

# Growling Grass Frog Habitat Assessment and Mapping: PSP 1067 Donnybrook and PSP 1096 Woodstock

Project: 14-001

Prepared for:

Metropolitan Planning Authority



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**Ecology Australia Pty Ltd**

Flora and Fauna Consultants

[www.ecologyaustralia.com.au](http://www.ecologyaustralia.com.au) [admin@ecologyaustralia.com.au](mailto:admin@ecologyaustralia.com.au)

88B Station Street, Fairfield, Victoria 3078, Australia

Tel: (03) 9489 4191 Fax: (03) 9481 7679

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## 1 Introduction

Ecology Australia was commissioned by the Metropolitan Planning Authority in May 2013 to undertake habitat assessment and mapping, and to subsequently develop a Concept Plan, for the Growling Grass Frog *Litoria raniformis* within the Donnybrook and Woodstock Precinct Structure Plan (PSP) areas. This species is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), is Listed under the *Flora and Fauna Guarantee Act 1988* (FFG Act), and is considered Endangered in Victoria (DSE 2013).

The Metropolitan Planning Authority (MPA) is managing the production of the PSP 1067 (Donnybrook) and PSP 1096 (Woodstock) draft urban structure plans, in consultation with the Department of Environment and Primary Industries (DEPI) and Mitchell Shire Council (PSP 1067) and City of Whittlesea (PSPs 1067 and 1096). The purpose of the PSP process is to facilitate the development of the precinct; for PSP 1067 and 1096 this will primarily consist of residential development. The precinct structure planning process includes the creation of open space such as retarding basins, wetlands and conservation reserves.

The objectives of this project are two-fold:

1. To gather data and information on existing habitat, including distribution and quality, for the Growling Grass Frog within the study area; this information will be used to inform and develop relevant planning documentation for the Precincts.
2. To develop Concept Plans for Conservation Areas 22, 25 and 34 within the two Precincts.

The requirement for a Concept Plan to be developed, as part of the Conservation Management Plan, is included in the Biodiversity Conservation Strategy (DEPI 2013a) and Sub-regional Species Strategy for the Growling Grass Frog (DEPI 2013b). These documents outline the process and requirements for the management and conservation of the Growling Grass Frog in Melbourne's growth areas, and are the guiding policy documents relevant to this project.

This report provides the methodology and results of habitat assessments and mapping for the Growling Grass Frog (GGF) within PSP 1067 and PSP 1096.

### 1.1 Study Area

The study area is located in Donnybrook and Beveridge, Victoria, and consists of sections of the Merri and Darebin Creeks, including associated vegetation, as well as terrestrial vegetation in Conservation Areas 22 and 25. Donnybrook (west) and Woodstock (east) Precincts are located adjacent to each other. The study area as a whole is bounded by Donnybrook Road to the south, the Melbourne-Sydney railway line in the west, the OMR/E6 road reservation to the north and Merriang road to the east (Figure 1).

Donnybrook and Woodstock precincts occur within the current Urban Growth Boundary (UGB) in the City of Whittlesea and Mitchell shire Council municipalities. The Precincts are part of the Port Phillip and Westernport Catchment Management Authority, and occur largely

within the Victorian Volcanic Plains bioregion, with a small area in the east of the site occurring in the Highlands Southern Fall bioregion.

Topographically, the study area is relatively flat with some undulating rises to low hills in the north, and some scattered stony outcrops. A number of waterways traverse the Precinct, most notably Merri Creek and Darebin Creek and associated tributaries. Much of the Merri Creek in the study area is relatively steeply dissected; Darebin Creek, however, is highly ephemeral in the study area, and reduced to a minor swale in the northern reaches.

The majority of land within the study area has a long history of agricultural use, primarily grazing with some cultivation, with a substantial area of native vegetation removed or substantially modified in the south of the study area. Remnant native vegetation within the study area comprises primarily Plains Grassland, Plains Grassy Woodland, Stony Knoll Shrubland, and Riparian Scrub Ecological Vegetation Classes (EVCs), with some Grey Clay Drainage-line Aggregate, Creekline Grassy Woodland, Scoria Cone Woodland, Valley Grassy Woodland and Swampy Woodland EVCs (DEPI 2013c) (Figures 2 and 3).

The precinct contains a large number of scattered trees, predominantly River Red Gums *Eucalyptus camaldulensis*, mostly along the creeklines (particularly Merri Creek), but also to the east of the Merri Creek in the north of the study area (Figures 1 and 2). Woody weeds are established in parts of the riparian corridor and surrounding terrestrial vegetation, including Gorse *Ulex europaeus*, Montpellier Broom *Genista monspessulana*, Sweet Briar *Rosa rubiginosa*, and African Boxthorn *Lycium ferocissimum*.

Much of the study area is well-known to support significant flora and fauna values, including and is considered to be of National conservation significance (Ecology Australia 2005; DEPI 2013a).

Plates 1 – 9 illustrate parts of the study area.

### 1.1.1 Growling Grass Frog distribution

Historically, the Growling Grass Frog has been widely distributed across south-eastern Australia, including Tasmania (Littlejohn 1963; Barker and Grigg 1977; Hero et al. 1991). However, since European settlement, and most notably over the past three decades, the species has declined markedly across much of this former range (Ashworth 1998; Wassens 2008). This is particularly evident in south and central Victoria where populations have experienced widespread declines and local extinctions (Mahoney 1999; DEPI 2013d).

The Growling Grass Frog is well known in areas to the north of Melbourne, including the Merri Creek, Kalkallo Creek, Darebin Creek and Edgars Creek waterways. There are consistent and numerous records for this species throughout most stretches of these creeks and surrounding areas, particularly the Merri Creek and associated tributaries/anabranches (DEPI 2013d).

Land use changes that have occurred over time within the study area and surrounds have reduced habitat continuity for GGF. Fragmentation of the overall Merri Creek population has occurred, and that the species is now comprised of a number of sub-populations (Heard and Scroggie 2009; Heard et al. 2010; Hale et al 2013). This is based upon the current distribution

of occupied wetland ‘clusters’ and the continuity of potential dispersal routes (open space, creek-lines or drainage lines) (Heard et al. 2003, 2004; Ecology Australia 2006). Recent research also suggest that these populations display ‘classic meta-population dynamics’ where the populations ‘blink’ in and out of existence, through regular frequent population extinction and recolonisation (Heard et al. 2009, 2010; Hale et al 2013). The sub-populations within the study area and surrounding areas generally occupy spatially discrete ‘wetlands’ (e.g. pools along streams, non-operational quarries, farm dams etc.), and individual frogs move between these wetlands, and hence between sub-populations (Heard et al. 2010).

Figures 1 and 2 show GGF records within the study area.

### 1.1.2 Threatening processes

Factors that have contributed to the decline of Growling Grass Frog across its range include habitat loss, the fragmentation and degradation of habitat (such as alteration of the alignment of watercourses, modification of vegetation structure by exotic flora, and changes to hydrological regimes), predation by introduced species (including predation of eggs and tadpoles by introduced fish, such as Eastern Gambusia *Gambusia holbrooki*), infection by the amphibian chytrid fungus *Batrachochytrium dendrobatidis*, salinisation, pollution of waterbodies and waterways by fertilisers, pesticides and toxicants, and impacts from climate change (including direct and indirect/cumulative impacts).

While many of these factors are presently impacting populations across the north of Melbourne, it is likely that habitat loss, fragmentation and degradation are the major, if not critical, factors threatening this species in the region (e.g. Heard et al. 2010); the precise contribution of chytrid fungus to the status of the species in the region is not well understood.

### 1.1.3 Potential impacts of development

A range of potential impacts to GGF can occur as a result of urban development. These include:

- Vegetation removal and/or disturbance of wetlands during construction activities.
- Habitat loss and fragmentation, including barriers to movement through the creation of pathways, road and/or other facilities.
- Changed hydrological regimes and altered water quality due to increased runoff from impermeable surfaces and changes to drainage within the study area.
- Increased sedimentation and pollution of the wetland from uncontrolled run-off and accidental fuel/oil spills from construction machinery on site.
- General habitat degradation due to increased recreational use of the area including trampling by pedestrian traffic, rubbish dumping and increased frequency of disturbances. Pathway and street lighting may also potentially impact foraging behaviour of this species.



- Pest and pathogen invasion. During construction, there is potential for feral animals, weeds and pathogens to be introduced to, or spread further around, the study area, and/or to be taken off-site. These include:
  - Introduction of weeds;
  - Predation by feral animals such as foxes and cats; and
  - Fungal diseases such as Chytridiomycosis (Chytrid infection); this has been implicated in the decline of frog species worldwide, and is listed as a key threatening process under the EPBC Act.
- Death and/or injury to individuals during construction activities.
- Roads and vehicular traffic – direct mortality from vehicles, as well as the potential increase in toxicant/pollution run-off from roads.
- Potential mortality due to domestic cats and dogs.
- Cumulative impacts – the general loss and degradation of habitat in the region, both within and outside of the study area, has the potential to reduce the number of subpopulations and therefore decrease the long-term viability of the frogs. Therefore, impacts associated with development within a precinct must be evaluated with consideration of the presence and viability of frog habitat within the wider region.

## 2 Methods

### 2.1 Desktop assessment

The desktop assessment included evaluation of fauna records held within the Department of Environment and Primary Industries (DEPI) Victorian Biodiversity Atlas (DEPI 2013d). Growling Grass Frog records within 5 km of the study area were reviewed.

Existing published literature and unpublished reports relevant to the study area were also reviewed.

### 2.2 Site assessments

Fieldwork was conducted in January and February 2014, and consisted of diurnal site visits to assess and map the distribution and quality of GGF habitat within the study area. The Merri and Darebin Creeks, and adjacent riparian areas and proximate waterbodies were assessed by two zoologists on 9 and 14 January and 12 February 2014. Conditions during the assessments were generally warm and clear (excepting 12 February which was overcast), with light winds to calm conditions.

Habitat assessments focused on the evaluation of the presence and quality of habitat, including the likely relative importance of habitat within the study area. The assessment focused on the creeklines and associated vegetation within the proposed Conservation Area where formal assessment points were located (Figures 2 and 3).

The formal assessment points included evaluation of the following parameters at waterbodies and in-stream pools along the creeks:

- Location of the site (GPS coordinates);
- General site description, including description of waterbody, vegetation structure/dominance, key species, and presence of terrestrial refuge sites (e.g. logs and rocks);
- The surface area of the waterbody;
- Estimation of the hydroperiod of the waterbody (e.g. permanent, semi-permanent, ephemeral, intermittent; *sensu* Heard et al. 2010);
- Mean percentage cover of aquatic vegetation (i.e. emergent, submerged and floating vegetation; as per Heard et al. 2010);
- Basic water chemistry parameters (i.e. DO, EC/Sal, pH, and turbidity);
- Presence/absence of predatory fish, where observed (e.g. Eastern Gambusia *Gambusia holbrooki*);
- Any frog species recorded during the assessment;
- Landscape context and connectivity, including potential barriers to dispersal;
- Potential works to enhance/maintain Growling Grass Frog habitat; and

- Overall relative quality of habitat (*sensu* Ecology Australia 2012, 2013; see below).

Apart from the formal assessment points, rapid assessments were carried out throughout the study area, which involved rapidly evaluating and recording relative habitat quality and key habitat features or opportunities.

Photographs were taken throughout the study area showing landscape and habitat features, some of these are presented in Section 6: Plates.

The habitat attributes above allowed an evaluation to be made of the habitat quality of each waterbody and in-stream pool, as well as the non-pool stretches of waterways. Identification of breeding habitat within the study area was based on known/likely reproductive sites as recorded from field surveys (e.g. Heard et al. 2004, 2009; Ecology Australia 2006, 2013; this survey) and habitat assessment. Three key elements are associated with breeding habitat within the Merri Creek-Donnybrook subpopulation, as follows:

- Off-stream wetlands and relatively large in-stream wetlands, or slow-flowing sections of a stream with a relatively stable water level, and;
- ‘Open-vegetated’ wetlands, little to no overhanging canopy and a combination of submergent, emergent and floating aquatic vegetation, generally of moderate to high cover; and
- Connectivity to other breeding sites (i.e. connectivity via the creekline, open space or associated tributaries creates a ‘cluster’ of occupied breeding wetlands within the subpopulation).

Based on the above parameters, areas of potential breeding habitat were categorised as follows:

1. High potential breeding habitat – supporting all of the elements associated with successful breeding (i.e. relatively high permanence, aquatic vegetation cover, refuge/foraging/basking resources, connectivity to other habitat); or supporting most of the elements associated with successful breeding and supporting repeated or recent records of the species;
2. Moderate potential breeding habitat – supporting most of the elements associated with successful breeding; and
3. Linking habitat – supporting some of the elements associated with successful breeding but having no records of the species; or supporting none of the elements associated with successful breeding but providing suitable linking habitat, or potential breeding habitat under favourable conditions.

For the purposes of mapping, these categories of breeding habitat quality were assigned for waterways (c. 10 m either side) within the study area (Figures 2 and 3). Areas outside of this are considered to represent terrestrial habitat, which are generally used more for foraging, dispersal and potentially overwintering, than breeding. This distinction is necessarily somewhat arbitrary, due primarily to the fact that these activities often overlap spatially, and

hence in some areas the realistic transition between breeding and terrestrial habitat may extend further, or less, than indicated.

The assessment included evaluation of potential locations for the creation of dedicated Growling Grass Frog ponds; these locations will be developed and discussed as part of the creation of the Concept Plan for the study area.

#### *Limitations*

Two properties were not able to be accessed during field surveys, and hence not all waterways and habitat within the Conservation Area were able to be assessed (see Figures 2 and 3). Growling Grass Frog individuals were heard calling from the property in question on the Merri Creek (Henderson property, 194 Donovans Lane), which is considered likely to support a continuation of at least moderate, and likely high, potential breeding habitat. The property not accessed on Darebin Creek occurred at the northern extent of the Conservation Area (Figure 3). At this property the Darebin Creek swale was significantly reduced and barely distinguishable in the landscape; we therefore do not consider that not surveying this property provides a material limitation for the project.

Several wetlands at assessment points on Darebin Creek were too shallow to allow water quality testing (see Appendix 2).

Targeted surveys for GGF were not undertaken as part of this project.



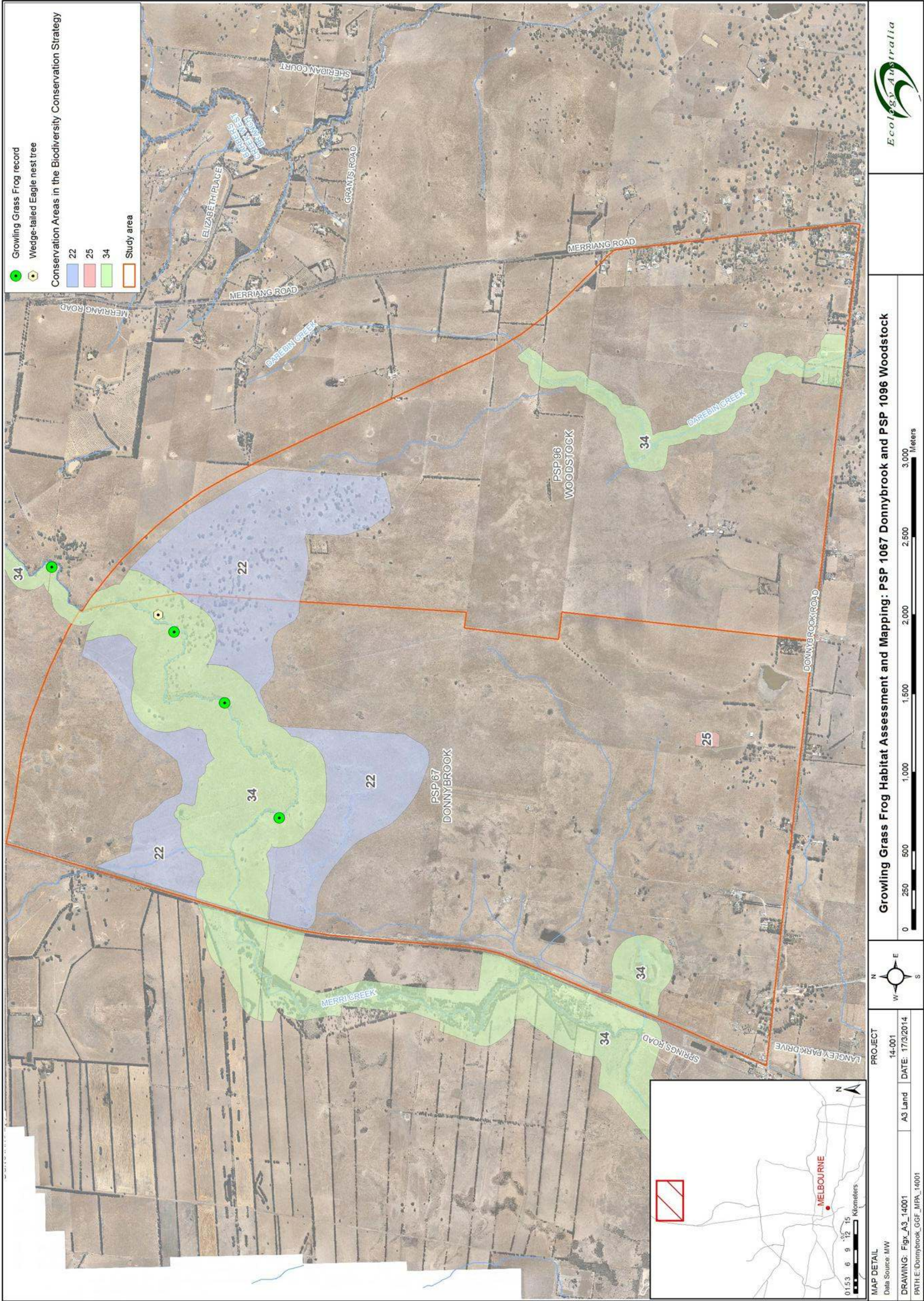


Figure 1 Donnybrook (PSP 1067) and Woodstock (PSP 1096), showing the study area, Conservation Areas, properties not accessed, and survey Growing Grass Frog records **To be updated**



### 3 Results

#### 3.1 Habitat assessment

Habitat for the Growling Grass Frog within Donnybrook and Woodstock is generally modified and degraded. The waterways have a history of agricultural impacts and use, particularly grazing, and in places are dominated by exotic vegetation, particularly woody weeds and exotic pasture grasses.

Remnant vegetation occurs throughout much of the study area, particularly around Merri Creek. This remnant vegetation largely comprises Plains Grassland and Plains Grassy Woodland EVCs, as well as numerous scattered River Red Gum *Eucalyptus camaldulensis*. Native vegetation also occurs along much of the riparian zone, dominated by River Red Gums with native sedges, rushes and grasses (e.g. *Phragmites australis*, Common Spike Rush *Eleocharis acuta*, *Juncus* spp., *Bolboschoenus* spp. and *Poa* spp.) and aquatic species (e.g. Water Ribbons *Triglochin procerum* s.l.).

Exotic woody weeds occur in minor to moderate infestations in much of Merri Creek area, including Montpellier Broom *Genista monspessulana*, Gorse *Ulex europaeus*, African Boxthorn *Lycium ferocissimum*, and Blackberry *Rubus fruticosus* sp.agg. Exotic pasture grasses, particularly Phalaris (Toowoomba Canary Grass) *Phalaris aquatica* are widespread in terrestrial areas and parts of the riparian zone in both the Merri and Darebin Creek areas. The introduced Artichoke Thistle *Cynara cardunculus* is also pervasive throughout the study area.

Despite the modification of areas of native vegetation in the study area, the riparian zone and various waterbodies within the study area provide potentially suitable habitat for GGF, which is generally influenced more by hydrological parameters and vegetation structure rather than vegetation composition or landuse *per se*.

Terrestrial habitat within the proposed Conservation Area 34 (i.e. land not proximate or adjacent to waterways and waterbodies) is relatively uniform and consists largely of grazed native vegetation and open pasture with some areas fenced to exclude stock. Knowledge of the precise use of terrestrial habitats by Growling Grass Frogs is not readily available; however, terrestrial habitat is important for foraging and dispersal movements of GGF, with recent modelling suggesting that reducing the width of this habitat around major creeklines can pose a substantial risk to the long-term viability of a population (Heard and McCarthy 2012). Grassy, low vegetation (including escarpments) surrounding the waterways is likely to be regularly used in areas where frogs occur; the regularity of use is likely to generally decline with distance from the water's edge.

The Growling Grass Frog was recorded during the current assessment, in four locations along Merri Creek (three within the study area boundary). Predatory fish were observed during the assessment, being Eastern Gambusia *Gambusia holbrooki*. It is highly likely that this species is present throughout Merri Creek when full, and may disappear from certain stretches and instream pools as water levels recede.

### 3.1.1 Merri Creek

Based on recent research, the Merri Creek GGF population is considered to display ‘classic metapopulation dynamics’ where the populations ‘blink’ in and out of existence given frequent population extinction and recolonisation (Heard et al. 2010). The populations within Merri Creek occupy spatially discrete wetlands (e.g. pools along streams, farm dams etc.), and individual frogs move between these wetlands and hence populations (Heard et al. 2010; Hale et al. 2013).

The Merri Creek waterway and associated riparian habitat within the study area is considered to represent ‘core permanent habitat’ for the Growling Grass Frog. Core permanent habitat is defined as being critical for the long-term persistence of a population; it is generally a permanent waterbody or waterway, however, water levels may fluctuate. Core permanent habitat provides continuity of habitat in the long-term and provides breeding habitat (in most years). Other habitat attributes are also associated with core habitat such as terrestrial foraging and over-wintering habitat. There are numerous records of Growling Grass Frog (current and historic) for the Merri Creek.

The Merri Creek is also categorised as a ‘habitat link within and between’ sub-population(s), providing continuity of habitat between breeding sites and habitat for dispersal and movement. Merri Creek provides connectivity of habitat between other wetland ‘clusters’ to the north and south of the precinct. This is important for dispersal, genetic interchange and habitat diversity (Hale et al 2013). Movement along habitat links may vary from year to year depending on the conditions of the habitat link.

Terrestrial habitats associated with Merri Creek (i.e. open space adjacent to waterways, waterbodies) are essential for the Growling Grass Frog, including long-term viability. Terrestrial habitats support dispersal, foraging and shelter/over-wintering habitat and can include a combination of open grassy/mud banks, dense fringing vegetation, rock rubble/boulders, soil cracks/crevices, leaf litter and logs, and open vegetation dominated by native and/or exotic grasses (i.e. grasslands adjacent to waterways).

The majority of Merri Creek within the study area is considered to provide high potential breeding habitat; this is in contrast to a small section in the south-west, which is considered to generally provide moderate potential breeding habitat (see Figure 2, Table 1). The high potential breeding habitat area in general supports a greater number of in-stream wetlands, more favourable aquatic vegetation cover, and more open water areas with less over-shading from woody species. The moderate potential breeding habitat was designated based primarily upon an apparent reduced hydroperiod (i.e. less areas holding water during dry periods), less in-stream pools, and generally less favourable aquatic vegetation. However, it is important to note that this distinction is subjective, and the lower category may not reflect the actual importance of particular habitat resources for the species in this area.

Water quality was relatively uniform throughout Merri creek, with results for all sites generally within the range of water quality results from known populations, including successful breeding sites (Ecology Australia 2011; unpublished data). However, there is a

paucity of data on the potential effects of water quality parameters on this species, including the effect of salinity or other parameters on chytrid fungus.

The majority of Merri Creek within the study area is lightly to heavily invaded by weeds, particularly woody weed species. It is likely this woody weed cover is increasingly impacting the suitability of riparian and terrestrial habitat for GGF.

The habitat parameters recorded along Merri Creek are presented in Appendix 2.

### **3.1.2 Darebin Creek**

The majority of Darebin Creek comprises a moderate to minor swale within a flat alluvial terrace. The creekline is ephemeral, with no water recorded within the drainage line apart from several in-stream wetlands/farm dams. The waterway is dominated by exotic pasture grasses and Artichoke Thistle. The creek itself is rocky, supporting a high cover of embedded and surface rock (Plates 7 – 8). The entire creek is considered to support linking habitat for the Growling Grass Frog.

In the northern reaches of Darebin Creek (i.e. above the tributary; Figure 3) the waterway is reduced to a very minor swale. Several small wetlands occur in the vicinity of the tributary; this area may offer potential for the creation of wetlands, with the objective of creating a small network of ponds, particularly as runoff from future surrounding development increases the hydroperiod of existing wetlands.

Water quality within Darebin Creek could only be assessed in one in-stream wetland, due to the low water levels. Within this wetland, water quality was substantially lower quality than within Merri Creek, particularly for turbidity and salinity/conductivity. The former is thought to be negatively correlated with GGF occupancy (Ecology Australia, unpubl. data), although this relationship appears to be relatively weak.

The habitat parameters recorded along Darebin Creek are presented in Appendix 2.

### **3.1.3 Off-stream waterbodies**

Other potential breeding habitat occurs within off-line waterbodies and depressions within the study area. There are a number of known records of the Growling Grass Frog in dams/wetlands within the region, which supports the potential importance of these waterbodies in the long-term viability of GGF in the area. Many of these dams are likely to be free of predatory fish, through periodic drying out, which may increase the likelihood of successful recruitment if breeding conditions are favourable (e.g. available water over the spring/summer period, moderate to high aquatic vegetation cover and available open space/connectivity to Merri Creek or other suitable habitat). These waterbodies may also provide habitat for non-breeding activities such as foraging and dispersal (e.g. 'stepping stones').

No dams or other off-stream waterbodies were recorded in proximity to the waterways, and hence no habitat assessments were undertaken for off-stream waterbodies.



**Table 1 Description of general habitat features within Donnybrook and Woodstock, by habitat type**

Habitat Type	Location (see Figures 2 to 3)	Field assessment points	General habitat attributes
<b>Known/high potential breeding habitat</b> (shown as green in Figures 2 and 3)	Merri Creek, from the E6 Reservation downstream to approximately 250 m prior to dissecting the Henderson property (194 Donovans Lane).	Merri Creek 1 – 9	Slow to moderate flowing sections of stream, moderately incised; some open sections and in-stream wetlands along the creek; generally comprised a moderate to high cover of aquatic vegetation, primarily emergent with some areas dominated by bulrushes, club-rushes and Phragmites; moderate to extensive overshadowing in some areas, primarily by exotic woody weeds and opportunistic native shrubs (e.g. Woolly Teatree, Tree Violet); GGF recorded calling in several areas.
<b>Moderate potential breeding habitat</b> (shown as blue in Figures 2 and 3)	Remainder of Merri Creek (c. 250 m long stretch in southwest)	n/a	More ephemeral portion of stream; flatter alluvial terraces; generally a moderate cover of aquatic vegetation, primarily emergent, often dominated by bulrushes, club-rushes and Phragmites; overshadowing by woody weeds and opportunistic native shrubs in some areas; apparent higher level of stock impacts.
<b>Linking habitat</b> (shown as orange in Figures 2 and 3)	Darebin Creek within the study area	Darebin Creek 1 - 5	Ephemeral drainage line running north to south; little to no aquatic vegetation; substantial surface and embedded rock cover; fringing vegetation dominated by exotic pasture grasses; may provide connectivity through the area when holding water.



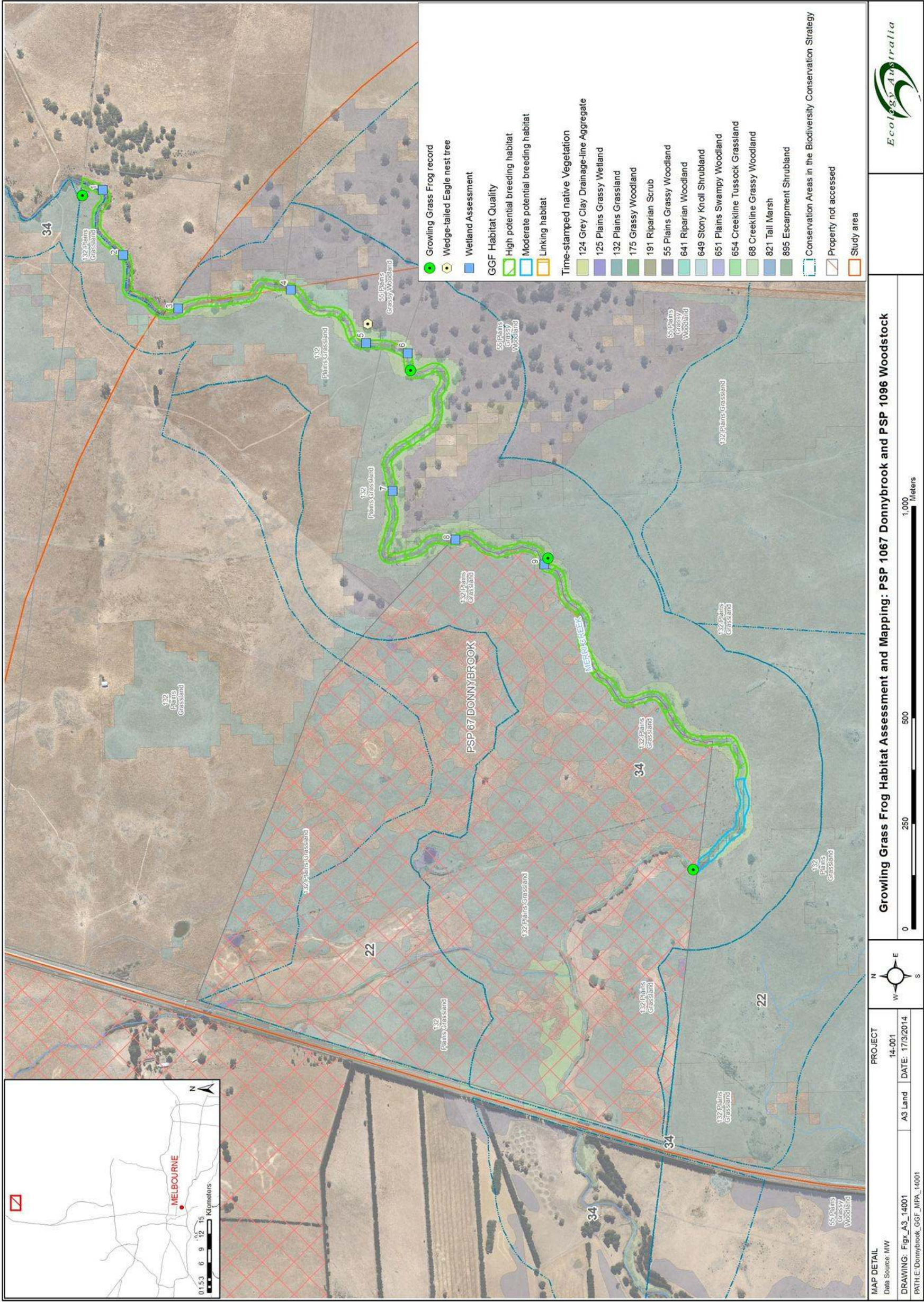


Figure 2 Growing Grass Frog habitat, wetland assessment points and native vegetation on Merri Creek within Donnybrook PSP (1067)



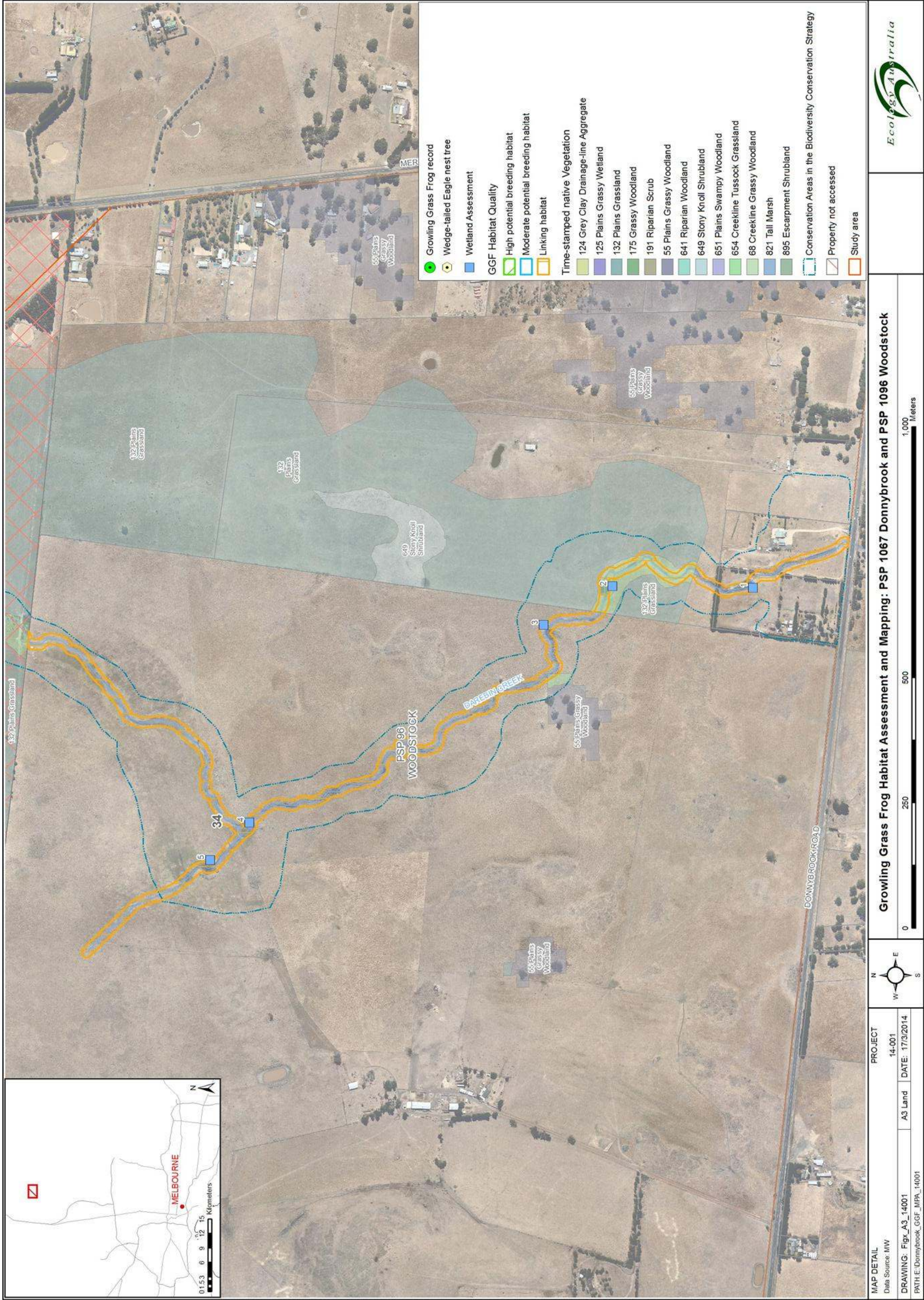


Figure 3 Growing Grass Frog habitat, wetland assessment points and native vegetation on Darebin Creek within Woodstock PSP (1096)



## 4 Conclusion

The findings of this Growling Grass Frog habitat assessment will inform the development of the Concept Plan for Conservation Area 34 within PSP 1067 Donnybrook and PSP 1096 Woodstock. The Concept Plan will provide recommendations and identify potential locations for the creation of dedicated Growling Grass Frog breeding wetlands, including the identification of potential ‘nodes’, where several wetlands may be located in proximity.

We make the following general comments and recommendations relevant to the study area:

- The entirety of the Merri Creek within the study area supports at least moderate, and primarily high, potential breeding habitat for GGF. Given the known importance of this waterway for the species it represents a very high priority for conservation and management.
- The high cover of woody weeds, on Merri Creek particularly, is likely to currently be significantly impacting on the quality of GGF habitat; woody weed control is required within riparian areas and adjacent habitat to ameliorate these impacts in the short to medium term (i.e. prior to the commencement of long-term Precinct-level conservation works). Many of the woody weed species extant within the study area are listed as Regionally Controlled under the *Catchment and Land Protection Act 1994* (e.g. Gorse, Hawthorn, Blackberry and African Boxthorn); this legislation obligates landowners to take all reasonable steps to prevent the growth and spread of these species on their land.
- The entirety of Darebin Creek in the study area supports linking habitat, although as increased inflows occur over time from surrounding development the quality of habitat may improve. The exclusion of stock would likely significantly improve the habitat quality of existing in-stream wetlands within Darebin Creek.

## 5 References

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## 6 Plates



Plate 1 Merri Creek near the northern boundary of the study area (January 2014).



Plate 2 In-stream wetland on the Merri Creek where Growling Grass Frogs were recorded calling (January 2014).





Plate 3 Over-shaded portion of Merri Creek, showing River Red Gum, Woolly Tea-tree and other woody shrubs (January 2014).



Plate 4 Merri Creek in the west of the study area, supporting moderate quality breeding habitat (January 2014).





Plate 5      Structurally diverse in-stream wetland on Merri Creek, with a high cover of aquatic vegetation (January 2014).



Plate 6      Remnant native vegetation adjacent and east of Merri Creek (January 2014)





Plate 7 Darebin Creek in the southeast of the study area; reduced to a rocky swale with little aquatic vegetation and extensive Artichoke Thistle (January 2014).



Plate 8 In-stream wetland on Darebin Creek, lack of aquatic vegetation and poor water quality is likely a result of regular stock access (January 2014).



Plate 9      Wetlands in Conservation Area 34, east of the Melbourne-Sydney railway line (February 2014).



**Appendix 1** Fauna species list recorded during Growling Grass Frog habitat mapping in Donnybrook and Woodstock Precincts.

**Key:**

En – Endangered; Vu – Vulnerable; L - Listed

Ma/Mi – listed under the Marine and/or Migratory schedules of the EPBC Act 1999.

Common Name	Scientific Name	EPBC Act	FFG Act	DSE 2013
<b>Mammals</b>				
Eastern Grey Kangaroo	<i>Macropus giganteus</i>			
Echidna	<i>Tachyglossus aculeatus</i>			
*European Hare	<i>Lepus europaeus</i>			
*European Rabbit	<i>Oryctolagus cuniculus</i>			
*Red Fox	<i>Vulpes vulpes</i>			
<b>Amphibians</b>				
Growling Grass Frog	<i>Litoria raniformis</i>	Vu	L	En
<b>Birds</b>				
Australian Magpie	<i>Gymnorhina tibicen</i>			
Australasian Pipit	<i>Anthus novaeseelandiae</i>	Ma		
Brown Falcon	<i>Falco berigora</i>	Mi		
Brown Thornbill	<i>Acanthiza pusilla</i>			
Clamorous Reed Warbler	<i>Acrocephalus stentorius</i>	Mi		
*Common Mynah	<i>Acridotheres tristis</i>			
Crested Pigeon	<i>Ocyphaps lophotes</i>			
Eastern Rosella	<i>Platycercus eximius</i>			
Golden-headed Cisticola	<i>Cisticola exilis</i>			
Little Raven	<i>Corvus mellori</i>	Ma		
Magpie-lark	<i>Grallina cyanoleuca</i>			
Masked Lapwing	<i>Vanellus miles</i>			
Pacific Black Duck	<i>Anas superciliosa</i>	Mi		
Red-rumped Parrot	<i>Psephotus haematonotus</i>			
Spotted Pardalote	<i>Pardalotus punctatus</i>			
Superb Fairy-wren	<i>Malurus cyaneus</i>			
Welcome Swallow	<i>Hirundo neoxena</i>	Ma		
Willie Wagtail	<i>Rhipidura leucophrys</i>			
Yellow-rumped Thornbill	<i>Acanthiza chrysorrhoa</i>			
<b>Invertebrates</b>				
Yabby	<i>Cherax destructor</i>			

**Appendix 2** Description and ecological parameters of in-stream waterbodies assessed within Merri and Darebin Creeks in Donnybrook and Woodstock Precincts.

Site ID	Site Description	Surface Area (m2)	Hydro-period	Habitat Quality	Aquatic Vegetation Cover	EC (us/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Recommended Enhancement Works	Gambusia	Notes
Merri Creek (see Figure 2)													
1	Wider section of creek, mostly open, moderate emergent vegetation, substantial floating vegetation (Triglochin) and surface rock	TBD	Semi-permanent	High potential breeding habitat	19	1170	0.58	4.25	8.22	47.3		Present	
2	Open water , mostly shaded, emergent vegetation on edges, little floating vegetation	TBD	Semi-permanent	High potential breeding habitat	7	1203	0.60	3.27	7.43	3.6		Not recorded	
3	Small pool, partially shaded	TBD	Semi-permanent	High potential breeding habitat	6	977	0.48	4.48	7.82	17.2		Present	
4	Small pool, mostly shaded	TBD	Semi-permanent	High potential breeding habitat	13	1523	0.76	2.56	7.82	5.2	Weed control	Not recorded	
5	Relatively wide open pool, partially shaded, rock jumble in middle	TBD	Semi-permanent	High potential breeding habitat	4	939	0.46	5.41	7.87	3.2	Woody weed control	Not recorded	
6	High quality in-stream habitat, moderate cover of aquatic vegetation, relatively narrow	TBD	Semi-permanent	High potential breeding habitat	22	1038	0.51	6.96	7.97	27.7	Stock exclusion, woody weed control	Present	Growing Grass Frog recorded calling.
7	Open section of creek, high cover of aquatic vegetation, partially shaded	TBD	Semi-permanent	High potential breeding habitat	35	931	0.46	2.87	8.03	12.5	Woody weed control	Present	
8	Open section of stream, moderate aquatic vegetation, some over-shading by woody weeds	TBD	Semi-permanent	High potential breeding habitat	12	1299	0.64	4.19	8.04	54.6	Woody weed control	Present, many	
9	Open section of stream, substantial trampling by stock	TBD	Semi-permanent	High potential breeding habitat	12	1089	0.54	7.73	8.12	28.9	Stock exclusion, woody weed control	Present, many	Growing Grass Frog recorded calling.
Darebin Creek (see Figure 3)													
1	Moderate size open waterbody, rocky, no aquatic vegetation	1094	Ephemeral	Linking habitat	0	n/a*	n/a*	n/a*	n/a*	n/a*	Stock exclusion, aquatic vegetation plantings	Not recorded	
2	Open waterbody, rocky, no aquatic vegetation	542	Ephemeral	Linking habitat	0	9605	4.8	9.1	8.94	257	Stock exclusion, aquatic vegetation plantings	Not recorded	
3	Open waterbody, some rocks, no aquatic vegetation	475	Ephemeral	Linking habitat	0	n/a*	n/a*	n/a*	n/a*	n/a*	Stock exclusion, aquatic vegetation plantings, weed control	Not recorded	
4	Moderate size open waterbody, rocky, no aquatic vegetation	1130	Ephemeral	Linking habitat	0	n/a*	n/a*	n/a*	n/a*	n/a*	Stock exclusion, aquatic vegetation plantings, weed control	Not recorded	
5	Small open waterbody, rocky, no aquatic vegetation	275	Ephemeral	Linking habitat	0	n/a*	n/a*	n/a*	n/a*	n/a*	Stock exclusion, aquatic vegetation plantings	Not recorded	

\* Wetland too shallow to permit water quality testing