce the negative impacts on biodiversity from the Mordialloc Bypass project.
Increase the local communities' awareness, appreciation and understanding of biodiversity, and create opportunities for participation in biodiversity management.	This objective is not relevant to the project.
Work in partnership with neighbouring municipalities and other land managers and stakeholders to enhance and protect biodiversity	The Mordialloc Bypass Project has involved collaboration with many stakeholders and land managers including Parks Victoria and Melbourne Water who oversee the management of important biodiversity areas such as Braeside Park and Waterways wetlands. In doing so, mitigation has been developed to help reduce biodiversity impacts of the Project (Section 7).

8.3.5 DRAFT HEALTHY WATERWAYS STRATEGY

Melbourne Water has developed a Draft Healthy Waterways Strategy (Melbourne Water 2018b) to provide strategic direction for the management of waterways within the Port Phillip and Westernport Region over the next 50 years. The draft strategy delivers a single framework that combines various State, national and international legislation, policy and agreements that outline the roles, responsibilities. expectations and obligations of communities and key agencies involved in waterway management. The Draft Strategy also outlines regional decision-making, investment, management activities and management issues for waterways.

There are five main catchments within the Port Phillip and Westernport Regions; Werribee, Maribyrnong, Yarra, Dandenong and Westernport. Each catchment has its own Catchment Works Program which sets out unique visons and goals that reflect the local waterways and landscape characteristics within each catchment. The Mordialloc Bypass project is situated within the Dandenong Catchment which covers an area of 882 square kilometres. Approximately 10% of the area retains its natural vegetation with 30% used for agriculture and 60% utilised for urban development.

The vision for Dandenong Catchment is:

> *A vibrant valued Dandenong catchment waterway and wetland network, whose ecological health and liveability attributes continue to improve through rehabilitated waterways and connected and secured biodiversity corridors (Melbourne Water 2018b)*

The Dandenong Catchment Works Program (Melbourne Water 2018a) outlines various cultural, economic, and waterway values which help to create short and long term goals for the management of rivers, wetlands and estuaries within the Dandenong Catchment. Performance objectives and targets have been developed to ensure goals are on track and that waterway management over the next 50 years is linked to desired outcomes. For the Draft Strategy, Dandenong Catchment has been divided into eight sub-catchments. The Mordialloc Bypass Project is located within Dandenong Creek Lower Sub-catchment.

The goals for waterway management within the Dandenong Catchment and their relevance to the Project are outlined below in Table 8.4. Similarly, the most relevant performance objectives of Dandenong Creek Lower Sub-catchment stipulated in the Dandenong Catchment Works Program are outlined in Table 8.5.

Table 8.4 Draft Healthy Waterways Strategy goals for Dandenong Catchment and their relevance to the Project

DRAFT HEALTHY WATERWAYS STRATEGY: DANDENONG CATCHMENT GOALS (MELBOURNE WATER 2018B)	PROJECT RELEVANCE
Management of the catchment is integrated and includes the whole water cycle	No specific relevance.
Impacts from urban, peri urban, industrial and transport activities are mitigated to protect our waterways and the Bay	Project impacts assessed and mitigated through EES process.
Exemplary leadership enables informed, engaged and an empowered community who value and connect with waterways and tackle collaborative action	No specific relevance.
Waterways, wetlands and floodplains provide biodiversity corridors that allow the key environmental values to move and adapt to changes in condition and climate	Biodiversity corridors associated with waterways, wetlands and floodplains are considered in this assessment. Impacts to corridors will be mitigated where possible. Some residual impacts on wildlife movement are expected, particularly at the floodplain between Woodlands wetlands and Braeside Park wetlands.
Waterways, wetlands and floodplains are inviting places that are connected and accessible for public enjoyment and amenity	Project will increase accessibility through the shared user path, however parts of the waterways, wetlands, and floodplains associated with the Project will become less inviting (close to road). This is addressed further in the Landscape and Visual Impact Assessment (ASPECT Studios 2018).
Existing sustainable habitats and refugia for iconic fish, bird and frog species and platypus are secured and rehabilitated to meet the challenge of climate change impacts	Project will be largely consistent with this objective, ensuring that impacts to wetland and waterway habitat will be mitigated such that habitats and refugia are retained or improved. Some loss of habitat at Mordialloc Creek will occur.
Remnant higher stream values and habitats are rehabilitated to ensure high quality elements remain in upper catchments	Not relevant to Project.
Secure and enhance the Edithvale–Seaford Ramsar site and surrounding creeks and wetlands within the South-east Green Wedge	The Project will not impact the Edithvale-Seaford Wetlands, and mitigation measures will be in place to minimise impacts upon the surrounding creeks and wetlands (Mordialloc Creek, Waterways wetlands, Woodlands wetlands, Braeside Park wetlands). Enhancement of these habitats is unlikely to result from the Project.

DRAFT HEALTHY WATERWAYS STRATEGY: DANDENONG CATCHMENT GOALS (MELBOURNE WATER 2018B)	PROJECT RELEVANCE
Streamside vegetation zones and floodplains within the catchment continue to retain and expand Swamp Scrub and River Red Gum communities	The project will result in the loss of some native vegetation, including Swamp Scrub, and large old trees, including River Red Gums. Effort has been made to avoid and minimise the loss of large old trees and significant habitat to all extent practicable by refining the alignment and mapping No-go Zones. Revegetation and landscaping for the Project will utilise indigenous native species, including River Red Gums and Swamp Scrub species. This may effectively expand these communities. Refer to the landscape plan for the Project.

Table 8.5 Dandenong Creek Lower Sub-catchment performance objectives and their relevance to the Project

DANDENONG CREEK LOWER SUB-CATCHMENT PERFORMANCE OBJECTIVES (Melbourne Water 2018a)	PROJECT RELEVANCE
RIVERS AND CREEKS PERFORMANCE OBJECTIVES	
Increase instream connectivity to provide fish passage between the mouth of Mordialloc Creek and Patterson River to Dandenong	A bridge will pass over Mordialloc Creek which will maintain waterway connectivity for fish and other species such as birds and frogs.
Establish and maintain a continuous riparian vegetated buffer (3 km) along priority reaches (using EVC benchmarks to at least a level 3 vegetation quality). Improve social values by increasing vegetation cover in existing and planned urban areas by 1 km	Temporary impacts to the riparian buffer at Mordialloc Creek will be rehabilitated with the appropriate EVCs.
Maintain recreational water quality at National Water Sports Centre (suitable for secondary contact)	No specific relevance.
Increase access along waterways from 57% to 65% (about 3 km) by filling gaps and improving connections to existing path networks	Project will increase accessibility through the shared user path.
WETLANDS PERFORMANCE OBJECTIVES: BRAESIDE PARK	
Investigate opportunities to improve wetland water regime to meet ecological watering objectives, improve ecosystem services, cultural and social value	The Project will not impact upon the wetland water regime at Braeside Park. Minor impacts from afflux (approx. 40mm in a five-year flood events) in the grassland next to the Project at Braeside Park are predicted, however this will not impact the wetlands themselves.
Reduce threat to native birds from foxes, cats and dogs to moderate	Project is unlikely to affect rates of fox and cat predation. Impacts from dogs will be minimised by the inclusion of a wildlife friendly stock fence (horizontal wires) between the shared user path and Braeside Park. This will help discourage access to the wetlands from people and domestic dogs.

DANDENONG CREEK LOWER SUB-CATCHMENT PERFORMANCE OBJECTIVES (Melbourne Water 2018a)	PROJECT RELEVANCE
Improve wetland buffer to 50 per cent of wetland perimeter	Landscaping is likely to effectively increase the wetland buffer.
WETLANDS PERFORMANCE OBJECTIVES: EDITHVALE WETLAND	
Reduce the threat of foxes and domestic cats and dogs to moderate	No specific relevance.
Implement priority actions from the Edithvale Seaford Ramsar Wetlands Site Management Plan, 2016	Not relevant to Project, although the Edithvale Seaford Ramsar Wetlands Site Management Plan ((Ecology Australia 2016)) has been considered in this assessment.
Ensure acid sulfate soils disturbance is kept to a minimum and that if there is any disturbance, appropriate management techniques are employed	Refer to the Contaminated Land Technical Impact Assessment (WSP 2018a) for details. No impacts upon Edithvale wetlands are anticipated.
Reduce the threat of salt tolerant weeds (e.g. Spiny Rush) to low	Impacts to salinity of the Edithvale wetlands are predicted to be negligible. Any effect would be a very slight decrease in salinity. Refer to Surface Water Impact Assessment (WSP 2018d) and Groundwater Impact Assessment (WSP 2018b).
Maintain critical water regime components in Edithvale wetlands to protect wetland environmental values	Impacts to water regime in the Edithvale Wetlands are expected to be negligible. No impacts upon the critical water regime components are anticipated (seasonal wetting and drying critical to migratory shorebirds).
Prepare the wetland buffer to include likely area of wetland migration and infill existing areas of the current wetland buffer with native vegetation	No specific relevance.
Continue to implement Ramsar monitoring program in accordance with the new Guidelines for Ramsar site monitoring and evaluation to inform performance against the limits of acceptable change	Groundwater and surface water monitoring will continue to be undertaken. Otherwise, no specific relevance.

9 CONCLUSION

The main biodiversity impacts from the Project can be summarised as:

- Up to 10.56 ha of native vegetation (patches) is currently proposed to be lost from ten EVCs. All these EVCs are considered 'endangered' or 'vulnerable' within the Gippsland Plain Bioregion. With scattered tree buffers added, the total native vegetation loss for offset calculations is 12.10 ha.
- This includes high quality revegetation at the Waterways wetlands and Mordialloc Creek, and 0.28 ha of EPBC Act and 0.39 ha of FFG Act communities. Direct impact has been minimised to all extent practicable.
- Some direct removal of habitat for birds listed under the EPBC Act and FFG Act (direct impact is minor). As above, direct impact, particularly at the Waterways wetlands will be minimised to all extent practicable.
- Indirect impacts on several migratory and threatened species, particularly birds, from increased fragmentation, noise, and light effects, and increased mortality, which can be substantially mitigated with appropriate design.
- Minor impacts upon significant flora, which do not constitute a significant impact on any species.
- Direct and indirect impacts upon common fauna species, of which the indirect impacts can be substantially mitigated with best practice design.

There is limited scope to move the road within the project area, and there are no alternative corridor options available. Therefore, as indicated above, emphasis has been placed on developing minimisation strategies and mitigation measures to reduce impacts from with the construction and operation of the road. There are opportunities for a range of solutions (informed by current research and expert opinion), to mitigate the impacts of the Project, particularly noise, light, and loss of connectivity. Mitigation strategies are provided in Section 7 and includes barrier structures, wildlife crossing structures, fauna-sensitive lighting, landscaping and revegetation, and measures during construction. Mitigation should be monitored to determine effectiveness, with appropriate management and contingency measures in place.

The native vegetation removal report (dated 3 September 2018) resulted in an offset amount of 4.426 general units and 24 large trees, with a minimum strategic biodiversity value score of 0.422. No specific species offset units are required. Options to create or improve areas of wetlands through the State offset process within the local area (City of Kingston council area nearby the project area) should be further explored, and would be well-received by stakeholders.

A permit will be required under the *Wildlife Act 1975* for fauna handling or salvage and a FFG Act licence will be required for all direct impacts on habitat for FFG Act listed species.

With appropriate mitigation in place, EPBC Act offsets are unlikely to be warranted for this Project. However, communication with the Commonwealth will be required to ensure they are satisfied with the extent of mitigation that is proposed with the final design. Further investigation during detailed design is recommended to ensure that the final design meets or exceeds expectations for mitigation of impacts upon EPBC Act listed fauna.

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