Public Environment Report

Chapter 5

Description of the environment

September 2019

Chapter 5 Description of the environment

This chapter responds to Section 2.4 of the PER Guidelines and provides a description of the environment within the study area that may be affected by the action.

The study area referenced in the ecology, surface water and groundwater sections of this chapter refers to the broader region surrounding the project boundary. This description covers a much broader area than the expected zone of impact, and the additional information captured has been used to provide context for discussion of the necessary features.

The description is divided according to the categories presented in Section 2.4 of the PER Guidelines and draws on the various technical reports appended to the PER.

Throughout this chapter, the area directly impacted by North East Link is defined by the project boundary, which is contained within the EPBC boundary, as defined by the referral variation – see 'Request to accept a Variation of a proposal (EPBC, 2018/8142).

5.1 Listed threatened species, ecological communities and migratory species

The Protected Matters Search Tool (PMST) identified Matters of National Environmental Significance (MNES) that may occur, or for which suitable habitat may occur within the associated five-kilometre buffer (the study area). The results of the PMST are summarised in Table 5-1.

Table 5-1 Summary of PMST results

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

In accordance with Section 2 of the PER Guideline requirements, the PER considers, but is not limited to, the following MNES that are protected under Part 3 of the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act):

Listed threatened species and communities (Sections 18 and 18A of the EPBC Act), including:

- Matted Flax-lily (*Dianella amoena*) (endangered)
- Grassy Eucalypt Woodland of the Victorian Volcanic Plain (critically endangered)
- Swift Parrot (*Lathamus discolor*) (critically endangered)
- Australian Painted Snipe (*Rostratula australis*) (endangered)

- Australasian Bittern (*Botaurus poiciloptilus*) (endangered)
- Macquarie Perch (*Macquaria australasica*) (endangered)
- River Swamp Wallaby-grass (*Amphibromus fluitans*) (vulnerable)
- Clover Glycine (*Glycine latrobeana*) (vulnerable)
- Growling Grass Frog (*Litoria raniformis*) (vulnerable)
- Australian Grayling (*Prototroctes maraena*) (vulnerable).

Listed migratory species (Sections 20 and 20A of the EPBC Act), including:

- Latham's Snipe (*Gallinago hardwickii*).

The likelihood of occurrence for all MNES recorded within five kilometres of the action's project boundary (Victorian Biodiversity Atlas: VBA) or predicted to occur (PMST) is presented in PER Technical Appendix A – Flora and fauna technical report.

The PER has also considered the following MNES, which were determined by the likelihood of occurrence assessment to have a moderate to high likelihood of occurrence in the study area:

- Green-striped Greenhood (*Pterostylis chlorogramma*) (vulnerable)
- Charming Spider-orchid (*Caladenia amoena*) (endangered)
- Seasonal Herbaceous Wetland of the Temperate Lowland Plains (critically endangered)
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (vulnerable)
- Murray Cod (*Maccullochella peelii*) (vulnerable).

MNES assessed to have a low likelihood of occurrence within the project boundary are considered unlikely to be impacted by the action, and so have not been considered further in this PER, with the exception of Dwarf Galaxias (*Galaxiella pusilla*). Due to the absence of historical fish survey data from Simpson Barracks, targeted surveys were undertaken for Dwarf Galaxias (*Galaxiella pusilla*) despite its low likelihood of occurrence. The results of these surveys are discussed in this chapter.

5.1.1 Information on the abundance, distribution, ecology and habitat preference

Grassy Eucalypt Woodland of the Victoria Volcanic Plain

Grassy Eucalypt Woodland of the Victorian Volcanic Plain is predicted to occur within five kilometres of the project boundary (PMST provided in Appendix D of PER Technical Appendix A – Flora and fauna technical report). The Victorian Volcanic Plain bioregion only applies to two areas within the project boundary: west of the M80 Ring Road (also known as the Metropolitan Ring Road) intersection, and the western-most section of the Eastern Freeway on the west side of the Yarra River. This community was not observed within the project boundary at these locations during the field assessment.

Outside the project boundary, a patch of Grassy Eucalypt Woodland of the Victorian Volcanic Plain occurs along the M80 Ring Road in a small (approximately 1.5 hectare) patch between Enterprise Drive and the M80 Ring Road. The site is characterised by a large, open canopy of mature River Red Gum. While the understorey lacks much of the shrubby mid-layer described in the community description, there is a high cover of native graminoid species including Wallaby Grasses, Kangaroo Grass and Mat Rush *Lomandra* spp. There is a relatively low cover of native forbs (small non-woody bushes/shrubs) but the community description allows for considerable variance in understorey composition. This site is currently managed by the City of Whittlesea.

Seasonal Herbaceous Wetlands of the Temperate Lowland Plains

Seasonal Herbaceous Wetlands occur on the lowland plains of Victoria. The ecological community is limited to plains and lower slopes or stony rises at elevations below 500 metres above sea level. The soils on which the Seasonal Herbaceous Wetlands occur are generally fertile but poorly draining clays of various geologies (Threatened Species Scientific Committee (TSSC, 2012).

In the vicinity of North East Link, two areas of Yarra River floodplain wetlands (Bolin Bolin Billabong and Banyule Swamp/Warringal Parklands) occur in landscapes potentially associated with Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains. Field surveys did not identify Seasonal Herbaceous Wetlands at either of the locations identified above.

Within the Banyule Flats and Warringal Parklands area an important remnant of relatively intact geomorphology exists, including: the Banyule Swamp in the north-west and the Banyule Billabong; a large section of old river course in the south-west; and various other apparently natural depressions. The Warringal Parklands has been significantly modified with the filling and levelling of the floodplain for sporting ovals, with the Warringal Swamp being retained. As wetlands in this area are primarily influenced by riverine processes and overbank flooding, they cannot support the Seasonal Herbaceous Wetlands community (Threatened Species Scientific Committee (TSSC, 2012).

Bolin Bolin Billabong is a regionally significant floodplain wetland, with largely intact riparian vegetation, but with considerable weed infestation. The greatest threat to the ecological values of the billabong appears to be the lack of hydrological connectivity with the Yarra River, resulting from increasingly rare overbank flows. Habitat hectare assessments revealed the vegetation is primarily Floodplain Riparian Woodland of the Gippsland Plain that does not meet the Seasonal Herbaceous Wetlands criteria set out by the Threatened Species Scientific Committee (TSSC, 2012).

Matted Flax-lily *Dianella amoena*

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

The results of targeted surveys conducted between October and December 2017 and subsequent surveys of the Hurstbridge rail line reserve are summarised in Table 5-2 and Figure 5-1 with reference to their location.

Table 5-2 Results of targeted surveys for Matted Flax lily

Location	Number of plants	Comments
Within project boundary	95 Including 83 individuals within Simpson Barracks	Individuals ranging from a few leaf tufts to large patches up to 4 x 4 m in size
Outside project boundary*	188	East of the project boundary (and west of the large grassed parade ground 'long green') and on the eastern side of Simpson Barracks

* Simpson Barracks is the only area surveyed outside the project boundary

Most Matted Flax-lily plants/patches observed during targeted surveys were in a healthy condition. Plants showed evidence of recent flowering and leaf growth and several were observed being pollinated by the native Blue-banded Bee *Amegilla cingulata*. Matted Flax-lily occurred in a number of different habitats including at the base of River Red Gums, on rocky open areas or in shallow depressions. They often co-existed with other Dianella species within the project boundary, in particular Black-anther Flax-lily *Dianella revoluta* and Arching Flax-lily *Dianella longifolia* var. *grandis*.

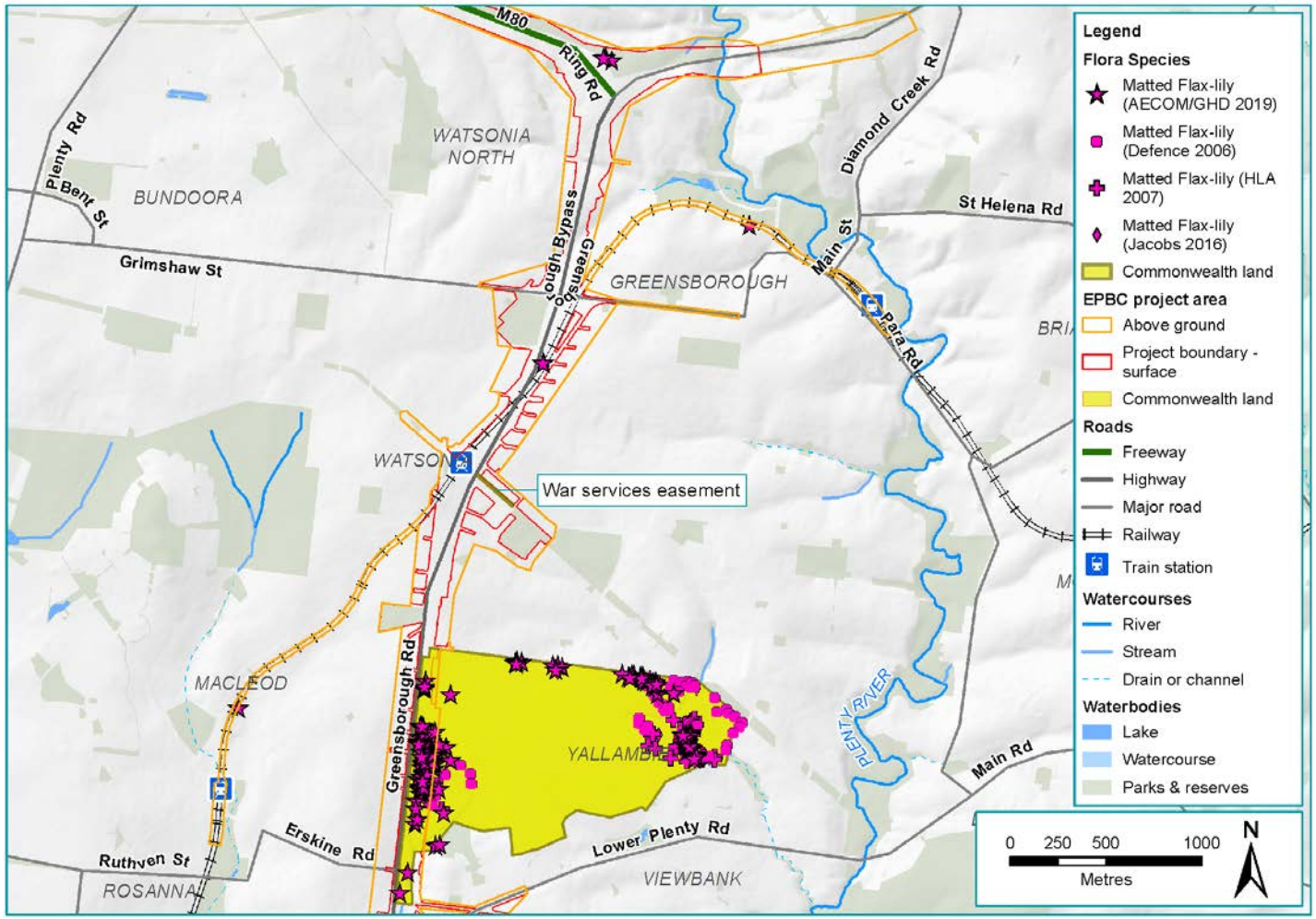


Figure 5-1 Results of targeted surveys for Matted Flax-lily

River Swamp Wallaby-grass *Amphibromus fluitans*

River Swamp Wallaby-grass is listed as vulnerable under the EPBC Act and is an aquatic perennial with one metre-long decumbent culms (aerial stems growing horizontally with tips turned up at the end) and often only the inflorescence is above water. It occurs in natural and man-made low flow water-bodies, including swamps, lagoons, billabongs and dams. An assessment of Victorian Biodiversity Atlas (VBA) data found a high likelihood of presence, with nine recent records within the five-kilometre buffer of the project boundary with the most recent record from 2011. Within the study area, optimal habitat for this species occurs in wetlands associated with the floodplain of the Yarra River.

Practical Ecology (2007b) also identified this species at the Trinity Grammar School Sporting Complex, Bulleen, within close proximity to the project boundary. There are some suitable areas of habitat such as Banyule Swamp, Trinity Grammar School Sporting Complex wetlands and Bolin Bolin Billabong. Despite this record, a targeted search for the species during its flowering time in December 2018 failed to locate any individuals.

Clover Glycine *Glycine latrobeana*

Clover Glycine is listed as vulnerable under the EPBC Act. It is a small perennial herb similar in appearance to common pasture clover (DPI, 2003; DSE, 2005b). It is endemic to south-east Australia and concentrated largely around South Australia, Tasmania and Victoria where it occurs mainly in grasslands and grassy woodland habitats.

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

Although no individuals were recorded, Clover Glycine is concluded to have a moderate likelihood of occurring within the project boundary based on the presence of potentially suitable habitat.

Charming Spider-orchid *Caladenia amoena*

Charming Spider-orchid is listed as endangered under the EPBC Act and is a listed species under Victoria's *Flora and Fauna Guarantee Act 1988* (FFG Act). This species is endemic to Victoria and is located in the north-eastern suburbs of Melbourne in the Greensborough-Plenty-Hurstbridge area as well as south-central Victoria; typically in grassy dry forest. In Melbourne, it is known only from a few small remnant populations.

No individuals were observed during field assessments, and the closest of the sparse historical records is located approximately two to three kilometres from the project boundary.

Green-striped Greenhood *Pterostylis chlorogramma*

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

During targeted surveys conducted in August 2018, no individuals or potentially suitable habitat were observed within the project boundary.

Swift Parrot *Lathamus discolor*

The Swift Parrot migrates to Victoria (and other parts of south-east Australia) in winter from breeding areas in Tasmania. In Victoria, it prefers dry, open eucalypt forests and woodlands, especially Box Ironbark Forest in north-central Victoria. Occasionally, this species is recorded in urban parks, gardens, street trees and golf courses with flowering ornamental trees and shrubs. Typically, small numbers of birds fly through the Melbourne area on their northerly and southerly migrations, mostly *en route* to or from central or western Victoria and further north. Birds are reported sporadically in small numbers across Melbourne (mainly in the northern and north-western suburbs) in most years, where suitable eucalypts occur and flower at appropriate times of the year.

Through desktop investigations and field habitat assessments, it was determined the Swift Parrot has at least some potential to visit almost any flowering trees within the project boundary occasionally, but is unlikely to use any of those habitats to any great degree. Given the dominant types of eucalypt across the project boundary, Swift Parrot visits are considered more likely towards the northern parts of the project boundary than the south-western or south-eastern extents. Other than the trees at Macleod Station, there is no evidence to suggest that Swift Parrots rely on other particular trees in the study area, or use them regularly or frequently.

Australian Painted Snipe *Rostratula australis*

The Australian Painted Snipe is a nomadic species potentially present at any suitable wetland across Australia, when conditions are favourable. This species is rare but widespread and can occur throughout most of eastern Australia.

According to the desktop assessment (VBA, Birdlife Australia [BLA] and e-Bird records), the most suitable habitat for this species is in and around Banyule Swamp. There is also potentially suitable habitat at Bolin Bolin Billabong, although there are no historical records of the species in the VBA, BLA or e-Bird databases at that location.

Other locations where this species may occur (such as Koonung Creek) are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. That, in association with the few VBA and e-Bird records, suggests those areas are very unlikely to support this species.

There is one exceptional and potentially erroneous 2012 BLA record of 80 birds in Darebin parklands about two kilometres north of the Eastern Freeway alignment near Chandler Highway. While the location is considered valid, this count of birds far exceeds any other VBA or BLA record for this species (the next highest count is two individuals) and is not consistent with prevailing reports from reliable sources (such as 'usually in pairs or small parties' (Marchant & Higgins, 1993).

There is a cluster of 16 BLA records of this species at and around Banyule Swamp. All these are from October/November 2001, with a maximum number of two birds being observed at any one time. Therefore, most of these 16 records are likely to be of the same two individuals. The VBA also contains two of those records. This species has not been recorded in the study area since then, and there is only one previous record, from 1970.

Consequently, it is very unlikely the areas within the project boundary support this species.

Australasian Bittern *Botaurus poiciloptilus*

The Australasian Bittern is rarely seen or reported. It prefers dense tall vegetation in permanent freshwater swamps and wetlands, particularly when dominated by sedges, rushes and reeds. There are records of Australasian Bittern along the Yarra River floodplain, but there are no records along Koonung Creek or Banyule Creek.

Within the study area, suitable habitat for this species occurs mainly along the Yarra River, particularly in the expansive Banyule Swamp area, where there are small numbers of historical records. The suitable habitat in this area is extensive and in good condition, and parts of it are relatively removed from disturbance sources (walking tracks, bike paths). The potential habitat along the smaller waterways (Koonung Creek, Banyule Creek) is degraded, highly disturbed, and only in relatively small and isolated patches, so is unlikely to support this species.

The Yarra River provides the most suitable habitat for this species in the project boundary, and the species may occur along or visit the Yarra floodplain occasionally in small numbers.

Growling Grass Frog *Litoria raniformis*

The Growing Grass Frog is a member of the 'Bell Frog' species complex (*Anura*: *Hylidae*) and is distributed across a large portion of south-east Australia. In Victoria it was previously widespread and common, absent only from the driest and highest parts of the state. Its typical habitats include lowland grasslands, open vegetated wetlands, flooded paddocks and drains. Floodplains tend to provide suitable habitat for this species, in that they are predominantly wet, and contain a range of waterbody types.

No Growling Grass Frogs were detected during targeted surveys. At present, the Growling Grass Frog is considered to be extinct from the habitats within the project boundary. Based on historical records, the Yarra River floodplain provides potentially suitable habitat, and some recolonising individuals may use the waterways/waterbodies if they disperse across the landscape.

Macquarie Perch *Macquaria australasica*

Macquarie Perch are a native freshwater fish species whose populations have declined in Victoria (DoE, 2018). They are now restricted to a small number of fragmented populations mostly in relatively undisturbed upland catchments, such as King Parrot Creek in the Goulburn Broken Catchment in northern Victoria (Bray & Thompson, 2018a). However, a self-sustaining population exists in the Yarra River from fish translocated in the 1920s (Bray & Thompson, 2018a) and possibly represents the most secure population in Australia (Douglas, 2002 cited in Ryan, O'Connor, Lyon, Lennie & Lieschke, 2003).

The species inhabits cool and clear freshwater reaches of rivers with deep holes and shallow riffles, as well as lakes and reservoirs (Bray & Thompson, 2018a). In rivers they prefer cool areas with aquatic vegetation, large boulders, woody debris and overhanging banks (Cadwallader & Eden, 1979; Bray & Thompson, 2018a).

In a study of fish movement in the Yarra River, Macquarie Perch were found to typically occupy restricted reaches (<450 metres) although movements up to 1,000 metres in response to large flow variations during the spawning season were observed (Koster, Dawson, Morrongiello & Crook, 2013). However, there was no evidence of synchronised migration or movement of multiple fish to specific locations (Koster, Dawson, Morrongiello & Crook, 2013). In rivers and streams they spawn in shallow, fast-flowing areas in the lower reaches from October to December, usually when water temperatures rise above 16°C (Bray & Thompson, 2018a) although the Department of Environment and Energy (DoEE, 2018e) suggests the breeding season can extend into mid-January.

Due to connectivity with the Yarra River, there would be a high potential for the species to also occur in Merri Creek. The species is reported as living in Mullum Mullum Creek and the Plenty River (Melbourne Water, 2012). Substantial barriers to fish passage prevent fish passage upstream from the Yarra River into Banyule Creek. Koonung Creek was also found to contain some significant covered sections that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. Given the movements of Macquarie Perch are generally limited (Koster, Dawson, Morrongiello & Crook, 2013) it is unlikely this species inhabits Banyule and Koonung Creeks. Furthermore, adults of the species are known to prefer deep water pool habitats (usually 15 to 30 metres long and at least 1.5 metres deep) (DoEE, 2017c) and these habitats are uncommon in these smaller waterways. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

Australian Grayling *Protroctes maraena*

Australian Grayling are the largest native salmoniform fish in Australia and the last surviving member of the family Prototroctidae (Ingram et *al*., 1990; DoEE, 2018a). The species occur in coastal rivers and streams in south-eastern Australia from the Shoalhaven River in New South Wales through to the Hopkins River in Victoria (Backhouse, Jackson & O'Connor, 2008a).

Australian Grayling usually prefer cool, clear waters with a gravel substrate and alternating pool and riffle habitats (Bishop & Bell, 1978; Berra, 1982) but can also occur in turbid water (Jackon & Keohn, 1988). They may form large schools, especially before spawning periods (Gomon & Bray, 2011). Adults prefer moderate to fast-flowing water, usually below altitudes of 200 metres, although in Victoria they have also been recorded above 1,000 metres (Gomon & Bray, 2011).

In the Yarra River, the construction of a fishway at Dights Falls has aided in the recovery of the species with increased recolonisation of upstream reaches (Backhouse, Jackson & O'Connor, 2008a). They are known to occur in the Yarra River between Mullum Mullum Creek and Dights Falls (Sinclair Knight Merz, 2012) and eggs and larvae have been retrieved at Fairfield (Koster, Dawson, Morrongiello & Crook, 2013). Consequently, due to connectivity with the Yarra River there is some potential for Australian Grayling to also exist in Merri Creek, although modelled distribution of the species suggests a low probability they would exist in Merri Creek (Walsh, Bond & Fletcher, 2013). The habitat assessment of Plenty River was found to potentially allow passage/migration corridors for the species from the Yarra River and this is also suggested by Lieschke et *al*., (Lieschke, Grgat & Zampetti, 2000).

The habitat assessment of all other waterways in the study area concluded the presence of Australian Grayling was unlikely, but is possible in waterways with direct connectivity to Yarra River and where suitable habitat was present. The habitat assessment of Banyule Creek identified significant barriers to fish passage that would prevent Australian Grayling from moving upstream from the Yarra River. Koonung Creek was also found to contain some significant covered sections that are potential barriers to fish passage that may impede the upstream movement of fish from the Yarra River. However, other fish species were located upstream of these covered sections, which indicates that passage maybe possible for some species. The absence of detection of individuals in these streams supports the assessment that these waterways do not support this species. They may be able to provide habitat for dispersing individuals at some times of the year, but they are not likely to provide important habitat for Australian Grayling populations.

Australian Grayling are not expected to inhabit the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp.

Dwarf Galaxias *Galaxiella pusilla*

Dwarf Galaxias are a mid-water, free swimming species with their entire life spent in freshwater (Saddlier, Jackson & Hammer, 2010). They typically occur in slow flowing and still, shallow, permanent and temporary, freshwater habitats including swamps, drains and backwaters that often contain dense stands of aquatic macrophytes and emergent plants (Cadwallader & Backhouse, 1983). However, they can also occur in creeks and streams (Bray, 2016) and in larger pools individuals are usually found amongst marginal vegetation (Saddlier, Jackson & Hammer, 2010). Temporary wetland habitats rely on seasonal flooding and connectivity to other sites where the species occur for habitat and population replenishment (Saddlier, Jackson & Hammer, 2010). They are also known to live in association with burrowing crayfish (*Engaeus* spp.) with the burrows providing refuge from predators and dry conditions (Beck, 1985; McDowell, 1996). It is not clear if they are capable of aestivation during dry conditions or if they rely on refuges such as crayfish burrows (Saddlier, Jackson & Hammer, 2010) or wet vegetation (Coleman, Raadik, Pettigrove & Hoffmann, 2016).

Dwarf Galaxias are a short-lived species that probably has poor dispersal abilities (Saddlier, Jackson & Hammer, 2010). They reach sexual maturity in their first year and likely die soon after spawning (Bray, 2016). Spawning occurs in late winter to spring with eggs usually attached on the underside of aquatic vegetation or on hard surfaces such as rock or timber (Saddlier, Jackson & Hammer, 2010). However, Bray (2016) suggests that Dwarf Galaxias can spawn all year round in suitable conditions. Larvae hatch after about two to three weeks and are around 4.5 millimetres long (Saddlier, Jackson & Hammer, 2010).

Although the Dwarf Galaxias is still widely distributed, populations are fragmented and patchy. In the Yarra River catchment, only translocated populations are known to exist in the La Trobe University wetlands (Saddlier, Jackson & Hammer, 2010). Their presence in the study area is considered unlikely. However, small aquatic habitats in the protected environment of Simpson Barracks may contain a similarly translocated population, which may be isolated due to lack of connectivity. The absence of fish records from this site means the presence of Dwarf Galaxias at this site is unlikely but possible.

Murray Cod *Maccullochella peelii*

The iconic Murray Cod is the largest freshwater fish in Australia but populations have reduced markedly throughout their natural range, and the species is now rare in some areas (National Murray Cod Recovery Team, 2010; Bray & Thompson, 2018a). They live in a variety of habitats including rivers, lakes and billabongs but are very territorial and in rivers prefer deep holes with boulders, fallen trees and other woody debris and banks with overhanging vegetation (DoEE, 2018a; Bray & Thompson, 2018b). Although they prefer the main channel of rivers, they can be found in inundated floodplain channels during high flows although this is reported as limited (DoEE, 2018a; Bray & Thompson, 2018b). Tracking studies in the Murray River found the species was strongly associated with structural woody habitat, deep (>2.4 metres), slow flowing water (<0.2 metres s-1) close river banks (Koehn & Nicol, 2014).

Murray Cod undertake a spawning migration each year and in rivers have been found to travel several hundred kilometres upstream (Koehn, et *al*., 2009). In southern areas, spawning tends to occur from early October to mid-December (Humphries, 2005; DoE, 2018). They form breeding pairs prior to spawning and select a site or nest that is usually a sunken log in lowland rivers, or a submerged rock in upland streams (DoE, 2018). Females lay demersal eggs that are guarded and fanned by her male partner until they hatch into pelagic larvae after about 25 days (Humphries, 2005; Bray & Thompson, 2018b).

After spawning, adults move back downstream and return to the same territory occupied before upstream (Koehn, et *al*., 2009). The species is endemic to river systems of the Murray–Darling Basin in south-eastern Australia. However, the species has been successfully introduced in the Yarra River (National Murray Cod Recovery Team, 2010; DoE, 2018). There is no overall Murray Cod population monitoring program within Victoria (National Murray Cod Recovery Team, 2010) which makes estimation of population sizes problematic. Recreational catches of Murray Cod measuring over one metre long have been reported in the Yarra River at Eltham, Wonga Park and Templestowe. The presence of Murray Cod in these areas, including the Plenty River catchment, is also reported by Melbourne Water (2012). Environmental flow recommendations have been made to support Murray Cod in the Yarra River between Yering Gorge and Dights Falls (Sinclair Knight Merz, 2012).

Given the territorial and sedentary nature of the species, and their preference to inhabit deeper areas of rivers, the Murray Cod is expected to occur within the project boundary in the Yarra River.

There is a high probability that Murray Cod also occur in Merri Creek and Plenty River due to their connectivity with the Yarra River and available habitat. The species is not expected to be in the disconnected waterbodies such as Bolin Bolin Billabong and Banyule Swamp, nor in Banyule and Koonung Creeks due to the presence of barriers to movement and absence of suitable habitat.

The EPBC listing of vulnerable for the Murray Cod does not apply protection to populations outside the natural range in the Murray-Darling Basin, and so does not apply to any population which may occur within the project boundary. For this reason, Murray Cod has not been considered further in this PER.

Grey-headed Flying-fox *Pteropus poliocephalus*

The Grey-headed Flying-fox uses a wide range of habitats in Victoria, from lowland rainforest and coastal Stringybark forests to agricultural land and suburban gardens. It occurs across the Melbourne area, foraging in densely vegetated flowering and fruiting trees. The VBA contains a large number of records of this species in the Melbourne area.

Grey-headed Flying-foxes have been coming to Melbourne for more than 100 years (EPA Victoria , 2018). Numbers have been increasing due to a loss of habitat in New South Wales and Queensland and the creation of a reliable food supply in Victoria. In 1986, a colony of Grey-headed Flying-foxes took up permanent residence in the Royal Botanic Gardens, Melbourne. Up to 6,000 individuals roosted in the gardens year-round, increasing to 20,000 during the breeding season. By 2002, the colony was out-growing its available habitat and was killing trees and damaging heritage-listed vegetation in the Botanic Gardens. Consequently, in 2003, a large-scale dispersal program successfully relocated the colony to Yarra Bend Park, Kew, in the vicinity of Bellbird Park.
The Management Plan for the Yarra Bend flying-fox colony (DSE, 2005a) shows the Flying-Fox Management Area to extend upstream from Bellbird Park to the Eastern Freeway. The camp at Yarra Bend Park is identified in the Australian Government's Department of the Environment and Energy (DoEE) interactive National Flying-fox Monitoring Viewer as a Nationally Important Flying-fox Camp (DoEE, 2014).

The northern limit of the flying-fox camp was visited on 16 November 2017 to ascertain current habitat use by roosting flying-foxes. Roosting flying-foxes were observed approximately 70 metres from the Eastern Freeway (though approximately 400 metres from the nearest freeway bridge across the river). No estimate of population size was made during the visit, but flying-foxes were observed to be roosting at high densities across a large area. Numerous individuals were seen carrying dependent young.

Aside from flying-foxes observed within the camp, the Grey-headed Flying-fox was observed in small numbers flying overhead during nocturnal field assessments at several locations across the project boundary. Targeted surveys for this species were not undertaken. Individuals are expected to forage across the entire study area, so its presence was assumed.

Latham's Snipe *Gallinago hardwickii*

Latham's Snipe is listed as Migratory under the EPBC Act. Latham's Snipe is a summer migrant/visitor to south-eastern Australia, returning each year to Japan and eastern Russia to breed during the northern summer. This species is present in south-eastern Australia only during the warmer months (August to March).

Latham's Snipe is a highly mobile species that forages in wet and flooded grasslands that are subjected to little disturbance. Preference of habitat does not appear to be determined by the diversity of native or introduced plants, but more related to the availability of suitably damp/wet habitat, food resources and level of disturbance (particularly people on foot, and presence of dogs). The species is omnivorous and feeds predominately on seeds, plant material and invertebrates.

The BLA database has 187 sightings of Latham's Snipe in the study area, until as recently as 2015. The VBA has 104 records up to 2013. This suggests that Latham's Snipe is a regular visitor to the study area. As indicated by these records, the most suitable habitat for this species is associated with the Yarra River and its associated floodplain in the Banyule/Bulleen area. This area satisfies the criteria to be considered as 'important habitat' under the EPBC Act. There is another notable cluster of records from La Trobe University, west of the study area, and from Dandenong Creek, well south-east of the study area.

Other locations within the project boundary where Latham's Snipe may occur are typically degraded, disturbed (particularly by people walking dogs) and within urbanised areas. There is one record from Tram Road Reserve along Koonung Creek (1989), and none from Banyule Creek. These areas are very unlikely to support large enough numbers of birds (18 or more) to be considered important habitat. The location where the Yarra River is crossed by the Eastern Freeway does not support habitats suitable for Latham's Snipe.

5.1.2 Known threats relevant to the action

PER Technical Appendix A – Flora and fauna technical report provides a list of key threatening processes identified under the EPBC Act (DoEE, 2017a; DoEE, 2017b) as well as an assessment of the likelihood of the threatening process occurring within the study area and whether North East Link would likely exacerbate the threat.

Of the threatening processes determined to be relevant to North East Link, one key threatening process listed under the EPBC Act is considered to have a moderate or higher likelihood of occurring within the study area. 'Land Clearance' is considered present within the project boundary and broader landscape due to historic and ongoing development of the urban environment for residential, industrial and transport purposes. North East Link would exacerbate this threatening process through the further loss of native vegetation within the project boundary. This vegetation is part of a highly fragmented mosaic across the urban north-eastern suburbs of Melbourne.

5.1.3 Maps identifying known or potential habits, and an assessment of its quality and importance

In accordance with item (a) in Section 2.4 of the PER guidelines, Figure 5-11 (a) to (t) (provided at the end of this chapter) shows the known and potential location of MNES and ecological values relevant to the environment on Commonwealth land. The environment on Commonwealth land shown includes relevant ecological values according to the EPBC Act Significant Impact Guidelines 1.2.

Figure 5-11 (a) presents an overview of these locations for the whole North East Link, and then Figures 5-11 (b) to (t) provides the locations of the targeted surveys for each section of North East Link. While the survey areas are only identified in the legend as what type of survey they were (flora, fauna, or aquatic), each map also provides identifying labels for which species were targeted in each area.

‘Known’ habitat

To address the ‘known’ habitat requirement, locations where MNES species and other relevant species for the environment on Commonwealth land were observed during targeted surveys, have been shown in Figure 5-11 and described in Section 5.1.1, 5.3.7, and 5.3.8.

‘Potential’ habitat

The ‘potential’ habitat requirement has been defined as the flora, fauna, and aquatic targeted survey locations undertaken for North East Link, in combination with previously recorded locations of EPBC listed fauna and migratory species, identified during the ecological desktop assessment.

Instead of only relying on mapping databases to identify potential habitat, during initial fieldwork undertaken, ecologists identified the most likely locations for MNES species habitat. These areas (both within the project boundary and in the surrounding areas) were then the focus for targeted surveys for these species. As such, these locations represent the most likely ‘potential’ habitat for these species.

For species that are known or likely to occur across the Melbourne area, targeted surveys were not undertaken because the result was unlikely to alter the conclusion drawn. Wide-ranging species, such as Swift Parrot, Grey-headed Flying-fox, Australian Painted Snipe and Latham’s Snipe may occur at a number of locations across the project area. For this reason, all potential habitat areas (other than those selected for targeted surveys) for these species are not shown.

Targeted surveys and their methodology are discussed in more depth in Section 5.1.4.

VBA point locations are also provided on Figure 5-11 for all previously recorded MNES within the project boundary and surrounding area. For wide ranging species in particular (e.g. migratory species), these locations do not indicate the presence or absence of potential habitat, but have been included for completeness. Due to the amount of VBA records, individual species labels have not been included on Figure 5-11. For detailed mapping of species including labels, see PER Technical Appendix A – Flora and fauna technical report.

Quality of habitat

Figure 5-11 does not differentiate between areas of potential habitat based on quality. The quality of each habitat area was only determined following targeted surveys. The quality and importance of habitat within the project boundary is discussed for each MNES under the relevant headings in Section 5.1.1 with further information on the environment on Commonwealth land provided in Section 5.3.7 and 5.3.8.

5.1.4 Scope, timing and assessment methodology for studies and surveys, having regard to publicly available guidance issued by the department

This section summarises the approach to the comprehensive ecological assessment undertaken to understand the existing conditions within the study area. Further detail is provided in PER Technical Appendix A –Flora and fauna technical report.

Review of existing literature

The assessment included an extensive review of existing literature including: previous environmental studies; public authority management plans, recovery plans and action plans; and environmental investigations and environmental feature descriptions from municipal councils and other administrative bodies. The aim of the literature review was to compile the findings of historical records, reports and information relevant to the action.

Desktop assessment of ecological databases

A desktop assessment was undertaken to provide an account of the ecological values previously recorded or modelled to occur within the EPBC boundary. A range of databases, which are mostly State and Commonwealth government-curated, were accessed. These are listed in PER Technical Appendix A – Flora and fauna, and Attachment VII – Reference list.

Likelihood of occurrence assessment

A likelihood of occurrence assessment was completed for each threatened or migratory species and each threatened community identified in the desktop assessment as either occurring, or having the potential to occur, within five kilometres of the project boundary. The results of this assessment are discussed in Section 5.1.1.

For threatened and migratory species, the likelihood assessment was used to determine the likelihood of the presence of each species within the project boundary based on the results of the habitat assessment, and the dates and number of previous records of each species.

Field assessment overview

Extensive field assessments were conducted over nine periods: in winter 2017, spring 2017, summer 2017/2018, autumn 2018, winter 2018, spring 2018, summer 2018/2019, autumn 2019 and winter 2019. The field assessments were conducted by up to four ecologists for flora, two ecologists for fauna, and two aquatic ecologists for the aquatic ecology assessment. Field assessments aimed to collect comprehensive information about the ecological values present or potentially present within the project boundary. Field surveys were undertaken for the whole of the project boundary, and also within areas of Commonwealth land. Separate field surveys were undertaken for flora, terrestrial fauna and aquatic fauna.

Flora

The general flora field assessments incorporated the following:

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

Fauna

General fauna field assessments included:

- High priority locations to assess were identified prior to the site visit, using aerial imagery and locations of historical threatened fauna records (VBA and BLA)
- Observations of threatened species were recorded at locations if seen/heard
- An assessment of the condition and landscape context of habitat patches considered most likely to support threatened species, such as woodland/forested habitats, grassland habitats and waterbody and waterway habitats.

Aquatic ecology

The field assessment for aquatic ecology included:

- Habitat assessment to determine instream habitat quality and potential for MNES
- Rapid bioassessment of waterways and wetlands
- Hydrology assessment of Banyule Creek
- Targeted surveys of EPBC listed species as outlined below.

Targeted surveys

Through the desktop review and initial site investigations, targeted surveys were conducted for those EPBC Act-listed threatened species and communities deemed to have a moderate to high likelihood of occurrence within the study area, or for species potentially inhabiting areas with little to none previous survey data (ie fish in Simpson Barracks). These included:

- Grassy Eucalypt Woodland of the Victorian Volcanic Plain
- Seasonal Herbaceous Wetlands of the Temperate Lowland Plains
- Matted Flax-lily *Dianella amoena*
- Clover Glycine *Glycine latrobeana*
- River Swamp Wallaby-grass *Amphibromus fluitans*
- Green-striped Greenhood *Pterostylis chlorogramma*
- Growling Grass Frog *Litoria raniformis*
- Macquarie Perch *Macquaria australasica*
- Dwarf Galaxias *Galaxiella pusilla*
- Australian Grayling *Prototroctes maraena*.

Targeted surveys were undertaken where there was doubt about the occurrence of a species or where the results were considered likely to change the conclusions drawn.

Targeted surveys were not undertaken for EPBC Act-listed threatened species that are known or likely to occur across the Melbourne area, because the result was unlikely to alter the conclusion drawn.

Targeted threatened flora surveys were undertaken in accordance with survey guidelines outlined in the DoEE Species Profile and Threats (SPRAT) Database for Matted Flax-lily, Clover Glycine and River Swamp Wallaby-grass. However, it should be noted that minimal guidance is provided for these species apart from survey timing requirements. Targeted survey for Green-striped Greenhood was largely based on the *Survey Guidelines for Australia's Threatened Orchids* (Australian Government, 2013). Where species did not have specific survey guidelines, the survey protocol is outlined in the sections below.

Targeted threatened fauna surveys for EPBC Act-listed species were undertaken in accordance with species-specific survey guidelines, as identified in the DoEE Species Profile and Threats (SPRAT) database.

The aquatic fauna surveys undertaken were based on the Survey Guidelines for Australia's threatened fish (DSEWPAC, 2011a). These include specific survey methods and habitats to be targeted for detecting fish listed as threatened under the EPBC Act.

Further information on the assessment for each of the above-mentioned species/communities, and rationale for those not targeted, is presented below.

Grassy Eucalypt Woodland of the Victoria Volcanic Plain

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

Only one site was considered to support the listed community at Enterprise Drive in Bundoora (described in Section 5.1.1 above). As this site is outside the project boundary, no further assessments were completed.

Seasonal Herbaceous Wetlands of the Temperate Lowland Plains

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

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

The following Ecological Vegetation Classes (EVCs) were identified as most likely to correspond to the Seasonal Herbaceous Wetland community and so were targeted during assessment where present:

- 125 – Plains Grassy Wetland + complexes
- 306 – Aquatic Grassy Wetland
- 647 – Plains Sedgy Wetland
- 678 – Ephemeral Drainage-line Grassy Wetland

- 778 – Gilgai Wetland
- 920 – Sweet Grass Wetland
- 956 – Herb-rich Gilgai Wetland.

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

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

- Surveys commenced at Simpson Barracks on 26 October 2017 when Matted Flax-lily was initially identified. A follow-up survey was undertaken on 2 November 2017 near the end of the Clover Glycine flowering season and while Matted Flax-lily was in bud (prior to flowering) and a final survey was undertaken on 21 November 2017 after Matted Flax-lily had commenced flowering and was consequently more visible. Surveys were undertaken along the Hurstbridge rail line and at the M80 Ring Road interchange on 24 October 2017 and again on 6 December 2017 to confirm presence and assess abundance.
- Where plants of either species were positively identified, sites were visited twice (Simpson Barracks, Hurstbridge rail line and M80 Ring Road interchange).
- Surveys for Matted Flax-lily were undertaken in accordance with the timing outlined in the DoEE Species Profile and Threats (SPRAT) Database (November to February). Surveys for Clover Glycine were undertaken in accordance with the flowering time of the species provided in VicFlora (September to December).
- Targeted survey effort was directed at potential native grassland and grassy woodland habitat, particularly better quality patches with low to moderate weed cover.
- Survey teams were led by botanists/ecologists familiar with the target species.

River Swamp Wallaby-grass *Amphibromus fluitans*

Targeted surveys of River Swamp Wallaby-grass were undertaken due to the likelihood of potentially suitable habitat, and proximity of works within Trinity Grammar, Bolin Bolin Billabong, Banyule Swamp and Banyule Flats.

- The Trinity Grammar survey was undertaken on 3 December 2018, with surveys at Bolin Bolin Billabong, Banyule Swamp and Banyule Flats undertaken on 6 December 2018.
- Targeted survey effort was directed at potential wetland and billabong habitat, including permanent and ephemeral wetlands, within and outside the project boundary. Wetlands outside the project boundary were selected to be surveyed based on the presence of historical records between 1995 and 2011, proximity to the project boundary, and the potential for groundwater drawdown associated with tunnelling to adversely affect the species in these areas.

- Survey teams were led by botanists familiar with the target species.
- Teams of two botanists slowly walked transects at five metre intervals, in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

Green-striped Greenhood *Pterostylis chlorogramma*

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

- The survey was undertaken in the middle of the known flowering season for the species (July to September (Commonwealth of Australia, 2013) on 26 August 2018, although a flowering reference population was not visited.
- Targeted survey effort was directed toward moist areas of heathy and shrubby forest habitat, in the northern portion of the project boundary (near where the species had previously been recorded in the local area).
- The survey team was led by a botanist familiar with the species.
- A team of two ecologists slowly walked transects at five-metre intervals (as recommended by the *Survey Guidelines for Australia's Threatened Orchids* (Commonwealth of Australia, 2013)), in all potential habitat. Reliable line of sight was approximately 2.5 metres either side of each ecologist. This level of effort is considered sufficient coverage to enable viewing within the space between transects.

Charming Spider-orchid *Caladenia amoena*

Targeted surveys were not undertaken for Charming Spider-orchid, as it was determined that field investigations were being conducted at a time when this species was observable. During field assessments, field teams were aware of the potential presence of this species on ridge tops and on sheltered slopes in dry sclerophyll forest, and any observations were mapped using a handheld GPS unit. Timing of surveys across the majority of the project boundary generally overlapped with the flowering period of Charming Spider-orchid (late August to late September) (Commonwealth of Australia, 2013). However, since orchids undergo periods of dormancy over one or more years, or may appear as non-reproductive plants (in leaf only) in some years, it is possible that Charming Spider-orchid may have been undetectable at the time field work was conducted.

Swift Parrot *Lathamus discolor*

Targeted surveys were not undertaken for Swift Parrot due to the low likelihood of detecting the species, and the fact that non-detection would not lead to a conclusion the species is absent. This species breeds in Tasmania only, and migrates to the mainland to forage during winter. The chance of detecting the species through targeted survey was considered low, yet drawing a subsequent conclusion of absence from non-detection would have been misleading. Therefore, assessment for Swift Parrot was restricted to habitat assessment, with occasional presence presumed in appropriate habitat.

Australian Painted Snipe *Rostratula australis*

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

Australasian Bittern *Botaurus poiciloptilus*

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

Growling Grass Frog *Litoria raniformis*

Between 31 October and 15 November 2017, two zoologists completed between one and three rounds of targeted frog surveys at six sites (Plenty River, Simpson Barracks, Bolin Bolin Billabong, Merri Creek, Kew Golf Course and Koonung Creek) where habitat was deemed suitable for the Growling Grass Frog. Surveys were undertaken during suitable weather conditions in accordance with EPBC survey guidelines for this species (DEWHA, 2010b). Sites deemed to not currently provide suitable habitat were not included further in the targeted surveys (some sites deemed to not currently provide suitable habitat were still surveyed at night on one occasion following the habitat assessment, simply because the ecologists were already at the site at the right time of day and under the right conditions).

The survey timing was chosen to target the peak activity period of the Growling Grass Frog (November to December) and to follow survey guidelines for the species (DEWHA, 2010b). While all habitat assessments were conducted during daylight hours, monitoring for the frogs was conducted at night, because frog activity is most likely to be detected at night.

Macquarie Perch *Macquaria australasica* and Australian Grayling *Prototroctes maraena*

Targeted surveys were conducted for two native fish species: Macquarie Perch *Macquaria australasica* and Australian Grayling *Prototroctes maraena*. As the methods used for targeted surveys also identified other fish species, the surveys provided general fish survey data on native and exotic species to inform the general aquatic ecosystem condition assessment of waterways affected by works on Commonwealth land.

Habitat assessments for each fish species, fyke netting and electrofishing were conducted at sites where records of the species were not known, but where connectivity to the known Yarra River population could be possible. Targeted surveys for Macquarie Perch and Australian Grayling were undertaken at the sites listed in Table 5-3.

The field surveys were conducted in accordance with the relevant State permits and approvals.

Table 5-3 Summary of fish survey methods

Site	Targeted round 1	Targeted round 2
Plenty River at Plenty River Drive	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Bulleen Road	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Doncaster Road	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting

Site	Targeted round 1	Targeted round 2
Koonung Creek at Jocelyn Avenue, Balwyn	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Valda Avenue, Box Hill North	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Frank Sedgman Reserve, Box Hill North	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Church Road, Doncaster	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Boronia Grove Reserve, Doncaster East	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting
Koonung Creek at Tunstall Road, Doncaster East	One night x two Fyke Nets, Backpack electrofish, Dip netting	One night x two Fyke Nets, Backpack electrofish, Dip netting

Dwarf Galaxias *Galaxiella pusilla*

Dwarf Galaxias are known to occur in ephemeral and intermittent waterbodies, but are typically associated with floodplain wetlands, dispersing during periods of overbank flow. This species is not known from the Yarra River catchment, although a translocated population is known from wetlands at La Trobe University (Saddlier, Jackson & Hammer, 2010). The presence of a similar isolated population to be present within the protected environment of Simpson Barracks was considered possible. Targeted surveys for this species were only conducted for this species at Simpson Barracks.

A habitat assessment, dip net sampling and backpack electrofishing of any aquatic habitat was undertaken during spring 2017 and autumn 2018. The use of bait traps was not appropriate for the habitat in Simpson Barracks, as the water depth (typically < 15 cm) was too low for the trap to be effective. The use of electrofishing and dip netting in this small, shallow waterway was considered appropriate for this targeted Dwarf Galaxias survey, in accordance with the survey guidelines for threatened fish (DSEWPAC 2011), as the aquatic habitat did not contain dense instream aquatic vegetation or high salinity that might otherwise limit the effectiveness of these methods.

Grey-headed Flying-fox *Pteropus poliocephalus*

Targeted surveys were not conducted for the Grey-headed Flying-fox. As discussed in Section 5.1.1 above, the species can disperse widely from its known colony and is presumed to forage throughout the project boundary. On 16 November 2017, the Yarra Bend colony was visited by zoologists (accessed from Fairlea Reserve, Fairfield) to determine proximity of the project boundary to current roosting areas used by flying-foxes.

Latham's Snipe *Gallinago hardwickii*

Targeted surveys were not conducted for Latham's Snipe. This species is migratory, and is present in southern Australia only during the warmer months (August to March). As discussed in Section 5.1.1 above, the locations in the project boundary where the species would potentially be found would not experience more than negligible impacts from North East Link.

5.1.5 Assessment of the adequacy of surveys carried out

The following limitations apply to field surveys conducted for North East Link:

- The need for targeted survey for listed threatened species was considered for those species identified by the investigation as having moderate or greater likelihood of occurrence in the study area.
- For fauna, targeted surveys were not undertaken for some threatened species that are known or likely to occur across the Melbourne area, because the result was unlikely to alter the conclusion drawn (such as Grey-headed Flying-fox *Pteropus poliocephalus* or Swift Parrot *Lathamus discolor*).
- The monitoring of waterways (Rapid Bioassessment) and lakes (Vlakes) was conducted during a particularly dry period, which may influence the assessment of aquatic ecosystems. The results from this monitoring event may or may not be representative of conditions during wet periods. This should be considered in future management plans.
- Targeted fauna (terrestrial or aquatic) surveys that do not detect the subject species cannot provide conclusive evidence that threatened species do or would not occur; just that they haven't been detected. The assessment of likelihood of occurrence is based on survey effort, background information and previous records compiled.
- It is almost impossible (except with molecular techniques) to accurately determine population size for Matted Flax-lily. Targeted surveys for this species recorded either discrete individual plants or patches separated by a gap of at least one metre between visible tufts of leaves. The use of this criterion implies that each plant/patch contains at least one plant but possibly more, and that where tufts are at least one metre apart, they are regarded as separate plants.

Notwithstanding these limitations, the extent of field survey and information available from other sources were considered adequate for the purpose of identifying potential impacts from the action on ecological values.

5.2 Relevant surface and groundwater resources

This section describes water resources within the study area that are relevant to the action, MNES and Commonwealth land. The section defines existing conditions for aquifers, waterways with respect to geomorphology, flow, flooding and water quality.

5.2.1 Surface water resources

Overview

North East Link lies within the urban waterway reaches of the Yarra River catchment. This highly urbanised part of Melbourne includes long-established residential areas, industrial precincts, parks and reserves, and community and recreation facilities.

North East Link is within a predominantly urban area of the Yarra River Catchment. Within this catchment, the North East Link intersects a number of waterways including the Yando Street Main Drain, Kempston Street Main Drain, an unnamed drainage system serving Watsonia Station, Banyule Creek, the Yarra River and Koonung Creek.

The PER focuses on the key waterways that may result in impacts on Commonwealth land and on listed threatened species and ecological communities, and migratory species (or their habitat) dependent on these water resources. The three drains mentioned above have been identified as unlikely to a measurable impact on matters of national environmental significance, and so are not discussed further in this chapter.

The key waterways are shown in Figure 5-4.

Other tributaries of the Yarra River in this area would not be affected by North East Link. These tributaries include Merri Creek, the Plenty River, Glass Creek and Bushy Creek, and are not discussed further in the PER.

Banyule Creek

Banyule Creek is an ephemeral stream with a length of approximately four kilometres and serves a catchment of four square kilometres. The creek begins in the Simpson Barracks area, flows south through the Banyule Swamp area, and discharges into the Yarra River. The majority of the catchment is urbanised with the exception of Simpson Barracks.

Geomorphology

The existing geomorphic conditions for waterway stability within Banyule Creek have been appraised through observations made during site visits. At Simpson Barracks, Banyule Creek is described as a small incision within the confined floodplain before changing into a more defined creek channel at the barracks boundary. From the barracks boundary the channel becomes heavily choked with Cumbungi reeds. Immediately downstream of Drysdale Road, the creek becomes more uniform and straightened. From Lower Plenty Road the channel becomes further incised through the residential surrounds.

Flow assessment

Banyule Creek is a minor urban tributary of the Yarra River and is not gauged so no flow data is available.

Flooding

Detailed hydraulic modelling has been undertaken for Banyule Creek to understand the behaviour of the current flooding.

At Simpson Barracks, the depth of flooding is generally less than 0.5 metres, aside from some isolated locations which are estimated to have depths up to one metre in a 1% annual exceedance probability (AEP) event. The elevation of Greensborough Road is higher than the surrounding properties, which results in stormwater flowing south along the western side of the road.

In the publicly accessible land south of Simpson Barracks, flood depths greater than two metres are estimated in a 1% AEP event and would extend over Borlase Street into private property.

From Drysdale Street to Lower Plenty Road, the 1% AEP flood extent is confined to Borlase Reserve. Banyule Creek then flows beneath Lower Plenty Road in two 1.6-metre diameter culverts. Downstream of Lower Plenty Road, the estimated flow is mainly confined to the creek reserve with depths of up to two metres.

The timing of the peak flow and water level influences the nature of the flooding within a catchment. Due to the short reach lengths and steep nature of the catchment, flash flooding occurs within Banyule Creek. The peak flow and/or water level typically occurs within one to two hours of rain starting.

Water quality

Water quality at Banyule Creek was assessed using data from three monitoring stations. Results show that dissolved oxygen, pH and turbidity exceeded State Environment Protection Policy (Waters) objectives. Further detail on water quality monitoring data is provided in Chapter 8 – Water related impacts.

Yarra River

The Yarra River catchment lies north and east of Melbourne, beginning on the southern slopes of the Great Dividing Range in the forested Yarra Ranges National Park. It occupies around 4,000 square kilometres and around two million people—around one-third of Victoria's population—live in the catchment. Around 70 per cent of Melbourne's drinking water comes from the pristine upper reaches. Most of the land along rivers and creeks in the middle and lower sections of the catchment has been cleared for agriculture or urban development.

The Yarra River catchment consists of various land uses along its length, including forested, agricultural and urban development. The land use within the catchment impacts the volume of surface water runoff and volume and type of water quality contaminants.

The Yarra River floodplain is extensive and comprises a number of land uses including but not limited to public recreation, conservation and special use zones such as golf courses.

Various storages exist within the Yarra River floodplain, including a dam within the Trinity Grammar School Sporting Complex and irrigation storages owned and operated by Manningham City Council.

On the western side of Bulleen Road, the recently completed Bolin Bolin integrated water management project collects, stores, treats and transports irrigation water. Water from this project is used to irrigate sports grounds located at Bulleen Park, the Carey Grammar School Sports Complex and the Freeway Public Golf Course.

Geomorphology

The Yarra River corridor contains some of the most valued geomorphic assets in metropolitan Melbourne. Indigenous vegetation and remnant riparian vegetation provide habitat and contribute to the protection of water quality and flow regimes. The Yarra River provides a natural landscape and key geomorphic features include river flats and billabongs.

The Yarra River reach between Diamond Creek and Merri Creek confluences has been described as having bed and banks that are relatively stable and well vegetated although somewhat weedy (Sinclair Knight Merz, 2005). The river channel comprises pools with the occasional gravel riffles and runs.

While much of the Yarra River floodplain has been cleared over time for urbanisation, some billabongs remain relatively intact such as Annulus Billabong and Bolin Bolin Billabong.

Flow assessment

Flows in the Yarra River are significantly altered from its natural condition due to the existence of water storages along its length and development within the catchment.

The flow duration curves shown in Figure 5-2 were developed using recorded gauge data at Banksia Street in Heidelberg (Melbourne Water, 02/08/2017).

Significant variability can be seen between a wet year and dry year. In a dry year, flow greater than four cubic metres per second occurred 20 per cent of the time, whereas in a typical wet year, flow greater than 55 cubic metres per second occurred 20 per cent of the time. Across the total period, 18 cubic metres per second was exceeded 20 per cent of the time.

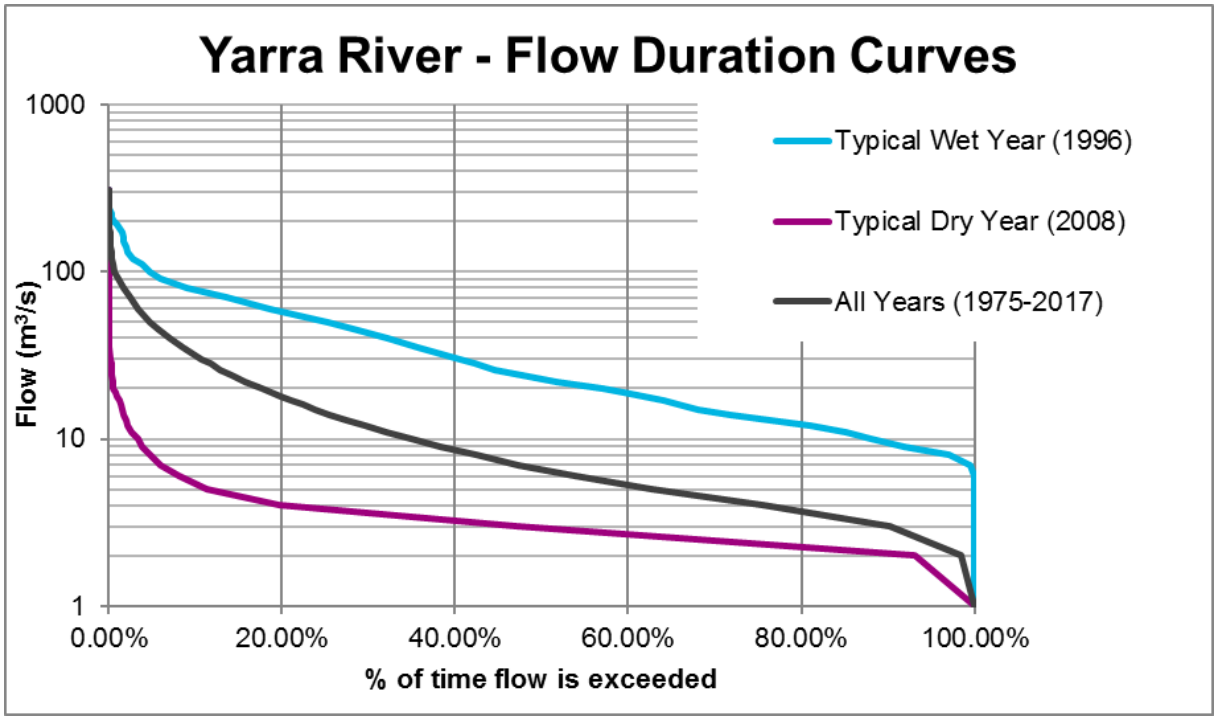


Figure 5-2 Yarra River flow duration curves

Flooding

The 1% AEP flood extent covers an extensive area used for public open space and recreational facilities as well as some areas of private residential, commercial and industrial properties along the fringes of the floodplain. In a 1% AEP event, flows in the Yarra River at Banksia Street are in the order of 1,200 cubic metres per second.

Due to the size of the Yarra River catchment upstream of the action, the peak flows occur several days following rain falling in the upper catchment. Smaller local rainfall events may cause local flooding within the catchment however would not typically cause widespread flooding.

Water quality

Water quality monitoring data was obtained for two monitoring stations on the Yarra River. The results show that for this dataset, the majority of the SEPP (Waters) objectives are met. Further detail on water quality monitoring data is provided in Chapter 8 – Water related impacts.

The most recent analysis provided on the Yarra and Bay website (EPA Victoria , 2018) of the available sampling of Yarra River in 2016–2017 indicates very good ratings for pH and salinity at Chandler Highway in Kew. In the same timeframe, very poor ratings are noted for water clarity, nutrients and metals (nitrogen, phosphorus and heavy metals) (EPA Victoria , 2018). DELWP combine the score of individual water quality parameters to produce an overall water quality index.

Figure 5-3 shows that, from 2000 to 2017, the water quality index for the Yarra River at Chandler Highway in Kew oscillated between very poor and poor. Since 2012 the water quality index has been improving.

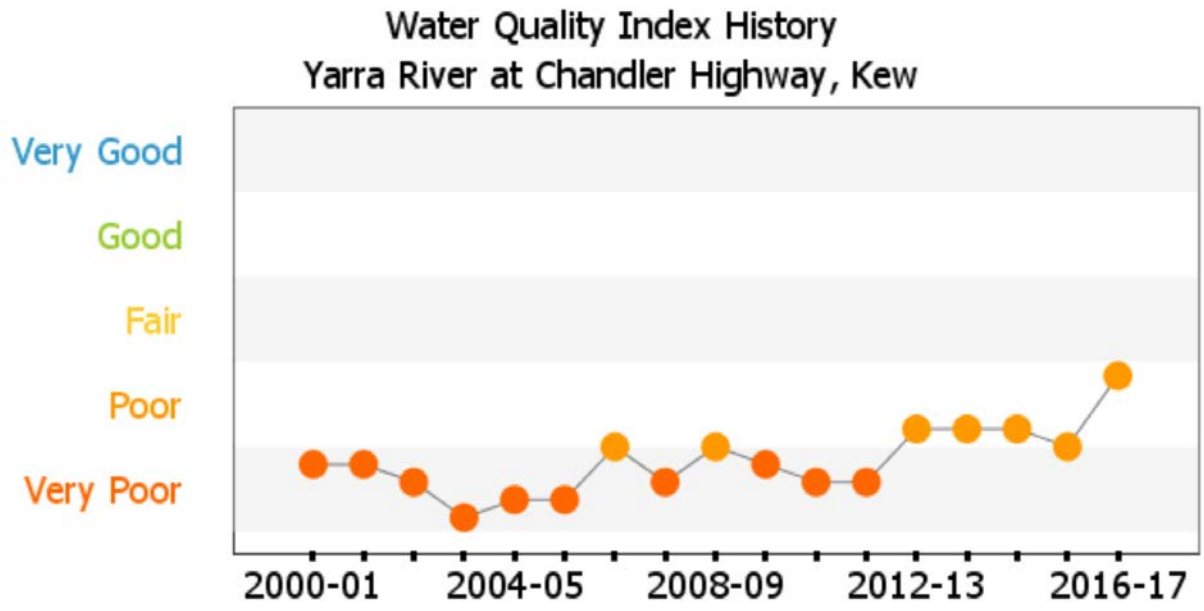


Figure 5-3 Water Quality Index, Yarra River at Chandler Highway, Kew (YAYAR3331) (DELWP, 2018)

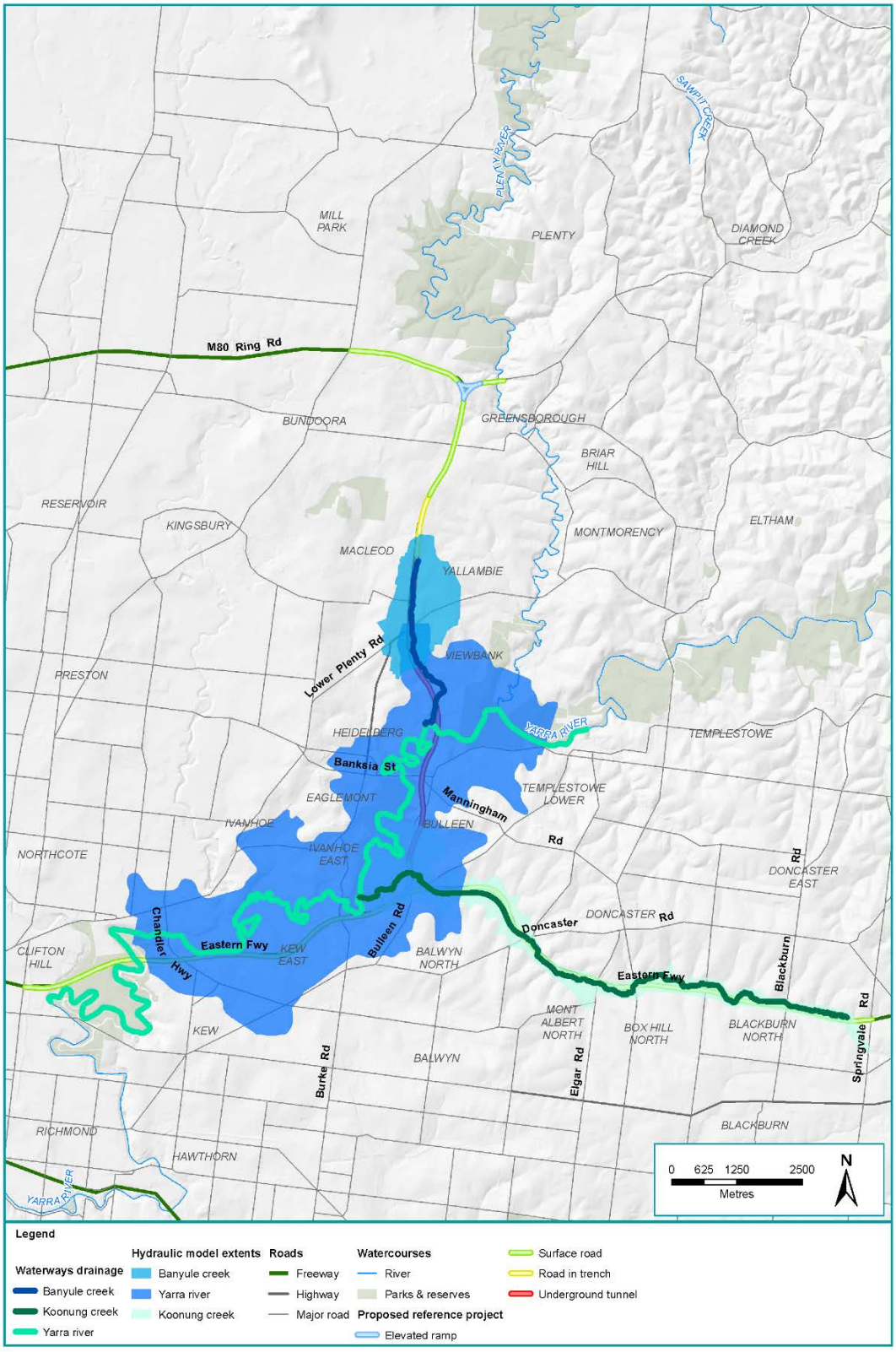


Figure 5-4 Surface water resources relevant to the PER

Koonung Creek

Koonung Creek is approximately 12 kilometres long and begins near Springvale Road in Blackburn North, where it flows west to join the Yarra River just north of the Freeway Public Golf Course. The creek meanders back and forth either side of the Eastern Freeway for much of its length and has been heavily modified by realignment and erosion control works, particularly those associated with the Eastern Freeway. Between Bulleen Road and Doncaster Road, Koonung Creek travels along a 2.4 kilometre long underground arch drain (Country Roads Board, 1982).

The catchment is predominantly urban, with dispersed as well as concentrated parklands along various reaches of the creek.

Flows into Koonung Creek enter from local catchment drainage connections including Melbourne Water drains, creeks and additional overland flow paths.

Geomorphology

The existing geomorphic conditions within Koonung Creek have been appraised through observations made during site visits. Koonung Creek is a heavily modified waterway due to the construction of the Eastern Freeway. The realignment works included significant lengths of erosion control, consisting of rock armouring of the creek in some areas between Doncaster Road and Springvale Road. Despite some sections of the creek having steep longitudinal grades and confined width, significant erosion protection works along with exposed natural rock cuttings contribute to a relatively stable creek showing minimal signs of erosion.

Flow assessment

Koonung Creek is a minor urban tributary of the Yarra River and is not gauged so no flow data is available.

Flooding

Existing flood extents along Koonung Creek as shown in the planning scheme no longer represent existing conditions for many areas. A new model of Koonung Creek was developed to assess flooding along Koonung Creek. The model includes parts of the local council drainage network and cross drainage across the existing Eastern Freeway. While this enables an understanding of impacts on local flooding networks, actual flooding on the local drainage system (council drainage) could and will often be greater than what has been predicted in the modelling.

Within the upper reaches of Koonung Creek from Springvale Road to Middleborough Road the 1% AEP flood extent is confined within the creek channel, surrounding parklands or publicly accessible vegetated area and does not extend to private properties. Downstream of Middleborough Road, flood extents expand and impact some private properties surrounding the Melbourne Water Tram Road retarding basin. Upstream of the 'arch culvert' under Elgar Road, the Koonung Creek flood extent expands into private properties to the south of the Eastern Freeway.

Downstream of Elgar Road, Bushy Creek joins Koonung Creek. The 1% AEP flow inundates various ovals within Elgar Park on the east and private properties on the west. The inundation extent resulting from the combined Koonung Creek and Bushy Creek flows extend across a series of wetlands. The flood extent is confined to Koonung Creek further downstream through a rock cutting, before entering a culvert and crossing to the north of the Eastern Freeway.

A short section of open channel connects into the underground arch drain, beginning near the Doncaster Park and Ride. The peak flow entering into this arch drain for the 1% AEP events is predicted to be 121.1 cubic metres per second. Surface inundation upstream of the arch drain is evident, and is from flows which exceed the capacity of the arch drain. Flood extents for the length of the arch drain are defined by a variety of issues including the overflow from the arch drain and capacity of the local stormwater network entering the arch drain.

The Yarra River 1% AEP flood extent intersects with the Koonung Creek 1% AEP flood extent, in the area that includes the Trinity Grammar School Sporting Complex, Marcellin College and the Carey Grammar Sports Complex. Significant flooding of the Yarra River typically results from prolonged rain events covering large areas of the catchment. In contrast, Koonung Creek is a significantly smaller urbanised catchment that is more likely to flood from shorter more intense and more concentrated rainfall events. These different types of critical events do not typically occur in the same general area at the same time. For this reason, it is unlikely that a significant flood on Koonung Creek would coincide with a significant Yarra River flood.

The outlet of the arch drain is downstream of Thompson Road, where the Koonung Creek flood extent expands across the Trinity Grammar School Sporting Complex and Marcellin College. Three culverts beneath Bulleen Road convey flood waters towards the Yarra River. In the 1% AEP flood event on Koonung Creek, Bulleen Road is overtopped by 0.5 metres.

In addition to the Koonung Creek catchment, the local catchment situated to the east of and including the Trinity Grammar School Sporting Complex has been modelled. Floodwaters from the 1% AEP flood event spread across most of the sporting ovals and water supply dam, before flowing through five overflow culverts beneath Bulleen Road into a wetland system on the western side of Bulleen Road, which discharges to the Yarra River.

Due to the short reach lengths and steep nature of the catchment, flash flooding occurs within Koonung Creek. Upstream of Thompsons Road, the flood peak might typically occur within one to two hours of rain starting. Further downstream major flooding is likely to result from longer duration storms, and the flooding response although still quick relative to a large river system may take several hours.

Water quality

Water quality data was obtained from four monitoring stations on Koonung Creek. Results show that dissolved oxygen, electrical conductivity (as a measure of salinity), pH and turbidity exceeded State Environment Protection Policy (Waters) objectives. Further detail on water quality monitoring data is provided in Chapter 8 – Water related impacts.

Water quality recordings at Koonung Creek, Bulleen Road note especially high levels of E.coli with 3,250 organisms per 100 millilitres (50th percentile) (Melbourne Water, 2015) greatly exceeding the State Environment Protection Policy (Waters) objective of under 1000 organisms per 100 millilitres (EPA Victoria, 2003). Potential sources of E.coli contamination include sewer blockages, seepage from the sewerage system and cross-connections between sewer and stormwater pipes (EPA Victoria, 2007).

The most recent analysis provided on the Yarra and Bay website (EPA Victoria , 2018) of the available sampling of Koonung Creek in 2016–2017 indicates a fair rating for pH at Bulleen Road in Bulleen. In the same timeframe, very poor ratings were noted for water clarity, dissolved oxygen, salinity, nutrients and metals due to high concentrations recorded for nitrogen, phosphorus and heavy metals (EPA Victoria, 2018).

EPA Victoria combines the score of individual water quality parameters to produce an overall water quality index.

Figure 5-5 shows that from 2000 to 2017, the water quality index for Koonung Creek at Bulleen Road in Bulleen has consistently remained very poor.

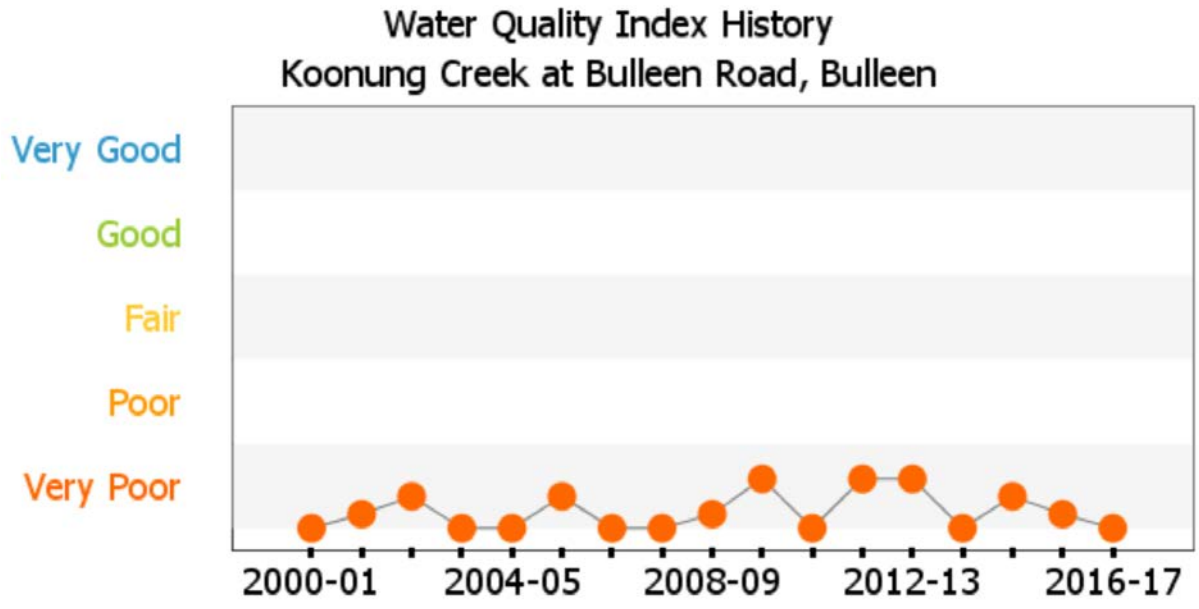


Figure 5-5 Water Quality Index, Koonung Creek at Bulleen Road, Bulleen (YAKOO0033) (DELWP, 2018)

5.2.2 Groundwater resources

Groundwater can have many and varied uses that benefit people and the environment. It may be used for drinking, irrigation, stock watering, industrial or commercial purposes or support ecosystems containing terrestrial vegetation, wetlands and rivers.

The groundwater conditions of the existing environment were assessed by investigating the geological setting, groundwater conditions and the users of groundwater. The study concentrated on the part of North East Link where below ground construction is planned (between Watsonia railway station and the southern portal).

Geology

The regional geological setting can be broadly described as a basement of folded and faulted Palaeozoic marine sedimentary rocks comprising mudstones and sandstones. These rocks were subsequently uplifted and eroded over time into a system of river valleys.

Surface geology for the study area is described as:

- **M80 Ring Road to northern portal** – in the west of this area, Older Volcanic Basalt has been mapped, with smaller outcrops of Older Volcanic and Newer Volcanic Basalt. Alluvial and colluvial sediments have been mapped along the Plenty River, although these tend to be laterally restricted and in close association with the river.
- **Simpson Barracks** – the Barracks are principally situated upon indurated Silurian sediments (Melbourne Formation), which have a thin cover of residual soils, and can be extensively weathered.
- **Northern portal to southern portal** – the geology in this area is mostly within the Palaeozoic bedrock, except near the Yarra River floodplain where alluvial sediments rest upon the bedrock.
- **Eastern Freeway** – the geology along the Eastern Freeway element is mostly comprised of shallow Quaternary alluvial sediments, as the freeway is generally located within or on the margins of the floodplain of the Yarra River or Koonung Creek.

Topography

The Palaeozoic bedrock forms undulating, rolling hills which have been dissected by the Yarra River and its floodplain. The topography is highest around the M80 Ring Road to northern portal area, extending to over 100 metres above sea level. The topography results in drainage towards the Yarra River floodplain, which generally lies between 10 to 20 metres above sea level.

Aquifers

Two basic aquifer systems are found in the North East Link area:

- **Fractured Rock Aquifers (or Bedrock Aquifer)** – these include Silurian Devonian indurated sediments and Basalts of the Newer (Quaternary/Upper Tertiary) and Older (lower Tertiary) Volcanics. Within these aquifers, groundwater is (mostly) transmitted by secondary flow mechanisms in these rocks such as fractures, joints and other discontinuities within the rock mass. This aquifer is identified across the whole of North East Link.
- **Porous Media Aquifer (or Alluvial Aquifer)** – the porous media formations include the Tertiary Brighton Group and the Quaternary (alluvial and colluvial) sediments. Within porous media aquifers, groundwater is stored and transmitted by flow between pore spaces of sedimentary grains. This aquifer was identified within the Yarra River and Koonung Creek floodplains.

Groundwater levels

Groundwater monitoring of the North East Link bore network indicates the following:

- Groundwater depth around the M80 Ring Road and Lower Plenty Road is at depths of greater than 10 metres below ground surface with the exemption of lower lying areas such as the Plenty River floodplain, north of Grimshaw Street and along the Hurstbridge rail line.
- Groundwater depth from the northern portal to the eastern freeway is generally less than 10 metres below the ground surface. Within the Yarra River and Koonung Creek floodplains, groundwater levels are approximately five metres below the ground surface.
- Groundwater depth around the Eastern Freeway is generally five to 10 metres below the ground surface. To the west of Bulleen Road, the groundwater level is less than five metres below the ground surface and to the east of Bulleen Road shallower groundwater levels are likely to be encountered within the floodplains of the Yarra River and Koonung Creek.

Mapping of modelled groundwater levels is provided found in Chapter 8 – Water related impacts.

Groundwater quality and use

Groundwater sampling for North East Link indicates that much of the bedrock aquifer is saline, particularly north of Lower Plenty Road and remote from the Yarra River floodplain. The groundwater in the alluvial sediments is generally less saline than the bedrock aquifer, thought to be due to greater interaction with fresh surface water.

Broad-scale mapping of the groundwater quality for the area is shown in Figure 5-6. More detailed discussion and sample results are provided in Chapter 8 – Water related impacts.

Groundwater abstraction in the area is limited due to the largely residential setting, where piped potable water is readily available. Due to the brackish to saline quality of groundwater available in the area, its use is limited.

There are 207 bores registered within one kilometre of the project boundary – these are discussed in Chapter 8 – Water related impacts. Two groundwater bores (monitoring bores) were identified on the Commonwealth land based on a site inspection by North East Link project officers undertaken on the western part of the land parcel only. These monitoring bores are not registered publicly, and so are not included in the discussion in Chapter 8 – Water related impacts.

Groundwater dependent ecosystems (GDEs)

Groundwater dependent ecosystems (GDEs) are often complex, dynamic systems relying on groundwater for some or all their water requirements, either permanently or intermittently (Richardson, et al., 2011); (Geosciences Australia, 2018). GDEs can be grouped into two categories (Eamus, 2009):

- GDEs that rely on surface expression of groundwater such as:
  - Wetland areas
  - Rivers where groundwater discharge provides a significant baseflow component to the system
- GDEs that rely on the availability of water beneath the surface (subsurface) such as:
  - Terrestrial vegetation that relies on groundwater close to the surface (within the root depth of the vegetation) which in turn supports animal communities
  - Aquifer and cave ecosystems
  - Estuarine systems that rely on submarine groundwater discharge.

The GDEs that have the potential to be impacted by North East Link are listed in Table 5-4. The GDEs are described in relation to the geographic area where indirect impacts may occur due to changes to groundwater from North East Link.

Table 5-4 GDEs relevant to North East Link

Geographic area	Relevant GDEs
Vicinity of the northern portal, including Simpson Barracks and Banyule Creek	Banyule Creek and surrounds (Simpson Barracks)
Banyule Flats	GDEs are modelled extensively across the Banyule Flats area
Location of the southern portal, on the floodplain of the Yarra River	Yarra Flats (including Yarra floodplain, ephemeral Yarra billabongs, and Bolin Bolin Billabong)

Of greatest importance to GDEs in the study area is the modelled depth to groundwater. Further discussion of GDEs is provided in Chapter 8 – Water related impacts.

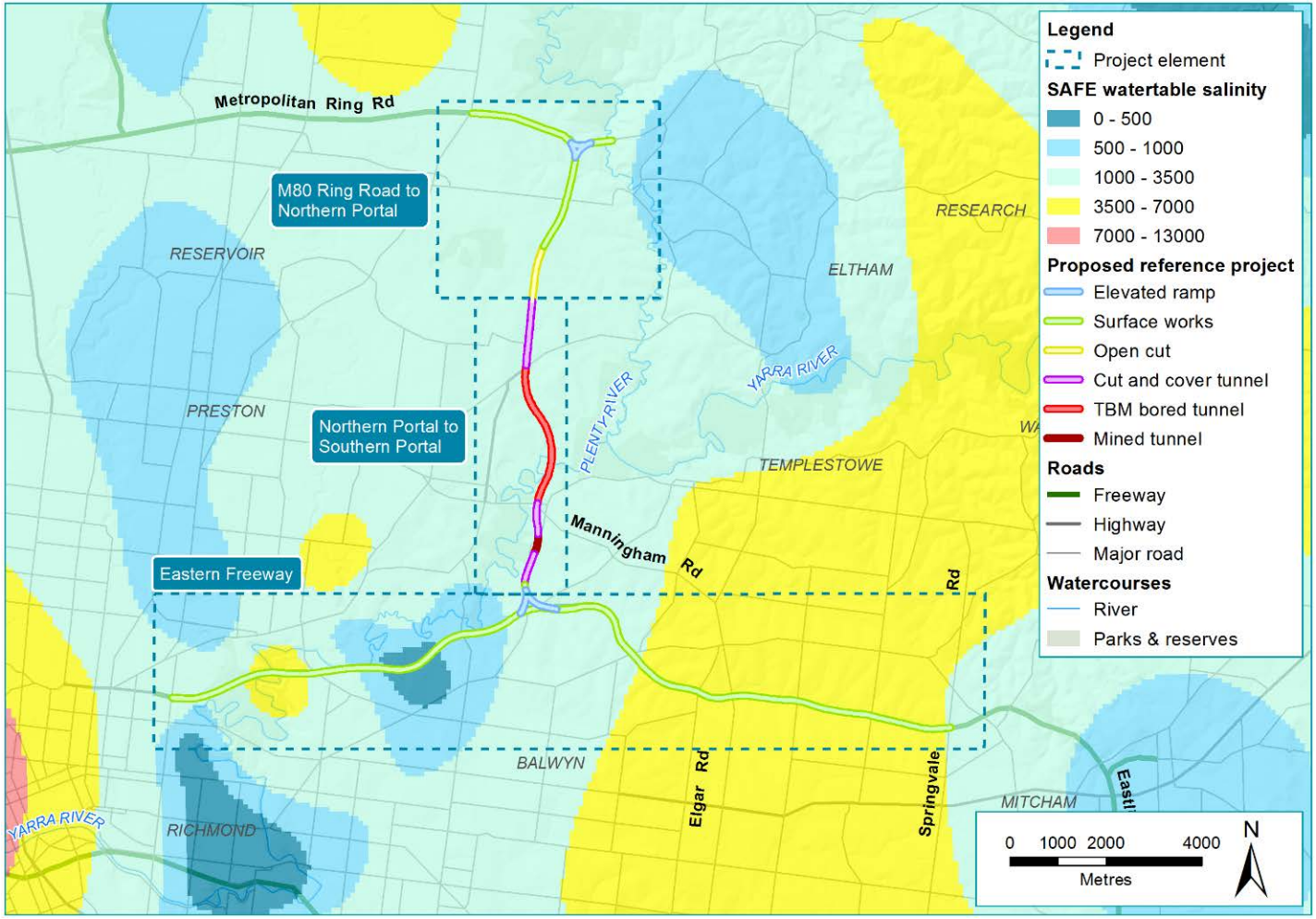


Figure 5-6 Regional groundwater salinity

5.3 Description of the environment on Commonwealth land

This section describes the components of the environment potentially affected by the impacts on Commonwealth land at Simpson Barracks and to the rear of properties on Elder Street at Watsonia (as discussed in Chapter 9 – Impacts on the whole of the environment on Commonwealth land). The environmental description is principally discussed in terms of the following areas:

- The area of the Commonwealth land directly impacted by the action (within the project boundary)
- 500 metres distance from where the action lies on Commonwealth land
- The whole of Commonwealth land.

Figure 5-7 shows the layout and key features of the Commonwealth land at Simpson Barracks for the areas listed above, with a further description provided in the sections below. The Commonwealth land at the rear of properties on Elder Street in Watsonia shown in Figure 5-8 is discussed in Section 5.3.1, and is not described further in the chapter.

5.3.1 Directly impacted area

Simpson Barracks

The area directly impacted by the action at Simpson Barracks contains mainly natural environment features. Bushland dominates with some grassland and the origin and upper reach of Banyule Creek are located on the Barracks. This area also contains the entry gate to the Barracks and the start of Blamey Road. Three training/office buildings would be directly impacted by the action. Two of these buildings are in the area between Yallambie and Blamey Roads; the northern-most building (vehicle shed) is likely to be retained, while the former guard house on Blamey Road would be demolished. One small building (shelter) is to the south of Blamey Road, at the eastern boundary of impact. This shelter is likely to be impacted, but the extent of impact is not currently known.

War Services easement

The land here is owned by the Director of War Service Homes, but is vacant and is understood to be maintained by Banyule Council as part of the electricity easement reserve. The site is mostly grassy open space, with some amenity tree plantings. The eastern edge of the site includes a shared use path. The area has no other identifying features.

5.3.2 Within 500 metres of the action

The area within 500 metres of the action also predominantly contains areas of natural environment. This mostly consists of bushland, with some open space areas which resemble sports ovals or parade areas. The built environment includes multiple roads and carparks, along with 28 training/office buildings, 27 accommodation buildings, two mess buildings, and seven buildings classified as 'other'.

5.3.3 Whole of environment

The remaining area is a mostly natural environment similar in nature to the rest of Simpson Barracks with the eastern-most area of the barracks remaining as grassland. The built environment includes roads, carparks and buildings with various uses including for training, offices and accommodation as displayed in Figure 5-7.

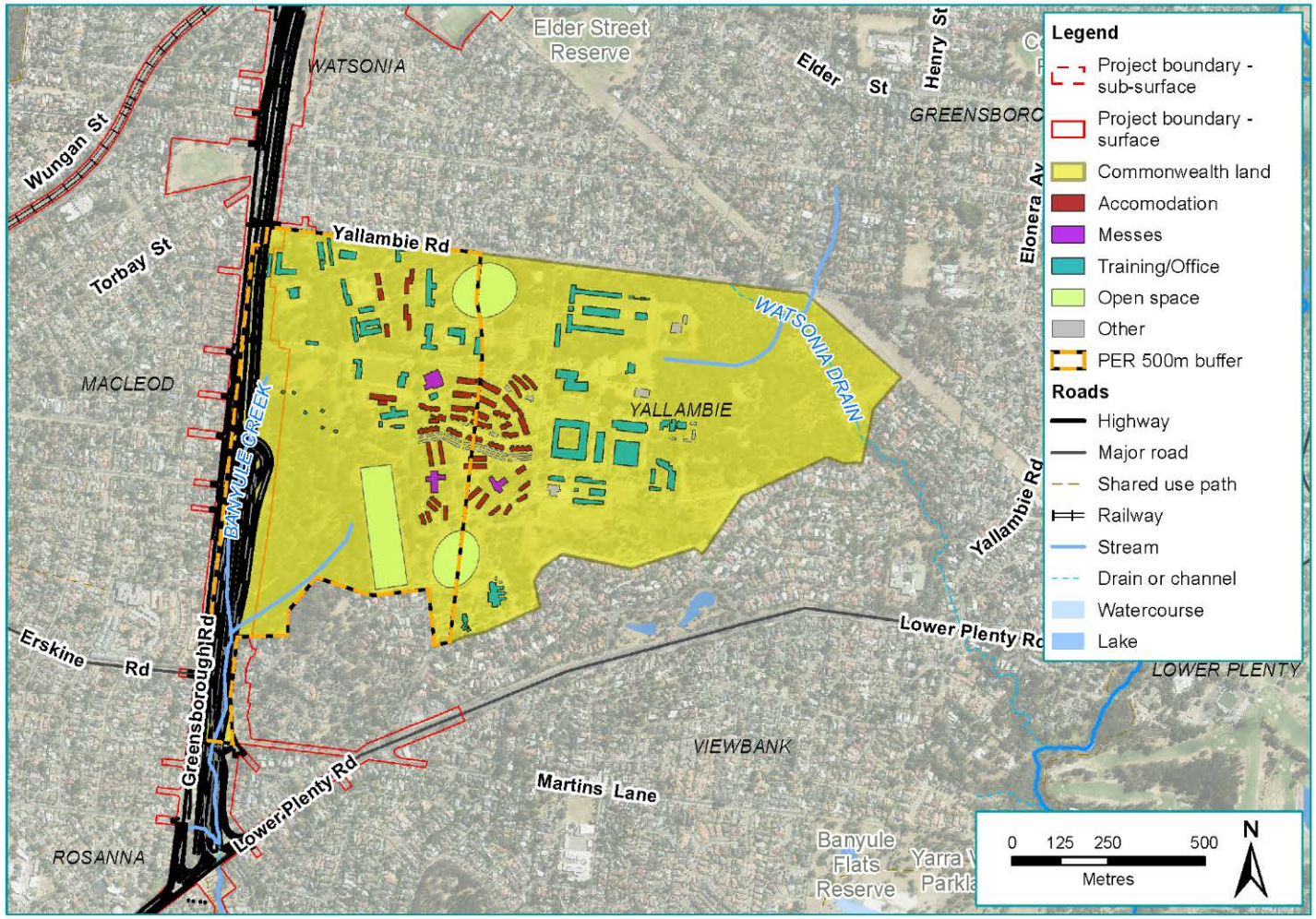


Figure 5-7 Simpson Barracks site layout

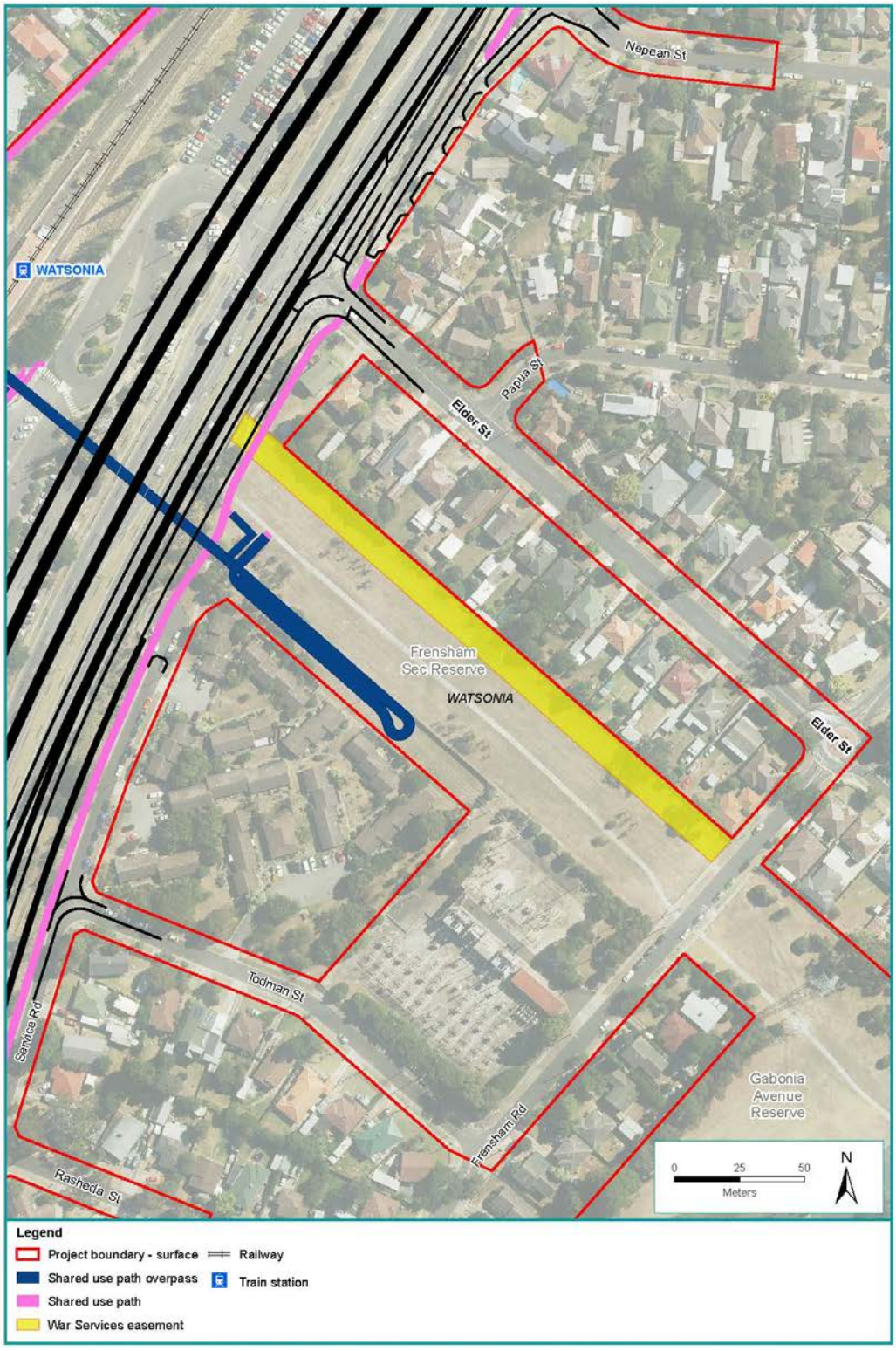


Figure 5-8 Area of Commonwealth land to the rear of properties on Elder Street at Watsonia

5.3.4 Landscapes and soils

Landscape

The Commonwealth land lies in shallow valley following the drainage line of Banyule Creek. The landscape rises in the east to a 'Ridgeline' that defines the local landscape character. Long views are provided to and from treed ridgelines, with multiple ridgelines present throughout the area.

The Commonwealth land at Simpson Barracks (including the unfenced area to the south) is the least urbanised environment of the area and has dense, predominately native established vegetation within the barracks, providing visual relief from the surrounding urban environment. This mostly recent vegetation has scattered older gum trees and a small number of large remnant trees that may date from the pre-contact period. Some of these remnant trees are visible along the Greensborough Road edge, while others are within the regenerating stands to the east.

Banyule Creek is a dominant landform in the area. The morphology of Banyule Creek is described in Table 5-5.

Table 5-5 Banyule Creek

Reach	Description
Simpson Barracks	Catchment begins near Yallambie Road, although the defined flow path starts at the culvert south of Blamey Road. From there, the surface flow path begins as a low flow, small incised channel through the vegetated depression with localised deeper and wider sections along the reach. This sits within the relatively steep (>1:40) natural valley depression within the confined floodplain. A number of local drainage connections are located along the reach from the east and west sides of the catchment. The stream form changes to a more defined creek channel where the bed profile steepens. The open drain becomes steeply graded, and attempts at placing erosion control and check dams have suffered damage with evidence of outflanking. Near the Simpson Barracks boundary the creek becomes a larger capacity channel joined by a tributary flow path from the east. At the boundary of the Barracks, the channel is intersected by a cyclone fence with a grill extending to the base of the channel for security. This would become an obstruction to flow during high rainfall events. This is evident from the localised erosion where turbulent flows have crossed the boundary.
Simpson Barracks boundary to Drysdale Road	The channel profile flattens (<1:100), with a bed width of 1–2 m, and becomes heavily choked with cumbungi reeds. The surrounding floodplain is heavily vegetated with mature gum trees and understorey, and so is relatively stable. The Drysdale Road culvert is a hydraulic restriction that may be influencing the characteristics of this reach.

Soil

According to the Geological Survey of Victoria 1:63,360 Map Sheet Yan Yean, the Simpson Barracks area is underlain by a Silurian Dargile formation, consisting of mudstone and minor very fine-grained sandstone, as shown in Figure 5-9.

Drilling completed as part of North East Link geotechnical investigation program indicates these rocks have a thin cover of residual soils (which can be extensively weathered), underlain by clay and then siltstone. The clay is a weathering product of the siltstone. There are small outcrops of Quaternary alluvial sediments associated with Banyule Creek in the south-west of the Barracks area.

The area is generally considered to have a low potential for the presence of acid sulfate soil or acid sulfate rock (ASR). However, moderately weathered to fresh Dargile Formation can potentially contain metal sulphides and so can potentially include ASR. No samples taken as part of preliminary investigations were classified as acid sulfate soil.

5.3.5 Water resources

General descriptions of the groundwater and surface water resources for North East Link are provided in Sections 5.2.1 and 5.2.2 above.

Surface water

Simpson Barracks is the only part of Commonwealth land that contains existing surface water resources, which relate to Banyule Creek and a small section of Melbourne Water's Watsonia Drain. The creek begins at Simpson Barracks, and flows through the Barracks and the unfenced area to the south.

Relevant geomorphology and flooding information for Banyule Creek at Simpson Barracks is discussed in Section 5.2.1 above.

Groundwater

Groundwater for both areas of Commonwealth land is at depths of greater than 10 metres below the surface. Relevant GDEs have been identified for the action in Section 5.2.2 above. Both types of GDEs occur at Simpson Barracks. The groundwater quality for Commonwealth land is also provided in Section 5.2.2.

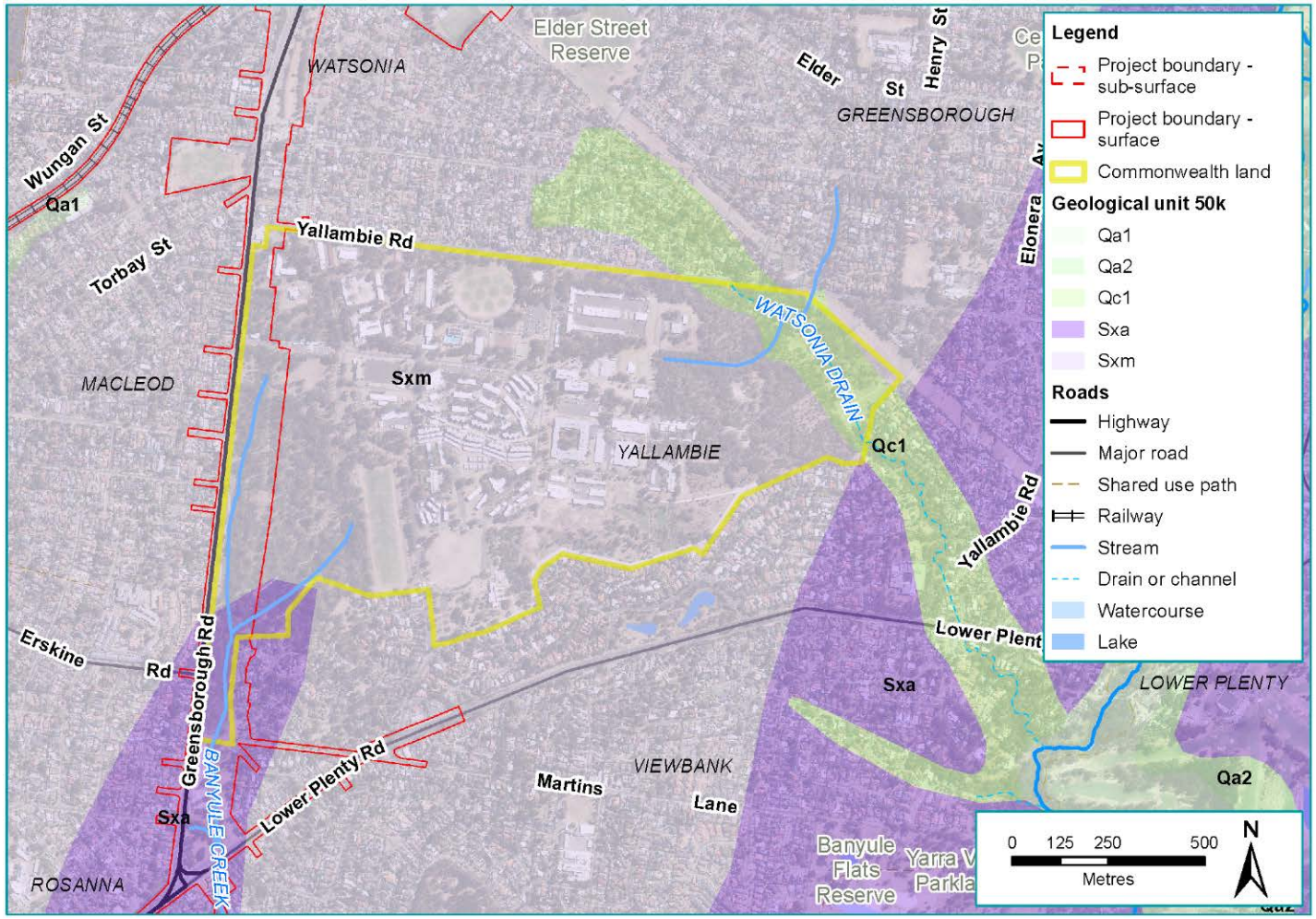


Figure 5-9 Geology of Simpson Barracks

5.3.6 Pollutants, chemicals, and toxic substances

Air quality

Air quality impacts are influenced by meteorological conditions, primarily in the form of wind flow regimes, and by local conditions driven by topographical features in the form of drainage flows. Topography, wind speed and the wind direction affect the dispersal and transport of pollutants. Data collected the Bureau of Meteorology taken from the closest monitoring station within the Banyule Flats Reserve illustrate the wind is most commonly blowing from the south-south-west or north-north-east quadrants.

The main sources of industrial and non-industrial emissions contributing to the local airshed include:

- Traffic using the road network, including Greensborough Road and Lower Plenty Road
- Domestic fuel burning (gas, liquid and solid)
- Residential activities (lawn mowers, barbeques)
- Industrial activity.

EPA Victoria conducts long-term ambient air quality monitoring to meet the obligations under the National Environmental Protection (SEPP) (Ambient Air Quality) Measure (Air NEPM). The results are compared with SEPP (Ambient Air Quality) environmental quality objectives.

The closest EPA Victoria performance monitoring station to North East Link is the Alphington ambient air quality monitoring station, located approximately 6.5 kilometres south-east of Simpson Barracks and is considered a good indicator of existing air quality in the local airshed. Background air quality data is used to quantify existing air quality in the assessment of air quality impacts from proposed works on Commonwealth land.

The five most recent calendar years of data (2013 to 2017) were analysed for particulate matter of 10 microns and below (PM_{10}), particulate matter of 2.5 microns and below ($PM_{2.5}$), carbon monoxide (CO) and nitrogen dioxide (NO_2). The data demonstrates that:

- CO 8-hour daily maximum concentrations ranged from 0.017 to 0.30 parts per million and complied with the SEPP (Ambient Air Quality) environmental quality objective
- NO_2 results also complied with the one-hour and annual SEPP (Ambient Air Quality) environmental quality objectives
- $PM_{10\ (24\text{-hour})}$ average results ranged from 2.1 to 64 micrograms per cubic metre with several SEPP (Ambient Air Quality) exceedances recorded from 2013 to 2017. Annual average results complied with the SEPP (Ambient Air Quality) environmental quality objective
- $PM_{2.5\ (24\text{-hour})}$ average results also showed days of non-compliance with the SEPP (Ambient Air Quality) environmental quality objective. The exceedances were attributed to bushfires, planned burns and urban sources, including smoke from wood heaters. The current $PM_{2.5}$ annual average objective was exceeded in 2009 and 2017.

While it is recognised that exceedances of the $PM_{2.5}$ and PM_{10} objectives occurred during the modelled years, air quality at the EPA Victoria Alphington ambient air quality monitoring station is generally considered good.

Greenhouse gases

Greenhouse gas emissions are a global issue and do not have localised existing conditions. Consequently, existing conditions are discussed in a regional context.

The Victoria Government has a target of net-zero emissions by 2050, meaning that greenhouse gas emissions will be reduced to the lowest possible amount, and the remaining emissions counteracted. The Australian Greenhouse Emissions Information System (AGEIS, 2018) total for Victoria in 2016 was 115,103 kilotonnes CO_2-equivalents, an approximate 2 per cent drop since the Victorian total of 117,757 kilotonnes CO_2-equivalents in the year 2000.

The most current available data for total greenhouse gas emissions emitted annually by Australian and Victorian transportation activities is 80,804 kilotonnes of CO_2-equivalents and 20,504 kilotonnes of CO_2-equivalents respectively.

Ground contamination

Potential and known contaminating activities on Simpson Barracks include:

- Bulk fuel storage and distribution
- Former sewage treatment plant
- Battery stores
- Several landfills that have been used to dispose waste from Defence operations
- Materials containing asbestos may be buried in many locations across the property.

Preliminary field investigations were undertaken to better understand the quality of soil and groundwater, landfills/fill sites and the presence of acid sulfate soil and rock at the barracks.

A total of 24 primary soil samples were analysed to assess the potential requirements for off-site treatment and disposal with the soil analytical results screened against current EPA Victoria Soil Hazard Categorisation and Management Guideline (Publication IWRG 621 – June 2009). Samples were submitted under chain of custody (COC) procedures to ALS Environmental Pty Ltd (primary laboratory) and Eurofins-MGT Pty Ltd (secondary laboratory). Both laboratories are NATA-accredited for the analysis requested.

Field observations during drilling did not identify any indications of landfilling. The concentrations of contaminants of concern were generally below laboratory levels of reporting (LOR) and the adopted waste classification criteria (IWRG 621). Data which exceeded the adopted waste classification criteria is summarised below:

- Twelve soil samples collected from nine locations exceeded the upper Fill Material threshold limits due to elevated concentrations of fluoride. This soil would be categorised as Category C. However, a number of lines of evidence suggest the fluoride is naturally occurring and there is a case for re-classification of those soils as Fill Material. The lines of evidence include:
  - The samples were from the Silurian siltstones
  - Elevated fluoride is commonly found in Silurian siltstones throughout Melbourne
  - The elevated fluoride occurs along the length of the alignment and there are no obvious sources of fluoride over such a large area
- Six samples reported lead concentrations indicating the need for leachate testing. Four were tested for leachability with the results indicating no detectable lead in the leachate.

5.3.7 Plants

Flora communities

Simpson Barracks contains a range of significant environmental values including Commonwealth and Victorian-listed flora as well as several Ecological Vegetation Classes (EVCs). A summary of ecological assessments conducted across the entire Simpson Barracks site includes:

- 52.5 hectares of remnant vegetation mapped
- 131 flora species have been recorded, including 66 indigenous and 65 exotic species.

Within the area proposed to be directly impacted at Simpson Barracks, the current study mapped five patches of native vegetation (10.976 hectares; 6.29 habitat hectares), 34 large trees in patches and 17 scattered trees (five large, 12 small). The area within Simpson Barracks that intersects with the project boundary comprises Plains Grassy Woodland (EVC 55).

Flora species

Flora of particular importance at the barracks are:

- A significant population of Matted Flax-lily *Dianella amoena* (Commonwealth and State listed) (see Section 5.1.1)
- A small population of Arching Flax-lily *Dianella longifolia var. grandis* (DELWP, vulnerable)
- A significant population of Studley Park Gum *Eucalyptus X studleyensis* (DELWP, endangered).

Ecological values mapped at Simpson Barracks are shown in Figure 5-10.

Arching Flax-lily Dianella longifolia var. grandis

Arching Flax-lily is not listed under the EPBC Act or the FFG Act. It is considered a vulnerable species under the DELWP Advisory List of Rare or Threatened Plants in Victoria – 2014 (DELWP Advisory List). It is a perennial graminoid that grows to 1.3-metres tall in solitary tufts or loose patches. Populations of this species are typically small and fragmented in Victoria, where it is mainly concentrated in the Victorian Volcanic Plain and Victorian Riverina bioregions.

During field surveys undertaken for the project, two individuals were identified at Simpson Barracks, although one of these is located outside the project boundary.

Studley Park Gum *Eucalyptus X studleyensis*

Studley Park Gum is a hybrid taxon and is not listed under the EPBC Act or the FFG Act. Studley Park Gum is classified as endangered under the DELWP Advisory list and is a hybrid between River Red Gum *Eucalyptus camaldulensis* and Swamp Gum *E. ovata*. It is morphologically variable and is distributed in the lower Yarra River corridor in Melbourne, primarily in the suburbs of Kew, Ivanhoe, Viewbank, Rosanna, Macleod, Watsonia, Yallambie, Plenty and Templestowe.

After exhibition of the PER, NELP undertook further field surveys within Simpson Barracks for the Studley Park Gum. It was observed to be sub-dominant to *E. camaldulensis* on low relief mid to lower slopes in Plains Grassy Woodland east of Greensborough Road. In total, 44 trees were identified to be located within the project boundary at Simpson Barracks. Of these, the majority were observed to be between 25 and 80 cm DBH (60%), and were observed to be in good condition (89%). As part of the surveys, juveniles were unable to be positively identified due to the lack of bud material. The survey of Studley Park Gum was extended outside of the project boundary, and a further 83 trees were identified at Simpson Barracks.

Groundwater dependent ecosystems (GDEs)

Parts of the Plains Grassy Woodland within Simpson Barracks are mapped as a GDE ('GDE – subsurface expression' [BOM] and 'GDE' [PPWCMA]). The dominant tree species are River Red Gum in the lower western section closest to the project boundary, in association with Yellow Box and Studley Park Gum.

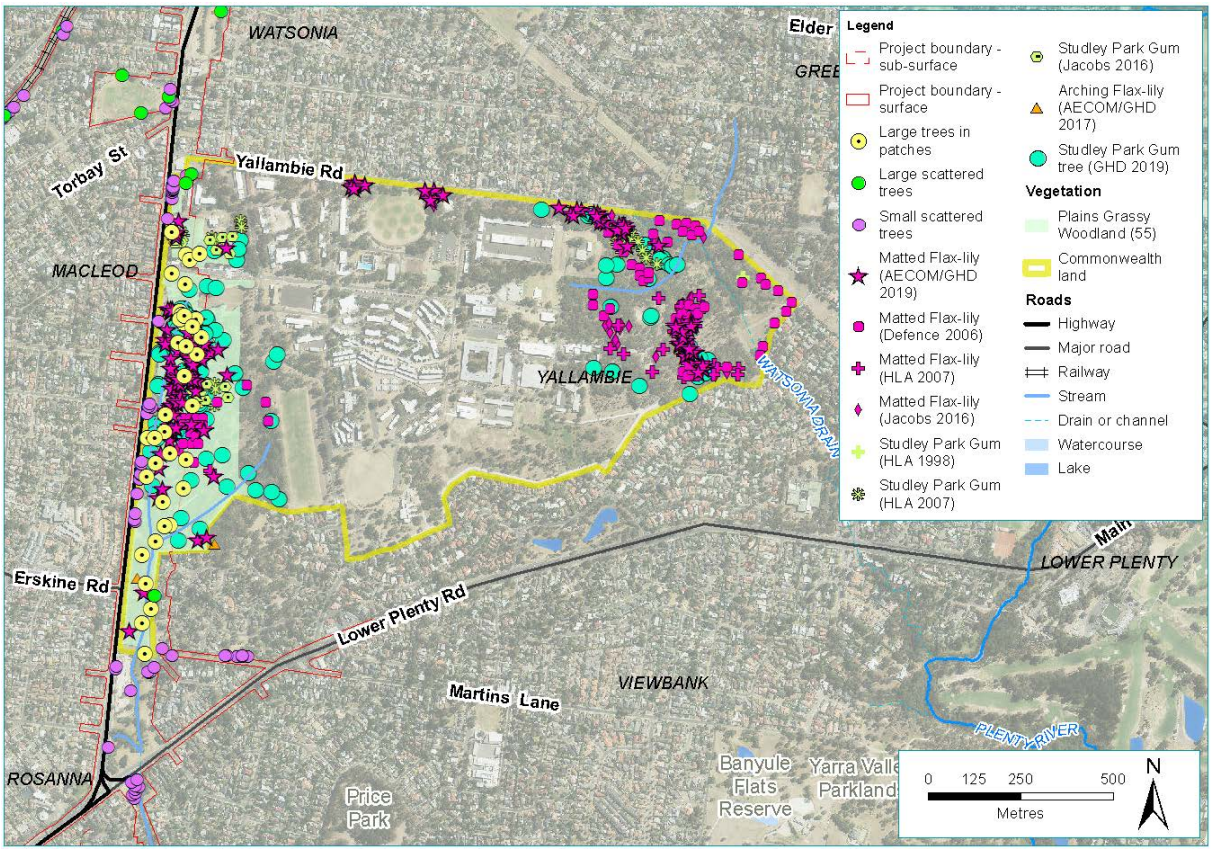


Figure 5-10 Summary of vegetation assessments at Simpson Barracks

5.3.8 Animals

Terrestrial fauna

Simpson Barracks contains relatively large areas of remnant woodland in an urbanised landscape and so likely attracts and supports a range of terrestrial fauna. However, because it is surrounded by urbanisation and has been considerably disturbed historically, the woodland is generally degraded and consequently unlikely supports the full range of threatened and non-threatened fauna that would have occurred there historically.

Habitats at the Simpson Barracks have moderate value for fauna. Patches of woodland (remnant, regrowth or planted) of this size within the Melbourne area tend to be characterised by bold, common and adaptable fauna (such as Red Wattlebird, Rainbow Lorikeet, Noisy Miner, Common Ringtail Possum (*Pseudocheirus peregrinus*), Common Brushtail Possum (*Trichosurus vulpecula*)). These can be aggressive and outcompete other native fauna.

Other non-threatened species that are reasonably common but more notable in the Melbourne area also likely visit Simpson Barracks. These include Common Bronzewing (*Phaps chalcoptera*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Horsfield's Bronze-Cuckoo (*Chrysococcyx basalis*), and Olive-backed Oriole (*Oriolus sagittatus*)). Habitats at Simpson Barracks may also occasionally or rarely attract threatened fauna such as Powerful Owl (*N. strenua*), Swift Parrot (*Lathamus discolor*) and the Grey-headed Flying-fox (*Pteropus poliocephalus*); although this is likely to be for foraging only and these species are not expected to breed or roost at the barracks frequently or regularly.

Previous assessment of Simpson Barracks identified potential habitat for three threatened fauna: Swift Parrot (*Lathamus discolor*), Grey-headed Flying-fox (*Pteropus poliocephalus*) and Brown Toadlet (*Pseudophryne bibroni*) (Jacobs, 2016).

HLA-Envirosciences Pty Ltd (2007) assessed flora and fauna at the site in September 2006, including Elliot and pitfall trapping for fauna. During that assessment, no Swift Parrots, Grey-headed Flying-foxes or Brown Toadlets were seen or heard, no small mammals were captured, and no threatened reptiles were detected.

Species that are unusual/rare in the Melbourne area, such as Grey Goshawk (*Accipiter novaehollandiae*), Black Falcon (*Falco subniger*), Barking Owl (*Ninox connivens*) and the White-throated Needletail (*Hirundapus caudacutus*) may visit the Barracks occasionally, but are unlikely to visit regularly, or depend on habitat at the site. Due to historical ground disturbance and vegetation clearance, native small mammals are not expected to persist at Simpson Barracks, a conclusion also reached by HLA (2007). Dense grassy habitats at Simpson Barracks are still likely used by common species of reptiles such as Tiger Snake (*Notechis scutatus*) and Common and Blotched Blue-tongued Lizards (*Tiliqua scincoides* and *T. nigrolutea*).

The woodland and grassland habitats at Simpson Barracks support a small population of Eastern Grey Kangaroos (*Macropus giganteus*) and are used by other notable fauna such as Swamp Wallaby (*Wallabia bicolor*), Short-beaked Echidna (*Tachyglossus aculeatus*) and the Common Wombat (*Vombatus ursinus*).

Results of the habitat assessment and targeted surveys undertaken at Simpson Barracks and upper reaches of Banyule Creek are summarised in Table 5-6.

Aquatic fauna

Simpson Barracks contains the headwater of Banyule Creek. The waterway habitats in the headwaters of Banyule Creek support very poor aquatic ecosystem conditions, as indicated by the very low diversity and the pollution tolerance of the macroinvertebrate community collected in the Rapid Bioassessment. There is no suitable habitat for fish in Banyule Creek at Simpson Barracks.

Away from the main channel of Banyule Creek, a number of constructed wetlands are present. These receive runoff from catch drains and appear to contain permanent water. These wetlands may provide good habitat for small bodied fish, although fish surveys did not detect any fish.

Targeted surveys were undertaken in Banyule Creek and wetlands at Simpson Barracks for Dwarf Galaxias (*Galaxiella pusilla*), based on the possibility that an isolated population may occur in this protected habitat. No Dwarf Galaxias or any other fish were detected at Simpson Barracks. No EPBC Act-listed fish species are expected to occur at Simpson Barracks.

Table 5-6 Summary of results of habitat assessment and targeted fauna surveys undertaken at Simpson Barracks and the upper reaches of Banyule Creek

Site	Species common name	Species scientific name	EPBC	FFG	DELWP	Habitat assessment	Targeted round 1	Targeted round 2	Other species recorded
Simpson Barracks (includes upper reach of Banyule Creek)	Brown Toadlet and Southern Toadlet	*Pseudophryne bibroni/P. semimarmorata*		L	EN	4/06/2018	4/06/2018*	N	Common Froglet (*Crinia signifera*)
	Growling Grass Frog	*Litoria raniformis*	VU	L	EN	2/11/2017	2/11/2017*	N	Common Froglet (*Crinia signifera*)
	Latham's Snipe	*Gallinago hardwickii*	Mi			2/11/2017	N	N	No other wetland birds
	Powerful Owl	*Ninox strenua*		L	EN	2/11/2017	2/11/2017*	N	No other nocturnal birds
	Swift Parrot	*Lathamus discolor*	CR	L	EN	2/11/2017	N	N	No threatened species

CR – Critically endangered; EN – endangered; VU – vulnerable; L – listed as threatened; Mi – Migratory; N – not undertaken (site deemed not suitable for species).

* One nocturnal survey undertaken anyway (despite habitat considered unsuitable) because survey was planned well in advance and ecologists were present.

5.3.9 People and communities

This section describes the social environment as relevant to actions on Commonwealth land. Commonwealth land is within the Banyule municipal boundary and is bound by the Yarra River to the south and the Darebin Creek to the west.

Defence community of Simpson Barracks

Simpson Barracks is a working army barracks and training facility. Personnel associated with the Barracks includes 672 full-time defence personnel, 431 reservists, 1,000 trainees, 100 cadets, 80 public servants and 80 contractors. Based on consultation with Defence, it is understood the majority of full-time Defence personnel live within the surrounding community (within 30 minutes commute). Ten to 15 per cent of full-time personnel live at Simpson Barracks. All trainees are housed there. Accommodation at the barracks is single quarters. The barracks provides accommodation for 1,000 personnel, with surge capacity for an additional 200 personnel.

Simpson Barracks is owned by the Department of Defence and has varied uses including buildings for accommodation, offices, training facilities, and for recreational activities, as shown in Figure 5-7. The barracks also accommodates a number of facilities including hairdressers, a bank and a chapel. There are also active open space land uses (Long Green, Silcock Oval and Main Oval) and passive open spaces such as the Banyule Creek area and Rentons Ridge.

Further south of the barracks is Commonwealth land adjacent to Greensborough Road that is unfenced and open to the public. This area of land is generally characterised by a continuation of the vegetation on the barracks land and is part of Banyule Creek.

5.3.10 Heritage

Non-indigenous heritage

Simpson Barracks

Simpson Barracks, formerly Watsonia Army Barracks, was established in 1943 on an initial 40.5-hectare site as a training facility. In 1951, an additional 59.5 hectare area was purchased and incorporated into the facility, which grew to include a number of additional headquarters and support facilities.

Buildings and structures from World War 2 were removed and replaced in major construction programs in the 1950s and 1960s, as well as more recently. A portion of the original land acquisition was separated in 1996 for the Streeton Views Estate. The majority of buildings on the site are in the centre and northern parts, within a bushland setting.

The western margin of the barracks which was not developed was used for grazing up until the 1940s, reportedly contained a nine-hole golf course until the late 1980s. The land has been subject to natural regeneration as well as planned revegetation works by the Department of Defence. While forming part of the barracks complex, no specific historical heritage associations or values have been identified with respect to this vegetation.

There are no heritage places on Commonwealth land which have been recognised through statutory listing and controls. However, the Victorian War Heritage Inventory (VHWI), a non-statutory register, includes reference to the Simpson Barracks as a whole, as well as to two elements on the site. These are the residence Aldermaston and the Watsonia Simpson Barracks Memorial in Watsonia. Two more non-statutory places, the Assembly Place and Lone Pine Commemorative Plantings located near Blamey Road, are present within the action's area of direct impact, as well as Building 147 Which is located at the far east side of the barracks.

Aldermaston

Aldermaston (former Ainslie Meares House) was constructed in 1936 and incorporated into Simpson Barracks in 1951. The residence is presently used by the Defence School of Music Aldermaston and is in the southern part of the barracks, adjacent to the present-day Streeton Views residential subdivision. Aldermaston was designed by architect Les Forsyth and constructed in an Old English style with decorative panels of clinker brick, steep slate-clad gabled roofs and a variety of embellishments. Aspects of the original residential landscape remain, including the tree-lined front drive and turning circle, stone terraced rear garden and remnants of the former orchard.

Aldermaston has been the subject of several heritage assessments, and most assessments have concluded it is a place of local significance.

Watsonia Simpson Barracks Memorial

The Simpson Barracks Memorial consists of a maturing Lone Pine tree planted at the head of a small parterre. The parterre consists of a cross-shaped, concrete-walled planter raised above a bed of gravel, with the Long Pine planted above the cross. A short flagpole is positioned just to the west of the parterre, adjacent to the footpath.

ANZAC Day services were held at the memorial until the services became too large for the space. Services are now held elsewhere at the barracks.

Assembly Place and Lone Pine Commemorative Plantings

An informal assembly place is south of the Blamey Road entrance to the barracks. This assembly place was formerly used for ANZAC services although these were discontinued in 2016 and moved to another location at the barracks. The place consists of a sloping lawn terminating at a small constructed mound with a flagpole on top, which is framed by two Aleppo Pine (*Pinus halepensis*) trees planted in 2005. Each pine has a plaque at its base, comprising engraved steel mounted on rough-hewn slabs of bluestone.

The Assembly Place and Lone Pine Commemorative Planting is considered to be significant as a contributing element to the local historical values of Simpson Barracks as a whole and as an individual element of potential social value to those associated with the barracks.

Building 147

Building 147 is a former satellite communications facility constructed in a joint US and Australian venture in the north-eastern corner of Simpson Barracks. The communications facility was decommissioned in 1995 and was repurposed to house a Signals Museum. Building 147 was identified as having local historical significance.

Aboriginal heritage

North East Link is located within the traditional language area of the Woi wurrung language group. The *Woi wurrung* clan most closely associated with the study region were the *Wurundjeri willam*, who identify with the Yarra River and Plenty River. Simpson Barracks contains a single watercourse (Banyule Creek) which would have contained a variety of food and medicinal resources that Aboriginal people would have used.

A search of the Victorian Aboriginal Heritage Register (VAHR) indicated three Aboriginal cultural heritage places are registered within 500 metres of the action on Commonwealth land, which are listed in Table 5-7. These comprise three scarred trees, although based on consultation with the Registered Aboriginal Party, two of the scarred trees are likely to be deregistered.

A further nine registered Aboriginal cultural heritage places are located on Commonwealth land outside the 500 metres nearest the action. These places consist of four artefacts scatters and five scarred trees.

Table 5-7 Aboriginal places, previously registered on Commonwealth land

VAHR	Name	Component number	Component type	Location
7922-0584	SAB 8	7922-0584-1	Scarred tree (likely to be deregistered)	Within 500 m of action
7922-0585	SAB 9	7922-0585-1		Within 500 m of action
7922-0586	SAB 10	7922-0586-1	Scarred tree	Within 500 m of action
7922-0577	SAB 1	7922-0577-1	Artefact scatter	Eastern side of barracks
7922-0578	SAB 2	7922-0578-1	Artefact scatter	Eastern side of barracks
7922-0579	SAB 3	7922-0579-1	Artefact scatter	Eastern side of barracks
7922-0580	SAB 4	7922-0580-1	Artefact scatter	Eastern side of barracks
7922-0581	SAB 5	7922-0581-1	Scarred tree	Southern edge of barracks
7922-0582	SAB 6	7922-0582-1	Scarred tree	Southern edge of barracks
7922-0583	SAB 7	7922-0583-1	Scarred tree	Southern edge of barracks
7922-0587	SAB 11	7922-0587-1	Scarred tree	Southern edge of barracks
7922-0588	SAB 12	7922-0588-1	Scarred tree	Southern edge of barracks

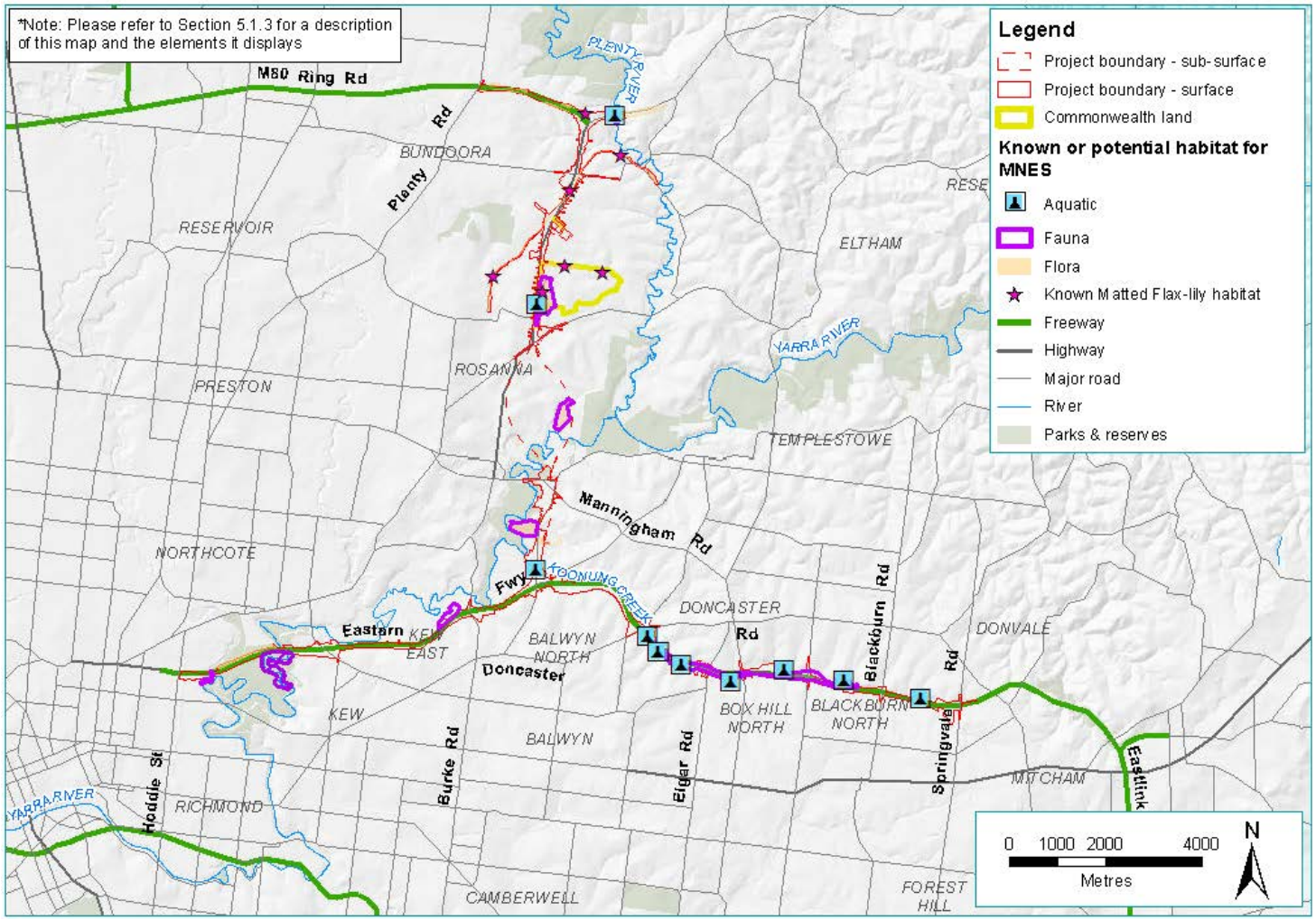
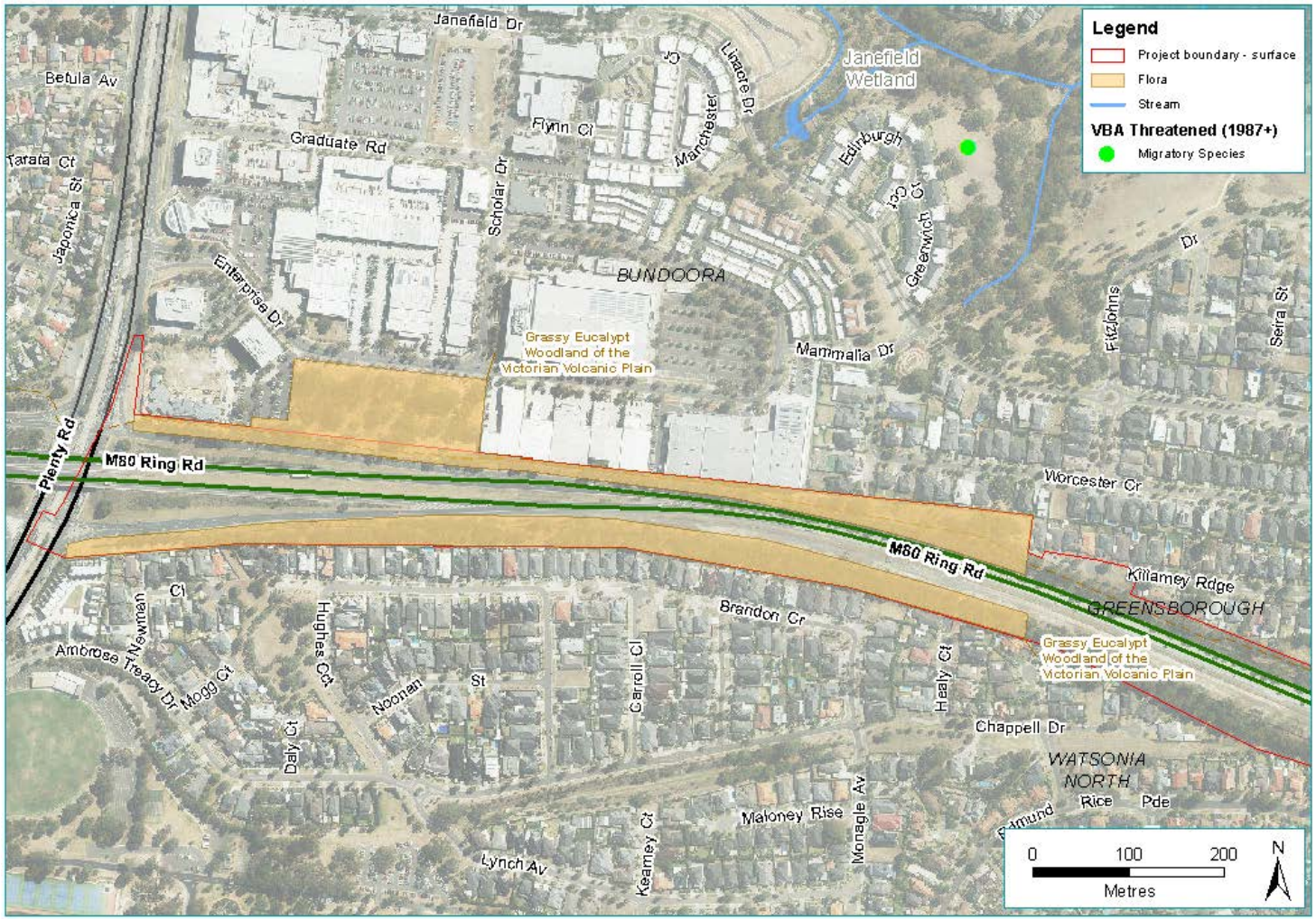


Figure 5-11(a) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land



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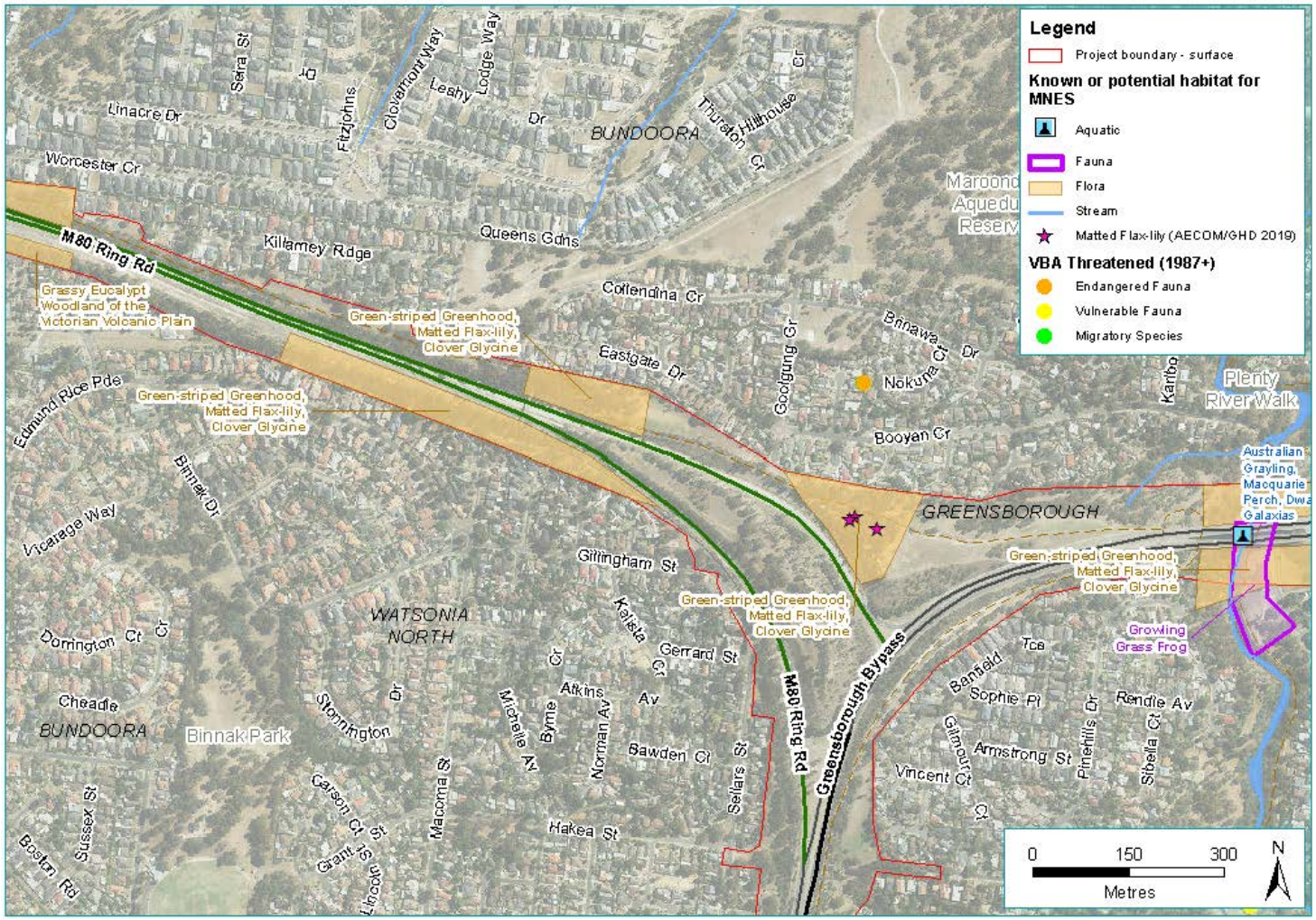

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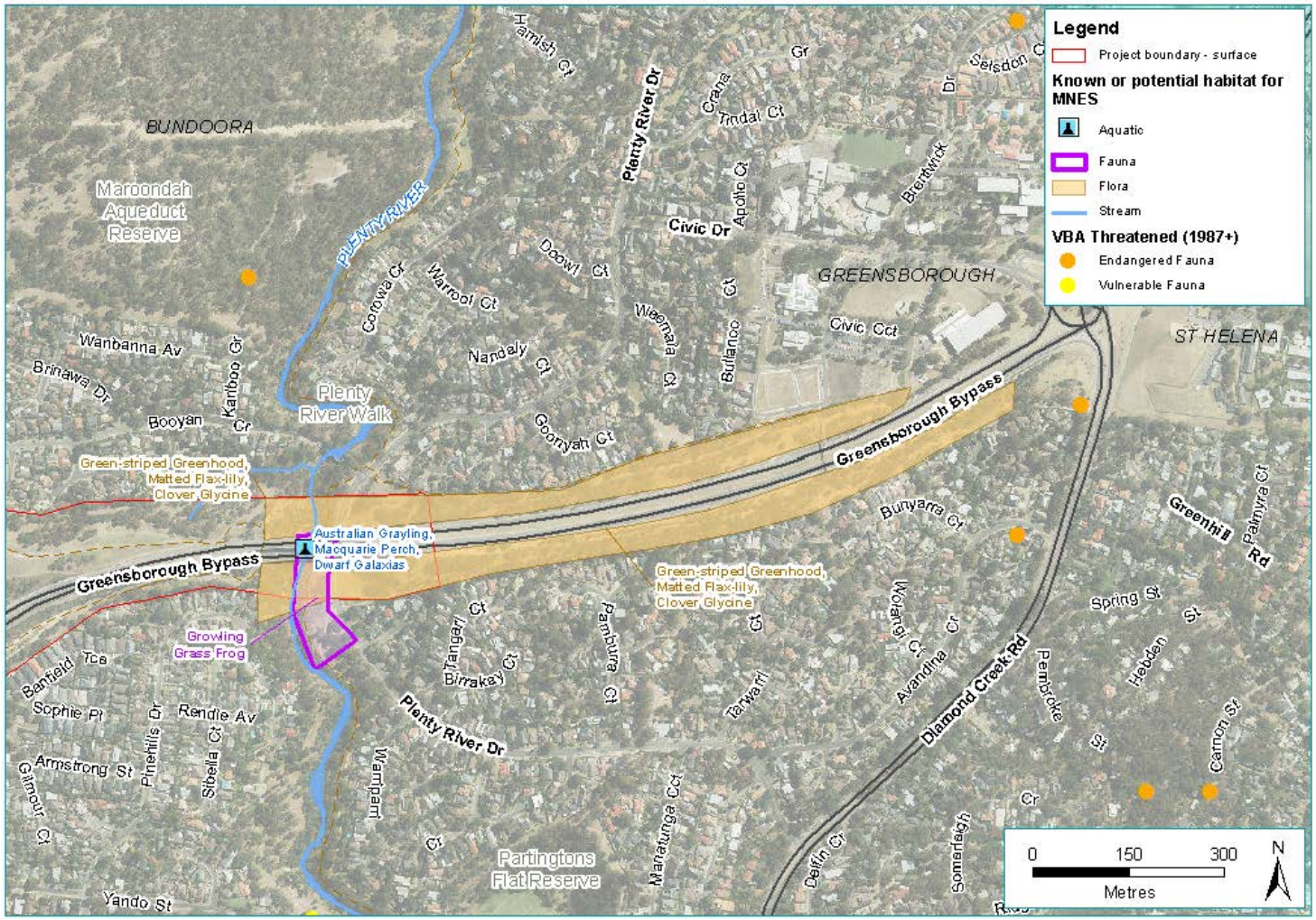

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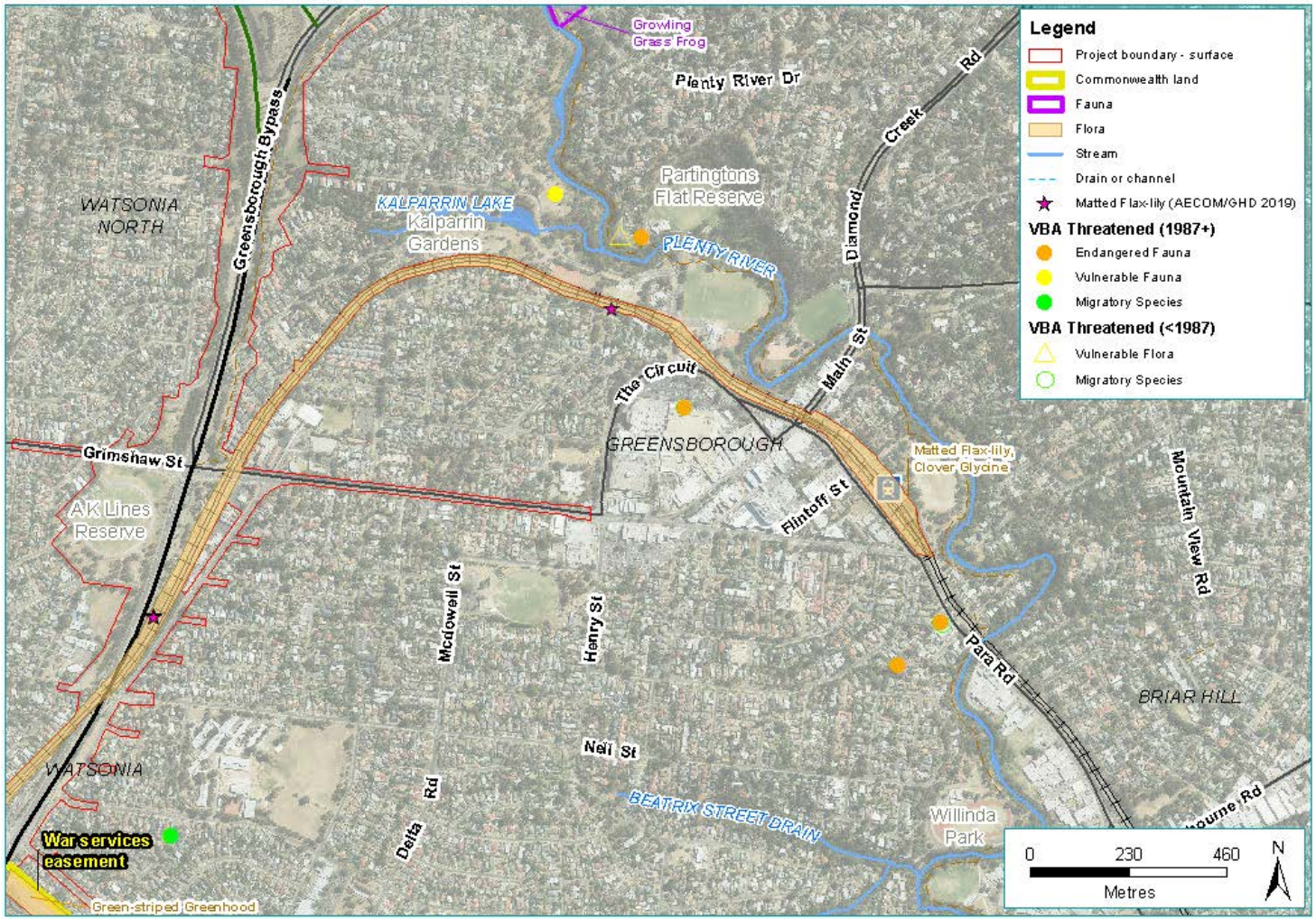

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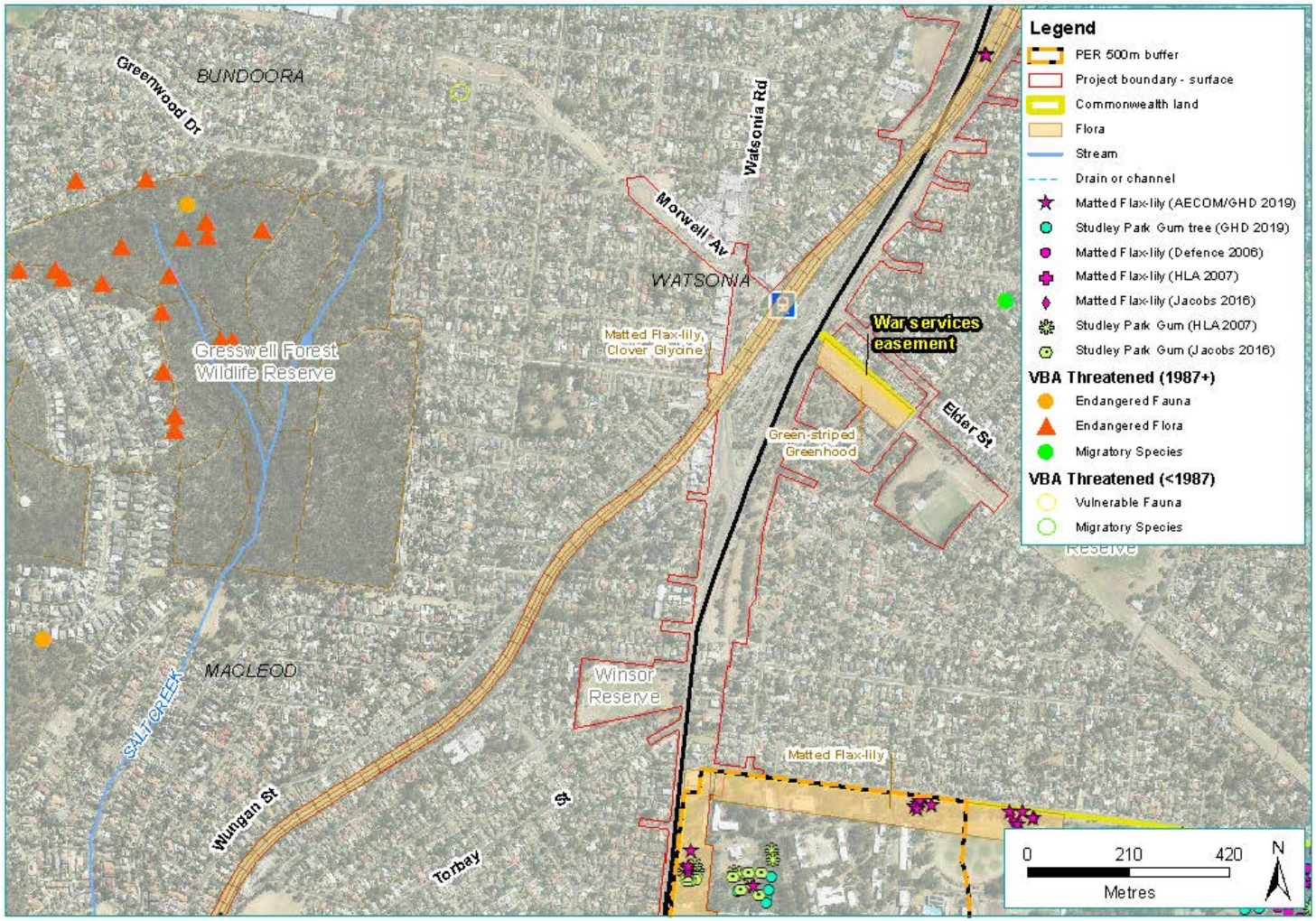

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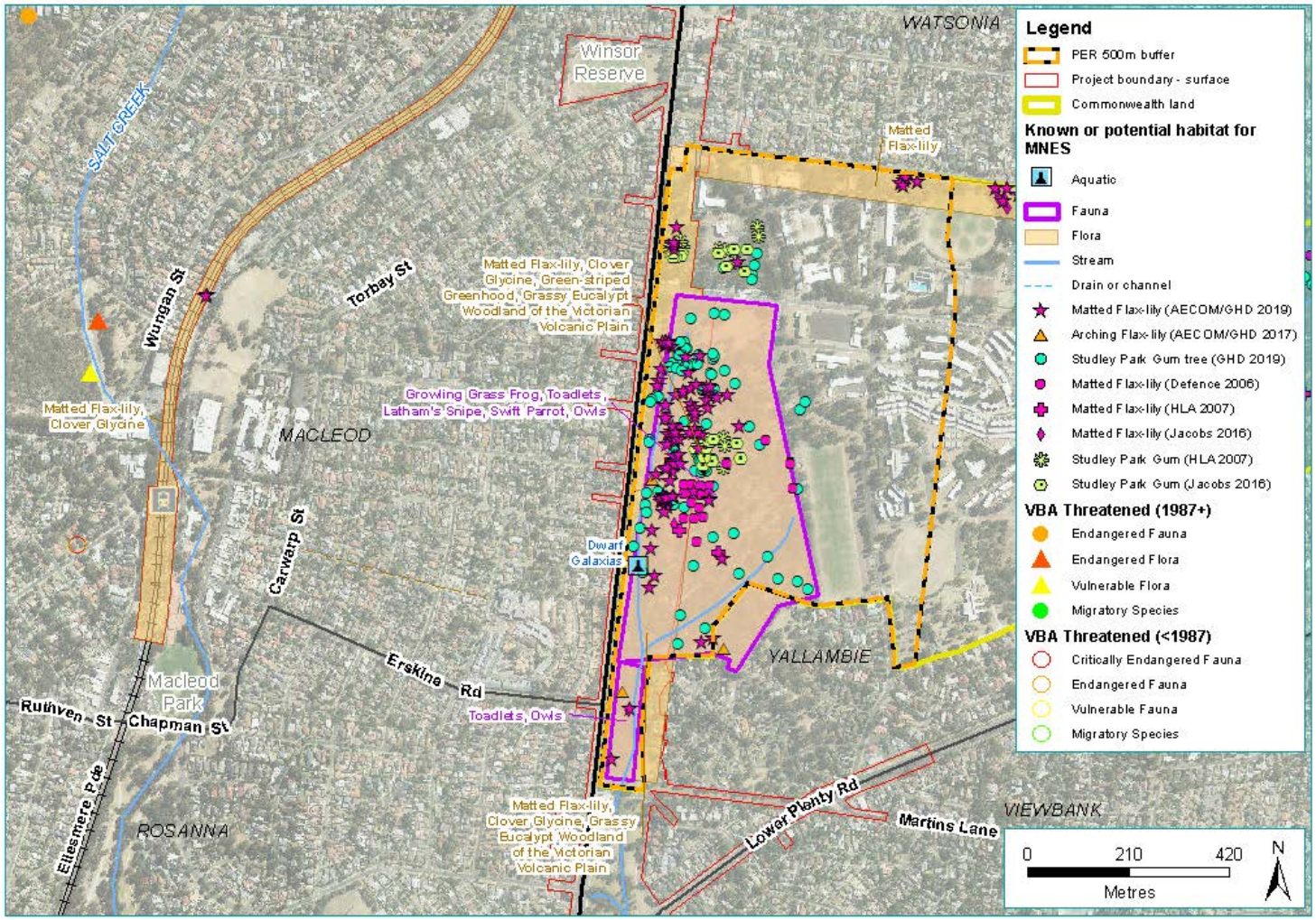
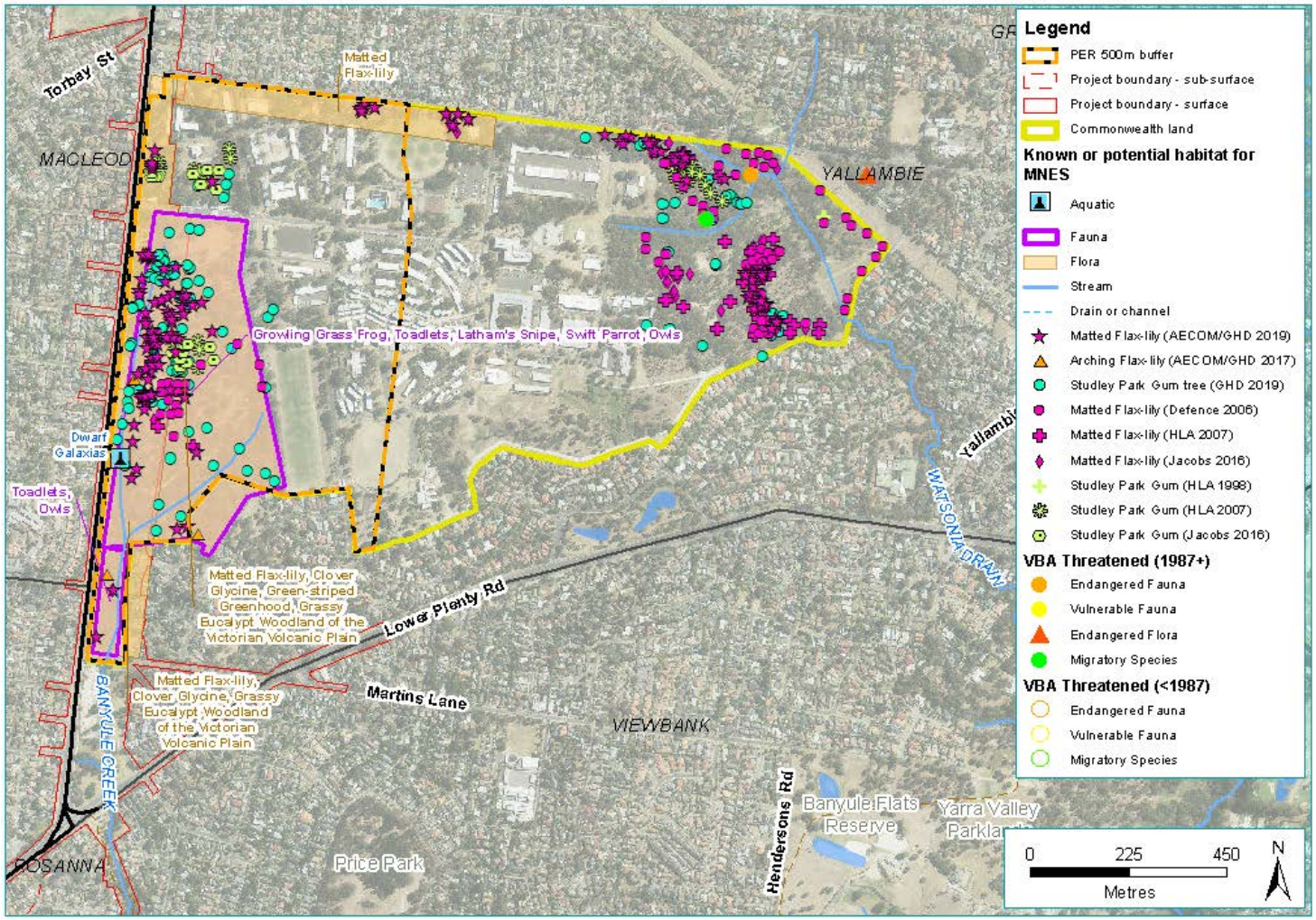


Figure 5-11(g) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land



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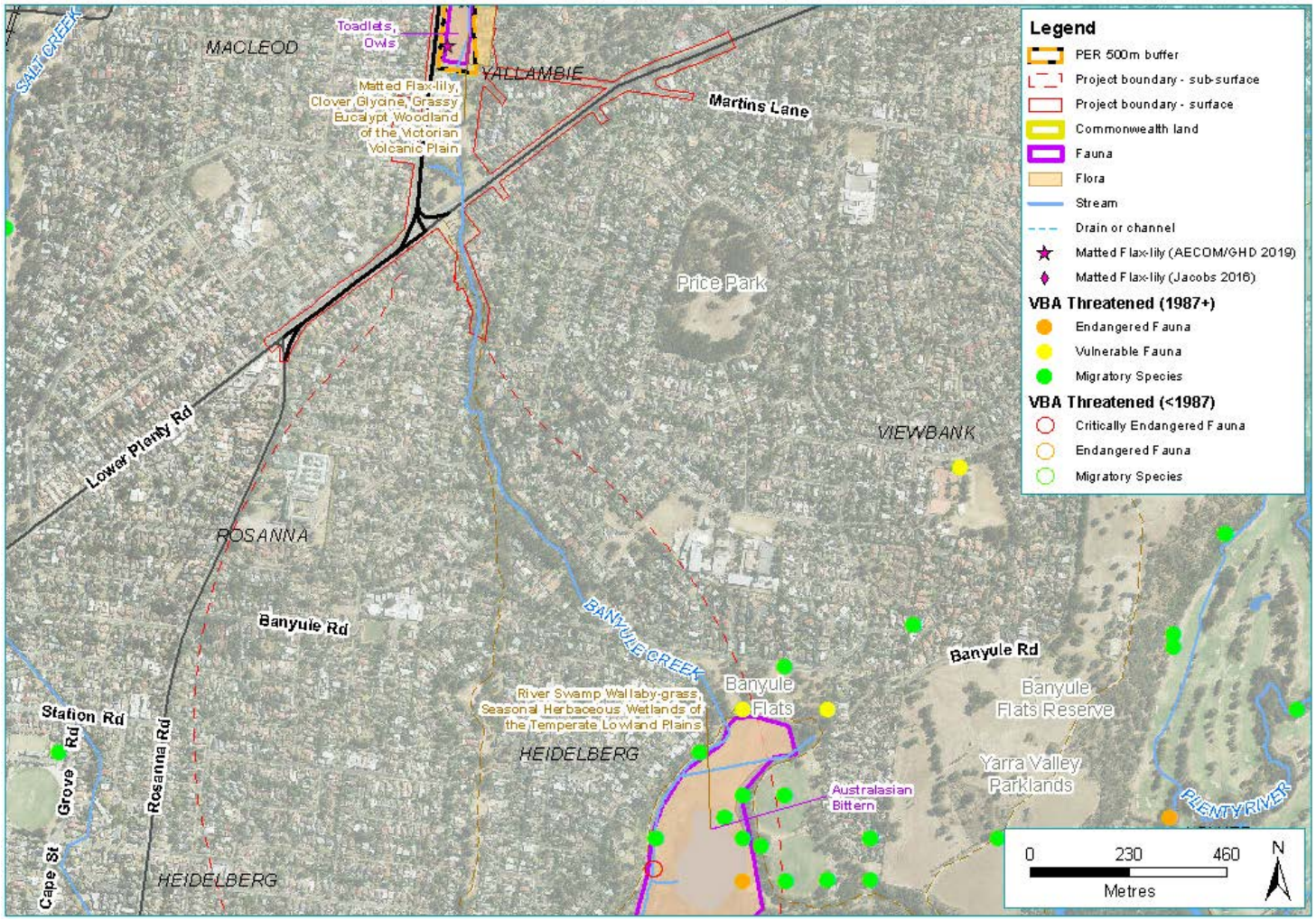


Figure 5-11(i) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land

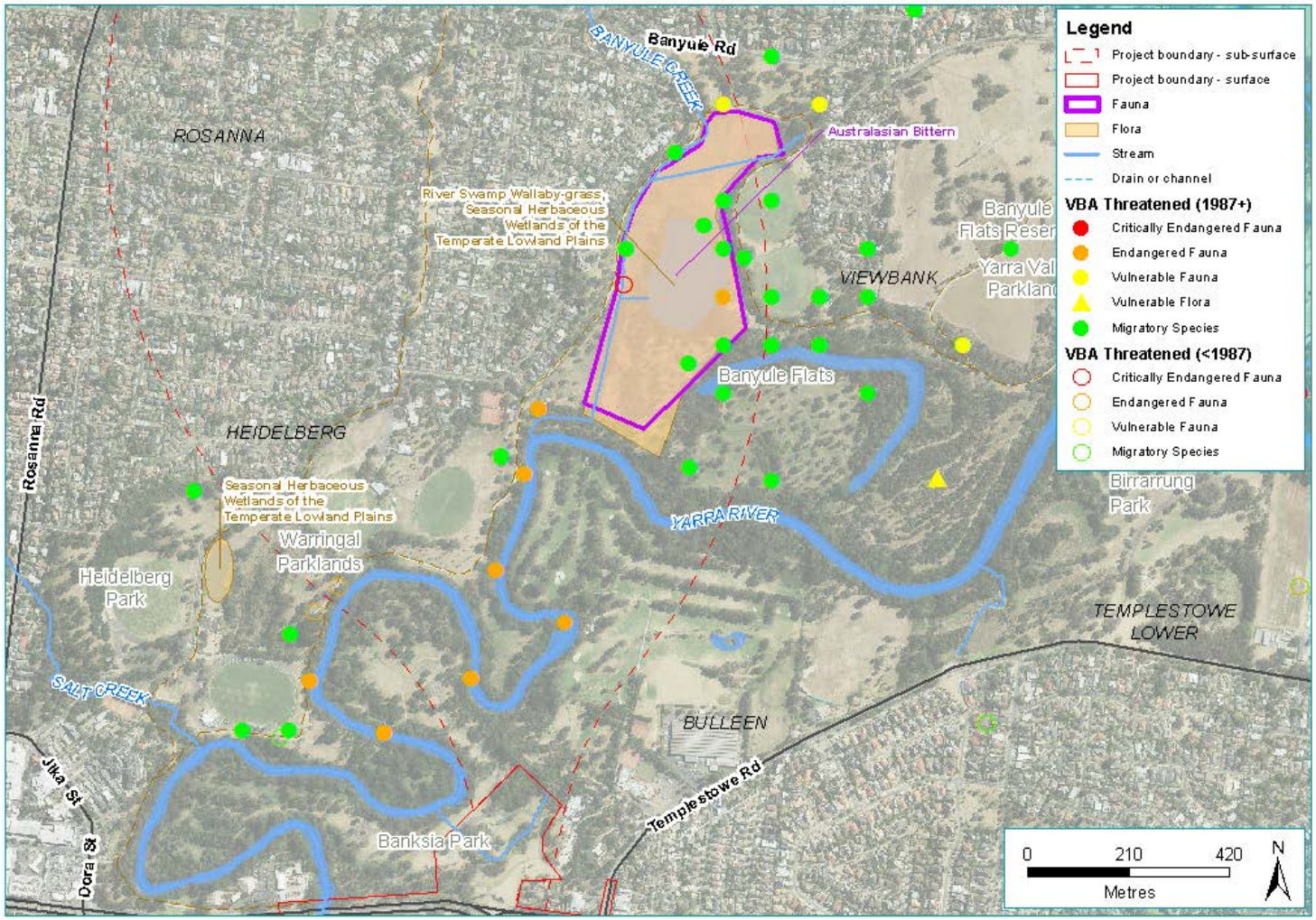


Figure 5-11(j) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land

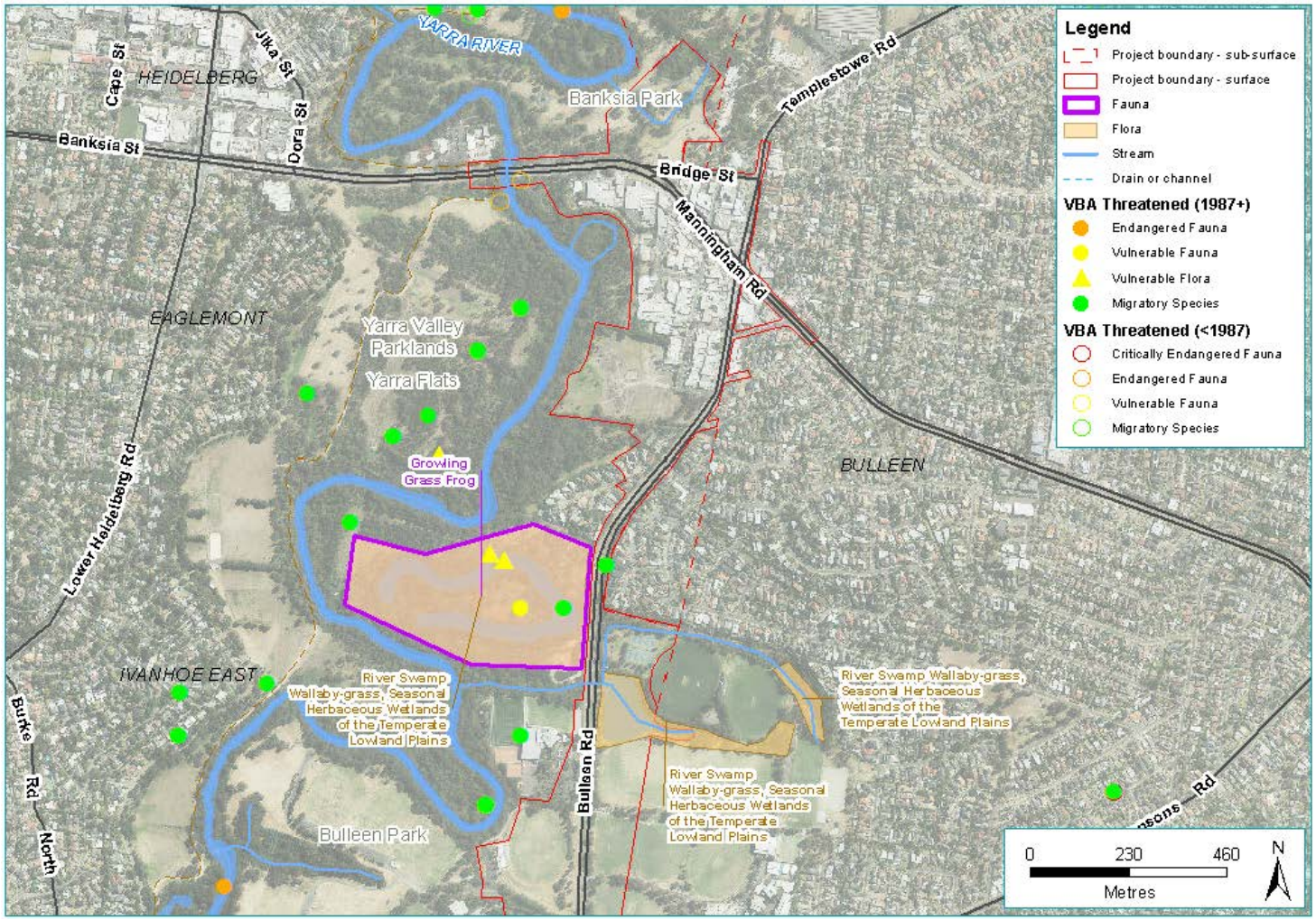
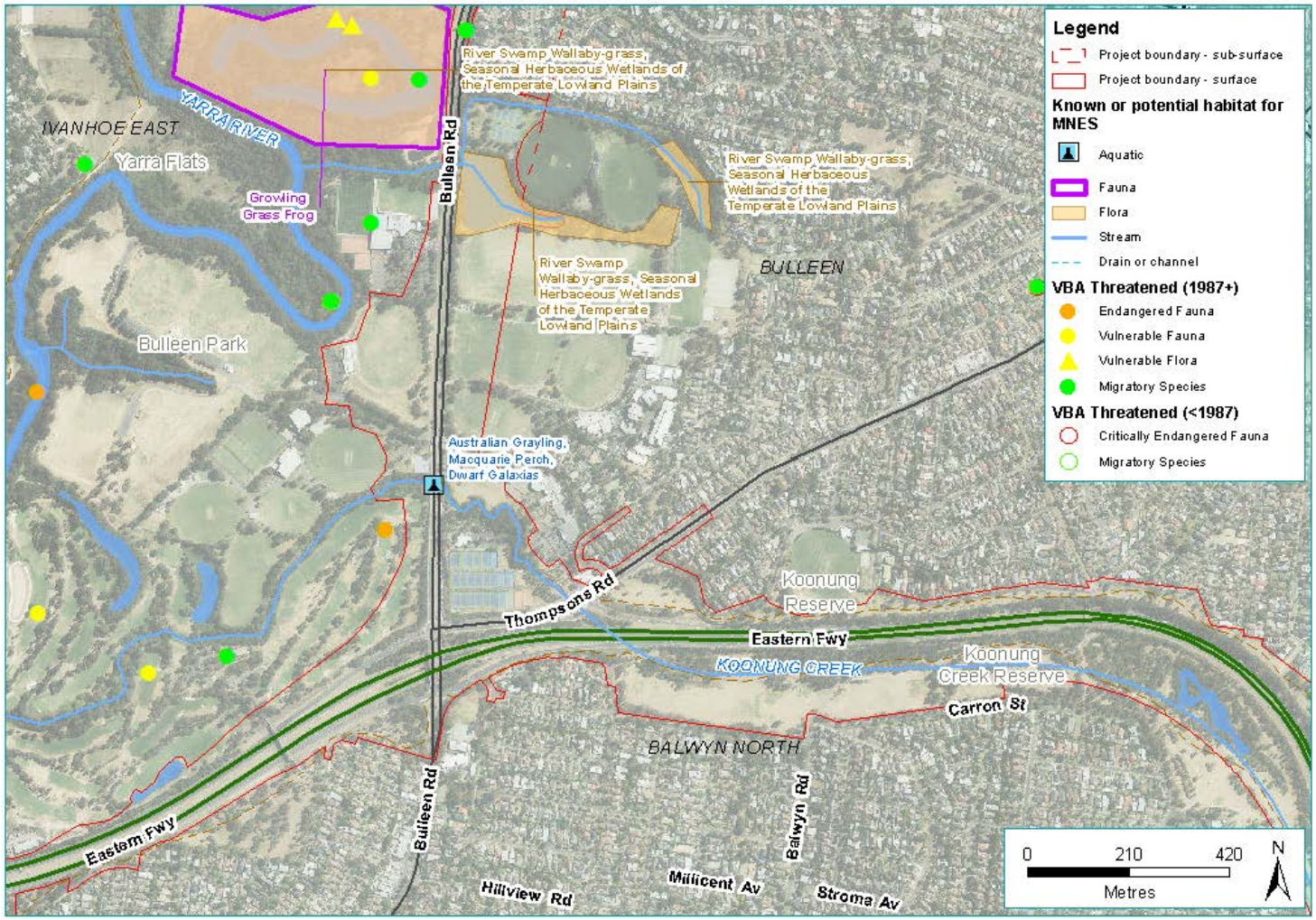


Figure 5-11(k) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land



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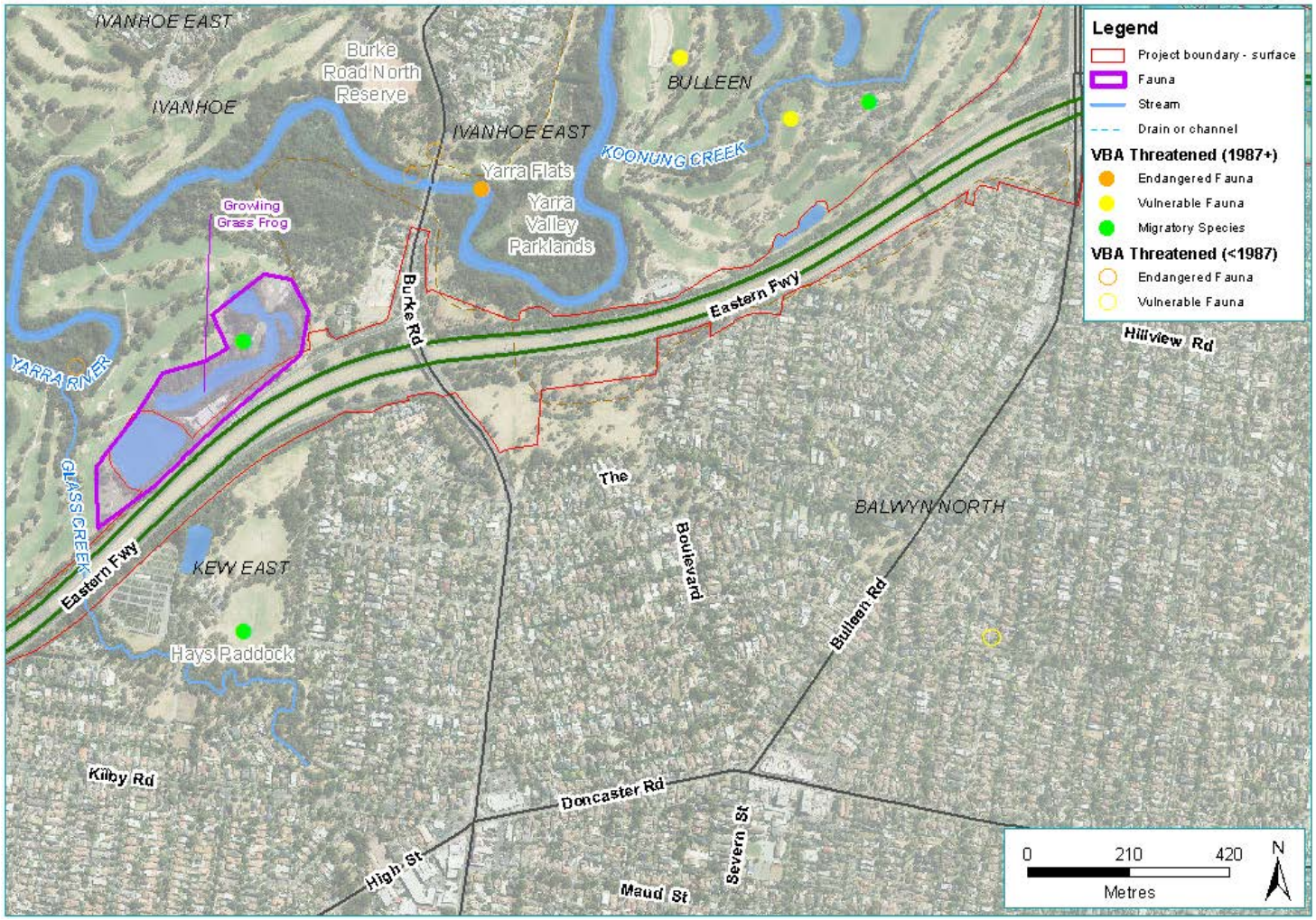

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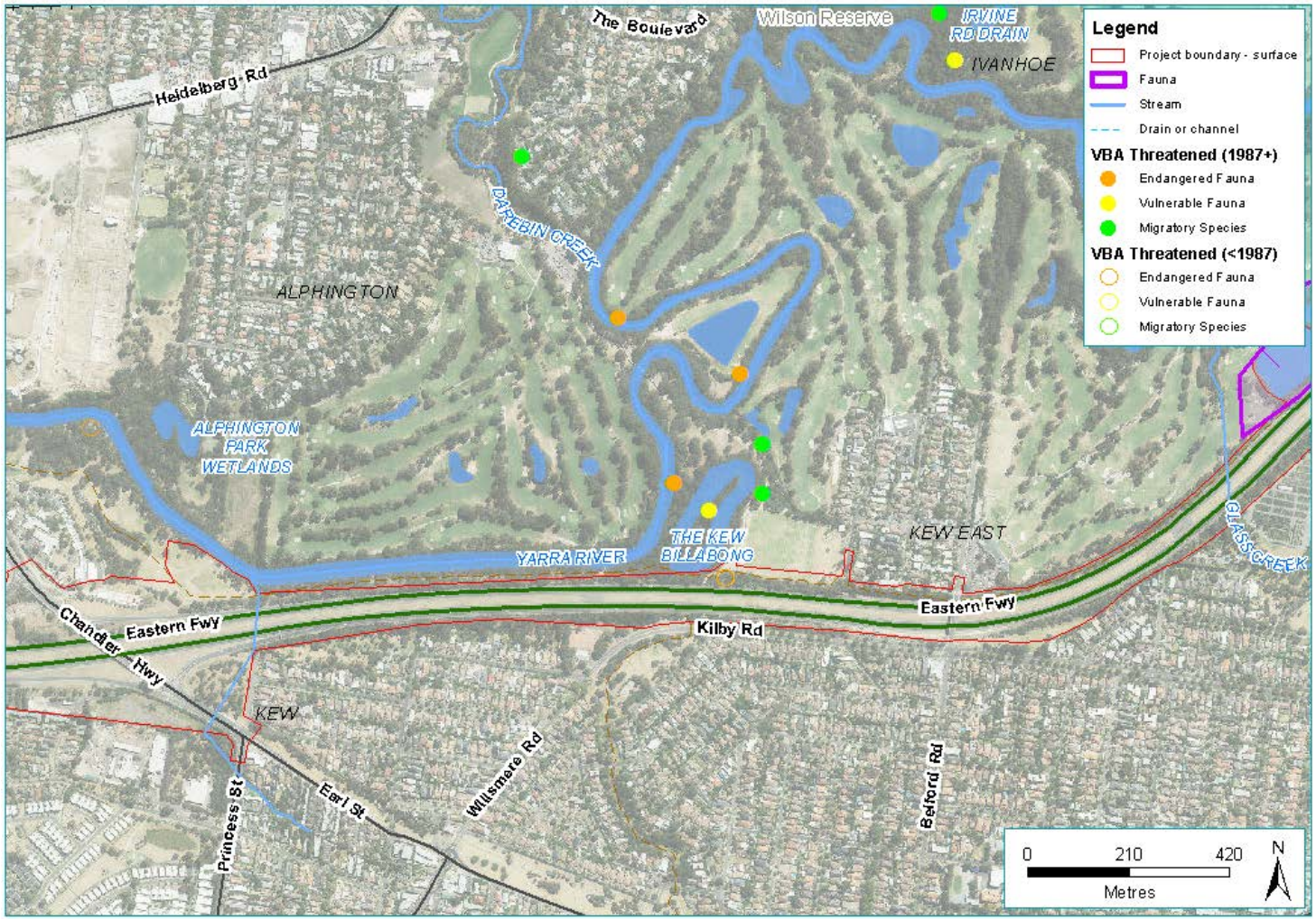

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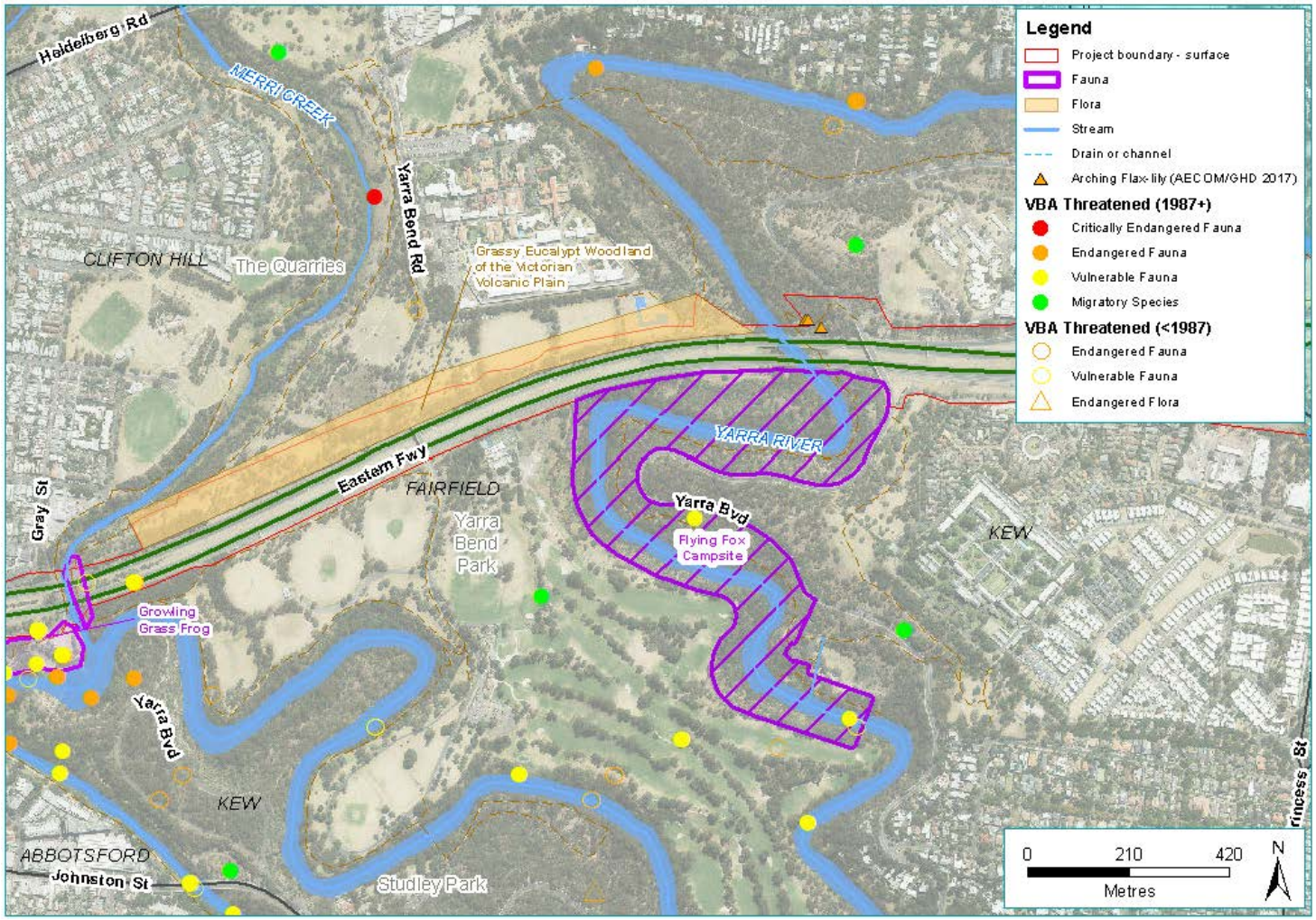
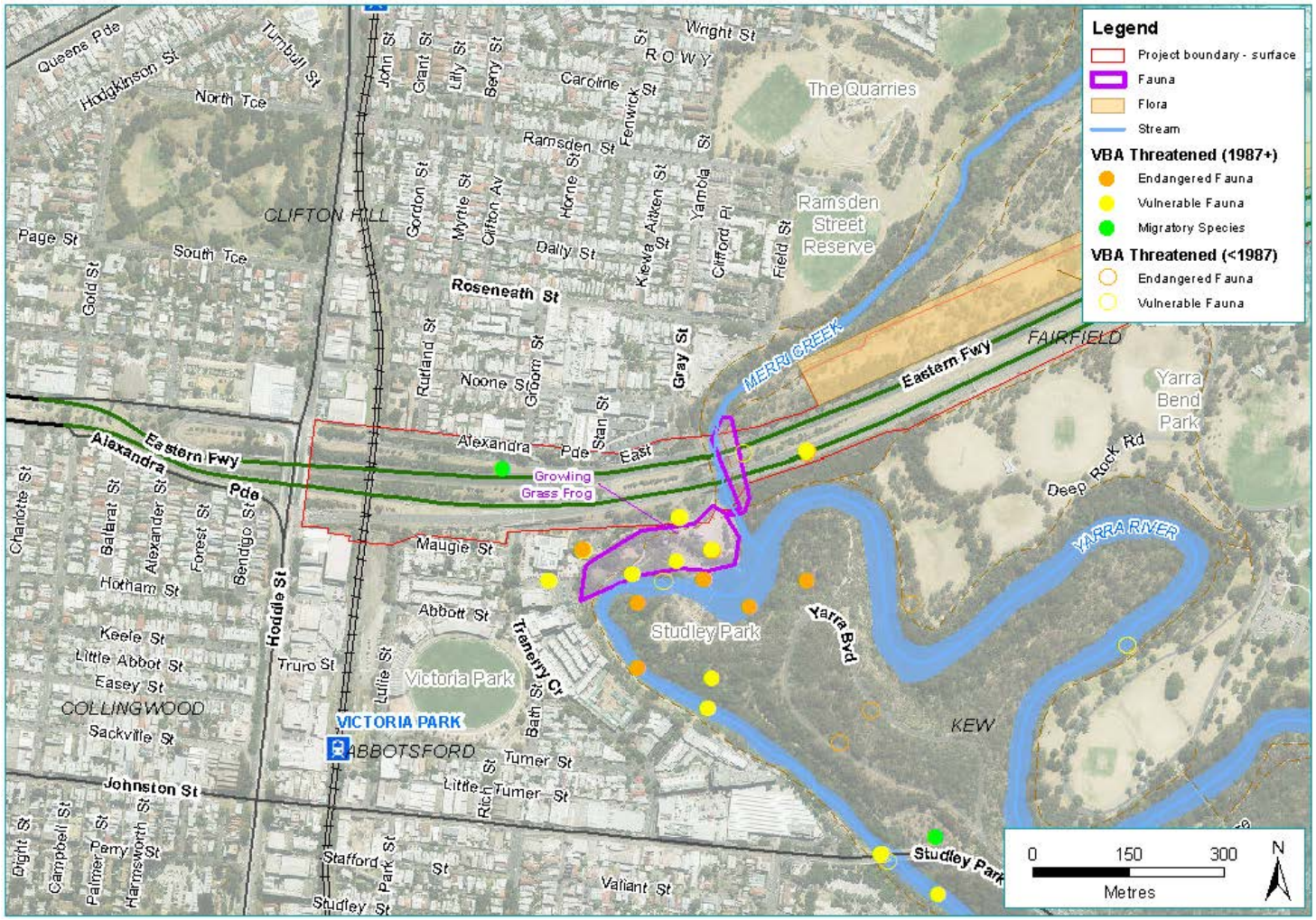


Figure 5-11(o) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land



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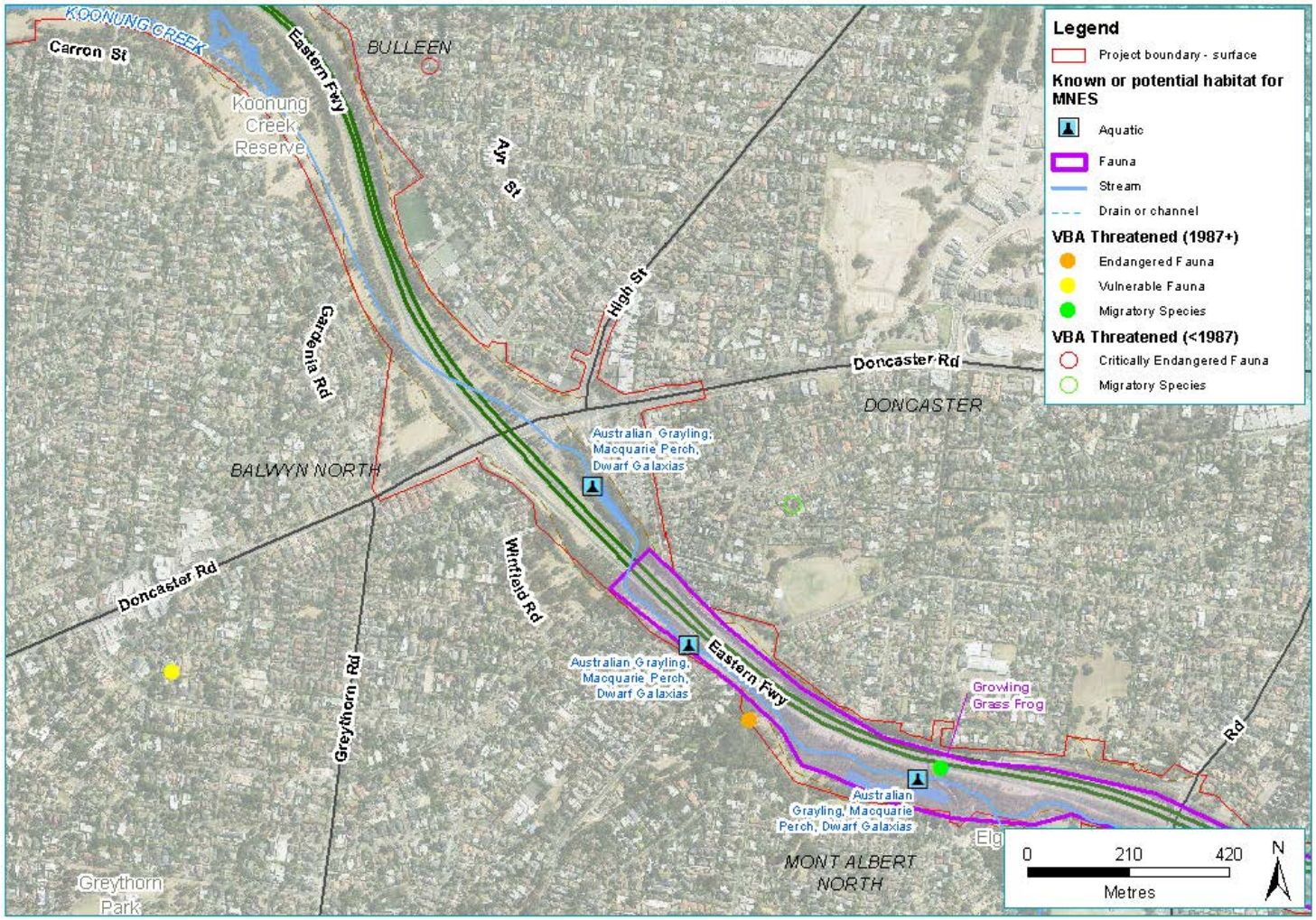

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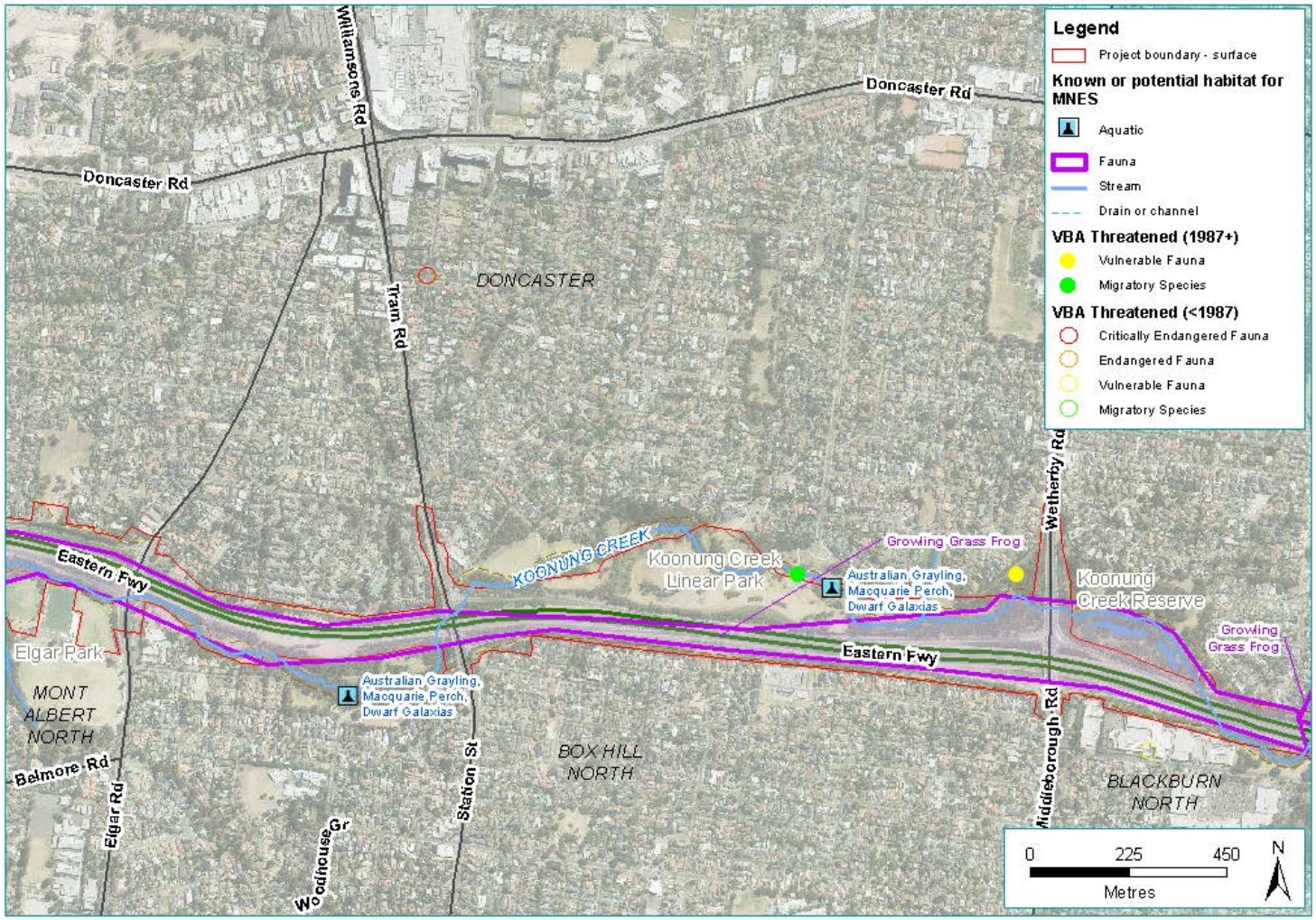

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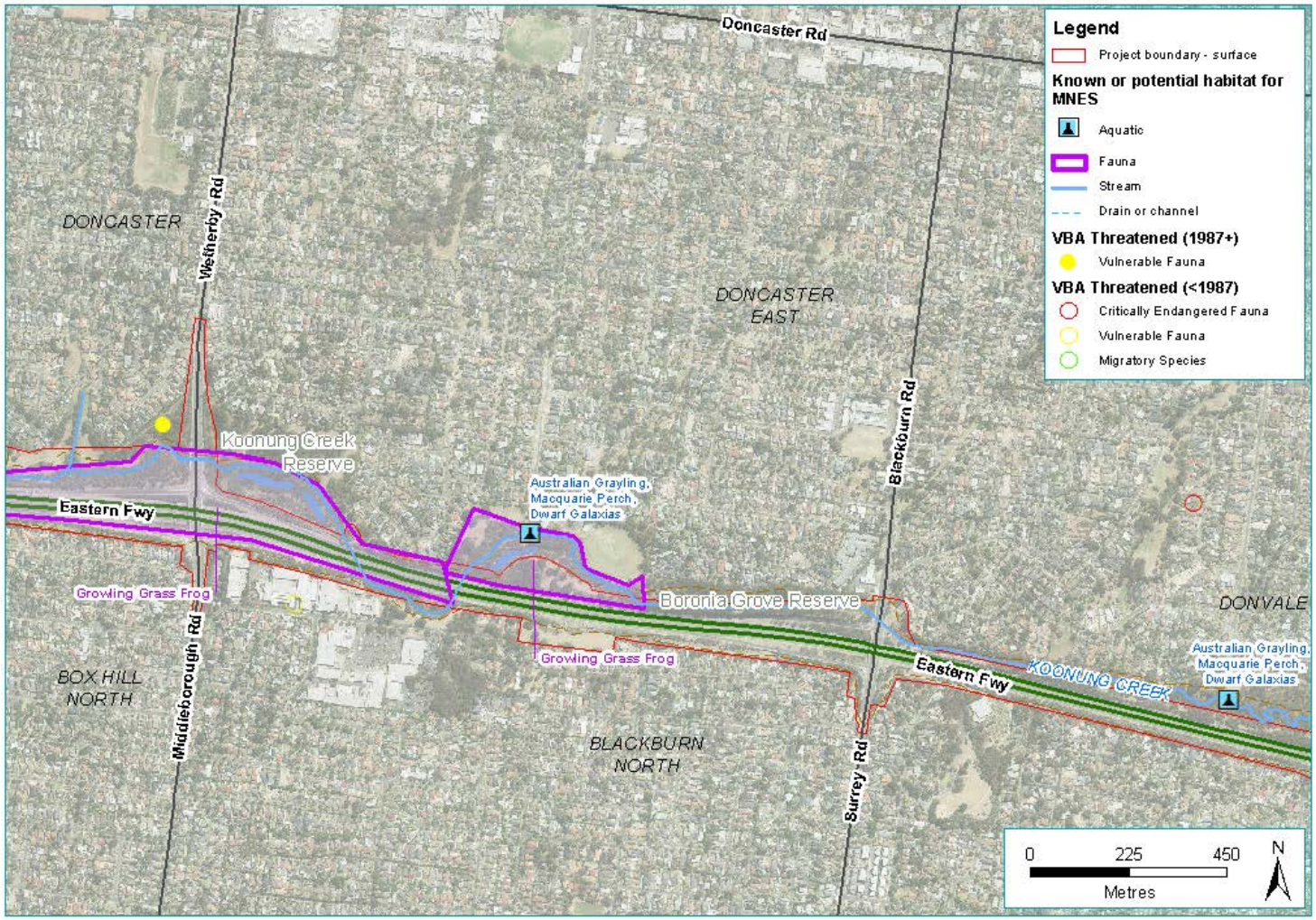

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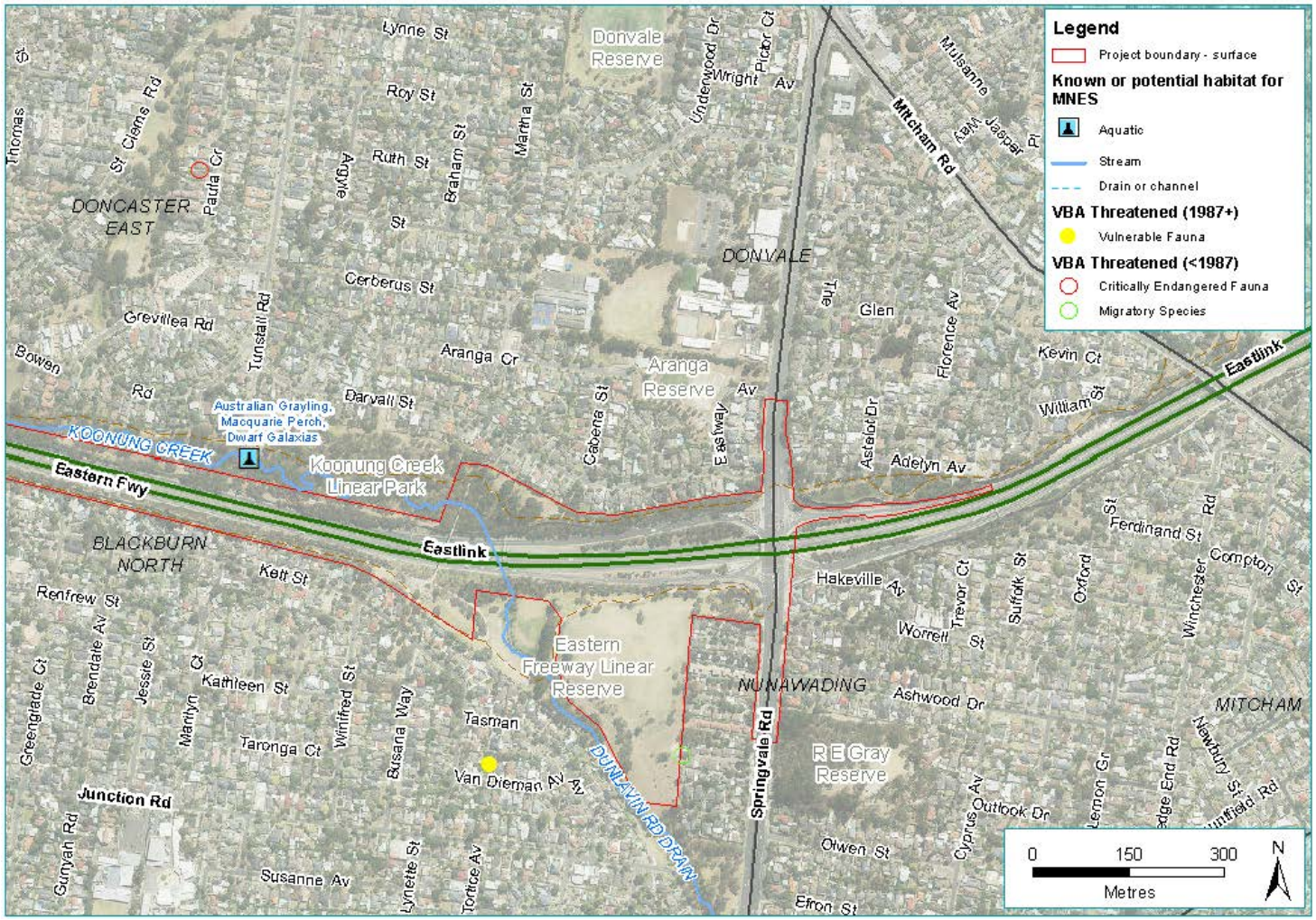

Figure 5-11(t) Known and potential location of MNES and ecological values relevant to the environment on Commonwealth land