

FINAL REPORT:

Cardinia Road Employment Precinct, Conservation Management Plan for Growling Grass Frog *Litoria raniformis*

PREPARED FOR

Cardinia Shire Council

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Ecology Partners Pty Ltd

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Cover photo: View of an existing farm dam within the Precinct (background), Growling Grass Frog *Litoria raniformis* (upper right and middle left insets) (Dan Weller, Ecology Partners Pty Ltd).

The following Ecology Partners Pty. Ltd. employees either undertook the field assessments and/or contributed to the preparation of the final report:
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EXECUTIVE SUMMARY

Ecology Partners Pty. Ltd. was commissioned by Cardinia Shire Council to prepare a detailed Conservation Management Plan (CMP) for the nationally threatened Growling Grass Frog *Litoria raniformis* (herein referred to as *L. raniformis*) as part of the proposed Cardinia Road Employment Precinct development, Cardinia Road, Officer, Victoria. This document provides a detailed plan for the management of *L. raniformis* for the development, during pre-construction, construction, and post-construction.

Precinct area

The CMP affects the entire area covered by the Cardinia Road Employment Precinct Structure Plan, herein referred to as ‘the Precinct’.

The Precinct area is located east of Officer, adjacent to the Pakenham Bypass, approximately 50 kilometres south east of Melbourne. It is bordered by the Pakenham Bypass to the north, Toomuc creek to the east, Gum Scrub creek to the west, and a transmission line easement to the south.

Issue

Based on the known distribution and habitat requirements of *L. raniformis* within the Precinct, the proposed development is likely to have a significant impact on the species. *L. raniformis* is listed under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and *Flora and Fauna Guarantee Act 1988* (FFG Act). The proposed development will result in direct impacts, through road mortality, mortality during construction, and removal of habitat or indirect impacts, through alteration to habitat conditions along the creeks and drainage line, fragmentation of suitable habitats, increased pollutants, noise or predation. Despite this, the current development plan will result in an overall improvement in the condition of frog habitat along the creeks and drainage line through the construction of:

- ponds that are designed, landscaped and managed specifically as dedicated *L. raniformis* habitat; and,
- online, continuously-fed stormwater treatment wetlands created as part of the Development Services Scheme (DSS), that have a primary function of flood mitigation.

Objective

The primary objective of this CMP is to provide a detailed plan to minimise the effects of the proposed development of the Precinct on resident *L. raniformis* populations and enhance current habitat attributes within the Precinct. The CMP outlines actions to satisfy obligations under the Strategic Impact Assessment (SIA), in accordance with the EPBC Act, specifically in relation to *L. raniformis* to allow for ecologically sensitive development within the Precinct.

It outlines actions such as salvage and translocation measures and on-going management and maintenance objectives, which are required to ensure the species is not adversely affected during and post-construction, and to provide suitable habitat for *L. raniformis* in the event the species naturally re-colonises, or is released into, ponds and wetlands on the site.

The management of *L. raniformis* as outlined in this CMP is ultimately an obligation of the landowners who are developing the land, as shown in Appendix 2. Management requirements may be transferred to Melbourne Water or Cardinia Shire Council, once land is transferred to a public authority. If landowners transfer land to Melbourne Water, this must be done through a legally binding agreement, and includes funds for implementing the required management requirements by Melbourne Water on behalf of the landowner.

To provide a coordinated approach to the implementation of this CMP, mechanisms have been put in place for landowners to make payments to the appropriate administering agency to undertake actions on their behalf. This will enable a coordinated, holistic approach to habitat creation and management. Funding is to be provided:

- For construction of waterbodies and enhancement of existing waterbodies to be retained, through:
 - developer contributions paid to Cardinia Shire Council to fund habitat creation along east-west corridors, including ponds, under the provisions of a Section 173 Agreement or any future Development Contributions Plan;
 - Development Services Scheme (DSS) payments made to Melbourne Water, to fund habitat creation and augmentation, including ponds and wetlands, along north-south waterway/drainage corridors; and,
 - a services agreement with Melbourne Water.
- For management, monitoring and maintenance of ponds as required in this CMP (which landowners would normally fund under individual EPBC Act referrals) for the 10 years post construction. After this 10 year post construction management period there will be ongoing management for floodplain areas and waterways to maintain habitat in accordance with Melbourne Water's standard maintenance policies and strategies. Where land is transferred to Melbourne Water, a payment is to be made by the landowner to Melbourne Water to undertake actions on their behalf prior to receiving a statement of compliance for a subdivision permit.

The most important element for the effective implementation of the management plan is the ongoing commitment and co-ordination from the landowner, developer, Cardinia Shire Council, Melbourne Water and the Department of Sustainability and Environment (DSE). Ongoing monitoring and management report reviews will be conducted by the regulatory authority, in this case, DSE.

Similarly, there needs to be continual communication between future developers, the regulatory authority, and specialist consultants experienced in undertaking monitoring and management of *L. raniformis* and its habitats.

The plan must be carried out in accordance with the specific actions outlined in this plan for the duration of Phase 1, being a period of ten years after the completion of the construction, defined as the date that individual ponds and wetlands are approved by DSE, as having been constructed or rehabilitated to the standards set out in this CMP (as recorded at Appendix 7). After this period, ongoing management and monitoring actions, as outlined in Phase 2 (Section 4) of this CMP, will continue to operate in perpetuity. Provided that construction and ongoing management and monitoring within the Precinct is in accordance with recommendations provided in this plan, there is likely to be a net improvement in habitat quality within the Precinct for a range of fauna, including *L. raniformis*.

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1 INTRODUCTION

1.1 Project Information

Ecology Partners Pty. Ltd. was commissioned by Cardinia Shire Council to prepare a detailed Conservation Management Plan (CMP) for the nationally threatened Growling Grass Frog *Litoria raniformis* (here in referred to as *L. raniformis*) as part of the proposed Cardinia Road Employment Precinct Structure Plan: a plan which will facilitate the development of a new urban area at Cardinia Road, Officer, Victoria (Figure 1). The plan has been developed with reference to additional information on the species' distribution in the Precinct area (Organ and Hamer 2006c; Ecology Partners Pty. Ltd. 2008a, 2008b, 2009a), in order to satisfy the obligations of landowners under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) [administered by the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPC)].

The development of the Cardinia Road Employment Precinct (hereafter referred to as 'the Precinct') will deliver a 595 hectare mixed-use development along Cardinia Road in Officer. The proposed development consists of a town centre and commercial precinct, industrial precincts, and low, medium and high density residential areas. A series of stormwater treatment wetlands and dedicated frog ponds will be constructed along the Cardinia Road Drain, which runs north-south through the centre of the development. Stormwater treatment wetlands and dedicated frog ponds will also be created along Toomuc Creek on the eastern boundary and Gum Scrub Creek on the western boundary of the Precinct. In addition, new east-west dispersal corridors through the Transmission Line Easement along the Precinct's southern boundary, and along the southern side of the Pakenham Bypass, west of Cardinia Road to Gum Scrub Creek, will provide habitat connectivity between the north-south corridors through the construction of interspersed dedicated frog ponds. These east-west links will be designed specifically to provide suitable habitat for *L. raniformis*, and will be offline from the main drainage and creek systems.

Previous assessments conducted in the area identified the potential for the *L. raniformis* to occupy habitats within the Precinct (Timewell 2003; Organ 2004; Organ 2005b; Organ and Hamer 2006a, 2006b, 2006c). Consequently, a flora and fauna survey was undertaken in January 2008 to ascertain the status of the species within the Precinct, and to assess any potential impacts on the frog and its habitats (Ecology Partners Pty. Ltd. 2008a). Several *L. raniformis* individuals were detected within the Precinct during this survey, with significant populations residing in several waterbodies (Ecology Partners Pty. Ltd. 2008a).

The survey also established that there was suitable breeding habitat for the species within the Precinct, and that *L. raniformis* may use the water courses and drainage line during dispersal to other higher quality habitats in the immediate area. Based on this recent survey of the species, and the presence of suitable breeding habitat within the Precinct, it was considered that the proposed development would impact the extant *L. raniformis* population and associated habitats.

The following document has therefore been developed to provide a detailed plan for the management of *L. raniformis* within the Precinct before, during and after construction.

1.2 Precinct Area

Cardinia Road Employment Precinct is located south of the Pakenham Bypass, in Officer South, approximately 50 kilometres south east of Melbourne, and is traversed by Cardinia Road (Melways Ref 215 B-E 9-11) (Figure 1). It is bound by the Pakenham Bypass to the north, Toomuc Creek to the east, Gum Scrub Creek to the west, and extends southwards to the transmission line.

The majority of the Precinct has been cleared for agriculture and is currently grazed by cattle. There are some small remnant patches of native vegetation west of Cardinia Road, however the highly modified habitat that encapsulates them means they are unlikely to support any significant species. Cardinia Road Drain runs through the property from the north to south. There are several artificial waterbodies within the Precinct, some of which currently support populations of the nationally significant *L. raniformis*.

According to DSE's Biodiversity Interactive Map (2010), the Precinct area is within the Gippsland Plain bioregion, which extends from Port Phillip Bay in the west to Bairnsdale in the east, between the southern slopes of the Great Dividing Range and Wilson's Promontory, excluding the Strzelecki Ranges.

1.3 Terminology

Throughout the following document, there are ongoing references to waterbodies, ponds and wetlands. To avoid confusion in the frequency and application of management and monitoring actions:

- *Waterbodies* in the following chapters has been used as a collective term for any existing pond, dam, dedicated frog habitat pond, ephemeral depression and stormwater treatment wetland;
- *Ponds* refer to any of the offline dedicated frog habitat ponds to be constructed in the Precinct, which ideally will have their own catchment and for the most part, receive no water from the creek and drainage line systems to prevent the incursion of fish; and,
- *Wetlands* refer to the eleven large online stormwater treatment wetlands to be constructed in the Precinct, that have the primary function of mitigating flood events and the treatment of stormwater runoff from the Precinct. These stormwater treatment wetlands are expected to provide incidental habitat for frog species, including *L. raniformis*, but as they will receive water continuously, cannot be effectively managed as fish free environments.

Throughout the following document, references to actions that “will” or “must” happen are required by the Conservation Management Plan and the approval under the EPBC Act.

Actions that are recommendations or “should” happen are not required to be undertaken under the approval of the Conservation Management Plan under the EPBC Act, but are guidelines and/or recommended directions for future actions.

The CMP outlines specific actions for management and monitoring for two operational phases:

- Phase 1 of the CMP includes requirements from the date of CMP approval through Pre Construction, Construction and Management and Monitoring stages for 10 years post completion of construction of ponds; and,
- Phase 2 of the CMP includes ongoing management and monitoring actions to be undertaken in perpetuity, which will commence at the completion of Phase 1, 10 years following construction.

2 BACKGROUND

The purpose of this chapter is to provide an overview of the ecology and significance of *L. raniformis*, its presence in the Precinct and the surrounding area, as well as known habitat requirements, which need to be considered in catering for the conservation of the species in an urban context. The recommendations encompass measures to protect, enhance and manage the future urban environment and the network of stormwater treatment wetlands and dedicated frog ponds throughout the Precinct.

This chapter also outlines a series of precinct design recommendations to mitigate the impacts of urban development within the Precinct. Primarily, this includes the retention of a selection of existing waterbodies, and the creation of new frog ponds and habitat corridors to offset the unavoidable removal of some existing waterbodies,

The implementation of the recommendations outlined in this chapter is set out in Chapter 3: Conservation Management Plan, which outlines the actions that will be undertaken, including commitments by the future public land managers, Cardinia Shire Council and Melbourne Water.

2.1 Growling Grass Frog *Litoria raniformis*

2.1.1 Conservation Status

The Growling Grass Frog is commonly known by several other names; Warty Bell Frog, Southern Bell Frog, Warty Swamp Frog and Green and Golden Frog. The species is listed as endangered in Victoria (DSE 2007) and vulnerable nationally (Tyler 1997). It is also listed as a threatened taxon under the EPBC Act and the Victorian *Flora and Fauna Guarantee Act 1988*. A draft Flora and Fauna Guarantee Action Statement (Robertson 2003) and a draft National Recovery Plan have been developed for the species. Overall the species is of national conservation significance.

Although formally widely distributed across southern eastern Australia, including Tasmania (Littlejohn 1963, 1982; Hero *et al.* 1991), the species has declined markedly across much of its former range. This has been most evident over the past two decades and in many areas, particularly in south and central Victoria, populations have experienced apparent declines (including within the Precinct) and local extinctions (AVW; Mahoney 1999; Organ pers. obs).

2.1.2 Habitat Requirements

This species is largely associated with permanent or semi-permanent still or slow flowing waterbodies (i.e. streams, lagoons, farm dams and old quarry sites) (Hero *et al.* 1991; Barker *et al.* 1995; Cogger 1996; Ashworth 1998). Frogs can also utilise temporarily inundated waterbodies for breeding purposes providing they contain water over the breeding season (Organ 2003).

Based on previous investigations, there is a strong correlation between the presence of the species and key habitat attributes at a given waterbody. For example, the species is typically associated with waterbodies supporting extensive cover of emergent, submerged and floating vegetation (Robertson *et al.* 2002, Organ 2004, 2005b). Emergent vegetation provides basking sites for frogs and protection from predators, while floating vegetation provides suitable calling stages for adult males, and breeding and oviposition (egg deposition) sites. Terrestrial vegetation (grasses, sedges), rocks and other ground debris around wetland perimeters also provide foraging, dispersal and over-wintering sites for frogs.

Within the Precinct and immediate surrounds, waterbodies supporting the above mentioned habitat characteristics and that are located within at least 300–500 metres of each other are more likely to support a population of *L. raniformis*, compared with isolated sites lacking important habitat features (Hamer and Organ 2008). Indeed, recent studies have revealed that the spatial orientation of waterbodies across the landscape is one of the most important habitat determinants influencing the presence of the species at a given site (Robertson *et al.* 2002; Heard *et al.* 2004a, 2004b; Hamer and Organ 2008).

For example, studies have shown there is a positive correlation between the presence of the species and the distance of freestanding waterbodies to another occupied site. This is comparable to the spatial dynamics of many amphibian populations, including the closely related Green and Golden Bell Frog *Litoria aurea* (Hamer *et al.* 2002). *L. raniformis* is known to forage over 100 metres from wetland habitat in which they are residing at the time (Organ pers. obs.), highlighting the need for substantial buffers around waterbodies when considering habitat conservation.

Through consultation with DSE and Cardinia Shire Council, it has been agreed that buffers surrounding constructed dedicated frog ponds within the Precinct will be at least 30–40 metres, given that larger areas of terrestrial habitat are being provided within the creek and drainage line corridors through extensive revegetation works, landscaping and habitat management regimes. Within this buffer zone there must be suitable refuge and foraging habitat for *L. raniformis*, and no roads, walking paths, or lighting to reduce the likelihood of impacting resident individuals. The buffer zone should be designed to restrict access from humans and their pets through fencing, landscaping and/or signage. This buffer will be achieved through the implementation of the Precinct Structure Plan and associated planning scheme controls, which designate these areas as encumbered open space and stipulate that no development may occur within them.

2.1.3 Habitat within the Precinct

There are currently several permanent artificial waterbodies and sites along both Toomuc Creek and Gum Scrub Creek within the Precinct that sustain the abovementioned habitat features, and either individuals or populations of *L. raniformis*. Although these waterbodies contain varying degrees of aquatic vegetation, the Cardinia Road Drain, which runs through the centre of the Precinct, is relatively narrow and quite shallow, containing poor water quality, and is isolated from larger waterbodies supporting extensive areas of aquatic and semi-aquatic vegetation.

However, it is likely that it maintains habitat connectivity and allows dispersal between several of the dams that are situated directly adjacent to it and currently support small populations of *L. raniformis*, especially during the wetter months of the year.

Suitable refuge sites and over-wintering cover is present in the majority of waterbodies within the precinct, and the area is highly likely to form part of an important dispersal corridor linking one or more occupied sites (Hamer and Organ 2008).

As such, the majority of waterbodies within the Precinct currently represent important habitat for this species, in addition to surrounding grassy areas which would be used for foraging.

2.1.4 Occurrence within the Precinct

Several populations have been recorded at artificial waterbodies within the Precinct over the past five years, and the populations throughout Officer and Pakenham are of national conservation significance (Timewell 2003; Organ 2004; Organ 2005b; Organ and Hamer 2006c; Hamer and Organ 2008). Ongoing monitoring of populations in the Pakenham and Officer area, primarily in the Precinct, has continued over the 2007/08 breeding period. Preliminary results reveal that populations continue to decline throughout the Precinct (Figure 2).

Within the Precinct, previous surveys identified that *L. raniformis* was present in six artificial waterbodies, with a significant breeding population inhabiting a large turkeys nest dam, approximately 500 metres south of the Pakenham Bypass, and west of Cardinia Road (referred to as Dam 38 in this report) (Hamer and Organ 2008).

Most permanent waterbodies adjacent to the Cardinia Road Drain have been previously occupied by the species, highlighting the importance of the drainage line as a dispersal corridor through the otherwise heavily fragmented surrounding environment.

During the most recent surveys, undertaken during the 2008/2009 breeding period, *L. raniformis* was recorded within the Precinct, and in waterbodies in its immediate vicinity.

Of the 40 dams identified from aerial photographs and daytime walkover assessments, 13 were completely dry, and an additional six were considered unsuitable due to degraded surrounding habitat and exceptionally poor water conditions. Of the remaining 21 dams, *L. raniformis* was identified in six of them (Appendix 5, Table 5.1, Figure 2).

It is evident that a significant population of the species exists within the Precinct, and individuals are likely to disperse or use the majority of waterbodies and water courses, depending on their habitat and water condition.

2.1.5 Distribution in Surrounding Area

The Precinct lies within the greater Pakenham metapopulation of this species, which is considered an ‘important population’ (nationally significant) by the criteria outlined in the EPBC Act Policy Statement developed specifically for the species. There have been over 180 documented records of the species in the local area (AVW).

There have been a number of targeted amphibian surveys recently undertaken throughout the Pakenham area, primarily as part of the proposed Pakenham Bypass project (Costello *et al.* 2003; Timewell 2003; Organ 2004, 2005b; Hamer and Organ 2008) and other proposed developments in the area (Brett Lane and Associates 2004, 2005; Norris 2004). In fact, recent surveys of the species has revealed that throughout the former Koo Wee Swamp and Pakenham areas, the species is widely distributed, with a number of relatively large populations present (principally in farm dams) (author pers. obs.). Extant populations throughout this area are important for the long-term persistence of the species in the wild, and are considered to be of national conservation significance for the species (Organ in prep).

One key breeding site for *L. raniformis* in the vicinity of the Precinct is a large dam directly east of Toomuc Creek, and south of the Pakenham Bypass. It is likely that this species uses Toomuc and Gum Scrub Creeks and the Cardinia Road Drain as dispersal routes through the Precinct. *Litoria raniformis* is known to successfully use created habitat in urban areas, such as within the nearby Lakeside Estate and in other areas around Melbourne (e.g. Caroline Springs development). However, ongoing management of habitats including the removal of predatory fish (e.g. Plague Minnow), protection of vegetation cover, maintenance of water levels and water quality, together with the preservation of habitat connectivity throughout the Precinct are important to ensure that the species persist in the future.

Additional recent surveys have revealed that the species is widely distributed throughout the Pakenham, Officer and Nar Nar Goon area (author pers. obs.), including throughout the Precinct.

More than 70 individuals were detected from constructed waterbodies along the Pakenham Bypass, west of Toomuc Creek, and immediately north of the precinct, during targeted surveys conducted over the 2008/09 breeding period (Ecology Partners Pty. Ltd. 2009a).

2.1.6 Threatening Processes

Causes of the decline of *L. raniformis* are not fully understood. However, factors that are likely to have contributed to the decline include habitat loss, fragmentation and degradation (such as land clearing for agriculture and urban development), altered flooding regimes of natural waterbodies, predation on eggs and tadpoles by introduced fish, salinisation, chemical pollution of waterbodies by fertilisers and pesticides, and infection by the amphibian chytrid fungus (Hamer *et al.* 2004; White and Pyke 1996). Some of these factors are presently acting on the metapopulation in the Pakenham area. However, habitat loss and modification, and prolonged drought conditions, resulting in the loss or significantly reduced suitability of previously occupied ponds, represent the greatest threat to the extant metapopulation.

2.2 Impacts

On the basis of the known distribution and habitat requirements of *L. raniformis* within the Precinct, individuals or local populations will be adversely affected by the proposed development.

While the consequences of these impacts on *L. raniformis* populations may not be evident in the short term, they have the potential to reduce long-term viability of populations within the Precinct. A summary of impacts associated with the proposed development is outlined below.

2.2.1 Habitat Loss

Thirty-five dams/ artificial waterbodies within the Precinct containing potential habitat for and populations of *L. raniformis* are proposed to be removed. The loss of this habitat will have a significant impact on the local population. In light of this, a salvage and translocation plan has been developed.

To compensate for the loss of these areas, extensive areas of habitat are proposed to be created and enhanced under the Precinct Structure Plan, through the provision of extensive wetlands and isolated frog habitat ponds along the length of Gum Scrub Creek, Toomuc Creek, Cardinia Road Drain and the east-west corridors within the Precinct (along the Transmission Line Easement and west of Cardinia Road along the Pakenham Bypass).

In particular, the loss of artificial waterbodies containing breeding populations of *L. raniformis* should be avoided, such as Dam 38.

2.2.2 Habitat Fragmentation

Most of the potential dispersal habitat on the subject site is restricted to Gum Scrub Creek, Toomuc Creek, and the Cardinia Road Drain. The 35 artificial waterbodies within the Precinct also provide important sheltering, breeding and dispersal habitat for *L. raniformis*. Potential habitat along Gum Scrub Creek is not proposed to be removed, and rather will be enhanced. Dispersal habitat of higher quality occurs along Toomuc Creek. The proposed series of stormwater treatment wetlands and frog ponds along Gum Scrub and Toomuc Creeks, and the Cardinia Road Drain will provide important north-south habitat connectivity through the Precinct.

The development of the Precinct will fragment the local population of *L. raniformis*, and limit east-west dispersal through the Precinct. To mitigate these effects, two artificial east-west dispersal corridors are proposed within the Precinct. These include construction of new ponds interspersed along the northern and southern boundaries of the Precinct, which link the ponds and wetlands along Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain.

2.2.3 Hydrology and Water Quality

Construction activities associated with the development of the Precinct have the potential to result in sedimentation of nearby waterways and produce sediment-laden runoff into Cardinia Road Drain and into Toomuc and Gum Scrub Creeks. Sediment-laden water also has the potential to be transported offsite, downstream to areas containing potential habitat for *L. raniformis*. There is also the potential for accidental spillage of chemicals from the construction area, which may runoff into culverts, the drainage line, and the creeks.

Increase in sediment input and input of toxic substances into Victorian rivers and streams due to human activities are both threatening processes under Schedule 3 of the FFG Act.

Once development is complete, and residential, commercial and industrial areas become occupied, stormwater runoff from roads and paved surfaces has the potential to drain into Gum Scrub Creek, Toomuc Creek, and any constructed ponds, wetlands and watercourses.

This runoff would be of greater volume and velocity than the runoff under current conditions. Runoff from residential areas often contains pollutants such as fertilisers, herbicides, oils, grease, petroleum, and seeds of weed species. Therefore, a reduction in water quality and weed invasion may occur in ponds, wetlands, both Toomuc and Gum Scrub Creeks, and in parts of the catchment further south as a result of the development of the Precinct.

Altered drainage patterns resulting from development also has the potential to modify the length of time the central drainage line and proposed associated stormwater treatment wetlands hold water. As one of the preferred habitat variables of *L. raniformis* is permanent water (Pyke 2002; Heard *et al.* 2004a; Hamer and Organ 2008), any reduction in permanent water may render the ponds and wetlands unsuitable as a potential movement corridor or habitat. The creation of new frog habitat should seek to maximise the number of ponds that provide permanent water levels throughout the year, while other ephemeral ponds should also be provided.

2.2.4 Roads and Vehicular Traffic

There is growing evidence from international research that roads and road traffic contribute significantly to amphibian mortality (Fahrig *et al.* 1995; Daly 1996; Vos and Chardon 1998; DeMaynadier and Hunter 2000; Hels and Buckwald 2001). This research suggests that many individual frogs may be killed by passing traffic while crossing roads between areas of habitat.

Frogs may undertake seasonal movements from overwintering sites to breeding sites and the construction of a road between the two important habitat areas may represent a significant barrier to breeding dispersal. Frogs may also move between breeding sites and other sites used for foraging and shelter, especially during and following wet weather.

If movement between habitats is impaired, such as by the creation of roads near potential or occupied habitats, the local population and possibly the wider metapopulation, may become fragmented, leading to local extinctions at waterbodies which cannot be recolonised by dispersing frogs. This is because fragmentation may increase the distance between waterbodies, beyond the distance typically travelled by dispersing *L. raniformis*.

Further, fragmentation leading to isolation of populations may result in reduced population size and increase the risk of extinctions through environmental stochasticity (e.g. drought, disease) and demographic stochasticity (e.g. inbreeding depression) (Hels and Buckwald 2001).

The consequences of these impacts on local frog populations in an area may not become evident for many years, although it is highly probable that the creation of a barrier to frog movement will reduce the long-term viability of a local population, and potentially, the wider metapopulation.

It is not known if or how traffic noise affects amphibian behaviour. However, traffic noise may interfere with the vocalisations by male *L. raniformis* in waterbodies adjacent to roads. Other aspects of the social behaviour of individuals may be affected such as changes in the spacing of calling males, which can potentially affect reproductive success (Robertson *et al.* 2002). Despite these potential consequences, *L. raniformis* is known to breed in waterbodies in close proximity to roads that carry heavy traffic, such as the Pakenham Bypass (Heard *et al.* 2004a).

Road construction can potentially result in the death of individuals through the gradual destruction and degradation of habitat. Road construction can lead to the sedimentation of waterbodies inhabited by frogs, reducing their suitability as habitat for *L. raniformis*. During the operational phase of a road, pollutants from vehicles, particularly accidental spillages from trucks, may wash into nearby waterbodies, usually via stormwater runoff. This may render such waterbodies unsuitable as breeding sites for several years.

Roads may also result in changes to adjacent vegetation, causing increased weed encroachment, and alter the hydrology (i.e. the frequency, timing, duration and extent of inundation) of nearby waterbodies. As discussed previously, modification of hydrology has the potential to reduce the suitability of waterbodies as habitat for *L. raniformis*, especially if the length of time they hold water (i.e. hydroperiod) is reduced.

In large scale residential or precinct developments, where waterbodies are often integrated into open space networks, such as parkland and general recreation areas, suitable frog habitat is almost always surrounded by an extensive road network. If no measures are installed to allow safe frog passage (drift fences, underpasses, culverts), foraging and dispersing individuals ultimately find their way onto paved surfaces, where they are susceptible to traffic strike. Therefore these mitigation measures are recommended as part of the Precinct's development to minimise further fragmentation of frog habitat and maintain connectivity between constructed ponds and wetlands.

It should also be noted that, sensitive design of the road network, including drainage reserve crossing points, and the location of constructed ponds and wetlands, will assist in minimising impacts on *L. raniformis*.

2.2.5 Human Access

Human occupancy of the Precinct has the potential to result in disturbance to frogs by people entering the newly created wetlands and frog pond areas. This may lead to the degradation of habitat in or around these waterbodies due to rubbish dumping, mechanical disturbance of vegetation from trampling, and weed invasion.

The placement of walking and/or bicycle paths and trails within 30 metres of frog ponds and stormwater wetlands should be avoided to minimise human disturbance in these areas. Construction activities should also be restricted in known habitat areas to minimise human and vehicular disturbance during the development of the Precinct.

2.2.6 Weeds

Increased weed encroachment into areas of indigenous or planted terrestrial and aquatic vegetation in wetlands and ponds may occur due to runoff from development. Weeds may also be transported via construction equipment and machinery, and people/animals entering the Precinct. Invasion of native vegetation by ‘environmental weeds’ is a threatening process under Schedule 3 of the FFG Act. Excessive weed growth can smother frog habitat, rendering it unsuitable as a breeding and/or foraging site.

2.2.7 Dog and Cat Ownership

Unrestrained dogs *Canis familiaris* and cats *Felis catus* have the potential to roam into frog ponds and wetlands within the Precinct. Cats, in particular, are known to predate upon dispersing or sheltering frogs. Predation of native wildlife by the Cat is a threatening process under Schedule 3 of the FFG Act.

2.2.8 Cumulative Impacts

In light of the loss of frog habitat and connectivity due to the construction of the Pakenham Bypass (Timewell 2003; Organ 2004; Organ 2005b), the loss of frog habitat elsewhere in the Pakenham area has the potential to further reduce the number of sub-populations and hence decrease the long-term viability of the metapopulation (Hamer and Organ 2008). Therefore, any impacts associated with residential development in the Precinct must be evaluated with consideration of the security of frog habitat in the wider Pakenham region.

2.2.9 Exotic Predators

2.2.9.1 Plague Minnow

The introduced Plague Minnow *Gambusia holbrooki* has been identified as a possible factor in the decline of species in the “bell frog species complex”, which includes *L. raniformis* (Mahony 1993; White and Pyke 1996; Hamer *et al.* 2002) because it eats the eggs and tadpoles of these species (Morgan and Buttermer 1996). This species may reduce the potential of a site to support breeding populations, although the extent of predation depends on aquatic vegetation and habitat complexity, and waterbody permanency (Hamer *et al.* 2002). Predation by Plague Minnow on tadpoles of *L. raniformis* may be a significant threat to the species (NSW Department of Environment and Conservation 2005a).

Within the Precinct, Plague Minnow was recorded in Gum Scrub Creek and is likely to occur in other drainage lines and some farm dams in the area. The presence of this fish in Gum Scrub Creek, together with the lack of established emergent vegetation, limits the habitat potential of the creek for *L. raniformis*, particularly for breeding purposes.

2.2.9.2 Red Fox

The Red Fox *Vulpes vulpes* has been recorded within the Precinct. The Red Fox is known to eat adult members of the bell frog species complex (NSW DEC 2005b), although it has not been identified as a threat to *L. raniformis* in the draft Recovery Plan (NSW DEC 2005b). Additionally, in the NSW Threat Abatement Plan for Predation by the Red Fox (NPWS 2001), *L. raniformis* is considered to be a species with a low sensitivity rating, which indicates that population impacts are unlikely to result from predation by the Red Fox. Nonetheless, there is likely to be some predation on frogs in the Pakenham area by the Red Fox (author pers. com.).

2.3 Potential Improvements

If frog ponds, wetlands, culverts and connecting habitats along the creeks and drainage line are constructed to the design criteria outlined in Sections 3.4.5 and 3.4.6 of this plan there is potential, not only for *L. raniformis* populations of the area to be sustained, but also for them to increase in the future. Some of the potential improvements to *L. raniformis* habitats associated with the proposed development include:

- The construction of new wetlands and ponds designed to rehabilitate area that currently provide low quality habitats, such as Gum Scrub Creek and the Cardinia Road Drain, increasing the amount of high quality habitat within the area;
- The overall improvement of water quality in creeks, wetlands and ponds; and,
- The provision of additional breeding habitat in the form of ephemeral and permanent ponds and stormwater treatment wetlands.

Currently, the overall habitat quality within the Precinct is relatively low, given that a large percentage of waterbodies are currently unsuitable for the species. This is due to a number of factors, which include:

- Stock grazing and subsequent waterbody degradation;
- Limited surrounding, fringing, submerged and emergent vegetation;
- No surrounding habitat features such as rocks and logs;
- Low water levels;
- Low water quality; and,
- Prevalence of exotic fish species such as Plague Minnow.

Several of the larger dams, including the large ‘turkey-nest’ dam, to the east of Cardinia Road and in the south of the Precinct (Dam 19), and the elongated dam to the west of Cardinia Road and south of Lecky Road (Dam 38), are proposed to be removed. Although *L. raniformis* have been recorded in these dams previously and in a concurrent survey (Ecology Partners Pty Ltd, 2006, 2008e, 2009b), they were not recorded in surveys conducted within the precinct during the 2008/2009 season (Ecology Partners Pty Ltd, 2009a). These two dams, despite offering sub-optimal conditions for the species over the last active season, are most important in periods of extended drought due to the permanency of the water they contain, and as such, are considered to be important habitat for the species in the area. The proposed removal of these dams must be offset by the creation of wetlands of equal size and frog ponds within the Cardinia Road Drain open space corridor.

Through the design, construction and re-vegetation of wetlands and ponds, as well as ongoing maintenance and management, there is likely to be an overall significant increase in the quality of *L. raniformis* habitat within the Precinct, which will contribute to the viability of the extant population in the long term.

3 CONSERVATION MANAGEMENT PLAN: PHASE ONE

3.1 Objectives

The primary objectives of this CMP are to outline specific measures to ensure:

1. That the proposed development of the Precinct has a negligible impact on any resident *L. raniformis* populations;
2. That any currently occupied *L. raniformis* habitat is either retained or enhanced; and,
3. The ongoing survival of *L. raniformis* in the Pakenham area in the future.

The plan provides comprehensive management guidelines which facilitate the ongoing protection and maintenance of *L. raniformis* populations, and their associated habitats, into the future, and features two main stages:

1. Provision of detailed habitat retention and improvement guidelines and detailed management requirements for the development construction phase, including a frog salvage and translocation plan;
2. Monitoring and maintenance recommendations subsequent to the completion of construction works.

The implementation of the plan will require the commitment of the future public land managers (Council and Melbourne Water), the collaboration of all relevant stakeholders and ongoing reviews by DSE and DSEWPC to ensure targets are being achieved.

Monitoring procedures detailed within this CMP, and all other management recommendations and protocol, are to commence as soon as the CMP has been approved by the regulatory authority.

Note: A plan for management of *L. raniformis* in relation to the Pakenham Bypass, part of which forms the northern boundary of the Precinct development, has been prepared for VicRoads (Organ 2005b). The current plan provides for management of the species in the area of the Officer development in such a way that the two plans are complementary. The success of both plans, and achievement of their objectives for the species, will be dependent upon cooperation and integrated management on the part of both the future developers of the Precinct and VicRoads.

3.2 Management Plan Implementation, Timeframe and Review

The commencement of the CMP will be defined as the approval date of the CMP by the Department of Sustainability and Environment. The CMP will then be implemented in perpetuity.

The CMP therefore outlines specific actions for management and monitoring for two operational phases:

- Phase 1, which includes requirements from the date of CMP approval through Pre Construction, Construction and Management and Monitoring stages for 10 years post completion of construction of ponds; and,
- Phase 2, which includes ongoing management and monitoring actions to be undertaken in perpetuity, which will commence at the completion of Phase 1, 10 years following construction

As the Precinct may not be fully developed for 30 years, the ‘completion of construction’ will occur in different parts of the Precinct at different times, staggered over an extended timeframe.

The ‘completion of construction’ is therefore defined by the date that retained and constructed ponds and wetlands are approved by DSE to have been constructed or rehabilitated to the standards set out in this CMP (as recorded at Appendix 7).

Management recommendations may need to be amended or updated if new information becomes available, or if management actions are considered inappropriate or inadequate for the long-term persistence of *L. raniformis* within the Precinct.

New information may become available through ongoing monitoring procedures undertaken by the contracted ecological consultant, or following review of ongoing reporting submitted to DSE. Recommendations based on this information will be provided to Cardinia Shire Council, who will ultimately be responsible for amending the existing CMP as required. Any extension of the duration, scope, or requirements outlined in this CMP, or any changes in proposed works, management actions and monitoring requirements, which may be deemed necessary during the life of the CMP must be determined by consultation and agreement between DSE, DSEWPC, Cardinia Shire Council and Melbourne Water, and subject to an appropriate funding mechanism. Public land managers that own land property within the Precinct will not be responsible for funding contingency actions unless a supplementary funding stream can be identified. If contingency funding is required public land managers will participate in identifying an appropriate funding source to enable these actions to be undertaken.

It is intended that in any year, during Phase 1 of the implementation of this CMP, that frog population and habitat management actions are undertaken, and implementation of habitat protection and enhancement measures occurs, an annual review of monitoring results and management outcomes will be undertaken by a qualified ecological consultant in conjunction with DSE, so that if any issues arise, they can be identified, rectified and addressed in the construction and augmentation of subsequent ponds, within the parameters of allocated funding.

3.3 Pre-Construction Phase

The pre-construction phase refers to the period prior to development occurring on any individual property within the Precinct, i.e. prior to any permits being issued and acted upon for subdivision, buildings and any other works that are associated with the implementation of the DSS and the PSP. Where a superlot subdivision is undertaken, this phase may continue to apply until such a time that subsequent permits are issued for works on that superlot.

During this phase, detailed planning and design will be undertaken for the Precinct.

For *L. raniformis*, this stage of the development is essential for identifying important *L. raniformis* habitat, creating additional or compensatory viable, secure and stable habitat for the species, through ecologically sensitive landscape design and open space networks, and to ensure that the Precinct remains a key area for the conservation of species in the long term.

3.3.1 Areas Requiring *L. raniformis* Habitat Maintenance

All dams within the Precinct that have been identified as occupied sites, or as supporting suitable habitat for *L. raniformis* must be maintained to the satisfaction of DSE, such that conditions remain suitable for the species prior to their removal (if required) as approved by DSE. This will include:

- The provision of permanent water;
- The retention of existing vegetation;
- No draining or removal of dams prior to the commencement of Precinct construction works without approval from DSE or DSEWPC; and,
- No change in land use prior to the commencement of Precinct construction works without approval from DSE or DSEWPC.

The transfer of ownership of existing waterbodies, land designated as terrestrial habitat, or open space to Melbourne Water or Cardinia Shire Council will not be supported without the provision of funding to maintain the waterbody or terrestrial habitat in accordance with the requirements outlined above, unless rehabilitated to the standards set out in Section 3.4.5.

3.3.2 Priority Areas for *L. raniformis* Conservation in the Precinct

The results from the most recent surveys, and the ongoing mark-recapture study in progress for monitoring the effects of the Pakenham Bypass, have revealed that 10 of the approximately 40 within the Precinct have been occupied. *Litoria raniformis* was recorded in dams 20, 21, 27, 33, 34 and 35 during the most recent surveys (Ecology Partners Pty. Ltd. 2009a), and in 37, 38, 39 and 40 in a previous study (Ecology Partners Pty. Ltd. 2008d, 2008e) (Figure 2). The results of the Pakenham Bypass mark-recapture study also demonstrate that frogs move between sites over the course of the active period (October – March), including juvenile dispersal from breeding sites to other waterbodies in the area.

Because of the positive correlation between the occurrence of *L. raniformis* and the proximity to permanent drainage channels and streams throughout Pakenham, it is likely that Gum Scrub Creek, Cardinia Road Drain, and Toomuc Creek are important dispersal corridors for the species in the Precinct. Given these results, the Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain open space corridors are considered high priority conservation areas. These corridors will be retained and extant habitat conditions enhanced wherever possible (Figure 2 and 3).

During periods of prolonged drought, in which many of the dams within the Precinct dry up or become unsuitable for *L. raniformis*, larger dams with increased water permanency and stability become critical to the ongoing survival of the species in the immediate area. Individuals of the species in the local area would migrate to such dams when others were drying up. There are two of these dams within the Precinct, Dam 19 and Dam 38 (Figure 2).

Although *L. raniformis* was not detected at these two dams during the most recent survey within the Precinct, they have been recorded at Dam 38 in both concurrent and previous studies (Ecology Partners 2006, 2008e, 2009b).

Dam 19 has not been surveyed in any previous studies except for the latest targeted survey (Ecology Partners Pty Ltd 2009a), due to the landholder prohibiting access, although it is likely to be utilised by *L. raniformis* when other dams in the area are evaporating or dry.

The removal of these two dams will be considered a last resort, and any replacement wetlands or ponds will be larger, deeper, and provide higher quality habitat characteristics, specific to the species.

The population in this high priority conservation area is linked to additional waterbodies to the east and south-east that are currently occupied by *L. raniformis* (Hamer and Organ 2008). It is reasonable to conclude that the population in the Precinct is part of the far north-west corner of a metapopulation that extends throughout Pakenham, Nar Nar Goon and Bayles, south of the Pakenham Bypass.

3.3.3 Priority Areas for Habitat Creation and Enhancement in the Precinct

Aside from providing stormwater conveyance and conservation functions, the Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain open space corridors within the Precinct provide opportunities to create additional high quality habitat and augment currently degraded habitats in which the population currently exists.

In addition, frogs ponds and wetlands created along the eastern, western and southern boundaries are likely to be colonised by *L. raniformis*, providing that they contain the necessary habitat characteristics such as ample size, patches of emergent and submerged vegetation, have good water quality, and provide a diversity of pond habitats, i.e. some with permanent water for habitat connectivity, and others with an ephemeral hydroperiod to ensure that some ponds remain fish free (see Section 4.6).

Given that the species is known to use Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain as dispersal corridors, suitable habitat created along these watercourses is highly likely to be colonised.

A total of 16 ponds are proposed to be created specifically for *L. raniformis* throughout the Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain open space corridors, in addition to seven ponds within the northern and southern east-west corridors within the Precinct. Ten existing waterbodies are proposed to be retained and enhanced as part of the proposed open space network in accordance with the guidelines for the construction of dedicated frog ponds (Section 3.4.5). Eleven large stormwater treatment wetlands are proposed to be constructed in Cardinia Road Drain open space corridor. Two of these wetlands are proposed within the Toomuc Creek corridor, north and south of Thompsons Road. Locations of all of proposed ponds and wetlands, in addition to the approximate timing of their creation are shown on Figures 3, 4 and 5.

The open space corridors through which Gum Scrub Creek and Toomuc Creek flow will be protected. Pyke (2002) recommends a minimum movement corridor width of 20 metres, (preferably 50 metres), for populations of *L. aurea* in New South Wales. A similar approach has been adopted in designing corridors for *L. raniformis* in Victoria, although the minimum buffer distances for direct impacts that will be implemented around dedicated frog ponds within the Precinct will be 30-40 metres.

It should be noted that this buffer distance, which should minimise direct impacts on habitat areas caused by light pollution, public infrastructure facilities, paths and roads, has been applied based on the provision of larger areas of terrestrial habitat being provided within the Precinct through the creation of open space habitat corridors, to the specifications listed below.

The design of the Precinct provides for the creation a network of new habitat corridors by establishing:

- a 100 metre wide buffer from the centre of Gum Scrub Creek to the future development area;
- a 50 metre wide buffer from the top of the bank of Toomuc Creek to the future development area;
- a minimum 70 metre wide corridor along Cardinia Road Drain, widening to a total width of 100 metres wherever stormwater treatment wetlands and dedicated frog ponds are located;
- a 150 metre wide transmission line easement along the Precinct's southern boundary, with interspersed ponds located at least 30 metre from the edge of future roads;
- a minimum 30 metre wide east-west corridor along the Pakenham Bypass, widening to 70 metre around wetlands and frog ponds, between Gum Scrub Creek and Cardinia Road; and,

- if possible, a larger catchment area will be provided adjacent to frog ponds that are not connected to permanent waterways through landscape design. This will provide a local water source, allowing the replenishment of these ponds without the risk of fish invasion from the online creek and drainage systems.

The creation of these corridors will also present opportunities to rehabilitate degraded swamp scrub vegetation, provide terrestrial foraging habitat for *L. raniformis*, and improve the quality of instream aquatic habitat for frogs, fish and other native fauna. A series of large dedicated frog ponds located off the main drainage channels will be constructed along the lengths of Gum Scrub Creek and Cardinia Road Drain, in addition to eleven large online wetlands.

3.3.4 Population and Habitat Monitoring

Local frog populations are known to vary on spatial and temporal scales depending upon habitat conditions at a particular site.

It is therefore important that population and habitat monitoring is undertaken prior to, during, and following the completion of the stormwater treatment wetland, frog pond and overall precinct construction, and for 10 years post construction (as defined in Section 3.2).

Prior to the commencement of construction, the annual monitoring regime, as described in this section, will commence immediately following approval of the CMP for all existing dams up until the time that:

- they are removed (if removal has been approved within this CMP); or,
- in the case of frog ponds that are proposed to be retained - up until the time that the 10-year monitoring period for adjacent newly constructed ponds is completed.

For the Precinct as a whole, monitoring is required to determine if *L. raniformis* has naturally colonised frog ponds and stormwater treatment wetlands, to determine if the population is persisting in the precinct during and following development, to determine reproductive success, and to ensure that management actions and habitats are suitable for a viable *L. raniformis* population.

Specific survey procedures will follow those used to monitor the species elsewhere, such as the detailed mark-recapture investigations being conducted throughout the Officer and Pakenham area (Organ in prep.).

The following survey methodology will apply to all surveys undertaken throughout the duration of this CMP.

Surveys will be undertaken annually during the species' active period between September and March, comprising:

- At least one day of diurnal survey during the active period and one day during the inactive period will be conducted to collect data on habitat variables, and to ensure that frog ponds remain suitable for the species; and,

- At least three nights of nocturnal monitoring surveys over the active period will be undertaken (Appendix 4), including one survey between December and February for metamorphs around the perimeter of frog ponds and wetlands.

Population and habitat monitoring of frog ponds, stormwater treatment wetlands, and associated habitats within the Precinct, will comprise the following:

- During diurnal surveys observers will walk around the perimeter of frog ponds and stormwater treatment wetlands to locate frogs basking on vegetation and/or to listen for frogs entering the water when alarmed;
- Nocturnal monitoring will be conducted on still nights when air temperatures are above 13°C, preferably less than 24 hours after rainfall;
- Where possible, survey areas and intensity at each waterbody will be the same during each visit;
- An initial period of five minutes will be spent conducting call-playback to locate resident frogs (all species) in and adjacent to wetlands and ponds;
- Experienced personnel will then use 30-50 watt 12 volt hand-held spotlights to locate calling males on floating vegetation in the waterbody and around the perimeter of wetlands and ponds. This technique is known to be reliable, as the eyes of frogs will often reflect light back allowing them to be located;
- Surveyors will search ground-level habitat including surface rocks, underneath hard litter, and at the base of vegetation for frogs;
- Morphological data including sex, body size, weight and reproductive condition will be recorded for all frogs captured; and,
- Each frog above 40 mm in size captured will also be permanently marked with a PIT tag so that subsequent recapture data can be obtained. Prior to tag insertion, the affected area of skin will be swabbed with iodine solution. The PIT tag will then be inserted posteriorly beneath the skin along the dorso-lateral line using a sterile syringe in which each tag is packaged. Wounds will be sealed using inert sealant tissue glue immediately after tag implantation. All specimens recaptured (unique PIT number) will be identified using an electronic tag reader (minireader) and their location recorded using a handheld GPS unit. The purpose of marking frogs is to accurately determine population sizes and density of frogs at a given wetland or pond, to establish movements within and between waterbodies and to determine the status of the population (i.e. increasing, decreasing or stable) within the Precinct.

Several site-specific habitat variables will also be assessed during the monitoring period (See also Section 3.5), specifically:

- Wetland depth, flow, permanency and a visual assessment of water quality;

- Availability and suitability of shelter and over-wintering sites;
- Vegetation diversity, structure, composition and percentage of cover;
- Presence of introduced fish, particularly Plague Minnow and Goldfish; and,
- Presence of pollutants, rubbish and other threatening processes.

A photographic reference will be taken at each pond and wetland at a marked location so that comparisons of habitat conditions can be made over time.

Measures to reduce the possible spread of infectious pathogens will be implemented in accordance with standards described by the New South Wales National Parks and Wildlife Service (NPWS 2001).

This includes, as a minimum, all equipment and footwear being treated with an appropriate biodegradable disinfectant (i.e. diluted bleach) prior to conducting surveys, while sick or injured frogs will be taken from the Precinct to a registered veterinarian for further analysis.

Commercially-available, collapsible bait-traps constructed of nylon netting will be baited with meat or florescent glow sticks, and then set at the completion of each spotlight survey, in an effort to capture tadpoles at predetermined locations to determine breeding activity within the wetland or pond. At least two traps will be set at each wetland for a minimum of two nights over the breeding period of *L. raniformis*.

Traps will be suspended (use of floats) so that at least part of the trap emerges above water-level, allowing tadpoles to breathe. Traps will then be retrieved the following morning, and checked for tadpoles and predatory fish. All tadpoles caught will be identified to species level, counted and released. Alternatively, dip nests will be used to sample for tadpoles at, or in the vicinity of sites where calling males are identified.

3.3.5 Mitigation Measures

There are several measures that will be incorporated into the Precinct to reduce the potential adverse impacts that may result from precinct development on potential *L. raniformis* habitat. Measures that will be adopted at the pre-construction phase of the development include:

- All existing waterbodies providing habitat for *L. raniformis* will be protected and the existing habitat values maintained. In the case of ponds where removal has been approved (as shown in this CMP), this applies until such time that the pond is removed;
- All planning permit applications within the Precinct will include the condition that a Construction Environmental Management Plan must be developed and implemented, including the following elements that are to be prepared in consultation with a suitably qualified ecological consultant, to the satisfaction of Cardinia Council and DSE:
 - A site specific salvage and translocation plan, if habitat for *L. raniformis* is proposed to be removed;

- erosion and sedimentation controls in accordance with the EPA Victoria Guidelines;
 - fencing of all waterbodies and habitat areas during adjacent construction works (unless the works are associated with the removal of an existing dam);
 - weed management actions, which address Cardinia Shire Council's Weed Management Strategy, particularly with regard to the environmental weeds list;
 - feral animal control measures for individual properties, to be updated in accordance with any future development of a Feral Animal Control Plan or Management Strategy by Cardinia Shire Council; and,
- Potentially placing a covenant on the development restricting cat ownership. Responsible pet ownership will be encouraged by Council through signage and provision of information, particularly regarding the proper confinement and restraint of pet animals.

3.3.6 Required Approvals

Management authorisation to 'live capture', collect and relocate *L. raniformis* under the *Wildlife Act 1975* specifically for the development of the Precinct has not yet been granted, however Ecology Partners Pty. Ltd. currently has management authorisation for the salvage and translocation of *L. raniformis* within Cardinia Shire (Permit Number 10004462).

Any marking of animals would need to be in accordance with a Department of Primary Industries animal ethics approval.

3.4 Construction Phase

The construction phase refers to the stage of the development when works occur to implement the Cardinia Road Employment Precinct Structure Plan and supporting drainage scheme. It is characterised by the commencement of initial disturbance (i.e. earthworks, existing building demolition, vegetation removal), up until the completion of development of individual properties within the Precinct.

The construction phase includes all actions that occur within this timeframe, including, but not limited to, landscaping, frog pond and wetland construction, building construction, road construction or any other activity that disturbs the existing environment.

Specific to *L. raniformis*, the construction phase includes the removal of existing dams, construction of wetlands and frog ponds, and the rehabilitation and augmentation of Cardinia Road Drain and both Toomuc and Gum Scrub Creeks.

3.4.1 Staging of Proposed Works

The need for a staged approach to the construction and development of the Precinct is required, due to:

- the proposed initial completion of the central and northern parts of the Precinct, and gradual construction of southern areas over the next two to three decades, with little certainty about the exact timing of development; and,
- the removal of known *L. raniformis* habitat in the precinct which has the potential to leave the species without suitable habitat and sever habitat connections to adjacent sites. Therefore developmental staging is required to ensure that there is sufficient suitable habitat provided at all times for the species.

The following staging principle should be applied where possible.

Staging Principle: Habitat for *L. raniformis* should not be removed until a sufficient number and area of proposed new ponds and wetlands are constructed and the habitat requirements in the constructed areas are established (i.e. vegetation growth and appropriate water level and quality apparent). Generally, this is expected take approximately 12 months, but could take up to 2 years. The aim of this principle is to ensure that the existing amount of suitable habitat for the species is available at all times throughout the construction process. The removal of any existing dam where *L. raniformis* has been recorded previously, may only take place following the successful colonisation of new frog ponds and wetlands in its vicinity. For example, based on the initial construction and development, focusing on the northern and central areas of the Precinct, proposed frog ponds (14–18) and wetlands (1–6) would need to be constructed, vegetated and left to establish for at least 12 months, before the removal of existing waterbodies in that specific area (see Figures 3 and 4).

Removal of existing waterbodies and the construction of proposed frog ponds and stormwater treatment wetlands will generally follow the development-sequencing schedule (Figure 4). The development-sequencing schedule is intended only as a guide and has been developed based on the anticipated timing of DSS construction and subdivision of land.

Particular groups of ponds (1 and 2) are likely to be constructed at the outset of the project and groups (3, 4 and 5) being constructed later. Exact dates are unable to be assigned at this stage of planning. As a result, the staging principle will be applied to planning permit applications for individual properties at the time the applications are made.

3.4.2 Mitigation Measures

There are several measures that will be incorporated into the proposed design of the new open space corridors to reduce the potential adverse impacts that may result from Precinct development on the subject site, and the removal of 35 dams. Other mitigation measures can be aimed at minimising the potential impacts of specific construction activities.

Measures to be adopted at the construction and post-construction phases of the development include:

- Constructing stormwater wetlands and frog ponds along the Toomuc Creek, Gum Scrub Creek, and the Cardinia Road Drain open space corridors, and the implementation of routine maintenance.

Frog ponds need to support key *L. raniformis* habitat attributes such as emergent, submerged and floated vegetation, and extensive terrestrial refuge sites such as rocks and timber;

- Constructing an east-west dispersal corridor along the southern boundary, including the creation of several interspersed permanent frog ponds, allowing frogs to move between wetlands and ponds along each of the north-south open space corridors. In addition to interspersed ponds, any linear reserves will be revegetated with indigenous grasses and sedges, or species typical of Swamp Scrub EVC, while introduced weeds must also be controlled. The southern east-west corridor is to be at least 150 metres wide;
- Constructing an east-west dispersal corridor along the northern boundary, including the creation of several interspersed permanent ponds, allowing frogs to move between wetlands and ponds along the northern boundary between Cardinia Road (to freeway underpass) and Gum Scrub Creek. In addition to interspersed ponds, any linear open space will be revegetated with indigenous grasses and sedges, or species typical of Swamp Scrub EVC, while introduced weeds must also be controlled. The northern east-west corridor is to be at least 50 metres wide, and 70 metres where there are frog ponds to account for the 30 metre frog pond buffer;
- Establishing and maintaining a minimum buffer distance around dedicated frog ponds, of at least 30 metres (see Section 3.4.4; Figure 5). No roads, footpaths or other infrastructure will be located within this buffer zone. This buffer zone will also be a designated a no-go zone during construction in adjacent areas. In regard to open space networks (where proposed frog ponds will be located), any lighting or paths for recreational purposes must be located outside of frog pond buffer zones;
- Providing terrestrial habitat for Growling Grass Frog within the 30 meter buffer as well as in other connected areas through the open space network and creek corridors. The terrestrial habitat will be provided through appropriate planting of vegetation using indigenous species.
- Minimising the likelihood of frog mortality through road kill, by installing frog exclusion or drift fences along roads adjacent to any potential frog habitat, the extent of which will be determined through consultation with an experienced ecological consultant and DSE;
- Minimising the impact of removing Dam 38 by the construction and establishment of artificial suitable breeding habitat within the Precinct prior to removal. Approval is subject to demonstration of successful reproduction, as defined by the presence of Growling Grass Frog metamorphs at a minimum of one waterbody shown in Figure 3, to the satisfaction of DSE. Salvage and translocation procedures (set out in Section 3.4.3) must be followed during any disturbance or removal of this waterbody;
- Undertaking pre-clearance surveys prior to removal of existing waterbodies by a suitably qualified herpetologist to salvage and translocate any resident frogs from existing ponds where they have been recently recorded, to nearby suitable habitat (as determined by the process set out in Section 3.4.3);

- Constructing proposed wetlands and ponds at the outset of development where possible, particularly where any individual property contains existing waterbodies designated for removal and is proposed to accommodate new frog ponds and/or stormwater treatment wetlands;
- Follow the staging principle where possible, to allow at least 12 months for new ponds and wetlands to establish, prior to removal of any existing dams.
- Gradually draining existing dams proposed for removal to encourage any resident frogs to naturally disperse and colonise newly established adjacent ponds. Frog pond and wetland design guidelines are provided in Sections 3.4.4 and 3.4.5, while a list of typical wetland vegetation species is provided in Appendix 6;
- Ensuring water and drainage is treated appropriately on-site to minimise impacts on the created frog ponds, wetlands and dispersal corridors (catchments under 60 hectares are generally to be managed by Cardinia Shire Council);
- Providing appropriate signage along the perimeters of ponds and wetlands to prevent accidental entry by construction personnel and machinery during construction;
- Discouraging all residents from planting known environmental weeds and declared noxious weeds within urban gardens; and,
- Prohibiting dogs being off-leash within the creek and drainage line corridors, including parks adjacent to, or integrated with, these corridors, and ensuring any parks providing dog off-leash areas are located centrally within residential or employment areas, away from habitat areas for *L. raniformis*.

The loss of any artificial water body must be compensated by the creation of another pond or wetland within the Precinct.

These ponds and wetland must be incorporated into a zone that is dedicated to conservation and public recreation within the Precinct, and must be connected to dispersal habitat. The maintenance of dispersal corridors in this area and the provision of extensive created frog habitat would offset the loss of any of the dams and will compensate for impacts on existing frog habitat.

Any frog habitat created within the Precinct must be linked to wetland habitat outside the Precinct, through the construction of frog underpasses or culverts where the development is bordered by roads, or through creating small ponds as ‘stepping stones’ and moist drainage channels to facilitate frog movement. The dispersal corridor along the northern boundary of the Precinct will provide habitat connectivity to the previously created underpasses as part of the Pakenham Bypass project.

Habitat along Gum Scrub and Toomuc Creeks will be enhanced by grading and revegetating the banks with indigenous species. The creeks presently contain low quality habitat for frog movement.

Recreating banks with gentle slopes and planting with indigenous wetland species would improve the habitat quality of the creeks, and central drainage line. A summary of mitigation measures is provided below in Appendix 2.

3.4.3 Frog Salvage and Translocation

The salvage and translocation process outlined in this section will be required for the removal of any existing waterbody in the Precinct.

As a condition of any planning permit where a waterbody is proposed to be removed, a site specific salvage and translocation plan will be required. The salvage and translocation plan is to be prepared to the satisfaction of DSE and Council prior to the removal of any waterbody, in accordance with the protocol outlined in this section.

It should be noted that the protocol outlined in this section will be the sole responsibility of each landowner/developer as part of their subdivision/construction works.

As per the recommendations in Heard *et al.* (2004a) and Organ (2005a), *L. raniformis* salvage and translocation measures will be implemented both immediately prior, and during disturbance to any dams, or Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain within the Precinct.

Salvage and translocation procedures at all dams, creeks, or drainage lines that are proposed to be disturbed or removed must then be followed, and are detailed below.

Any salvage and translocation operation must follow the relevant protocol during:

- Decommissioning of existing waterbodies (refer Section 3.4.3.1);
- Waterbody pre-removal requirements (i.e. frog salvage) (refer Section 3.4.3.2); and,
- Translocation, if any Growling Grass Frogs are found during salvage (refer Section 3.4.3).

3.4.3.1 Decommissioning of Existing Waterbodies

Waterbodies proposed to be removed must first be drained, and left without water for at least one month prior to any further disturbance, to allow any remaining *L. raniformis* to naturally disperse and recolonise adjacent habitats. Dams should be drained using filters on pump intakes to reduce frog mortality.

3.4.3.2 Salvage Requirements

Prior to works being undertaken, areas of suitable Growling Grass Frog habitat will be salvaged by a suitably qualified zoologist. The site will be searched for Growling Grass Frog as close as possible to the commencement of works (i.e. 1 day – 1 week).

3.4.3.2.1 Salvage during active season (September – March)

Known/potential habitat areas

- Salvage will take place prior to site disturbance, but as close as possible to proposed construction periods, i.e. one day to a week (a longer intervening period may mean frogs have moved back into the area). Two observers will spend a minimum two nights surveying, by spotlighting in key areas within the Precinct prior to the commencement of works in their vicinity;
- Frog and tadpole salvage will also be undertaken during the drainage/pumping of any dams identified as known habitat by the species within the Precinct;
- Salvage during preliminary earthworks, drainage line construction, creekline augmentation and landscaping, and frog pond removal or filling will also be conducted. This will involve an observer actively searching surrounding terrestrial habitat (i.e. 200 metre from a waterbody) such as soil, vegetation and other ground debris for frogs immediately prior to, and during excavation around and/or filling of existing waterbodies. This will principally occur in the vicinity of Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain, occupied dams, and any other dams within the Precinct; and,
- Footwear will be washed in disinfectant at the beginning and end of each salvage period to prevent the introduction and/or spread of any diseases.

Unsuitable habitat areas

In unsuitable habitat areas, only salvage during construction will be conducted, except at dams that are completely dry.

- This will involve an observer actively searching soil, vegetation and other ground debris for frogs immediately prior to, and during excavation works. This will principally occur in the vicinity of Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain, occupied dams, and any other dams within the Precinct;
- Footwear will be washed in disinfectant at the beginning and end of each salvage period to prevent the introduction and/or spread of any diseases; and,
- Dams that are completely dry will not require any salvage and translocation measures.

3.4.3.2.2 Salvage during inactive season (April to August)

Known/potential habitat areas

As any *L. raniformis* that may be present will be aestivating, no nocturnal surveys prior to construction activities will need to be undertaken.

- Salvage during construction will be conducted at all dams, even if they are dry.

This will involve an observer actively searching areas around wetlands, creeklines, and drainage lines (i.e. 200m) including soil, vegetation and other ground debris for frogs immediately prior to, and during excavation works. This will principally occur in the vicinity of Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain, occupied dams, and any other dams within the Precinct; and,

- Footwear will be washed in disinfectant at the beginning and end of each salvage period to prevent the introduction and/or spread of any diseases.

Unsuitable habitat areas

- In unsuitable habitat areas, only salvage during construction will be conducted, except at dams that are completely dry. This will involve an observer actively searching soil, vegetation and other ground debris for frogs immediately prior to, and during excavation works;
- Dams that are completely dry will not require any salvage and translocation measures; and,
- Footwear will be washed in disinfectant at the beginning and end of each salvage period to prevent the introduction and/or spread of any diseases.

Any frogs encountered during salvage operations will be removed from properties within the Precinct and released at a predetermined translocation site in the immediate area (see below). Salvage measures will be undertaken by a qualified zoologist experienced with these operations. Salvage must be undertaken at all dams, creeks, or drainage lines that are proposed to be disturbed.

All salvage procedures will be conducted in accordance with the hygiene protocol for the control of disease in frogs (NPWS 2001).

If a suitably qualified herpetologist/zoologist is not present at any waterbody during construction activities, contractors will be required to contact a nominated ecological consultant immediately in the event that any frogs are located, and cease works immediately, until the ecological consultant is present on site to supervise further works in the immediate area.

Contractors will be made fully aware of the appearance of *L. raniformis* through the provision of an identification sheet at the outset of construction works, which will be available for download off the Cardinia Shire Council website.

In the event that a zoologist is not on site and *L. raniformis* is discovered, any individuals will be stored in an appropriate container (see below) and kept in a cool place out of direct sunlight until a qualified herpetologist/zoologist arrives.

An emergency handling kit will need to be prepared prior to the commencement of construction works. It must be easily accessible on site and all contractors must be briefed on its location and how to use it. As a bare minimum it must contain:

- A *L. raniformis* identification sheet;
- Plastic holding containers, at least 20 x 20cm in size, which are sealable but have adequate aeration (i.e. several holes in the lid to provide some air flow);
- Only one frog should be temporarily housed per container if there are multiple individuals located); and,
- Latex gloves (new pair to be used for each frog handled).

Given that *L. raniformis* is active for only part of the year, generally between September and March, salvage procedures differ depending on the time of year they are undertaken.

3.4.3.3 Translocation Protocol

Potential translocation sites in the vicinity of the Precinct have been determined (Figure 3). In order to translocate frogs to another site in the local area a number of national and Victorian legislation and conditions would need to be met.

Currently there are four potential translocation sites, which are considered suitable:

- 1) the constructed frog pond and wetland immediately south of the Pakenham Bypass and west of Cardinia Road;
- 2) the constructed frog ponds immediately south of the Pakenham Bypass and west of Toomuc Creek;
- 3) the large dam in adjacent farmland east of Toomuc Creek and south of the Pakenham Bypass; and,
- 4) if frog ponds and wetlands are established and provide suitable habitat conditions, constructed wetlands proposed within the Precinct.

Prior to frog translocation, owners or land managers of the translocation sites need to be notified and an agreement made to ensure that future land use and management does not compromise the longevity of the species within the Precinct. This should be in the form of a letter of support. Additionally, the chosen translocation sites would need to be agreed upon by the proponent and DSE.

A qualified zoologist, with specific translocation experience, must undertake frog translocation processes. The following applies:

- Prior to release a frogs morphological data including body size, sex and reproductive condition will be recorded for all frogs captured;

- Each individual captured will be marked by injection of a passive integrated transponder (PIT) tag. This technique is currently being used by Ecology Partners Pty. Ltd. as part of a detailed mark-recapture study on the species throughout the Officer and Pakenham area. The technique is also being used as part of a mark-recapture studies on *L. raniformis* in the Merri Creek Corridor (Organ per obs.), and has been used successfully to individually mark *L. aurea* (a closely related species of *L. raniformis*) during research in New South Wales (Christy 2000; Organ per obs.);
- Frogs will be released at night into favourable micro-habitats such as areas containing rocks or dense vegetation around the perimeter of a waterbody where there is sufficient cover;
- Frogs will be translocated as soon as practicable after capture;
- Translocation of any frogs must be undertaken to minimise potential for the spread of diseases (chytrid fungus), and impacts on *L. raniformis* and other frog populations at translocation sites (refer to Section 3.4.3);
- Any visibly sick or dying specimens will not be translocated and will be transported to a registered veterinarian for further analysis, to determine if infected with chytrid fungus;
- The introduction of *L. raniformis* from nearby source populations into created (artificial) ponds may be considered if the species has not naturally colonised ponds after two years, and if habitats are considered suitable for the long-term persistence of populations (i.e. ongoing breeding and recruitment) within the Precinct. However, this would be subject to a separate approval process and permits would be required from DSE. DSEWPC may also need to be notified if frogs are to be translocated into ponds; and,
- The success or failure of frog translocation will be monitored and documented and submitted to DSEWPC and DSE for review on an annual basis, following the results of required monitoring procedures at all *L. raniformis* habitats through the Precinct. This will involve the inclusion of the final translocation site in the annual monitoring surveys (if any *L. raniformis* are translocated during the development of the Precinct).

3.4.4 Frog Pond Design and Construction

Key design requirements to be incorporated into pond creation will follow the recommendations of Organ (2005a, 2005c), which outlined design features for created ponds to mitigate the impacts of the Pakenham Bypass.

It should be noted that the same standards do not apply to online stormwater treatment wetlands, which principally have a stormwater treatment and flood mitigation function and incidentally provide frog habitat, as compared to the dedicated frog ponds that are specifically designed and constructed to provide habitat for *L. raniformis*.

A suitably qualified and experienced zoologist must be present during:

- All initial earthworks which are within 30 metres of suitable habitat for *L. raniformis*;

- Draining and removal of all existing dams and waterbodies; and,
- Proposed wetland and frog pond construction (excluding revegetation).

3.4.4.1 Guidelines for Locating Frog Ponds

Previous research on *L. raniformis* has shown that a landscape-based approach to habitat creation and management is required (Robertson *et al.* 2002; Hamer *et al.* 2002). For example, the likelihood of the species occupying a waterbody is largely dependent on the distance to a nearby occupied site (Hamer and Organ 2008).

Creation of habitat close (i.e. within 300-500 metres) to existing populations in the far south-east corner of the Precinct, as well as in proximity to occupied dams, is a requirement set by DSE, to augment the current extent of habitat for *L. raniformis*.

3.4.4.2 Design Requirements

The ‘Growling Grass Frog *Litoria raniformis* Habitat Creation and Management Guidelines’ (Ecology Partners 2010) must be referred to during all phases of frog pond design and construction. A comprehensive list of recommended frog pond vegetation species is also provided in Appendix 6.

Detailed design must ensure that permanently wet habitat ponds are sufficiently connected as part of a greater habitat corridor, to facilitate dispersal, and that some ponds have the ability to routinely dry out to assist in the control of pest fish species. A mosaic of habitat ponds will be created including ponds with permanent water levels, and ephemeral ponds. Landscaping surrounding all offline frog ponds will be designed to capture as much water as possible from local catchments to minimise the requirement for artificial maintenance of water levels. Detailed design will also seek to establish a suitable hydrological regime that achieves appropriate wet and dry periods with minimal artificial intervention.

It should be noted that frog pond construction by developers is subject to a 24 month maintenance period under both Melbourne Water’s DSS or any proposed services agreement, and Cardinia Shire Council’s Defects Liability Period.

Requirements for the creation of dedicated frog ponds include:

- The creation of natural habitat ponds which do not require significant interventionist management, including the regulation of water levels, will be achieved through detailed design;
- The provision of a terrestrial impact buffer of 30-40 metres is created in which there is no development around ponds where:
 - A ‘core’ buffer zone is provided, with a densely planted area of no less than ten metres from the edge of the pond. Landscaping will provide a diversity of indigenous grasses, herbaceous species and low shrubby vegetation (but no trees); and,

- A 'secondary' buffer area is provided, extending 30-40 metres from the edge of the pond, which comprises open grassy areas with no roads, pathways or other artificial structures. Mowing, slashing and use of herbicides and pesticides should be restricted within this area (refer Section 3.5.6).
- Throughout the Precinct, there should be at least two dedicated frog ponds in each of the north-south corridors (six ponds in total) which are actively maintained to be permanently free of fish species, such that there is always optimal breeding habitat for *L. raniformis* during the breeding season. Detailed design will seek to strategically locate these six ponds throughout the Precinct, so that they are not confined to a single area;
- The landscaping of any ponds, including augmentation of existing dams and landscaping of new frog pond habitats must:
 - Have a planting schedule approved by a suitably qualified and experienced zoologist prior to landscaping works occurring;
 - Be inspected prior to landscaping works occurring (depth, dimensions etc);
 - Be inspected following construction, landscaping and revegetation works to ensure created habitats are suitable for *L. raniformis*.
- The use of wetland vegetation species that are drought resistant are preferred, as the use of these particular species will cater for the periodic drying out or draining of ponds, and will be less likely to require routine replanting;
- Trees and/or large shrubs are not planted densely within 20 metres of the banks of frog ponds as this may shade out ponds, thus potentially rendering them unsuitable for *L. raniformis*; and,
- Ponds will have a low invert drain with a valve to draw down the water level where possible.

3.4.4.3 Design Requirements for Frog Ponds in Open Space and Drainage Corridors

Ecologically sensitive Precinct design integrates habitat linkages which are located along the north-south waterways of Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain, in addition to interconnecting east-west corridors along the Pakenham Bypass, west of Cardinia Road, and along the length of the Transmission Line Easement along the Precinct's southern boundary. These corridors are multi-functional, serving a range of purposes including flood conveyance and stormwater treatment, in addition to recreational functions, such as the provision of passive open space and walking and cycling trails.

In addition to the requirements set out in Section 3.4.4.2 above, the requirements for how these functions are to be effectively integrated with the creation and maintenance of dedicated frog habitat areas within the open space and drainage corridors are set out below:

- The detailed design of the drainage system and the ponds must:
 - ensure replenishment of water levels will be delivered from local catchment run-off (e.g. from adjacent parkland areas);
 - minimise the possibility of water inundation from the waterway;
 - minimise the potential for fish incursion;
 - integrate a non-mechanical pond drainage mechanism, such as a drainage valve or regulator, where possible. Detailed design must seek to ensure that pond levels and elevation allows for the effective operation of any such mechanism;
- All constructed frog ponds should be located and designed such that they receive minimal (if any) water from Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain during frequent flood events. This may be achieved through perching frog ponds in positions that are substantially elevated from the main watercourse, or by the creation of levies or bunds to prevent the influx of flood water into ponds. Where these measures are adopted, they may alter flood conveyance and storage. If the use of bunds, banks or other works is proposed at the time of DSS construction, then the design of the waterway corridor will need to demonstrate how flood storage and conveyance has been offset. These measures are required primarily to reduce the likelihood of fish incursion during flood events (see Section 3.5.3 for management actions);
- Tracks and pathways must be located at the edges of the 30-40 metre buffer zones and should be boardwalks rather than a path at ground level, to minimise trampling damage and potential erosion by pedestrian and bicycle traffic;
- Buildings and other related infrastructure are to be located at least 50 metres away from frog ponds (Figure 5);
- No access tracks, roads, houses and other infrastructure will be located near frog ponds, and there will be no barriers to dispersal along proposed dispersal corridors (e.g. fencing perpendicular to corridor direction);
- If fencing is necessary as a safety or security requirement, standard farm or garden fencing such as Stocklock® should be utilised. Safety or security fencing must not act as a barrier to frog movement, and should only be installed to restrict human and domestic animal access to frog ponds (see Section 3.4.9); and,
- Gross pollutant traps and/or sediment filters are installed at all appropriate inlet areas.

3.4.4.4 Frog Pond Construction Standards

Construction standards for frog ponds must be maintained in accordance with these requirements:

- The minimum size of created frog ponds will be 300 square metres, however, where possible, ponds will be greater than 400 square metres in size (e.g. 20 metres x 20 metres, 40 metres X 10 metres). The following design guidelines apply:
- Recommended dimensions for all proposed frog ponds are detailed in Appendix 3;
- Long, thin, frog ponds will be used in areas where the availability of space is an issue;
- All frog ponds must have appropriate water levels (i.e. some ponds with permanent water and others with a variable hydroperiod), and be constructed between 0.5 metres and 4 metres in depth. Where constructed ponds are unable to be dug to 4 metres in depth, ponds should be excavated to the maximum possible depth in order to minimise the likelihood that ponds dry out through summer.

In some cases, the provision of permanent water for some ponds may not be able to be achieved due to constraints imparted by their elevation relative to other elements within the waterway corridors (e.g. creeks and drains, wetlands and culvert placement). However, where possible, detailed design will seek to maximise the duration of water being present in any individual pond;

- A diversity of emergent (excluding *Typha* spp.), submerged and floating (particularly *Potamogeton* spp.) vegetation will be planted in frog ponds, while dense areas of low growing shrubs, sedges and grasses will be planted around the perimeter. Vegetation structure and composition will be consistent with the known habitat requirements of *L. raniformis* and will be similar to other sites where ponds and wetlands have been created for the species (e.g. Caroline Springs, Botanica Park - Bundoora);
- Terrestrial shelter in the form of rock piles, rock mattresses and logs will be used, and will cover approximately 30-40% of the perimeter of the each pond. The spaces between refugia and their orientation will vary to optimise habitat variability;
- Where possible, larger concave shaped rocks (300 – 1500 millimetres in size) will be placed along the banks of ponds, and rock sizes and placement will be approved by a qualified zoologist prior to installation;
- A density of at least six semi aquatic and terrestrial plants per square metre and three plants per square metre for aquatic species will be employed;
- Frog fencing will be installed to prevent frogs from entering all road pavement areas that are adjacent to dispersal corridors and frog pond/wetland habitats;
- Water-sources will be used that provide adequate water quality for the species;

- Protective netting will be installed over aquatic plants, particularly immediately after planting to prevent damage by waterfowl. Once vegetation is established netting will be progressively removed, which may take between six to twelve months;
- A range of edge habitats will be provided; and,
- Frog ponds will be managed so that they have low water turbidity, be still, and have low nitrate and phosphate, and salinity levels.

3.4.5 Stormwater Wetland Design and Construction

The ‘Constructed Wetland Systems Design Guidelines for Developers’ (Melbourne Water 2005) and ‘Constructed Waterways in Urban Development Guidelines’ (Melbourne Water 2009) must be referred to during all phases of stormwater treatment wetland design and construction. A comprehensive list of recommended wetland vegetation species is also provided in Appendix 6. The use of wetland vegetation species that are drought resistant are preferred, as the use of these particular species will cater for the periodic drying out or draining of ponds, and will be less likely to require routine replanting.

Specific provisions in the development design relating to stormwater management are important to ensure that any future populations of *L. raniformis* and associated habitats are managed appropriately.

The primary treatment of surface runoff for sediment and gross-pollutant removal should take place within grassed swales, prior to entering wetland systems. Each wetland inlet should incorporate an energy dissipation and filtration zone, or preferably sediment pond, prior to connection with the main wetland body.

Detailed design is also expected to provide complementary frog habitat adjacent to stormwater treatment wetlands that will remain suitable if the wetland has to be taken offline for de-silting and re-setting, given that these works are to be undertaken during periods of low flow (i.e. Summer), which coincides with the breeding season for *L. raniformis*.

The key elements of the stormwater wetlands are described below:

- Stormwater treatment wetlands will comprise a series of deeper, open pools connected by shallow marsh/wetland areas;
- Hydraulic structures and appropriate landscaping will take into account potential frog movements;
- Online permanent stormwater treatment wetlands should have several smaller ephemeral frog ponds located in proximity to them, to increase the likelihood of fish-free habitat being available in these areas;
- Wetlands will support an extensive cover of aquatic and semi-aquatic vegetation to ensure that there is sufficient nutrient uptake to enhance water quality in wetlands.

Wetlands will also contain deeper sections (up to two metres) of open water where floating vegetation (principally *Potamogeton* spp.) can grow; and,

- The presence of extensive areas of *Potamogeton* spp. is considered one of the most important habitat characteristics required by *L. raniformis*, as rafts of vegetation provide suitable calling stages for adult males during the breeding season and protection for tadpoles.

3.4.6 Road Watercourse Crossings

If constructed and positioned appropriately, bridges or road culvert crossings should facilitate frog movement between opposite sides of the road, and reduce the risk of frog mortality through roadkill. Maintaining habitat connectivity also allows for frog dispersal and increases the likelihood of long-term persistence (viability) of populations in the immediate area.

Frog drift fences along either side of watercourse crossing must be designed so that they do not impede frog movement under the road (i.e. block the subway), and they should funnel frogs towards the entrance.

This funnelling effect can also be achieved through increasing the vegetation (low growing sedges and grasses) at and towards the entrances, and through the construction of wetlands and/or frog ponds (see below) within 5-20 metres from each road watercourse crossing. Additional wetlands are likely to be an effective method of increasing the permeability of the roads within the Precinct, thus reducing the severity of barriers to frog dispersal.

A suitably qualified zoologist or ecologist must be appointed by Cardinia Shire Council, VicRoads or by the successful contractor during construction to ensure that road watercourse crossings are appropriately constructed.

3.4.6.1 Design Requirements

Road watercourse crossings will be designed and constructed in a way that maximises their potential to facilitate frog movement under roads.

Requirements for the creation of road watercourse crossings include:

- Strategically locate ponds adjacent to crossings to ensure they link suitable habitat areas, and make subways (under road crossings) as short as possible;
- Light or air slots in the top of the subway must be incorporated into the design for aeration and temperature equilibrium. A suitably sized grated heavy duty pit lid openings within the central median of the road is recommended to allow light to enter the subway. The grates must be 50 millimetres x 50 millimetres in size. Additionally, grates must be protected from receiving direct runoff from roads, which could potentially contain harmful pollutants;
- Vehicle and foot access will be kept to a minimum close to the subway entrances (frog habitat) and along frog drift fences;

- Flaring at subway entrance points will be adopted, and a smooth surface will be provided along the base of the subway, with a flat bottom rather than curved. Any subway will be rectangular in cross section with minimum dimensions of 900 centimetres high x 1.5 metres wide (i.e. standard size of a box culvert) at ground level and as straight as possible (no bends), running perpendicular to the road, not diagonal;
- Relatively open areas will be provided leading to the entrances of each subway. Clear access in and out of the subway is required, while any openings along the subway length are to be such that they do not enable fauna to access the road surface;
- Artificial lighting at entrances will be discouraged as this may reduce their effectiveness to facilitate frog movement;
- Entrances of the subway will support areas of suitable wetland habitat, comprising a variety of indigenous aquatic and semi-aquatic vegetation, and extensive areas of rock;
- Constructed ponds and wetlands at subway entrances will be at least 30 metres x 10 metres in diameter, up to four metres in depth (if possible), and contain sufficient vegetation cover and refuge sites. No obstructions such as rocks or logs will be placed within the subway, and there must be visibility from one end of the subway to the other, although suitable refuge habitat must be available in close proximity to entrances;
- Subways must not be permanently inundated and will be designed to receive water periodically;
- Grates must be installed at each end of the subway to exclude rabbits, foxes and cats. Grates must be galvanised steel with grids 90 ± 10 millimetres square. The grates must be fitted in a frame, with the frame bolted to the subway end. A minimum gauge on the grate wire should be 2.5 millimetres, and grates must be padlocked to the frame;
- Monitoring devices such as PIT (Passive Implanted Transponder) sensor and associated data loggers at each end of subways could be considered as a way of monitoring frog usage and recording dispersal characteristics;
- Alternatively motion sensitive cameras, could be used. The purpose of these devices is to investigate the usage of these areas by *L. raniformis* and other species under the road.

If any barriers to dispersal are identified Cardinia Shire Council will be responsible for ensuring they are, where possible, removed so that frog movement between ponds within the Precinct and dispersal opportunities beyond the Precinct are not affected.

Conversely, where roads are proposed directly adjacent to frog ponds and wetlands, permanent frog fencing must be installed between the road and some distance back from the wetland banks (see Section 3.4.9). The primary purpose of fencing is to prevent frogs dispersing from wetlands across the road pavement and potentially being killed by traffic.

A number of road-killed *L. raniformis* have been found at constructed wetlands at Botanica Park, Bundoora, where wetlands are situated within three metres of a suburban road (Organ pers. obs.). Ongoing loss of frogs as a result of road kill has the potential to adversely affect any resident population.

3.4.7 Frog Movement and Dispersal

As populations of this species are reliant upon a diversity of habitat features interconnected to each other, ponds and wetlands will be designed and constructed in a way not only to provide potential breeding habitat for *L. raniformis*, but also to allow for ongoing and uninterrupted frog movement between and within ponds and wetlands within the Precinct.

Recent surveys of *L. raniformis* have identified occupied waterbodies throughout the Precinct development site (Ecology Partners Pty. Ltd. 2008a, 2008b, 2009a; Hamer and Organ 2008). Dispersal opportunities between ponds and wetlands within the Precinct and adjacent habitat are currently maintained by Toomuc and Gum Scrub Creeks, Cardinia Road Drain and over 30 interspersed artificial waterbodies (Figures 4 and 5).

The proposed development will enhance north-south dispersal habitat by the provision of created wetlands and ponds along each of the water courses, and allow east-west dispersal by the creation of habitat corridors containing isolated ponds along the northern and southern boundaries of the Precinct.

Furthermore, the proposed east-west corridor along the northern boundary of the development, which abuts the Pakenham Bypass, will link the newly constructed ponds and wetlands to underpasses, which have been constructed as part of the Pakenham Bypass development. Wetlands and ponds will be created at the entrances of these underpasses to encourage frog dispersal both north and south of the Pakenham Bypass.

3.4.8 Fencing

3.4.8.1 Temporary Protective Fencing

Due to Precinct construction occurring over an extended timeframe, different areas within the Precinct will be exposed to disturbance from construction activities at different times. As part of construction on any individual property, temporary protective fencing will be required to protect all waterbodies during adjacent works.

Temporary protective fencing will be in the form of two metre high chain-link material, or other materials which are easy to supply, install, maintain and uninstall.

Protective fencing must be erected and maintained at a distance of 20 metres from the edge of water bodies and water courses which are to be retained, when construction activities are within 100 metres of their edge, to protect these areas from inadvertent damage.

Protective fencing should also be installed around areas of ecological values (i.e. remnant native vegetation along Lecky Road) prior to any disturbance.

The protective fencing will remain until construction activities have completed in the vicinity of the water body or water course, to the satisfaction of the developer's contracted ecological consultant and the responsible authority (Cardinia Shire Council).

Similarly, protective fencing will be installed to the above specifications to exclude construction machinery or unauthorised access to newly created wetlands and frog ponds, such that inadvertent damage does not occur, slowing down the establishment process of these *L. raniformis* specific areas.

3.4.8.2 Frog Drift Fencing

Drift fencing must be used along both ends of all proposed underpasses and culverts, and along the edges of any wetlands and ponds which come in direct contact with roads within the development. They will be designed to prevent frogs entering the road surface by guiding frogs towards underpasses (see Van Leeuwen 1982).

Overseas studies investigating the effectiveness of underpasses or tunnels in providing habitat connectivity and offsetting the barrier effects of roads have shown that frogs have difficulty in finding these structures if drift fences are not installed (Brehm 1989).

The following are requirements for the design of frog fencing in the Precinct:

- Either a solid (preferred – concrete or UV resistant plastic) or a mesh structure could be used. The solid structure could be a constructed with concrete or other material, while durable mesh is commercially available;
- Fencing must be installed both sides of roads that directly abut any of the ponds or wetlands within the Precinct. The length of this drift fencing will vary;
- Fencing must be 1 metre high with an additional 0.2 metres below ground and a 0.2 metre section at the top angled outwards (away from the road) and downward from horizontal;
- Fencing must be erected along the edge (10 metre buffer from the edge of any waterbody) of ponds and wetlands either running parallel, or at a 45 degree angle to the road verge to prevent frogs entering the road pavement;
- Acoustic fencing may be used to act as a barrier to frog movement onto the road; however, they must not impede frog movement at entrances of underpasses and culverts;
- Rock, wood and logs, and other debris such as course may be placed at least one metre away from the fence, along likely dispersal routes, to provide temporary sites of refuge; and,
- Vegetation within 0.5 metres of the drift fencing will be less than 0.5 metres high.

3.4.8.3 Safety Fencing

At the completion of each wetland and pond, a safety audit may be required to establish whether safety fencing is needed to prevent unauthorised access into pond and wetland areas. Fencing may be required around any pond or wetland exceeding one metre in depth for safety purposes.

Integration of safety fencing and frog drift fencing will also be considered, as a single fence which achieves the purposes of safety, unauthorised access prevention, and a barrier for preventing frogs accessing paved areas is achievable and preferable in terms of functionality, aesthetics and maintenance.

3.4.9 Vegetation Netting

It is highly recommended that any newly planted vegetation be protected by appropriate vegetation netting, to allow the vegetation to become established, and subsequently increase the habitat suitability for *L. raniformis*.

Vegetation of created waterbodies is an important requirement of design which will ultimately determine the suitability of habitat for *L. raniformis*. Newly vegetated waterbodies are particularly vulnerable to damage caused by various species of waterfowl, which use the vegetation for foraging, roosting and nesting sites, and cause extensive damage through trampling.

3.4.10 Movement Corridors

Movement and dispersal corridors are essential for population maintenance in developed areas. The metapopulation of *L. raniformis* in the Pakenham area has been able to re-colonise and persist in disturbed areas by utilising artificial waterbodies within heavily grazed farmlands. Within the Precinct, the proposed ponds and wetlands along the course of Toomuc and Gum Scrub Creeks, and the Cardinia Road Drain will provide important movement corridors through the Precinct from north to south. Underpasses which have been previously constructed as part of the Pakenham Bypass project maintain habitat connectivity between the Precinct and areas north of the Pakenham Bypass.

There is also a proposed reserve along north-western boundary of the Precinct to connect the north-south creek and drainage line habitat corridors. Within this area, interspersed permanent ponds and associated wetland vegetation need to be provided to ensure the habitat is suitable for *L. raniformis* movement. An underpass under Cardinia Road links east and west sides of habitat along the northern edge of the development.

It is a mandatory requirement that similar pond and wetland dispersal habitat be constructed under the transmission line easement, along the southern boundary of the development, to enhance east-west movement and dispersal potential through the development.

3.4.11 Signage

Appropriate signage will be deployed to notify residents of the presence of *L. raniformis* in specific areas. There will also be signage for the following:

- Pet restrictions within wetland areas/ on-lead areas for dogs;
- Warnings to construction vehicles and personnel; and,
- Prohibition of rubbish dumping within Gum Scrub Creek, Toomuc Creek, Cardinia Road Drain and the east-west habitat corridors along the Transmission Line Easement and Pakenham Bypass.

3.5 Management and Monitoring

Management and monitoring refers to procedures which must be implemented as soon as the *L. raniformis* CMP for the Precinct has been approved by the DSE. The procedures must be followed throughout Phase 1: pre-construction, construction and post construction stages.

The 'Post Construction' stage, which is referred to in this section, relates to the stage following the completion of development in the Precinct, encompassing subdivision works, building construction and drainage scheme construction. At this stage of the development of the Precinct, the implementation of the CMP will focus on monitoring and management of *L. raniformis* populations and constructed habitats, such that the dynamics of the extant population and their habitats can be maintained and improved.

All monitoring procedures detailed in this section must be undertaken in all existing dams throughout the Precinct from the date of approval of this CMP. Monitoring of constructed ponds and wetlands must be undertaken following their construction and subsequent inundation.

A number of actions set out in this section must be undertaken for a period of time post-construction. In relation to all retained and constructed ponds and wetlands, these activities are required to be undertaken from the date the pond or wetland is approved by DSE to have been constructed or rehabilitated to the standards set out in this CMP. The commencement date for these actions for each pond is recorded in Appendix 7.

3.5.1 Population and Habitat monitoring

Population and habitat monitoring must be undertaken prior to, during, and following the completion of wetland and overall precinct construction, and for 10 years post construction, or rehabilitation, of new and existing ponds.

Population and habitat monitoring procedures are detailed in Section 3.3.4.

3.5.2 Habitat Management and Maintenance

The ongoing maintenance of ponds and wetlands is to be conducted: in particular the maintenance of aquatic vegetation diversity and structure and terrestrial habitats this will be essential to ensure these habitat types become, and remain suitable for *L. raniformis*. Once established, ponds and wetlands are expected to primarily be self-sustaining. It is expected that detailed design will result in the creation of natural habitat ponds which do not require significant interventionist management, including the regulation of water levels.

The selection of vegetation species for ponds and wetlands (Appendix 6) is directed towards providing distinct habitat zones based on *L. raniformis* requirements for particular water depths.

At this stage monitoring of the pond and wetland vegetation will take place every six months, for the first two years post construction by a qualified herpetologist, or zoologist experienced in conducting such surveys. An annual report will be submitted to the DSEWPC and DSE detailing the outcome of these surveys.

Consultation must occur between Cardinia Shire Council and a specialist revegetation or land management practitioners in all instances that require maintenance of constructed *L. raniformis* ponds and associated terrestrial habitats.

The following will need to be undertaken as part of habitat maintenance:

- If necessary, additional plants will be planted to ensure that waterbodies and terrestrial habitats remain suitable;
- Additional refuge sites such as rocks, logs and dense low-lying vegetation will be added if it is considered, during site monitoring, that the area of shelter is insufficient;
- Routine maintenance of grassed areas within Toomuc Creek, Gum Scrub Creek and Cardinia Road open space corridors will generally comprise:
 - areas maintained by Melbourne Water will be subject to mowing biannually or quarterly;
 - slashing of open space corridors maintained by Cardinia Shire Council that do not abut a residential area at least every six weeks, principally to minimise fire risk; or,
 - mowing of open space corridors maintained by Cardinia Shire Council to a ‘neighbourhood’ standard, where they abut a residential area. This will occur at least every three weeks;
- The control of pest animals such as foxes and cats will be undertaken in accordance with local government laws and relevant legislation;

- In the first two years, biannual inspections will be conducted to detect any weed species, so that they can be removed before they become a significant problem. Annual inspections will be conducted following the initial two years of monitoring;
- Where possible, weeds will be controlled by hand or with the use of implements. Alternatively, a frog sensitive herbicide (non-residual herbicide) will be selectively used (refer Section 3.5.2). The use of other herbicides or pesticides within, or in close proximity to ponds, wetlands, shelter sites and likely dispersal areas will be prohibited;
- Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from wetlands and ponds. The removal of rubbish is particularly important over the first few years during pond and wetland establishment; and,
- Gross pollutant traps and/or sediment filters will be checked and, if necessary, subsequently cleaned, particularly after heavy rain or storm events.

The clean out of wetlands and frog ponds will typically be required every 15-20 years to remove sediment and build-up of organic material, or as considered necessary from annual habitat monitoring inspections. For this purpose, ponds and wetlands will have a low invert drain with a valve to draw down the water level where possible.

Clean-out will only be undertaken once ponds and wetlands have been assessed by a water quality expert and it is determined that sediment build-up and organic matter has accumulated to the point necessary to require clean-out. Clean-out will be undertaken in a staged approach (i.e. cleaned out gradually over a couple of years).

Prior to wetland clean-out, a suitably qualified zoologist will be consulted to give advice in relation to the appropriateness of such actions in terms of the potential impacts the operations may have on tadpoles in ponds and/or resident frog populations. Stormwater treatment wetlands will ideally be cleaned out during the periods of low flow, and although this will coincide with the later stages of the *L. raniformis* breeding season (i.e. December - March), adjacent habitat areas with suitable habitat will be constructed to allow for this maintenance procedure.

Wetlands and ponds must be re-established with a diversity of wetland plants and refuge sites, if these habitat features are disturbed during the draining process.

Any frogs encountered during these operations will be salvaged and translocated by a qualified herpetologist into another suitable ponds nearby following the procedures outlined in Section 3.4.3.

3.5.3 Pest Fish Management

The absence of Plague Minnow from all ponds and wetlands in the Precinct is not necessary for the survival of *L. raniformis* or its ability to breed in the area.

In areas that are subject to routine flooding where the incursion of fish is unavoidable, such as the online stormwater treatment wetlands, the provision and maintenance of dense submerged and floating aquatic vegetation can increase *L. raniformis* recruitment and survival rates by providing a greater amount of submerged cover for eggs and tadpoles.

While it is preferred that all waterbodies be kept fish-free, in an urban setting the introduction of fish through routine flood events, or artificial introduction by residents, is highly likely.

It is important to ensure that at least six dedicated frog ponds provide secure and uncompromised breeding habitat for *L. raniformis* at all times. The staging of the Precinct is such that not all six ponds will be created or monitored for the same period of time. As such, the provision of these six ponds should be according to the following benchmarks:

- a minimum of two fish-free ponds per north-south corridor (only applying to corridors where dedicated frog ponds have been constructed); and,
- management of at least 20% of frog ponds across the Precinct to ensure they are fish free (applying only to ponds where the 10 year monitoring period is still taking place).

3.5.4 Pollution and Hard Rubbish Management

Noise Pollution

Information regarding the potential impact of artificial noise upon populations of *L. raniformis* is currently unavailable. The species has been found to occur and reproduce within wetlands close to roads with heavy traffic flows and/or within areas with high industrial noise (e.g. Hume Highway, Somerton and Botanica Park, Bundoora) (Heard *et al.* 2004a).

Consequently, there appears to be low potential for adverse impacts upon *L. raniformis* within the proposed wetlands and frog ponds in the Precinct from noise generated from roads themselves.

The potential for noise related impacts on any *L. raniformis* populations within the Precinct after completion of construction works could be mitigated through the use of acoustic barriers and sound-attenuation fences along wetland areas. This measure could be implemented under the provisions of 3.6 Contingency Actions, however are not planned to be provided.

Hard Rubbish

Industrial subdivisions are notorious for their generation of litter and the subsequent illegal dumping of hard rubbish which impact open space, wildlife, conservation reserves and waterways. The following management actions will be adopted within these areas:

- Limit vehicle access throughout the Precinct to reduce dumping of hard rubbish into retained areas;
- Erect signs around the Precinct stating fines will be allocated if hard rubbish is dumped within the development area;

- Regularly monitor areas within the Precinct for litter and hard rubbish and remove as soon as possible;
- Fences will be constructed with minimal impact to remnant native vegetation within the Precinct (i.e. no soil/material stock piling);
- Litter levels will be kept low within the Precinct; and,
- There will be no hard rubbish dumped throughout the Precinct.

3.5.5 Water Quality Monitoring and Management

Annual habitat and population monitoring procedures will include a visual assessment of water quality to identify issues such as turbidity or surface residue.

In-situ probe testing of each waterbody will be undertaken during routine habitat monitoring surveys to ascertain values for the following parameters:

- Turbidity (NTU);
- Temperature;
- pH;
- Dissolved Oxygen (% Saturation); and,
- Salinity (mg/L).

Acceptable ranges for these parameters can be found in the Australian and New Zealand Guidelines for Freshwater and Marine Water Quality (ANZECC 2000).

3.5.5.1 Water Quality for Dedicated Frog Ponds

Based on known information of water quality tolerances and preferences by *L. raniformis* it appears that the species requires waterbodies containing low levels of nitrates, nitrides and phosphates (Ashworth 1998; Organ 2002, 2003). Water quality is particularly important for larval development and recruitment.

For example, ponds or wetlands containing low levels of pollutants and turbidity are more likely to lead to higher survivorship of tadpoles and a greater recruitment of metamorphs (juveniles) (Organ 2003).

3.5.5.2 Management Actions

Stormwater water quality is proposed to be managed by implementing the following management policy:

- No pesticides, herbicides, fungicides or fertilisers are to be used throughout the open space network (except as described at 3.5.6), as if used, in the event of heavy rain they may contaminate the drainage and wetland systems and/or frog ponds;
- Frog ponds will be devoid of gross pollutants such as heavy metals, petroleum products, herbicides and solvents.

In the event of a chemical spill or water contamination affected ponds and wetlands will need to be drained. An enforcement action to enable the adequate clean-up of any such spill or dumping of litter would be pursued under Cardinia Shire Council's Local Laws and any applicable EPA provisions;

- The depositing of oil (intentionally or unintentionally) on driveways, roads or foot paths, and failure to undertake timely and appropriate clean up measures is strictly prohibited;
- Within the waterway corridors, the frog ponds and surrounding habitats are primarily for *L. raniformis*, although they are likely to support other native flora and fauna.

Public access will be minimised, and activities such as swimming, diving, fishing, boating, sailing, removing or introducing animals (including fish), disposal of rubbish or pollutants in the wetland systems or frog ponds is strictly prohibited; and,

- Basic *in situ* water quality monitoring will be undertaken annually during population and habitat monitoring to ensure that all ponds are suitable for breeding, larval development and recruitment (see Section 3.5.4).

3.5.6 Feral and Domestic Animal Control

There is currently a high density of Red Foxes within the Precinct (Organ pers. obs.). For example, during previous detailed mark-recapture studies several foxes and fox cubs were observed in the vicinity of Gum Scrub Creek. It is possible that foxes may be following the tracks of field personnel, which unfortunately has lead to an increase in predation.

Foxes are known to hunt and kill Bell Frogs and therefore pose a risk to the population of *L. raniformis* in the Precinct. Feral Animal Control measures will be developed and implemented in the Precinct to reduce the population size of foxes.

Future residential development of the Precinct is likely to introduce unrestrained cats that may also hunt and kill *L. raniformis*. Therefore, implementation of a night-time curfew on cats should be considered, or alternatively, a cat covenant may be considered as part of future development in the area.

Responsible pet ownership will be encouraged, by:

- enforcing the *Domestic Animals Act 1994* with respect to the proper confinement of cats and dogs;
- prohibiting dogs from walking through or swimming in frog ponds and wetlands;
- enforcing Cardinia Shire Council's Local Laws, with respect to:
 - dogs being kept on leads at all times in public places except where signage designates an off-leash environment; and,
 - cats over the age of 3 months being desexed to control cat populations.

3.5.7 Pest Plant Control

The control of pest plants is a major requirement for management, as the Precinct is under continual pressure from weed invasion (e.g. Blackberry).

In order to control and/or eradicate these weed species, particularly in and adjacent to areas of remnant native vegetation, several on-going techniques can be used (e.g. herbicide application).

With any weed control works it is important to establish a cover of native species as soon as possible to occupy the newly vacated environment. While native species will naturally re-colonise such areas, so will exotic species, if weed seed is present.

Several management techniques are recommended to control weeds, including physical removal, brush cutting and herbicide application. In the majority of cases, herbicide will only be applied to weeds by using the spot-spraying technique, to prevent off-target issues.

Herbicides are currently proposed to be used to eradicate thistle species and other broad-leaved weeds, particularly during spring and summer.

It is important to ensure that weed control works using herbicides are both targeted (i.e. spot spraying) and undertaken at the right time of the year, as this can also reduce the requirement for future weed control works.

3.5.7.1 General Guidelines

The following general guidelines must be taken as basic management principles in regards to weed control:

- Weed management should be undertaken throughout all open space areas, with particular attention given to vegetated areas which are not subject to routine maintenance such as slashing;
- Any weed control will be done in a manner that minimises soil disturbance;

- Herbicide use within the open space network will be minimised to avoid adverse effects on frogs and invertebrates.

Where herbicide application is necessary, waterway sensitive products such as Roundup Biactive®, Weedmaster Duo® or Weedmaster 360® will be employed, without the addition of surfactant;

- Where herbicides are used, selective application is preferable to broad area application;
- Non-residual herbicides are preferable to residual herbicides;
- Pest plants that reproduce sexually (by seed) are best controlled before seed ripens; and,
- Weed control works will be monitored regularly to assess their effectiveness, perform follow up works and evaluate the feasibility of management objective.

3.6 Contingency Actions

This section identifies a range of management issues that may arise during the implementation of the CMP, which cannot be foreseen or quantified in terms of scale, frequency or impact to the resident *L. raniformis* population.

These actions are not required as obligations of this CMP and as such, contributions by landowners under any implementation funding agreement with Melbourne Water, will not be used to finance these actions. However, if any of these circumstances arise, this section outlines some of the potential management responses in order to ensure the Precinct continues to provide viable habitat for the species. Adaptive management is paramount in the successful implementation of this CMP and ongoing persistence of *L. raniformis* within the Precinct.

In the event that any of these circumstances arise, Cardinia Shire Council will facilitate a meeting with DSE and Melbourne Water to discuss and outline an appropriate response. The discussion will include identification of a suitable funding source. Public land managers that own property within the precinct will not be responsible for funding contingency actions, unless a supplementary revenue stream can be identified. If contingency actions are required to be implemented during the life of the CMP, public land managers will participate in identifying an appropriate funding source to enable these actions to be undertaken.

It should be noted that this section does not aim to identify an exhaustive list of possible stochastic events and subsequent resolutions, but a select number of key issues based on Ecology Partners' experience in implementing *L. raniformis* CMP's across the greater Melbourne region.

3.6.1 Population and Habitat Monitoring, Management and Maintenance

Some issues that are likely to require contingency measures include:

- *L. Raniformis* population decline or localised extinctions:

Local frog populations are known to vary on spatial and temporal scales depending upon habitat conditions at a particular site. For the Precinct as a whole, regular population monitoring will determine if *L. raniformis* is declining or has abandoning certain frog ponds. Due to natural variation in habitats available within the Precinct, it is expected that certain ponds and wetlands are likely to be occupied during some seasons, but unoccupied in others. This fluctuation in occurrence can be due to obvious causes, such as unsuitable habitat conditions (i.e. high water turbidity), and other causes which may be difficult to identify (i.e. water chemistry).

Obvious causes of abandonment of specific frog ponds or habitat corridor areas by *L. raniformis* will be rectified as soon as possible. Some of these actions may include:

- habitat augmentation, such as the installation of rocks and rock banks;

- planting of additional vegetation, or conversely, removal of pond or wetland vegetation (if it is smothering the waterbody);
 - identification and removal of barriers to dispersal;
 - increasing the intensity of feral animal controls;
 - drainage of ponds to remove fish; and,
 - drainage or alteration of ponds to rectify chemical imbalances, or deficiencies in water chemistry parameters.
- Drying out of frog ponds;

Dry frog ponds will not be used by *L. raniformis*, and are therefore not serving their intended purpose of providing suitable habitat for the species. Dry or drying ponds will be identified by maintenance operations prior to the commencement of the breeding season each year. Drying or dry ponds will also be noted during annual frog population and habitat monitoring surveys.

In the event of ponds drying out or being in the process of drying, water may need to be diverted from the main creek or drainage line systems, or as a last resort by pumping where practicable. Any transfer of water from online systems, including stormwater treatment wetlands, must be subject to an effective means of preventing the transfer of fish which are likely to be present in these systems (e.g. use of a fish grate).

- Degradation in habitat quality and vegetation dieback:

The degradation of *L. raniformis* habitats can occur through a wide range of active and passive processes. Typical processes causing habitat degradation are:

- Lack of adequate maintenance;
- Ongoing erosion and sedimentation;
- Chemical and/or hard rubbish influx following flood events;
- Trampling;
- Fish incursion;
- Vegetation trampling, removal and/or dieback; and,
- Low water levels and/or poor water quality.

Habitat degradation will be an ongoing issue within the Precinct, especially during and post-construction of infrastructure. Degraded habitat areas are unlikely to support *L. raniformis*, in addition to potentially reducing the dispersal and breeding opportunities which would normally be facilitated by the presence of these waterbodies.

Any evidence of habitat degradation will be noted in the annual habitat monitoring program, and Cardinia Shire Council and Melbourne Water notified as soon as possible. Management response actions will depend on the type of process that is causing a reduction in overall habitat quality for *L. raniformis*. These are summarised below:

- Lack of adequate routine maintenance;
 - o Increase frequency and intensity of maintenance operations,
- Ongoing erosion and sedimentation;
 - o Installation and routine maintenance of sediment and erosion controls in key areas,
 - o Installation of rock banks, boulders and logs to stabilise soils in affected areas,
 - o Increase maintenance and monitoring operations in affected areas until problem areas are improved.
- Chemical and/or hard rubbish influx following flood events;
 - o Wetland or frog pond draining,
 - o Chemical treatment (for rectifying acidity or alkalinity),
 - o Once-off intensive hard litter removal (if required between normal maintenance schedule).
- Vegetation trampling, removal and/or dieback;
 - o Installation of protective fencing,
 - o Installation of adequate signage,
 - o Increase maintenance and monitoring operations in affected areas,
 - o Replacement of dead vegetation as required.
- Fish incursion;
 - o Wetland or frog pond draining,
 - o Supplementary planting of submerged aquatic vegetation to provide dense cover for frogs and tadpoles.
- Low water levels and/or poor water quality;
 - o Diversion of water from online creek and drainage line systems into drying ponds (using mobile, temporary pump infrastructure as a last resort), provided that adequate measures for preventing the transfer of fish are implemented,

- Inspection of all swales and drainage points leading to ponds and wetlands for chemical spills, leaks, and rectify where necessary,
 - Increase in submerged vegetative cover by supplementary planting, and
 - Conduct inspections to ascertain the presence of fish (which may cause high water turbidity) as/where required.
- Fish incursion:

The invasion of frog ponds by predatory fish such as Plague Minnow, Goldfish and Redfin will be carefully monitored to ensure frog pond a kept fish-free in accordance with Section 3.5.3. Ongoing monitoring will identify invaded ponds and subsequently advise Cardinia Shire Council and Melbourne Water if and when seasonal draining or other fish control methods are required, to achieve the standards set out in Section 3.5.3. In the event that introduced fish such as Plague Minnow and/or Goldfish are found, ponds should be allowed to completely dry out (not simultaneously), preferably via a drainage valve, or as a last resort, by pumping where practicable (in-situ or mobile pump infrastructure). Frog ponds and wetlands should be designed to allow for staged emptying and filling from one end to the other.

It may also be appropriate to periodically dry ponds during late summer or early autumn, and then allow them to refill over winter so that they contain water from September of each year, even if fish are not detected, as the manipulation of water depths and wetland permanency (i.e. disturbance regime) is considered important for *L. raniformis* (Organ 2003). Detailed design will seek to establish a suitable hydrological regime that achieves appropriate wet and dry periods with minimal intervention. Where ponds need to be drained, additional drainage should occur where practicable through the use of valves, or pumps if there is no other option;

- Sedimentation:

Sedimentation events are covered in the next Section, 3.6.2.

- Fences and signage removal or damage:

Safety fences (if installed), and frog drift fences will be routinely inspected during maintenance operations and habitat monitoring surveys. If a downed or damaged sections of fence are detected while undertaking these works, Cardinia Shire Council will be notified immediately so that a fencing contractor can be employed to rectify any damage present immediately.

3.6.2 Water Quality Monitoring and Management

In the event that surveys demonstrate that the frog is not inhabiting new ponds, water sampling including laboratory testing may be required based on the advice of a qualified ecologist.

Should this occur, the extent of water quality analysis, including location and number of samples will be agreed between DSE, Melbourne Water and Cardinia Shire Council.

Water samples will be taken from an upstream location at the start of the wetland system and at the downstream end of the wetland system every to determine if water chemistry is being altered from a source within the Precinct area or further upstream. Water sampling must follow the EPA guidelines, which can be found on the web at www.epa.vic.gov.au.

Some issues that are likely to require contingency measures include:

- Flood events bringing high levels of sediment or contaminants (including chemical spills) from upstream or stormwater runoff from paved surfaces within the Precinct;

If chemical spills are detected or if there is a noticeable deterioration in water quality, water sampling and testing will be required, particularly to detect any dramatic increases in phosphate, ammonia, nitrate and nitrite concentrations. If water chemistry measurements do not fall within the accepted ranges for these parameters then mitigation actions, such as drying or flushing of ponds or wetlands will need to be implemented.

After a large scale flood event, the clean out of wetlands and/or frog ponds may be required to remove sediment and build-up of organic material. Clean-out will only be undertaken once ponds have been assessed by a water quality expert and it is determined that sediment build-up and organic matter has accumulated to the point necessary to require clean-out. Prior to pond clean-out a suitably qualified zoologist will be consulted to give advice in relation to the appropriateness of such actions in terms of the potential impacts the operations may have on tadpoles in wetlands and/or resident frog populations.

Any frogs encountered during these operations will be salvaged and translocated by a qualified herpetologist into another suitable pond nearby following the procedures outlined in Section 3.4.3.

- Consistently high water turbidity;

Consistently high water turbidity may be caused by a range of factors, but is most likely to be a key issue during development of the Precinct. Sediment and erosion controls should be mandatory on all development sites and be subject to a strict inspection regime to ensure they are performing effectively and as intended. Where there is no obvious evidence for sediment laden runoff, ponds should be checked for:

- the presence of fish species, which may be causing the problem through disturbance during foraging;
- complete, established and adequate in-pond revegetation works; and,
- evidence of access by domestic animals, such as dogs.

- Significant amount of dumped hard rubbish.

Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from all frog pond, wetland and open space corridor areas on an as-required basis. The regular removal of litter will form part of the routine maintenance operations.

The removal of rubbish is particularly important over the first few years during the development of lots and wetland establishment;

The required contingency actions for each of these issues will be in accordance with normal management and monitoring protocol outlined in Section 3.5 above.

3.6.3 Pest Plant Control

Invasion and aggressive spread of noxious weed species, such as blackberries, will be noted during each habitat monitoring survey, and any of the routine maintenance works which are proposed to be undertaken.

The extent of spread and risk to surrounding *L. raniformis* habitat areas will be assessed and allocated an appropriate response, which will most likely involve the immediate implementation of weed control measures such as spraying and/or removal by hand or machinery.

3.7 Responsibilities for Management

Melbourne's Strategic Impact Assessment (the SIA) process implements the State-Commonwealth Agreement to undertake broad scale strategic assessments with respect to any matters of National Environmental Significance (NES) listed under the EPBC Act (Section 146(1) Agreement, Part 10 Strategic Assessment). Subsequent to this agreement, on 8 July 2010, the Commonwealth Minister for the Environment approved the actions associated with urban development surrounding Melbourne, provided that they are undertaken in accordance with the endorsed program report: *Delivering Melbourne's Newest Sustainable Communities* (Department of Planning and Community Development (DPCD), 2010) in the 28 precincts within the current extent of the Urban Growth Boundary. One of the conditions of the approval is that actions must be in accordance with approved prescriptions for the protection of matters of National Environmental Significance (NES):

(<http://www.environment.gov.au/epbc/notices/assessments/pubs/melbourne-28-precincts.pdf>).

The SIA process employs a precinct-wide approach to matters of NES. As a result, measures to protect and enhance habitat for nationally-significant flora and fauna are being implemented for the whole Cardinia Road Employment Precinct. This requires a coordinated, precinct-wide approach to habitat creation and protection, as well as management, monitoring and maintenance. The approved prescription for *L. raniformis* requires a Conservation Management Plan to be prepared for precincts such as Cardinia Road Employment Precinct, which contain suitable habitat for the species.

Under existing environmental conditions, dams, surrounding terrestrial habitat and landscapes that allow for movement of *L. raniformis* are located on all properties, many of which will be removed as part of the development of the Precinct.

This CMP allows for the removal of these dams to be offset through the creation of consolidated habitat corridors that provide a superior environment, by augmenting habitat along north-south waterways and providing east-west links to enable movement between them. In some cases, this approach will result in some landowners removing habitat from their land, which is to be offset on other properties. As a result, all landowners have an obligation to fund the creation of new habitat, as well as management and maintenance requirements post-construction. Prior to the endorsement of the SIA process, this would have triggered a referral by individual landowners under the EPBC Act for an action that is likely to have a significant impact on any matters of NES. Through the application of the SIA process, this CMP outlines the obligations for landowners within the Precinct, resulting in referrals under the EPBC Act no longer being required on a property-by-property basis.

The management of *L. raniformis* as outlined in this CMP is ultimately an obligation of the landowners who are developing the land, as shown in Appendix 2. Management requirements may be transferred to Melbourne Water or Cardinia Shire Council, once land is transferred to the relevant public authority.

If landowners transfer land to Melbourne Water, this must be done through a legally binding agreement, which includes funding for implementing the required management requirements by Melbourne Water on behalf of the landowner.

To provide a coordinated approach to the implementation of this CMP, mechanisms have been put in place for landowners to make payments to the appropriate administering agency to undertake actions on their behalf. This will enable a coordinated, holistic approach to habitat creation and management. Funding is to be provided:

- For construction of waterbodies and enhancement of retained existing waterbodies, through:
 - developer contributions paid to Cardinia Shire Council to fund habitat creation along east-west corridors, including frog ponds, under the provisions of a Section 173 Agreement or any future Development Contributions Plan;
 - the Development Services Scheme (DSS) under the *Water Act 1989*, through which payments are made to Melbourne Water to fund habitat creation and augmentation, including both frog ponds and wetlands, along north-south waterway/drainage corridors; and,
 - services agreements with Melbourne Water.
- For management, monitoring and maintenance of ponds as required in this CMP (which landowners would normally undertake as part of individual approvals under the EPBC Act). Where land is transferred to Melbourne Water, funding is to be provided by the landowner to Melbourne Water to undertake actions on their behalf, prior to receiving a statement of compliance for a subdivision permit.

3.7.1 Key Responsibilities

Cardinia Shire Council will be responsible for the following actions for Phase 1 of the CMP:

- Ensuring landowners and/or developers do not remove existing dams until adjacent constructed ponds and wetlands are established 12 months prior to frog pond removal in consultation with DSE;
- Ensuring landowners and/or developers undertake appropriate salvage and translocation measures during removal of dams and disruption of suitable habitat in the Precinct as outlined in this report;
- Ensuring appropriate maintenance, monitoring and surveys are conducted in accordance with this report and reported, in relation to:
 - *L. raniformis* population monitoring;
 - Habitat monitoring;
 - Water quality; and,

- Assessment of the presence of fish.
- Providing an annual summary of the results of frog surveys and water quality and habitat monitoring to the Minister for (refer Appendix 7 and 8).

The timeframe coincides with the estimated period for the completion of the staged construction of the development and is probably the minimum period to determine the success of the artificial habitat for *L. raniformis*. In the second and fourth years of Phase 1 a progress report will be provided to the Minister on the implementation of the frog management plan noting any key issues and management responses;

- Informing the Minister of any significant change to the approved plans; and,
- Revising the CMP when significant additional information becomes available. This can include information from site inspections, maintenance and monitoring activities. A revision to the management plan does not necessarily require preparation of a comprehensive new plan but will more likely involve the development of a supplementary plan or addendum.

Note: Management and maintenance of waterway corridors along Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain will be subject to a Memorandum Of Understanding (MOU) between Cardinia Shire Council and Melbourne Water.

The MOU may vary or define in detail which party carries out some of the actions described in the CMP. These variations are likely to reflect a more practical management and maintenance arrangement that fits within existing practices, which will not be determined until such a time that the Development Services Scheme is constructed and detailed plans can be prepared that demarcate the areas of responsibility and actions that will be undertaken by each party.

3.7.2 Reporting and CMP Review

The following protocols to inform both DSEWPC and DSE of relevant issues, milestones and results of surveys and studies, will be implemented to keep the regulatory authorities informed:

- An annual summary of the results of all monitoring procedures, wetland creation and any maintenance activities will be provided to DSEWPC and DSE for a period of ten years post finalisation of the construction phase;

- In the second and fourth years of the development a progress report will be provided to DSEWPC and DSE on the implementation of the CMP, noting any key issues and management responses;
- If a landowner or developer wishes to carry out any activity otherwise than in accordance with the DSEWPC and DSE approved plans, revised plans will be submitted for DSEWPC and DSE approval. It should be noted that the extent of the 'buffers' and the width of the creek and open space corridors are defined in the Cardinia Road Employment Precinct Structure Plan and cannot be varied without a planning scheme amendment. If DSEWPC and DSE approves a revised plan that particular plan must be implemented rather than plan as originally approved, subject to the consistency of land use with the Precinct Structure Plan; and,
- Both DSEWPC and DSE will be informed of any significant finding resulting from period surveys, and monitoring activities.

In addition:

- If DSEWPC or DSE believe that it is necessary or desirable for the better protection of the environment to do so, they may request the landowner or developer, or Cardinia Shire Council to make specified revisions to the plan, and to submit the revised plan for DSEWPC and DSE approval. The body or institution taking the action must comply with any such request. If DSEWPC or DSE approves a revised plan pursuant to this condition, the landowner, developer or Cardinia Shire Council will implement that plan instead of the plan as originally approved; and,
- A review of the CMP will be undertaken every five years following its approval as well as at the end of Phase 1. The review will be undertaken in consultation with DSE (and DSEWPC if necessary), to address and rectify any issues that may arise during the implementation and use of the CMP, such as significant population decreases, major changes in habitats, or new processes to inform and update adaptive management procedures.

In the event that through the above review process, it is proposed to extend the requirements outlined in this CMP, including changes to the current scope of proposed works, management actions and monitoring requirements that have been deemed necessary during the life of the CMP, these must be determined by consultation and agreement between DSE, Cardinia Shire Council and Melbourne Water. Any changes will be subject to the provision and commitment of an appropriate funding mechanism. Public land managers owning property within the precinct will not be responsible for funding contingency actions, unless a supplementary revenue stream can be identified. If contingency actions are required to be implemented during the life of the CMP, public land managers will participate in identifying an appropriate funding source to enable these actions to be undertaken.

4 CONSERVATION MANAGEMENT PLAN: PHASE TWO

After the completion of Phase 1 under this CMP, Phase 2 will be implemented in perpetuity.

Phase 2 will require the ongoing implementation of the following:

- Maintenance of Melbourne Water land and waterways in accordance with Melbourne Water's standard waterway maintenance policies and programs.
- Ongoing monitoring of Growling Grass Frog population is to be funded through alternative funding sources. This obligation will not be funded by Melbourne Water and Cardinia Council.
- Implementation of contingency plans if unforeseen circumstances occur in accordance with Section 3.6 Contingency Actions. As outlined in Section 3.6, Contingency Actions, contingency obligations will not be funded by Melbourne Water or Cardinia Shire Council unless a supplementary funding stream can be identified
- If any future works are likely to have a significant impact on Growling Grass Frog then a referral will be required to the Commonwealth Government under the EPBC Act.

5 CONCLUSION

Provided that the construction and long-term management of the Precinct is in accordance with this plan and other documents relating to the Precinct (Hamer and Organ 2006a, 2006b; Ecology Partners Pty. Ltd. 2008a, 2008b; Hamer and Organ 2008), there is likely to be a net improvement in habitat quality and availability. *Litoria raniformis* is likely to naturally recolonise created ponds within the Precinct, particularly if they are constructed and managed appropriately, and connections between waterbodies both within the Precinct, and outside it, are available.

The primary objective of this plan is to provide design and management requirements to support a viable breeding population of *L. raniformis* within the Precinct in the future. There are opportunities to modify these if additional information becomes available during frog and habitat monitoring, subject to approval from DSE and DSEWPC.

An important element of the effective implementation of the management plan is the ongoing commitment from the future land developers, Cardinia Shire Council, Melbourne Water and DSE. Similarly, there needs to be continual communication between future developers, referral authorities and specialist consultants experienced in undertaking monitoring and management of *L. raniformis* and its habitats.

Finally, current and future landowners need to be aware of the regulatory obligations they have in terms of meeting DSEWPC (EPBC Act provisions) and DSE requirements with respect to the long-term management of the Precinct for the nationally threatened *L. raniformis*.

REFERENCES

References

- ANZECC. 2000. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand. *Australian and New Zealand Guidelines for Freshwater and Marine Water Quality*.
- Ashworth, J.M. 1998. An appraisal of the Conservation of *Litoria raniformis* (Kefferstein) in Tasmania. University of Tasmania March 1998. Unpublished Masters thesis.
- Aspect 2005. Fairway Waters Landscape Concept Overall Plan. Aspect Melbourne Pty. Ltd. Landscape Architecture and Urban Design.
- AVW. Atlas of Victorian Wildlife
- Barker, J., Grigg, G.C. & Tyler, M.J. 1995. A Field Guide to Australian Frogs. Surrey Beatty & Sons. New South Wales.
- Brehm K. 1989. The acceptance of 0.2-metre tunnels by amphibians during their migration to the breeding site. Toad Tunnel Conference, Rendsburg.
- Brett Lane & Associates Pty. Ltd. 2004. Existing Pakenham Golf Course, Flora and Fauna Assessment report 2004.48(1). Unpublished report for Cardinia Shire Council.
- Brett Lane & Associates Pty. Ltd. 2005. Targeted survey for the Growling Grass Frog at the existing and proposed Golf Course sites. Unpublished report for Cardinia Shire Council.
- Christy, M. 2000. The ecology and conservation biology of the Green and Golden Bell Frog *Litoria raniformis*. Unpublished PhD thesis. University of Sydney.
- Cogger, H. 1996. Reptiles and Amphibians of Australia. Reed Books, Sydney.
- Cogger, H.G., Cameron, E.E., Sadler, R.A. & Eggler, P. 1993. *The Action Plan for Australian Reptiles*. Australia Nature Conservation Age.
- Costello, C., Timewell, C. & Organ, A. 2003. Flora and fauna assessment of the proposed Pakenham Bypass, Pakenham, Victoria. Unpublished report prepared for VicRoads.
- Daly, G. 1996. Some problems in the management of the Green and Golden Bell Frog *Litoria aurea* (Anura: Hylidae) at Coomonderry Swamp on the South Coast of New South Wales. *Australian Zoologist* **30**, 199-207.
- DeMaynadier, P.G. & Hunter, M.L. 2000. Road effects on amphibian movements in a forested landscape. *Natural Areas Journal* **20**, 56-65.
- Department of Planning and Community Development (DPCD), 2010. *Delivering Melbourne's Newest Sustainable Communities* Victorian Government, East Melbourne, Victoria, 3002.
- DSE 2007. *Advisory List of Threatened Vertebrate Fauna in Victoria - 2003*. Department of Sustainability & Environment, Victoria.
- DSE 2005. *Advisory List of the Threatened Flora in Victoria – 2005*. Department of Sustainability and Environment, Melbourne.
- Ecology Partners Pty Ltd. 2006. Growling Grass Frog *Litoria raniformis* Monitoring 2005/06, Pakenham Bypass, Pakenham, Victoria. Unpublished Report prepared for VicRoads.
- Ecology Partners Pty Ltd. 2008a. Flora and Fauna Assessment of the Cardinia Employment Corridor (west), Officer, Victoria. Unpublished report prepared for Cardinia Shire Council.

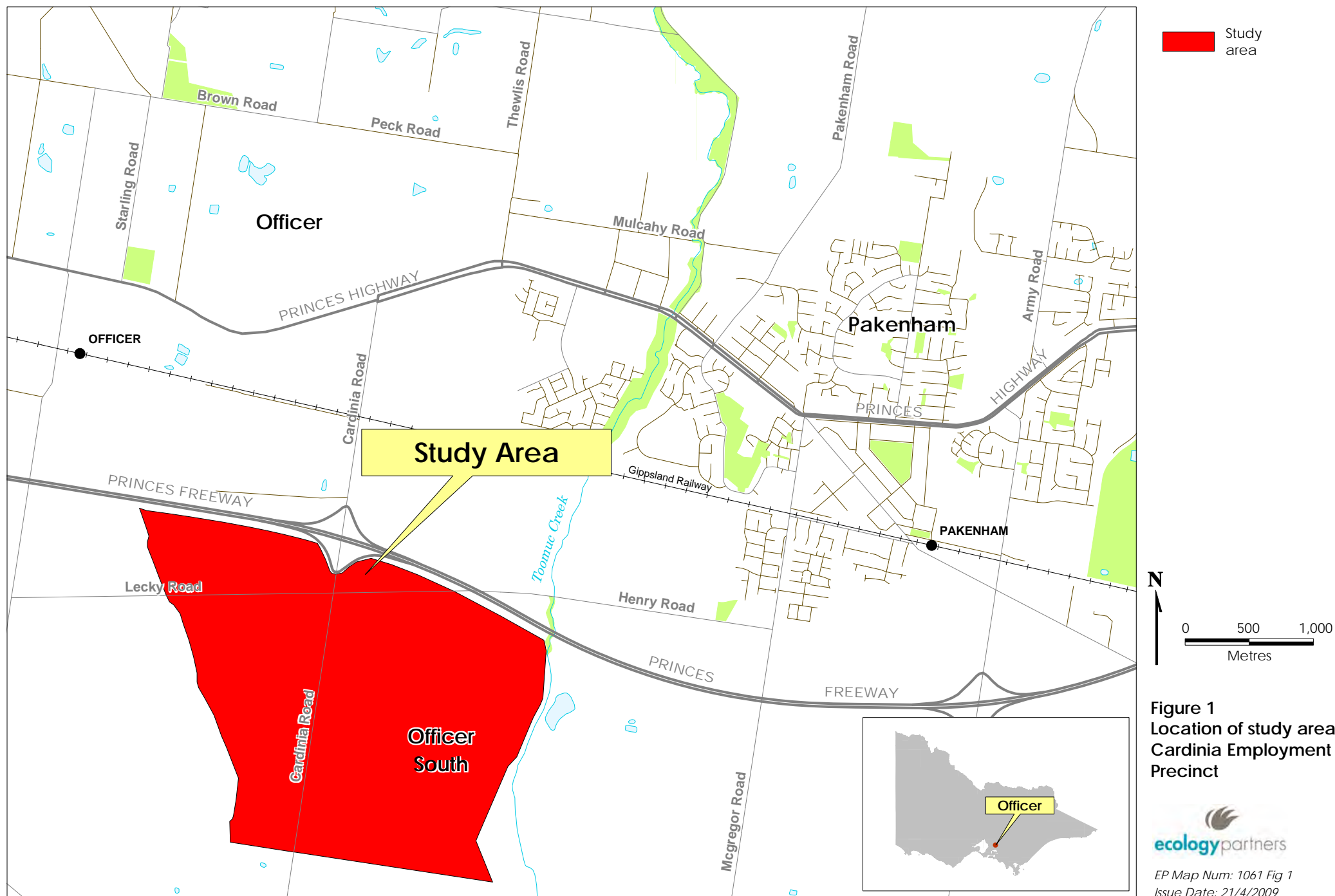
- Ecology Partners Pty Ltd. 2008b. Native Vegetation Precinct Plan: Cardinia Road Employment Precinct. Unpublished report prepared for Cardinia Shire Council.
- Ecology Partners Pty Ltd. 2008c. Biodiversity Management Plan, Cardinia Road Employment Precinct, Officer, Victoria. Unpublished report prepared for Cardinia Shire Council.
- Ecology Partners Pty Ltd. 2008d. Growling Grass Frog *Litoria raniformis* Monitoring 2007/08, Pakenham Bypass, Pakenham, Victoria. Unpublished report prepared for VicRoads.
- Ecology Partners Pty Ltd. 2008e. Growling Grass Frog *Litoria raniformis* Monitoring 2007/08, Pakenham Bypass, Pakenham, Victoria. Unpublished Report prepared for VicRoads.
- Ecology Partners Pty Ltd. 2009a. Targeted Growling Grass Frog *Litoria raniformis* Survey within Cardinia Road Employment Precinct, Pakenham, Victoria. Unpublished report prepared for Cardinia Shire Council, on behalf of Macroplan Pty Ltd.
- Ecology Partners Pty Ltd. 2009b. Growling Grass Frog *Litoria raniformis* Monitoring 2008/09, Pakenham Bypass, Pakenham, Victoria. Unpublished Report prepared for VicRoads.
- Ecology Partners Pty Ltd. 2010. Draft Growling Grass Frog *Litoria raniformis* Habitat Creation and Management Guidelines. Unpublished report prepared for Melbourne Water.
- Erickson, P.A., Camougis, G. & Robbins, E. J. 1978. Highways and ecology: impact assessment and mitigation. US Department of Transportation. Federal Highway Administration, Washington.
- Fahrig, L., Pedlar, J.H. Shealagh, E.P., Taylor, P.D. & Wegener, J.F. 1995. Effect of road traffic on amphibian density. *Biological Conservation* **73**, 177-182.
- Hamer, A.J., Lane, S.J. & Mahony, M. 2002. Management of freshwater wetlands for the endangered Green and Golden Bell Frog *Litoria aurea*: roles of habitat determinants and space. *Biological Conservation* **106**, 413-424.
- Hamer, A.J. & Organ, A. 2006a. Distribution, Habitat Use, Movement Patterns and Conservation Management of the Growling Grass Frog *Litoria raniformis* throughout the Pakenham Area, Pakenham, Victoria. Unpublished report prepared for the Department of Sustainability and Environment, Box Hill, by Ecology Partners Pty Ltd.
- Hamer, A.J. & Organ, A. 2006b. Targeted Survey and Conservation Management Plan for the Growling Grass Frog *Litoria raniformis*: Pakenham Urban Growth Corridor, Pakenham, Victoria. Unpublished report by Ecology Partners Pty Ltd prepared for the Department of Sustainability and Environment, Box Hill.
- Hamer, A.J. & Organ, A. 2008. Aspects of the ecology and conservation of the Growling Grass Frog *Litoria raniformis* in an urban-fringe environment, southern Victoria. Proceedings of the Biology and Conservation of Bell Frogs Conference, Australian Zoologist **34**, 414-425.
- Heard, G.W., Robertson, P. & Moysey E.D. 2004a. Management Plan for the Growling Grass Frog *Litoria raniformis* within the 'Fairway Waters' development, Pakenham, Victoria. Unpublished report to Westmont Holdings Pty Ltd & Simons Builders Pty Ltd. Wildlife Profiles Pty Ltd, Ecology Australia Pty Ltd.

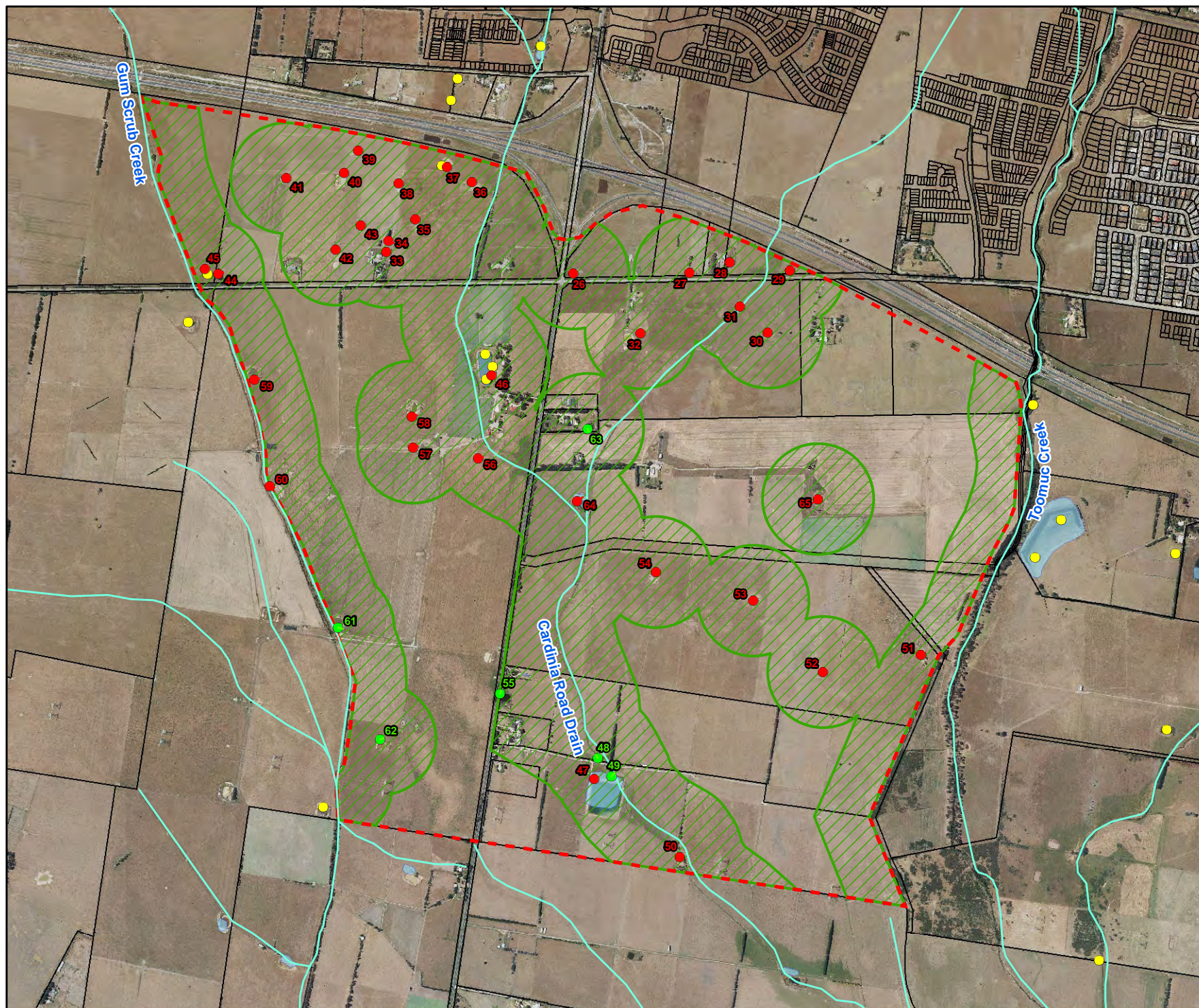
- Heard, G.W., Robertson, P. & Scroggie, M. 2004b. The ecology and conservation status of the Growling Grass Frog *Litoria raniformis* within the Merri Creek corridor. Wildlife Profiles Pty. Ltd. and Arthur Rylah Institute for Environmental Research.
- Hels, T. & Buchwald E. 2001. The effect of road kills on amphibian populations. *Biological Conservation* **99**, 331-340.
- Hero, J.M., Littlejohn, M. & Marantelli, G. 1991. Frogwatch Field Guide to Victorian Frogs. Department of Conservation and Environment, East Melbourne.
- IUCN 2009. *2009 IUCN Red List of Threatened Animals*. International Union for the Conservation of Nature & Natural Resources, Geneva.
- Langton, T.E.S. (ed.) 1989a. Amphibians and Roads. Proceedings of the Toad Tunnel Conference, Rendsburg, Federal republic of Germany, 7-8 January 1989. ACO Polymer Products Ltd. Shefford, England.
- Langton, T. E. S. (ed.) 1989b. Reasons for preventing amphibian mortality on roads. Proceedings of the Toad Tunnel Conference, Rendsburg, Federal republic of Germany, 7-8 January 1989. ACO Polymer Products Ltd. Shefford, England.
- Littlejohn, M.J. 1963. Frogs of the Melbourne area. *Victorian Naturalist*. **79**:296-304.
- Littlejohn, M.J. 1982. Amphibians of Victoria. *Victorian Yearbook*. **85**:1-11.
- Mansergh, I.M. & Scotts, D.J. 1989. Habitat continuity and social organisation of the Mountain Pygmy-possum restored by tunnel. *Journal of Wildlife Management* **53**, 701-707.
- Mahoney, M. 1999. Review of the declines and disappearances within the bell frog species group (*Litoria aurea* species group) in Australia. In: Declines and Disappearances of Australian Frogs. The University of Newcastle, Newcastle, NSW.
- Melbourne Water Corporation. 2005. *Constructed Wetland Systems – Design Guidelines for developers*. Melbourne Water Corporation.
- Melbourne Water Corporation. 2009. *Constructed Waterways in Urban Development Guidelines*. Melbourne Water Corporation
- Morgan, L.A. & Buttermer, W.A. (1996). Predation by the non-native fish *Gambusia holbrooki* on small *Litoria aurea* and *L. dentata* tadpoles. *Australian Journal of Zoology*: **30**:143-149.
- Moysey, E. D., Kohout, M. & Carr G. W. 2003. Flora and Fauna Assessment of 'Fairway Waters' Racecourse Road, Pakenham. Unpublished report by Ecology Australia for Westmont Holdings Pty. Ltd. / Simon's Builders Pty Ltd.
- Norris, K. 2004. Survey for *Litoria raniformis* Greenhills, Pakenham. Unpublished report to Environmental Resources Management Australia Pty Ltd.
- NPWS (National Parks & Wildlife Service) 2001. Hygiene Protocol for the Control of Disease in Frogs. Information Circular No. 6. N.S.W. National Parks & Wildlife Service, Hurstville.
- NPWS (2001) New South Wales Threat Abatement Plan for Predation by the Red Fox. New South Wales National Parks and Wildlife Service, unpublished report.

- NSW Department of Environment and Conservation (NSW DEC) (2005). *Southern Bell Frog Litoria raniformis Draft Recovery Plan*, [Online], Sydney, NSW Department of Environment and Conservation (DEC). Available from: <http://www.environment.nsw.gov.au/resources/nature/recoveryplanDraftSouthernBellFrog.pdf>.
- Oates & Taranto 2001, Vegetation Mapping of the Port Phillip and Westernport Region. Department of Sustainability & Environment, Victoria.
- Organ in prep. Ecology and conservation significance of the Growling Grass Frog *Litoria raniformis* throughout the Pakenham area, south eastern Melbourne, Victoria.
- Organ, A. 2002. Survey for the Warty Bell Frog *Litoria raniformis*, at the Western Treatment Plant, Werribee, Victoria. Biosis Research Pty Ltd unpublished report for Melbourne Water Corporation.
- Organ, A. 2003. Growling Grass Frog *Litoria raniformis* monitoring over the 2002/03 breeding period, Western Treatment Plant, Werribee, Victoria. Biosis Research Pty Ltd unpublished report for Melbourne Water Corporation.
- Organ, A. 2004. Pakenham Bypass: Growling Grass Frog *Litoria raniformis* 2003/04 survey, Pakenham and surrounds Victoria. Biosis Research Pty Ltd unpublished report for VicRoads.
- Organ, A. 2005a. Targeted Growling Grass Frog *Litoria raniformis* survey and management recommendations for the proposed Fairway Waters, Pakenham, Victoria. Ecology Partners Pty Ltd unpublished report for Thinc Projects Pty Ltd.
- Organ, A. 2005b. Pakenham Bypass: Conservation Management Plan for the Growling Grass Frog *Litoria raniformis*, Pakenham, Victoria. Biosis Research Pty Ltd unpublished report for VicRoads.
- Organ, A. 2005c. Growling Grass Frog *Litoria raniformis* Monitoring 2004/05, Western Treatment Plant, Werribee, Victoria. Biosis Research Pty Ltd unpublished report for Melbourne Water Corporation.
- Organ, A. & Hamer, A.J. 2006a. Flora and Fauna Assessment and Targeted Growling Grass Frog *Litoria raniformis* survey, O'Connor's Abattoirs, Koo Wee Rup Road, Pakenham, Victoria. Ecology Partners Pty Ltd unpublished report for G & K O'Connor Pty. Ltd.
- Organ, A. & Hamer, A.J. 2006b. Growling Grass Frog *Litoria raniformis* survey and advice relating to the proposed rezoning in the north east corner of Koo Wee Rup Road and Green Hills Road, Pakenham. Ecology Partners Pty Ltd unpublished report for Parklea Pty. Ltd.
- Organ, A. & Hamer, A.J. 2006c. Growling Grass Frog monitoring 2005/06, Pakenham Bypass, Pakenham, Victoria. Ecology Partners Pty Ltd unpublished report for VicRoads.
- Pyke G.H. & White A.W. 1996. Habitat requirements for the Green and Golden Bell Frog *Litoria aurea* (Anura: Hylidae). *Australian Zoologist* **30**(2): 224-232
- Pyke G.H. 2002. A review of the biology of the Southern Bell Frog *Litoria raniformis* (Anura: Hylidae). *Australian Zoologist* **32**: 32-48.
- Robertson, P. 2003. Draft Flora and Fauna Guarantee Action Statement for the Growling Grass Frog, *Litoria raniformis*. (Department of Sustainability and Environment, Victoria).

- Robertson, P., Heard, G. & Scroggie, M. 2002. The Ecology and Conservation Status of the Growling Grass Frog *Litoria raniformis* within the Merri Creek Corridor. Interim Report: Distribution, Abundance and Habitat Requirements. Report produced for the Department of Natural Resources and Environment.
- Timewell, C. 2003. Pakenham Bypass: Survey for the Warty Bell Frog *Litoria raniformis*, Pakenham and surrounds, Victoria. Unpublished report prepared for VicRoads by Biosis Research Pty Ltd.
- Tyler, M.J. 1997. *The Action Plan for Australian Frogs*. Environment Australia, Canberra.
- Van Leeuwen, B.H. 1982. Protection of mitigating common toad *Bufo bufo* against car traffic in The Netherlands. *Environmental Conservation* 9.1.
- Vos, C.C. & Chardon, J.P. 1998. Effects of habitat fragmentation and road density on the distribution pattern of the Moor Frog *Rana arvalis*. *Journal of Applied Ecology* **35**, 44-56.
- White A. W. & Pyke G.H. 1996. Distribution and conservation status of the green and golden bell frog *Litoria aurea* in New South Wales. *Australian Zoologist* **30(2)**: 177-189.
- Wilson, C. & Crowfoot, L.V. 2005. Net Gain and Wetland Design Assessment: Fairway Waters, Pakenham. Ecology Australia Pty. Ltd. unpublished report for Premier Places and Simon's Builders Pty Ltd.

FIGURES

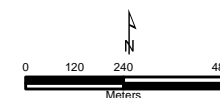




Legend

- Pond Occupied Recently (2008/09 Survey)
- Pond not Occupied to Date (Including 2008/09 Survey)
- Ponds Previously Occupied (Including 2007/08 Survey)
- Creeks/Drains
- - - Study Area
- Suitable Habitat Areas where a Salvage and Translocation Plan is likely to be Required by DSE
- Existing Lake/Dam

Figure 2
Growling Grass Frog
Survey Results and
Habitat Areas,
Cardinia Employment
Precinct





Legend








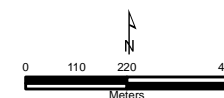
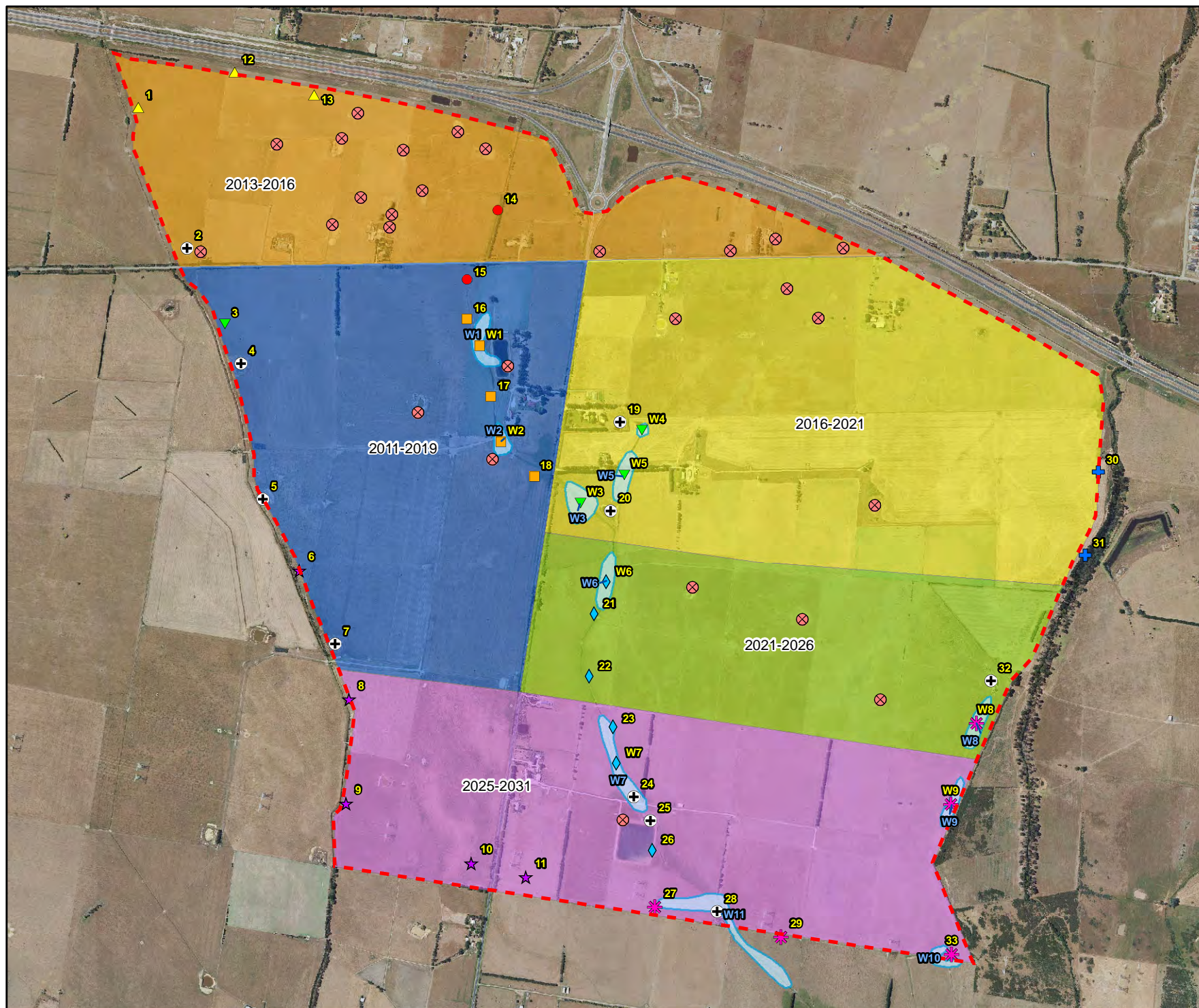
-  Dedicated GGF Ponds to be Created
-  Potential Translocation Site
-  Existing Dam to be Retained and Enhanced
-  Existing Dam to be Removed
-  Stormwater Wetlands to be Created
-  Waterways
-  Study Area

Figure 3
Biodiversity
Management Plan
Ponds and Wetlands,
Cardinia Employment
Precinct





Legend

 Study Area

Indicative Frog Pond to be Created

● Group 1

■ Group 2

▲ Group 3

▼ Group 4

◆ Group 5

⊕ Group 6

★ Group 7

✱ Group 8

⊕ Existing Dam to be Retained and Enhanced

⊗ Existing Dam to be Removed

■ Stormwater Wetlands to be Created

Estimated Development Sequencing

■ 2011-2019

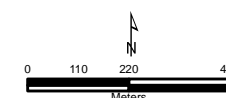
■ 2013-2016

■ 2016-2021

■ 2021-2026

■ 2025-2031

Figure 4
Indicative Frog Pond
Implementation &
Development
Sequencing
Cardinia Employment
Precinct





LEGEND

Precinct Structure Plan Area

Urban Growth Boundary

Road Network

- State Freeway
- Arterial Road
- Connector Street
- Access Street

Land Use

- Employment
- Residential

Open Space and Environment

Unencumbered Open Space

- Parks

Encumbered Open Space

- Waterways drainage corridor
- Conservation Reserve EVCs
- East West Habitat Link
- Major Easements
- Existing Creeks
- Drainage Lines
- Existing Major Easements
- Existing Wetlands
- New online linear wetlands
- New offline linear wetlands
- Existing waterbodies to be relocated
- Existing pond with GGF Records
- Existing pond without GGF Record
- Indicative location for proposed Growing Grass Frog ponds
- Offline ponds (30m buffer areas)
- Online ponds (30m buffer areas)

Other land

- Existing Major Easements
- Future Urban Land
- Existing Urban Land

Note: Pond dimensions in metres with 30m buffers provided from roads and footpaths

Numbered ponds are within the Cardinia Road Employment Precinct Conservation Management Plan, unnumbered ponds are on adjacent sites or precincts

smec urban
consulting group

0 75 150 225m

Scale: 1:7,500m @ A1
1:15,000m @ A3

Ref: 3410116UCR
Date: 26 August 2010
Rev: U
Drawn: RL
Checked: MH

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Figure 5: Biodiversity Management Cardinia Road Employment Precinct Structure Plan

APPENDICES

Appendix 1 – Significance Assessment

Criteria used by Ecology Partners Pty Ltd to define conservation significance, vegetation condition and habitat quality is provided below.

A1.1. Rare or Threatened Categories for listed Victorian taxa

Table A1.1. Rare or threatened categories for listed Victorian taxa.

Rare or Threatened Categories
<p>CONSERVATION STATUS IN AUSTRALIA (Based on the EPBC Act 1999, Briggs and Leigh 1996*)</p>
EX - Extinct: Extinct is when there is no reasonable doubt that the last individual of the species has died.
CR - Critically Endangered: A species is critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
EN - Endangered: A species is endangered when it is not critically endangered but is facing a very high risk of extinction in the wild in the near future.
VU - Vulnerable: A species is vulnerable when it is not critically endangered or endangered but is facing a high risk of extinction in the wild in the medium-term future.
R* - Rare: A species is rare but overall is not currently considered critically endangered, endangered or vulnerable.
K* - Poorly Known: A species is suspected, but not definitely known, to belong to any of the categories extinct, critically endangered, endangered, vulnerable or rare.
<p>CONSERVATION STATUS IN VICTORIA (Based on DSE 2005, DSE 2007, FIS)</p>
x - Presumed Extinct in Victoria: not recorded from Victoria during the past 50 years despite field searches specifically for the plant, or, alternatively, intensive field searches (since 1950) at all previously known sites have failed to record the plant.
e - Endangered in Victoria: at risk of disappearing from the wild state if present land use and other causal factors continue to operate.
v - Vulnerable in Victoria: not presently endangered but likely to become so soon due to continued depletion; occurring mainly on sites likely to experience changes in land-use which would threaten the survival of the plant in the wild; or, taxa whose total population is so small that the likelihood of recovery from disturbance, including localised natural events such as drought, fire or landslip, is doubtful.
r - Rare in Victoria: rare but not considered otherwise threatened - there are relatively few known populations or the taxon is restricted to a relatively small area.
k - Poorly Known in Victoria: poorly known and suspected, but not definitely known, to belong to one of the above categories (x, e, v or r) within Victoria. At present, accurate distribution information is inadequate.

A1.2. Defining Ecological Significance

Table A1.2. Defining Ecological Significance.

Criteria for defining Ecological Significance	
NATIONAL SIGNIFICANCE	
Flora	National conservation status is based on the EPBC Act list of taxa considered threatened in Australia (i.e. extinct, critically endangered, endangered, vulnerable).
	Flora listed as rare in Australia in <i>Rare or Threatened Australian Plants</i> (Briggs and Leigh 1996).
Fauna	National conservation status is based on the EPBC Act list of taxa considered threatened in Australia (i.e. extinct, critically endangered, endangered, vulnerable).
	Fauna listed as extinct, critically endangered, endangered, vulnerable, Rare or Lower Risk (near threatened, conservation dependent or least concern) under National Action Plans for terrestrial taxon prepared for the Department of the Environment, Water, Heritage and the Arts: threatened marsupials and monotremes (Maxwell <i>et al.</i> 1996), bats (Duncan <i>et al.</i> 1999), birds (Garnett and Crowley 2000), reptiles (Cogger <i>et al.</i> 1993), and amphibians (Tyler 1997).
	Species that have not been included on the EPBC Act but listed as significance according to the <i>IUCN 2009 Red List of Threatened Species</i> (IUCN 2009).
Communities	Vegetation communities considered critically endangered, endangered or vulnerable under the EPBC Act and considering vegetation condition.
STATE SIGNIFICANCE	
Flora	Threatened taxa listed under the provisions of the FFG Act.
	Flora listed as extinct, endangered, vulnerable or rare in Victoria in the DSE Flora Information System (most recent Version).
	Flora listed in the State Government's <i>Advisory List of Rare or Threatened Plants in Victoria</i> , 2005 (DSE 2005).
	Flora listed as poorly known in Australia in <i>Rare or Threatened Australian Plants</i> (Briggs and Leigh 1996).
Fauna	Threatened taxon listed under Schedule 2 of the FFG Act.
	Fauna listed as extinct, critically endangered, endangered and vulnerable on the State Government's <i>Advisory List of Threatened Vertebrate Fauna in Victoria – 2007</i> (DSE 2007).
	Listed as Data Deficient, Lower risk – Near threatened, or Insufficiently Known under National Action Plans for terrestrial species prepared for the Department of the Environment, Water, Heritage and the Arts: threatened marsupials and monotremes (Maxwell <i>et al.</i> 1996), bats (Duncan <i>et al.</i> 1999), birds (Garnett and Crowley 2000), reptiles (Cogger <i>et al.</i> 1993), and amphibians (Tyler 1997).

Criteria for defining Ecological Significance	
Communities	Ecological communities listed as threatened under the FFG Act.
	Ecological vegetation class listed as threatened (i.e. endangered, vulnerable) or rare in a Native Vegetation Plan for a particular bioregion (DSE Website) and considering vegetation condition.
REGIONAL SIGNIFICANCE	
Flora	Flora considered rare in any regional native vegetation plan for a particular bioregion.
	Flora considered rare by the author for a particular bioregion.
Fauna	Fauna with a disjunct distribution, or a small number of documented recorded or naturally rare in the Gippsland Plain bioregion.
	A particular taxon that is has an unusual ecological or biogeographical occurrence or listed as Lower Risk – Near Threatened, Data Deficient or Insufficiently Known on the State Government’s Advisory List of <i>Threatened Vertebrate Fauna in Victoria – 2007</i> (DSE 2007).
Communities	Ecological vegetation class listed as depleted or least concern in a Native Vegetation Plan for a particular bioregion (DSE Website) and considering vegetation condition.
	Ecological vegetation class considered rare by the author for a particular bioregion.
LOCAL SIGNIFICANCE	
Local significance is defined as flora, fauna and ecological communities indigenous to a particular area, which are not considered rare or threatened on a national, state or regional level.	

A1.3 Defining Site Significance

The following geographical areas apply to the overall level of significance with respect to the current survey.

National: Australia

State: Victoria

Regional: Gippsland Plain bioregion

Local: Within 10 kilometres surrounding the Precinct area.

Table A1.3. Defining Site Significance.

Criteria for defining Site Significance
<p>NATIONAL SIGNIFICANCE</p> <p>A site is of National significance if:</p> <ul style="list-style-type: none"> - it regularly supports, or has a high probability of regularly supporting individuals of a taxon listed as 'Critically Endangered' or 'Endangered' under the EPBC Act and/or under National Action Plans for terrestrial taxon prepared for the Department of the Environment, Water, Heritage and the Arts. - it regularly supports, or has a high probability of supporting, an 'important population' as defined under the EPBC Act of one or more nationally 'vulnerable' flora and fauna taxon. - it is known to support, or has a high probability of supporting taxon listed as 'Vulnerable' under National Action Plans. - it is known to regularly support a large proportion (i.e. greater than 1%) of a population of a taxon listed as 'Conservation Dependent' under the EPBC Act and/or listed as Rare or Lower Risk (near threatened, conservation dependent or least concern) under National Action Plans. - it contains an area, or part thereof designated as 'critical habitat' under the EPBC Act, or if the site is listed under the Register of National Estate compiled by the Australian Heritage Commission. - it is a site which forms part of, or is connected to a larger area(s) of remnant native vegetation or habitat of national conservation significance such as most National Park, and/or a Ramsar Wetland(s).
<p>STATE SIGNIFICANCE</p> <p>A site is of State significance if:</p> <ul style="list-style-type: none"> - it occasionally (i.e. every 1 to 5 years) supports, or has suitable habitat to support taxon listed as 'Critically Endangered' or 'Endangered' under the EPBC Act and/or under National Action Plans. - it regularly supports, or has a high probability of regularly supporting (i.e. high habitat quality) taxon listed as 'Vulnerable', 'Near threatened', 'Data Deficient' or 'Insufficiently Known' in Victoria (DSE 2005, 2007), or species listed as 'Data Deficient' or 'Insufficiently Known' under National Action Plans. - it contains an area, or part thereof designated as 'critical habitat' under the FFG Act. - it supports, or likely to support a high proportion of any Victorian flora and fauna taxa. - it contains high quality, intact vegetation/habitat supporting a high species richness and diversity in a particular Bioregion. - it is a site which forms part of, or connected to a larger area(s) of remnant native vegetation or habitat of state conservation significance such as most State Parks and/or Flora and Fauna Reserves.

REGIONAL SIGNIFICANCE
<p>A site is of Regional significance if:</p> <ul style="list-style-type: none"> - it regularly supports, or has a high probability of regularly supporting regionally significant fauna as defined in Table 1.2. - it contains a large population (i.e. greater than 1%) of flora considered rare in any regional native vegetation plan for a particular bioregion. - it supports a fauna population with a disjunct distribution, or a particular taxon that has an unusual ecological or biogeographical occurrence. - it is a site which forms part of, or is connected to a larger area(s) of remnant native vegetation or habitat of regional conservation significance such as most Regional Parks and/or Flora and Fauna Reserves.
LOCAL SIGNIFICANCE
<p>Most sites are considered to be of at least local significant for conservation, and in general a site of local significance can be defined as:</p> <ul style="list-style-type: none"> - an area which supports indigenous flora species and/or a remnant Ecological Vegetation Class, and habitats used by locally significant fauna species. - an area which currently acts, or has the potential to act as a wildlife corridor linking other areas of higher conservation significance and facilitating fauna movement throughout the landscape.

A1.4. Defining Vegetation Condition

Table A1.4. Defining Vegetation Condition.

Criteria for defining Vegetation Condition
<p>Good condition - Vegetation dominated by a diversity of indigenous species, with defined structures (where appropriate), such as canopy layer, shrub layer, and ground cover, with little or few introduced species present.</p>
<p>Moderate condition - Vegetation dominated by a diversity of indigenous species, but is lacking some structures, such as canopy layer, shrub layer or ground cover, and/or there is a greater level of introduced flora species present.</p>
<p>Poor condition - Vegetation dominated by introduced species, but supports low levels of indigenous species present, in the canopy, shrub layer or ground cover.</p>

A1.5. Defining Habitat Quality

Several factors are taken into account when determining the value of habitat. Habitat quality varies on both spatial and temporal scales, with the habitat value varying depending upon a particular fauna species.

Table A1.5. Defining Habitat Quality.

Criteria for defining Habitat Quality
HIGH QUALITY
High degree of intactness (i.e. floristically and structurally diverse), containing several important habitat features such as ground debris (logs, rocks, vegetation), mature hollow-bearing trees, and a dense understorey component.
High species richness and diversity (i.e. represented by a large number of species from a range of fauna groups).
High level of foraging and breeding activity, with the site regularly used by native fauna for refuge and cover.
Habitat that has experienced, or is experiencing low levels of disturbance and/or threatening processes (i.e. weed invasion, introduced animals, soil erosion, salinity).
High contribution to a wildlife corridor, and/or connected to a larger area(s) of high quality habitat.
Provides known, or likely habitat for one or more rare or threatened species listed under the EPBC Act, FFG Act, or species considered rare or threatened according to DSE 2007.
MODERATE QUALITY
Moderate degree of intactness, containing one or more important habitat features such as ground debris (logs, rocks, vegetation), mature hollow-bearing trees, and a dense understorey component.
Moderate species richness and diversity - represented by a moderate number of species from a range of fauna groups.
Moderate levels of foraging and breeding activity, with the site used by native fauna for refuge and cover.
Habitat that has experienced, or is experiencing moderate levels of disturbance and/or threatening processes.
Moderate contribution to a wildlife corridor, or is connected to area(s) of moderate quality habitat.
Provides potential habitat for a small number of threatened species listed under the EPBC Act, FFG Act, or species considered rare or threatened according to DSE 2007.
LOW QUALITY
Low degree of intactness, containing few important habitat features such as ground debris (logs, rocks, vegetation), mature hollow-bearing trees, and a dense understorey component.
Low species richness and diversity (i.e. represented by a small number of species from a range of fauna groups).
Low levels of foraging and breeding activity, with the site used by native fauna for refuge and cover.
Habitat that has experienced, or is experiencing high levels of disturbance and/or threatening processes.
Unlikely to form part of a wildlife corridor, and is not connected to another area(s) of habitat.
Unlikely to provide habitat for rare or threatened species listed under the EPBC Act, FFG Act, or considered rare or threatened according to DSE 2007.

Appendix 2 – Summary of Mitigation Strategies

Table A2.1. Summary of actions and strategies to mitigate against impacts to *L. raniformis* as a result of the proposed development.

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
Conservation Management Plan: PHASE 1				
Planning and Design Phase				
All waterbodies within the proposed development of the Precinct.	Plan the location of <i>L. raniformis</i> ponds and wetlands in line with Biodiversity Management Plan map.	Development planning and design.	Cardinia Shire Council	PSP to outline areas to be retained, removed and constructed
	Avoid the loss of waterbodies supporting breeding populations of <i>L. raniformis</i> .	Development planning and design.	Cardinia Shire Council	<i>L. raniformis</i> breeding ponds retained where possible
	Provision of east-west dispersal corridors along both north and south boundaries.	Development planning and design.	Cardinia Shire Council	Dispersal corridors integrated into PSP
	Establishment of a suitable distance (at least 40 metres) between wetlands and any development areas, preferably separated by parkland.	Development planning and design.	Cardinia Shire Council	Buffer zones implemented around dispersal corridors and frog ponds on PSP
	Staged approach to wetland construction - construct ponds and wetlands at outset of project to allow them to become established before removing any existing waterbodies (Refer to development sequencing schedule).	Development planning and design.	Cardinia Shire Council	Development sequencing schedule
	Water and drainage treated appropriately on-site.	Development planning and design.	Me bourne Water	Stormwater treatment wetlands designed in line with Me bourne Water guidelines
Priority areas for habitat creation and enhancement: Gum Scrub Creek, Toomuc Creek and Cardinia Road Drain open space corridors.	Target these priority areas for habitat creation and enhancement at the planning and design level of the development.	Development planning and design.	Cardinia Shire Council	Extensive dispersal corridors and frog pond networks integrated in PSP
	Provision of stormwater treatment wetland complexes along courses of priority areas.	Development planning and design.	Cardinia Shire Council	Stormwater treatment wetlands integrated into creek and drainage line corridors
	Consider habitat connectivity and movement corridors during the design phase through enhancing existing and creating new frog ponds. Road underpass installations will be also required.	Development planning and design.	Cardinia Shire Council	Offline frog ponds integrated into PSP
Planning Permit Applications: Construction Environmental Management Plan (CEMP) requirements	Includes weed management actions, which address Cardinia Shire Council's Weed Management Strategy	Development planning and design.	Land Owner	Approved CEMP
	Includes erosion and sedimentation controls in accordance with the EPA Victoria Guidelines	Development planning and design.	Land Owner	Approved CEMP
	Includes feral animal control measures for individual	Development planning and design.	Land Owner	Approved CEMP

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
	properties, to be updated in accordance with any future development of a Feral Animal Control Plan or Management Strategy by Cardinia Shire Council.			
General	Explore placing a covenant on development restricting cat ownership.	Development planning and design.	Cardinia Shire Council	Letter drop or signage for prospective land owners
	Discourage residents from planting known environmental weeds.	Development planning and design.	Cardinia Shire Council	Letter drop or signage for prospective land owners
Pre-construction Phase				
All existing waterbodies within the proposed development of the Precinct (including Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain).	Maintain water levels and quality in all existing water bodies to retain habitat	Prior to works commencing	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	<i>L. raniformis</i> population maintained
	Commence population and habitat monitoring for all existing ponds from the date of CMP approval (as per protocol in Section 3.3.4.	Annually until: - the time the pond is removed (if removal is approved in this CMP); or - in the case of ponds being retained, until the 10-year monitoring period for adjacent new ponds is complete.	Cardinia Shire Council	Monitoring undertaken and completed as required, and reports submitted to Cardinia Shire Council, DSEWPC and DSE
	Obtain permit to remove habitat and take indigenous fauna under Wildlife Act 1975	Prior to works commencing.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	n/a
Waterbodies classified as high impact (sites 20, 21, 27, 33, 34 and 35) and medium impact (sites 2, 9, 19, 30, 31, 32, 39 and 40) to <i>L. raniformis</i> if removed.	Obtain permit to 'live capture', collect and relocate <i>L. raniformis</i> under the Wildlife Act 1975.	Prior to works commencing.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	Permit acquired.
	Notify owners or land managers of translocation sites.	Prior to salvage and translocation measures.	Land Owner unless transferred to a public Authority such as Cardinia Shire Council or Melbourne Water.	Written agreement as to use of site as translocation site for <i>L. raniformis</i> .
	Undertake targeted <i>L. raniformis</i> surveys. If <i>L. raniformis</i> is detected salvage and translocation	Immediately prior to construction works. During active season for <i>L.</i>	Land Owner unless transferred to a public	Report detailing results of pre-construction surveys and

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
	measures will be undertaken (also during construction phase).	<i>raniformis</i> (October to March).	Authority through a legally binding agreement with funds provided.	translocation measures to be submitted to DSEWPC and DSE for review.
	Identify and fence off potential and known habitat areas to prevent unnecessary access by construction staff	Prior to works commencing.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	Known and potential <i>L. raniformis</i> habitat fenced off and protected prior to disturbance/removal, or during entire construction period if retained
Construction Phase				
Waterbodies classified as high impact (sites 20, 21, 27, 33, 34 and 35) and medium impact (sites 2, 9, 19, 30, 31, 32, 39 and 40) to <i>L. raniformis</i> if removed. Also Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain.	Prior to construction works a zoologist will check the sites for the presence of <i>L. raniformis</i> , particularly under and around suitable terrestrial shelters (e.g. logs, rocks).	Prior to ground preparation works.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	No frog mortality. Any translocation reported to DSE
	Removal of topsoil will be carried out the supervision of a zoologist in case animals are unearthed. If <i>L. raniformis</i> is detected then salvage and translocation measures will be implemented.	During ground preparation works.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	No frog mortality. Any translocation reported to DSE
	If <i>L. raniformis</i> is detected in the absence of a qualified zoologist, works with the potential to impact on the species will cease immediately and a zoologist contacted to undertake salvage and translocation procedures.	At any time during construction works.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided.	Report detailing results of translocation measures to be submitted to DSEWPC and DSE for review.
Proposed constructed wetlands and frog ponds	Construct proposed frog ponds and stormwater treatment wetlands, including revegetation	Construction phase, as per development sequencing schedule	Land Owner to fund through S173/DCP and DSS, or services agreement with Melbourne Water. Cardinia Shire Council or Melbourne Water to construct or enforce construction standards if developer constructs as works in lieu of payment.	Completion of frog pond and wetland construction to the satisfaction of the Ecological Consultant
	Staged approach to wetland construction - construct ponds and wetlands at outset of project to allow them to become established before removing any existing waterbodies (Refer to development sequencing schedule and Staging Principle in Section 3.4.1).	Construction phase, as per development sequencing schedule.	Land Owner unless land is transferred to a public Authority through a legally binding agreement. Once transferred the	Completion of frog pond and wetland construction to the satisfaction of the Ecological Consultant

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
			responsibility will be Melbourne Water Cardinia Shire Council.	
Waterbodies classified as low impact to <i>L. raniformis</i> if removed (all remaining waterbodies)	All contractors and employees will be inducted by a qualified zoologist as to the significance and possible presence of <i>L. raniformis</i> .	At any time during construction works.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	Induction and information pamphlet.
	If <i>L. raniformis</i> is detected in the absence of a qualified zoologist, works with the potential to impact on the species will cease immediately and a zoologist contacted to undertake salvage and translocation procedures.	At any time during construction works.	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	Report detailing results of translocation measures to be submitted to DSEWPC and DSE for review.
General	Follow the guidelines for wetland establishment and vegetation netting as outlined in Sections 3.4.4 and 3.4.10.	During enhancement of existing waterbodies or construction of created waterbodies.	Land Owner to fund through S173/DCP and DSS, or services agreement with Melbourne Water. Cardinia Shire Council or Melbourne Water to construct or enforce construction standards if developer constructs as works in lieu of payment.	Wetlands constructed and revegetated in accordance with guidelines and ecological consultant
	Follow the guidelines for road watercourse crossings and drift fencing as outlined in Sections 3.4.6 and 3.4.8.	During underpass and drift fence installation	Land Owner to fund through S173/DCP and DSS, or services agreement with Melbourne Water. Cardinia Shire Council or Melbourne Water to construct or enforce construction standards if developer constructs as works in lieu of payment.	Appropriate drift fencing and underpasses installed
	No dumping of soil or material on <i>L. raniformis</i> habitats	At any time during construction works.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Melbourne Water	<i>L. raniformis</i> habitats undamaged during construction activities

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
			and Cardinia Shire Council	
	<i>L. raniformis</i> population and habitat monitoring	Annually until: <ul style="list-style-type: none"> - the time the pond is removed (if removal is approved in this CMP); or, - the 10-year maintenance and monitoring period for new ponds is complete; or - in the case of ponds being retained, until the 10-year monitoring period for adjacent new ponds is complete. 	Cardinia Shire Council	Monitoring undertaken and completed as required, and reports submitted to Cardinia Shire Council, DSEWPC and DSE
	Installation of signs to discourage vegetation trampling, rock disturbance and rubbish ingress.	At any time during construction works.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Melbourne Water and Cardinia Shire Council	Appropriate signage installed
Post-construction Phase				
All waterbodies within the Precinct (including Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain)	<i>L. raniformis</i> population and habitat monitoring.	Annually until: <ul style="list-style-type: none"> - the time the pond is removed (if removal is approved in this CMP); or, - the 10-year maintenance and monitoring period for new ponds is complete; or - in the case of ponds being retained, until the 10-year monitoring period for adjacent new ponds is complete. 	Cardinia Shire Council	Annual report submitted to DSEWPC and DSE.
	Wetland vegetation monitoring.	Biannually for the first two years post pond construction, then annually until: <ul style="list-style-type: none"> - the 10-year maintenance and monitoring period for new ponds is complete; or - in the case of ponds being 	Cardinia Shire Council and Melbourne Water	Annual report submitted to DSEWPC and DSE.

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
		retained, until the 10-year monitoring period for adjacent new ponds is complete.		
	Water quality monitoring (excludes Toomuc, Gum Scrub Creeks and Cardinia Road Drain).	Annually until: <ul style="list-style-type: none"> - the time the pond is removed (if removal is approved in this CMP); or, - the 10-year maintenance and monitoring period for new ponds is complete; or - in the case of ponds being retained, until the 10-year monitoring period for adjacent new ponds is complete. 	Cardinia Shire Council and Melbourne Water	Annual report submitted to DSEWPC and DSE.
	Weed inspection and removal from ponds and wetlands	Annually, for at least 10 years: <ul style="list-style-type: none"> - from the date of wetland construction for new ponds; or - in the case of ponds being retained, until the 10-year monitoring period for adjacent new ponds is complete. 	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Cardinia Shire Council and Melbourne Water	Annual report submitted to DSEWPC and DSE.
	Routine maintenance of open space corridors, including weed removal.	Every six weeks.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Cardinia Shire Council and Melbourne Water	Annual report submitted to DSEWPC and DSE.
	Additional planting to ensure wetlands and terrestrial habitats remain suitable.	As required.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Cardinia Shire Council and Melbourne Water	Annual report submitted to DSEWPC and DSE.
	Additional refuge sites provided if considered	As required.	Land Owner unless land is	Annual report submitted to

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
	necessary after site monitoring.		transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Cardinia Shire Council and Melbourne Water.	DSEWPC and DSE.
General	Feral and domestic animal control.	Undertaken in accordance with local government laws and relevant legislation.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Cardinia Shire Council	n/a
	Pest plant control.	Ongoing post-construction.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Cardinia Shire Council, Melbourne Water	n/a
	Removal of building materials and other unwanted debris from wetlands.	Ongoing post-construction.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Melbourne Water and Cardinia Shire Council	Wetlands and frog ponds clear of rubbish and debris
	Gross pollutant traps (GPT)/sediment filters checked and/or cleaned.	After heavy rain or storm events.	Land Owner unless land is transferred to a public Authority through a legally binding agreement with funds provided. Once transferred responsibility will be Melbourne Water	GPT's maintained such that they operate consistently and effectively
	Pollution and stormwater management (as outlined in Sections 3.5.4 and 3.5.5).	As required.	Land Owner unless land is transferred to a public Authority through a legally	n/a

Site	Mitigation Actions	Timing	Responsible agent	Measurable outcomes
			binding agreement with funds provided. Once transferred responsibility will be Melbourne Water	
	Summary of frog surveys and water quality monitoring.	Every year in which monitoring activities occur throughout the duration of the CMP.	Cardinia Shire Council	Annual report submitted to DSEWPC and DSE.
	Progress report on the implementation of the CMP, noting any key issues and management responses.	In the second and fourth years after construction of individual ponds.	Cardinia Shire Council	Report submitted to DSEWPC and DSE.
Conservation Management Plan: Phase 2				
Ongoing Management and Monitoring				
All waterbodies within the Precinct (including Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain)	Ongoing monitoring requirements See Table 4A.2.	Every 5 years where possible	Government of Victoria	See Table A 4.2 in Appendix 4.
All waterway land within the Precinct (including Toomuc Creek, Gum Scrub Creek and Cardinia Road Drain)	Manage land and waterways in accordance with existing Government (Melbourne Water) standard waterway maintenance policies and programs.	Annually	Land Owner unless transferred to a public Authority through a legally binding agreement with funds provided.	

Appendix 3 – Waterbody Removal and Creation schedule

Table A3.1. Waterbody removal and creation schedule.

Note: ‘Potential impacts to GGF’ apply if pond is impacted or removed. The magnitude of impacts have been classified as follows:

Low – Poor quality habitat, no records of GGF

Medium – High quality habitat, no records of GGF OR poor quality habitat, GGF records from previous survey

High – GGF records from current survey from the site and the site contains high quality habitat

Waterbody number	Waterbody status	Approximate Waterbody Dimensions	<i>L. raniformis</i> recorded	Potential impact to <i>L. raniformis</i> if pond removed
1	Remove	0.5 x 6.5	No	Low
2	Remove	6 x 5	No	Medium
3	Remove	10 x 6	No	Low
4	Remove	8 x 5	No	Low
5	Remove	6 x 6	No	Low
6	Remove	6 x 6	No	Low
7	Remove	15 x 13	No	Low
8	Remove	10 x 8	No	Low
9	Remove	30 x 5	No	Medium
10	Remove	20 x 6	No	Low
11	Remove	25 x 15	No	Low
12	Remove	12 x 12	No	Low
13	Remove	15 x 15	No	Low
14	Remove	25 x 10	No	Low
15	Remove	15 x 5	No	Low
16	Remove	30 x 25	No	Low
17	Remove	10 x 8	No	Low
18	Remove	30 x 7	No	Low
19	Remove	80 x 80	No	Medium
20	Retain, renumber to C24	7 x 4	Yes	High
21	Retain, renumber to C25	20 x 4	Yes	High
22	Retain, renumber to C28	10x10	No	Low
23	Retain, renumber to C32	5 x 10	No	Low
24	Remove	20 x 10	No	Low
25	Remove	20 x 10	No	Low
26	Remove	10 x 20	No	Low
27	Remove	30 x 30	Yes	High
28	Remove	10 x 10	No	Low
29	Remove	20 x 15	No	Low
30	Remove	20 x 15	No	Medium
31	Retain, renumber to C4	30 x 25	No	Medium
32	Retain, renumber to C5	30 x 10	No	Medium
33	Retain, renumber to C7	10 x 8	Yes	High
34	Remove	8 x 8	Yes	High
35	Retain, renumber to C19	20 x 6	Yes	High

Waterbody number	Waterbody status	Approximate Waterbody Dimensions	<i>L. raniformis</i> recorded	Potential impact to <i>L. raniformis</i> if pond removed
36	Retain, renumber to C20	40 x 40	No	Low
37	Remove	15 x 15	No	Low
38	Remove	100 x 35	No (occupied in previous survey)	High (high number of records in previous monitoring season)
39	Retain, renumber to C2	5 x 5	No (occupied in previous survey)	Medium
40	Remove	5 x 5	No (occupied in previous survey)	Medium
C1	To be created	20 x 40	-	-
C3	To be created	20 x 30	-	-
C6	To be created	20 x 30	-	-
C8	To be created	15 x 50	-	-
C9	To be created	20 x 40	-	-
C10	To be created	40 x 40	-	-
C11	To be created	40 x 40	-	-
C12	To be created	20 x 40	-	-
C13	To be created	15 x 20	-	-
C14	To be created	10 x 40	-	-
C15	To be created	20 x 30	-	-
C16	To be created	20 x 30	-	-
C17	To be created	10 x 40	-	-
C18	To be created	15 x 30	-	-
C21	To be created	10 x 20	-	-
C22	To be created	20 x 20	-	-
C23	To be created	10 x 20	-	-
C26	To be created	20 x 30	-	-
C27	To be created	40 x 40	-	-
C29	To be created	40 x 40	-	-
C30	To be created	40 x 40	-	-
C31	To be created	20 x 30	-	-
C33	To be created	10 x 20	-	-
C34	To be created	10 x 20	-	-

Appendix 4 – Monitoring and Management Schedule

Table A4.1. Summary table outlining the monitoring requirements for *L. raniformis* after completion of construction in Phase 1 of the CMP.

Monitoring requirement	Start time	Timing	Standards	Contingency Plan (if survey results are unsatisfactory)	Reporting
<i>L. raniformis</i> population and habitat monitoring.	CMP approval	Annually for at least ten years after wetland construction. Surveys will be undertaken during the active season for the species (October to March).	Nocturnal frog surveys over two nights; diurnal habitat survey.	If population decline becomes apparent through annual population monitoring, DSE and DSEWPC must be notified immediately and a suitable contingency plan must be developed. This is not a responsibility of Melbourne Water to fund. If habitat establishment is unsatisfactory refer to vegetation and water quality monitoring results and recommendations. Other issues (e.g. Plague Minnow infestation) refer to recommendations outlined in report.	Annual summary submitted to DSE and DSEWPC.
Wetland vegetation monitoring (including weed monitoring).	CMP approval	Every six months for the first two years post wetland construction, then annually up until ten years after wetland construction.	Establishment and maintenance of a diversity of emergent, submerged, fringing and floating vegetation. Absence of weeds and other invasive species e.g. <i>Phragmites australis</i> and <i>Typha</i> spp.	Dependent on survey results. Contingency plan may involve but is not limited to: weed removal; additional vegetation planting; increasing wetland water levels; identification and removal of pollution source.	Annual summary submitted to DSE and DSEWPC.
Invasive fish species monitoring	CMP approval	Annually for at least ten years after frog pond or wetland construction.	Fish presence/absence noted during habitat surveys	If fish present in required ponds, frog ponds must be drained and left dry over inactive period for the species. Must be refilled prior to subsequent active season (refer to Section 3.5.3)	Annual summary submitted to DSE and DSEWPC.

Monitoring requirement	Start time	Timing	Standards	Contingency Plan (if survey results are unsatisfactory)	Reporting
Pollution and Stormwater	Commencement of Construction until conclusion of Phase 1 of CMP.	Annually for at least ten years after wetland construction.	Low turbidity, moderate dissolved oxygen, low nutrient concentration, minimal toxicant concentration. No hard rubbish or litter in waterways, waterbodies or the surrounding area.	Monthly inspections undertaken by council. Clean up as required	Annual summary submitted to DSE and DSEWPC.
Water quality monitoring.	CMP approval until conclusion of Phase 1 of CMP.	Annually for at least ten years after wetland construction.	Low turbidity, moderate dissolved oxygen, low nutrient concentration, minimal toxicant concentration. Water quality must meet EPA SEPP objectives and ANZECC guidelines.	Dependent on survey results. Contingency plan may involve but is not limited to: increasing wetland water levels; identification and removal of pollution source; additional vegetation planting.	Annual summary submitted to DSE and DSEWPC.
Litter and Hard Rubbish	Commencement of Construction until conclusion of Phase 1 of CMP.	Ongoing	No hard rubbish or litter in waterways, waterbodies or the surrounding area.	Monthly inspections undertaken by council. Clean up as required	Annual summary submitted to DSE and DSEWPC.
CMP review	Post Construction until conclusion of Phase 1 of CMP.	Every five years following commencement of the CMP	Review of procedures and protocol	N/A	Revised CMP submitted to DSE and DSEWPC for approval.

Appendix 5 – *L. raniformis* records and dam habitat descriptions

Table A5.1. *L. raniformis* records during the 2008/09 survey period, Cardinia Road Employment Precinct.

Waterbody No.	Survey Date	Location description	Size	Easting	Northing	<i>L. raniformis</i> recorded
1	19,20/1/2009, 19/2/2009	poor water quality	0.5x6.5	362631	5783814	No
2	19,20/1/2009, 19/2/2009	moderate water quality, some vegetation	6x5	363050	5783816	No
3	19,20/1/2009, 19/2/2009	dry	10x6	363195	5783854	No
4	19,20/1/2009, 19/2/2009	poor water quality	8x5	363411	5783825	No
5	19,20/1/2009, 19/2/2009	almost dry, poor water quality	6x6	363332	5783601	No
6	19,20/1/2009, 19/2/2009	dry	6x6	363231	5783695	No
7	19,20/1/2009, 19/2/2009	poor water quality	15x13	362874	5783598	No
8	19,20/1/2009, 19/2/2009	poor water quality, some submerged vegetation	10x8	361958	5783892	No
9	19,20/1/2009, 19/2/2009	moderate water quality, some fringing vegetation	30x5	361966	5783932	No
10	19,20/1/2009, 19/2/2009	dry	20x6	362063	5784009	No
11	19,20/1/2009, 19/2/2009	dry	25x15	362266	5784143	No
12	19,20/1/2009, 19/2/2009	poor water quality	12x12	362002	5784139	No
13	19,20/1/2009, 19/2/2009	dry	15x15	361857	5784257	No
14	19,20/1/2009, 19/2/2009	dry	25x10	361806	5784176	No
15	19,20/1/2009, 19/2/2009	grazed and highly degraded	15x5	361597	5784157	No
16	19,20/1/2009, 19/2/2009	grazed and highly degraded	30x25	361775	5783900	No
17	19,20/1/2009, 19/2/2009	poor water quality, degraded by grazing	10x8	361866	5783987	No
18	19,20/1/2009, 19/2/2009	poor water quality, degraded by grazing	30x7	361353	5783813	No
19	19,20/1/2009, 19/2/2009	limited vegetation, good water quality, saline?	80x80	362706	5781993	No
20	19,20/1/2009, 19/2/2009	some fringing vegetation, poor water quality	7x4	362719	5782068	Yes
21	19,20/1/2009, 19/2/2009	poor water quality, some fringing, submerged and emergent vegetation, Plague Minnow present	20x4	362769	5782002	Yes
22	19,20/1/2009, 19/2/2009	poor water quality, degraded by grazing	10x10	363015	5781712	No
23	19,20/1/2009, 19/2/2009	dry	5x10	363884	5782440	No
24	19,20/1/2009, 19/2/2009	dry	20x10	363531	5782378	No
25	19,20/1/2009, 19/2/2009	dry	20x10	363280	5782635	No
26	19,20/1/2009, 19/2/2009	dry	10x20	362929	5782738	No
27	19,20/1/2009, 19/2/2009	poor water quality, some fringing, submerged and emergent vegetation, Plague	30x30	362368	5782300	Yes

Waterbody No.	Survey Date	Location description	Size	Easting	Northing	<i>L. raniformis</i> recorded
		Minnow present				
28	19,20/1/2009, 19/2/2009	dry and overgrown	10x10	362288	5783148	No
29	19,20/1/2009, 19/2/2009	poor water quality	20x15	362054	5783186	No
30	19,20/1/2009, 19/2/2009	poor water quality, some fringing, submergent and emergent vegetation, Plague Minnow present	20x15	362050	5783298	No
31	19,20/1/2009, 19/2/2009	good water quality, some fringing vegetation	30x25	361482	5783431	No
32	19,20/1/2009, 19/2/2009	good water quality, fringing, submergent and emergent vegetation	30x10	361537	5783048	No
33	19,20/1/2009, 19/2/2009	poor water quality	10x8	361784	5782538	Yes
34	19,20/1/2009, 19/2/2009	turbid, some fringing vegetation	8x8	361935	5782135	Yes
35	19,20/1/2009, 19/2/2009	good water quality, fringing, submergent and emergent vegetation	20x6	362683	5783254	Yes
36	19,20/1/2009, 19/2/2009	triangular, poor water quality	40x40	362645	5782993	No
37	19,20/1/2009, 19/2/2009	dry, some water couch	15x15	363513	5783001	No
38	19,20/1/2009, 19/2/2009	Good water quality	100x35			No
39	19,20/1/2009, 19/2/2009	poor water quality	5x5			No
40	19,20/1/2009, 19/2/2009	dry	5x5			No

Appendix 6 – Wetland vegetation species

Table A6.1 Species list of recommended plants for revegetation

Botanical Name	Common Name	Essential Species	Melbourne Water Preferred species
<i>Potamogeton ochreatus</i>	Blunt Pondweed	X	X
<i>Potamogeton tepperi</i>	Floating Pondweed	X	X
<i>Eleocharis acuta</i>	Common Spike-sedge	X	X
<i>Vallisneria americana</i>	Ribbon-weed	X	
<i>Triglochin procerum</i> s.l.	Water Ribbons	X	X
<i>Ottelia ovalifolia</i>	Swamp Lily	X	
# <i>Eleocharis sphacelata</i>	Tall Spike-sedge		
<i>Melaleuca ericifolia</i>	Swamp Paperbark		
<i>Poa labillardierei</i> var. <i>labillardierei</i>	Common Tussock-grass		X
<i>Lachnagrostis filiformis</i>	Common Blown-grass		
<i>Calystegia sepium</i>	Large Bindweed		
<i>Carex appressa</i>	Tall Sedge		X
<i>Carex fascicularis</i>	Tassel Sedge		
<i>Carex bichenoviana</i>	Plains Sedge		X
<i>Carex tereticaulis</i>	Poong'ort		X
<i>Epilobium billardierianum</i>	Smooth Willow-herb		
<i>Juncus amabilis</i>	Hollow-rush		
<i>Juncus gregiflorus</i>	Green Rush		
<i>Juncus procerus</i>	Tall Rush		
<i>Juncus sarophorus</i>	Broom Rush		
<i>Juncus flavidus</i>	Gold Rush		X
<i>Urtica incisa</i>	Scrub Nettle		
<i>Crassula helmsii</i>	Swamp Crassula		X
<i>Hydrocotyle sibthorpioides</i>	Shining Pennywort		
<i>Carex gaudichaudiana</i>	Fen Sedge		
<i>Persicaria praetermissa</i>	Spotted Knotweed		
<i>Persicaria subsessilis</i>	Hairy Knotweed		
<i>Ranunculus inundatus</i>	River Buttercup		
<i>Alisma plantago-aquatica</i>	Water Plantain		X
<i>Amphibromus nervosus</i>	Common Swamp Wallaby-grass		X
<i>Amphibromus fluitans</i>	River Swamp Wallaby-grass		
<i>Baumea articulate</i>	Jointed Twig-sedge		X
<i>Cladium procerum</i>	Leafy Twig-sedge		
<i>Glyceria australis</i>	Australian Sweet-grass		
<i>Lycopus australis</i>	Australian Gypsywort		
<i>Lythrum salicina</i>	Small Loosestrife		
<i>Myriophyllum crispatum</i>	Upright Water-milfoil		
<i>Myriophyllum simulans</i>	Amphibious Water-milfoil		
<i>Neopaxia australasica</i>	White Purslane		
<i>Persicaria decipiens</i>	Slender Knotweed		
<i>Ranunculus amphitrichus</i>	Running Marsh Flower		
<i>Rumex bidens</i>	Mud Dock		
<i>Schoenoplectus tabernaemontani</i>	River Club-sedge		X
<i>Villarsia reniformis</i>	Running Marsh Flower		
<i>Myriophyllum caput-medusae</i>	Coarse Water-milfoil		X

limit use of this species, it can become invasive.

NOTE – Species belonging to the *Typha* genus have been excluded from this list and should not be used in any revegetation works.

Appendix 7 – Schedule of dam & waterbody construction, completion and occupancy/habitat quality records *

* To be completed as ponds are constructed and updated as part of the review of the CMP

Table A7.1. Records of *L. raniformis* in Cardinia Road Employment Precinct by dam for 10 year period from date of DSE approval

Waterbody No. (Refer Figure 3)	Size L x W	Location Coordinates		Date Construction Standard Approved by DSE	Annual records of <i>L. raniformis</i> by Dam for 10 years post-approval (A = Adult, M = Metamorphs, T= Tadpoles, nil = none found, nc = not constructed, c = complete) see annual monitoring reports for detailed results and habitat quality																	
		Easting	Northing	Commencement date for management/monitoring /maintenance activities	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	..
PONDS																						
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
11																						
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17																						
18																						
19																						
20																						
21																						

Waterbody No. (Refer Figure 3)	Size L x W	Location Coordinates		Date Construction Standard Approved by DSE	Annual records of <i>L. raniformis</i> by Dam for 10 years post-approval (A = Adult, M = Metamorphs, T= Tadpoles, nil = none found, nc = not constructed, c = complete) see annual monitoring reports for detailed results and habitat quality																	
		Easting	Northing	Commencement date for management/monitoring /maintenance activities	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	..
PONDS																						
22																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						
31																						
32																						
33																						
WETLANDS																						
W1																						
W2																						
W3																						
W4																						
W5																						
W6																						
W7																						
W8																						
W9																						
W10																						
W11																						

Appendix 8 – Frog and Habitat Survey Data Sheet

Table A8.1. Frog and Habitat Survey Data Sheet

Growling Grass Frog Survey and Habitat Data Sheet					
Project no.	Attach map to this datasheet!				Pg ____ of ____
Location	AMG coordinates				
Date	Time start				
Personnel present	Time finish				
Weather Conditions					
Cloud cover (0-8)	Dry bulb: start		Wet bulb: start		
Rain (0-3)	finish		finish		
Moonlight (0-4)	Water temperature:				
Wind (0-4)	Wind direction:				
Habitat Assessment					
Site no.			Waypoint no.		Photo no.
Type (circle): <i>Pond, Dam, Wetland, River, Creek, Billabong, Drain, Ditch</i>	Water quality (circle): <i>Poor / Mod / Good</i>		Flow (circle): <i>Still / Slow / Rapid</i>		Habitat quality (circle): <i>Poor / Mod / Good</i>
Vegetation Cover:	% Fringing (% of total bank cover)	% Emergent (% of total waterbody cover)	% Floating (% of total waterbody cover)	% Submerged (% of total waterbody cover)	Fish present? Yes/No Species:
Comments					
GGF Survey					
No. GGF calling					
No. GGF seen					
Adult male	Adult (sex unknown)	Adult female	Subadult	Juvenile	Metamorph
Other frog species observed					
Comments					