

Growling Grass Frog Conservation
Management Plan for the
VicUrban Development at Officer,
Victoria



Report to VicUrban

Growling Grass Frog Conservation
Management Plan for the VicUrban
Development at Officer, Victoria

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Final Report

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ABBREVIATIONS

AVW	Atlas of Victorian Wildlife
DEWHA	Commonwealth Department of the Environment, Water, Heritage and Arts
DSE	Department of Sustainability and Environment
EPA	Environment Protection Agency
EPBC	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
FFG	<i>Flora and Fauna Guarantee Act 1988</i>

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SUMMARY

Biosis Research Pty. Ltd. was commissioned by VicUrban to prepare a detailed Conservation Management Plan for the Growling Grass Frog *Litoria raniformis* for its proposed development at Officer, Victoria. This document provides a detailed plan for the management of *L. raniformis* for the development, including the design stage and the periods during and after construction.

The VicUrban development area is located at Officer, east of Melbourne. It is bounded by the Princes Highway in the north, Leckey Road in the south, Stephens Road in the west and Cardinia Road in the east. The development includes a number of rural properties covering approximately 386 hectares within these boundaries.

Current Issue

Based on the known distribution and habitat requirements of the Growling Grass Frog within the VicUrban development area, populations may be adversely affected by the proposed development. The development may have an impact on populations, either directly through actual mortality during construction or road mortality, or indirectly by changes to habitat conditions along the creeks, fragmentation of suitable habitats, and increased pollutants, noise and predation. Notwithstanding the above, the current development plan has the potential to lead to improvements in frog habitat along the creeks and through the construction of well-designed and well-managed wetlands.

Conservation Management Plan

The purpose of this conservation management plan is to provide detailed measures to ensure the proposed development does not have a significant impact on Growling Grass Frog populations and associated habitats. The plan provides detailed management requirements necessary for ongoing protection and maintenance of Growling Grass Frog populations and associated habitats in the future, and covers three key stages:

- 1) Provision of detailed habitat protection and creation guidelines during the design process (pre-construction);
- 2) Inclusion of detailed management specifications, including a frog salvage protocol during construction; and
- 3) Monitoring and maintenance recommendations after construction.

The implementation of the plan will require the collaboration of all relevant stakeholders and coordination from the Victorian Department of Sustainability and Environment (DSE) and the Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA). The plan will be implemented over a number of years, and VicUrban will be responsible for implementation whilst it is the landowner/manager.

1.0 INTRODUCTION

Biosis Research Pty. Ltd. was commissioned by VicUrban to prepare a detailed Growling Grass Frog *Litoria raniformis* Conservation Management Plan, as part of the proposed urban development at Officer, Victoria.

The plan provides detailed management recommendations relating to the protection of sites currently occupied by Growling Grass Frog, and fulfils VicUrban's obligations under the *Environment Protection and Biodiversity Conservation Act 1999* (administered by DEWHA) and the objectives of the Action Statement for the species prepared in accord with the *Flora and Fauna Guarantee Act 1988* (administered by Victoria's Department of Sustainability and Environment).

Targeted survey for the species throughout the VicUrban development area (Biosis Research 2005b) demonstrated that it is present within suitable wetland habitat at a number of locations (farm dams etc.), some of which are breeding habitat for the species.

The water bodies within the VicUrban development area have been surveyed for Growling Grass Frog intermittently since the 2002/3 breeding season, when the species was initially discovered in the area. The Growling Grass Frog population in the Officer / Pakenham area was identified following surveys for the species as part of the Pakenham Bypass flora and fauna assessments (Biosis Research 2003a, 2003b; Biosis Research 2004; Biosis Research 2005a, 2005b). Occupied water bodies on the VicUrban Officer land have also been surveyed as part of strategic management plans for the species in the Officer and Pakenham area (Hamer and Organ 2006a, 2006b, 2006c; Organ in prep.).

This document builds upon recent surveys for the species within the VicUrban development area, and forms part of VicUrban's ongoing commitment to ensure that the proposed development and future activities do not have a detrimental impact on the Growling Grass Frog and its habitats.

1.1 VicUrban development area

The VicUrban development area includes a number of rural properties covering approximately 377 hectares. These properties are colloquially known by the name of their previous or current owner and include: Gilbert (21ha), Leber (8 ha), Roto (7.8 ha), Quinn (12 ha), Ahern (23 ha), Novaso (42 ha), Williamson (198 ha), McIntosh (12 ha), Myalong (12 ha), Hendrix (3ha), Mastromanno (2ha), Hewlett (12 ha), Dengar (13 ha) Egerton (11 ha), Spry (0.5 ha) and three house lots adjacent to Gilbert (about 0.4 ha).

Gilbert, Leber, Mastromanno, Roto and Quinn are north of the Pakenham rail-line, while the others are all south of the railway. Leber and Mastromanno are also adjacent to Officer Station. Gilbert, Roto and Quinn have frontage to the Princes Highway. The Pakenham Bypass bisects the Williamson property with 91 hectares remaining south of the bypass.

2.0 BACKGROUND

2.1 Growling Grass Frog

The Growling Grass Frog *Litoria raniformis* is referred to by a variety of English names in the literature. Recent DSE publications generally use the name Growling Grass Frog for the species.

The Growling Grass Frog is a species of national conservation significance. It is listed as Vulnerable under provisions of the Federal *Environment Protection and Biodiversity Conservation Act 1999* and as a threatened species under Victoria's *Flora and Fauna Guarantee Act 1988*. It is listed as Endangered on DSE's *Advisory list of Threatened Vertebrate Fauna of Victoria* (DSE 2003).

Historically, the Growling Grass Frog was recorded in much of Victoria, with the exception of Mallee and Alpine areas. However, a decline in the species has been noted throughout its range in eastern Australia. The species is known to have disappeared entirely from many localities where it was previously known (Tyler 1997). In south and central Victoria there are reports of serious declines and local extinctions. Some of the species' most substantial populations persist at several localities in metropolitan Melbourne and nearby. The Officer – Pakenham area has been shown to support one such population (AVW records, Organ 2005)

While all of the complexities involved in the species' decline are not completely understood, there are a variety of factors that are believed to have contributed to it. These include: loss and fragmentation of habitat caused by drainage and degradation of wetlands for agriculture and urban and industrial development; increased soil and water salinity and other pollutants; increased depredation of tadpoles by introduced fish; exposure to ultra-violet radiation; prolonged drought; and susceptibility to herbicides and pesticides (Gillespie 1999).

The species prefers permanent or semi-permanent waterbodies (Hero et al. 1991; Cogger 1996). It has also been found that a waterbody is much more likely to have a population of Growling Grass Frogs present if there is another known population nearby (Robertson et. al. 2002). Habitat characteristics, such as the extent of fringing aquatic vegetation and submerged vegetation, also can have a positive impact on the likely use of a waterbody by the Growling Grass Frog, but are not as important as the distance to the nearest population (Robertson et al. 2002). This suggests that dispersal between waterbodies is an important activity in the life history strategies of the frogs.

Male Growling Grass Frogs are known to call from August until April (Hero et al. 1990), although their peak calling period is typically between September and December. This calling season may vary between years depending upon weather conditions, habitat quality and other factors. Growling Grass Frogs have a distinctive call which allows the species to be identified without the need to observe and/or trap individuals.

2.2 Growling Grass Frog population and habitat

2.2.1 Growling Grass Frog habitats within the VicUrban development area

Known and potential habitat for the species within VicUrban's development at Officer is shown in Figure 1. The habitat (both known and potential) consists of a number of farm dams (identified as A-Q), drainage lines (e.g. Gum Scrub Creek) and associated terrestrial habitats (mostly pasture). Growling Grass Frogs have not been recorded at all potential habitats within the VicUrban development area. Important breeding habitat components and/or localities where the species has been recorded comprise the following:

- Known breeding habitat (presence of metamorphs) at one large dam (Dam D) immediately west of Gum Scrub Creek and north of the railway line.
- Potential breeding habitat (as evidenced by the presence of calling males, adult females and/or juveniles) in Dams A, B, C, E, G, H, I, and L.
- Dams presently considered unsuitable for breeding, but known to be used on an irregular basis for dispersal, foraging etc.). These include Dams F, J and K.
- Dams where the species has never been recorded and considered to be unsuitable habitat for the species (M, N, O, P and Q).
- A number of drainage lines that traverse the entire development area; 1) a drainage line from north of the Princes Hwy extends through the Gilbert property and along the length of Officer South Road; 2) Gum Scrub Creek; 3) along the length of the railway line and through the Ahern property). A number of these link the current known and potential additional breeding sites.
- Terrestrial (primarily pasture) habitat that would be used by the species for foraging, dispersal, and potentially over wintering.

2.2.2 The Growling Grass Frog population

The *L. raniformis* population within the VicUrban development area has been subject to a number of surveys since its discovery in 2002. These surveys have been undertaken as part of surveys for other projects including the Pakenham Bypass (Biosis Research 2003a,b; Biosis Research 2004; Biosis Research 2005a,b) and as part of conservation strategies for the species in the local area (Hamer and Organ 2006; Hamer and Organ 2007). The population was most recently surveyed in March 2008 (Biosis Research 2008, Organ in prep.). While these surveys have not been systematic, and have not necessarily been undertaken at optimal periods, they provide important information on the occupancy of individual waterbodies within the VicUrban development area and details where successful breeding has occurred. Data from these surveys is shown in Table 1.

Together, these surveys suggest that total number of sites (dams) occupied by Growling Grass Frog has been generally consistent over the 2002 – 2008 period. The total number of individuals recorded each year (i.e. estimates of population size) shows a population whose numbers oscillate between years. For example, 61+Adults, 1 Juvenile and 1 Metamorph were recorded in 2003/04, compared to 72+ Adults, 2 Juveniles and 1+Metamorphs were recorded in 2005/06.

There has been a potential decline in Growling Grass Frog occupancy at sites K and L (2005 – 2008). However, this potential decline is demonstrated across only five survey years and in the case of dam K involves single frogs in each year, which is difficult to describe as a decline. Dams M, N, O, P and Q were not subject to survey in the past (2002 – 2007) due to the poor quality habitat present for Growling Grass Frog. Not surprisingly Growling Grass Frog was not recorded in these dams during the 2007/08 active season and these dams are unlikely to provide important habitat for the species in their current condition.

The fluctuations in the Growling Grass Frog population within the VicUrban development area are likely to be the result of variable environmental factors including the prolonged drought conditions that are affecting southern Victoria. That is, the drier conditions are resulting in reduced dispersal and movement of frogs. There may also be changes in some characteristic of these dams (e.g. water quality, aquatic vegetation, introduced fishes, etc.) that has rendered them less suitable to the frogs. Nevertheless, the species may be found in these dams during future surveys.

The intensity and timing of surveys is also likely to have had an impact on the above findings.

Breeding was confirmed during the 2007/08 season within the VicUrban land as

has been the case in previous years (Table 1). Breeding was confirmed at Dam D, where 15 metamorphs were recorded (Organ in prep.). A juvenile frog was also recorded during the present survey at Dam F, which had presumably moved here from Dam D (Dam F is poor quality habitat for breeding). A juvenile was also recorded at Dam I and based on the habitat characteristics of this dam it is likely that this dam is also a breeding site. However, tadpoles and metamorphs have not been surveyed for or recorded in this dam. It is therefore possible that the juvenile observed originated from Dam I, although it is also possible this juvenile originated from the dam on the Intrapac land or from Dam D. To date only Dam D has been confirmed as a definite breeding site. A juvenile was also recorded in the vicinity of Dam K (along a drainage line) in the 2003/04 breeding season (Biosis Research 2005b). It is unlikely that this individual originated from Dam K, but rather it may have moved downstream along the existing drainage line from Dam I, a more suitable breeding site.

Table 1. Results of surveys for Growling Grass Frog in Officer Horizons development area, October 2002 - March 2008 (Biosis Research 2003a¹; Biosis Research 2004²; Biosis Research 2005b³; Hamer and Organ 2006c⁴; Hamer and Organ 2007⁵; Biosis Research 2008⁶; Organ in prep.⁷).

Dam	Survey season and maximum number of Growling Grass Frogs observed together with the source of the survey data					
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
A	Not surveyed	None recorded ³	Not surveyed	6 Adult males, 2 Adult females ⁴	None recorded ⁵	None recorded ⁶ 5 Adult males and 1 Adult female ⁷
B	Not surveyed	15 Adult males ²	Not surveyed	None recorded ⁴	None recorded ⁵	None recorded ^{6,7}
C	Not surveyed	15 Adult males ⁴	Not surveyed	1 Adult male ⁴	None recorded ⁵	1 Adult ⁶
D	Not surveyed	Not surveyed	Not surveyed	31 Adult males, 3 Adult females, unknown number of Metamorphs ⁴	2 Adult males ⁵	None recorded ⁶ 15 Adult males, 2 Adult females and 15 Metamorphs ⁷
E	Not surveyed	Not surveyed	Not surveyed	1 Adult male, 11 Adult females, 2 Juveniles ⁴	None recorded ⁵	None recorded ⁶ 2 Adult males and 3 Adult females ⁷
F	Not surveyed	Not surveyed	Not surveyed	1 Metamorph ⁴	None recorded ⁵	1 Juvenile ⁶
G	Not surveyed	Adults present number not recorded ³	Not surveyed	None recorded ⁴	None recorded ⁵	None recorded ^{6,7}

Dam	Survey season and maximum number of Growling Grass Frogs observed together with the source of the survey data					
	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
H	Not surveyed	1 Adult female, 5 Adult males ²	Not surveyed	13 Adult males, 4 Adult females ⁴	3 Adult males and 1 Juvenile ⁵	1 Adult male ⁶ 4 Adult males, 1 Adult female and 2 Juveniles ⁷
I	Not surveyed	None recorded ³	Not surveyed	Adults present but number not recorded ^{6,7,8}	None recorded ⁵	1 Juvenile ⁶ 1 Adult male and 1 Juvenile ⁷
J	Not surveyed	1 Metamorph ²	Not surveyed	None recorded ⁴	None recorded ⁵	None recorded ^{6,7}
K	1 Adult ¹	1 Juvenile in drainage line in vicinity of K ³	Not surveyed	None recorded ⁴	None recorded ⁵	None recorded ^{6,7}
L	5 Adult males ¹	25 Adults ⁴	Not surveyed	None recorded ⁴	None recorded ⁵	None recorded ^{6,7}
M	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	None recorded ^{6,7}
N	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	None recorded ^{6,7}
O	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	None recorded ^{6,7}
P	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	None recorded ^{6,7}
Q	Not surveyed	Not surveyed	Not surveyed	Not surveyed	Not surveyed	None recorded ^{6,7}

2.2.3 Significance of the Growling Grass Frog population in the VicUrban development area

The Growling Grass Frog populations within the VicUrban development area and surrounds are considered to be of national conservation significance. The species is listed as 'Vulnerable' under provisions of the EPBC Act (1999) for threatened fauna. Over its distributional range the species has declined, however the area between Cardinia Creek and Pakenham, including the area affected by the proposed VicUrban development, supports part of one of the largest populations known in Australia. The Officer sub population is considered to be at the north western extremity of the larger Pakenham, Bayles, Koo Wee Rup population and the species is not known to occur to the north of the Princess Highway (Authors pers obs., Organ 2008). In this context, the area may be considered to support an '*important population*' of the species, as defined by the EPBC Act.

An *important population* is one that is necessary for a species' long-term survival and recovery. This may include populations that are:

- key source populations either for breeding or dispersal,
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

Under provisions of the EPBC Act, an action has, will have, or is likely to have a '*significant impact*' on a Vulnerable species if it does, will, or is likely to:

- decrease the size of an *important population* of a species, or
- reduce the area of occupancy of an *important population*, or
- fragment an existing *important population* into two or more populations, or
- adversely affect critical habitat, or
- disrupt the breeding cycle of an *important population*, or
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
- directly or indirectly result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat, or
- interferes substantially with the recovery of the species.

In order to meet the requirements of the EPBC Act, it is thus necessary to ensure that proposed development will have none of the significant impacts listed above for Vulnerable species. Creation of new wetlands as part of the proposed development, if appropriately designed and managed, have the potential to provide habitat additional to that which currently exists in the VicUrban development area.

2.3 Potential impacts on Growling Grass Frog

On the basis of the known distribution and habitat requirements of the Growling Grass Frog in the VicUrban development area and vicinity, it is considered that the species might be adversely affected by the proposed development if the development does not include appropriate measures to ensure that that does not occur (Biosis Research 2005b). The residential development, both in its construction and long-term effects may have impacts on Growling Grass Frog populations, either directly through mortality, or indirectly by changes to habitat conditions, fragmentation of suitable habitats, increased exposure to pollutants and predators. While consequences of these potential effects upon Growling Grass Frog population may not be evident for many years, they all have potential to reduce long-term viability of populations within the VicUrban development area.

A summary of potential impacts associated with the proposed development is outlined below.

2.3.1 Direct impacts

Direct impacts that may result from the proposed development within the VicUrban development area include:

- Direct loss of habitat through drainage of dams and other wetlands;
- Degradation of waterways caused by increased sedimentation and/or pollution;
- The proposed action may have an impact on the GGF due to predation from dogs and cats. However, the vegetation cover will minimise the potential impact from predation by providing protection in the created wetlands and linking habitat.
- Loss of individuals during weed control and revegetation operations both mechanically and from exposure to herbicides toxic to frogs;
- Direct mortality of individuals sheltering under rocks and other refuges within the VicUrban development area during construction;
- Direct road-kill mortality;
- Damage to frog habitats through inappropriate placement and storage of equipment and machinery;
- Damage to frog habitats through the inappropriate storage of soil and rocks displaced during construction; and,
- Creation of artificial barriers to movement. Roads may act as barriers to dispersal of frogs. As a general rule, the higher the traffic volumes using a road, the more of a barrier to fauna it becomes.

2.3.2 Indirect impacts

Potential indirect impacts of the development proposal on the species include:

- Reduction of genetic diversity within the regional population due to reduction or loss of the Officer population or to disrupted capacity for the species to move within and through the VicUrban development area;
- Increased predation and disturbance from introduced waterfowl and/or artificially high numbers of native waterbirds attracted to Growling Grass Frog habitats;
- Accidental introduction of pathogens such as Amphibian Chytrid Fungus *Batrachochytrium dendrobatidis*, which could subsequently infect the Growling Grass Frog and other frog species.
- Introduction of introduced predatory fish e.g. Plague Minnow *Gambusia holbrooki* and Goldfish *Carrassius auratus*.
- Increase in weed invasion and rubbish accumulation around wetlands and along watercourses, particularly if there are areas where the back boundaries of properties abut wetland or creek reserves.

Notwithstanding the above, adherence to this Conservation Management Plan should prevent these impacts from occurring.

2.3.3 Potential improvements

If wetlands and other habitats along the creek and drainage lines are constructed to appropriate design criteria there is good potential not only for Growling Grass Frog populations of the area to be sustained, but also for them to increase into the future. Some of the potential improvements to Growling Grass Frog habitats associated with the proposed development include:

- Improved water quality in creeks and wetlands;
- Construction designed to rehabilitate presently degraded former habitats, such as Gum Scrub Creek, with a view to improving the quality and quantity of breeding and dispersal habitats within the area; and,
- Provision of additional breeding sites in the form of aesthetic and/or stormwater treatment wetlands and ephemeral waterbodies adjacent to such sites.
- Ability to manage predatory fish via Dedicated Growling Grass Frog wetlands which are designed to be drained.
- Diversity of habitats created resulting in a net gain for species habitat.
- Improved quality of movement corridors.

3.0 CONSERVATION MANAGEMENT PLAN

3.1 Objectives

The purpose of this conservation management plan is to provide detailed measures to ensure the proposed development does not have a significant deleterious impact on Growling Grass Frog populations and associated habitats. The plan provides detailed management recommendations necessary for ongoing protection and maintenance of Growling Grass Frog populations and associated habitats in the future, and covers three key stages:

1. Provision of detailed habitat protection and enhancement guidelines during the design process (pre-construction);
2. Inclusion of detailed management specifications, including a frog salvage protocol during construction; and
3. Monitoring and maintenance recommendations for the period after construction.

The implementation of the plan will require the collaboration of all relevant stakeholders and coordination from DSE and DEWHA.

Note: A comprehensive plan for management of the Growling Grass Frog in relation to the Pakenham Bypass, part of which traverses the Officer development, has been prepared for VicRoads (Organ 2005). 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. That is, both plans provide for the retention of existing habitat, the creation of new habitat and the provision of open space movement corridors. The success of both plans in achievement of their objectives for the species will be dependant upon co-operation and integrated management on the part of both VicUrban and VicRoads.

3.2 Timeframe

The plan will be implemented over a number years. VicUrban will be responsible for implementation during the period in which it is the landowner/manager. Ultimately, management responsibility is expected to rest with Cardinia Shire Council and or Melbourne Water depending on whom assumes responsibility for the created wetlands.

Management recommendations provided in this plan may need to change in light of new information, or if measures for the long term maintenance of Growling Grass Frog populations are found to be inadequate. Habitat and population monitoring should be reviewed at intervals agreed to by DEWHA and DSE to

ensure protective measures and management actions are achieving their objectives.

3.3 Responsibility for implementation

- VicUrban, as proponent and manager of the Officer development project, is responsible to ensure that this plan is implemented whilst it is the landowner/manager.
- Biosis Research Pty. Ltd., under contract to VicUrban, proposes to advise VicUrban throughout implementation of the plan and to monitor its progress on-site as required.
- DSE will determine suitability of the plan and its capacity to meet requirements of the *Flora and Fauna Guarantee Act 1988*. At its discretion it will issue relevant permits required for implementation of the plan.
- DEWHA will determine suitability of the plan and its capacity to meet requirements of the EPBC Act. At its discretion it will issue relevant permits required for implementation of the plan.

VicUrban has ultimate responsibility for the implementation of this plan. Recommendations outlined in the plan, and any additional requirements of DEWHA and/or DSE, will be incorporated into the development contract specifications. On-going liaison between VicUrban, contractors working on the project, relevant referral authorities (e.g. DSE, DEWHA, Cardinia Shire Council, Melbourne Water Corporation), and a Biosis Research zoologist with experience in relation to the Growling Grass Frog will be required to ensure the measures provided in the plan are implemented.

3.4 Pre-construction and construction phases

3.4.1 Pre-construction design for habitat protection and enhancement

Retention of all known and potential habitat within the VicUrban development area is not possible. Therefore, a habitat program has been developed to allow for the retention of some existing habitat (dams, drainage lines, movement corridors), together with the staged removal of other habitat and the creation of new habitat (stormwater treatment wetlands and dedicated Growling Grass Frog wetlands). This habitat program is outlined in Appendix 2 and should be read in conjunction with Figures 2 and 3 (pg 49-50).

Existing habitat and linkages to be retained within the VicUrban development include:

- Dams H and I;
- A 30 m wide movement corridor south of the railway line running from Gum Scrub Creek to the edge of the VicUrban property line, inclusive of vegetated swale and recreation path (approximately 1100m in length);
- A 100 m wide movement corridor along the extent of Gum Scrub Creek which is within the VicUrban landholding. The corridor will be 50m wide on either side of the centre line of the creek.

The Mitigation Measures plan details the retention of Dams I and H within the movement corridor south of the rail line (Figure 3). Dams D and E (the turkey nest dams) will be retained *in situ* until successful breeding in newly constructed wetlands can be demonstrated. Successful breeding is defined in Section 3.5.1. Dedicated wetlands designed specifically to cater for the breeding requirements of Growling Grass Frog will be created throughout the development to compensate for habitats to be lost (Figure 3).

Timing of construction of new wetlands and any proposed removal of existing habitat is an important consideration in managing the impact of loss of habitat for Growling Grass Frog. New habitats take time to establish and become suitable for Growling Grass Frog.

It is not possible to create all proposed dedicated and stormwater treatment wetlands prior to the commencement of construction of the residential development. However, the staged removal and creation of habitat, together with the retention of existing habitat, will ensure that significant areas of suitable breeding habitat (both retained and created) is always available to the frogs throughout the development timeframe (Appendix 2).

Key areas for the retention and creation of suitable Growling Grass Frog habitat are as follows (Figure 3):

- Area A - the south-east corner of the subject land, bordered to the east by Cardinia Road and to the south by Mary Street;
- Area B – a dedicated frog corridor south of the railway line;
- Areas C and D – the corridor along Gum Scrub Creek; and
- Area E – land adjacent to Gum Scrub Creek south of the Pakenham Bypass
- Area F – land on the eastern side of Gum Scrub Creek, north of the rail line.

The key mitigation measures to be undertaken in each of these areas area as follows:

Area A

Creation of a series of stormwater treatment wetlands together with one dedicated Growling Grass Frog wetland. Whilst the Growling Grass Frog wetland is physically separated from the stormwater treatment wetlands, the intention is for it to be filled with treated water from the wetland system with inflow via solar powered pump or windmill. The Growling Grass Frog wetlands has been designed to be able to be drained should it become infested with mosquito fish. These wetlands are incorporated in areas of public open space, which will also provide a significant area of suitable terrestrial habitat for Growling Grass Frog.

Area B

The provision of a dedicated 30m wide movement corridor south of the railway line, incorporating one newly constructed dedicated Growling Grass Frog wetland, the retention of dams H and I, a bicycle path and a kerbside swale. The retained dams and created wetland will have a 25m terrestrial buffer around them, with the 25m measured from the waters edge. The exact size of the newly constructed wetland is yet to be finalised as detailed design has not been undertaken. VicUrban will be guided by the design requirements outlined in this document.

Areas C and D

The provision of a 100m open space corridor along Gum Scrub Creek, together with one stormwater treatment wetland and two dedicated Growling Grass Frog

wetlands. The wetland within Area D will have a 50m terrestrial buffer (measured from the waters edge) around it. The exact size of the newly constructed stormwater wetland and the Growling Grass Frog wetlands is yet to be finalised as detailed design has not been undertaken. VicUrban will be guided by the design requirements outlined in this document with regard to the Growling Grass Frog wetlands and the relevant drainage scheme in relation to the stormwater wetlands.

Area E

Area E provides for the construction of a large stormwater treatment wetland on Gum Scrub Creek south of the Pakenham Bypass and the construction of one dedicated Growling Grass Frog wetland. Cardinia Shire Council is yet to finalise the Cardinia Road Employment Precinct Structure Plan which applies to land south of the Pakenham Bypass between Gum Scrub Creek, Toomuc Creek with the transmission easement forming the southern boundary. Until the structure plan is finalised, the width of the Gum Scrub Creek buffer is not known, therefore the principles applied to Gum Scrub Creek north of the Pakenham Bypass have also been used for Area E (i.e.: 100m buffer, 50m either side of centreline of Gum Scrub Creek and Growling Grass Frog wetland where possible they will be located sufficiently within the 50m buffers so as to provide 25m terrestrial buffers).

Area F

Includes the provision of two dedicated Growling Grass Frog Wetlands on the eastern side of Gum Scrub Creek, north of the rail line and adjacent to AV Jennings Arena Development. These wetlands are intended to offset the removal of Dams D & E should successful breeding be demonstrated. The exact size of the newly constructed wetlands is yet to be finalised as detailed design has not been undertaken. VicUrban will be guided by the design requirements outlined in this document. As the wetlands will be located within the Gum Scrub Creek buffer, where possible they will be located sufficiently within the 50m buffers so as to provide 25m terrestrial buffers).

3.4.2 Wetland design and construction

Retained wetlands

Dams H and I are to be retained. These waterbodies currently contain habitat attributes that make them suitable Growling Grass Frog habitat and both dams have been shown to be used by Growling Grass Frog (Table 1). As such, they do not need to be modified to enhance habitat suitability for the species. However, Dam I is known to contain Plague Minnow. The presence of this introduced fish may be reducing the suitability of Dam I as a breeding site for Growling Grass Frog. It is recommended that Dam I be drained completely and then refilled to remove this fish species. For information on the ongoing management of retained wetlands, see Section 3.5.3.

VicUrban ultimately proposes to remove Dams D and E as they provide a significant impediment to overland flows within the Gum Scrub Creek floodplain and pose a safety risk due to their high walls and very steep embankments. An indication of the size of the walls of the turkey nest dams is provided in the following image which shows part of the south facing wall of Dam E.



In addition, the dams have historically been filled by pumping water from Gum Scrub Creek which increases the chances of introducing predatory fish. The dams have not been filled from Gum Scrub Creek since VicUrban's ownership and therefore they have relied solely on natural rainfall.

Approval for removal of Dams D and E is to be subject to the satisfaction of DEWHA that Growling Grass Frogs have successfully colonised and successful reproduction, as defined as the presence of Growling Grass Frog metamorphs at a water body, is occurring in at least two of the constructed wetlands for the site. Successful reproduction is to be established for at least three non-consecutive years prior to removal of Dams D and E.

Dams D and E currently provide potential (Dam E) or known (Dam D) breeding habitat for Growling Grass Frog. As such, modification to their current design is not considered necessary. However, they will be managed in accordance with the wetland management regime outlined in Section 3.5.3) until such time as they

are removed (See Appendix 2), or, in perpetuity if it is necessary for them to be retained (if successful breeding in the created wetlands has not been demonstrated). Two dedicated Growling Grass Frog wetlands are to be constructed on the east side of Gum Scrub Creek, adjacent to Dams D and E. It is intended that these dedicated wetlands will directly offset the loss of these dams.

In the interim, the following management measures will be implemented for dams D and E:

- The dams have been fenced off to prevent stock and construction access.
- Signage will be erected prior to any construction works in the vicinity of the dams (unlikely to occur prior to 2010) clearing stating the protected status of the dams.
- Water levels will be monitored to ensure that sufficient water is present during the breeding season (September to March). Should it become necessary, water will be pumped into the dams (subject to approval from the relevant water authority) via a filter to ensure that predatory fish species are not introduced.
- Growling Grass Frog breeding success will be monitored at both dams by surveying for metamorphs during December and January each year.
- A report will be provided to DEWHA and DSE every 2 years, advising the status of Growling Grass Frog at Dams D and E.

Created wetlands

A total of 7 dedicated Growling Grass Frog wetlands will be incorporated into the proposed development, to mitigate against habitat losses. Their location is shown in Figure 3. The wetlands will:

- be a maximum of 500 m apart (within the dispersal capabilities of Growling Grass Frog);
- be located within the rail line and Gum Scrub creek movement corridors; and
- vary in size and will have the ability to be drained in order to manage the presence of predatory fishes.

Regardless of the presence of key habitat characteristics at a particular waterbody, previous research on Growling Grass Frog and the closely related Green and Golden Bell Frog *L. aurea* have shown that a landscape-based

approach to habitat creation and management is required (Robertson et al. 2002; Hamer et al. 2002). For example, it has been shown that the likelihood of frogs occupying a particular waterbody is largely dependent upon the distance to a nearby occupied site. Therefore, the provision of additional habitat close to existing populations would provide opportunities for recolonisation, particularly if currently occupied sites become unsuitable (e.g. environmental stochasticity such as drought).

The Growling Grass Frog is a highly dispersive species and has the ability to rapidly colonise newly created habitats. There are a number of examples where this species has readily colonised, and subsequently bred in newly created waterbodies around Melbourne (author, pers. obs.).

This CMP focuses on the retention of existing habitat and the development of dedicated Growling Grass Frog wetlands within the development area. However, it should be noted that, in addition to the dedicated wetlands, a several stormwater treatment wetlands will be constructed throughout the development area. These wetlands will augment the habitat provided by the dedicated wetlands and in all likelihood will provide additional breeding sites for the species and facilitate the movement of Growling Grass Frog through the landscape. The location of these stormwater wetlands is indicated in Figure 3.

3.4.2.1 Key design features of dedicated Growling Grass Frog wetlands

The following describes ways in which the proposed dedicated Growling Grass Frog wetlands within the VicUrban development area will be designed to incorporate key habitat variables suitable for the species. The 'Constructed Wetland Systems Design Guidelines for Developers' produced by Melbourne Water (2002) will also be referred to during all phases of wetland design and construction, and a suitably qualified wetland revegetation contractor, in consultation with a qualified zoologist will be commissioned either through VicUrban or the successful contractor.

Bank design

Wetland banks will vary in the degree of slope, from areas of gentle undulation (which is preferable) to steep banks that drop off sharply. A variety of edge types and the provision of different microhabitats such as rocks and vegetation will also create a diversity of habitats for Growling Grass Frog.

Shape, size and depth

Wetlands will ideally be long and narrow, ideally 20 m long x 5-10 metres wide, but each wetland will necessarily vary somewhat in shape and size to reflect its location, and catchment area. The long rectangular shape of wetlands means that

they will have a high edge to area ratio. This configuration will maximise the refuge area around the waterbody for frogs.

The minimum depth of the dedicated wetlands will be 1.5 m. They will contain shallower areas which will dry out periodically, and deeper sections which will hold water permanently. It is imperative that the dedicated wetlands contain permanent water; if they are to dry out then this should only occur for short periods of time. The exception to this rule is when a wetland is deliberately drained for the control of introduced fishes (see below).

It is possible that wetlands whose maximum depth is less than 2 m might become dominated by emergent macrophytes such as Cumbungi *Typha* spp. and Common Reed *Phragmites australis*. If left uncontrolled, these plants can shade areas of open water, which is required by Growling Grass Frogs (unshaded wetlands support the dense rafts of submergent vegetation that the species depends upon for calling, oviposition and as refuge for tadpoles). To prevent this, wetlands will be monitored regularly (see Section 3.5.3) and if emergent macrophytes are becoming dominant, they will be appropriately controlled.

Terrestrial buffers around wetlands and corridors for frog movement

Very little information exists on the recommended corridor widths for Growling Grass Frog and most of the information available is for its close relative, the Green and Golden Bell Frog *Litoria aurea*. It is important to note that assessments and recommendations in relation to “movement corridors” for these species often rely on assumptions, general principles and the experience of the assessor, because actual data regarding a number of features (for example, minimum effective width) are scarce or non-existent.

While there is no data to show that Growling Grass Frogs preferentially use the rail corridor in Officer as a movement route, the habitat characteristics within the rail corridor and the presence of breeding and foraging habitat next to the rail corridor (dams), suggests that this is the most appropriate location for the provision of open space for this species (apart from Gum Scrub Creek, which is arguably the most important movement corridor for Growling Grass Frog in the VicUrban development area).

The precautionary principle states that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the case of the Green and Golden Bell Frog, recent genetic studies (Burns *et al* 2004) have shown that maintaining areas of continuous habitat is critical to the conservation of the species. Thus, the continued survival of the Growling Grass Frog in the Officer area may depend on maintaining habitat linkages between these potential and known breeding sites, including breeding habitats that may be

created for the species.

Definitive information regarding factors such as the minimum effective width of corridors is scarce or non-existent and there is currently no proven “recipe” for a Growling Grass Frog movement corridor. However, information from some researchers and the experience of previous management techniques can be used as a guide. Individuals of both Growling Grass Frog and Green and Golden Bell Frog have been observed on wet nights in a variety of situations, such as hopping across roads, areas of bare rock or mown turf.

Although both species have been observed crossing a variety of substrates, for the purposes of the VicUrban development at Officer, it was assumed that the preservation of a suitable “corridor habitat” would be likely to improve the potential for movement between breeding habitats and hence the long-term survival of the population.

Suitable corridor habitat is most likely to consist of open, grassy areas, particularly those situated along drainage lines or other areas that are particularly moist (Christy 2001). The rail reserve and land immediately south of has such features and this, together with the presence of existing wetland habitat, is why a corridor was stipulated for this area.

Biologists assume that the wider the corridor and the shorter the distance between habitats, the more likely the corridor will be effective. This rule applies to frogs as well as a number of other vertebrates.

Features likely to be suitable for Green and Golden Bell Frog movement corridors for Sydney Olympic Park were proposed by Pyke (1995), on the basis of information available regarding the species at that time, and accepted by the (then) NSW National Parks and Wildlife Service. Proposed features were based on general principles rather than actual experimental data, and included:

- Width (as wide as possible - minimum of 20 m and preferably 50 m);
- Position (should follow drainage lines);
- Vegetation (should provide continuous vegetation, grass where possible);
- Shelter sites (rock piles at intervals along corridor);
- Ponds (at regular intervals along corridor); and
- Barriers (should be minimised; roads should include underpasses).

To a large extent, the corridor widths recommended by various workers in Victoria in relation to Growling Grass Frog have been based on their

recommendations for the Green and Golden Bell Frog at the Sydney Brick Pit at Homebush Bay, which stipulates a minimum of 20 m (Pyke 1995).

There is little or no scientific basis for setting a minimum corridor width for Growling Grass Frog. The available literature suggests a minimum of 20m, but preferably 50m. These recommendations are based on those recommended for Green and Golden Bell Frog in NSW, which in turn was based in the ‘wider is better’ principle, rather than rigorous scientific experimentation.

VicUrban acknowledges that Growling Grass Frog can and does move distances greater than 50m during nightly foraging and during dispersal events; however it is felt that the movement corridors and proposed terrestrial buffers around created and retained wetlands will be sufficient to conserve the Growling Grass Frog population in the VicUrban development area.

As outlined earlier, the dedicated Growling Grass Frog wetlands will be located within a 100m wide (in total) corridor along Gum Scrub Creek and within a 30m wide corridor along the southern side of the rail reserve. The width of the corridor will expand where waterbodies are located to provide a 25m terrestrial buffer. It is important to note that this does not include the rail corridor itself or the rail corridor buffer that exists in the development on the northern side of the rail reserve (both outside the VicUrban development area). The addition of these areas results in a movement (and habitat) corridor in excess of 60m in width.

The primary purpose of the corridor along the railway reserve is for the movement of the species. Discussions have been held with relevant Growling Grass Frog experts, including those from DSE. From these discussions it is apparent that there is no information available on the minimum buffer size around wetlands or movement corridor widths required for this species. Indeed, there is an overall lack of knowledge of the importance of terrestrial habitat for this species generally. The determination of an appropriate buffer size is therefore problematic. However, it is felt that the buffer size indicated above is sufficient to provide the frogs with enough space to meet their terrestrial habitat requirements.

The most important factor affecting the suitability of the terrestrial buffer is no absolute size *per se*, but rather the management regime applied to it. Accordingly, the buffers around the wetlands will be designed to include habitat features such as:

- Rock piles and plantings of indigenous grasses and small shrubs for foraging and shelter;
- Regularly mown grassy areas for foraging and to aid in unhindered

movement

Public access

The presence of humans in or near the designated corridors is unlikely to have a negative impact on Growling Grass Frog or affect corridor function. Growling Grass Frog is primarily nocturnal and most movements are undertaken at night when human use of pedestrian trails is comparatively low. There are a number of developments around Melbourne that have managed to retain and even enhance Growling Grass Frog populations in the urban matrix and these include Caroline Springs, Cairnlea Estate and Botanica Park in Thomastown (D.Gilmore, pers. obs.). There is no evidence to suggest that human presence (noise, foot traffic etc.) is having a negative impact on any of these populations, which have persisted in an urban environment for more than 5 years and nearly 10 years in the case of Caroline Springs. While careful consideration needs to be paid where there is an interface between the urban landscape and areas designated for conservation of Growling Grass Frog, the two land uses are by no means incompatible and the mitigation measures outlined in this Plan will help to ensure that populations are maintained within the development area.

Vegetation

Vegetation planted in and around the dedicated Growling Grass Frog wetlands will replicate that found in habitats currently used by Growling Grass Frog in the VicUrban development area. A relatively open design is proposed, with a dense cover and diversity of fringing vegetation around wetlands (for day refuge and basking) and a dense cover of submerged and floating vegetation in deeper water (for calling and breeding) (Plates 3, 4 & 7). Vegetation plantings have been separated into three distinct zones, which are consistent with planting regimes at other constructed or proposed wetlands specifically designed for *L. raniformis* (Heard et al. 2004b) and include:

- Zone 1 – Shallow verge located adjacent to wetland bank.
- Zone 2 – Macrophyte planting inundated to 0.5 metres dominated by emergent aquatic or semi-aquatic ringing vegetation (no Cumbugi or Common Reed); and
- Zone 3 – Submerged and floating vegetation zone inundated up to 3 metres.

Vegetation will be floristically and structurally diverse, and areas around the perimeter of wetlands will be planted emergent aquatic plants such as Spike-sedges (*Eleocharis* spp.) and rushes (*Juncus* spp.). Floating aquatic plants such as Water Ribbon *Triglochin procerum*, and submergent aquatic plants such as Floating Pondweed *Potamogeton tricarlinatus*, will also be planted in wetlands. A full list of plants suggested for wetland establishment is provided in Appendix

3.

Wetlands will be planted out using expert advice from qualified wetlands ecologists and wetland contractors experienced with creating wetlands specifically for the Growling Grass Frog.

Refuge and shelter sites

Refuge sites provide perennial diurnal and non-breeding shelter sites for frogs and other fauna. Suitable refuge sites such as rock piles and large woody debris will be provided around the edges of wetlands. Dense areas of rocks will be located along the banks of the dedicated wetlands, extend at least 2 m from the water's edge. The configuration of these refugia will be guided by expert input from a suitably qualified zoologist.

Water

The catchment areas for the dedicated wetlands are large enough to ensure that the dedicated Growling Grass Frog wetlands will contain permanent water or do not dry out during the breeding season (September – March).

The dedicated wetlands will be designed in such a way that they can be completely drained to remove predatory fishes, should they become established.

The water for the dedicated wetlands will be sourced from the wetlands that contain treated stormwater and from surface runoff from public open space areas (grassed, vegetated areas).

Water quality tolerances and preferences of Growling Grass Frog are currently poorly understood, but several studies have revealed that, the species is likely to be tolerant to a range of water conditions (Ashworth 1998; Hamer et al. 2002; Pyke et al. 2002). However, Growling Grass Frogs prefer waterbodies possessing low levels of nutrients and salinity levels for successful breeding and recruitment to (Ashworth 1998). As such, the physio-chemistry properties of wetlands will be tested every 6 months to ensure that they remain within the range known at sites occupied by Growling Grass Frog.

Wetlands will be designed to ensure that there is low water turbidity (suspended particles). This will be achieved by planting dense areas of aquatic plants (suspended particles will adhere to the plants).

Wetlands will be at full water level (FWL) within at least six months to a year after construction to provide breeding opportunities for frogs.

Stormwater will be treated to best practice standards (>80% TSS removal, >45%

TP and TN removal, no gross pollutants).

Although detailed design of the majority of the system has not been undertaken, it is understood that water will be supplied to each of the areas in the following ways;

- Area A - The Growling Grass Frog wetland is separated from the main wetland but is intended to be filled with treated stormwater from the wetland system with inflow via solar powered pump or windmill.
- Area B – Retained dams I and H are located at the crest of the catchment. The predominant source of water would be the runoff from the abutting development which would first pass through vegetated swales to be treated. It is also possible that the ponds could receive water from Gum Scrub Creek and the rail reserve via backflow along the table drains in times of higher flow-similar to the ponds at Area F. The Growling Grass Frog pond immediately downstream of the railway on Gum Scrub will be fed from Gum Scrub Creek at times of higher flow several times per year. It is unlikely to receive any development stormwater as it is too high in the catchment. Windmill feed is an option too if more defined separation is required between the pond and the creek.
- Area C - the two Growling Grass Frog wetlands will be terminal ponds at the end of the stormwater treatment train, receiving treated low flows from drains discharging from the development to the east. High rate stormwater flows would be discharged away from the GGF ponds. As they are located in the floodplain, they will also receive overflows at times from the creek.
- Area D – Stormwater treatment wetland.
- Area E - The Growling Grass Frog wetland can only receive water from the creek- no development drainage. There is potential that this wetland be integrated in the wetland/retarding basin concept.
- Area F - These wetlands are the same operating environment as those to be built in AV Jennings Arena Estate immediately adjacent. They are completely isolated from any development stormwater and will be fed by backflow from Gum Scrub Creek via the table drains in the rail reserve and culverts under the future road, and finally by link pipes and swales between the ponds. They will also receive overland floodwater from the creek at times of high flow (>10 years ARI) but velocities will be negligible at such times. Windmill feed is an option too if more defined separation is required between the ponds and the creek.

Other considerations

A number of other factors will be considered in the design and construction of the dedicated wetlands. For example:

- Wetlands will be small enough to be managed effectively for vegetation and to enable easier draining to remove predatory fishes should they be detected

(but still within the size range the species is known or likely to use);

- Where co-located with larger wetlands, perched above these wetlands to enable easier draining;
- Wetlands will be designed such that they can be completely drained to remove predatory fishes, should such species become established;
- There will be no apparent barriers to the dispersal of Growling Grass Frogs between wetlands and along dedicated movement corridors; and
- The use of herbicides and pesticides within or in close proximity to wetlands will be avoided.

3.4.3 Road crossings of movement corridors

The exact location of possible road crossings over creeks and potentially dedicated Growling Grass Frog corridors has not been finalised. However, it is envisaged that one or more road crossings of Gum Scrub Creek will be entailed in the development. Culverts are expected to be used at these crossings and will be designed to allow unimpeded frog movements along watercourses or along corridors, thereby reducing the risk of Growling Grass Frogs being killed on roads. Appropriately designed open ended culverts in combination with drift fencing or hard barriers, will achieve this. Note that culverts under roads required for drainage purposes simply require appropriate placement and design to provide for the needs of frogs.

A number of studies have discussed the effectiveness of crossing structures to mitigate against adverse affects of roads upon amphibian populations (Langton 1989a, 1989b; Van Leeuwen 1982). In addition, a number of recent road developments around Melbourne (e.g. Craigieburn Bypass, Edgars Road extension – Thomastown) also have either culverts or underpasses installed to mitigate against the likely impacts (e.g. barriers to dispersal, fragmentation of populations) on Growling Grass Frog populations (Robertson 2002). For the Pakenham Bypass project, Biosis Research (2005) provided recommendations to facilitate passage of Growling Grass Frogs under the Bypass along watercourses within the Officer development area. These structures are now in place.

Culverts at creek crossings will be constructed to:

- allow frog dispersal between and within breeding, foraging and over-wintering sites along creeks and nearby areas;
- provide uninterrupted movement for frogs dispersing after metamorphosis; and,
- facilitate the ongoing exchange of individuals between suitable sites.

Overseas studies in relation to use of underpasses or culverts by frogs have shown that frogs have difficulty in finding these structures if drift fences are not

installed, while frogs generally find underpass entrances easily when drift fences are in place (Brehm 1989).

Ongoing consultation between VicUrban and DSE during and after construction is imperative to ensure that culverts at creek crossings are suitable and are functioning as intended.

Drift fencing will be used along both ends of culverts, and will be designed to prevent frogs from accessing the road surface by guiding them towards the culvert opening. Drift fencing will be designed so that it does not impede frog movement under the road (i.e. block the entrance), and will funnel frogs towards culverts. This funnelling effect will be augmented by vegetation (i.e. low growing native sedges and grasses), and rocks near culvert entrances.

Construction of wetlands (see below) within 5 – 20 m of culvert entrances that are not along creeks may also facilitate the movement of frogs through culverts rather than over roads. Wetlands located in the vicinity of roads will also have drift fencing or barriers to prevent frogs from crossing roads and being killed by cars.

While the recommendations provided below outline the key design aspects of drift fencing that will be constructed at culverts and underpasses, the final design of fencing at each creek crossing will be determined after consultation with DSE and a suitably qualified zoologist.

3.4.3.1 Design of frog culverts and underpasses

Culverts

Culverts will be designed and constructed in a way that maximises their potential to facilitate frog movement under roads. Key design parameters guiding the construction of culverts within the VicUrban development area are as follows:

- Culverts will be as short as possible with smooth surfaces along the base and with flat, rather than curved, bottoms.
- Either single culverts or a series/chain of culverts will be used.
- Where possible, a small, appropriately vegetated pool (approx 5 m in diameter and at least 0.5 m deep) will be constructed close to each culvert entrance with a view to attracting frogs to the location of the culvert.
- Culvert entrances will be kept clear of rubbish, hard litter and other debris at all times.
- Two-way access is required to allow frog movement along creeks, and any openings along the length of culverts must prevent frogs from accessing the road surface.
- Vehicle and foot traffic close to culverts and along drift fences (see below)

will be kept to a minimum.

- Artificial lighting (e.g. street lights) near culvert entrances will be minimised as this may reduce their effectiveness.
- No obstructions such as rocks or logs will be placed within culverts.
- Culverts will be designed to allow frogs to move through the culvert during high flows.

Drift fencing

Drift fences will be used in association with the culverts as described above.

The following design aspects for drift fencing are will be used:

- A suitable mesh (of appropriate gauge) or a solid structure will be used. If a solid structure is used then it will be made from concrete or other material.
- Drift fencing will be installed along both sides of culverts entrances. The length of the drift fencing will be as long possible.
- Fences will be erected along the edge of the road, at a 45 degree angle to the road verge, to prevent frogs entering the road pavement. Fences will not be at right angles to the road as this is unlikely to guide frogs into the underpass.
- Fences will be at least 0.5 m high with an additional 0.2 m below ground and (if mesh fencing is used) a 0.2 metre section at the top angled outwards (away from the road).
- Rock and other debris such as coarse woody debris will be placed at least one metre away from the fence, along likely dispersal routes to provide temporary shelter sites.
- Vegetation within 0.5 m of the drift fencing will be less than 0.5 m high.
- Drift fences will be inspected and approved by DSE and a qualified zoologist to ensure that they are appropriately installed and are likely to function as intended.

3.4.4 Monitoring of the Growling Grass Frog population

Monitoring of the Growling Grass population will be undertaken during pre-construction and construction phases and will be undertaken in accordance with the methods outlined in Section 3.5.1.

3.4.5 Pedestrian footpaths and bike tracks

Pedestrian foot paths and bike tracks that are planned for the development will be designed to minimise losses of habitat and disturbance to Growling Grass Frogs. Where practicable, pedestrian foot paths and bike tracks will be located away from the edge of creeks and wetlands.

3.4.6 Interpretation and publicity

Interpretive signage and informative material (e.g. information brochures) relating to Growling Grass Frog ecology and the significance of the site for the species, will be used to encourage residents to protect frog habitats and other ecological values throughout the area. Signs will be strategically located either in the vicinity of known Growling Grass Frog sites, or at dedicated Growling Grass Frog wetland sites. Information brochures, pictures, newsletters and information sessions on the frog and other environmental values at the site will also be used in sales or information offices.

3.4.7 Frog salvage and translocation

It is envisaged that the dedicated Growling Grass Frog wetlands and the stormwater treatment wetlands will be colonised naturally by Growling Grass Frogs already inhabiting wetlands nearby. However, to augment this process and to potentially to minimise the number of individuals killed during the removal of existing habitat, salvage and translocation will be undertaken.

Over recent years salvage operations specifically for Growling Grass Frog have been recommended and/or undertaken as part of a number of developments. Salvage and translocation involves locating and capturing frogs in wetlands that are to be removed (see Figure 2) and relocating specimens to appropriate sites nearby. Sites for the release of salvaged animals will be identified with DSE.

Prior to the removal of any habitat, water will be drained from existing dams in an attempt to move frogs on to adjacent and/or nearby habitats (see Section 3.5.3.1).

Translocation involves some risk to the translocated frogs as the current state of knowledge on the success of translocation operations for Growling Grass Frog is limited. Therefore on-going survival of translocated frogs cannot be assured. Consequently, translocation operations would need to consider subsequent monitoring requirements to determine the success of translocation. These monitoring requirements, if required, will be developed in consultation with DSE.

3.4.7.1 Salvage requirements

Salvage will be undertaken in accordance with the following salvage protocol outlined in written advice received from Jack Krohn of the Department of Sustainability and Environment dated 10 September 2008 ;

- Salvaging will be undertaken particularly at, or in the vicinity of sites where the species was recorded during the previous survey (as per Table

1 and continued monitoring reports for the project).

- It is preferable that in the year of dam removal as per project timelines, dams specified for removal be made unsuitable to retain water or to be drained well in advance of removal. This action should take place during the inactive season for the species.
- Salvage will take into account consideration of seasonal activity patterns. Suggested salvage requirements are as follows;
 - If construction is planned during the inactive period (between April and August) then salvaging will occur up to one week in advance of site stripping. Salvage operators will not be required to undertake nocturnal surveys but will search surrounding terrestrial habitat (rocks, litter, vegetation and other ground debris).
 - If construction must coincide with the active period (between September and March) then salvaging will occur in the week running up to actual day of site stripping. Salvage operator will undertake nocturnal search around wetland, search surrounding terrestrial habitat (rocks, litter, vegetation and other ground debris) and dip net for tadpoles and metamorphs.

In addition, the following protocols will also be observed:

- Salvage will be undertaken by qualified zoologists, or someone who has knowledge and experience with handling and transporting frogs;
- Prior to any salvage operations an appropriate wildlife permit from DSE will be obtained.
- 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.
- If a frog is found during construction, but in the absence of a suitably qualified zoologist, contractors will be advised to contact a nominated person immediately. Captured frogs will be stored in an appropriate container until someone arrives.
- Adult and metamorph frogs will be captured by hand.
- Latex surgical gloves will be worn at all times when handling frog(s). Gloves will be changed after each frog if more than one frog is to be handled;
- Frogs will be transported in suitable capture bags, preferably plastic, and a one frog one bag approach will be adopted to minimise disease transmission.
- Salvage procedures will be conducted in accordance with the hygiene

protocol for the control of disease in frogs (National Parks and Wildlife Service 2001). This should help prevent the spread of chytrid fungus *Batrachochytrium dendrobatidis*, and thus reduced frog mortality.

3.4.7.2 Translocation requirements

The following translocation requirements should be followed if any frogs are located:

- The translocation sites will be identified in consultation with DSE, but in the first instance animals will be translocated to the existing and constructed wetlands shown in Figure 3. Any translocation operations will consider the potential spread of diseases (chytrid fungus), and impacts upon Growling Grass Frog and other frog populations at the translocation site.
- Frogs will be released into favourable micro-habitats (e.g. rocks or dense vegetation where there is sufficient cover).
- Frogs will be released at sites as soon as practicable after capture.
- Any sick, dying and/or visibly diseased specimens will not be translocated and instead will be held until a determination is made on what should be done with these individuals.
- Subject to animal ethics approval and approval from DSE, monitoring of translocated frogs will be undertaken to determine translocation success. Radio tracking has successfully been used to monitor frog populations, including Growling Grass Frog. For example, radio-tracking of Growling Grass Frog has recently been undertaken at newly created wetlands, Botanic Park, Bundoora, and Werribee Zoo.
- Any marking of frogs should be undertaken by personnel who have experience with these monitoring techniques.

Testing for Chytrid Fungus *Batrachochytrium dendrobatidis* in individuals to be translocated will not be required as it is likely that the fungus is already present within the local population and moving individuals within the Officer sub-population is unlikely to have any impact.

3.4.8 Habitat protection during construction

The Growling Grass Frog uses a variety of both aquatic and terrestrial habitats, so it is necessary to put measures in place to protect both frogs and their habitats during the construction phase of the project. To that end, a number of measures will be implemented to ensure that detrimental impacts are avoided or minimised wherever possible during construction activities.

The publication Construction Techniques for Sediment Control (EPA publication 275) will be implemented for this project. The measures to be adopted to control

erosion and sediment during construction include:

- Installing erosion control measures before construction commences.
- Keeping areas of land cleared to a minimum, and the period of time areas remain cleared to a minimum
- Keeping construction vehicles to well-defined haul roads.
- Rehabilitating cleared areas promptly.
- Locating stockpiles away from concentrated flows and divert runoff around them.
- Establishing an adequate inspection, maintenance and cleaning program for sediment runoff control structures.
- Ensuring that contingency plans are in place for unusual storm events.
- Continually assessing the effectiveness of sediment control measures and making the necessary improvements.

Stormwater will be managed during construction by:

- Minimising the quantity of uncontaminated stormwater entering cleared areas.
- Establishing cut-off or intercept drains to redirect stormwater away from cleared areas and slopes to stable (vegetated) areas or effective treatment installations.
- Reducing water velocities.

The Contractor's Environmental Management Plan will address the above general principles prior to the commencement of any construction works.

- All construction area footprints will be clearly marked and adequately fenced to prevent unnecessary access by construction vehicles to retained or created habitat.
- Construction materials and spoil will not be stored, dumped or stockpiled within areas of potential habitat.
- Induction of all construction and site personnel will include information about the Growling Grass Frog and its habitat within the development area, along with protection measures that will be in place and enforced during the construction period.

3.4.8.1 Required approvals and permits

A permit from DSE is required to 'live capture, collect and relocate' Growling Grass Frog during construction operations will be required. Prior to any marking

of frogs a DSE 'Management Authorisation' will be obtained under the Victorian *Wildlife Act 1975*, and any marking of animals would be in accordance with DSE ethics approval.

3.5 Post construction phase

VicUrban is responsible for ongoing management and maintenance of wetlands and infrastructure provided by the development project for protection of the Growling Grass Frog until such time as its overall responsibility for the project ceases. It is anticipated that VicUrban will maintain assets for a period of 2 years after construction and its responsibility will cease once an asset is transferred to a new responsible authority (i.e.: Cardinia Shire Council or Melbourne Water).

Post-construction management and monitoring should be undertaken in consultation with a suitably qualified zoologist in conjunction with other relevant authorities (e.g. DSE, Melbourne Water, Cardinia Shire), to ensure that measures are suitable for Growling Grass Frog and remain so into the future.

3.5.1 Monitoring of the Growling Grass Frog population

VicUrban will monitor the Growling Grass Frog population whilst it is the landowner/manager. The objectives of monitoring will be to determine the success of the protection and conservation measures implemented through the CMP and the identification of potentially threatening processes. The continued persistence of a Growling Grass Frog *population* within the development area is the key measure of success for the purposes of this CMP.

The number of adult frogs recorded within the development area is likely to vary markedly between years (see Table 1) and as such the absolute number of adult and metamorph frogs is not a good measure of success. While occupation rates at wetlands are also likely to vary on an annual basis (due to natural variability in the size of the population and / or temporary changes in habitat suitability), they are generally more stable and hence are a better indicator of success of the CMP (see Table 1).

Key indicators of the success of the CMP will be measured by:

1. Growling Grass Frog occupation rates at retained and created habitats, measured by the presence / absence of adult frogs during annual surveys. The minimum target is the presence of adult frogs in at least 4 created and / or retained wetlands within the development area in any given year.
2. Confirmation of successful reproduction every year for the duration of the monitoring period. For the purposes of the CMP, successful reproduction is defined as the presence of Growling Grass Frog metamorphs at a minimum of two constructed wetlands within the development area.

3.5.2 Frog survey methods

All retained and constructed wetlands will be surveyed twice a year; once during October/November to detect aggregations of calling adults at wetlands (an indicator of site occupancy), and again during late December/January to determine where successful breeding has occurred (as defined by the presence of metamorphs). All sites will be visited twice in each survey period.

Nocturnal surveys will be conducted by experienced zoologists. Surveys will be conducted on calm warm nights, ideally when air temperatures exceed 15°C, and preferably after or during rain. Observers will also record weather conditions at the time of survey. Visual observations of frogs will be made with the aid of spotlights, to assist with verification of the numbers of animals. The number of frogs heard or seen, their sex and age, disease status and location will be recorded.

3.5.3 Wetland management and maintenance

Monitoring and management of newly created wetlands is essential, particularly during the first two years after establishment, and will include the following:

- Vegetation condition at wetlands will be monitored by a qualified zoologist every six months. If wetlands become undesirable habitat due to vegetation (eg: overgrown with *Typha* spp) then appropriate measures will be undertaken. Management of vegetation in shallow wetlands is of particular importance as areas of open water should be maintained for Growling Grass Frog habitat.
- Removal of any plants (terrestrial or aquatic) considered undesirable for the species will be undertaken with physical removal as the primary control method. However, herbicides may be used selectively and would need to be sensitive to frogs and their habitats (e.g. a 'frog-friendly' Glyphosate product such as Roundup Bio-active).
- Damage to aquatic vegetation by waterfowl, particularly immediately after planting will be prevented by using protective netting until vegetation is established.
- Interpretative signage will be erected at strategic locations to advise of the importance of the wetlands to the species and the need to exclude fish from the wetlands.
- Wetlands will be surveyed to determine the presence of fish species on a six-monthly basis. If predatory fish species such as Plague Minnow are shown to be present, in a given wetland, then it will be completely drained and refilled within six months to remove the species.
- Mowing and slashing exclusion zones must be maintained in the long-term to protect habitat in the vicinity of creeks and wetlands.
- Monitor refuge and shelter sites around the perimeter of wetlands at least

every six months after construction, to ensure they remain suitable.

- Provision of additional refuge sites for frogs if the extent of shelter and refugia is considered inadequate.
- Water quality monitoring of dedicated Growling Grass Frog wetlands will be undertaken every 6 months to ensure that quality is suitable for the species.
- Water quality will comply with specified water quality criteria identified in the latest version of Clause 56 of the Victorian Planning Provisions refer Appendix 4 (this is consistent with the EPBC approval DEWHA have issued for VicUrban's Riverwalk Development).
- It is anticipated that the dedicated Growling Grass Frog wetlands will be at full capacity within six months of their construction. If this does not occur then artificial filling will be considered.

3.5.3.1 Draining wetlands and dams

It is anticipated that wetlands will need to be drained both for maintenance (e.g. periodically drained to remove predatory fishes) and to passively facilitate the dispersal of Growling Grass Frogs from existing dams to be removed and the salvage protocol details which dams will be drained to aid GGF dispersal.

The following guidelines will be followed in relation to the draining of wetlands in the VicUrban development:

- Wetlands and dams will be drained during the non-breeding season (March-August), when few, if any eggs, tadpoles and metamorphs would be expected in the wetlands.
- Wetlands and dams will be drained using a water pump with a suitable filter fitted to ensure that any Growling Grass Frog tadpoles are not pumped out of the waterbody.
- Dams to be removed will be drained at least 1 month prior to being filled in, to give Growling Grass Frogs enough time to passively disperse from the dam to alternative habitat.
- Dedicated Growling Grass Frog wetlands and retained dams that are drained to remove predatory fishes will be refilled prior to the onset of the breeding season (before October) to ensure that breeding habitat is available to the species.

3.5.3.2 Culverts and drift fences

Continued monitoring and maintenance of culverts and drift fences will be important to ensure these structures are suitable to facilitate movement of frogs under the road, and to assess the overall effects on frog populations in the VicUrban development area.

The following post construction recommendations for culverts and drift fences

include:

- Removal of rubbish which might impede frog movement;
- Removal of weeds and vegetation within 1m of fences to prevent frogs climbing over them and vegetation taller than one metre at culvert entrances. Vegetation can either be manually removed and/or selectively sprayed using a non-residual 'frog-friendly' Glyphosate herbicide such as Roundup Bio-active);
- Provision of additional low-growing vegetation (grasses, sedges) or placement of shelter near underpass and culvert entrances may be required;
- Drift fencing should be checked at least every six months to ensure that it continues to function as intended. Immediate repair should be made of gaps in, or under, drift fencing.

3.5.3.3 Other considerations

Other post-construction monitoring and management requirements that should be considered:

- Interpretive signage about the frog and its habitat should be maintained in good repair.

3.5.3.4 Reporting

A report outlining the results of monitoring, wetland creation and maintenance activities will be provided each year to the DEWHA and DSE.

3.6 Conservation management plan review

It is intended that this plan, along with the habitat protection and enhancement recommendations it details, will be implemented over a number of years, and VicUrban will be responsible for implementation for the duration of its management responsibility for the land. Formal review of the plan will be undertaken at 5 year intervals by VicUrban whilst it is the land manager, in consultation with DSE.

Conservation management of Growling Grass Frogs and their habitats on the site thereafter would need to be determined by responsible authorities, which are likely to include Cardinia Shire, DSE and Melbourne Water Corporation. Changes to monitoring and management recommendations from those outlined here may need to occur in the light of any new information about the species and its habitat requirements applicable to the VicUrban development area.

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APPENDICES

APPENDIX 1

Implementation Schedule

A number of key steps are required for the conservation of Growling Grass Frog in the VicUrban development area. The following steps for the implementation of the plan are outlined below:

<p>Pre-construction and construction phase</p> <ul style="list-style-type: none"> - Fence Dams D E, H and I (2008). - Erect protective signage on retained dams (2008). - Obtain relevant permits from DSE for salvage and translocation operations (2008). - Appoint a wetland developer who has had previous experience relating to Growling Grass Frog habitat creation (2008-ongoing) - Undertake annual population monitoring (twice yearly) of existing habitats (dams), and created wetlands as they become suitable for the species (October 2008-ongoing). - Remove existing occupied dams and construct dedicated Growling Grass Frog wetlands (early 2009-2015) in accordance with the Habitat Program including the planting and establishment of vegetation and provision of rocks, logs and other refuge at dedicated Growling Grass Frog wetlands. - Salvage and translocate frogs from occupied dams to be removed immediately prior to removal. This should be in accordance with the salvage and translocation protocol (early 2009-2014). - Culvert construction. - Appoint a suitably qualified person to construct culverts; <ul style="list-style-type: none"> - Zoologist should be consulted to ensure that habitat features are appropriately constructed - Provision of refuge sites – rock and logs - Vegetation establishment - Investigate the potential to relocate (assisted movement) of frogs into wetlands if required.
<p>Post-construction (ongoing)</p> <ul style="list-style-type: none"> - Monitoring and maintenance of wetlands. <ul style="list-style-type: none"> - Provision of additional plants and refugia (rocks, logs) where necessary. - Pumping wetlands dry if pollutants or predatory fish are present. - Weed control, rubbish removal. - Monitoring and maintenance of culverts and drift fencing <ul style="list-style-type: none"> - Provision of additional plants and refuge (rocks, logs) near entrances where necessary; - Weed control, rubbish removal and vegetation removal/maintenance along fences - Growling Grass Frog population and habitat monitoring <ul style="list-style-type: none"> - Populations – distribution, sizes, morphological data, breeding and recruitment. - Habitats – vegetation suitability (type, cover, structure), hydrology (flow, permanency), shelter and over-wintering sites (rocks, vegetation), water quality, and introduced fish.

APPENDIX 2

Habitat Program

VicUrban's Development at Officer – Growling Grass Frog Habitat Program

	2008	2009	2010	2011	2012	2013	2014	2015
Corridors with dedicated frog ponds and associated open space to be <u>created</u>				Area B – Frog corridor along railway line (inc 2 frog ponds & 2 x dams retained in situ) 41,000m ²			Area C – Gum Scrub Creek corridor (inc 3 frog ponds) 78,000m ²	
Wetlands with dedicated frog ponds and associated open space to be <u>created</u>		Area A (inc 1 frog pond) 45,000m ²				Area D (inc 1 frog pond) 10,000m ² Area E (inc 2 frog ponds) 8,000m ²		Area F (inc 1 frog pond) 60,000m ² TOTAL 242,000m ²
Existing dams to be <u>removed</u>		Dam K 5,500m ²	Dam J 855m ²			Dam A 415m ² Dam B 283m ² Dam C 1,235m ² Dam F 675m ²⁰ Dam G 760m ²	Dam D 5,768m ² Dam E 4,960m ² Provided successful recruitment* demonstrated in constructed and enhanced dedicated frog wetlands + refer to pg ** of CMP for classification	Dam L 706m ² TOTAL 22,228m ²
Dams to be <u>retained in situ</u> *conservation and enhancement of existing habitat				Dam H* 756m ² Dam I* 315m ²				

APPENDIX 3

Recommended Revegetation List

The following is a guide to indigenous species useful for the recreation of habitat within a landscaped environment. It is not a detailed specification and other locally indigenous plants should also be used.

Table A2.1 : Wetland planting list

Scientific name	Common name
Zone 1 – shallow verge vegetation along banks of waterbody	
<i>Carex appressa</i>	Tall Sedge
<i>Juncus holoschoenus</i>	Joint-leaf Rush
<i>Juncus procerus</i>	Tall Rush
<i>Poa labillardierei</i>	Common Tussock-grass
Zone 2 – emergent vegetation within the waterbody	
<i>Glyceria australis</i>	Australian Sweet-grass
<i>Eleocharis sphacelata</i>	Tall Spike-sedge
<i>Schoenoplectus tabernaemontani</i>	River Club-sedge
<i>Amphibromus nervosus</i>	Common Swamp Wallaby-grass
<i>Eleocharis acuta</i>	Common Spike-sedge
<i>Glyceria australis</i>	Australian Sweet-grass
<i>Myriophyllum crispatum</i>	Upright Water-milfoil
<i>Myriophyllum simulans</i>	Amphibious Water-milfoil
<i>Persicaria decipiens</i>	Slender Knotweed
<i>Ranunculus inundatus</i>	River Buttercup
<i>Stellaria angustifolia</i>	Swamp Starwort
Zone 3 – submerged and floating vegetation with the waterbody	
<i>Marsilea drummondii</i>	Common Nardoo
<i>Myriophyllum caput-medusea</i>	Coarse Water-milfoil
<i>Potamogeton tricarinatus</i>	Floating Pondweed
<i>Potamogeton ochreateus</i>	Blunt Pondweed
<i>Triglochin procerum</i>	Common Water-ribbons
<i>Vallisneria americana</i>	Ribbon-weed

APPENDIX 4

CLAUSE 56

56.07 INTEGRATED WATER MANAGEMENT

09/10/2006
VC42

56.07-1 Drinking water supply objectives

09/10/2006
VC42

To reduce the use of drinking water.

To provide an adequate, cost-effective supply of drinking water.

Standard C22

The supply of drinking water must be:

- Designed and constructed in accordance with the requirements and to the satisfaction of the relevant water authority.
- Provided to the boundary of all lots in the subdivision to the satisfaction of the relevant water authority.

56.07-2 Reused and recycled water objective

09/10/2006
VC42

To provide for the substitution of drinking water for non-drinking purposes with reused and recycled water.

Standard C23

Reused and recycled water supply systems must be:

- Designed, constructed and managed in accordance with the requirements and to the satisfaction of the relevant water authority, Environment Protection Authority and Department of Human Services.
- Provided to the boundary of all lots in the subdivision where required by the relevant water authority.

56.07-3 Waste water management objective

09/10/2006
VC42

To provide a waste water system that is adequate for the maintenance of public health and the management of effluent in an environmentally friendly manner.

Standard C24

Waste water systems must be:

- Designed, constructed and managed in accordance with the requirements and to the satisfaction of the relevant water authority and the Environment Protection Authority.
- Consistent with any relevant approved domestic waste water management plan.

Reticulated waste water systems must be provided to the boundary of all lots in the subdivision where required by the relevant water authority.

Urban run-off management objectives

To minimise damage to properties and inconvenience to residents from urban run-off.

To ensure that the street operates adequately during major storm events and provides for public safety.

To minimise increases in stormwater run-off and protect the environmental values and physical characteristics of receiving waters from degradation by urban run-off.

Standard C25

The urban stormwater management system must be:

- Designed and managed in accordance with the requirements and to the satisfaction of the relevant drainage authority.
- Designed and managed in accordance with the requirements and to the satisfaction of the water authority where reuse of urban run-off is proposed.
- Designed to meet the current best practice performance objectives for stormwater quality as contained in the Urban Stormwater – Best Practice Environmental Management Guidelines (Victorian Stormwater Committee 1999) as amended.
- Designed to ensure that flows downstream of the subdivision site are restricted to pre-development levels unless increased flows are approved by the relevant drainage authority and there are no detrimental downstream impacts.

The stormwater management system should be integrated with the overall development plan including the street and public open space networks and landscape design.

For all storm events up to and including the 20% Average Exceedence Probability (AEP) standard:

- Stormwater flows should be contained within the drainage system to the requirements of the relevant authority.
- Ponding on roads should not occur for longer than 1 hour after the cessation of rainfall.

For storm events greater than 20% AEP and up to and including 1% AEP standard:

- Provision must be made for the safe and effective passage of stormwater flows.
- All new lots should be free from inundation or to a lesser standard of flood protection where agreed by the relevant floodplain management authority.
- Ensure that streets, footpaths and cycle paths that are subject to flooding meet the safety criteria $d_a V_{ave} < 0.35 \text{ m}^2/\text{s}$ (where, d_a = average depth in metres and V_{ave} = average velocity in metres per second).

The design of the local drainage network should:

- Ensure run-off is retarded to a standard required by the responsible drainage authority.
- Ensure every lot is provided with drainage to a standard acceptable to the relevant drainage authority. Wherever possible, run-off should be directed to the front of the lot and discharged into the street drainage system or legal point of discharge.
- Ensure that inlet and outlet structures take into account the effects of obstructions and debris build up. Any surcharge drainage pit should discharge into an overland flow in a safe and predetermined manner.

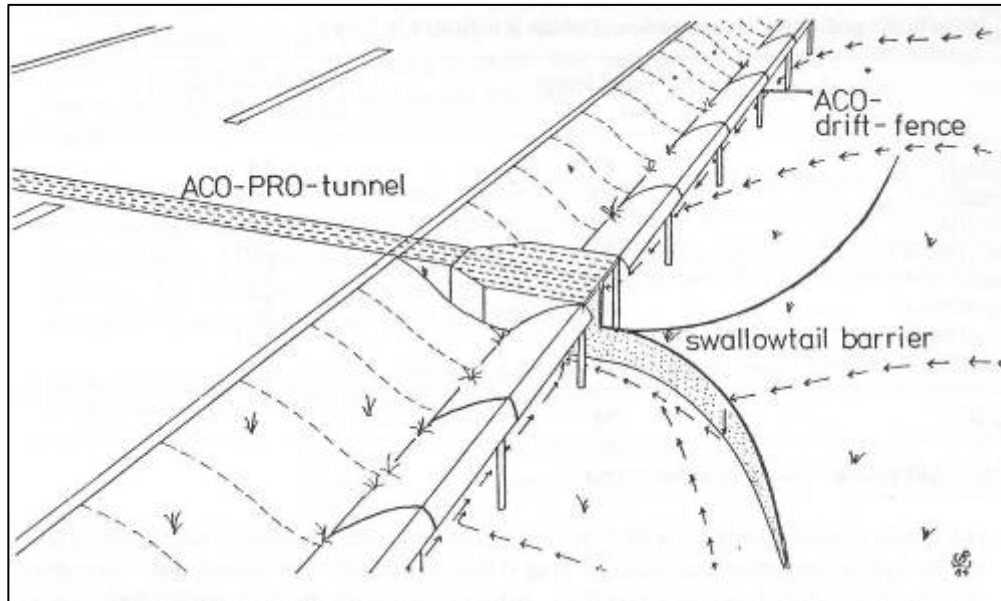
- Include water sensitive urban design features to manage run-off in streets and public open space. Where such features are provided, an application must describe maintenance responsibilities, requirements and costs.

Any flood mitigation works must be designed and constructed in accordance with the requirements of the relevant floodplain management authority.

PLATES

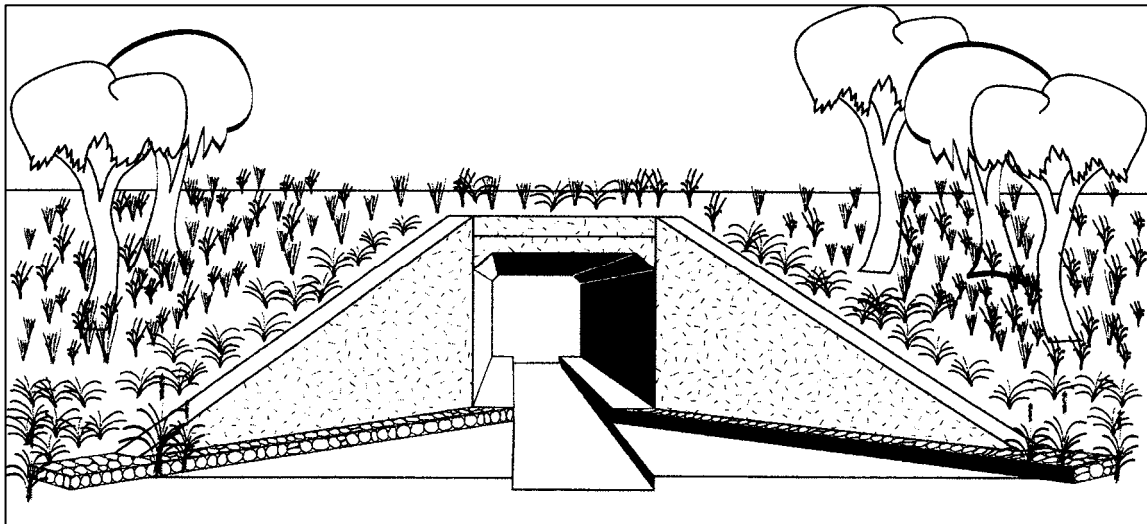
Design and construction requirements

Plate 1. An overseas design of a frog tunnel with 'shallowtail' barrier, which has proven successful in allowing frogs to move under roads.



(Source: Brehm 1989)

Plate 2. Typical culvert design containing benching on either side to allow for fauna movement during high flow.



Reproduced with permission from - Witheridge G. (2002) Fish Passage Requirements for Waterway Crossings - Engineering Guidelines

Plate 3. Wetland occupied by *L. raniformis* supporting an extensive cover of floating vegetation.



Plate 4. Recently constructed wetlands planted out with a diversity of wetland plants, Pakenham, Victoria.



Plate 5. Artificial wetland created specifically for *L. raniformis* at Botanica Park prior to vegetation establishment 2002, Bundoora, Victoria.



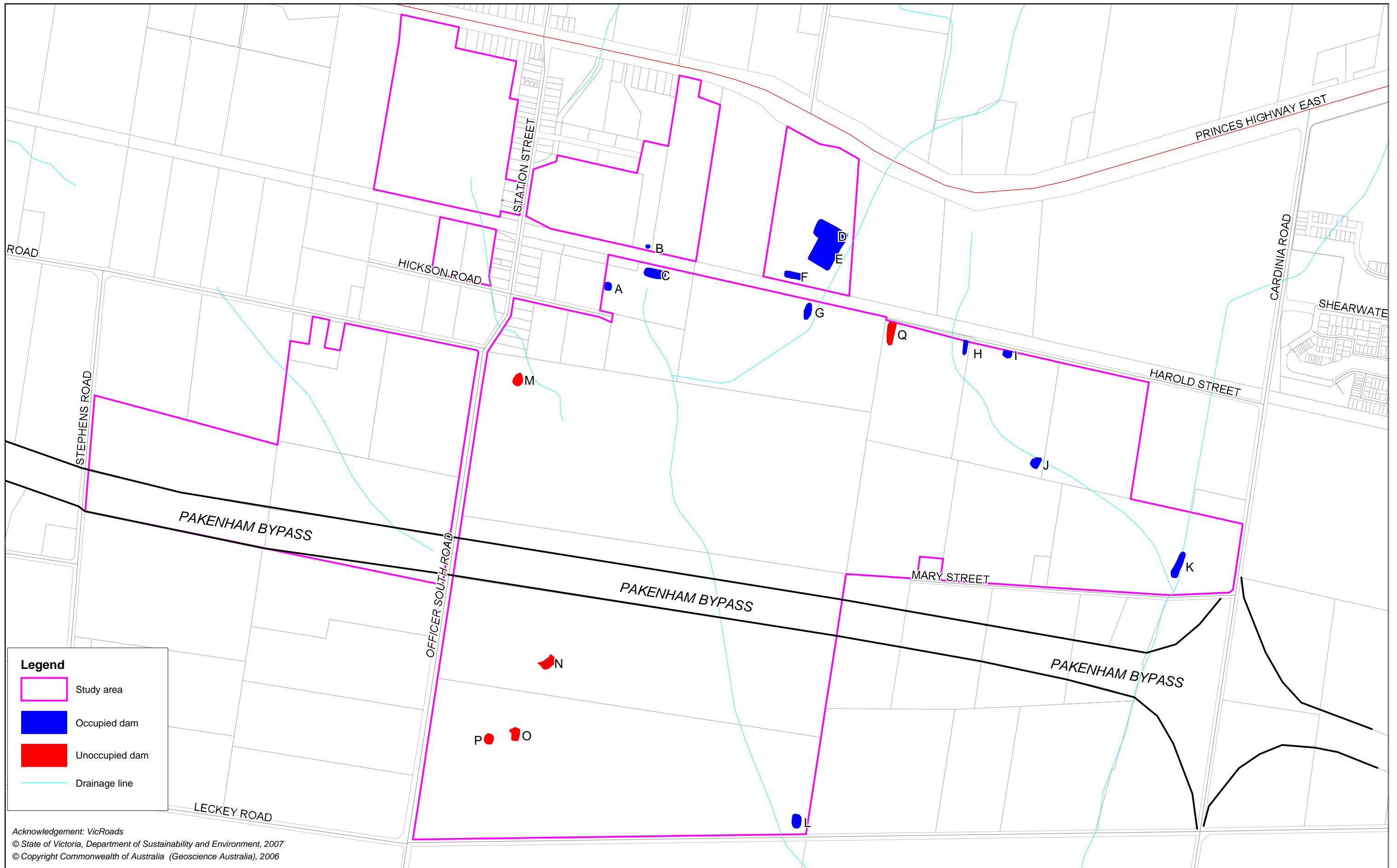
Plate 6. Artificial wetland created specifically for *L. raniformis* at Botanica Park prior to vegetation establishment 2002, Bundoora, Victoria.



Plate 7. Artificial wetland created specifically for *L. raniformis* at Botanica Park after vegetation establishment 2004, Bundoora, Victoria.




FIGURES



Legend

- Study area
- Occupied dam
- Unoccupied dam
- Drainage line

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Figure 1: Occupied and unoccupied Growsing Grass Frog habitat, Officer (2002-2008)

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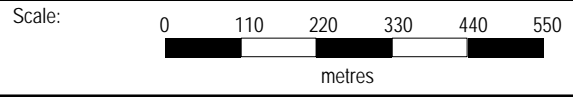
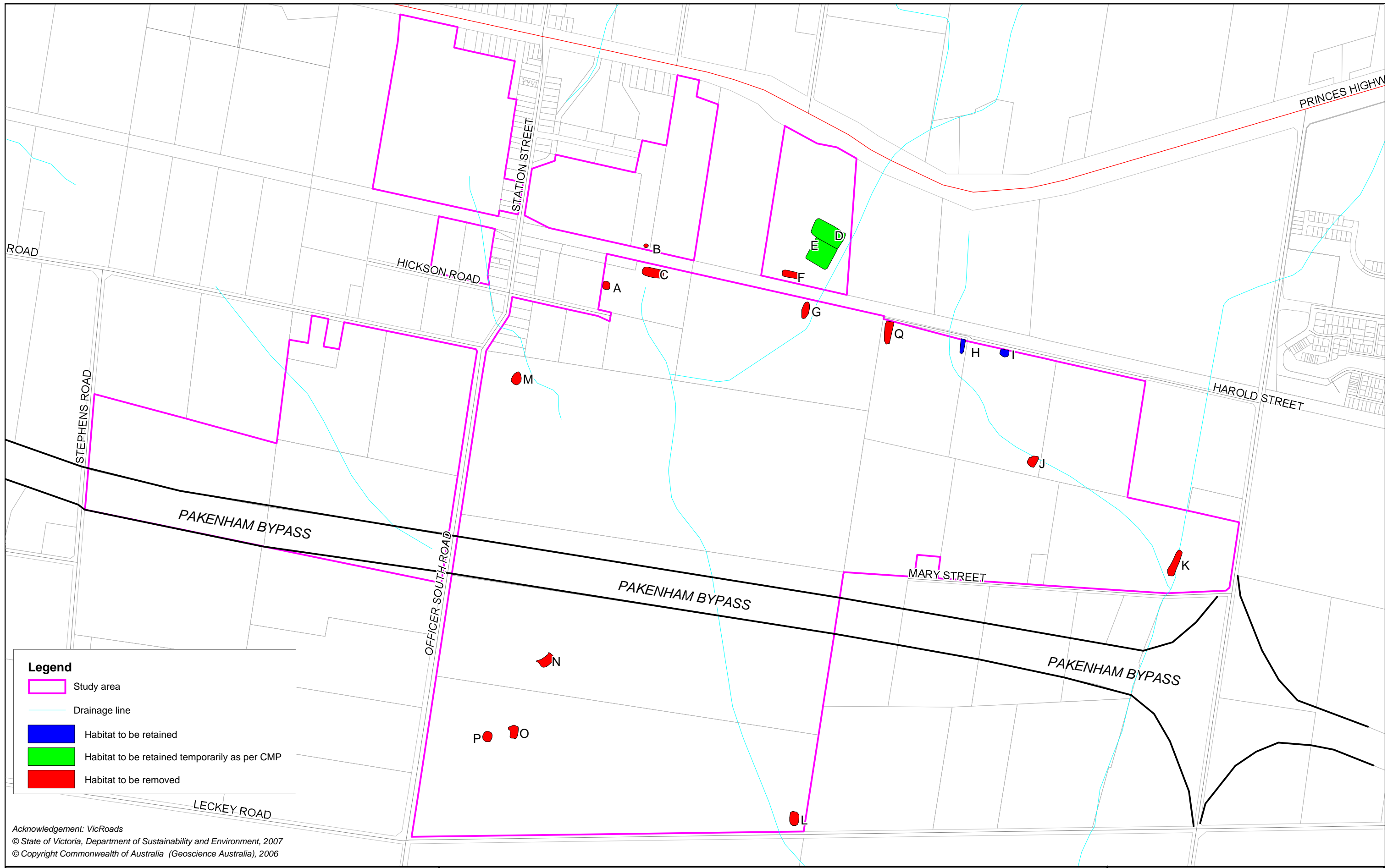


Figure 1: Occupied and unoccupied Growsing Grass Frog habitat, Officer (2002-2008)

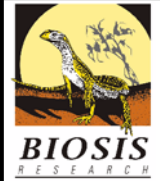




Legend

- Study area
- Drainage line
- Habitat to be retained
- Habitat to be retained temporarily as per CMP
- Habitat to be removed

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Figure 2: Growsing Grass Frog habitats to be removed and retained, Officer

DATE: 15 July 2008
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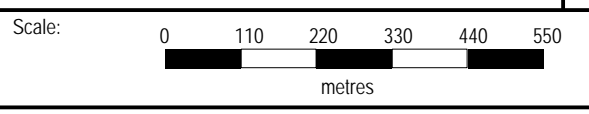
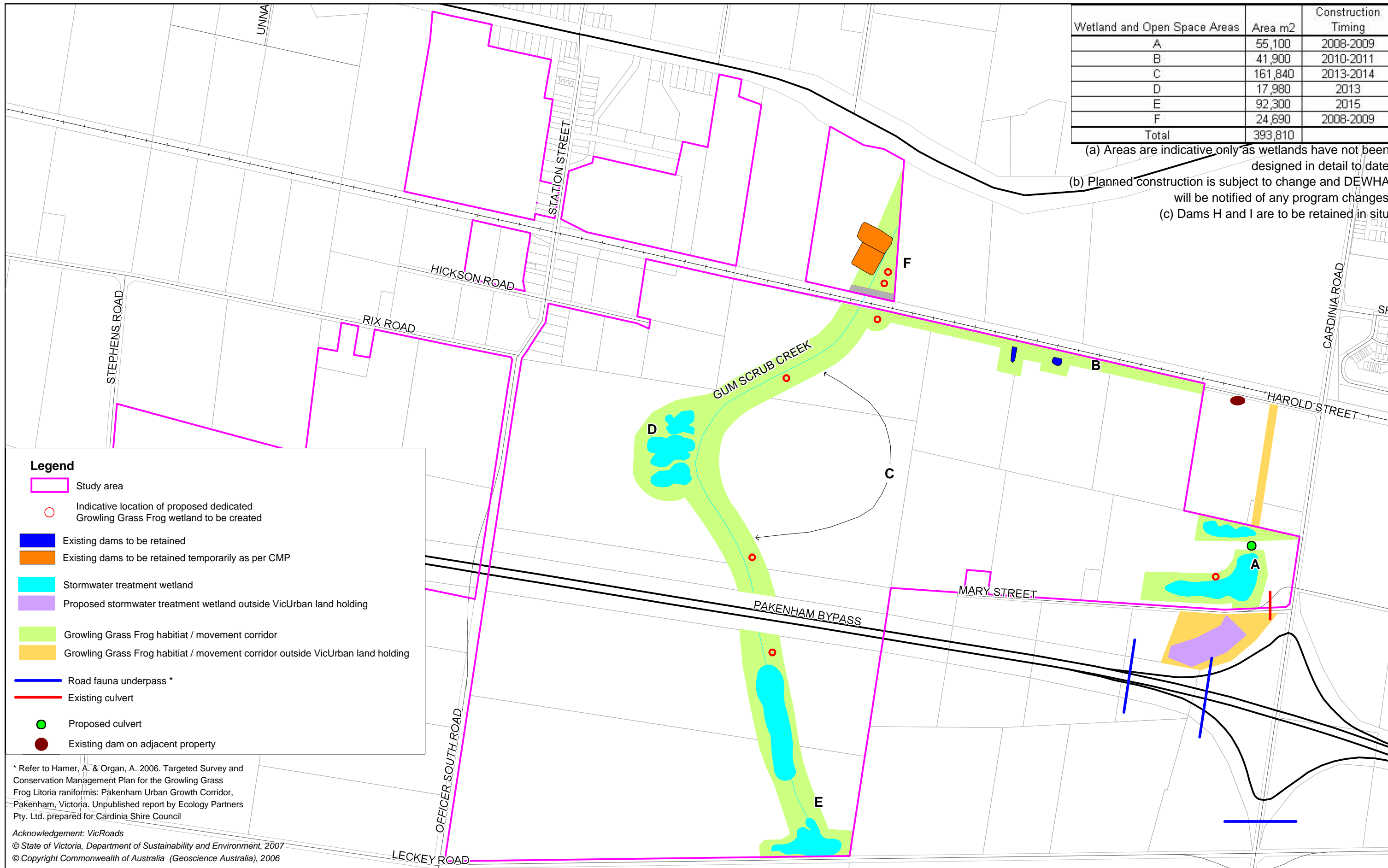


Figure 2: Growsing Grass Frog habitats to be removed and retained, Officer



Wetland and Open Space Areas	Area m2	Construction Timing
A	55,100	2008-2009
B	41,900	2010-2011
C	161,840	2013-2014
D	17,980	2013
E	92,300	2015
F	24,690	2008-2009
Total	393,810	

(a) Areas are indicative only as wetlands have not been designed in detail to date
 (b) Planned construction is subject to change and DEWHA will be notified of any program changes
 (c) Dams H and I are to be retained in situ




Legend

- Study area
- Indicative location of proposed dedicated Gwolling Grass Frog wetland to be created
- Existing dams to be retained
- Existing dams to be retained temporarily as per CMP
- Stormwater treatment wetland
- Proposed stormwater treatment wetland outside VicUrban land holding
- Gwolling Grass Frog habitat / movement corridor
- Gwolling Grass Frog habitat / movement corridor outside VicUrban land holding
- Road fauna underpass *
- Existing culvert
- Proposed culvert
- Existing dam on adjacent property

* Refer to Hamer, A. & Organ, A. 2006. Targeted Survey and Conservation Management Plan for the Gwolling Grass Frog *Litoria raniformis*: Pakenham Urban Growth Corridor, Pakenham, Victoria. Unpublished report by Ecology Partners Pty. Ltd. prepared for Cardinia Shire Council

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Figure 3: Gwolling Grass Frog mitigation measures, Officer

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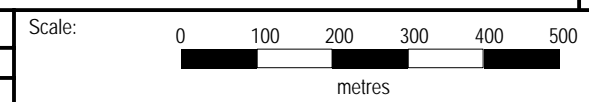


Figure 3: Gwolling Grass Frog mitigation measures, Officer

