

# Healesville - Koo Wee Rup Road Upgrade: Growling Grass Frog and Swamp Skink survey

Project: 08-01

Prepared for:

VicRoads

Ecology Australia Pty Ltd  
Flora and Fauna Consultants

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

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

88B Station Street, Fairfield,

Victoria, Australia 3078

Tel: (03) 9489 4191

Fax: (03) 9481 7679



© 2008 Ecology Australia Pty Ltd

This publication is copyright. It may only be used in accordance with the agreed terms of the commission. Except as provided for by the Copyright Act 1968, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, without prior written permission of Ecology Australia Pty Ltd.

**Document information**

---

This is a controlled document. Details of the document ownership, location, distribution, status and revision history are listed below.

All comments or requests for changes to content should be addressed to the document owner.

**Bioregion (for EA record keeping purposes):** Gippsland Plain

<b>Owner</b>	Ecology Australia
<b>Author</b>	Darren G. Quin and Christina Renowden
<b>Location</b>	O:\ProgDevp\SC-Strategic Planning\Healesville-Koo Wee Rup Road\Flora & Fauna\HKWR_GGF & SS Final\Healesville - Koo Wee Rup Road GGF and SS survey final.doc
<b>Distribution</b>	

<b>Document History</b>			
<b>Status</b>	<b>Changes</b>	<b>By</b>	<b>Date</b>
Draft 1	First Draft	Darren G. Quin and Christina Renowden	29/4/08
Final	Final	Darren G. Quin	13/6/08

## **Contents**

---

Summary	1
1 Introduction	5
1.1 Previous work undertaken for VicRoads	5
1.2 Objectives of this study	6
1.3 Conservation Status	7
2 Study Area	8
2.1 Growling Grass Frog	8
2.2 Swamp Skink	8
2.3 Broader study area	8
3 Methods	11
3.1 Growling Grass Frog survey	11
3.1.1 Desktop review	11
3.1.2 Field surveys	11
3.2 Swamp Skink survey	18
3.2.1 Desktop review	18
3.2.2 Field survey	18
4 Results	28
4.1 Growling Grass Frog survey	28
4.1.1 Frog species recorded	28
4.1.2 Growling Grass Frog records and habitat assessment	28
4.2 Swamp Skink survey	33
4.3 Other species captured	33
5 Discussion	36
5.1 Growling Grass Frog	36
5.1.1 Growling Grass Frog distribution	36
5.1.2 Growling Grass Frog habitat and habitat availability	36
5.1.3 Growling Grass Frog habitat within the study area	37
5.2 Swamp Skink	38
5.2.1 Swamp Skink distribution	38
5.2.2 Swamp Skink habitat and habitat availability	39
5.2.3 Swamp Skink habitat in the study area	40
6 Potential Impacts	41
6.1 Growling Grass Frog	41
6.2 Swamp Skink	42
7 Legislative Implications	43

7.1	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i> - Growling Grass Frog	43
7.2	Victorian Flora and Fauna Guarantee Act 1988 – Growling Grass Frog and Swamp Skink	44
7.3	Wildlife Act 1975	45
7.4	Local Planning Policy	45
8	Summary and Recommendations	47
9	References	48
10	Acknowledgments	53

## Tables

---

Table 1	Healesville – Koo Wee Rup Road Upgrade: list of sites assessed for Growling Grass Frog ( <i>Litoria raniformis</i> ) habitat and identified as potential survey sites	13
Table 2	Healesville – Koo Wee Rup Road Upgrade: definitions of the variable categories used to describe water permanency of all the sites surveyed for Growling Grass Frog within the study area.	15
Table 3	Healesville – Koo Wee Rup Road Upgrade: definitions for each vegetation category sampled at sites surveyed for Growling Grass Frog within the study area.	16
Table 4	Healesville – Koo Wee Rup Road Upgrade: number of traplines, traps and trap days used for the Swamp Skink survey undertaken as part of the Road Upgrade study (11-13 February 2008).	20
Table 5	Healesville – Koo Wee Rup Road Upgrade: habitats recorded at Swamp Skink survey sites (11-13 February 2008).	20
Table 6	Healesville – Koo Wee Rup Road Upgrade: tabulated results of the Growling Grass Frog survey. Figure 1 provides a pictorial representation of these locations.	30
Table 7	Vertebrate species captured during the trapping survey for Swamp Skinks (11-13 February 2007). A total of 180 trap days were undertaken.	34

## Figures

---

Figure 1	Healesville – Koo Wee Rup Road Upgrade: map and aerial photograph of study area showing sites assessed for Growling Grass Frogs ( <i>Litoria raniformis</i> ) and traplines for Swamp Skink ( <i>Egernia coventryi</i> ).	10
----------	---	----

## Plates

---

Plate 1.	Healesville – Koo Wee Rup Road Upgrade: west bank of Cardinia Creek and upstream of South Gippsland Highway, looking south (February 2008).	23
----------	--	----

- Plate 2 . Healesville – Koo Wee Rup Road Upgrade: view of east bank of Cardinia Creek and upstream of South Gippsland Highway, looking south (February 2008). 23
- Plate 3 . Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Cardinia Creek and upstream of South Gippsland Highway, looking north (February 2008). 24
- Plate 4. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Deep Creek and upstream of South Gippsland Highway, looking south (February 2002008). 24
- Plate 5. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Deep Creek and upstream of South Gippsland Highway, looking north (February 2008). 25
- Plate 6. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Deep Creek and upstream of South Gippsland Highway, looking south (February 2008). 25
- Plate 7 . Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of McGregors Drain and upstream of South Gippsland Highway, looking north (February 2008). 26
- Plate 8 . Healesville – Koo Wee Rup Road Upgrade: view to northeast along Southern Boundary Drain and upstream of South Gippsland Highway; forms part of the Koo Wee Rup Swamp Lookout (February 2008). 26
- Plate 9 . Healesville – Koo Wee Rup Road Upgrade: view from west to east bank of the McDonalds Drain (and North West Drain) and upstream of South Gippsland Highway, looking northeast (February 2008). 27
- Plate 10. Healesville – Koo Wee Rup Road Upgrade: technique for detecting Swamp Skinks included trapping with Elliott folding small mammal aluminium traps. This site is the capture site of the Swamp Skink. 27
- Plate 11 . Healesville – Koo Wee Rup Road Upgrade: market garden dam along Ballarto Road on the east side of the Healesville – Koo Wee Rup Road where 49 Growling Grass Frog were recorded (March 2008). 31
- Plate 12 . Healesville – Koo Wee Rup Road Upgrade: market garden dam along Ballarto Road on the west side of the Healesville – Koo Wee Rup Road where three Growling Grass Frog were recorded perching in the band of *Typha* around the dam edge (March 2008). 31
- Plate 13. Healesville – Koo Wee Rup Road Upgrade: dam along Railway Road with moderate quality habitat for Growling Grass Frogs, including emergent vegetation (*Eleocharis* sp.) (March 2008). 32
- Plate 14. Healesville – Koo Wee Rup Road Upgrade: one of the 49 Growling Grass Frogs recorded (on algae) on the market garden dam on Ballarto Road (March 2008). 32
- Plate 15. Healesville – Koo Wee Rup Road Upgrade: Swamp Skink (*Egernia coventryi*) captured along the east side of Cardinia Creek (February 2008). 35
- Plate 16. Healesville – Koo Wee Rup Road Upgrade: White Skink (*Egernia whitii*) captured along the east side of Cardinia Creek (February 2008). 35

## **Appendices**

---

<b>Appendix 1</b>	Wetland habitat assessment pro-forma for Growling Grass Frogs	54
<b>Appendix 2.</b>	Healesville- Koo Wee Rup Road Upgrade: Habitat assessment and Growling Grass Frog survey results from the study area.	55
<b>Appendix 3.</b>	Compilation of recent records (2002-2008) of Growling Grass Frogs from previous surveys for the study area (original table from Ecology Australia 2008; updated with records from this study).	59

## Summary

### Background

Ecology Australia was commissioned by VicRoads, South East Metropolitan Region, to undertake a targeted fauna survey for the Growling Grass Frog (*Litoria raniformis*) and Swamp Skink (*Egernia coventryi*) as part of a planning study to determine options for the future upgrade of the Healesville – Koo Wee Rup Road, between the Pakenham Bypass and the South Gippsland Highway. This survey generally investigated areas not covered by the previous targeted survey for this study. Since 2005, a number of flora and fauna assessments have been undertaken as part of the Road Upgrade. These assessments have identified the Growling Grass Frog, which is listed as a Vulnerable species under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) and a threatened taxon under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG), as being a significant issue in the Pakenham and Koo Wee Rup areas. More recently with the extension of the study area in the south, the Swamp Skink, which is listed as a threatened taxon under the FFG Act, has also been identified as being a significant issue.

This study involved targeted surveys for the Growling Grass Frogs in the north for an alternative connection to the Pakenham Bypass, and an area in the south for one of the options for a bypass of Koo Wee Rup. The area in the north is bounded by the Pakenham Bypass to the north and Toomuc Creek to the west (near McGregor Road) and extends south eastwards to Healesville - Koo Wee Rup Road in the vicinity of Deep Creek. The area in the south extends from Manks Road (to the northwest of Koo Wee Rup) to the South Gippsland Highway in the vicinity of Prestons Road. Proposed interchange sites in the central section of the study area at Hall and Ballarto Roads are near farm dams and were also investigated.

For the bypass option in the south, works will potentially be undertaken on the South Gippsland Highway where the Highway crosses a number of watercourses of which the lower reaches are under tidal influence from Westernport Bay and support saline vegetation communities (e.g. Mangroves, Coastal Saltmarsh and Estuarine Grass Flats); these vegetation communities are potential habitat for Swamp Skink. The watercourses which were surveyed include Cardinia Creek, Moodys Inlet, Deep/Toomuc Creek, McGregors Drain, McDonalds Drain and Southern Boundary Drain (the latter two in the vicinity of Bunyip River Drain).

The study area falls within the Gippsland Plain Bioregion, the Westernport Catchment and the Shire of Cardinia administrative boundary. It forms part of the original Koo Wee Rump Swamp prior to drainage and clearance of extensive areas of the Swamp vegetation in the early 19<sup>th</sup> Century. The majority of the study area and surrounding landscape comprises pastoral land, with smaller areas under crop cultivation. Relatively, small, narrow and linear patches of remnant vegetation remain along roadsides, Cardinia, Toomuc and Deep Creeks, the Bunyip River and numerous drains (e.g. McGregors Drain and McDonalds Drain).

Cardinia Creek, Moodys Inlet, Toomuc/Deep Creek, and the Bunyip River and associated drains to the immediate west of the Koo Wee Rup Swamp Lookout flow into the Westernport Ramsar

Wetland Site on the south side of the South Gippsland Highway. Ramsar wetlands are internationally important wetlands listed under the International Convention on Wetlands (Ramsar Convention) and are also matters of national environmental significance listed under the EPBC Act 1999. The Westernport Ramsar site is important in regards to total numbers and/or numbers of species of waterbird and the integrity of the saltmarsh-mangrove-seagrass wetland ecosystems.

### **Results and Discussion**

Growling Grass Frogs were recorded during spotlight surveys at three sites, including two dams in the central section and one dam in the southern section of the study area. Three Growling Grass Frogs were recorded in a dam along the north side of Ballarto Road and to the west of the Healesville – Koo Wee Rup Road, whilst 49 frogs were recorded at a dam along Ballarto Road to the east. In the south, one Growling Grass Frog was recorded in a dam c. 1.2 km northwest of the South Gippsland Highway and Rossiter Road intersection. Habitat assessment of another 19 dams in the study area suggested that most, if not all, are likely to be used (in conjunction with creeks and drains) at some stage of the species' life cycle (e.g. for breeding, foraging, dispersal, movement and/or shelter).

The assessment suggests that the entire study area incorporating the Healesville – Koo Wee Rup Road Upgrade (i.e. between the Pakenham Bypass and Koo Wee Rup), should be considered an 'important population' due to the continuity of habitat (and likely continuity of colonies) between an 'important population' previously identified in the northern section of the study area around McGregor Road and areas to the south and southeast.

Swamp Skinks were recorded along the east side of Cardinia Creek and immediately upstream of the South Gippsland Highway: one was captured in a small mammal Elliott aluminium folding trap used to survey for this species; and the second was opportunistically sighted whilst checking traps. One of the skinks was captured in Estuarine Flats Grassland bordering Coastal Saltmarsh, whilst the second was observed in the interface between these two vegetation communities. In the Westernport region (e.g. at Tooradin Airfield, the mouth of the Bunyip River and Crib Point at Hastings), the Swamp Skink has been recorded in these vegetation communities. Consequently, and as the lower reaches of all watercourses surveyed support Coastal Saltmarsh and Estuarine Flats Grassland (e.g. Moodys Inlet, Deep/Toomuc Creek, McGregors Drain), including areas immediately upstream of the South Gippsland Highway, Swamp Skinks have a high likelihood of regular occurrence in these areas.

### **Potential impacts**

Potential impacts to Growling Grass Frogs include the loss and/or fragmentation of habitat and isolation of colonies comprising the larger population, sedimentation and pollution of creeks and drainage lines from uncontrolled run-off, and increased mortality due to road kill.

Potential impacts to Swamp Skink include loss and/or fragmentation of suitable habitat and colonies and degradation of habitat due to inputs of pollutants (e.g. petroleum) into watercourses during construction works.



These would need to be addressed in a detailed impact assessment once an alignment is finalised. An Environmental Management Plan detailing conservation strategies for the Growling Grass Frog, Swamp Skink and significant vegetation and watercourses will also need to be produced.

### **Policy and Legislative Implications**

The area in the north to the west of McGregors Road and including Toomuc Creek (i.e. at West Pakenham and Officer South) has previously been identified as supporting an ‘important population’ of Growling Grass Frogs by Ecology Partners (i.e. this population is a key source population for breeding and dispersal). Areas investigated during this study to the southeast at Pakenham South and Koo Wee Rup also appear to satisfy the basis for this definition (under the EPBC Act), plus the definition drafted at a recent Growling Grass Frog workshop conducted by the Commonwealth Government (i.e. comprise a series of occupied and unoccupied water bodies and associated aquatic and terrestrial habitats which permit breeding and dispersal, and ongoing persistence characterised by local extinction and re-colonisation).

It is recommended that VicRoads develop an EPBC Referral which includes consideration of the Growling Grass Frog and Westernport Ramsar site. The design of the final alignment would determine whether or not a significant impact upon the Growling Grass Frog is likely and thus, whether the project be referred as a ‘controlled’ or ‘not a controlled’ action.

Under the FFG Act, and if necessary, a permit to remove Growling Grass Frog and Swamp Skink habitat may be required from the Department of Sustainability and Environment.

### **Recommendations**

The following recommendations are made in order to reduce impacts:

- avoid impacts to habitat links for Growling Grass Frogs by keeping works well away from (and fencing-off) Toomuc Creek, and by spanning Deep Creek so that no pylons or machinery enter the Creek;
- the construction width of bridges should be minimised over Deep Creek;
- suitably qualified Growling Grass Frog zoologists assist VicRoads with the final alignment to minimise impacts as far as is possible through further habitat assessments of water bodies within or adjoining the alignment;
- adequately span the watercourses/drains flowing into Westernport Bay;
- avoid loss or disturbance of the vegetation communities and Swamp Skink habitat extending upstream in the watercourses/drains from Westernport Bay;
- minimising the construction width of bridges over these watercourses/drains;
- a detailed impact assessment be undertaken on the final alignment; and

- prepare an Environmental Management Plan (EMP) which addresses the Growling Grass Frog, Swamp Skink, other significant flora and fauna species and vegetation communities and protection of the Westernport Ramsar site.

## 1 Introduction

Ecology Australia Pty Ltd was commissioned by VicRoads, South East Metropolitan Region, to undertake a targeted fauna survey for the Growling Grass Frog (*Litoria raniformis*) and Swamp Skink (*Egernia coventryi*) as part of a planning study to determine options for the future upgrade of the Healesville – Koo Wee Rup Road, between the Pakenham Bypass and the South Gippsland Highway. This survey generally investigated areas not covered by the previous targeted survey for this study.

### 1.1 Previous work undertaken for VicRoads

The initial work undertaken in early 2005 for VicRoads as part of the Healesville - Koo Wee Rup Road upgrade investigated a strip of land adjoining both sides of the current alignment of the Road between the Princes Highway at Pakenham and South Gippsland Highway at Koo Wee Rup. This initial investigation included a broader area of land in the southern part of the study area bounded by Koo Wee Rup township in the north, the Koo Wee Rup Swamp Lookout (including the Bunyip River and a number of drains) in the southwest, the South Gippsland Highway near Koo Wee Rup in the south and Sybella Avenue in the southeast, to allow for possible alignments for a bypass of Koo Wee Rup. The work included:

- a desktop review of flora and fauna values which identified the key issues as being the River Swamp Wallaby-grass (*Amphibromus fluitans*), Growling Grass Frog and Southern Brown Bandicoot (*Isodon obesulus obesulus*), all listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (i.e. EPBC-listed) (Ecology Australia 2005).

The three key issues identified during the desktop study were investigated in detail in 2006 and involved:

- a Growling Grass Frog survey of the study area addressed during the desktop review (Ecology Australia 2006a);
- a Southern Brown Bandicoot survey of the same study area (Ecology Australia 2006b); and
- a rare plant survey focusing on River Swamp Wallaby-grass (Ecology Australia (2006c).

In 2007, Ecology Australia undertook a desktop review of flora and fauna values of a new area in the north for an alternative connection to the Pakenham Bypass. The new area was bounded by the Pakenham Bypass in the north and Toomuc Creek in the west (near McGregor Road) and extended south eastwards to the Healesville - Koo Wee Rup Road in the vicinity of the Deep Creek crossing and the Pakenham Sewage Treatment Plant (Ecology Australia 2008). The key fauna issue identified was the Growling Grass Frog's potential occurrence at numerous farm dams in the study area and habitat linkages which provide dispersal routes (i.e. creeks and drains).

## 1.2 Objectives of this study

Apart from the new area in the north for an alternative connection to the Pakenham Bypass, a new area has also been targeted for detailed surveys in the south. This covers a larger area for one of the options for a bypass of Koo Wee Rup than investigated in earlier studies. This area extends from Manks Road (to the northwest of Koo Wee Rup) and runs in a southwesterly direction to the South Gippsland Highway in the vicinity of Prestons Road.

Proposed works for this bypass option pass near to, or over, Cardinia Creek, Moodys Inlet, Toomuc/Deep Creek and the drains and Bunyip River to the immediate west of the Koo Wee Rup Swamp Lookout. These inlets/creeks are tidal and support saltmarsh and associated salt-influenced vegetation which are known habitat for the Swamp Skink, which is listed as a threatened taxon under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act).

Additional survey work was also undertaken at proposed interchange sites at Hall Road and Ballarto Road, where aerial photographic interpretation identified farm dams, and thus, potential Growling Grass Frog habitat.

Therefore, the objectives of this study include undertaking targeted fauna surveys for the:

- EPBC- and FFG-listed Growling Grass Frog in:
  1. the northern section - from the Pakenham Bypass to the Healesville-Koo Wee Rup Road near Deep Creek;
  2. in the central section of the Healesville – Koo Wee Rup Road near interchanges proposed for Hall and Ballarto Roads; and
  3. the southern section - between Manks Road and Prestons Road/South Gippsland Highway; and
- FFG-listed Swamp Skink near roadworks proposed on the South Gippsland Highway at:
  4. Cardinia Creek;
  5. Moodys Inlet;
  6. Toomuc/Deep Creek; and
  7. the drains and Bunyip River to the immediate west of the Koo Wee Rup Swamp Lookout, including McGregors Drain, McDonalds Drain, North West Drain, Bunyip River Drain and Southern Boundary Drain.

### 1.3 Conservation Status

The conservation status of the Growling Grass Frog and Swamp Skink is as follows.

Growling Grass Frog <i>Litoria raniformis</i>				
Australia			Victoria	
IUCN Red List 2004	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Tyler 1997 – National Action Plan for Frogs	Victorian <i>Flora and Fauna Guarantee Act 1988</i>	Department of Sustainability and Environment (2007) – Advisory List of Threatened Vertebrate Fauna in Victoria
Endangered	Vulnerable	Vulnerable	Listed	Endangered

Swamp Skink <i>Egernia coventryi</i>				
Australia			Victoria	
IUCN Red List 2004	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Cogger et al. 1993 – National Action Plan for Reptiles	Victorian <i>Flora and Fauna Guarantee Act 1988</i>	Department of Sustainability and Environment (2007) – Advisory List of Threatened Vertebrate Fauna in Victoria
-	-	Rare or Insufficiently Known	Listed	Vulnerable

## 2 Study Area

The study area for this component of the project comprises four discrete areas. The areas and species they potentially support are described below.

### 2.1 Growling Grass Frog

The first area comprises the proposed new alignment route and associated road reservation currently being considered for an alternative connection to the Pakenham Bypass from the Healesville - Koo Wee Rup Road (see Ecology Australia 2008). The area targeted for Growling Grass Frog surveys stretches south of the Pakenham Bypass between Toomuc Creek and McGregor Road. Bounded by Watson Road at the southern end, it continues eastwards, to the eastern side of the Healesville - Koo Wee Rup Road. At the eastern boundary, the study area is intersected by Deep Creek, and is adjoined by the South East Water Pakenham Treatment Plant. The study area includes a small section (south western corner) of the Pakenham Treatment Plant, but does not include the lagoons or treatment ponds (Figure 1).

The second area is for one of the options for a bypass of Koo Wee Rup (Figure 1). It commences at Manks Road (to the northwest of Koo Wee Rup) and runs in a southwesterly direction through the Pakenham Railway Line and Railway Lane, to join the South Gippsland Highway to the east of Prestons Road.

The third area occurs in the central section of the Healesville - Koo Wee Rup Road where interchanges are proposed for Hall and Ballarto Roads. Aerial photographic interpretation identified farm dams (and drains) in the vicinity of the interchanges which are potential Growling Grass Frog habitats (see Ecology Australia 2005, 2006a and 2008).

### 2.2 Swamp Skink

Proposed roadworks for one of the options for a bypass of Koo Wee Rup occur in the vicinity of Cardinia Creek, Moodys Inlet, Toomuc/Deep Creek, and the watercourses/drains to the immediate west of the Koo Wee Rup Swamp Lookout (i.e. McGregors Drain, McDonalds Drain, North West Drain, Bunyip River Drain and Southern Boundary Drain). The lower reaches of these watercourses are tidal and support Coastal Saltmarsh and Estuarine Flats Grassland. The Swamp Skink has been recorded in these habitats at the Tooradin Airstrip, Lyall's Inlet and the Bunyip River mouth (Schultz 1985; DSE 2005a; Ecology Australia 2007). Consequently, survey sites were established along reaches of the above-mentioned watercourses on the north side of the South Gippsland Highway (Figure 1).

### 2.3 Broader study area

The broader area has been described in previous reports (see Ecology Australia 2002, 2003, 2004a, 2004b, 2004c, 2005a, 2005b, 2006a, 2006b, 2006c, 2006d, 2006e, 2006f, 2007 and 2008).

The study area forms part of the original Koo Wee Rup Swamp prior to drainage and clearance of extensive areas of the Swamp vegetation in the early 19<sup>th</sup> Century (Yugovic and Mitchell 2006). It would have originally supported reed- and rush-dominated vegetation in an inner swamp, Swamp Paperbark (*Melaleuca ericifolia*) Scrub on the outskirts in seasonally inundated areas, Swampy Riparian Woodland on natural levees along watercourses and sand ridges, and grassland and *Acacia* woodland outside the band of *Melaleuca* (Yugovic and Mitchell 2006; DSE 2007a and 2007b). Remnant Swampy Riparian Woodland and Swamp Scrub habitats can be found at the Bayles Fauna Park and Koo Wee Rup Swamp Lookout, respectively.

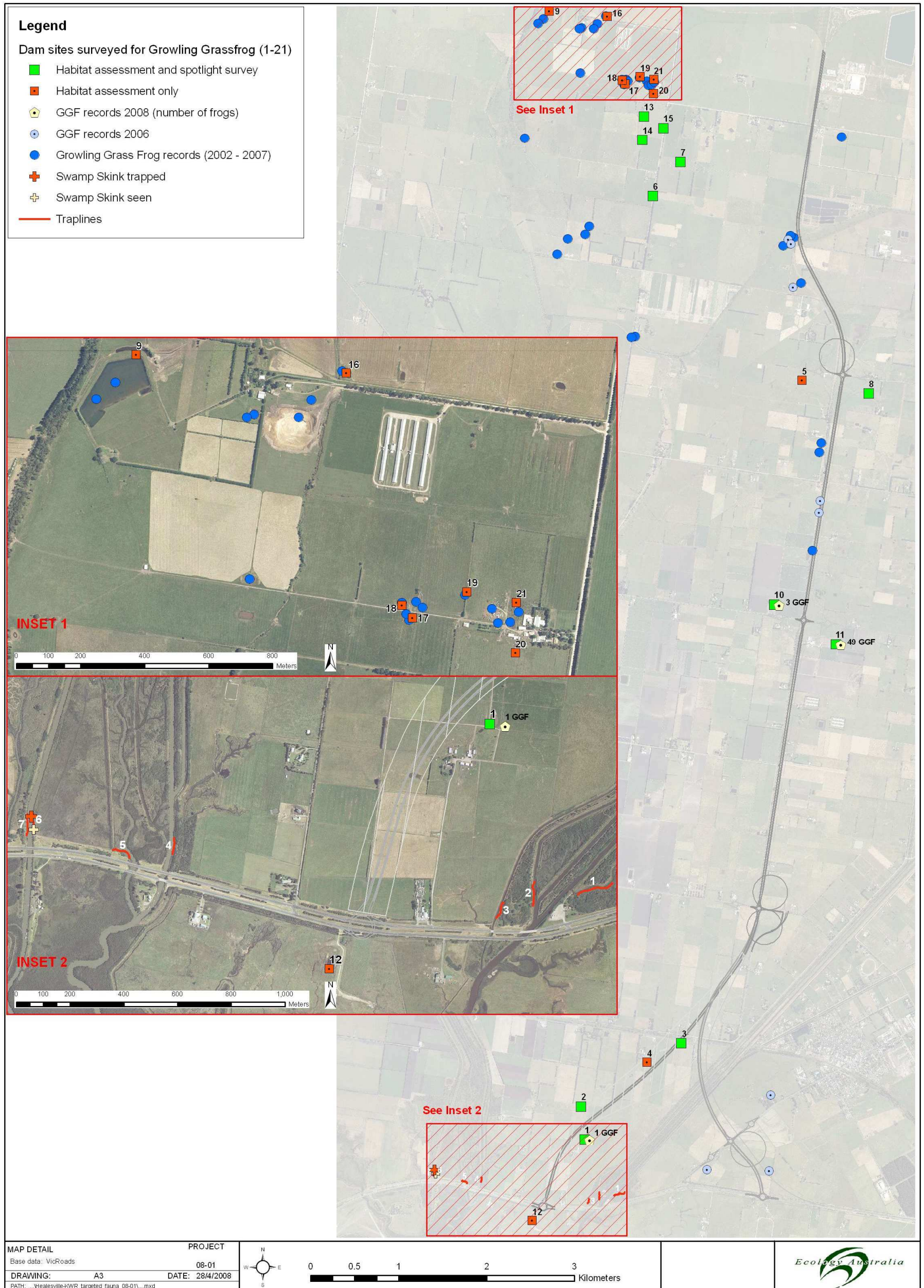
The study area has been highly modified and subjected to a long history of disturbance since the drainage of the Koo Wee Rup Swamp, construction of drainage channels, and land clearance for agriculture. The majority of the study area and surrounding landscape comprises pastoral land, with smaller areas under crop cultivation. Relatively, small, narrow and linear patches of remnant vegetation remain along roadsides, Cardinia, Toomuc and Deep Creeks, the Bunyip River and numerous drains (e.g. McDonalds Drain). Larger patches of remnant vegetation persist around Yallock Creek at Bayles in the surrounding areas. Adjoining the study area, and immediately to the north of the Pakenham Bypass, is the residential area of Pakenham. The areas north of Key Lane (west of McGregor Road) and south of Greenhills Road (east of McGregor Road), now forms part of the Casey - Cardinia Urban Growth Area (DSE 2005b).

The study area falls within the Gippsland Plain Bioregion, which experiences a relatively uniform, temperate climate of warm, dry summers and cool, wet winters. The mean daily maximum temperatures at Tooradin, the closest weather station, range from 13.1°C in July and 26.0°C in January (Bureau of Meteorology data). Mean daily minimum temperatures range between 3.8°C in July to 12.1°C in February. Mean annual rainfall is 853 mm at Tooradin.

The soils are sedimentary, formed during the Pleistocene, comprising stream alluvium, floodplain and low level terrace deposits. They are comprised of Quaternary alluvium consisting primarily of stream alluvium, sand, silt, clay and gravel (Geological Survey Map Warragul Series, Mines Department, Melbourne 1971).

Cardinia Creek, Moodys Inlet, Toomuc/Deep Creek, and the Bunyip River and associated drains to the immediate west of the Koo Wee Rup Swamp Lookout flow into the Westernport Ramsar Wetland Site on the south side of the South Gippsland Highway (ANCA 1996; DSE 2003) and immediately downstream of the study area. The south side of the South Gippsland Highway forms the Ramsar boundary. Ramsar wetlands are internationally important wetlands listed under the International Convention on Wetlands (i.e. the Ramsar Convention), and are also matters of national environmental significance listed under the EPBC Act 1999. The Westernport Ramsar site is important in regards to total numbers and/or numbers of species of waterbird and the integrity of the saltmarsh-mangrove-seagrass wetland ecosystems. The bay supports about half of Victoria's mangrove communities, which comprise a single species of state significance, the White Mangrove (ANCA 1996; DSE 2003).

**Figure 1** Healesville – Koo Wee Rup Road Upgrade: map and aerial photograph of study area showing sites assessed for Growling Grass Frogs (*Litoria raniformis*) and traplines for Swamp Skink (*Egernia coventryi*).





## 3 Methods

### 3.1 Growling Grass Frog survey

#### 3.1.1 Desktop review

Three sources were interrogated to develop a table and map/aerial photograph of the distribution of Growling Grass Frog records within the Pakenham – Koo Wee Rup area. The map and table are presented in Ecology Australia (2008). The table is presented in Appendix 3. The sources included:

- The Atlas of Victorian Wildlife (AVW) database (DSE 2005);
- the Conservation Management Plan for the Growling Grass Frog in Pakenham (Ecology Partners 2005);
- the Pakenham Bypass Environmental Management Plan for the Growling Grass Frog (Biosis 2005); and
- the results of the initial Ecology Australia (2006a) survey as part of the Healesville – Koo Wee Rup Road upgrade.

This step provided a potential list of sites which would be visited during this assessment in order to:

- assess the quality of wetlands/dams where Growling Grass Frogs had previously been recorded if we had not visited them during the earlier study;
- place the quality of wetland habitats potentially affected by the Road upgrade in context of those investigated in more detail during this study; and
- determine the survey sites to be surveyed/assessed as part of this study.

In other words, not all wetlands could be surveyed in detail given the large number of farm dams occurring in the broader study area. Hence, a daytime habitat assessment was undertaken at some farm dams where Growling Grass Frogs had previously been recorded. A habitat assessment and night time spotlight survey were undertaken at others where no previous survey had been undertaken.

#### 3.1.2 Field surveys

##### Site Selection

Aerial photographs and topographic maps were initially assessed for potential survey sites within the area comprising VicRoads' "Band of Interest", plus a 100 m zone either side of this Band. The three areas identified under Section 2.1 were targeted, including (Figure 1):

- the proposed new alignment route and associated road reservation being considered in the north as an alternative connection to the Pakenham Bypass from the Healesville - Koo Wee Rup Road (Ecology Australia 2008);
- the area in the south for one of the options for a bypass of Koo Wee Rup; and
- the central section of the Healesville - Koo Wee Rup Road where interchanges are proposed for Hall and Ballarto Roads.

A total of 22 sites were assessed for their habitat attributes for Growling Grass Frogs (Table 1; Figure 1; Appendix 1). Of these sites:

- a habitat assessment and spotlight survey were undertaken at 11 (Sites 1, 2, 3, 6, 7, 8, 10, 11, 13, 14 and 15);
- a habitat assessment only was undertaken at seven where Growling Grass Frogs had previously been recorded (Sites 9, 17, 18, 19, 20, 21 and 22);
- a habitat assessment only was undertaken at one as the dam was found to be too salty for Growling Grass Frogs (Site 12); and
- a habitat assessment only was undertaken at three dams found to be dry during the period of the survey (Sites 4, 5 and 16).

**Table 1 Healesville – Koo Wee Rup Road Upgrade: list of sites assessed for Growling Grass Frog (*Litoria raniformis*) habitat and identified as potential survey sites**

Type of assessment: Habitat = daytime habitat assessment only; Habitat/spotlight = daytime habitat assessment and night spotlight survey

Site No.	Date(s) of visit	Type of Waterbody and Location	Easting	Northing	Type of Assessment
1	11/2/2008	Dam in property off South Gippsland Highway, c. 800 m northwest of Rossiter Road intersection	364830	5770126	Habitat/spotlight
2	11/2/2008	Dam in property off South Gippsland Highway, c. 1.2 km northwest of Rossiter Road intersection	364786	5770502	Habitat/spotlight
3	12/2/2008, 6/3/2008	Dam in property off Railway Lane, Koo Wee Rup, c. 500 m west of HKWRR and south of railway line	365930	5771220	Habitat/spotlight
4	12/2/2008	Dam in property off Railway Lane, Koo Wee Rup, c. 600 m west of HKWRR and south of railway line	365537	5771005	Habitat
5	12/2/2008	Dam on west side Healesville - Koo Wee Rup Road and opposite Hall Road	367299	5778779	Habitat
6	11/2/2008, 6/3/2008	Dam along west side of McGregor Road, c. 1 km south of Key Lane	365603	5780884	Habitat/spotlight
7	11/2/2008	Dam along east side of McGregor Road, c. 750 m south of Key Lane	365919	5781271	Habitat/spotlight
8	6/3/2008	Dam east side Healesville - Koo Wee Rup Road on Hall Road	368059	5778630	Habitat/spotlight
9	12/2/2008	Large dam c. 1500 m west of McGregor Road and 500 m south of Pakenham Bypass	364424	5782987	Habitat

Healesville - Koo Wee Rup Road Upgrade: Growling Grass Frog and Swamp Skink survey



Site No.	Date(s) of visit	Type of Waterbody and Location	Easting	Northing	Type of Assessment
10	13/2/2008, 6/3/2008	Dam c. 300 m west side of HKWRR and north side of Ballarto Road	366984	5776226	Habitat/spotlight
11	13/2/2008, 6/3/2008	Dam c. 400 m east side of HKWRR and south side of Ballarto Road	367685	5775774	Habitat/spotlight
12	6/3/2008	Dam on south side of South Gippsland Highway, c. 150 m west of Prestons Road	364230	5769211	Habitat
13	6/3/2008	Middle dam adjacent to stockyards on west side of McGregor Road, c. 250 m south of Key Lane	365502	5781792	Habitat/spotlight
14	6/3/2008	Southwest dam on west side of McGregor Road, c. 500 m south of Key Lane	365486	5781526	Habitat/spotlight
15	6/3/2008	Southeast dam on west side of McGregor Road, c. 400 m south of Key Lane	365723	5781660	Habitat/spotlight
16	11/2/2008	Dam 300 m south of Pakenham Bypass and 900 m west of McGregor Road	No AMG	No AMG	Habitat
17	11/2/2008	Dam 200 m North of Key Lane and 600 m west of McGregor Road	No AMG	No AMG	Habitat
18	11/2/2008	Dam 250 m North of Key Lane and 600 m west of McGregor Road	No AMG	No AMG	Habitat
19	11/2/2008	Dam 250 m North of Key Lane and 500 m west of McGregor Road	No AMG	No AMG	Habitat
20	11/2/2008	Dam 200 m North of Key Lane and 200 m west of McGregor Road	No AMG	No AMG	Habitat
21	11/2/2008	Dam 250 m North of Key Lane and 200 m west of McGregor Road	No AMG	No AMG	Habitat
22	11/2/2008	Dam 650 m North of Key Lane and 1200 m west of McGregor Road	No AMG	No AMG	Habitat

### Habitat assessment proforma

The habitat present at each monitoring site was assessed using a habitat assessment Proforma developed by Ecology Australia and which includes collection of data pertaining to a standard set of habitat variables (see Appendix 1). Habitat assessments were conducted on 11, 12 and 13 February and 6 March 2008. To eliminate observer bias, the assessments were done by the same observers throughout (authors). The variables assessed can be assigned to five categories; the following is a description of each.

#### *Physical features*

Each monitoring site was classified into one of three water body types. These were a creek site, dam, or wetland. For the dam and wetland sites, the area (m<sup>2</sup>) was recorded by estimating the length and width, while all creek sites were c. 50 m in length. For creek sites, the width and depth of the channel was also recorded.

#### *Hydrology*

The hydrology of each monitoring site was assessed using two methods adapted from Pyke and White (1996) and Robertson et al. (2002). The water flow of creeks was classified as still, low, moderate or high. The nature of the water present at each site was classified into one of four categories: 0 (sporadic); 1 (ephemeral); 2 (semi-permanent); and 3 (permanent) (Table 2).

**Table 2 Healesville – Koo Wee Rup Road Upgrade: definitions of the variable categories used to describe water permanency of all the sites surveyed for Growling Grass Frog within the study area.**

Variable	Definition
<b>Water Permanency</b>	
0	Water bodies that fill sporadically (at least every five years) with fluctuations in annual rainfall, water may be short lived after a filling event
1	Ephemeral or seasonal water bodies, fill yearly with average rainfall and contain water for months at a time
2	Permanent water bodies that display high seasonal fluctuations in water level, can be susceptible to drying out in drought years
3	Permanent water bodies that display a relatively stable water level all year, and are not susceptible to drying out in drought years, though water level may be reduced

*Vegetation*

At each monitoring site, the cover and structure of vegetation was assessed. Vegetation cover is defined as the percent of the ground surface that would be obscured if a given area was viewed from directly above. The vegetation at each monitoring site was categorised as emergent, submergent, floating and fringing (see Table 3) and a visual assessment was used to estimate the percentage cover of each category. Emergent vegetation was assessed on the banks of the water body, including c. two meters into the water body and one meter above the water line. Submergent and floating vegetation was assessed over the entire water body surface, while fringing vegetation was assessed within the first five metres of bank away from the waterline.

Dominant vascular plant species were also identified at each survey site.

**Table 3 Healesville – Koo Wee Rup Road Upgrade: definitions for each vegetation category sampled at sites surveyed for Growling Grass Frog within the study area.**

<b>Vegetation Category</b>	<b>Definition</b>
Emergent vegetation	Semi-aquatic plant species in which the foliage grows primarily above the water surface
Submergent vegetation	Aquatic plant species in which the foliage grows primarily below the water surface
Floating Vegetation	Aquatic plant species in which the foliage floats upon the water surface, including Water Ribbon ( <i>Triglochin procera</i> ) and the upper foliage layer of submergent species
Fringing Vegetation	Terrestrial grasses, tree or shrub species growing within five metres of the waters edge

*Evidence of Grazing*

The trampling of bank-side and in-stream vegetation from livestock occurs at many of the survey sites. Rather than quantifying this, comments were made on the extent of disturbance at each monitoring site. Other disturbance factors noted were recreational disturbance, pollution and rubbish.

*Presence of Predatory Fish*

The presence or absence of both exotic and native fish species were recorded at each monitoring site. Exotic fish e.g. Mosquito Fish (*Gambusia holbrooki*), have been implicated in the decline of several Australian frog species (Tyler 1997, Komak and Crossland 2000, Pyke and White 2001, Anstis 2002, Heard et al. 2004).

### Spotlighting Surveys

Spotlighting surveys were carried out on 11 and 12 February and 6 March 2008.

Only standing waterbodies (i.e. dams) were surveyed for this study as all drains potentially impacted by the road upgrade were dry during the period of the assessment.

Surveys of standing water bodies (i.e. dams) covered the entire circumference of the water body, and a strip of bank c. 10 m in width, incorporating 5 m either side of the water-line. Any emergent or floating vegetation within the water body was also scanned with binoculars.

Surveys for the Growling Grass Frog were undertaken at night by teams of two people between 2100 and 2330 h DST. Hand-held 30 W spotlights were used to detect the frogs; this is a commonly used and effective technique for detecting Bell Frogs (Williams 2001, Hamer et al. 2002, Robertson and Heard 2002). Survey time for water bodies varied according to the size and habitat complexity of each site. Where possible, surveys were limited to suitable weather conditions (i.e. night = air temp. greater than 12°C and/or absence of a strong wind).

At the beginning of each survey, a period of five minutes was spent listening for male frogs calling. The abundance of all calling males from all frog species was recorded during this time. Weather variables were recorded at the beginning of each survey, including: air temperature, cloud cover, rain, wind levels and a general description of the weather conditions. Following this, each site was systematically searched for active frogs using the following techniques (outlined in Crump and Scott 1994):

- whilst traversing the length of the water bodies, spotlights were used to scan the surface and edge of the water bodies, focussing on the fringing and aquatic vegetation;
- frogs were detected either by direct encounter or identification of the frogs' distinctive eye shine with the aid of binoculars (see Williams 2001);
- upon detection, the time, AMG coordinates using a Garmin GPS unit, and microhabitat (e.g. floating on Water Ribbon) were recorded; and
- frogs were assigned to a size class - metamorphlings (specimens equal to or less than 40 mm in total length), sub-adult (between 40-60 mm), or adult (specimens above 60 mm).

Methods to reduce the possible spread of infectious pathogens (such as 'chytrid fungus') between sites were implemented in accordance with standards described by the New South Wales National Parks and Wildlife Service (NPWS 2001). For purposes of hygiene management, water bodies with no probable interchange of specimens were considered separate sites (NPWS). The following measures were used to mitigate the spread of disease between sites:

- footwear was thoroughly disinfected (saturated with 'Toilet Duck') at the commencement of field work and between each survey site; and
- wetlands were only approached on foot to eliminate car tyres as a source of transmission.

### Limitations

Due to the large area occupied by dams, creek lines and drains, the whole area could not be surveyed. This was partially overcome by surveying as many dams as possible. Dams where previous records were obtained were assessed for habitat suitability rather than re-surveying.

## 3.2 Swamp Skink survey

### 3.2.1 Desktop review

Three sources were investigated to determine:

- areas and habitats in the region in which Swamp Skink has previously been recorded;
- suitable Swamp Skink habitat throughout the Koo Wee Rup area; and
- areas of potential Swamp Skink habitat which will potentially be impacted by the road upgrade and require survey to clarify Swamp Skink status.

These sources included:

- The Atlas of Victorian Wildlife (AVW) database (DSE 2005);
- the scientific literature (e.g. Schulz 1985); and
- the results of the Ecology Australia (2007) assessment of the nearby Lyall's Inlet.

### 3.2.2 Field survey

#### Site Selection

Aerial photographs were assessed for potential survey sites within the area comprising VicRoads' "Band of Interest". The four areas identified under Section 2.1 were targeted, including (Figure 1):

- Cardinia Creek;
- Moodys Inlet;
- Toomuc/Deep Creek; and
- the drains/watercourses to the immediate west of the Koo Wee Rup Swamp Lookout, including McGregors Drain, McDonalds Drain, North West Drain, Bunyip River Drain and Southern Boundary Drain.

The lower reaches of all watercourses are under daily tidal influence, and the habitats occurring at these sites are described in Table 5 (also see Ecology Australia 2007). Photographs of the habitats are shown in Plates 1 to 9.



### Trapping survey

Small mammal Elliott traps were used to survey for Swamp Skinks (Plate 10). Traplines running parallel with Cardinia Creek, Moodys Inlet, Toomuc/Deep Creek and the drains to the immediate west of the Koo Wee Rup Swamp Lookout were set on 11 February 2008 (see Figure 1). Traplines were set immediately upstream of the South Gippsland Highway to avoid trapping in the Westernport Ramsar site. The number of traps set and their location are given in Table 4 (also see Figure 1).

- Cardinia Creek two traplines;
- Moodys Inlet – one trapline;
- Toomuc/Deep Creek – one trapline; and
- the Koo Wee Rup Swamp Lookout, including one trapline along the west side of McGregors Drain, one along the west bank of the McDonalds Drain and one along the east side of Southern Boundary Drain.

Elliott type A aluminium folding traps (measuring 33 x 10 x 9 cm) (Elliott Scientific Equipment Co., Upwey, Victoria) spaced at c. 10 m intervals were used in each trapline. Traplines were operated (kept open) for three days for a total of 180 trap days.

Elliott traps were placed on the ground, in the branches of low shrubs (e.g. Shrubby Glasswort *Sclerostegia arbuscula*), or on the tops of grass or sedge tussocks. Traps were baited with a mixture of peanut butter, rolled oats, honey and sardines.

Traps were opened between 0830 and 1130 h DST of each morning (i.e. 11, 12 and 13 February), checked each afternoon/evening between 1630 and 1930 h DST for any animals (e.g. Swamp Skink or small mammals) potentially captured during daylight hours, and were closed overnight and re-opened the following morning.

Captured animals were identified and released at the point of capture. Any Swamp Skinks captured were weighed, sexed and aged prior to release.

**Table 4 Healesville – Koo Wee Rup Road Upgrade: number of traplines, traps and trap days used for the Swamp Skink survey undertaken as part of the Road Upgrade study (11-13 February 2008).**

Location	Side of waterway		Total traps	No. traplines	Total trap days
	West side	East side			
<i>The Inlets</i>					
Cardinia Creek	8	7	15	2	45
Moodys Inlet	7	0	7	1	21
Toomuc/Deep Creek	0	8	8	1	24
<i>Drains/watercourses adjacent to the Swamp Lookout</i>					
McGregors Drain	0	7	7	1	21
McDonalds Drain	8	0	8	1	24
Southern Boundary Drain	0	15	15	1	45
<b>Totals</b>	-	-	60	7	180

**Table 5 Healesville – Koo Wee Rup Road Upgrade: habitats recorded at Swamp Skink survey sites (11-13 February 2008).**

Location	Habitat description
<i>The Inlets</i>	
<b>Cardinia Creek (Plates 1, 2 and 3)</b>	A trapline was established on each side (east and west) of the Creek which is under daily tidal influence. North of the South Gippsland Highway, Grey Mangroves ( <i>Avicennia marina</i> ssp. <i>australasica</i> ) from the Mangrove Shrubland Ecological Vegetation Class (EVC, mangroves form extensive communities in Westernport Bay) have extended up the Creek and border the channel and occur on mudflats within the tidal zone. A narrow strip (< 5 m wide) of Coastal Saltmarsh EVC occurs immediately above the marine and estuarine tidal flats and grades into Estuarine Flats Grassland EVC. The Coastal Saltmarsh is dominated by Beaded Glasswort <i>Sarcocornia quinqueflora</i> ssp. <i>quinqueflora</i> , and Shrubby Glasswort ( <i>Sclerostegia arbuscula</i> ), with occurrences of Rounded Noon-flower ( <i>Disphyma crassifolium</i> ssp. <i>clavellatum</i> ), Saltbush ( <i>Rhagodia</i> sp.) and Sea Rush ( <i>Juncus kraussii</i> ssp. <i>australiensis</i> ). On the inland side, Coastal Saltmarsh grades into Estuarine Flats Grassland EVC on slightly higher ground; these flats are often associated with old beach berms or sand sheets that are occasionally inundated by high tides. It forms

	<p>large tussocks of Coast Tussock-grass (<i>Poa poiformis</i> ssp. <i>poiformis</i>), Chaffy Saw-sedge (<i>Gahnia filum</i>) and Prickly Spear-grass (<i>Austrostipa stipoides</i>), and whilst scattered occurrences occur on the west side of the Cardinia Creek, extensive stands occur on the east side. A levee on the west side supports scattered Blackwoods (<i>Acacia melanoxylon</i>) over a grassy ground layer, and Estuarine Flats Grassland occur further to the west of the levee.</p>
<b>Moodys Inlet (No Plate)</b>	<p>Moodys Inlet supports a similar suite of vegetation communities and species to Cardinia Creek, including Mangroves, Coastal Saltmarsh and Estuarine Flats Grassland. The trapline was situated on the west side of the Inlet. Prominent species include Grey Mangrove on tidal flats, Beaded Glasswort and Shrubby Glasswort above the tidal flats, and Coast Tussock-grass, Chaffy Saw-sedge, Prickly Spear-grass, Australian Saltmarsh-grass (<i>Puccinellia stricta</i>), Swamp Paperbark (<i>Melaleuca ericifolia</i>) and *Broom (<i>Genista</i> sp.) on a levee.</p>
<b>Toomuc/Deep Creek (Plates 4, 5 and 6)</b>	<p>The trapline was established on the east side of the Creek. Deep Creek supports similar floristic communities to Cardinia Creek and Moodys Inlet. Mangroves (Grey Mangrove) line the channel on marine and estuarine tidal flats, with saltmarsh on slightly higher ground dominated by Beaded Glasswort, Shrubby Glasswort and Australian Saltmarsh-grass. The upper east bank supports Coast Tussock-grass, Chaffy Saw-sedge and Prickly Spear-grass. The upper banks border a mowed maintenance track with Kangaroo Grass (<i>Themeda triandra</i>). A levee further to the east supports scattered Blackwoods, Black Wattles (<i>Acacia mearnsii</i>), Swamp Paperbark thickets, *Blackberry (<i>Rubus</i> sp.) and *Gorse.</p>
<b><i>Koo Wee Rup Swamp Lookout</i></b>	
<b>McGregors Drain (Plate 7)</b>	<p>The trapline was established on the east side of the drain. The saltmarsh (and possibly mangroves) had been cleared on the west side, and the cleared bank borders pasture. A narrow (i.e. less than 5 m) and linear strip of Coastal Saltmarsh dominated by Beaded Glasswort borders the east side of the drain, and the odd Grey Mangrove plant grows in the channel. Saltbush (<i>Rhagodia</i> sp.) and Marsh Saltbush (<i>Atriplex paludosa</i> ssp. <i>paludosa</i>) are prominent on slightly higher ground. Australian Saltmarsh-grass, Coast Tussock Grass, Sea Rush and Chaffy Saw-sedge grow on the banks with young regenerating Swamp Paperbarks. Common Reed (<i>Phragmites australis</i>) and Kangaroo Grass (<i>Themeda triandra</i>) grow on the upper banks, including along the access track. A levee occurs further to the east which supports Swamp Paperbark Scrub, Blackwood, Black Wattle, Common Reed, *Blackberry, *Broom and *Gorse.</p>
<b>McDonalds Drain (Plate 9)</b>	<p>The trapline was established on the west side of the Drain. The odd Grey Mangrove plant grows on tidal flats in the channel. A narrow (i.e. less than 5 m) and linear strip of Coastal Saltmarsh dominated by Beaded Glasswort borders the west side of the Drain above the tidal flats. Saltbush (<i>Rhagodia</i> sp.) and Marsh Saltbush are prominent on slightly higher ground. Australian Saltmarsh-grass, Common Reed</p>

	<p>and Coast Tussock Grass grow on the banks with young regenerating Swamp Paperbarks. Common Reed (<i>Phragmites australis</i>) and Kangaroo Grass grow on the upper banks, including along the access track. A levee occurs further to the west which supports Swamp Paperbark Scrub, Blackwood, Black Wattle, Common Reed, *Blackberry, *Broom and *Gorse.</p>
<p><b>Southern Boundary Drain (Plate 8)</b></p>	<p>This site is part of the Koo Wee Rup Swamp Lookout Reserve. The trapline ran along the east side of the Southern Boundary Drain. Common Reed and low sedge/saltmarsh vegetation borders the drain. Swamp Scrub dominated by thickets of Swamp Paperbark occurs on higher ground with Chaffy Saw-sedge, Coast Tussock Grass, Sea Rush, Prickly Spear-grass and Salt Grass. Dominant plants in the saltmarsh include Beaded Glasswort, Sea Rush, Saltbush sp. and Marsh Saltbush. The odd Grey Mangrove grows in the drain.</p>



Plate 1. Healesville – Koo Wee Rup Road Upgrade: west bank of Cardinia Creek and upstream of South Gippsland Highway, looking south (February 2008).



Plate 2. Healesville – Koo Wee Rup Road Upgrade: view of east bank of Cardinia Creek and upstream of South Gippsland Highway, looking south (February 2008).



Plate 3. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Cardinia Creek and upstream of South Gippsland Highway, looking north (February 2008).



Plate 4. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Deep Creek and upstream of South Gippsland Highway, looking south (February 2002/2008).



Plate 5. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Deep Creek and upstream of South Gippsland Highway, looking north (February 2008).



Plate 6. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of Deep Creek and upstream of South Gippsland Highway, looking south (February 2008).



Plate 7. Healesville – Koo Wee Rup Road Upgrade: view from east to west bank of McGregors Drain and upstream of South Gippsland Highway, looking north (February 2008).



Plate 8. Healesville – Koo Wee Rup Road Upgrade: view to northeast along Southern Boundary Drain and upstream of South Gippsland Highway; forms part of the Koo Wee Rup Swamp Lookout (February 2008).





Plate 9. Healesville – Koo Wee Rup Road Upgrade: view from west to east bank of the McDonalds Drain (and North West Drain) and upstream of South Gippsland Highway, looking northeast (February 2008).



Plate 10. Healesville – Koo Wee Rup Road Upgrade: technique for detecting Swamp Skinks included trapping with Elliott folding small mammal aluminium traps. This site is the capture site of the Swamp Skink.

## 4 Results

### 4.1 Growling Grass Frog survey

#### 4.1.1 Frog species recorded

Four frog species were recorded during the current survey: Growling Grass Frog, Southern Brown Tree Frog (*Litoria ewingii*), Whistling (or Verreaux's) Tree Frog (*Litoria verreauxii*) and Spotted Marsh Frog (*Limnodynastes tasmaniensis*). The sites where the different species were recorded are given in Table 6.

#### 4.1.2 Growling Grass Frog records and habitat assessment

The Growling Grass Frog records from this study are mapped in Figure 1 and the habitat assessments are provided in Appendix 2; the records were collected from three of the 11 sites surveyed. None was recorded in the north of the study area. Records were obtained in the central section, along Ballarto Road on both sides of the Healesville – Koo Wee Rup Road, and further south to the north of the South Gippsland Highway.

The record of 49 Growling Grass Frogs from the market garden dam on Ballarto Road to the east of the Healesville – Koo Wee Rup Road, which was also being grazed by cattle at the time of the survey, most likely represents the results of successful breeding at the site (Site 11; Plate 11). The three generations of Growling Grass Frogs represented included: a few measured >6 cm and one large female measured c. 10 cm long which are adult frogs; a few measured between 4–6 cm in length which are probably sub-adult frogs from the previous breeding season; and most measured 3–4 cm which are probably metamorphs from the current breeding season. The record also represents one of the largest known recent recordings of Growling Grass Frogs at a single site. The dam in question would not, on face value, represent high quality habitat in that there is little diversity at the site (Plate 11). Suitable habitat attributes would include a dense surrounding cover of grass (potential over-wintering habitat), a dense mat of floating green algae (for perching and foraging and possible shelter underwater for frogs and tadpoles), some areas of open water and adjoining drains potentially used as habitat links. There was very little or no emergent or submergent aquatic vegetation (*Typha*, *Phragmites* and *Potamogeton*).

The dam along Ballarto Road on the west side of the Healesville – Koo Wee Rup Road where three Growling Grass Frogs were recorded supports a dense band of Cumbungi (*Typha* sp.) around the edges and dense weedy vegetation on the banks (Site 10; Plate 12). Due to the difficulties with surveying this dam (i.e. dense vegetation making observational work difficult, steepish banks making movement difficult for observers), it is believed that there were probably considerably more Growling Grass Frogs than the three recorded. This dam is on a property owned by the same landholder who owns the dam on the east side of Ballarto Road (Site 11).

The dam on the north side of the South Gippsland Highway where one Growling Grass Frog was recorded is situated on a deer farm (Site 1). The dam is fenced off and surrounded by dense grass and supported a dense mat of green floating algae on which the frog was recorded. Again, the habitat would not be regarded as optimal, but provides some of the appropriate habitat attributes utilised by this species.

The dam along Railway Road, Koo Wee Rup, in the south of the study area supports moderate habitat quality, including emergent aquatic/semi-aquatic vegetation (*Eleocharis* sp.). However, no Growling Grass Frogs were recorded over two nights of survey (Site 3; Plate 13).

With the exception of the large dam in the north of the study area off McGregor Road and adjacent to Toomuc Creek (Site 9), but outside the proposed alignment/band of interest, most other dams assessed were of low or low-moderate quality. Furthermore, previous records (e.g. obtained by Ecology Australia 2006a; Ecology Partners via Aaron Organ, pers. comm.; Biosis 2005; and the Atlas of Victorian Wildlife, or AVW, DSE 2005), and the results of the field assessment indicates that most, if not all, dams in the study area (and surrounds) may be utilised even if only temporarily used (whilst on route to better quality habitat) despite an absence of breeding habitat attributes occurring at some dams (see Appendix 3). With the exception of Sites 9, 10 and 11 and possibly Site 3, most dams assessed/surveyed are considered likely to support smaller numbers of Growling Grass Frogs (e.g.  $\leq 10$  frogs).

Some landholders reported Growling Grass Frogs on their properties, especially during wetter months/years (see Figure 1). Landholders reported Growling Grass Frogs at Site 12, 13, 14 and 15, despite no records being listed in the AVW (DSE 2005).

**Table 6 Healesville – Koo Wee Rup Road Upgrade: tabulated results of the Growling Grass Frog survey. Figure 1 provides a pictorial representation of these locations.**

Site No.	Type of Waterbody and Location	
1	Large fenced dam in deer property north of South Gippsland Highway, Koo Wee Rup.	1 Growling Grass Frog sitting on algae.
3	Sand scraped dam off Railway Road, Koo Wee Rup.	1 Southern Brown Tree Frog calling from dam. 1 Whistling Tree Frog calling from Railway Road drain 2 metamorph Spotted Marsh Frogs sitting on dam edge
10	Large market garden dam west side of Healesville - Koo Wee Rup Road and along north side of Ballarto Road.	3 Growling Grass Frogs perched in Cumbungi. 1 Southern Brown Tree Frog calling in dam. 1 Whistling Tree Frog calling from Healesville Koo Wee Rup Road reserve.
11	Large market garden dam, currently grazed by cattle, east side of Healesville - Koo Wee Rup Road and along south side of Ballarto Road.	49 Growling Grass Frogs on bare banks of dam, in cattle pugs and on algae at water's edge – includes three generations – a few at 6-10 cm, a few 4-6 cm in length, and most measuring 3-4 cm in length.
13	Middle dam adjacent stockyards on the west side of McGregor Road	1 Southern Brown Tree Frog calling in dam.
14	Southwest dam on the west side of McGregor Road	1 Southern Brown Tree Frog calling in dam. 1 Whistling Tree Frog calling in distance.



Plate 11. Healesville – Koo Wee Rup Road Upgrade: market garden dam along Ballarto Road on the east side of the Healesville – Koo Wee Rup Road where 49 Growling Grass Frog were recorded (March 2008).



Plate 12. Healesville – Koo Wee Rup Road Upgrade: market garden dam along Ballarto Road on the west side of the Healesville – Koo Wee Rup Road where three Growling Grass Frog were recorded perching in the band of *Typha* around the dam edge (March 2008).



Plate 13. Healesville – Koo Wee Rup Road Upgrade: dam along Railway Road with moderate quality habitat for Growling Grass Frogs, including emergent vegetation (*Eleocharis* sp.) (March 2008).

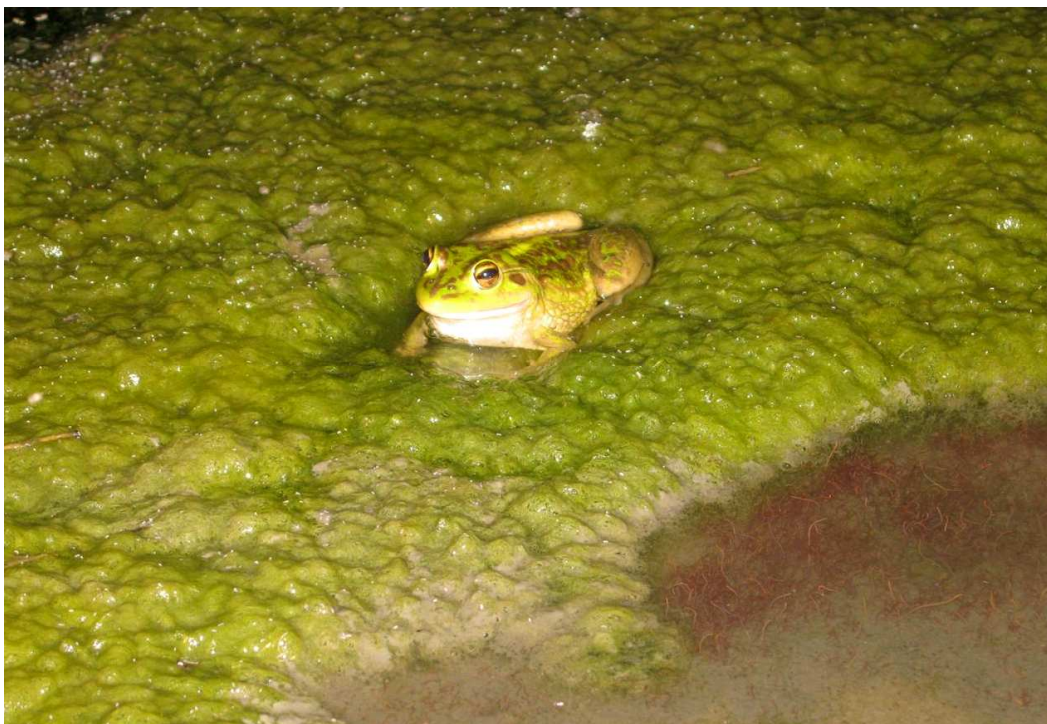


Plate 14. Healesville – Koo Wee Rup Road Upgrade: one of the 49 Growling Grass Frogs recorded (on algae) on the market garden dam on Ballarto Road (March 2008).

## 4.2 Swamp Skink survey

One Swamp Skink was captured over the 180 trap days giving a trap success of 0.56%. The Swamp Skink was captured on 11 February 2008 on the eastern side of Cardinia Creek just north of the South Gippsland Highway at AMG: 363121; 5769779 (Table 7; Figure 1; Plate 15). The capture site was situated amongst large tussocks of Coast Tussock-grass and Prickly Spear-grass.

On 13 February 2008, a second Swamp Skink was recorded on the east side of Cardinia Creek, adjacent to the trapline at the following AMG: 363130; 5769732. The Swamp Skink was seen scurrying in an area supporting Beaded Glasswort, Shrubby Glasswort and Coast Tussock-grass.

## 4.3 Other species captured

Non-target species incidentally captured included two small mammal species and one reptile species (Table 7).

Small mammal species included the native Swamp Rat (*Rattus lutreolus*) and introduced \*House Mouse (*Mus musculus*). Swamp Rats were captured along Moodys Inlet, McDonalds Drain and Southern Boundary Drain (i.e. at the Swamp Lookout). House Mice were caught at Moody's Inlet, McGregors Drain and Southern Boundary Drain.

Two White's Skinks (*Egernia whitii*) were captured, including an individual along the east side of Cardinia Creek and one along McGregors Drain (Plate 16).

**Table 7 Vertebrate species captured during the trapping survey for Swamp Skinks (11-13 February 2007). A total of 180 trap days were undertaken.**

Species	Location							Number captures (%)
	Cardinia Creek		Moodys Inlet	Toomuc / Deep Creek	McGregors Drain	McDonalds Drain	Southern Boundary Drain	
	West	East	West	East	East	West	East	
<b>Trap days</b>	<b>24</b>	<b>21</b>	<b>21</b>	<b>24</b>	<b>21</b>	<b>24</b>	<b>45</b>	<b>180</b>
<i>Mammals</i>								
Swamp Rat			1			1	2	4 (2.22%)
House Mouse			1		1		1	3 (1.67%)
<i>Reptiles</i>								
Swamp Skink		1						1 (0.56%)
White's Skink		1			1			2 (1.12%)





Plate 15. Healesville – Koo Wee Rup Road Upgrade: Swamp Skink (*Egernia coventryi*) captured along the east side of Cardinia Creek (February 2008).



Plate 16. Healesville – Koo Wee Rup Road Upgrade: White Skink (*Egernia whitii*) captured along the east side of Cardinia Creek (February 2008).

## 5 Discussion

### 5.1 Growling Grass Frog

#### 5.1.1 Growling Grass Frog distribution

In Victoria, the Growling Grass Frog is widely distributed in most regions except for the western desert and alpine regions. Whilst there are significant populations in urban and semi-rural Melbourne, population declines have been recorded across much of southern and central Victoria, including Melbourne (Tyler 1997; Robertson et al. 2002; Wilson 2003; Biosis 2005).

Records of Growling Grass Frogs, including those collected during this study indicate that the Officer, Pakenham and Koo Wee Rup areas support suitable breeding habitat and a significant population on a spatial scale and in terms of population size (Biosis 2005; DSE 2005; Ecology Australia 2005b, 2006a, 2006e and 2008; Ecology Partners 2007; Appendix 3; Figure 1). The results of these surveys demonstrate that the Growling Grass Frog has a broad distribution in these areas, and that although the colonies/sub-populations are scattered in areas of suitable habitat (i.e. along creeks and drains and at farm dams), the larger population is effectively linked through the network of drains, dams and creeks dispersed throughout the Officer, Pakenham and Koo Wee Rup areas. In other words, the sub-populations occurring in the Healesville – Koo Wee Road Upgrade study area constitute part of the nationally-significant population recorded in the Pakenham area by Organ (2005) (also see Ecology Australia 2006a and 2008).

On a site-specific basis, and using the results of the current survey, the large breeding colony occurring at the market garden dam along Ballarto Road to the east of the Healesville – Koo Wee Rup Road (where 49 frogs were recorded), and the likelihood of a large breeding colony occurring along the same road to the west (three frogs), represent important sites within the network of dams, creeks and drains throughout the Officer, Pakenham and Koo Wee Rup area.

#### 5.1.2 Growling Grass Frog habitat and habitat availability

The Growling Grass Frog is a relatively large (e.g. females can grow to 80-100 mm long) and highly mobile species, which has generally been recorded in or around water that is shallow and still or slow-moving, usually with emergent, submergent, fringing and floating aquatic vegetation, including pondweed, sedges and Cumbungi (Tyler 1997; Pyke 2002; Robertson et al. 2002; Biosis 2005). Habitats with these features have included: lakes or reservoirs; lagoons; marshes; swamps; ponds, ditches and other artificial depressions; farm dams; former quarry pits; areas which receive artificial flood-irrigation; and still back-waters and other sluggish areas of rivers and streams. The species breeds in permanent or near-permanent water bodies, but has also been recorded breeding in ephemeral waterbodies (Heard et al. 2004; Ecology Australia 2006g). The Growling Grass Frog spends the non-breeding season (approximately May to August) sheltering in terrestrial environments (e.g. rocks, fallen timber or dense ground vegetation) some distance from water.

Waterbodies with extensive cover of wetland vegetation (e.g. fringing, floating, emergent or submergent), reasonable water quality and an absence of predatory fish are preferred by this species for breeding. The aquatic vegetation provides calling stages for male frogs, sites for egg deposition and development, and food and shelter for tadpoles. Dense submergent vegetation is important for protecting eggs and tadpoles from predation. The Growling Grass Frog will use degraded habitat, particularly where adjacent offstream waterbodies, such as farm dams or quarry pits, provide this breeding habitat (Pyke 2002; Robertson and Heard 2002; Heard and Robertson 2003; Robertson et al. 2002; Wilson 2003; Heard et al. 2004; Organ 2005; Wassens et al. 2008).

At a landscape scale, suitable Growling Grass Frog habitat comprises (Biosis 2005):

1. a high density of suitable wetlands (with fringing, emergent, submergent and floating aquatic and semi-aquatic vegetation for breeding) and terrestrial habitats in close proximity to one another (e.g. less than 500 m) for foraging and over-wintering;
2. the presence of drainage lines, creeks, rivers, water channels and artificial drains adjacent to suitable wetlands which enable dispersal and movement between sites; and
3. no or very few barriers to dispersal (e.g. housing development and sealed roads).

### 5.1.3 Growling Grass Frog habitat within the study area

The habitat available to Growling Grass Frogs within the study area has been discussed in Biosis (2005) and Ecology Australia (2005a, 2006a and 2008). Creeks and drains are likely to be used as habitat links for dispersing and/or moving during the breeding season (September to March), as well as for foraging. The dense ground layer cover of vegetation would also provide shelter for over-wintering during the non-breeding season (April to August) and during the day during the breeding season. Several drains or sections of drains (e.g. a section along the Healesville – Koo Wee Rup Road and south of Ballarto Road, Site 13 in Ecology Australia 2006a) with extensive floating and emergent vegetation (Water Ribbon *Triglochin* sp. and Floating Pondweed *Potamogeton tricarinatus*), also appear to provide potential breeding habitat.

Several farm dams within the study are more likely to provide potential breeding habitat for Growling Grass Frogs as they support important habitat characteristics. For example, Sites 3, 10 and 15 support emergent vegetation, including Spike-rush (*Eleocharis* sp.), Common Reed (*Phragmites australis*), Cumbungi (*Typha* sp.), Rush (*Juncus* sp.) and Water Ribbon (Plates 12 and 13). This emergent vegetation and exposed banks and rocks (if present) provide calling sites for male frogs, basking sites and elevated perches from which frogs can ambush prey. Submergent and floating vegetation (e.g. Sago Pondweed *Potamogeton pectinatus* and filamentous algae) provide sites for egg deposition, shelter for tadpoles and foraging platforms and surfaces where invertebrates congregate (e.g. Sites 3 and 11, Plate 14). While some dams were dry during the field assessment (e.g. Site 5) of February/March, they may have provided breeding habitat earlier in the breeding season (e.g. October/November).

Not all farm dams assessed within the study area are suitable for breeding. Several dams (e.g. Sites 2, 7 and 14) support no or very little aquatic or semi-aquatic vegetation due to livestock grazing.

Furthermore, water quality is likely to have deteriorated due to cattle droppings. Nonetheless, in the study area, Growling Grass Frogs have been recorded in these low quality dams (e.g. Site 8 to the south of Deep Creek in the study of Ecology Australia 2006a) as they appear to fulfil an important habitat linkage function in the landscape.

Another factor rendering habitat unsuitable for breeding is the presence of the introduced and predatory Mosquito Fish or Eastern Gambusia (*Gambusia holbrooki*). A dam at Site 8 along Hall Road supported good quality breeding habitat with emergent and floating vegetation (Tall Spike-rush *Eleocharis sphacelata*, Pondweed *Potamogeton* sp. and filamentous algae), but also supported a large population of Mosquito Fish, as well as at least one Short-finned Eels (*Anguilla australis*). This fish species has the potential to reduce the likelihood of successful breeding by predated frog eggs, and has been implicated in the decline of the Growling Grass Frog (Tyler 1997, Komak and Crossland 2000, Pyke and White 2001, Anstis 2002, Heard et al. 2004).

The configuration of water bodies in the landscape is favourable for Growling Grass Frogs. Creeks (Toomuc and Deep Creeks) and numerous drains within a predominantly pastoral landscape permit unimpeded movement. Aside from movement along watercourses, Growling Grass Frogs forage on and traverse pasture on humid nights when light rain is falling. Therefore, the configuration provides important habitat links between potential breeding sites. The configuration also reduces the likelihood of sub-populations in the Officer, Pakenham and Koo Wee Rup area becoming isolated, and local extinctions occurring when conditions become unfavourable (e.g. dams dry out or predatory fish are introduced to waterbodies).

It should be noted that although the configuration of water bodies is believed to be highly suitable for the Growling Grass Frog population in the broader area, the dearth of evidence about frog movements between sites results in the importance of each water body or series of water bodies for the long-term viability of the larger population being only speculative. However, the movement data provided in Wassens et al. (2008) provide strong evidence that the conclusions regarding the configuration of waterbodies and their permanence are generally sound, despite her study being undertaken in the semi-arid zone.

## 5.2 Swamp Skink

### 5.2.1 Swamp Skink distribution

The Swamp Skink occurs in southeastern Australia, where it has a disjunct distribution throughout southern Victoria from the New South Wales border, and extending into the Mt Gambier region of South Australia. It is patchily distributed with concentrations of records in the Portland area, Grampians, Warrnambool, Port Campbell, Apollo Bay, Anglesea, Mornington Peninsula/Western Port hinterland (including French Island), South Gippsland/Wilsons Promontory, Lakes Entrance and East Gippsland (Robertson 1998, Wilson and Swan 2003, DSE 2005, Clemann 2006; Friends of Tootgarook Wetlands, undated).

Most records from the saltmarshes of Westernport Bay are dated and occur further downstream of the South Gippsland Highway, including records collected from (Schulz 1985, DSE 2005):

- the Bunyip River mouth and c. 1.5 km downstream of the Koo Wee Rup Swamp Lookout in 1981 (five records), 1982 (five records), 1986 (one record) and (1993 one record);
- the Tooradin Airstrip/Dalmore Road Drain/Lyall's Inlet area in 1996 and c. 1 km downstream of the South Gippsland Highway and 1 km west of Cardinia Creek;
- southeast of Tooradin in 1981 and c. 2.5 km downstream of the South Gippsland Highway and 3 km west of Cardinia Creek; and
- French Island.

The records obtained during this study are interesting as they demonstrate that Swamp Skinks extend upstream to areas north of the South Gippsland Highway with tidally-influenced and suitable vegetation, namely Coastal Saltmarsh and Estuarine Flats Grassland. This is consistent with the flora and fauna assessment undertaken for the West Dalmore Road Drain and Lyall's Inlet where Swamp Skinks were predicted to occur both upstream and downstream of the South Gippsland Highway in narrow linear strips of Coastal Saltmarsh and more extensive areas of Estuarine Flats Grassland (Ecology Australia 2007a). It is likely that the Swamp Skinks are continuously distributed between the mouths or entrances of these watercourses in Westernport Bay downstream of the South Gippsland Highway and the upstream limits of the suitable habitat (see below), upstream of the South Gippsland Highway.

### 5.2.2 Swamp Skink habitat and habitat availability

The Swamp Skink is a cryptic and elusive species which is often associated with dense ground level vegetation at freshwater swamps and associated watercourses, or adjacent wet heaths, sedgeland and saltmarsh, especially those supporting Paperbarks (*Melaleuca* spp.) and Tea-trees (*Leptospermum* spp.). However, it has more recently been recorded in heathy woodland at the headwaters of a drainage line without any Paperbark thickets (near Ballarat) and in coastal heathland situated some distance from water (e.g. see Schulz 1985, Clemann et al. 1998, Robertson 1998, Clemann and Beardsell 1999, Clemann 2000, 2006; Andrew McMahon, Ecology Australia, pers. obs.). Within these habitats, it is not uniformly distributed, but selects micro-environments where vegetation is dense below two metres, but with little overstorey. Thus, it basks on grass tussocks (including weeds), reeds, sedges, logs and rocks, where there is a break in the canopy (Clemann 2006; Nick Clemann, DSE, pers. comm.). For example, at Tootgarook Swamp in Rye, tall dense *Melaleuca ericifolia* thickets are avoided, but margins of these thickets and adjacent *Gahnia* sp. sedgeland or other dense, low vegetation are used extensively (Robertson 1998).

The habitats the Swamp Skinks were recorded in along Cardinia Creek comprised an interface of Saltmarsh dominated by Beaded Glasswort and Shrubby Glasswort, and Estuarine Flats Grassland dominated by Coast Tussock-grass and Prickly Spear-grass. These are precisely the habitats in which Schulz (1985) recorded Swamp Skinks at Tortoise Head on French Island, Crib Point near

Hastings, the Tooradin Airfield at Tooradin and the Bunyip River mouth south of Koo Wee Rup. These habitats are represented at each site surveyed for Swamp Skinks (see Table 5).

### **5.2.3 Swamp Skink habitat in the study area**

Based on the results of the trapping survey and habitat assessment (Table 5), the results of the survey undertaken in 1981 by Schulz (1985), and the records presented in the AVW (DSE 2005), Swamp Skinks are likely to occur in Coastal Saltmarsh and Estuarine Grass Flats around Westernport Bay, including tidally-influenced areas upstream of the South Gippsland Highway. In other words, Swamp Skinks are likely to be continuously distributed in these habitat types from the entrances of these watercourses in Westernport Bay to areas upstream of the South Gippsland Highway, including all watercourses/drains surveyed as part of this study: Cardinia Creek, Moodys Inlet and Toomuc/Deep Creek, plus the watercourses adjoining the Koo Wee Rup Swamp Lookout, including McGregors Drain, McDonalds Drain, North West Drain, Bunyip River Drain and Southern Boundary Drain. We suggest a high likelihood of occurrence along these watercourses/drains, including areas where the South Gippsland Highway crosses.

## 6 Potential Impacts

### 6.1 Growling Grass Frog

Potential impacts to the Growling Grass Frog associated with the Healesville – Koo Wee Rup Road Upgrade have been discussed in Ecology Australia (2006a and 2008). Potential impacts include the loss and/or fragmentation of habitat, sedimentation and pollution of creeks and drainage lines from uncontrolled run-off and increased mortality due to road kill.

Direct impacts include habitat loss which relates to the loss of farm dams or vegetation associated with creeks/drains (e.g. Deep Creek and roadside drains), which may either represent breeding habitat and/or important dispersal/movement links in the landscape. There is also potential loss of foraging habitat with the conversion of pasture to a roadway (i.e. as Growling Grass Frogs are known to forage in pasture on humid nights).

An indirect impact usually associated with road projects is the fragmentation and isolation of animal populations and habitats. Thus, roads may present a physical (or psychological) barrier to the movement of animals, resulting in isolation and reduction in sizes of populations, which increases the stochastic risk of extinction. Roads may also increase the dispersal distances between populations (e.g. see Andrews 1990; Forman 1995; Forman et al. 1995; Forman and Alexander 1998; Biosis 2005; Ecology Australia 2006a, 2006f and 2008). As such, fauna underpasses and culverts are often designed specifically to mitigate barrier effects and maintain continuity of animal populations and habitat links (e.g. Mansergh and Scotts 1989; Forman 1995; Forman et al. 1995; AMBS 1997; Robertson 2002; Biosis 2005).

Ideally, the design of the road upgrade would avoid areas where Growling Grass Frogs occur or potentially occur. Thus, and as far as is possible, the alignments would avoid all dams and drains/creeks within the 100 m zone either side of the alignments, as they are likely to be utilised by frogs at some stage during their life cycle (i.e. for breeding, dispersal, shelter or foraging). However, considering the broad distribution of Growling Grass Frogs and suitable habitat in the study area (i.e. c. 16 km north to south range, which includes the entire study area), it will probably be difficult to avoid all known or potential habitat.

Once the alignment is refined, further habitat assessments may be required to assess the significance of each water body, and therefore the potential impacts from the road upgrade. Further refinement could be undertaken to minimise impacts as far as is possible. For example, a zoological assessment could be undertaken and the road alignment moved slightly and where possible to avoid certain dams. A set of criteria could be developed to assess dams within the alignment and if deemed to be of high quality and important to the population, suggestions to avoid these areas could be undertaken.

In particular, dams which are large, permanent, well vegetated and in close proximity to other occupied dams or drains/creeks should be avoided. In addition, creeks/drains which provide suitable habitat should be avoided, bridged or relocated where possible (i.e. drains with semi-

permanent to permanent water for potential breeding, and suitable vegetation for shelter, foraging and movement).

Impacts from sedimentation and pollution of creeks and drains can be avoided through best management practice and addressed in an Environmental Management Plan. There are studies investigating the success of fauna underpasses for Growling Grass Frogs, however, there is no evidence to date suggesting that these structures are used (Christina Renowden, pers. obs.).

## 6.2 Swamp Skink

Potential impacts associated with the Road Upgrade (e.g. see Clemann 2006) to the Swamp Skink may include loss and fragmentation of suitable habitat (i.e. Coastal Saltmarsh and Estuarine Flats Grassland) along the lower reaches of watercourses/drains through works (e.g. road widening) undertaken along the South Gippsland Highway (Figure 1). The watercourses/drains include Deep Creek, McGregors Drain, McDonalds Drain, North West Drain, Bunyip River Drain and Southern Boundary Drain. The extent to which Swamp Skinks can move unimpeded under the current bridges of the Highway over these watercourses is not known.

Ideally, the proposed works would avoid loss or disturbance to Coastal Saltmarsh and Estuarine Flats Grassland and maintain habitat continuity under the bridges and avoid any potential barrier effects.

Other potential impacts which could potentially result in degradation of Swamp Skink habitat (from Clemann 2006), but which can be avoided or minimised through road or bridge design and best management practice include:

- alteration to the “natural” flow regime of these watercourses through inappropriate pylon placement (e.g. altering the hydrology);
- input of toxic substances into Victorian rivers and streams (i.e. pollutants alter vegetation floristics and structure); and
- input of petroleum and related products to these estuarine habitats.



## 7 Legislative Implications

The key legislation relevant to the Growling Grass Frog and Swamp Skink are discussed below.

### 7.1 Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* - Growling Grass Frog

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) pertains to matters of national environmental significance, including Ramsar Wetlands, listed threatened species and ecological communities, listed migratory species and Commonwealth Marine Areas. It applies to both public and private land.

The proponent is obliged to refer matters to the Commonwealth Environment Minister if such values may be affected by a proposed action. The Department of Environment, Water, Heritage and the Arts (DEWHA) decides whether there will be a significant impact and if it needs to be a 'controlled action' and require a formal assessment under the Act. The Commonwealth can intervene to modify or block an action if it deems this necessary for the protection of a species or community of national significance.

For the proposed works associated with the Healesville – Koo Wee Rup Road Upgrade, it is recommended that VicRoads prepare an EPBC Act referral for DEWHA which includes consideration of the Growling Grass Frog and Westernport Ramsar site. The referral will need to consider the significance of the study area to an 'important population' of the Growling Grass Frog. The area in the northwest of the study area in the vicinity of an alternative connection to the Pakenham Bypass (i.e. to the west of McGregor Road and including Toomuc Creek at West Pakenham and Officer South) has been identified as supporting an 'important population' of the Growling Grass Frog as defined under the EPBC Act 1999 (see Ecology Australia 2007). The basis for this definition is that this population is a key source population for breeding and dispersal (Ecology Partners 2007).

At a recent workshop held by DEWHA and attended by numerous Growling Grass Frog biologists, definitions of an important Growing Grass Frog population, or habitat for an important population of Growling Grass Frogs, were drafted (Christina Renowden, pers. obs.). These draft definitions defined important habitat as “comprising a series of occupied and unoccupied water bodies and associated aquatic and terrestrial habitats which allow important population dynamics to occur. These population dynamics include breeding and dispersal, and ongoing persistence characterised by local extinction and re-colonisation. A population could also be considered important if it is well studied, and hence provides opportunity for greater understanding of *L. raniformis* through a long-term dataset”.

In this definition, water bodies include, but are not limited to: wetlands, farm dams, creeklines, and irrigation or drainage channels. Water bodies which only contain water periodically (i.e.

ephemeral water bodies) are important habitat for *L. raniformis*, as their flooding can trigger breeding (particularly in semi-arid areas) or provide ‘stepping-stones’ for dispersal between periodically disconnected water bodies. During drought, the assessment of the importance of ephemeral water bodies (likely to be dry at the time) should be conservative.

Our assessment suggests that the entire study area incorporating the Healesville – Koo Wee Rup Road Upgrade, including areas to the southeast (i.e. Pakenham South and Koo Wee Rup) of the ‘important population’ identified by Ecology Partners (2007), should also be considered part of the ‘important population’. This is due to the:

- continuity of habitat (and likely continuity of sub-populations) between the ‘important population’ and adjoining areas;
- size of some breeding colonies recorded during this study (e.g. 49 frogs of three generations at Site 11); and
- large spatial area over which these colonies occur.

The Pakenham South and Koo Wee Rup areas which adjoin the areas at West Pakenham identified as supporting an ‘important population’ by Ecology Partners (2007) also appear to satisfy the basis for this definition (i.e. this population is a key source population for breeding and dispersal as per Ecology Partners 2007), plus the definition drafted at the Growling Grass Frog workshop (i.e. comprise a series of occupied and unoccupied water bodies and associated aquatic and terrestrial habitats which permit breeding and dispersal, and ongoing persistence characterised by local extinction and re-colonisation).

A referral appears imminent, and the nature of the final alignment would determine whether the Road Upgrade should be referred as a ‘controlled’ or ‘not as a controlled’ action.

## 7.2 Victorian Flora and Fauna Guarantee Act 1988 – Growling Grass Frog and Swamp Skink

The Victorian *Flora and Fauna Guarantee Act 1988* lists species and ecological communities recognized as rare or threatened in Victoria. There are also provisions for listing of threatening processes. Flora identified as susceptible to over-collection although not necessarily rare or threatened, such as orchids are also protected under this Act. This is the State’s primary legislature for flora and fauna; however, it is dated and poorly tied to the planning process. It effectively applies only to public land, but may have implications for private to the extent planning authorities enforce. Once purchased, private land will become public land. Therefore the proposed corridor may require a permit from DSE if FFG-listed species are affected.

Both the Growling Grass Frog and Swamp Skink are listed under the FFG Act and occur in areas affected by the Road Upgrade. A permit may be required from DSE if any habitat of these species requires removal as part of the Road Upgrade.

FFG Act Threatening Processes which are relevant or potentially relevant to the Road Upgrade and require addressing in an Environmental Management Plan include:

- Alteration to the “natural” flow regime of rivers and streams (e.g. through inappropriate pylon placement and alteration of the hydrology);
- Degradation of native riparian vegetation along Victorian rivers and streams (e.g. loss of vegetation, facilitation of weeds, etc.);
- Habitat fragmentation as a threatening process for fauna in Victoria (e.g. barrier effects of roads, isolation of Growling Grass Frog and Swamp Skink habitat and colonies, etc.);
- Input of toxic substances into Victorian rivers and streams (e.g. pollutants alter vegetation floristics and structure);
- Input of petroleum and related products into Victorian marine and estuarine environments;
- Input of sediment into Victorian rivers and streams through human activities; and
- Infection of amphibians with Chytrid fungus, resulting in chytridiomycosis.

### **7.3 Wildlife Act 1975**

The *Wildlife Act 1975* lists protected fauna species and applies to both public and private land. Targeted surveys were undertaken as part of the study under a wildlife permit held by the Ecology Australia. If salvage and translocation of animals (e.g. Growling Grass Frogs) associated with loss of habitat is required at a later date, an application for a Management Authorisation under the *Wildlife Act* will need to be submitted to DSE.

### **7.4 Local Planning Policy**

The Local Planning Policy (Cardinia Shire) contains the Municipal Strategic Statement (MSS) and Local Planning Policies. MSS encapsulates significant planning directions for the municipality and in turn provides the strategic basis for the application of the zones, overlays and particular provisions in the planning scheme. It applies to both public and private land. A planning scheme is binding on all people and corporations, on every Minister, government department, public authority and municipal council. Further information can be found on the DSE web page (Planning Schemes On-line),

Relevant overlays include Floodway (FO), Land Subject to Inundation (LSIO), Environmental Significance (ESO) and Significant Landscape (SLO) Overlays.

The purposes of a FO are to: identify waterways, major floodpaths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding; ensure any development maintains the free passage of temporary flood water; and protect water quality and waterways as a natural resource in accordance with State Environment Protection Policies (SEPP). FOs apply to the following waterways/drains and adjoining properties in the study area: Cardinia

Creek, Moodys Inlet, Toomuc/Deep Creek, and the watercourse and drains adjacent to the Koo Wee Rup Swamp Lookout (e.g. Bunyip River, McDonalds Drain). A permit is required to construct or carry out works, including buildings, fences and roadworks.

The purposes of a LSIO are to: identify land in a flood storage or flood fringe area affected by the 1 in 100 year flood or any other area determined by the floodplain authority; ensure any development maintains the free passage of temporary flood water; and protect water quality and waterways as a natural resource in accordance with SEPP. LSIOs apply to most of the study area, excluding areas bordering the Healesville – Koo Wee Rup Road and situated between the Pakenham Bypass and Greenhills Road. A permit is required to construct or carry out works, including buildings, fences and roadworks.

Cardinia Creek, Moodys Inlet, Toomuc/Deep Creeks and adjoining properties downstream of the South Gippsland Highway, and areas of these watercourses and adjoining properties upstream to the South Gippsland Railway Line, are covered by an ESO Schedule 2 (ESO2). The ESO2 covers the saltmarsh and mangrove communities of Westernport Bay, and aims to protect these significant features of Westernport Bay through sensitive design and development. A permit may be required from the Shire of Cardinia if works are planned for these areas.

Eight kilometres of shoreline of Westernport Bay between Tooradin and Koo Wee Rup (adjoining the south side of the South Gippsland Highway) have been recognised by the National Trust as a significant landscape. This area is covered by a SLO Schedule 2 (SLO2). The aims of the SLO2 are to: conserve and enhance landscape quality of Western Port; conserve and enhance the flora, fauna and ecological processes of Westernport Bay; encourage harmonious development. An application may need to be lodged with the Shire of Cardinia to construct or build, including works which will involve removal, destruction or lopping of vegetation.

## 8 Summary and Recommendations

The most significant issue is the occurrence in the entire study area of an ‘important population’ of Growling Grass Frogs as defined under the EPBC Act 1999. The population inhabiting the study area appears to fulfil older (“this population is a key source population for breeding and dispersal”) and more recently drafted (“comprise a series of occupied and unoccupied water bodies and associated aquatic and terrestrial habitats which permit breeding and dispersal, and ongoing persistence characterised by local extinction and re-colonisation”) definitions (Section 7.1).

Impacts to Toomuc and Deep Creeks, which are important habitat links and foraging and sheltering habitat for the EPBC-listed Growling Grass Frog, could be avoided by keeping works well away from (and fencing-off) Toomuc Creek, and by spanning Deep Creek so that no pylons or machinery enter the Creek. The construction width of bridges should also be minimised (also see Ecology Australia 2008).

Once the alignment is refined, and to minimise impacts as far as is possible, further habitat assessments may be required to assess the significance of each water body within or adjoining the alignment, and therefore the potential impacts from the road upgrade. Further alignment refinement, where possible to avoid certain dams, could be undertaken. A set of criteria could be developed to assess dams within and adjoining the alignment and if deemed to be of high quality and important to the population, suggestions to avoid these areas could be undertaken.

A detailed impact assessment will need to be undertaken on the final alignment.

A referral to the Commonwealth DEWHA will be required, and the nature of the final alignment will determine whether the project is referred as ‘a controlled action’ or ‘not a controlled action’.

Potential impacts to Swamp Skink can potentially be avoided through adequately spanning the watercourses/drains flowing into Westernport Bay, avoiding loss or disturbance of the vegetation communities extending upstream in these watercourses under tidal influence from Westernport Bay and minimising the construction width.

Once the alignment is finalised, an Environmental Management Plan (EMP) will need to be produced. The EMP would address conservation measures for the Growling Grass Frog, Swamp Skink, other significant flora and fauna species and vegetation communities. The EMP would also include measures to avoid impacts from sedimentation and pollution of creeks and drains and potential downstream impacts to the Westernport Ramsar site.

## 9 References

- ANCA (Australian Nature Conservation Agency) (1996). Directory of Important Wetlands in Australia. (Australian Nature Conservation Agency: Canberra.)
- Andrews, A. (1990). Fragmentation of habitat by roads and utility corridors: a review. *Australian Zoologist* **26**, 130-141.
- Australian Museum Business Services (1997). Fauna passage of Three Underpasses Beneath the F3 Freeway Between Sydney and Newcastle. Report prepared for Roads and Traffic Authority NSW (AMBS: Sydney.)
- Antis, M. (2002). Tadpoles of South-eastern Australia: A Guide with Keys. (Reed New Holland, New South Wales.)
- Biosis (2005). Pakenham Bypass Growling Grass Frog Environmental Management Plan. Report prepared by Organ, A. for Vic Roads. (Biosis Research Pty Ltd: Port Melbourne)
- Brett Lane and Associates (2004). Pakenham Golf Course Relocation Flora and Fauna Assessment. Unpublished report prepared for Robert Luxmore Pty Ltd and Cardinian Shire Council (Brett Lane and Associates, Carlton North, Victoria.)
- Clemann, N. (2000). Survival in the suburbs! The rediscovery of the threatened Swamp Skink *Egernia coventryi* east of Melbourne, with comments on the failure of Elliott traps in a survey for this species. *The Victorian Naturalist* **117 (5)**, 180-183.
- Clemann, N. (2006). Distribution and Ecology of the Swamp Skink *Egernia coventryi* in the Port Phillip and Western Port Region. Unpublished report prepared for Melbourne Water (Arthur Rylah Institute for Environmental Research, Heidelberg.)
- Clemann, N., and Beardsell, C. (1999). A new inland record of the Swamp Skink *Egernia coventryi* Storr, 1978. *The Victorian Naturalist* **116 (4)**, 127-128.
- Clemann, N., Brown, P., and Brown, G. (1998). A note on bait selection when trapping the Swamp Skink *Egernia coventryi* in Elliott traps. *The Victorian Naturalist* **115 (3)**, 81-83.
- Cogger, H.G., Cameron, E.E., Sadler, R.A., Egger, P. (1993). The Action plan for Australian reptiles. (Australian Nature Conservation Agency: Canberra.)
- Crump, M.L. and Scott, N.J. (1994). Visual encounter surveys. In *Measuring and monitoring Biological Diversity: standard methods for amphibians*. (Eds. W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek and M.S. Foster.) pp. 82-93. (Smithsonian Institution Press, Washington).
- Department of Sustainability and Environment (2003). Western Port Bay Ramsar Site Strategic Management Plan (Department of Sustainability and Environment: Melbourne, Victoria.)
- Department of Sustainability and Environment (2005a). Victorian Fauna Display. (DSE/Viridians Biological Databases: Brighton East.)
- Department of Sustainability and Environment (2005b). A plan for Melbourne's Growth Areas. (Department of Sustainability and Environment: East Melbourne).

- Department of Sustainability and Environment. (2007a). Ecological Vegetation Class Benchmarks website: <http://www.dse.vic.gov.au/dse/nrence/nsf>
- Department of Sustainability and Environment. (2007a). Biodiversity interactive map: <http://nremap-sc.nre.vic.gov.au/MapShare.v2/imf.jsp?site=bnr-v1>
- Department of Sustainability and Environment (2007b). Advisory List of threatened vertebrate fauna in Victoria – 2007 (Department of Sustainability and Environment, East Melbourne.)
- Ecology Australia (2002). Proposed Bridge Re-alignment, Koo Wee Rup – Longwarry Road, Bayles: Additional Fauna Assessment. Report prepared by Williams, L.M. for VicRoads. (Ecology Australia Pty Ltd: Fairfield)
- Ecology Australia (2003). Flora and Fauna Assessment of 'Fairway Waters' Racecourse Road, Pakenham. Report prepared by Moysey, E.D., Kohout, M., Carr, G.W., for Westmont Holdings Pty Ltd/ Simon's Builders Pty Ltd (Ecology Australia Pty Ltd: Fairfield.)
- Ecology Australia (2004a). Re-appraisal of biodiversity values at Yallock Creek and Number 4 Drain, Bayles and EPBC implications of the proposed bridge replacements. Report prepared by D.G., Crowfoot, L.V., McMahon, A.R.G., McGuckin, J. for VicRoads. (Ecology Australia Pty Ltd: Fairfield and Streamline Research Pty Ltd: Eltham).
- Ecology Australia (2004b). Environment Protection and Biodiversity Conservation Act 1999 referral form. Referral form completed by VicRoads in association with Quin, D.G., Crowfoot, L.V., McMahon, A.R.G. of Ecology Australia for the Department of Environment and Heritage.
- Ecology Australia (2004c). Indigenous vegetation survey: An inventory of sites of biodiversity significance in the Pakenham growth corridor and adjoining area. Report prepared by McMillan, S.E., Way, S. for Shire of Cardinia. (Ecology Australia Pty Ltd: Fairfield).
- Ecology Australia (2005a). Healesville- Koo Wee Rup Road- Flora and Fauna Issues, Desktop Review. Report prepared by Crowfoot, L.V., Quin, D.G., McMahon, A.R.G. for VicRoads (Ecology Australia Pty Ltd, Fairfield).
- Ecology Australia (2005b). Results of a follow up Growling Grass Frog and threatened plant survey along Yallock Creek- Bayles. Report prepared by Quin, D.G., Wilson, C., Crowfoot, L.V., Campbell, C., for VicRoads (Ecology Australia Pty Ltd: Fairfield).
- Ecology Australia (2006c). Sub-regional Conservation Strategy for the Growling Grass Frog - Epping/Somerton, Victoria. Unpublished report prepared by C. Renowden, L.E. Conole, G.W. Heard and P. Robertson for Department of Primary Industries and Major Projects Victoria (Ecology Australia, Fairfield.)
- Ecology Australia (2006a). Healesville- Koo Wee Rup Road Upgrade- Growling Grass Frog Surveys. Report prepared by Renowden, C., Quin, D.G. for VicRoads (Ecology Australia Pty Ltd: Fairfield).
- Ecology Australia (2006b). Healesville- Koo Wee Rup Road- Southern Brown Bandicoot Survey. Report prepared by Renowden, C., Quin, D.G., Moysey, E., for VicRoads (Ecology Australia Pty Ltd: Fairfield).

- Ecology Australia (2006c). Healesville- Koo Wee Rup Road – Rare plant survey focusing on *Amphibromus fluitans*. Report prepared by Crowfoot, L.V., Campbell, C., Carr, G.W. for VicRoads. (Ecology Australia Pty Ltd: Fairfield)
- Ecology Australia (2006d). Flora and fauna values Deep Creek South Floodplain, Pakenham. Report prepared by Ashby, L., Quin, D.G. for Melbourne Water Corporation. (Ecology Australia Pty Ltd: Fairfield).
- Ecology Australia (2006e). Results of Growling Grass Frog Surveys, 2006: Bayles Bridge preconstruction. Report prepared by Renowden, C., Quin, D.G., for VicRoads (Ecology Australia Pty Ltd: Fairfield).
- Ecology Australia (2006f). Koo Wee Rup – Longwarry Road, Bayles/ Growling Grass Frog and Southern Brown Bandicoot EMP. Report prepared by Quin, D.G., Renowden, C., for VicRoads. (Ecology Australia Pty Ltd: Fairfield).
- Ecology Australia (2006g). Sub-regional Conservation Strategy for the Growling Grass Frog - Epping/Somerton, Victoria. Unpublished report prepared by C. Renowden, L.E. Conole, G.W. Heard and P. Robertson for Department of Primary Industries and Major Projects Victoria (Ecology Australia, Fairfield.)
- Ecology Australia (2007). Preliminary Flora and Fauna Assessment (Marine and Terrestrial) Lyalls Inlet – West Dalmore Road Drain, Tooradin. Unpublished report prepared by Moysey, E.D., Campbell, C.J., Judd, A., Quin, D.G., and Edmonds, M., for Melbourne Water Corporation (Ecology Australia Pty Ltd: Fairfield and Australian Marine Ecology, Kensington.)
- Ecology Australia (2008). Healesville – Koo Wee Rup Road – Pakenham Bypass, Alternate Connection. Desktop Review of Flora and Fauna Values. Unpublished report prepared by Schmidt, B., Quin, D., and Crowfoot, L., for VicRoads (Ecology Australia Pty Ltd: Fairfield)
- Ecology Partners (2007). Flora and fauna assessment for the proposed Pakenham industrial and employment precinct, Pakenham, Victoria. Draft Report prepared by Rybak, B., Organ, A., for Cardinia Shire Council. (Ecology Partners Pty Ltd: Brunswick).
- Forman, R.T.T. (1995). Land Mosaics: The Ecology of Landscapes and Regions. (Cambridge University Press, Cambridge.)
- Forman, R.T.T., and Alexander, L.E. (1998). Roads and their major ecological effects. *Annual Review of Ecology and Systematics* **29**, 207-231.
- Forman, R.T.T. (1995). The ecological effects of roads: toward three summary indices and an overview for North America. Pp. 40-54. In: Habitat Fragmentation and Infrastructure. Proceedings of the International Conference on Habitat Fragmentation, Infrastructure and the roles of Ecological Engineering. (Ministry of Transport, Public Works and Water Management: The Netherlands.)
- Hamer A.J., Lane S.J. and Mahony M. (2002). Management of freshwater wetlands for the endangered Green and Golden Bell Frog (*Litoria aurea*): roles of habitat determinants and space. *Biological Conservation* **106**:413-424.



- Heard, G., and Robertson, P. (2003). Yallock Creek and Yallock Cut Amphibian Study. Report of a Further Field Evaluation of the Habitat for Amphibians in the Yallock Creek Area, north of the South Gippsland Highway. Report prepared for Melbourne Water (Wildlife Profiles: Heidelberg.)
- Heard G., Robertson P. and Scroggie M. (2004). The ecology and conservation status of the Growling Grass Frog (*Litoria raniformis*) within the Merri Creek Corridor. Report prepared for the Department of Sustainability and Environment. (Wildlife Profiles P/L and the Arthur Rylah Institute for Environmental Research.)
- Komak, S. and Crossland, M.r. (2000). An assessment if the introduced mosquito fish (*Gambusia affinis hobrooki*) as a predator of eggs, hatchlings and tadpoles of native and non-native anurans. *Wildlife Research*, Vol: 20 pp 185-189.
- Mansergh, I.M, and Scotts, D.J. (1989). Habitat continuity and social organization of the Mountain Pygmy-possum restored by tunnel. *Journal of Wildlife Management* **53**, 701-707.
- National Parks and Wildlife Service (2001). Hygiene protocol for the control of disease in frogs. Information Circular No. 6. (N.S.W. National Park s and Wildlife Service, Hurstville).
- Pyke, G.H. (2002). A review of the biology of the Southern Bell Frog *Litoria raniformis* (Anura: Hylidae). *Australian Zoologist* **32**, 32-48.
- Pyke G.H. and White A.W. (2001). A review of the biology of the Green and Golden Bell Frog *Litoria aurea*. *Australian Zoologist* **31**: 563-598.
- Robertson, P. (1998). *Egernia coventryi* Swamp Skink Nomination prepared for Listing on Schedule 2 of the *Flora and Fauna Guarantee Act*, 1988. Unpublished report prepared for the Scientific Committee. (Wildlife Profiles, Heidelberg.)
- Robertson, P. (2002). Discussion Paper: Design requirements for structures to ameliorate the potential effects on frog movement of construction and operation of the proposed Craigieburn Bypass Freeway. Report prepared for VicRoads (Wildlife Profiles, Heidelberg.)
- Robertson, P., and Heard, G. (2002). Yallock Creek and Yallock Cut Amphibian Study. Report of a Field Evaluation of the Habitat for Amphibians in the Yallock Creek Area, south of the South Gippsland Highway. Report prepared for Melbourne Water (Wildlife Profiles: Heidelberg.)
- Robertson P., Heard G. and Scroggie M. (2002) The ecology and conservation status of the Growling Grass Frog (*Litoria raniformis*) within the Merri Creek Corridor, Interim report: Distribution, abundance and habitat requirements. Report prepared for DSE by Wildlife Profiles Pty Ltd and Arthur Rylah Institute for Environmental Research.
- Schulz, M. (1985). The occurrence of the mourning skink, *Egernia coventryi* Storr, in saltmarsh in Westernport Bay, Victoria. *The Victorian Naturalist* **102(5)**, 148-152.
- Tyler, M. (1997). The Action Plan for Australian Frogs. (Wildlife Australia Endangered Species Program for Environment Australia: Canberra.)

- Wassens, S., Watts, R.J., Jansen, A., and Roshier, D. (2008). Movement patterns of southern bell frogs (*Litoria raniformis*) in response to flooding. *Wildlife Research* **35**, 50-58.
- Williams, L.M. (2001). Proposed Hume (F2) Freeway: Southern Bell Frog (*Litoria raniformis*) survey. Unpublished Report prepared for VicRoads (Ecology Australia: Melbourne.)
- Wilson, C. (2003). The use of translocations as a conservation strategy for the Growling Grass Frog *Litoria raniformis*. Unpublished Third year research project. (Deakin University, Burwood.)
- Yugovic J. and Mitchell, S. (2006). Ecological review of the Koo-Wee-Rup Swamp and associated grasslands. *The Victorian Naturalist* **123**, 323 – 334.

## 10 Acknowledgments

We would like to thank the following people for assistance with the production of this report:

- Andrew McMahon, Bernadette Schmidt, Lisa Crowfoot and Jamie McMahon (Ecology Australia);
- Tony Hillman (VicRoads); and
- Property owners who kindly assisted with access to survey sites.

**Appendix 1** Wetland habitat assessment pro-forma for Growling Grass Frogs

**GGF Site Habitat Variables**

**Location:**

**AMG:**

**Personnel Present:**

**Date:**

**Time of Day:**

<b>Type of Waterbody:</b>
<b>Flow (H; M; L):</b>
<b>Length of stream (m):</b>
<b>Stream Width (m):</b>
<b>Stream Depth (m):</b>
<b>Perimeter of Waterbody (m):</b>

<b>Temperature:</b>	
<b>Permanence (0 – 3):</b>	
0 = sporadic	
1 = ephemeral	
2 = semi-permanent	
3 = permanent	

**Vegetation Cover (%)**

Emergent:
Submergent:
Floating:
Fringing (within 5 m of shoreline):
Dominant Plant species:

*General description of vegetation/habitat structure and quality:*

*Evidence of grazing/disturbance:*

<b>Substrate (%)</b>
Bare rock
Bare ground/soil
Rock rubble
Logs/Fallen Timber
Artificial

**Comments:**

**Appendix 2.** Healesville- Koo Wee Rup Road Upgrade: Habitat assessment and Growling Grass Frog survey results from the study area.

Site No.	Type of Waterbody	Size (approx.)	Permanence	Vegetation cover %				Dominant plant species	Grazing	Substrate %					Comments	Frogs
				Emergent	Submergent	Floating	Fringing			Bare rock	Bare ground/soil	Rock rubble	Logs/fallen timber	Artificial		
1	Dam	30 by 15 m	3	0	0	35	0	Algae, grasses	Deer; pugged	0	100	0	0	0	Fenced off dam on deer farm; 35% algal cover and remainder open water; pugged bare banks, with exotic grasses on edge; and some steep banks.	1 GGF on floating algae
2	Dam	100 by 20 m	3	0	0	0	0	grasses	Deer; pugged	0	100	0	0	0	Large dam with largely incised/eroded banks and no vegetation within or on banks; and exotic grasses outside.	0 GGF
3	Dam	96 by 8 m	3	20	30	0	40	<i>Eleocharis</i> , <i>Juncus</i> , <i>Potamogeton</i> , <i>Rubus</i> , exotic grasses	Cattle grazing	0	60	5	5	0	Good quality GGF habitat, but none recorded during survey. GFF likely.	0 GGF 1 SBTF in dam 1 WTF in drain along Railway Lane. 2 metamorph SMF
4	Dam	No water	0	-	-	-	-	No assessed	-	-	-	-	-	-	Dry at time of assessment	No survey
5	Dam	22 by 15 m	1	-	-	-	-	<i>Carex</i> , <i>Potamogeton</i> , exotic grasses	Cattle grazing	-	-	-	-	-	Dry at time of survey; potential habitat when wet earlier in season; numerous drainage lines with dense exotic grass (i.e. overwintering and dispersal habitat).	No survey
6	Dam	34 by 15 m (75% capacity)	3	5	0	0	30	Exotic grasses and <i>Juncus</i>	Cattle grazing	0	60	0	0	0	Low-moderate quality habitat; large area of bare banks; drains along HKWRR adjoin dam. GGFs likely.	0
7	Dam	25 by 12 m	0	0	0	0	5	Pasture grasses	Cattle	0	95	0	0	0	Low quality dam with	0

		(60% capacity)							grazing						heavily grazed and pugged banks, opaque water.	
8	Dam	60 by 12 m (30% capacity)	3	35	20	15	5	<i>Eleocharis</i> , <i>Potamogeton</i> , Filamentous algae, exotic grasses, blackberry	Fenced off from horses	0	95	0	0	0	Structurally diverse aquatic vegetation, but banks deeply incised; banks lightly vegetated with grasses and other weeds. Dam full of Mosquitfish and one Short-finned Eel seen.	0
9	Dam	275 by 50 m	3	10	15	15	90	<i>Juncus</i> , algae, <i>Potamogeton</i> , exotic grasses	Cattle grazing	0	5	0	0	0	Large dam adjacent Toomuc Creek; excellent, structurally diverse GGF habitat; GGFs previously recorded, including 39 metamorphs, 4 adult males and 3 adult females (Biosis 2005; also see Ecology Australia 2008).	No survey undertaken; outside alignment
10	Dam	70 by 40 m (40% capacity)	3	15	0	5	95	<i>Typha</i> , exotic grasses	-	0	5	0	0	0	Large and deep market garden dam with dense narrow band of emergent <i>Typha</i> on edges. Probably many more than 3 GGF, but difficult to survey. Drains along adjoining roads.	3 GGF – clinging to <i>Typha</i> . 1 SBTF in dam. 1 WTF in road reserve.
11	Dam	47 by 42 m (60% capacity)	3	0	20	10	90	Exotic grasses and filamentous and floating algae	Cattle grazing	0	100	0	0	20	Large, deep market garden dam, with no emergent vegetation. A patch of floating algae below water line. A 2 m strip of bare banks, then dense exotic grasses fenced off from bare cropped land. Drains along adjoining roads (Ballarto and HKWRR).	49 GGF, including three generations – mostly 4-6 cm; one at 10 cm and a few 6-10 cm long.
12	Dam	25 by 8 m	3	<5	100	0	100	Submergent salt tolerant algae, Phragmites, <i>Sarcocornia</i> , Spiny Rush, Salt	None	0	10	0	0	0	Very salt affected dam. Owner has tested water which is very salty. Algae is possibly a sea species. Probably unsuitable for	No survey.

								Grass, Pigs face, <i>Lemna</i> , exotic grasses, <i>Poa</i> and <i>Phalaris</i>							GGF. Owner has recorded GGF in depressions after rain and around septic tank spray areas. Abundant long grasses would provide shelter if GGF's need to stay after rain.	
13	Dam	20 by 8 m (only 30% capacity)	2-3	30	15	40	100	Water Couch, <i>Juncus</i> , and other exotic grasses.	No recent	0	0	0	0	0	Fenced off stock dam which has had low water capacity for some time. Poor water quality, but lots of dense grass adjoining for overwintering. Land holder reports GGF in past.	0 GGF, 1 SBTF
14	Dam	20 by 15 and 30 by 20 m	3	0	0	0	20	Exotic grasses and <i>Juncus</i>	Cattle grazing	0	80	0	0	0	Degraded stock dam with heavily pugged edges, no aquatic vegetation and incised banks. Low quality, but GGF likely. Land holder reports GGF in past.	0 GGF, 1 SBTF 1 WTF
15	Dam	28 by 10 m	3	25	0	5	60	<i>Phragmites</i> , <i>Potamageton</i> , exotic grasses, <i>Juncus</i> , Water Couch and <i>Phalaris</i>	Cattle grazing	0	40	0	0	0	Degraded stock dam with heavily pugged edges, with a patch of <i>Potamageton</i> and <i>Phragmites</i> in the centre. Low quality drains run along adjoining road. Low quality, but GGF likely. Land holder reports GGF in past.	0 GGF
16	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	Part of a system of small stock dams of low-moderate quality (i.e. fringing vegetation, but little submergent or floating vegetation, and drains (Toomuc Creek, close-by) within close proximity. GGFs recorded in past, in low numbers (e.g. 1-6 frogs; see Biosis 2005 and Ecology Australia 2008).	No survey undertaken Habitat Assessment only.



17	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	Ditto (6 adult males recorded, Biosis 2005)	ditto
18	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	ditto	ditto
19	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	ditto	ditto
20	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	ditto	ditto
21	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	ditto	ditto
22	Dam	-	-	-	-	-	-	-	-	-	-	-	-	-	ditto	ditto

GGF = Growling Grass Frog (*Litoria raniformis*). SBTF = Southern Brown Tree Frog (*Litoria ewingii*). WTF = Whistling (Verreaux's) Tree Frog (*Litoria verreauxii*). SMF = Spotted Marsh Frog (*Limnodynastes tasmaniensis*).



**Appendix 3.** Compilation of recent records (2002-2008) of Growling Grass Frogs from previous surveys for the study area (original table from Ecology Australia 2008; updated with records from this study).

Legend: A= Adult; J= Juvenile; Met= Metamorphling

F= Female; M= Male

N= North; E= East; S=South; W= West

Date	Record	Location	Source
<b>Officer group</b>			
<i>Records begin 2 km NW of study area</i>			
1/12/2002	3 heard	N of Lecky Rd., near Gum Scrub Crk.	DSE 2004
1/12/2002	15 heard	In dam immediately S of Pakenham Bypass	DSE 2004
1/12/2002	3 heard	In dam 300 m S of Lecky Rd., west side of Cardinia Rd.	DSE 2004
23/01/2003	1 AF seen	In dam adjacent to Cardinia Rd., on the west side	DSE 2004
20/11/2003	1 AM seen	Leckey Rd, where it crosses Gum Scrub Crk	Biosis 2005
20/11/2003	17 AM heard	200 m W of Cardinia Rd., and 400 m S of Leckey Rd.	Biosis 2005
20/11/2003	5 AM heard	300 m W of Cardinia Rd., 600 m S of Princess Hwy, along railway line	Biosis 2005
3/12/2003	28 AM seen	200 m W of Cardinia Rd., and 400 m S of Leckey Rd.	Biosis 2005
3/12/2003	5 AM heard	300 m W of Cardinia Rd., 600 m S of Princess Hwy, along railway line	Biosis 2005
4/12/2003	15 AM heard	600 m SE of Officer, along railway line	Biosis 2005
4/12/2003	5 AM heard; 1 AF trapped	800 m W of Cardinia Rd., and 500 m S of Princess Hwy, along railway line	Biosis 2005
25/02/2004	1 Met. trapped	200 m W of Cardinia Rd., and 1.3 km S of Princess Hwy	Biosis 2005
25/02/2004	2 A seen	400 m W of Cardinia Rd., and 1.4 km S of Princess Hwy	Biosis 2005
13/12/2004	1 Met. trapped	400 m W of Cardinia Rd., and 1 km S of Princess Hwy	Biosis 2005
3/12/2004	3 AM heard; 2 AF trapped; 1 J seen	400 m W of Cardinia Rd., and 1.4 km S of Princess Hwy	Biosis 2005
25/12/2004	2 AM seen	Leckey Rd, where it crosses Gum Scrub Crk	Biosis 2005
<b>Toomuc Creek group</b>			
<i>Includes study area</i>			
1/12/2002	2 heard	In dam near a drainage line of Toomuc Crk, 300 m N of Wenn Rd.	DSE 2004
1/12/2002	2 heard	In dam 200 m N of Key Lane.	DSE 2004
1/12/2002	2 heard	In dam 300 m NW of Key Lane	DSE 2004
2003	3 SA seen; 6 AM heard	700 m W of McGregor Rd., and 400 m N of Watsons Rd.	Biosis 2005
20/11/2003	6 AM heard	Along Watsons Rd where it crosses Toomuc Creek, 1 km W of McGregor Rd.	Biosis 2005
4/12/2003	2 AM heard	200 m N of Key Lane, and 800 m E of Toomuc Crk.	Biosis 2005
4/12/2003	6 AM heard	200 m N of Key Lane and 600 m W of McGregor Rd.	Biosis 2005
4/12/2003	1 AM heard	150 m N of Key Lane and 500 m W of McGregor Rd.	Biosis 2005
4/12/2003	3 AM heard	150 m N of Key Lane and 200 m W of McGregor Rd.	Biosis 2005
24/12/2003	2 AM heard; 3 AM seen	Along Watsons Rd where it crosses Toomuc Creek, 1 km W of McGregor Rd.	Biosis 2005
24/12/2003	4 A, 1 J seen	750 m W of McGregor Rd., and 300 m N of Watsons Rd.	Biosis 2005
2004	39 Met., 4 AM seen; 3 AF trapped	Large dam along Toomuc Crk., 500 m S of Pakenham Bypass	Biosis 2005
12/02/2004	1 AF, 15 Met. seen	300 m S of Pakenham Bypass, along drainage line of Toomuc Crk.	Biosis 2005
12/02/2004	2 Met. Trapped	300 m S of Pakenham Bypass, and 700 m E of Toomuc Crk.	Biosis 2005
12/02/2004	3 Met. Trapped	400 m S of Pakenham Bypass, and 700 m E of Toomuc Crk	Biosis 2005

# Healesville - Koo Wee Rup Road Upgrade: Growling Grass Frog and Swamp Skink survey



Date	Record	Location	Source
Nov - Dec 2006	unspecified record	Large dam immediately adjacent to Toomuc Crk, 500 m S of Pakenham Bypass.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	Along Toomuc Crk., 1.5 km W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	200 m N of Key Lane, and 600 m W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	250 m N of Key Lane, and 600 m W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	250 m N of Key Lane, and 500 m W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	200 m N of Key Lane, and 200 m W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	250 m N of Key Lane, and 200 m W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	650 m N of Key Lane, and 1.2 km W of McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	300 m S of Pakenham Bypass and 900 m W of McGregor Rd.	Ecology Partners 2007
<b>McDonalds Drain group</b>		<b>Records begin 1.8 km E of study area</b>	
Jan-Feb 2003	unspecified record	Along Five Mile Rd. 1.8 km E of McDonalds Drain Rd., and 2.7 km NE of Pakenham South.	Biosis 2005
19/02/2003	16 Met., 10 AM seen	350 m E of McDonalds Drain Rd., and 1.8 km NE of Pakenham South. 1 km SE of Deep Crk.	Biosis 2005
15/11/2003	10 AM heard	350 m E of McDonalds Drain Rd., and 1.8 km NE of Pakenham South. 1 km SE of Deep Crk.	Biosis 2005
15/11/2003	5 AM heard	150 m W of McDonalds Drain Rd., and 1.1 km N of Pakenham South	Biosis 2005
15/11/2003	2 AM heard	Along McDonalds Drain, Pakenham South.	Biosis 2005
19/11/2003	5 AM heard	600 m E of Five Mile Rd., and 3.4 km NE of Pakenham South.	Biosis 2005
19/11/2003	2 AM heard	600 m E of Five Mile Rd., and 3.8 km NE of Pakenham South.	Biosis 2005
19/11/2003	25 AM heard	Along Seven Mile Rd. 5 km ENE of Pakenham South.	Biosis 2005
20/11/2003	5 AM heard	1.8 km E of McDonalds Drain Rd., and 2 km NE of Pakenham South, along Five Mile Rd.	Biosis 2005
20/11/2003	20 AM heard; 1 AM seen	Along McDonalds Drain, Pakenham South.	Biosis 2005
9/12/2003	1 Met. trapped	450 m E of McDonalds Drain Rd., and 1.2 km NE of Pakenham South.	Biosis 2005
9/12/2003	5 AM seen	Along McDonalds Drain, Pakenham South.	Biosis 2005
9/12/2003	2 AM seen	250 m W of Seven Mile Rd., and 4.5 km ENE of Pakenham South.	Biosis 2005
9/12/2003	2 AM, 1 J seen	250 m W of Seven Mile Rd., and 4.7 km ENE of Pakenham South.	Biosis 2005
10/12/2003	1 SA seen	150 m E of McDonalds Drain Rd., and 1.2 km NE of Pakenham South.	Biosis 2005
10/12/2003	3 AM heard	200 m E of McDonalds Drain Rd., and 1.3 km NE of Pakenham South.	Biosis 2005
10/12/2003	20 AM heard	800 m E of McDonalds Drain Rd., and 1.3 km NE of Pakenham South.	Biosis 2005
19/12/2003	1 AM heard	800 m E of McDonalds Drain Rd. , and 1.8 km NE of Pakenham South.	Biosis 2005
19/12/2003	15 AM heard	Along Seven Mile Rd. 5 km ENE of Pakenham South.	Biosis 2005
25/02/2004	6 AM seen	900 m E of McDonalds Drain Rd., and 1.3 km NE of Pakenham South.	Biosis 2005
<b>Pakenham Golf Course group</b>		<b>Records begin 7.2 km NE of study area</b>	
1/12/2002	3 heard	In dam in a paddock along railway line.	DSE 2004
1/12/2002	1 heard	In culvert adjacent t to railway line.	DSE 2004
11/12/2003	23 heard	In dams just N of railway line	DSE 2004

Date	Record	Location	Source
26/12/2002	10	Pakenham Golf course	DSE 2004
Jan-Feb 2003	unspecified record	900 m E of Ryan Rd., along railway line	Biosis 2005
Jan-Feb 2003	unspecified record	950 m E of Ryan Rd., along railway line	Biosis 2005
23/01/2003	5 seen	In dams within Golf course	DSE 2004
23/02/2003	4 heard	Five Mile Rd., adjacent to drain of Ararat Crk., feeding into McDonalds drain.	DSE 2004
13/11/2003	2 AM heard; 1 A seen	800 m E of Ryan Rd., and 800 m NE of Canty Lane	Biosis 2005
13/11/2003	10 AM heard; 5 A seen	800 m E of Ryan Rd., and 450 m NE of Canty Lane	Biosis 2005
14/11/2003	2 AM heard	Pakenham Golf Course, 800 m E of Ryan Rd., and 600 m E of Deep Creek.	Biosis 2005
14/11/2003	2 AM heard	1.05 km E of Ryan Rd., along railway line	Biosis 2005
14/11/2003	3 AM heard	1.15 km E of Ryan Rd., along railway line	Biosis 2005
14/11/2003	3 AM heard	1.5 km E of Ryan Rd., along railway line	Biosis 2005
9/01/2004	5 AM, 1 AF trapped	450 m E of Mt. Ararat Rd., and 900 m S of Princess Hwy.	Biosis 2005
27/01/2004	2 AM heard; 4 AF seen	2 km E of Ryan Rd., along railway line, 250 m W of Mt. Ararat Rd.	Biosis 2005
4/02/2004	7 AM seen; 1 AF trapped	400 m E of Mt. Ararat Rd., and 600 m S of Princess Hwy.	Biosis 2005
4/02/2004	7 A seen	600 m E of Mt. Ararat Rd., and 500 m S of Princess Hwy.	Biosis 2005
<b>Koo Wee Rup South group</b>			
9/01/2006	1 A seen	Waterbody 100 m N of Rossiter Rd., 200 m W of South Gippsland Hwy.	Ecology Australia 2006a
9/01/2006	1 A seen	Waterbody 70 m S of Rossiter Rd., 700 m E of Bunyip River	Ecology Australia 2006a
11/01/2006	1 A heard	Waterbody 150 m N of South Gippsland Hwy., 500 m SE of Rossiter Rd.	Ecology Australia 2006a
11/02/2008	1 A seen	Waterbody c. 800 m NE of South Gippland Highway and Rossiter Road intersection	Ecology Australia this study
<b>Deep Creek Group</b>			
23/01/2003	2 seen	Deep Crk, on the bank of channel east side of McGregor Rd.	DSE 2004
5/02/2003	2 seen	Deep Crk, on the bank of channel east side of McGregor Rd.	DSE 2004
21/12/2005	2 A seen	Waterbody 50 m W of Healesville - Koo Wee Rup Rd., at Deep Crk.	A. Organ, Ecology Partners. <i>Pers. Comm.</i>
21/12/2005	5 A seen (1 dead) by night; 2 A seen by day	Waterbody 50 m S of Deep Crk, west side of Healesville - Koo Wee Rup Rd.	Ecology Australia 2006a
11/01/2006	2 A heard and seen	Along Healesville - Koo Wee Rup Rd. 1.2 km S of Hall Rd.	Ecology Australia 2006a
12/01/2006	1 A heard and seen	500 m S of Deep Crk., and 150 m W of Healesville - Koo Wee Rup Rd.	Ecology Australia
Nov - Dec 2006	unspecified record	Along Deep Crk., where it crosses McGregor Rd.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	125 m W of Healesville - Koo Wee Rup Rd., on the S side of Deep Crk.	Ecology Partners 2007
Nov - Dec 2006	unspecified record	375 m E of Healesville - Koo Wee Rup Rd., on S side of Greenhills Rd.	Ecology Partners 2007
6/03/2008	3 A seen	300 m W of Healesville - Koo Wee Rup Rd., on N side of Ballarto Rd.	Ecology Australia this study

Healesville - Koo Wee Rup Road Upgrade: Growling Grass Frog and  
Swamp Skink survey

---



<b>Date</b>	<b>Record</b>	<b>Location</b>	<b>Source</b>
6/03/2008	49 seen	400 m E of Healesville - Koo Wee Rup Rd., on S side of Ballarto Rd.	Ecology Australia this study

---