ecology & heritage partners

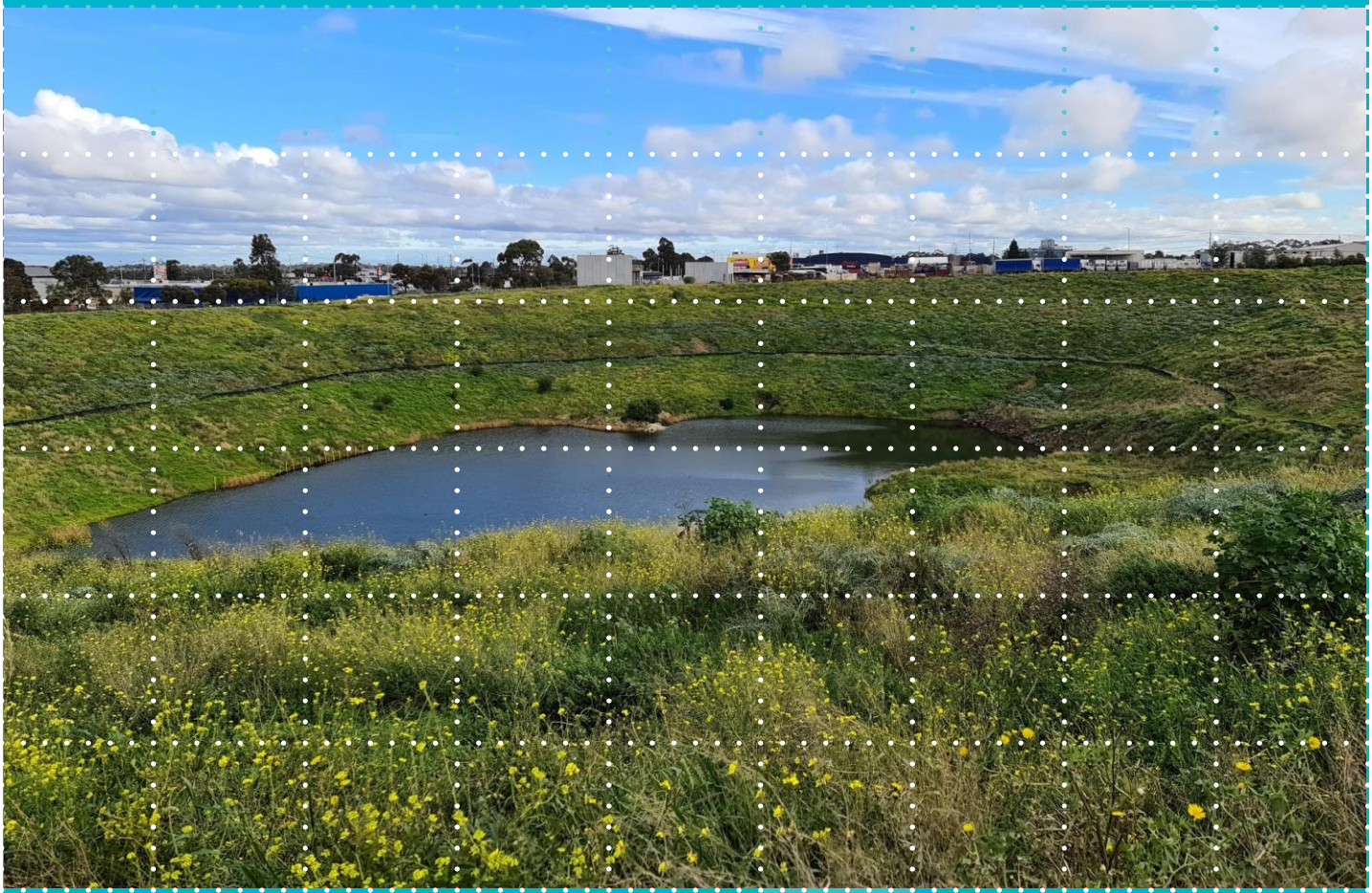
Final Report

Preliminary Documentation: Proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria (EPBC 2020/8748).

Prepared for

Forte Group Pty Ltd

May 2021



Ecology and Heritage Partners Pty Ltd

MELBOURNE: 292 Mt Alexander Road Ascot Vale VIC 3032 **GEELONG:** PO Box 8048 Newtown VIC 3220
BRISBANE: Level 22, 127 Creek Street Brisbane QLD 4000 **ADELAIDE:** 22 Greenhill Road Wayville SA 5034
CANBERRA: Level 6, 39 London Circuit, Canberra ACT 2601 **SYDNEY:** Level 5, 616 Harris Street, Ultimo, NSW, 2007
www.ehpartners.com.au | 1300 839 325

DOCUMENT CONTROL

Assessment	Preliminary Documentation (EPBC 2020/8748)
Address	75-135 Bolinda Road Campbellfield, Victoria
Project number	13138
Project manager	Jeremy Coyne (Zoologist / Team Leader - Natural Heritage)
Report reviewer	Aaron Organ (Director/Principal Ecologist)
Mapping	Monique Elsley (GIS Co-Ordinator)
File name	13138_EHP_PD_ 75-135 Bolinda Road Campbellfield _Final V4_26052021
Client	Forte Group Pty Ltd
Bioregion	Victorian Volcanic Plain
CMA	Port Philip and Westernport
Council	Hume City Council

Report versions	Comments	Comments updated by	Date submitted
Draft	Submitted to client for review		22/10/2020
Draft	Submitted to DAWE for review		09/11/2020
Final	Submitted to client for review		24/12/2020
Final V2	Submitted to DAWE for review		11/02/2021
Final V3	Submitted to DAWE for review		22/04/2021
Final V4	Submitted to DAWE for review		26/05/2021

Acknowledgements

We thank the following people for their contribution to the project:

- William Tan (Forte Group Pty Ltd) for project information and site access;
- John Glossop (Glossop Town Planning) for project information;
- Joe Cornetta (Cornetta Partners Architects) for project information;
- Craig Czarny (Hansen Partnership Pty Ltd) for project information; and,
- Victorian Department of Environment, Land, Water and Planning (DELWP) and the Commonwealth The Commonwealth Department of Agriculture, Water and the Environment's (DAWE) for access to online ecological databases.

Copyright © Ecology and Heritage Partners Pty Ltd

This document is subject to copyright and may only be used for the purposes for which it was commissioned. The use or copying of this document in whole or part without the permission of Ecology and Heritage Partners Pty Ltd is an infringement of copyright.

Disclaimer

Although Ecology and Heritage Partners Pty Ltd have taken all the necessary steps to ensure that an accurate document has been prepared, the company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report and its contents.

GLOSSARY

Acronym	Description
CaLP	*Catchment and Land Protection Act 1994*
CMA	Catchment Management Authority
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DELWP	Victorian Department of Environment, Land, Water and Planning
DEPI	(former) Victorian Department of Environment and Primary Industries
DoE	(former) Commonwealth Department of Environment
DoEE	Commonwealth Department of Environment and Energy
DSEWPaC	(former) Commonwealth Department of Sustainability, Environment, Water, Populations and Communities.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
FFG Act	*Flora and Fauna Guarantee Act 1988*
FIS	Flora Information System
GGF	Growling Grass Frog *Litoria raniformis*
HabHa	Habitat Hectare
NES	National Environmental Significance
NVIM Tool	Native Vegetation Information Management Tool (DELWP)
P&E Act	*Planning and Environment Act 1987*
PMST	Protected Matters Search Tool (DAWE)
VBA	Victorian Biodiversity Atlas (DELWP)

SUMMARY

Ecology and Heritage Partners Pty Ltd were commissioned by Forte Group Pty Ltd to prepare the Preliminary Documentation for the proposed commercial development at 75-135 Bolinda Road Campbellfield, Victoria (the study area) (EPBC 2020/8748).

It has been determined under Section 75 of the EPBC Act that the proposed action is a 'controlled action', and that the development of the study area will likely have a significant impact on 'Listed threatened species and communities' (section 18 and Section 18A). It has also been determined that the proposed action will be assessed by preliminary documentation.

Specifically, the matter of National Environmental Significance (NES) that the Commonwealth Department of Agriculture, Water and the Environment's (DAWE) has requested additional information for is regarding the EPBC Act-listed Growling Grass Frog *Litoria raniformis*.

The study area is approximately 16.4 hectares in size and the extent of approved filling of the former quarry has recently been completed in accordance with the works authority (WA109) to develop a safe and stable final landform to the satisfaction of the Victorian Department of Jobs, Precincts and Regions (DJPR).

The study area is proposed to be developed in nine stages in line with the Industrial 1 zoning for the land, with construction planned to commence in June 2021. The area within the quarry void will remain as an area to support the extant Growling Grass Frog population.

A biodiversity assessment was completed by Ecology and Heritage Partners in March 2020 which investigates the ecological significance of the site and the likely impacts of the proposed action. Growling Grass Frog has previously been recorded within, and in close proximity to the study area (e.g. as well as in the broader geographic region.

Growling Grass Frog breeding habitat is present within the study area in the form of one large open waterbody at bottom of the quarry void. The resident population constitutes an 'important population' in accordance with the significant impact guidelines for the species. Based on the proposed action, all areas of breeding habitat will be retained as will all high-quality terrestrial foraging habitat directly adjacent to the quarry wetland. The proposed development will impact an area of low quality and degraded terrestrial habitat around the rim of the quarry void covering approximately 1.5 hectares (Figure 2). The habitat quality in these areas is consistent with the low quality or lack of habitat in the disturbed areas outside the quarry void. Only degraded and low-moderate quality terrestrial habitat will be impacted.

To mitigate against the potential impacts (i.e. impact to terrestrial habitat and isolation) to the resident Growling Grass Frog population, habitat creation and improvement will be undertaken within the study area in three distinct offset areas. These Proposed Offset areas are described below (Table S1) and represented on Figure 3, and will provide additional breeding, dispersal and foraging habitat for Growling Grass Frog. Areas identified for habitat creation have the primary aim of ensuring there is an overall improvement for the species (i.e. provision of high-quality breeding habitat) (Appendix 2) (Figure 2).

Table S1. Offset Area breakdown

Offset Area	Description	Area of Habitat (Ha)
Offset Area 1	Terrestrial habitat within the quarry void	1.5
Offset Area 2	Wetland habitat within the movement corridor	0.39
Offset Area 3	Terrestrial habitat within the movement corridor	0.5

The development of the surrounding area will create a barrier to movement between the quarry waterbody and Merri Creek to the east. Therefore a dedicated dispersal corridor will be constructed to facilitate frog dispersal between the quarry void and Merri Creek. The proposed dedicated wetlands (Offset Area 2) will include a back-up water delivery system in the design using water from within the quarry void to maintain water levels in the wetlands, including during periods of low rainfall (e.g. drought). The design of this system will incorporate a holding tank which will be filled with water from the quarry, which is controlled by a manually operated butterfly valve and discharged into Pond 1 within the constructed dispersal corridor.

While the existing Growling Grass Frog habitat within the quarry void will not be impacted by the development, these areas will be enhanced (Offset Area 1) through the provision of supplementary terrestrial habitat such as rock, logs and other ground debris and aquatic habitat (supplementary aquatic vegetation), as outlined in the Landscape Management Plan developed by Hansen Partnership Pty Ltd. Terrestrial habitat within the movement corridor (Offset Area 3) will also be enhanced through the provision of supplementary terrestrial habitat, as shown on the Landscape Management Plan (Appendix 1), and described in the Growling Grass Frog Conservation Management Plan (Appendix 2).

There will be ongoing management of threatening processes such as weed and pest animal control, and there will be no alteration to existing aquatic vegetation, or introduction of additional predatory species within the quarry void where existing breeding habitat is present.

The proposed development will not impact any other species or ecological community listed under the EPBC Act. The constructed waterbodies and associated dispersal corridor will create a net increase in the availability of breeding habitat for Growling Grass Frog (Appendix 1). While a total of 1.5 hectares of low quality foraging and dispersal habitat will be removed around the rim of the quarry void as part of development, the provision of eight created waterbodies in strategic locations along the dispersal corridor and the improvement of suitable terrestrial habitat within the quarry void adequately offsets the removal of habitat for the species.

CONTENTS

1 INTRODUCTION

1.1 Project Background

Ecology and Heritage Partners Pty Ltd were commissioned by Forte Group Pty Ltd to prepare the Preliminary Documentation for the proposed commercial development at 75-135 Bolinda Road Campbellfield, Victoria (EPBC 2020/8748) (Figure 1).

On 4 September 2020, it was determined by a delegate for the Department that under Section 75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) the proposed action is considered a controlled action, and that the development of the study area will likely have a significant impact on 'Listed threatened species and communities (Section 18 & Section 18A)'. It has also been determined that the proposed action will be assessed by preliminary documentation.

Owing to the known presence of a population of the nationally significant Growling Grass Frog (*Litoria raniformis*) within the former clay quarry, a referral under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (EPBC 2012/6372) covering the proposed activity was submitted on 20 April 2012 and deemed a 'Controlled Action' by DAWE [formally the Commonwealth Department of the Environment and Energy (DoEE)] on 30 May 2012 (Ecology and Heritage Partners 2012a). The initial approval conditions were provided by DAWE on 5 November 2014. A variation to the proposed action was accepted by DAWE on the 28 January 2014 and allowed for the following action within the study area:

> *'Partially filling in the waterbody and completely filling in the drainage line that has formed in the Bolinda Quarry'*.

In September 2016 Ecology and Heritage Partners was engaged by Bolinda Operations Pty Ltd to prepare a Conservation Management Plan (CMP) for the Growling Grass Frog population at Bolinda Road Quarry, Campbellfield, Victoria (Ecology and Heritage Partners 2016). The overall objective of the CMP was to provide detailed measures to ensure the proposed activity did not have a significant impact on the resident Growling Grass Frog population and associated habitats.

Between April 2010 and January 2019 filling work were undertaken at the site to the extent of approved filling of the former quarry, in accordance with the works authority (WA109) to develop a safe and stable final landform to the satisfaction of the Victorian Department of Jobs, Precincts and Regions (DJPR) (Plates 1-6). In January 2019 emergency works were undertaken under the existing works authority to address the issue of surface runoff flooding neighbouring properties to the south, adjacent to Roebourne Crescent Reserve. Following initial investigation, it was evident that the existing council drainage asset was no longer sufficient to handle the ensuing increased surface runoff resulting from the completed filling activities, and that the proponent was required under the *Water Act 1989* to implement additional measures to prevent further property damage and risk to public safety. Consequently, an open swale was excavated along the southern boundary of the study area which directs excess surface water to the east where it flows into the neighbouring property (Plate 15).

Ecology and Heritage Partners Pty Ltd was commissioned by Forte Group Pty Ltd in November 2019 to conduct a Biodiversity Assessment for a proposed Commercial Development at the site. The purpose of the assessment was to identify the extent and type of remnant native vegetation present within the study area, determine the

likely presence of significant flora and fauna species, and to discusses the potential ecological and legislative implications associated with the proposed action.

A development plan has been prepared as part of the planning permit application for the proposed commercial development, and this plan includes the provision of a dedicated dispersal corridor which will be constructed within the study area to facilitate frog dispersal between the quarry void and to the boundary of the property, with the future opportunity to continue the link to Merri Creek in the east. All high-quality habitat and associated dispersal corridors within the area will be retained and significantly enhanced through the construction of an unbroken chain of waterbodies and wetlands constructed throughout the length of the dispersal corridor to allow unimpeded dispersal of frogs. These waterbodies will be designed and constructed taking into consideration the *Growling Grass Frog Habitat Design Standards* (DELWP 2017a).

Ecology and Heritage Partners has prepared a Growling Grass Frog Conservation Management Plan for the proposed development which includes detail on the proposed development and how project impacts to the species will be avoided and measures to ensure that the resident population at the site remains viable in the future. The proposed development will not impact any other species or ecological community listed under the EPBC Act.

The following information includes that outlined in the EPBC Act referral, as well as additional information requested by DAWE regarding impacts of the action and the strategies proposed to avoid, mitigate and/or offset those impacts. The contents page of this report provides a reference table detailing where each of the requirements of the preliminary documentation request is addressed.

Plate 1. Progressive filling activities within the study area (Nearmap 01/04/2010)

Plate 2. Progressive filling activities within the study area (Nearmap 20/08/2011)

Plate 3. Progressive filling activities within the study area (Nearmap 23/10/2012)

Plate 4. Progressive filling activities within the study area (Nearmap 04/04/2016)

Plate 5. Progressive filling activities within the study area (Nearmap 08/02/2017)

Plate 6. Progressive filling activities within the study area (Nearmap 13/01/2019)

1.2 Site Context

The study area is located in Campbellfield, Victoria, approximately 27 kilometres north of Melbourne (Figure 1). It is surrounded by residential, commercial and industrial land to the north, west and south, and a resource recovery centre and former landfill site to the east. Approximately 16.2 hectares in size, the study area is dominated by sloping banks of bare earth, and open areas dominated by introduced grasses and weeds. A large waterbody has formed at the lowest point of the former quarry, and aquatic vegetation within the study area is largely limited to areas on the edge of the waterbody. Merri Creek is approximately 600 meters east of the study area and approximately 850 meters east of the waterbody. Areas to the north, south and west are development (residential and commercial development) with a large open area to the east which has not been developed and is owned by council. The topography of the study area in its current state is such that all surface water flows are directed away from the edge of the quarry void. The retained waterbody located at the lowest point of the quarry void is fed by groundwater, providing a permanent water source.

In 2009, the high-level Bolinda Road Former Landfill Site Master Plan (Meinhardt 2009) was developed for the former landfill site located approximately 180 metres east of the quarry. The Master Plan supported the development of a Public Open Space area (approximately nine hectares) and there is an opportunity to provide

additional habitat for Growling Grass Frog, allowing for the connection between the study area and Merri Creek to the east. The long-term success of the proposed habitat corridor within the study area will be dependent on the future connection of terrestrial and aquatic habitats that extent east from the study area (across the Council owned land) terminating at Merry Creek. It is also important that another large wetland, or a series of wetlands, are constructed within 100 metres of the eastern boundary of the current study area (on council land) and extend in an eastern directly to the Merri Creek. Continuous habitat, that incorporates the key habitat features required by the species (i.e. large waterbodies, suitable terrestrial habitat and habitat permeability / connectivity), will need to be created and managed appropriately to ensure the long-term persistence of the population in this area.

According to the Department of Environment, Land, Water and Planning (DELWP) NatureKit Map (DELWP 2021a), the study area occurs within the Victorian Volcanic Plain bioregion. It is located within the jurisdiction of the Port Philip and Westernport Catchment Management Authority (CMA) and the Hume City Council municipality.

2 DESCRIPTION OF THE ACTION

The site has been acquired for the subdivision and development of the land for industrial and commercial purposes in line with the Industrial 1 Zone for the land (DELWP 2021b). The site is proposed to be developed in nine stages, with construction planned to commence in June 2021. Activities will include:

- Remediation and rehabilitation of the land to be suitable for commercial development.
- Site levelling works and removal of clean fill deposits for the construction of road/infrastructure corridors.
- Development of associated site drainage, holding ponds and dedicated wetland corridor to aid in stormwater treatment and the dispersal and foraging ability of the population of frogs within the existing quarry void.
- Provision of pedestrian links and trails to encourage pedestrian activity in and around the site. Encouraging appropriate passive recreation can improve outcomes, such as allowing for the passive surveillance of waterbodies that can help reduce pollution (e.g. dumping of waste).
- Sewer, water main and storm water drainage construction and associated trenching areas already cleared of topsoil deposits.
- Construction of buildings on the lots together with car parking, fencing and landscaping.

The proposed action will include clearance and redevelopment across the site with the exception of the central quarry void and the habitat corridor proposed to be created on the southern boundary of the study area (Plate 8 and 9).

The proposed development and work area covers an area of approximately 10.5 hectares and consists of all areas outside the quarry void, and will impact an area of low quality and degraded terrestrial habitat around the rim of the quarry void covering approximately 1.5 hectares (Figure 2). The habitat quality in these areas is consistent with the low quality or lack of habitat in the disturbed area outside the quarry void. Frogs may occasionally use these areas during dispersal events (i.e. warm, wet conditions). However, given the degraded and highly modified condition of these areas, they are not considered to provide important or limiting habitat for the species. The location of the areas proposed to be impacted are also unlikely to provide any dispersal habitat (i.e. entirely developed and inhospitable for the species) as there are no wetlands, waterbodies or movement corridors to the north, west or south of the quarry void where frogs may attempt to access these areas.

3 DESCRIPTION OF THE ENVIRONMENT AND MNES

3.1 The Environment

A biodiversity assessment was completed by Ecology and Heritage Partners in March 2020. The purpose of the assessment was to identify the extent and type of remnant native vegetation present within the study area and to determine the likely presence of significant flora and fauna species. The entire study area was assessed with all commonly observed vascular flora and fauna species recorded, significant records mapped and the overall condition of vegetation and habitats noted.

Due to the long history of quarrying and landfill activities at the site (Plates 1-6), the terrestrial habitat on site is highly degraded and the site is now dominated by exotic flora species (Plate 7 and 8). The only native species recorded in the study area were Common Spike Rush *Eleocaris acuta*, Cumbungi *Typha orientalis* and Common Wallaby-grass *Rytidosperma caespitosum* the cover of which is minimal and does not constitute a patch under the *'Guidelines for the removal, destruction or lopping of native vegetation'* (the Guidelines) (DELWP 2017b). The study area consists of heavily modified open areas that contain exotic pastures likely to be used as a foraging resource by common generalist bird species which are tolerant of modified open areas. Areas outside the quarry void may occasionally be used by Growling Grass Frog during dispersal events (i.e. warm, wet conditions). However, given the highly modified and degraded condition of these areas they are not considered to be regularly used by the species.

A large section of the study area covering approximately 3.4 hectares along the Eastern boundary is currently being used as a storage facility and stand-off area for a range of construction equipment, building material and storage containers (Plate 9) (Figure 2). This area is not considered to contain any of the habitat characteristics require by Growling Graff Frog, and consists of predominantly bare ground and access tracks used by vehicles to access the equipment stored on site. Vegetation in this area is sparse and limited to scattered occurrences of exotic species.

Plate 7. Introduced grass and weed species within the study area (Ecology and Heritage Partners Pty Ltd 11/03/2020).

Plate 8. Location of proposed dispersal corridor on the southern boundary of the study area (Ecology and Heritage Partners Pty Ltd 11/02/2016)

Plate 9. Storage facility and stand-off area in the east of the study area (Ecology and Heritage Partners Pty Ltd 23/09/2020).

Plate 10. Degraded Growling Grass Frog foraging and dispersal habitat in the east of the study area (Ecology and Heritage Partners Pty Ltd 23/09/2020)

3.1.1 Quarry Wetland

The quarry void (Figure 2) (Plates 5-8), is large with steep sloping banks on all sides. The northern, western and southern banks are dominated by introduced grasses, woody weeds and thistles. The presence of a permanent water source combined with fringing, aquatic and semi-aquatic vegetation such as Common Spike-rush, Cumbungi *Typha orientalis* and Fennel Pondweed *Potamogeton pectinatus* provides high quality breeding and refuge habitat for the extent Growling Grass Frog population and a range of locally common frog species (Plates 5-8).

The north eastern bank is partially devoid of vegetation, with a large section of rock established for structural integrity of the bank (Plate 13). This rocky bank provides suitable foraging and over-wintering sites for Growling Grass Frog along with important refuge sites from predators and are likely to be used by the species for thermoregulation.

At the time of the assessments, the water within the wetland was clear, free of odour and generally free of litter. Floating aquatic vegetation is limited, and submerged vegetation largely comprises areas of algae and Fennel Pondweed, particularly in the north east section of the waterbody. Additional refuge sites for Growling

Grass Frog in the form of large logs and stumps along the northern bank of the waterbody have been provided and this is consistent with the management actions outlined in the GGFCMP (Ecology and Heritage Partners 2016) (Plate 11 and 14). The waterbody covers an area of approximately one hectare and likely to be several metres deep (i.e. permeant waterbody fed by an underground aquifer).

The high-quality terrestrial habitat within the quarry void, including the additional habitat enrichment (e.g. rocks, logs and stumps) that were placed in this area as part of the previous EPBC Act approval will be retained to ensure conditions remain suitable for this species prior to, during and post construction works. Habitat protection and management actions, together with habitat improvement and population/ habitat monitoring are detailed in the Growling Grass Frog Conservation Management Plan (Appendix 2).

Plate 11. Waterbody within the quarry void looking from the north west corner (Ecology and Heritage Partners Pty Ltd 07/09/2018).

Plate 12. Waterbody within the quarry void looking from the eastern edge of the quarry void (Ecology and Heritage Partners Pty Ltd 15/06/2020).

Plate 13. Rocky banks on the eastern end of the waterbody (Ecology and Heritage Partners Pty Ltd 07/09/2018).

Plate 14. Fringing and floating vegetation within the waterbody **(**Ecology and Heritage Partners Pty Ltd 07/09/2018).

Plate 15. Drainage line constructed on the southern boundary of the study area looking east (Ecology and Heritage Partners Pty Ltd 07/09/2018).

Plate 16. Degraded Growling Grass Frog foraging and dispersal habitat in the east of the study area (Ecology and Heritage Partners Pty Ltd 23/09/2020).

3.2 Matters of National Environmental Significance

3.2.1 Growling Grass Frog

A large population of Growling Grass Frog has previously been recorded at the quarry during research undertaken in 2004/05 by Dr Geoff Heard, and colleagues, from the University of Melbourne (Heard 2010). This researched revealed that there was a high level of breeding and recruitment by the species, along with evidence of high genetic diversity in the population.

In January 2012, Ecology and Heritage Partners Pty Ltd was commissioned to undertake targeted Growling Grass Frog surveys, inclusive of desktop and habitat assessments, and nocturnal spotlighting (Ecology and Heritage Partners Pty Ltd 2012a). A diurnal habitat assessment was undertaken on 16 February 2012. Seven sites were assessed, and this included two sites within the study area as well as five sites nearby, outside of the study area. The sites outside of the study area were assessed to determine if any suitable habitat occurs between the quarry and Merri Creek that may support a large population of Growling Grass Frogs or facilitate the movement of frogs from Merri Creek into the study area.

Nocturnal Growling Grass Frog surveys were undertaken at the seven sites on two separate evenings (7 and 16 February 2012) in accordance with the *Significant impact guidelines for the vulnerable growling grass frog (Litoria raniformis*). Surveys were conducted during the species' active season (October - March), in weather conditions considered optimal for detection (i.e. warm and humid, overnight temperature not less than 14°C, preferably post rain) and when the species was known to be active elsewhere in the region (Table 2). The survey effort consisted of two Zoologists spotlighting (using a hand-held 30-watt 12-volt spotlight) in and around each of the sites searching for frogs in open water; floating, emergent and fringing vegetation; and under logs and other refuge. The following habitat features were recorded as part of the assessment:

- Waterbody type;
- Visual water quality;
- Flow and depth;
- Overall habitat quality
- Cover of fringing, emergent, floating and submerged vegetation;

- Landscape connectivity; and
- *In situ* water quality using a calibrated Horiba™ multiprobe measuring; dissolved oxygen, pH, electrical conductivity, temperature and total dissolved solids.

During the habitat assessments, attributes of the land traversed on foot between sites was also noted for the presence (or otherwise) of suitable dispersal and/or foraging habitat. Results of the habitat and water quality assessment is provided below (Table 1).

The habitat assessment identified that high quality habitat for Growling Grass Frog is present within the study area by means of a large waterbody at the base of the quarry void. The waterbody provides a large, open and permanent area of water that supports varying levels of fringing and emergent aquatic vegetation.

Table 1. Habitat assessment results from February 2012 (Ecology and Heritage Partners Pty Ltd 2012a)

Site	Waterbody type	Water quality (visual)	Water quality (in situ)	Flow	Capacity full (%)
Site 1 (within study area)	Lake in quarry	Good	Temp: 23.8°C PH: 9.28 EC: 5.06 mS/cm DO: 13.79 mg/L TDS: 3.19 g/L	Still	80
Site 2 (within study area)	Drainage line into quarry	Moderate	Temp: 19.66°C PH: 5.82 EC: 5.82 mS/cm DO: 17.54 mg/L TDS: 3.66 g/L	Slow	70

Table 2: Details and weather conditions of the nocturnal Growling Grass Frog surveys (Ecology and Heritage Partners Pty Ltd 2012a)

Date	Survey Times	Air temp (°C) Start	Humidity (%)	Wind (0-4)	Post rain	Growling Grass Frog active elsewhere on the survey night
07/02/12	2030 - 0100	17 °C	62%	0	Yes	Bundoora Wetlands, Bramble Crescent
16/02/12	2100 - 2300	20.5°C	88%	1	Yes	Thomastown East Reserve

Successive site visits and targeted surveys during and following the completion of filling activities on site were conducted in May and November 2017, on two occasions in December 2017 and in September 2018. The results of these surveys confirmed the persistence of the population within the waterbody, with a large number of adults observed or heard calling within and surrounding the waterbody on each occasion (Ecology and Heritage Partners 2020).

Growling Grass Frog breeding habitat is present within the study area in the form of the large open waterbody at the base of the former quarry. A resident population of the species is known to occur in this area (Ecology and Heritage Partners 2012a, 2020). The quarry void (Figure 2) (Plates 5-8), is large with steep sloping banks on all sides. The northern, western and southern banks are dominated by introduced grasses, woody weeds

and thistles. The presence of a permanent water source combined with fringing, aquatic and semi-aquatic vegetation such as Common Spike-rush, Cumbungi and pasture grasses provides suitable breeding and refuge habitat for the known population of Growling Grass Frog and a range of locally common frog species.

Given the confirmed presence of a viable population within the study area, this population is defined as an 'important population' as described in the significant impact guidelines for the species (DEWHA 2009).

3.2.2 Other Matters of National Environmental Significance

The Victorian Biodiversity Atlas contains records of 18 nationally significant fauna species previously recorded within 10 kilometres of the study area (DELWP 2018a) (DAWE 2020) (Figure 4). Of these species, Grey-headed Flying-fox *Pteropus poliocephalus* (listed as Vulnerable under the EPBC Act) is the only species besides Growling Grass Frog considered likely to visit the study area on occasions for behaviours such as belly dipping to utilise the reliable water resource on site. This species will not be impacted by the proposed development of the area surrounding the quarry void. No other MNES were recorded during the site assessment and based on the survey results and the highly modified nature of the study area the proposed development will not impact any other species or ecological community listed under the EPBC Act.

4 RELEVANT IMPACTS

Potential impacts to the Growling Grass Frog population and associated impacts as a result of the proposed development come from two main sources: impacts from construction activities, and impacts resulting from the construction of a barrier to movement between the quarry waterbody and Merri Creek to the East. The following outlines the potential impacts to the species associated with the development.

4.1 Direct Impacts

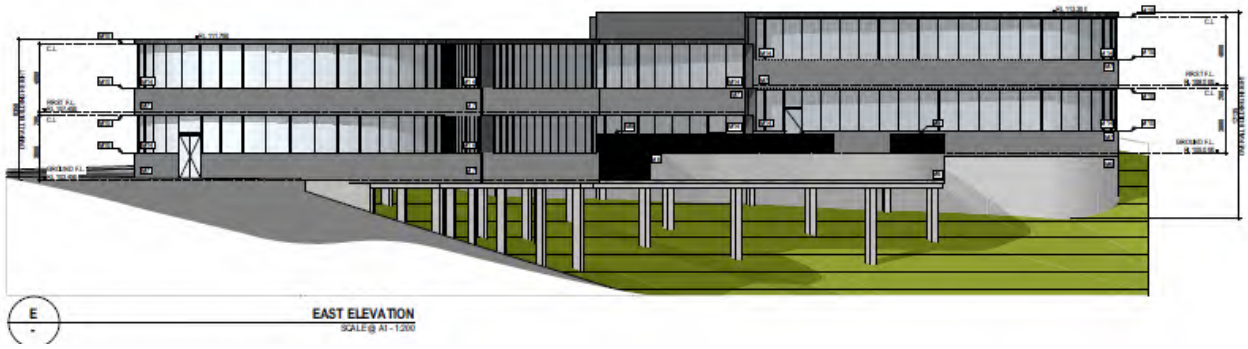
The proposed development will impact an area of low quality and degraded terrestrial habitat around the rim of the quarry void covering approximately 1.5 hectares (Figure 2). The habitat quality in these areas is consistent with the low quality or lack of habitat in the disturbed area outside the quarry void.

The proposed development will not impact breeding habitat within the quarry void or any terrestrial foraging habitat within 40 meters of the quarry wetland. A small area on the edge of the quarry void will be disturbed by the installation of the building pilings (Figure 2). The habitat in these areas is equivalent to the low quality and disturbed habitat in the area outside the quarry void (i.e. high degraded). While frogs may use these areas during dispersal events (i.e. warm, wet conditions), given the degraded and highly modified condition of these areas they are not considered to provide important or limiting habitat for the species. That is, there is sufficient terrestrial habitat available surrounding the quarry void for the persistence of the species at this location. Given the surrounding development to the north, south and west (i.e. completely urbanised) the terrestrial habitat proposed to be impacted does not connect to other suitable breeding habitat surrounding the quarry void.

The design of the structures surrounding the quarry void are to be integrated with the topography and include a contained area of under croft due to their alignment around the quarry edge. Landscaping and rock arrangements will be incorporated into the design of the under croft areas which will provide opportunity for further habitat enrichment and refuge for Growling Grass Frog (Plate 17). These structures will also provide a physical barrier to limit unauthorised access and the dumping of rubbish, which has been a significant issue to date. All habitat improvement works within the quarry void will be undertaken by a qualified and experienced wetland revegetation specialist/ contractor in accordance with the GGFCMP.

The pilings proposed to be used in some areas surrounding the quarry void will not intercept groundwater, and the structure around the rim of the quarry will not create any additional shade in areas of high-quality breeding habitat within the quarry wetland. The piles will be reinforced concrete bored piers below ground and exposed ‘formatube‘ (permanent formwork) columns above ground.

Plate 17. Surrounding buildings relative to sloping quarry walls (Cornetta Partners Architects, January 2020).



Areas proposed to be disturbed outside the quarry void are highly modified and dominated by noxious weeds (Plates 1 and 2). Measures to avoid and mitigate impacts to the Growling Grass Frog are outlined in Section 5.

4.2 Indirect impacts

Potential indirect impacts associated with the proposed development includes changes in the hydrology in the quarry void, the deterioration of water quality, the introduction and spread of chytrid fungus, human access, spreads of weeds, and noise and lighting impacts. The prevention and/or management of these indirect impacts is outlined in the Growling Grass Frog Conservation Management Plan (Appendix 2).

4.2.1 Hydrology and Water Quality

Based on known information of water quality tolerances and preferences by Growling Grass Frog it appears that the species requires waterbodies containing low levels of nitrates, nitrides and phosphates (Ashworth 1998; Organ 2002, 2003). Water quality may be particularly important for larval development and recruitment. It should also be noted that studies have shown conflicting findings on the relationship between basic water quality parameters and wetland occupancy (Heard and Scroggie 2008). For example, Wassens (2005) found a preference for wetlands with a relatively low pH, whereas Hamer and Organ (2008) found the opposite to be the case. Similar discrepancies have been found with conductivity (Heard and Scroggie 2008), and this relationship is also confounded by the fact that conductivity may affect the prevalence of Chytrid fungus. It is recommended that generally efforts to control basic water quality parameters for Growling Grass Frog may be unnecessary; however, conductivity should not increase the approximate limit for the species of beyond 10000 µS/cm (Heard and Scroggie 2008).

A Stormwater Management Strategy report has been developed (Appendix 3). Major event flows will be safely conveyed through the underground drainage, with flows greater than the capacity of the underground drainage conveyed overland through the wetlands along the dispersal corridor. As such, it is considered that there will be no indirect stormwater impacts to the existing quarry wetland or the population of Growling Grass Frog within Merri Creek as a result of the proposed action. However, construction activities associated with the development have the potential to result in release of sediment-laden runoff into the quarry wetland and the constructed wetlands within the proposed dispersal corridor. There is also the potential for accidental spillage of chemicals from the construction area to runoff into the wetlands. Increase in sediment input and input of toxic substances into Victorian rivers and streams due to human activities are both threatening processes under Schedule 3 of the FFG Act.

4.2.2 Chytrid Fungus

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen *Batrachochutrium dendrobatidis*, commonly referred to as Chytrid fungus. Chytrid fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly the Growling Grass Frog, severely compromised (DEWHA 2006). The disease that results from Chytrid fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson 2012). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material; the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Chytrid prevalence has found to be decreased in wetlands with elevated salinity levels and higher temperatures (Heard *et al.* 2012).

4.2.3 Human Access

Human occupancy within the study area has the potential to result in disturbance by persons entering the quarry void and wetland. This may lead to the degradation of habitat in or around the waterbody due to rubbish dumping, mechanical disturbance of vegetation from trampling, and weed invasion.

The placement of walking and/or bicycle paths and trails will be prohibited within the 'no impact' buffer zone within the quarry void and the existing Growling Grass Frog habitat to minimise human disturbance in these areas. Construction activities should also be restricted in known habitat areas to minimise human and vehicular disturbance during the development study area. An exclusion zone will be implemented around the main quarry water body and associated constructed wetlands to protect the core Growling Grass Frog habitat on site.

4.2.4 Weeds

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

Consequently, a Weed Management Plan has been prepared to identify potential threats associated with pest plant species, that may impact environmental values within the study area. The Weed Management Plan provides appropriate management actions to address weed infestations and vertebrate pest species, to ensure environmental values within the study area are maintained and enhanced.

4.2.5 Noise

The distance from construction works to the quarry wetland and the topography of the quarry void is considered to provide sufficient protection for frogs from noise pollution created by construction activities. Nonetheless, noise from building and other works relating to the development will comply with the Hume City

Council Building and Works Code of Practice (Hume City Council 2013), where; building or other works that may produce noise can only be carried out on any land between the hours 7.00 am and 6.00 pm on weekdays, 9.00 am and 5.00 pm on Saturdays, and 12.00 noon and 4.00 pm on Sundays. Restricting noise created by building works will allow males to call to attract a mate, and thus the noise associated with construction and the future use of the area (i.e. commercial use) is unlikely to reduce breeding success by the species.

4.2.6 Light Pollution

Growling Grass Frog are a predominantly nocturnal species. Artificial light pollution may increase the risk of predation of Growling Grass Frog by foxes and Cats and may also disrupt mating activities of the species. As such, sources of artificial light from the surrounding development will be directed away from the quarry void. There will be no additional lighting directed towards the wetland within the quarry void or along the dispersal corridor, to allow frogs to move along the corridor undisturbed, and to avoid any negative impact caused by artificial light pollution. Overall, there are likely to be no significant impacts related to noise and light pollution associated with the project.

4.3 Other Threatening Processes

4.3.1 Dogs, Cats and Exotic Predators

Unrestrained dogs *Canis vulpes* and cats *Felis catus* have the potential to roam into Growling Grass Frog wetlands within the Precinct. Predation of native wildlife by the Cat is a threatening process under Schedule 3 of the FFG Act. Cats are likely to enter the site from the adjoining residences and may predate on Growling Grass Frog. As such, Hume City Council is encouraged to implement a night-time curfew applicable to all residential properties surrounding the study area.

The proposed dispersal corridor is to be designated a 'Dog on Leash Area' through installation of appropriate signage throughout the Area. Hume City Council will need to enforce all dog on leash areas.

The introduced Eastern Gambusia *Gambusia holbrooki* has been identified as a possible factor in the decline of species in the "bell frog species complex", which includes Growling Grass Frog (Mahony 1999; White and Pyke 1996; Hamer *et al.* 2002) because it eats the eggs and tadpoles of these species (Morgan and Buttermer 1996). This species may reduce the potential of a site to support breeding populations, although the extent of predation depends on aquatic vegetation and habitat complexity, and waterbody permanency (Hamer *et al.* 2002). Predation by Eastern Gambusia on tadpoles of Growling Grass Frog is likely to present a significant threat to the species on the site both in the existing quarry void and the wetlands that will be constructed as part of the proposed development. The ability to drain wetlands (i.e. via a valve) in the event that Eastern Gambusia is detected within the proposed wetlands will be accommodated in the design.

The Red Fox *Vulpes vulpes* has been recorded within the study area (Ecology and Heritage Partners 2020). The Red Fox is known to hunt and eat adult members of the bell frog species complex. Feral Animal Control measures will be considered for development in the study area to reduce the population size of foxes.

4.3.2 Unknown, unpredictable or irreversible impacts

All high-quality habitat and the proposed dispersal corridor in the south east will be retained and significantly enhanced through the creation of a series of connected waterbodies along the length of the dispersal corridor

to allow unimpeded dispersal of frogs. These waterbodies will be designed and constructed in accordance with the *Growling Grass Frog Habitat Design Standards* (DELWP 2017a).

There is a potential risk that the new wetlands may not support water or substrate characteristics that are conducive to ongoing breeding, recruitment and dispersal by the species. Therefore, the use of spring fed water from within the quarry void will maintain the habitat characteristics inherent to the quarry that have resulted in the extant Growling Grass Frog population on the site, including some of the mineral content that may influence water qualities related to reduced Chytrid Fungus incidence (e.g. comparatively higher salt content which is known to suppress Chytrid Fungus compared with water runoff from the surrounding catchment).

The majority of surface flows in the area outside the quarry void are directed to the southern end of a study area, where a basic swale trench extends along the southern boundary of the site, carrying excess stormwater to the south east corner where it flows into the neighbouring property (Plate 15) (Appendix 3). In its current state this area does not constitute suitable habitat for Growling Grass Grog given there is no standing water or aquatic vegetation within or adjacent to the swale, therefore construction of the dispersal corridor along the southern boundary is not considered to be impacting significant habitat for the species.

4.3.3 Habitat connectivity beyond the study area

Due to the confirmed presence of a viable population within the study area, it is considered that this population is an 'important population' as described in the significant impact guidelines for the species (DEWHA 2009). In 2009, the high-level Bolinda Road Former Landfill Site Master Plan (Meinhardt 2009) was developed for the former landfill site located approximately 180 metres east of the quarry. The Master Plan supported the development of a Public Open Space area (approximately nine hectares) at the site (Figure 1). In 2011, a draft Master Plan (Meinhardt 2011) was prepared for the development of the open space reserve, which will form the biggest Council-managed reserve in Campbellfield. Council are in the process of finalising the Master Plan, however, Council's current timeframe for the development of the area is not known. Given that the Master Plan has not been finalised, there is an opportunity for Council to integrate the retained waterbody and an extension of the proposed dispersal corridor (from the property boundary of the study area) and improve habitat links between the quarry wetland, existing dams to the east and Merri Creek.

Wetlands created within a suitable distance to the east of the quarry are likely to be colonised by Growling Grass Frog and form an important link with Merri Creek, provided they contain the necessary habitat characteristics such as suitable size, patches of emergent and submerged vegetation, have good water quality, provide a diversity of pond habitats and are not disconnected from the existing populations by significant barriers. A variety of wetlands would provide the most suitable habitat opportunities for Growling Grass Frog (i.e. some with permanent water for habitat connectivity, and others with an ephemeral water level to increase the likelihood that they are free of predatory fish (e.g. Eastern Gambusia). Given that Growling Gross Frog is known to use Merri Creek as a dispersal corridor, suitable habitat created along this watercourse is also likely to be colonised. Through the design, construction and establishment of aquatic vegetation in wetlands, and ongoing maintenance and management, there is a significant opportunity for Council to increase the overall quality of Growling Gross Frog habitat in and surrounding the study area. This will contribute to the long-term viability (population processes) of local populations.

An indicative extension of the dispersal corridor between the quarry void (i.e. the study area) and Merri Creek is shown below (Plate 18).

Plate 18. Indicative area for Hume City Council's dispersal corridor extension to the east (Metromap 2020).

This area is currently managed by Hume City Council, and it is important to note that the responsibility for construction works required to complete the habitat corridor outside the study area will be the responsibility of Forte Group Pty Ltd as it is not their land.

5 PROPOSED AVOIDANCE AND MITIGATION MEASURES

5.1 Avoidance

The quarry waterbody within the quarry void will be retained along with adequate terrestrial habitat surrounding this breeding habitat.

5.2 Mitigation Measures

A range of mitigation measures will be implemented by the construction contractor to manage direct and indirect impacts to Growling Grass Frog where impacts cannot be avoided. Measures to mitigate impacts upon terrestrial and aquatic values present within the study area include:

- Soil disturbance and sedimentation within wetlands will be kept to a minimum, to avoid, or minimise impacts to fauna habitats;
- All habitat improvement works within the No-Go-Area will be undertaken by a qualified and experienced wetland revegetation specialist/ contractor in accordance with the provisions of this CMP and the DELWP approved Landscape Plan;
- All contractors will be made aware of ecologically sensitive areas in order to minimise the likelihood of inadvertent disturbance to areas marked for retention, particularly in areas of high-quality Growling Grass Frog breeding and foraging habitat within the quarry void. Areas of sensitivity and no-go zones will be included as a mapping overlay on any construction plans;
- Construction stockpiles, machinery, roads, and other infrastructure will be placed away from areas of sensitivity or wetlands, particularly in regard to areas of high-quality Growling Grass Frog breeding habitat within the quarry void and wetland construction along the southern boundary of the site. As such, there will be no direct or indirect disturbance of the waterbody and surrounding high quality terrestrial foraging habitat for Growling Grass Frog covering an area of approximately 5.7 hectares;
- As outlined above, all stormwater flow and discharge from the surrounding area will be directed away from the quarry wetland to ensure that there is no negative impact to water quality or that external contaminants are inadvertently introduced to the waterbody within the quarry void;
- Best practice sedimentation and pollution control measures will be undertaken at all times, in accordance with Environment Protection Authority guidelines (EPA 1991; EPA 1996; Victorian Stormwater Committee 1999) to prevent offsite impacts into the quarry void and surrounding areas (e.g. Merri Creek);
- Given that indigenous flora provides valuable habitat for indigenous fauna, landscape plantings as part of the proposed development will include indigenous species sourced from a local provenance, rather than exotic deciduous trees and shrubs. The *Growling Grass Frog Habitat Design Standards* (DELWP 2017a) will be reviewed to provide a list of suitable species to be used when establishing vegetation within Growling Grass Frog habitat (Table A1, Appendix 4);
- Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog wetlands as this may shade out ponds, thus potentially rendering them unsuitable for the species;

- Incorporating rainwater tanks into the proposed industrial estate, to capture and store roof top run off, acting as a water source should the wetland require additional water to maintain levels;
- Use of the underground aquifer currently supplying the existing waterbody at the quarry, to incorporate a water delivery system including holding tanks in the design to maintain water levels in the wetlands, even over dry periods;
- Bio-retention basins and sedimentations ponds to appropriately treat stormwater flows through the constructed wetlands, and avoid residual impacts to Growling Grass Frog habitat in Merri Creek; and,
- As detailed in the stormwater management strategy report (E2 Design Labs 2020), minor and major event flows will be conveyed via the underground drainage network via Bolinda Road to a legal point of discharge in the north-eastern corner of the site as nominated by Melbourne Water, with flows greater than the capacity of the underground drainage conveyed overland and treated in purpose-built storm-water retention and treatment ponds within the wetlands in the dispersal corridor. Therefore, no increased sedimentation or decrease in water quality is anticipated in this habitat.

5.3 Sediment/ Frog Exclusion Fencing

Sediment/ frog exclusion fencing will be re-instated around the outer parameter of Offset Area 1 prior to the commencement of construction to provide a physical barrier between the development area and retained habitat within the quarry void. Fencing will also be installed along the entire northern boundary of the dispersal corridor (Offset Areas 2 and 3) to prevent Growling Grass Frog from entering the development area during and after construction. The frog fencing around Offset Area 1 will be decommissioned once all construction activities have been completed to allow frogs to access the entire retained terrestrial habitat within the quarry void for foraging and overwintering activities. Prior to this, permanent frog exclusion fencing will be installed around the perimeter of the quarry void (i.e. around the edge of the development area) (Appendix 1). The frog fencing along the northern boundary of the dispersal corridor will remain in place to prevent frogs accessing pavement areas.

There will be an integrated approach to safety fencing and frog exclusion fencing, with a single fence achieving the purpose of safety, the prevention of unauthorised access, and a physical barrier between suitable terrestrial frog habitat and surrounding development across the site. Fence inspections and maintenance / repair (where necessary) will be undertaken in accordance with the Growling Grass Frog Conservation Management Plan. The following controls apply to the installation of sediment/ frog exclusion fencing:

- Fencing must be constructed of a cloth or plastic material and only appropriate fencing material that withstands variable weather conditions over long periods of time must be used;
- Fencing must be installed at least one metre high, with an additional 0.2 metres buried below-ground. 0.2 metres of the top of the fence must be bent/ angled over at less than 90 degrees to the vertical on the frog habitat side (not the excluded habitat side) to prevent frogs from climbing or hopping over the fence;
- Refugia for shelter must be placed at least one metre away from the fence and any vegetation within one metre of the fence must not exceed 0.5 metres to prevent frogs from escaping (i.e. low-growing grasses should be planted).
- Fences must be taut without creases or folds;

- Fence posts must be installed on the outer fencing side (i.e. excluded habitat side) and fastened with nails or similar, and lie flush with fencing material to prevent frogs from climbing up posts and escaping over the fence; and,
- Regular inspection of the fencing is required to ensure its effectiveness, including:
    - Inspections of fencing between May and August, prior to Growling Grass Frog breeding season and the repair or replacement of any damaged or ineffective material;
    - Maintenance of vegetation within one metre of fencing at less than 0.5 metres high; and,
    - Removal of any litter or other debris caught in fencing which could assist frogs to climb over.

Forte Group Pty Ltd will have ultimate responsibility for meeting performance criteria in accordance with the environmental objectives and mitigation measures, including satisfying requirements for monitoring, reporting and should any incidents occur, ensuring they are addressed, and appropriate corrective actions are undertaken in a timely manner.

Habitat design requirements and considerations are further discussed in the Growling Grass Frog Conservation Management Plan (Appendix 2). An example of suitable frog exclusion fencing currently installed around the quarry void is shown below (Plate 19).

Plate 19. Example of suitable frog exclusion fencing

5.4 Ongoing Management

A Growling Grass Frog Conservation Management Plan has been prepared for the proposed development within the study area (Appendix 2). This Plan provides detailed information relating to the design of the dispersal corridor (including the proposed wetlands) to ensure the species can disperse between the quarry void and the south eastern corner of the study area, with the future connection to Merri Creek provided on the council owned land to the east. The Growling Grass Frog Conservation Management Plan includes specific information on the proposed development (extent and timing), the likely and potential impacts to the species, and proposed management actions to ensure a resident population persists in the quarry void (and along the dispersal corridor) in the long-term, and that permeability between the quarry void and the south eastern edge of the study area is maintained to allow for future connection to Merri Creek.

The ongoing survival of the extant Growling Grass Frog population can be established by maintaining or enhancing wetland hydroperiods and aquatic vegetation cover. Long term persistence of the species requires a network of populations, within which migration and re-colonisation can occur. Hydroperiod and aquatic vegetation cover are considered the most important features to maintain Growling Grass Frog occupancy (Heard *et.al.* 2010). A wetland's hydroperiod is important in maintaining a stable probability of Growling Grass Frog occupancy. Efforts will be made to maintain or enhance hydroperiods in the constructed wetlands through increasing inflows via the use of water from within the quarry void to maintain water levels, and/or by capturing stormwater and rooftop runoff from within the development. It is important to note that any works to enhance the hydroperiod within the constructed wetlands will be designed and monitored appropriately in order to avoid negatively impact the waterbody within the quarry void and the constructed wetlands.

Moderate to high aquatic vegetation cover, inclusive of emergent, submergent and floating aquatic vegetation will be provided to achieve Growling Grass Frog occupancy and persistence at the site. Most favourable is a total of 40% aquatic vegetation, comprising 30% emergent, 60% submergent and 30% floating vegetation.

Intensive management of the wetland and dispersal corridor will be undertaken over the life of the Growling Grass Frog Conservation Management Plan, followed by arrangements with relevant organisations (for example, Merri Creek Management Committee, Hume City Council) to manage the sites thereafter. Once established, arrangements for the management of the dispersal corridor in the Council's open-space to be absorbed into the greater open-space management by Hume City Council will be sought.

Ongoing weed control is one of the primary management issues within the study area. Additionally, European Rabbit *Oryctolagus cuniculus* listed under the CaLP Act and Red Fox *Vulpes vulpes* have been observed within the study area (Ecology and Heritage Partners 2020). Consequently, a Weed Management Plan has been prepared to identify potential threats associated with pest plant and animal species, that may impact environmental values within the study area. The Weed Management Plan provides appropriate management actions to address weed infestations and vertebrate pest species, to ensure environmental values within the study area are maintained and enhanced.

Eastern Grey Kangaroo *Macropus giganteus* home range is likely to encompass the entire study area, due to the presence of water sources and palatable grass species throughout most of the site. Indeed, up to fifteen Eastern Grey Kangaroos have been observed within the quarry void as recently as September this year. Therefore, a Kangaroo Management Plan has been prepared to ensure the safety and welfare of Eastern Grey Kangaroos is considered and managed throughout the development process.

Additional actions to mitigate impacts to Growling Grass Frog (e.g. minimising the spread of Chytrid fungus during construction, establishing 'no go' areas and fencing to protect existing habitat, timing of construction) will be outlined in a Construction Environmental Management Plan CEMP to be approved by the Commonwealth prior to commencing the action.

5.5 Monitoring

Ongoing population and habitat monitoring will be conducted in accordance with the detailed Growling Grass Frog Conservation Management Plan to assess any impacts associated with proposed development and to ensure habitat conditions within the study area remain suitable for the species. Monitoring at the quarry waterbody and through the dispersal corridor will be conducted during the species' active period between

September and March following the initial disturbance event, and then once annually (in the active season) for the life of the Conservation Management Plan.

The results of the annual monitoring will be presented in an annual report and provided to the Department. If monitoring suggests an unexplained decline in the population of Growling Grass Frog at the site (i.e. not as a result of prevailing conditions), adaptive management actions will be implemented to improve Growling Grass Frog habitat.

6 RESIDUAL IMPACTS AND PROPOSED OFFSETS

To determine the suitability of offsets for the proposed development at 75-135 Bolinda Road Campbellfield, the guidelines for offsetting outlined in DSEWPaC (2012a) were taken into consideration which define environmental offsets as: "*measures that compensate for the residual adverse impacts of an action on the environment*" (Appendix 2). The aim of offsets is to provide environmental benefits to compensate the impacts of an action after avoidance and mitigations measures have been applied (DSEWPaC 2012b; Appendix 6).

Habitat creation within the study area will provide additional breeding, dispersal and foraging habitat for Growling Grass Frog, and areas identified for habitat creation have the primary aim of ensuring there is an overall improvement or 'net gain' for the species (i.e. provision of high quality breeding habitat) (Appendix 2) (Figure 2).

To compensate for the residual impacts to Growling Grass Frog as a result of the proposed development the following will be undertaken:

- Maintenance and where possible the improvement of the known breeding habitat available in the main quarry waterbody.
- The provision of a connected dispersal corridor with a length of 200 metres and a width of 25 metres (Appendix 1). Two larger wetlands proposed south of the quarry void and located to the west of the proposed six wetlands to the east (Appendix 1).
- The construction of a total of eight wetlands to provide breeding, dispersal and foraging habitat for Growling Grass Frog (offset area 2). - The design of wetlands will incorporate breeding and foraging habitat specifically designed and managed for the Growling Grass Frog (Appendix 1).
- The provision of supplementary terrestrial habitat such as aquatic vegetation, rock, logs and other ground debris and aquatic habitat within the quarry void (Offset Area 1), as outlined in the Landscape Management Plan developed by Hansen Partnership Pty Ltd (Appendix 1).
- Terrestrial habitat within the movement corridor (Offset Area 3) will also be enhanced through the provision of supplementary habitat, as shown on the Landscape Management Plan (Appendix 1), and described in the Growling Grass Frog Conservation Management Plan (Appendix 2).
- Distance between wetlands (≤ 200 metre).
- The provision of a suitably designed frog exclusion fence along the entire northern boundary of the habitat corridor to prevent frogs from moving into the proposed development to the north.
- Emphasis on groundwater as a water source.
- Design parameters and vegetation requirements for breeding wetlands.
- Mechanisms for removing any predatory fish.
- Ongoing commitment to habitat management requirements.

Each waterbody will 1.5 to 4 metres deep and will be between 180m^2 and 1950m^2 in size, resulting in a total of 4,500 square metres or 0.39 hectares of wetland area that will be created as part of the project. In addition, terrestrial habitat surrounding the eight waterbodies (which will provide suitable habitat for the species) will be included as part of the creation of Growling Grass Frog movement corridor. This equates to a total habitat

area of 0.89 hectares (i.e. total created wetland will be 0.39 hectares with 0.5 hectares of terrestrial habitat). Further, habitat enhancement activities (i.e. the provision of 1.5 hectares of high quality shelter sites) surrounding the quarry wetland and on the south eastern slopes of the quarry void (between the constructed wetlands and the quarry wetland) will result in improved terrestrial habitat the species (Appendix 2). In summary, the total area of Growling Grass Frog offset proposed as part of the project is 2.39 hectares and is shown in Table 3 (i.e. 0.39 hectares of wetland, 0.5 hectares of terrestrial habitat to be constructed within the movement corridor and 1.5 hectares of terrestrial habitat to be enhanced within the quarry void). The analysis of the gains is provided below (Appendix 6).

With respect to the calculation of offsets for the project the Commonwealth Offsets Assessment Guide (excel spreadsheet) was used to calculate the overall gains associated with the creation of waterbodies and terrestrial habitat improvements and to demonstrate what is proposed will compensate for the proposed impacts to low quality Growling Grass Frog foraging and dispersal associated with the project (Appendix 6). Based on the proposed habitat creation and improvement, the minimum direct offset for the project will be achieved on all aspects of the habitat construction and enhancement (Table 3).

Table 3: Breakdown of offset assessment calculation

Site	Description	Area to be offset (Ha)	Quality	Area of Habitat (Ha)	Start Quality	Future quality	% of impact offset	Minimum (90%) direct offset requirement met?
Offset Area 1	Terrestrial habitat within the quarry void	0.75	3	1.5	5	6	141.08%	Yes
Offset Area 2	Wetland habitat within the movement corridor	0.35	3	0.39	3	6	128.45%	Yes
Offset Area 3	Terrestrial habitat within the movement corridor	0.4	3	0.5	3	6	137.68%	Yes

The creation of dedicated Growling Grass Frog waterbodies within the proposed movement corridor (Offset Areas 2 and 3) and the improvement of terrestrial habitat within the quarry void (Offset Area 1) will compensate for potential impacts to the species (i.e. loss of low quality terrestrial habitat) as these dedicated areas will support key habitat features required by the species, and will be constructed at strategic locations (i.e. along the movement corridor and between the quarry wetland and the movement corridor) to ensure that dispersal opportunities throughout the local area (within and between the site) is maintained. In addition, created waterbodies will be secured in perpetuity, protected from the surrounding industrial land uses, and will be managed in accordance with a suitable management regime (Appendix 2). Further, habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will provide direct connection between the suitable habitat within the movement corridor and the quarry wetland.

6.1 Likelihood of Significant Impacts for the Permanent Removal of Habitat

While a total of 1.5 hectares of low quality terrestrial habitat will be removed around the rim of the quarry void as part of development, the provision of eight created waterbodies along the dispersal corridor and the improvement of suitable terrestrial habitat within the quarry void adequately offsets the removal of habitat for the species.

This is based on the following factors:

- Low quality habitat to be removed which is not considered limiting habitat and habitat the species would use on a regular basis, or at all, when not located near important habitats such as the quarry wetland or confirmed high quality foraging habitat where the species has been detected.
- Eight waterbodies will be created to provide additional breeding habitat, and to improve habitat connectivity and frog dispersal within the property to allow for a future link from the study area to the Merri Creek (i.e. to the east of the project area).
- Growling Grass Frog is unlikely to use the low-quality terrestrial habitat that is proposed to be removed on a regular basis or at all
- Appropriate mitigation measures including staff inductions, pre-clearance surveys and contingency measures will be undertaken to prevent direct impacts to the species during construction or the removal of habitats.
- In accordance with the detailed Growling Grass Frog Conservation Management Plan that has been prepared for the project, the existing Growling Grass Frog habitat within the quarry void will be enhanced with the provision of additional refuge sites (rocks, logs and other ground debris).

Overall, the removal of low-quality terrestrial habitat is not considered likely to impact the species, particularly given as the detailed mitigation measures during construction and management and monitoring activities (as outlined in the Conservation Management Plan for the species) after the development will need to be implemented .

6.2 Habitat Enhancement, Creation and Management

The existing Growling Grass Frog habitat within the quarry void will be enhanced such that habitats will be augmented, and conditions are improved for Growling Grass Frog refuge, foraging and breeding purposes. This will include:

- An exclusion zone will be implemented around the main quarry waterbody and associated constructed wetlands to protect the core Growling Grass Frog habitat on site.
- Preparation of a Landscape Plan by a qualified wetland revegetation specialist and the project zoologist, and submission to DELWP for approval. The Landscape Management Plan provides a detailed account of all habitat improvement works within the No-Go-Area (Appendix 1).
- Supplementary habitat installation (i.e. logs, rocks).
- Weed and pest animal control.
- Supplementary aquatic vegetation planting.

According to Heard and Scroggie (2009) Growling Grass Frog populations throughout the Merri Creek Corridor that inhabit permanent wetlands with high aquatic vegetation cover, and close to other populations, have a higher probability of persistence, and were more likely to be recolonised should extinction of the species in the wetland occur (i.e. a classic meta-population structure). If not designed appropriately to cater for ongoing connection between the quarry void and Merri Creek to the east, the development of areas to the east of the study area is likely to create a barrier and sever the terrestrial habitat in this area. As outlined in Heard *et.al.* (2010), urban infrastructure / development presents a significant barrier to Growling Grass Frog dispersal, limiting or preventing the species from moving across the landscape within and between suitable breeding habitat. Thus, compromising the long-term viability of the species in an urban context where there is a disruption of the meta-population dynamics. Therefore suitable, well connected, terrestrial and aquatic habitat (i.e. wetlands located within 500 metres of each other) need to be available across the landscape to allow ongoing exchange of frogs and for populations to remain viable in the future. Considering the habitat requirements and population dynamics of the species, a dispersal corridor comprising a series of dedicated wetlands will be designed, constructed and managed to allow the movement of individuals between the quarry void and areas to the east (i.e. Merri Creek).

The primary function of the constructed wetlands along the dispersal corridor is to provide additional breeding habitat, and to improve habitat connectivity and frog dispersal within the property and to allow for a future link from the study area to the Merri Creek (i.e. across the Council owned land). The intent is to also attract frogs into the study area from the core dispersal habitat along Merri Creek, in turn allowing genetic mixing and diversity, and leading to a more viable population in the future. Emphasis has been placed on the quality of the habitat within the corridor, which extends approximately 220 meters from the proposed sedimentation pond to the property boundary (Figure 2). The following habitat features will be incorporated along the proposed dispersal corridor:

- The construction of eight dedicated Growling Grass Frog wetlands across the habitat corridor which will be designed to improve habitat connectivity within and adjacent to the study area (i.e. Merri Creek to the east).
- Wetlands will be permanent and designed to exclude predatory fish such as Eastern Gambusia.
- Extensive rock beaching will be installed around the perimeter of each constructed wetland to provide basking, sheltering and overwintering habitat.
- As indigenous flora provides valuable habitat for indigenous fauna, any landscape plantings that are undertaken as part of the proposed works will be conducted using indigenous species sourced from a local provenance, rather than exotic deciduous trees and shrubs. The Growling Grass Frog Habitat Design Standards (DELWP 2017a) will be reviewed to provide a list of suitable species to be used when establishing vegetation within the Growling Grass Frog habitat. The cover of trees and shrubs will be low to avoid shading the wetlands or providing vantage points for predatory birds.

The ongoing maintenance of ponds and wetlands, particularly the maintenance of aquatic vegetation diversity and structure and terrestrial habitats will be essential to ensure these habitat types become and remain suitable for the species. Once established, ponds and wetlands are expected to be self-sustaining. Maintenance of created habitats will be implemented every six months for the first two years post habitat and vegetation installation, and on an annual basis thereafter.

- If necessary, additional plants will be planted to ensure that waterbodies and terrestrial habitats remain suitable;

- Additional refuge sites such as rocks, logs and dense low-lying vegetation will be added if it is considered during site monitoring, that the area of shelter is insufficient;
- Routine maintenance of grassed areas within Offset Area 3 around the periphery of the waterbodies;
- Wetlands will be kept free of predatory fish, such as Eastern Gambusia and Redfin. The ongoing monitoring program will identify invaded ponds and subsequently instruct managers that draining is required;
- Where possible, weeds will be controlled by hand or with the use of implements. Alternatively, a frog sensitive herbicide (non-residual herbicide) will be selectively used. The use of other herbicides or pesticides within, or in close proximity to ponds, wetlands/waterways, shelter sites and likely dispersal areas will be prohibited;
- Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from wetlands/waterways and ponds. The removal of rubbish is particularly important over the first few years during pond and wetland establishment; and,
- Where relevant gross pollutant traps and/or sediment filters will be checked every 6 months and cleaned when required, particularly after heavy rain or storm events.

The quality of the habitat in the areas proposed to be impacted on the north west edge and around the rim of the quarry void is equivalent to the low quality and disturbed habitat in the surrounding area (Plate 10 and 15). Frogs may occasionally use these areas during dispersal events (i.e. warm, wet conditions). However, given the degraded and highly modified condition of these areas, they are not considered to provide important or limiting habitat for the species. Consequently, the construction of the wetlands throughout the dispersal corridor, along with habitat enrichment within the quarry void provides a significant increase in the quality of the habitat within the study area, as well as a net increase in the available breeding and terrestrial habitat for the species.

6.3 Timing of the Action and Habitat Construction / Improvement

The site is proposed to be developed in nine stages, with construction planned to commence in June 2021. This timeframe has been established to allow for public comment and review period of the preliminary documentation before a decision is made on the proposed action.

Temporary frog exclusion fencing will be re-instated around the outer parameter of Offset Area 1 prior to the commencement of construction to provide a physical barrier between the development area and retained habitat within the quarry void. Habitat enhancement activities associated with Offset Area 1 within the quarry void will commence during the first stage of the development. Habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will provide direct connection of suitable habitat between proposed waterbodies within the movement corridor (Offset Area 2) and the quarry wetland.

Given Growling Grass Frogs are active in the warmer months of the year (September to March), habitat improvement activities in Offset Area 1 will be conducted outside Growling Grass Frog active breeding season and will be completed by mid-August 2021 to avoid disturbing the species' breeding activity within the quarry wetland. As this is the only known breeding habitat within the study area, prioritising this area of habitat enrichment, and avoiding land management activities during the species active season will minimise residual impacts to the species, and allow the population in this area to benefit from habitat improvements during the 2021/22 breeding season while Offset Areas 2 and 3 are constructed and established.

The habitat corridor will be constructed during the early stages (i.e. from Stage 2 onwards) of the development to allow frogs to naturally colonise the wetlands during the species active season. Fencing will also be installed along the entire northern boundary of the dispersal corridor (i.e. along the northern boundary of Offset Areas 2 and 3) prior to the commencement of Stage 2 to prevent Growling Grass Frog from entering the development area during and after construction. Temporary frog fencing around Offset Area 1 will be decommissioned once all construction activities have been completed to allow frogs to access the entire retained terrestrial habitat within the quarry void for foraging and overwintering activities. Prior to this, permanent frog exclusion fencing will be installed around the perimeter of the quarry void (i.e. around the edge of the development area) (Appendix 1). Permanent frog fencing will remain in place along the northern boundary of the dispersal corridor to prevent frogs accessing pavement areas.

The control of pest animals such as foxes and cats will be undertaken in accordance with local government laws and relevant legislation. Given the threat posed by feral predators such as Red Fox, an assessment of feral predators Offset Area 1 will be completed prior to the commencement of construction, and if evidence of these species are found, appropriate control measure will be implemented immediately to reduce the potential threat posed by predatory pests.

6.4 Management of Wetland Hydroperiod and Water Quality

The established wetlands will be hydrologically independent from Merri Creek (which aims to limit exposure to Eastern Gambusia; a known threatening process for the species) and will be located to facilitate connections with other Growling Grass Frog populations in the area. The wetlands will contain a drainage outlet for removing some or all water from the system. The drainage capacity is important for maintenance purposes and could be used for the removal of pest fauna species such as Eastern Gambusia.

The proposed wetlands will have a water delivery system to direct water from within the quarry void into the wetlands to ensure water levels are suitable for the species during dry periods (e.g. during drought). The design of this system is to incorporate a holding tank to be filled with water from the quarry wetland, which is controlled by a manually operated butterfly valve and discharged into Pond 1 within the constructed dispersal corridor (Figure 2). This will then flow through each corresponding wetland through a series of stormwater linkage drains between each pond.

A water quality monitoring will be established within the quarry wetland prior to the commencement of construction and at a second site within the movement corridor immediately following the completion of the constructed wetlands. Water quality monitoring will follow the program outlined in the GGFCMP, and trigger values will be established based on pre-construction water quality within the quarry wetland. Water will be released from the water delivery system if these trigger values are exceeded in order to 'flush' the system with water from within the quarry wetland.

Water levels will be actively maintained and checked monthly over the species breeding season (October to March). Depth gauges will be installed in all ponds, and wetland depth will be monitored monthly for the first two years following construction. Water levels will not be allowed to fall below 0.5 metres and will be checked every two months if water levels are shown to be relatively stable over cooler months (April-September). Water will be release from the water delivery system if levels fall below 0.5 metres within the constructed wetlands during the species active breeding season (Spring and Summer) and will be regularly filled in order to retain water over the entire breeding season. Wetlands will be drained (i.e. via a valve) and allowed to completely dry out in the event that Eastern Gambusia is detected and/or if the water quality within the

proposed wetlands is not suitable for breeding by the species. Wetlands will only be drained outside of the Growling Grass Frog active season (i.e. Spring and Summer) and will be re-filled using the water delivery system once the wetlands have completely dried and after it is confirmed that Eastern Gambusia (or other predatory fish) is not present.

Heard *et.al.* (2012b) suggests that there may be something inherent in the water qualities of spring-fed quarries that limit the prevalence of Chytrid Fungus and conclude that quarries may provide important refuge for Growling Grass Frogs from this disease. As such, the use of spring fed water from within the quarry void will maintain as many of the habitat characteristics inherent to the quarry that have resulted in the extant Growling Grass Frog population on the site, including some of the mineral content that may influence water qualities related to reduced Chytrid Fungus incidence.

Growling Grass Frog have been found to inhabit wetland with salinity levels over 5mS/cm. Salinity level taken during targeted surveys prior to quarry decommissioning were found to be between 5.06mS/cm and 5.82mS/cm (Table 1). The holding tank will be fitted with an EC meter to identify if salinity levels are unsuitable for the species. The tank will not be released into the constructed wetland if salinity levels within the tank reach >7mS/cm, and the water will be flushed through the water delivery system with freshwater from rainwater tanks collected from rooftops within the development, or supplemented water from a water truck if required.

Pumping water from within the quarry may result in water levels within the quarry wetland fluctuating following pumping events and subsequent recharge from the groundwater aquifer. In a review of Southern Bell Frog biology, Pyke (2002) found that while it was unclear to what extent this species breeds in wetlands that were either semi-permanent, permanent or ephemeral, evidence suggests that the species persists in water bodies that were ephemeral or fluctuate significantly in water level. Fluctuating water levels and flooding have been shown to stimulate breeding in Southern Bell Frogs in the semi-arid region of Western NSW (Wassens 2005).

The existing wetland in the quarry void in its current state contains areas of shallow water supporting emergent vegetation, particularly along the north eastern banks of the waterbody (Photograph E2). Minor fluctuations in the water level may have the added benefit of stimulating emergent vegetation growth due to elevated solar radiation and water temperature, which can also increase tadpole development. Warm water resulting from fluctuating water levels also increases the productivity of wetlands, which in turn provides additional food resources such as invertebrates for Growling Grass Frog populations and providing additional foraging habitat along newly exposed shallow banks (DELWP 2017a).

The quarry void is large, and although the total holding capacity and recharge rate from the underground aquifer are not known, it is considered that these will be sufficient to sustain water levels within the waterbody should pumping be undertaken to re-fill the holding tank or to supplement water levels in the constructed wetland within Offset Areas 2 and 3.

6.4.1 Habitat Design Standards (DELWP 2017a)

The habitat design will broadly conform with the *Growling Grass Frog habitat design standards* (DELWP 2017a) with some exceptions, including:

- Wetland size - which will be compensated for by constructing a new water delivery system to ensure wetlands remain permanent. Heard *et.al.* (2010) found that while wetland size does not appear to be as important as hydroperiod and aquatic vegetation, larger wetlands are less likely to dry out and have

the capacity to support a diverse range of aquatic flora, therefor making them more likely to be occupied by the Growling Grass Frog. Heard and Scroggie (2009) found that wetlands occupied by Growling Grass Frog supported a mean water surface area of 3851 m^2, and while it is encouraged that habitat creation and enhancement aim to achieve a similar surface area, hydroperiod and aquatic vegetation are considered a priority. As such, the implementation of a water delivery system using water from within the quarry void to maintain water levels in the wetlands, even over dry periods, will increase the potential for Growling Grass Frog to occupy the constructed wetlands, potentially creating a more desirable environment than that found in a larger ephemeral wetland that experiences longer periods of drying.

Table 4: Breakdown of offset area 1 wetlands

Wetland ID	Total Area (m^2)	Area (Hectares)
Wetland 1	447	0.447
Wetland 2	1947	1.947
Wetland 3	227	0.227
Wetland 4	330	0.33
Wetland 5	184	0.184
Wetland 6	306	0.306
Wetland 7	228	0.228
Wetland 8	182	0.182
Total	**3851**	**3.851**

- Terrestrial buffer width – While wide terrestrial buffers are important for Growling Grass Frog, modelling suggests that the construction of additional wetlands habitat can help reduce the impact of narrow terrestrial buffer widths on Growling Grass Frog persistence (Heard and McCarthy 2012). While a relatively wide terrestrial buffer (>100 metres wide) is considered beneficial for the species, data from surveys in the greater Melbourne region suggest that Growling Grass Frog populations can persist, at least in the medium term, in the absence of sizeable terrestrial buffers. For example, a series of sediment ponds and treatment wetlands were constructed at Village Park in Caroline Springs, Victoria, in the early 2000s. The surrounding developed land consists primarily of residential properties, and terrestrial buffer between ponds generally ranges from approximately 10 to 30 metres. Surveys during the 2014/15 and 2015/16 breeding seasons showed that seven of the 17 ponds were occupied by Growling Grass Frog, with up to 50 individuals observed at a pond and successful breeding recorded (Ecology Australia 2017). Further surveys of the area by Ecology and Heritage Partners over the 2017/18 season confirmed the presence of the species in three of the four wetlands surveyed in Village Park. Several historical records, particularly between 2004 and 2007 (DELWP 2018) suggest that the population has persisted in this wetland cluster since at least 2004. The average vegetated buffer around occupied wetlands is less than 20 metres. From available aerial

imagery, the wetland complex appears to have had its current level of development since around 2004. Given the above information, and that there is very little apparent connectivity through the landscape to the populations nearest known core habitat in Kororoit Creek, it seems likely that this Growling Grass Frog population has persisted and apparently maintained population function in this wetland cluster for at least 16 years, with small terrestrial buffers.

The terrestrial buffer between constructed wetlands and the development within the study area varies from 2.26 metres to 3.9 metres (Appendix 1). The primary function of the constructed wetlands along the dispersal corridor is to provide additional breeding habitat, and to improve habitat connectivity by providing a suitable area for frogs to disperse within the property, and to allow for a future link from the suitable breeding area in the quarry void to the Merri Creek to the east (i.e. across the Council owned land). The intent is to also attract frogs into the study area from the core dispersal habitat along Merri Creek, in turn allowing genetic mixing and diversity, and ensuring that the population remains viable in the future. Emphasis has been placed on the quality of the habitat within offset Areas 2 and 3 and prioritising the size of constructed wetlands over terrestrial buffers within the corridor, which extends approximately 220 meters from the proposed sedimentation pond to the property boundary (Figure 2).

7 SOCIAL AND ECONOMIC MATTERS

7.1 Overview

The site is located in Central Campbellfield and is close to an activity centre. Building large format warehouses will not work here as pricing will not allow it and location is not a significant determinant. Furthermore, large format warehouses will fail to capture the essence of what this site can provide to the overall community in terms of the open space parkland and other essential amenities.

There is currently an undersupply of smaller, boutique warehouses that cater to small businesses and start-ups in the area, which are likely to be spaces that are required as we emerge from the current public health crisis. Many smaller businesses service much larger companies and are critical in the supply chain. In Australia, there are 2 million small businesses accounting for 97 percent of all business (employing less than 20 people). There are approximately 4.8 million employees that work for small businesses which subsequently employ 45% of the total workforce. These businesses need somewhere to operate from and providing these entry level size warehouses/offices will suit their needs.

These smaller businesses are especially sensitive to location and proximity of amenities: far more so than larger warehouse businesses that are more price sensitive. These businesses are generally occupied by buyers/tenants with young families so proximity to their home, children's school and childcare takes more priority over pricing.

This site is adjacent to Campbellfield plaza, so additional amenities such as childcare facility, food and beverage offering, and medical suites will provide a one stop shop for the businesses and creates a self-sufficient community.

7.1.1 Key findings

The Campbellfield area has long been characterised by poor quality industrial and warehouse spaces. Most of the buildings are very old and of poor quality. The developer is proposing is to change that out-look and to provide a high-class office/warehouse design and to encourage more unique businesses to come back. The natural landscape of this site also provides a distinct opportunity to deliver something different for the area.

The total build cost for the whole complex will be in excess of $100M. This will be over 250 warehouse units, 30,000m2 of GFA commercial space and 4000m2 of retail area.

Over 500 new jobs will be created during the construction phase of this project and will support many local services and equipment within the City of Hume. One example will be Rocla Pipes, which will be supplying all of the civil and hydraulic works. There are likely to be numerous local business in the City of Hume that will be supported over the lifespan of this development. Once development is completed, there is expected to be a further 500-600 jobs created within the business park community. The childcare centre will also provide much needed childcare services for local workers and residents.

Trade services will be engaged such as electricians, plumbers, civil works contractors, concreters, form workers, carpenters, roofers, glazers, welders, steel riggers and many more. There will also be several consultants involved as well as civil engineers, structural engineers, architects, marketing agencies, real estate agents and services consultants and so on.

Once completed, it is expected that high numbers of existing businesses will be moving into this complex, which will create a secondary level of investment in Hume. It is anticipated that this will be a thriving business community that will see more jobs and services created.

The consultant and client team have responded to this challenging site in a unique and innovative way. In addition to the manifest economic benefits, there will be positive economic and social benefits (protecting the water supply, developing important ecological habitat, new landscaping and social infrastructure such as trails, childcare centres and so forth).

This type of business park has no parallel in the City of Hume. It is reflective of a high end architectural and urban planning input. Undoubtedly, this will attract substantial numbers of businesses to Hume and create more investment opportunities for the City.

7.1.2 Context

Most office spaces in the region are provided through a warehouse format. The plan is to provide smaller strata titled offices over multiple levels to allow for flexibility to the market and the sizes can be changed should a tenant require a larger space. As most of the population growth in Melbourne in the coming years is likely to be in the north and western region, and the highest employment growth will likely come from the technology and healthcare industries, most of which will require affordable office spaces. As a result, the demand for co-working space has picked up significantly over the last 2-3 years, most of which is concentrated within 5-10 kilometres of the city. This development presents a unique opportunity to provide the first proper office space offering for the area, coupled with a great building and urban design suitable for the development.

Currently, there are no significant retail offering (as well as food and beverage offering) in the area apart from the Campbellfield Plaza. This would certainly increase the supply and provide a complementary extension to the Plaza.

It is also understood that a retail centre on the south side will activate the public realm open space, especially if Council is wanting to connect the Roebourne Reserve onto the property. This can create activities for the housing residents in the south (and north) to use our open space which will lead to the retail precinct.

In conclusion, this project presents a vital, strategic investment opportunity for the area and more importantly, the clients are shovel ready for the first stage of works.

7.2 Consultation

Hume City Council have been engaged throughout the design and development stage of the project, and are strongly committed to positioning Hume as a place for businesses to prosper, providing a supportive environment to sustain and expand existing businesses, attract a diversified range of new business investments and creating employment opportunities for local residents. The Council is committed to attract new business investments that create jobs and strengthen Hume's economy to prosper following the impacts of the Covid-19 public health crisis. Hume City Council support the application from an Economic Development perspective. Advice has been received from Council Environmental Representatives regarding the councils greater open-space management and ongoing development investigations for the resource recovery centre to the east in relation to the protection of the population of Growling Grass Frog.

There has been on-going consultation with DELWP in the development of the project. Specific advice has been received and incorporated into the development of a Concept Plan for the protection and enhancement of

Growling Grass Frog. A pre-referral site meeting was held with Council Environmental Representatives and assessment officers from DELWP on the 15 June 2020.

To date, there has been broad stakeholder support for the current proposal. Further stakeholder engagement and statutory public consultation will occur in accordance with state and Commonwealth requirements as the development progresses.

8 ENVIRONMENTAL RECORD OF PROPONENT

Forte Group is committed to sound environmental management practiced and environmental sustainability as this is a fundamental part of the company culture. As a real estate development company, Forte Group will involve managers, employees, clients and suppliers to ensure the use of environmentally sound and safe work practices and procedures.

Forte Group is committed to the following objectives:

- Design development projects with environmental sustainability in mind with regards to raw materials used, energy sources, end-user usage and health and overall environmental impact;
- Adopt design approach so that completed development projects improve upon existing environmental conditions, where appropriate;
- Implement best-available, financially feasible construction technology and techniques that minimise environmental impact;
- Maintain compliance with applicable environmental requirements; and,
- Ensure that all company employees and contractors are informed of these objectives, and periodically review and update objectives and procedures.

Forte Group have undertaken several development projects that have presented environmental risks and challenges. The company welcomes these challenges and in all their business undertakings aim for a positive outcome that benefits all stakeholders including the environment.

Forte Group has not been subject to any known prosecution for environmental breaches.

9 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

The National Strategy for Ecologically Sustainable Development (1992) sets out the policy framework for the Australian Government to make decisions and take actions to pursue ecologically sustainable development (ESD). The National Strategy requires government departments to develop institutional arrangements to ensure that the principles and objectives of ESD are delivered and sets out the following core objectives for achieving ESD:

- To enhance individual and community well-being by following a path of economic development that safeguards the welfare of future generations.
- To provide for equity within and between generations.
- To protect biological diversity and maintain essential ecological processes and life-support systems.

The proponent proposes to provide a high-class office/warehouse design and to encourage more unique businesses to come back. The natural landscape of this site also provides a distinct opportunity to deliver something different for the area. This type of business park has no parallel in the City of Hume and is reflective of a high end architectural and urban planning input. This will attract substantial numbers of businesses to Hume and create more investment opportunities for the City.

More than 500 new jobs will be created during the construction phase. Once development is completed, it is expected that another 500-600 jobs will be created within the business park community. The project presents a vital, strategic investment opportunity for the area. Once completed, high numbers of existing businesses are expected to move into this complex. This will create a secondary level of investment in Hume. It is anticipated that this will be a thriving business community that will see more jobs and services created.

The proposed development will see the retention of the quarry void that is known to support a breeding population of Growling Grass Frog and the creation of a habitat corridor along the south and south east of the study area.

10 CONCLUSION

The proposed development will impact an area of low quality and degraded terrestrial habitat around the rim of the quarry void covering approximately 1.5 hectares (Figure 2). The habitat quality in these areas is consistent with the low quality or lack of habitat in the disturbed areas outside the quarry void. Frogs may occasionally use these areas during dispersal events (i.e. warm, wet conditions). However, given the degraded and highly modified condition of these areas, they are not considered to provide important or limiting habitat for the species.

While the existing Growling Grass Frog habitat within the quarry void will not be impacted by the development, these areas will be enhanced through the provision of supplementary terrestrial habitat (rock, logs and other ground debris) and aquatic habitat (supplementary aquatic vegetation), and there will be ongoing management of threatening processes such as weed and pest animal control. A range of habitat features will be incorporated along the proposed Growling Grass Frog dispersal corridor in the south and south east of the study area, including the construction of eight dedicated (permanent) Growling Grass Frog wetlands. Habitat enhancement activities within Offset Area 1 within the quarry void will commence during the first stage of the development. Habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will also provide direct connection of suitable habitat between waterbodies within the movement corridor and the quarry wetland. The habitat corridor will be constructed during the early stages (i.e. from Stage 2 onwards) of the development to allow frogs to naturally colonise the wetlands. The constructed waterbodies and associated dispersal corridor will create a net increase in the availability of breeding habitat for Growling Grass Frog (Appendix 1).

While a total of 1.5 hectares of low quality foraging and dispersal habitat will be removed around the rim of the quarry void as part of development, the provision of eight created waterbodies in strategic locations along the dispersal corridor and the improvement of suitable terrestrial habitat within the quarry void adequately offsets the removal of habitat for the species.

REFERENCES

DAWE 2020. Protected Matters Search Tool: Interactive Map [www Document]. URL: <http://www.environment.gov.au/epbc/pmst/>. Commonwealth Department of the Environment and Energy, Canberra, ACT.

DELWP 2017a. *Growling Grass Frog Habitat Design Standards*, Melbourne Strategic Assessment. Published document prepared by the Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2017b. Guidelines for the removal, destruction or lopping of native vegetation. December 2017.Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2018. Victorian Biodiversity Atlas. Sourced from GIS layers: "VBA_FLORA25", "VBA_FLORA100", "VBA_FAUNA25", "VBA_FAUNA100", July 2018. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2021a. NatureKit Map [www Document]. URL: http://maps.biodiversity.vic.gov.au/viewer/?viewer=NatureKit. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2021b. VicPlan Map [www Document]. URL: https://mapshare.maps.vic.gov.au/vicplan/. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria

DEPI 2013a. Sub-regional species strategy for the Growling Grass Frog. Published Victorian Government. Department of Environment and Primary Industries, Melbourne, May 2013.

DEWHA 2009. Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis*. Nationally threatened species and ecological communities EPBC Act policy statement 3.14. Department of Environment, Water, Heritage and the Arts. Commonwealth of Australia, Canberra.

DoE 2013b. Matters of National Environmental Significance. Significant impact guidelines 1.1. *Environment Protection and Biodiversity Conservation Act 1999*. Australian Government Department of the Environment (DoE), Canberra.

DoEE 2016. DRAFT Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis. Published by the Commonwealth Department of the Environment and Energy, Canberra, ACT. Commonwealth of Australia.

DSEWPaC 2012a. *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (October 2012). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPaC 2012b. Offsets Assessment Guide: For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2 October 2012). Microsoft Excel spreadsheet developed by the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Ecology Australia Pty Ltd 2006. Sub-regional conservation Strategy for the Growling Grass Frog – Epping/Somerton, Victoria. Ecology Australia Pty Ltd for Department of Primary Industries.

Ecology Australia 2017. Frog Conceptual Model Project: Modelling and Final Report. Report prepared for Melbourne Water by J Urlus. Ecology Australia Pty Ltd, Fairfield

Ecology and Heritage Partners 2012a. EPBC Act Referral - Bolinda Road Quarry decommission, filling in waterbody and drainage line within the quarry. Unpublished report prepared for Bolinda Operations Pty Ltd.

Ecology and Heritage Partners 2012b. Targeted Growling Grass Frog surveys and legislative advice for the proposed decommission of the Bolinda Road Quarry, Campbellfield, Victoria. Unpublished report prepared for Bolinda Operations Pty Ltd.

Ecology and Heritage Partners 2016. Growling Grass Frog *Litoria raniformis* Conservation Management Plan, Bolinda Road Quarry, Campbellfield, Victoria.

Ecology and Heritage Partners 2019. Ecological advice in relation to potential impacts on Growling Grass Frog *Litoria raniformis* associated with a proposed 3-Lot subdivision, Bolinda Road Quarry, Campbellfield, Victoria. Unpublished report prepared for Tomkinson Group Pty Ltd.

Ecology and Heritage Partners 2020. Biodiversity Assessment for the proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria. Report prepared for Forte Group Pty Ltd.

EPA 1991. Construction Techniques for Sediment Pollution Control. Published document prepared by the Victorian Environment Protection Authority, Melbourne, Victoria.

EPA 1996. Environmental Guidelines for Major Construction Sites. Published document prepared by the Victorian Environmental Protection Authority, Melbourne, Victoria.

Hale, J., Heard, G.W., Smith, K.L., Parris, K.M., Austin, J., Kearney, M., and Melville, J. *in press*. Structure and fragmentation of growling grass frog metapopulations*. Conservation Genetics*

Hamer, A.J. and Aaron, A.K., 2008. Aspects of the ecology and conservation of the Growling Grass Frog *Litoria raniformis* in an urban-fringe environment, southern Victoria. *Australian Zoologist*: 34, No. 3, pp. 393-407.

Heard, G., and McCarthy, M. 2012. Metapopulation viability of the Growling Grass Frog in Melbourne's urban growth areas. Report prepared for Victorian Department of Sustainability and Environment. School of Botany, The University of Melbourne, Parkville

Heard, G.W and Scroggie, M.P. 2009. *Assessing the impact of urbanisation on Growling Grass Frog metapopulaitons*. Report to the Victorian Department of Sustainability. Arthur Rylah Institute for Environmental Research, Heidelberg.

Heard, G.W., Scroggie, M.P., and Clemann, N. 2010. Guidelines for managing the endangered Growling Grass Frog in urbanising landscapes. Arthur Rylah Institute for Environmental Research Technical Report Series No. 208. Department of Sustainability and Environment, Heidelberg, Victoria

Heard, G.W., Scroggie, M. and Clemann, N. 2012b. *Correlates and consequences of chytridiomycosis for populations of the Growling Grass Frog in peri-urban Melbourne*. Report to the Victorian Department of Sustainability and Environment. Arthur Rylah Institute for Environmental Research, Heidelberg.

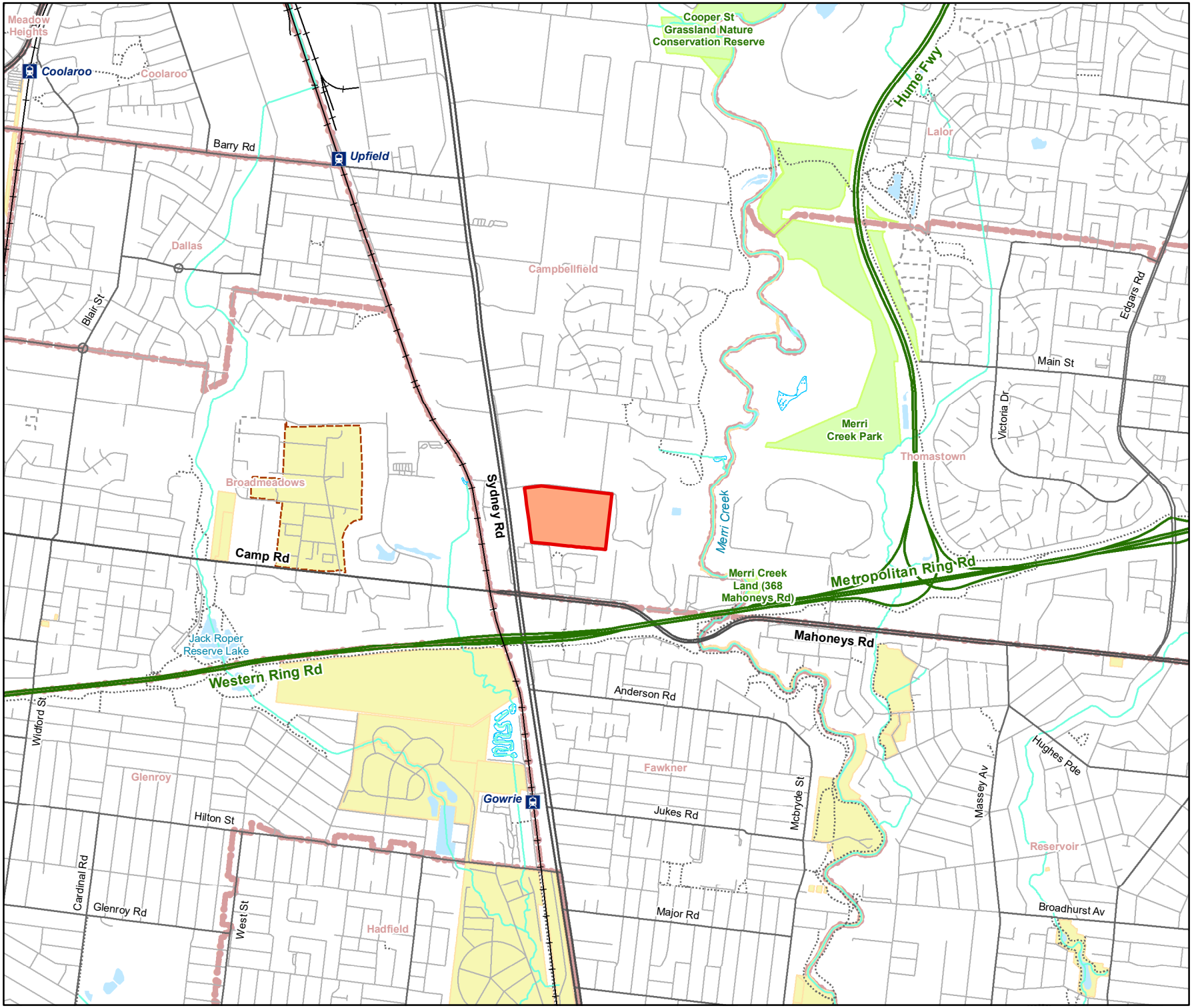
Hume City Council 2013, *Building and Works Code of Practice*, Attachment to General Local Law No.1.

Metromap 2020. https://metromap.com.au/products/2d/ [web application] [Accessed December 2020]

Meinhardt 2011. Draft Bolinda Road Open Space Master Plan. Unpublished report for Hume City Council.

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. Wildlife Profiles Pty Ltd/Arthur Rylah Institute for Environmental Research for DNRE, Flora and Fauna Branch.

FIGURES



Legend

- Study Area
- Railway
- Freeway
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Walking Track
- Minor Watercourse
- Permanent Waterbody
- Wetland/Swamp
- Parks and Reserves
- Commonwealth Land
- Crown Land
- Localities

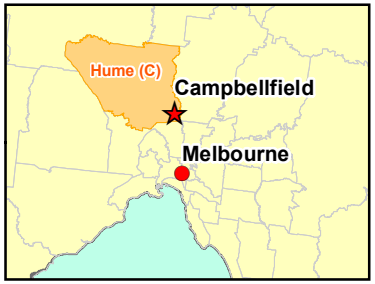


Figure 1

Location of the study area

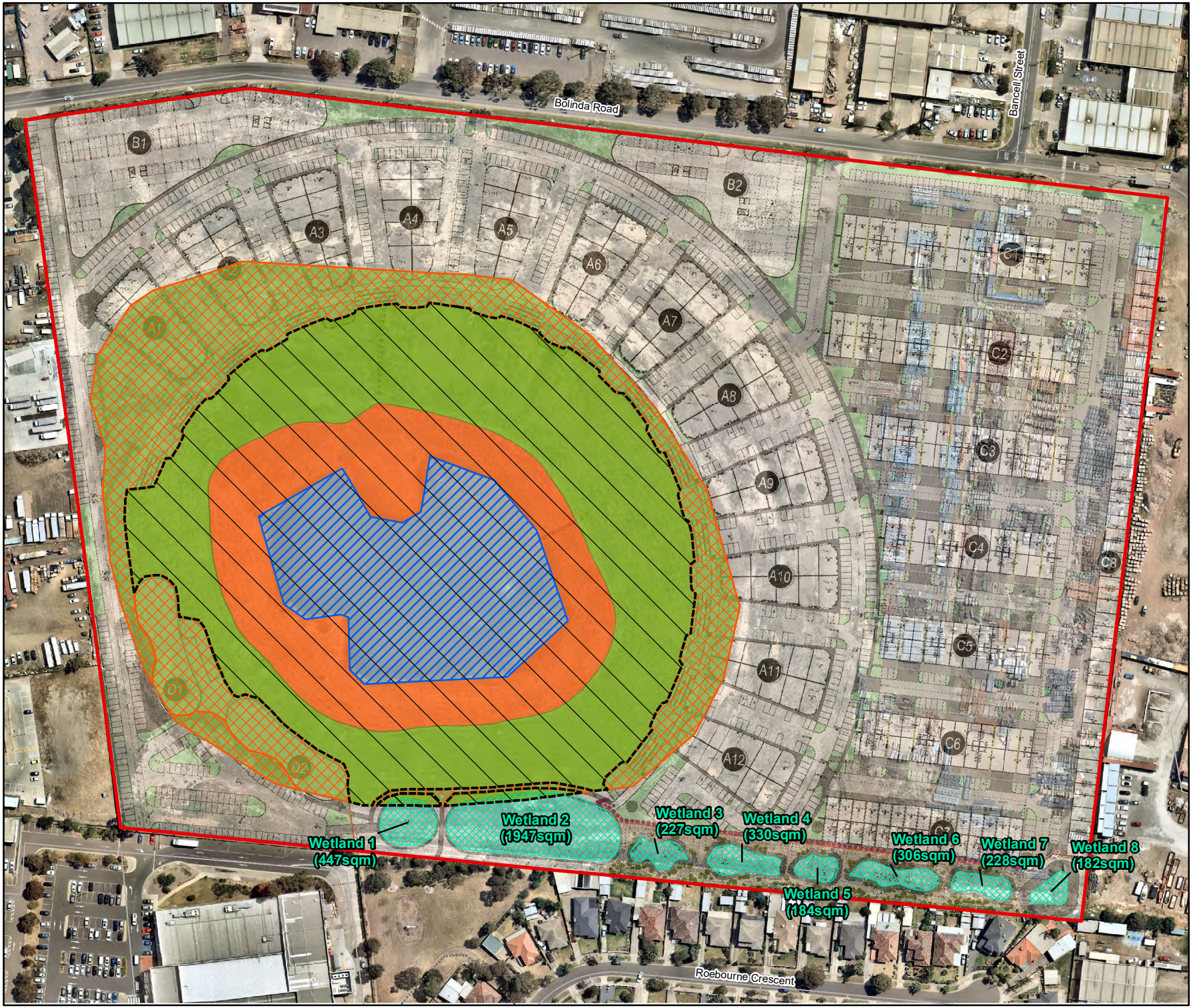
Biodiversity Assessment for 75 Bolinda Road, Campbellfield

0 500 1,000
Metres

Map Scale: 1:30,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.



Legend

- Study Area
- High quality Growling Grass Frog foraging habitat
- Growling Grass Frog dispersal and foraging habitat
- Impacted Growling Grass Frog Terrestrial Habitat
- Known Growling Grass Frog breeding habitat
- Proposed Constructed Wetland
- No-go zone

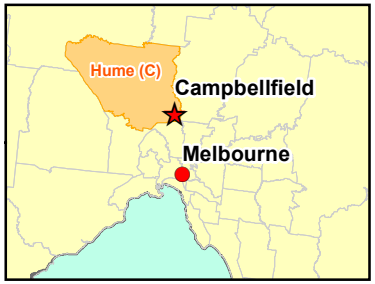


Figure 2

Ecological features

Biodiversity Assessment for 75 Bolinda Road, Campbellfield

N

0 30 60

Metres

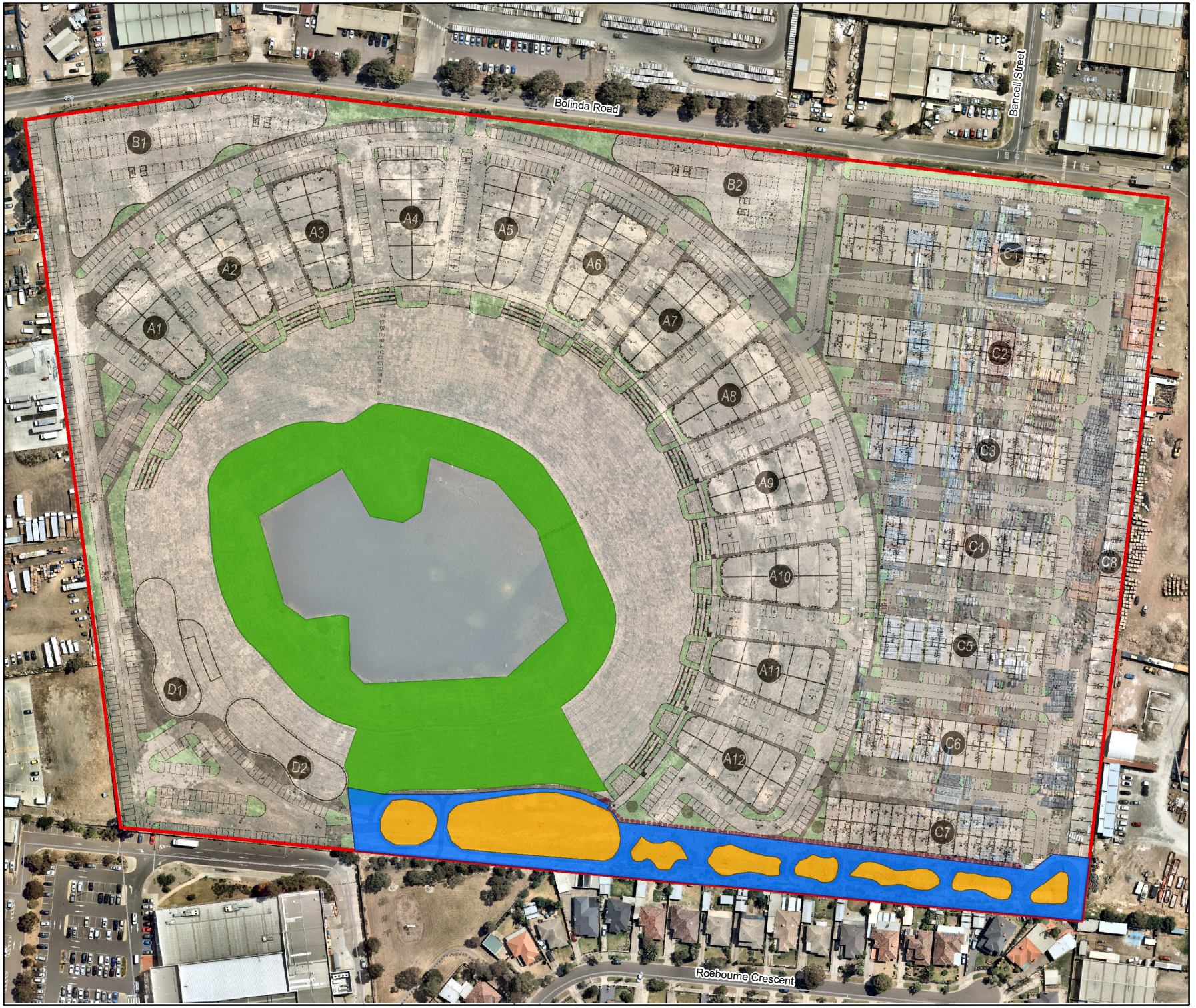
Map Scale: 1:2,300 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

13138_Fig02_EcoFeat_G20 5/02/2021 psorensen

Aerial source: Nearmap 2019



Legend

- Study Area
- Offset Area 1
- Offset Area 2
- Offset Area 3

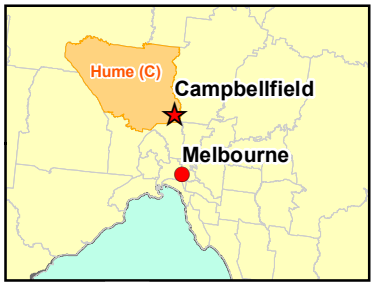


Figure 3

Proposed Offset Areas

75 Bolinda Road, Campbellfield

0 30 60

Metres

Map Scale: 1:2,300 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

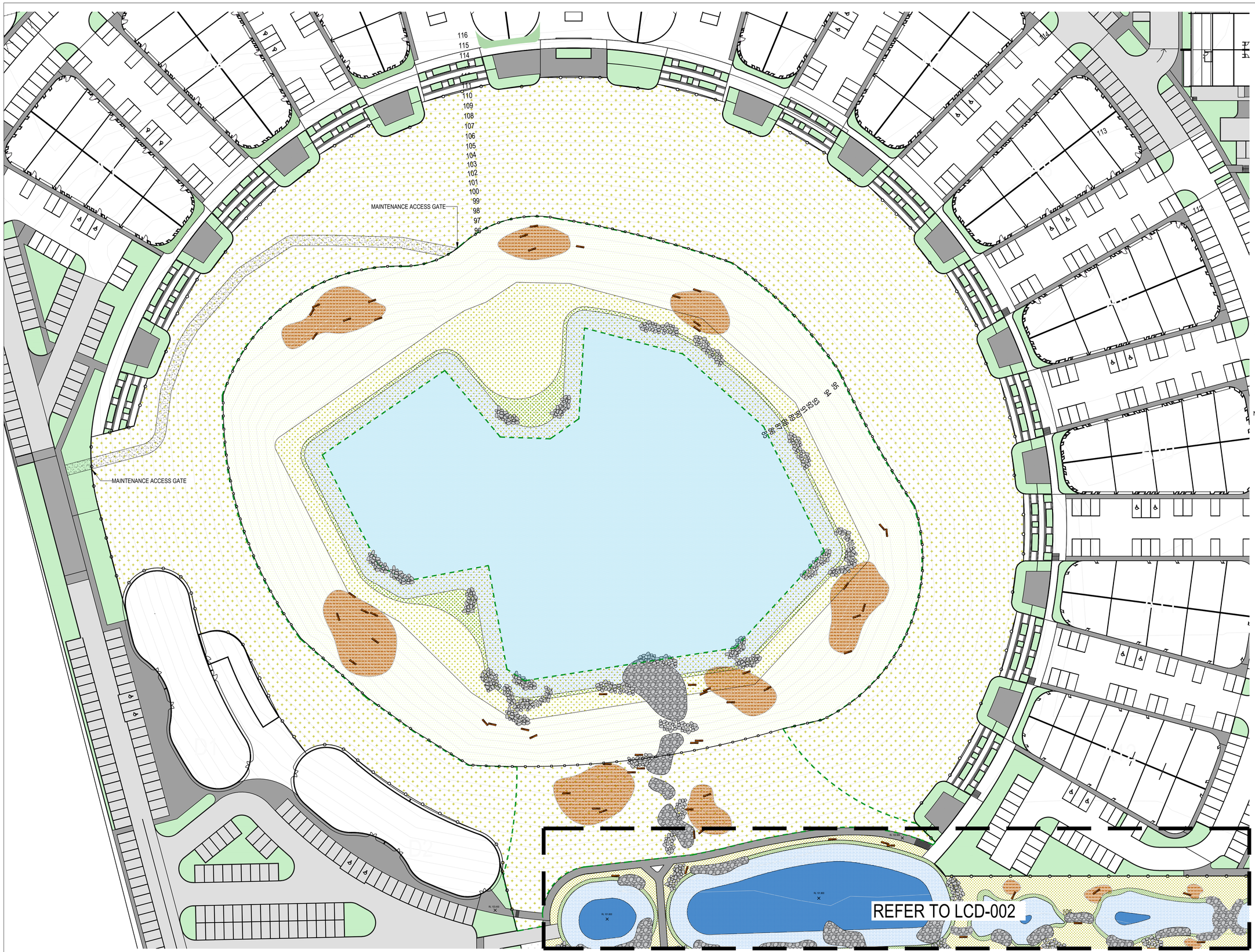
VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

13138_Fig01_PropOS_G20 15/04/2021 melsley

Aerial source: Nearmap 2019

APPENDICES

APPENDIX 1 – LANDSCAPE MANAGEMENT PLAN



WARNING

BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE INDICATIVE ONLY. THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. DIAL B4 U DIG PH: 1100

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK. REPORT ALL DISCREPANCIES TO SUPERINTENDENT PRIOR TO CONSTRUCTION. FIGURED DIMENSIONS TO BE TAKEN INPREFERENCE TO SCALED DRAWINGS. ALL DRAWINGS MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT PRIOR PERMISSION FROM THE LANDSCAPE ARCHITECT.

STATUS

FOR ENDORSEMENT
NOT FOR CONSTRUCTION

NO.	REVISION	DATE
A	FOR ENDORSEMENT	01/04/2021
B	FOR ENDORSEMENT	19/04/2021
C	FOR ENDORSEMENT	24/05/2021

LEGEND

REFER TO PROPOSED PLANT SCHEDULE ON LCD-003.

- EXTENT OF HIGH QUALITY HABITAT AREA ENRICHMENT 1.5HA
- EXISTING GROWLING GRASS FROG TERRESTRIAL ZONE - DISPERSAL AND FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- EXISTING HIGH QUALITY GROWLING GRASS FROG TERRESTRIAL ZONE - FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- NEW FRINGING AND EMERGENT - LITTORAL AND EPHEMERAL ZONE
- NEW EMERGENT - ENTRY ZONE
- NEW SUBMERGENT AND FLOATING SUBMERGENT - EMBANKMENT ZONE
- NEW WETLAND DEEP WATER ZONE
- NEW TERRESTRIAL ZONE - SHORT, MOWN GRASS WITH AN OPEN STRUCTURE (20% MAX COVER), WITH PATCHES OF DENSE TUSSOCK PLANTING
- EXISTING QUARRY VOID WATER BODY TO BE RETAINED AND PROTECTED
- ROCK MATTRESSING/PILES
- AREA OF LARGE WOODY DEBRIS (WITHIN LITTORAL/EPHEMERAL ZONE)
- WOOD LOGS/ RECYCLED TIMBER SLEEPERS
- LARGE CONCAVE ROCKS (300-1500mm DIAMETER)
- SMALL CONCAVE ROCKS (3-5 BOULDERS / m^2)
- SEDIMENT/FROG EXCLUSION FENCING TO BE INSTALLED AROUND THE PERIMETER OF THE NO-GO AREA
- TEMPORARY FROG EXCLUSION FENCING
- PROPOSED FOOTPATH
- EXTENT OF MAINTENANCE ACCESS PATH

Level 4, 136 Exhibition Street
Melbourne VIC 3000
Tel. +61 3 9654 8844
Fax. +61 3 9654 8088
Email info@hansenpartnership.com.au
Web www.hansenpartnership.com.au

hansen

CLIENT

BOLINDA PLACE PTY LTD ATF
BOLINDA PLACE UNIT TRUST

PROJECT

75-135 Bolinda Road
Campbellfield

DRAWING TITLE

QUARRY VOID
LANDSCAPE PLAN

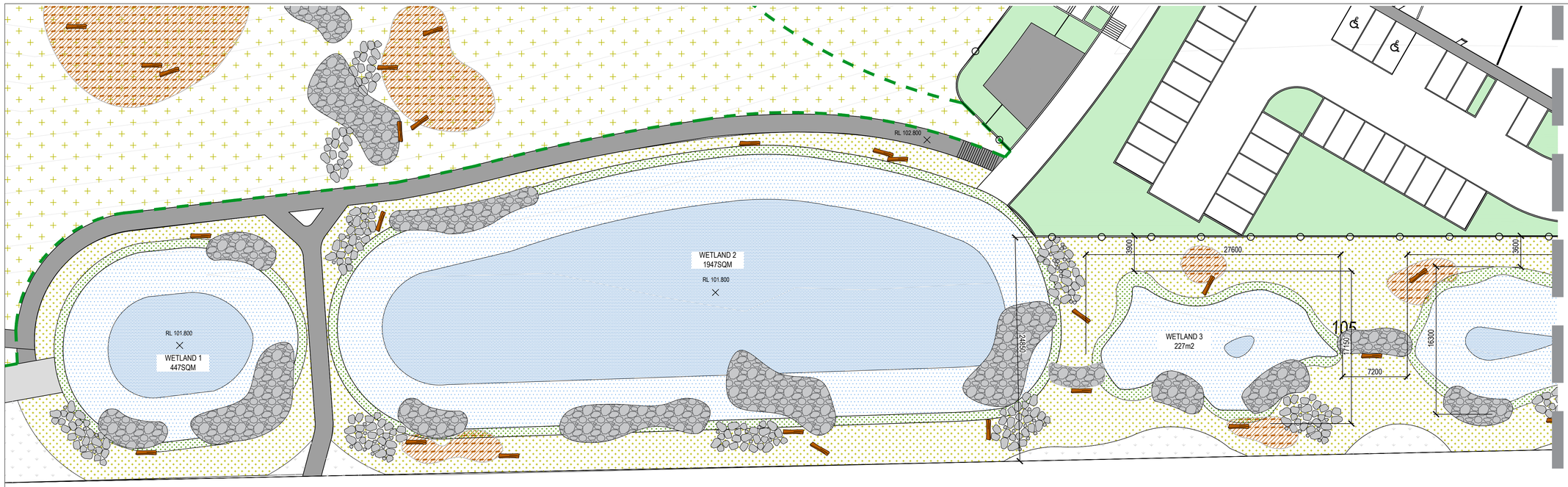
DRAWN	CHECKED	SCALE A1	SCALE A3
BY	CS	1:500	1:1000

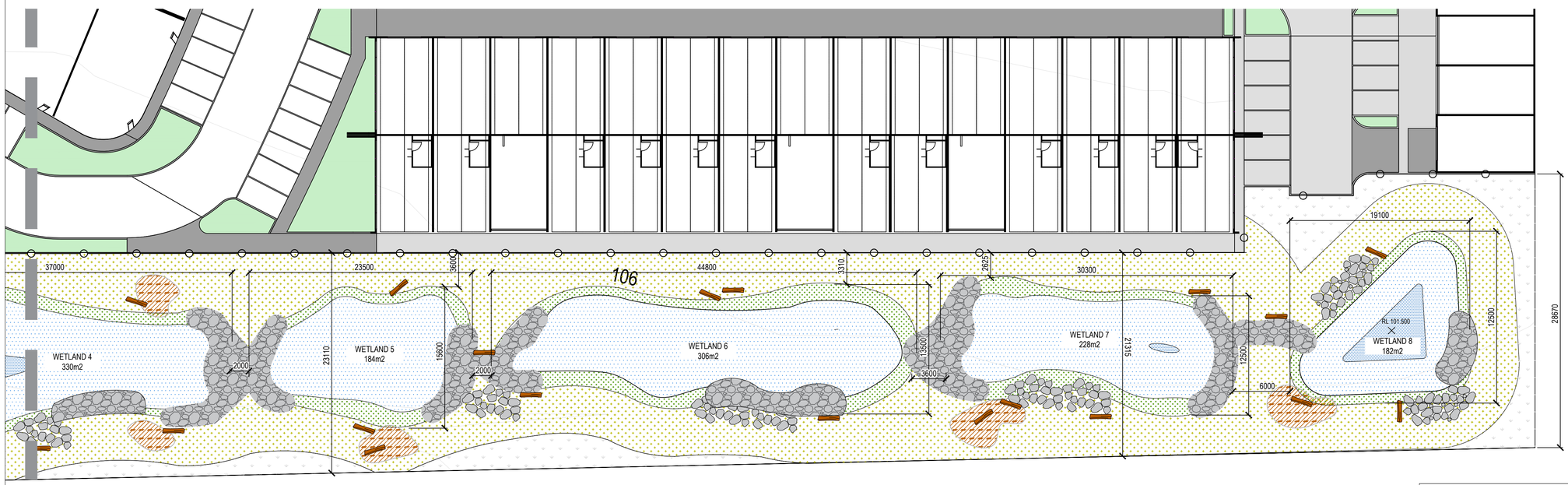
5 0 10 20 30m

PLOT DATE	JOB NUMBER	CLIENT REF
	2019.417	-

DRAWING NUMBER REV

LCD-001 C





ROCK PILE NOTES:

- ROCK PILES AT LEAST ONE METRE DEEP MUST BE CONSTRUCTED ADJACENT TO THE WETLAND MARGIN USING A VARIETY OF ROCK SIZES BETWEEN 10CM - 1M IN DIAMETER.
- ROCK PILES IN/ADJACENT TO THE DISPERSAL CORRIDOR PONDS SHOULD BE STACKED HIGH (1-1.5M).

WARNING

BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE INDICATIVE ONLY. THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. DIAL B4 U DIG PH: 1100

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK. REPORT ALL DISCREPANCIES TO SUPERINTENDENT PRIOR TO CONSTRUCTION. FIGURED DIMENSIONS TO BE TAKEN INPREFERENCE TO SCALED DRAWINGS. ALL DRAWINGS MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT PRIOR PERMISSION FROM THE LANDSCAPE ARCHITECT.

STATUS

FOR ENDORSEMENT
NOT FOR CONSTRUCTION

NO.	REVISION	DATE
A	FOR ENDORSEMENT	01/04/2021
B	FOR ENDORSEMENT	19/04/2021
C	FOR ENDORSEMENT	24/05/2021

LEGEND

REFER TO PROPOSED PLANT SCHEDULE ON LCD-003.

- EXTENT OF HIGH QUALITY HABITAT AREA ENRICHMENT 1.5HA
- EXISTING GROWLING GRASS FROG TERRESTRIAL ZONE - DISPERSAL AND FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- EXISTING HIGH QUALITY GROWLING GRASS FROG TERRESTRIAL ZONE - FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- NEW FRINGING AND EMERGENT - LITTORAL AND EPHEMERAL ZONE
- NEW EMERGENT - ENTRY ZONE
- NEW SUBMERGENT AND FLOATING SUBMERGENT - EMBANKMENT ZONE
- NEW WETLAND DEEP WATER ZONE
- NEW TERRESTRIAL ZONE - SHORT, MOWN GRASS WITH AN OPEN STRUCTURE (20% MAX COVER), WITH PATCHES OF DENSE TUSSOCK PLANTING
- EXISTING QUARRY VOID WATER BODY TO BE RETAINED AND PROTECTED
- ROCK MATTRESSING/PILES
- AREA OF LARGE WOODY DEBRIS (WITHIN LITTORAL/EPHEMERAL ZONE)
- WOOD LOGS/ RECYCLED TIMBER SLEEPERS
- LARGE CONCAVE ROCKS (300-1500mm DIAMETER)
- SMALL CONCAVE ROCKS (3-5 BOULDERS / m^2)
- SEDIMENT/FROG EXCLUSION FENCING TO BE INSTALLED AROUND THE PERIMETER OF THE NO-GO AREA
- TEMPORARY FROG EXCLUSION FENCING
- PROPOSED FOOTPATH
- EXTENT OF MAINTENANCE ACCESS PATH

Level 4, 136 Exhibition Street
Melbourne VIC 3000
Tel. +61 3 9654 8844
Fax. +61 3 9654 8088
Email info@hansenpartnership.com.au
Web www.hansenpartnership.com.au

hansen

CLIENT

BOLINDA PLACE PTY LTD ATF
BOLINDA PLACE UNIT TRUST

PROJECT

75-135 Bolinda Road
Campbellfield

DRAWING TITLE

WETLAND CORRIDOR LANDSCAPE PLAN

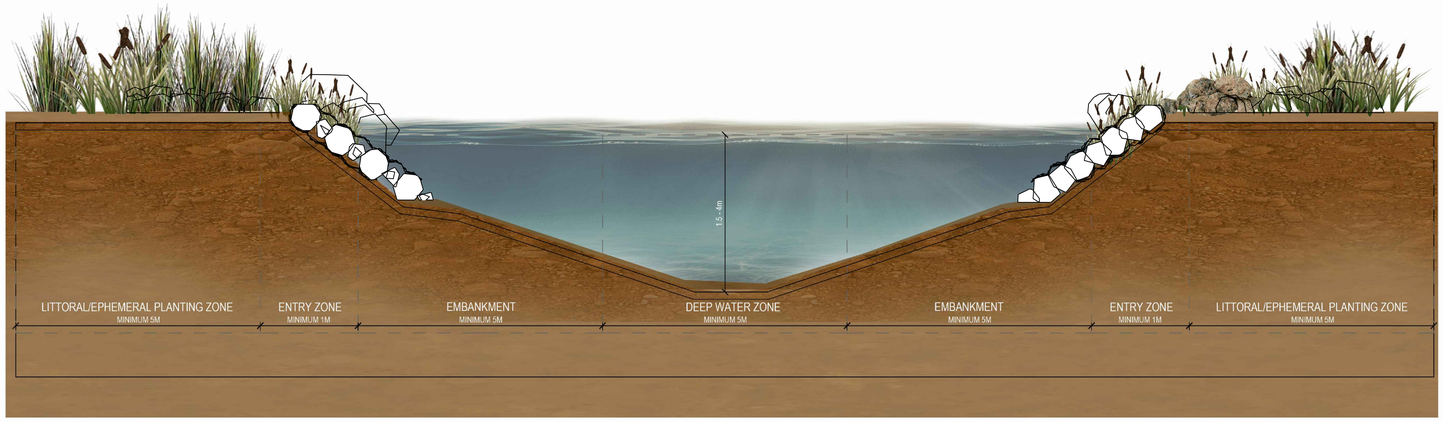
DRAWN	CHECKED	SCALE A1	SCALE A3
BY	CS	1:250	1:500

0 8 16m
2 12

PLOT DATE	JOB NUMBER	CLIENT REF
	2019.417	-

DRAWING NUMBER REV

LCD-002 C



01 TYPICAL WETLAND CROSS SECTION
SCALE 1: @A1 1: @A3

PROPOSED PLANTING SCHEDULE - QUARRY VOID AND WETLAND

	Code	Botanical Name	Common Name	Typical height x Width (m)	Spacing	Installed Size
	FRINGING AND EMERGENT - LITTORAL/EPHEMERAL ZONE					
*	**CAR app**	*Carex appressa*	Tall Sedge	1.00 x 0.50m	6 per m2	150mm pot
*	**CRA hel**	*Crassula helmsii*	Swamp Crassula	0.30 x 4.00m	6 per m2	150mm pot
*	**EPI bill**	*Epilobium billardierianum*	Smooth Willow-herb	1.00 x 0.35m	6 per m2	150mm pot
*	**POA lab**	*Poa labillardierei var. labillardierei*	Common Tussock-grass	1.20 x 0.50m	6 per m2	150mm pot
*	**POT och**	*Potamogeton ochreatus*	Blunt Pondweed	4.00 x 0.08m	6 per m2	150mm pot
					Allow for areas of bare ground between plantings.	
	EMERGENT - ENTRY ZONE					
*	**AMP flu**	*Amphibromus fluitans*	River Swamp Wallaby-grass	0.25 x 0.50m	6 per m2	150mm pot
*	**BAU art**	*Baumea articulata*	Jointed Twig-sedge	1.50 x 2.50m	6 per m2	150mm pot
*	**JUN ama**	*Juncus amabilis*	Hollow-rush	1.20 x 0.50m	6 per m2	150mm pot
*	**PER dec**	*Persicaria decipiens*	Slender Knotweed	0.30 x 0.50m	6 per m2	150mm pot
	SUBMERGENT AND FLOATING SUBMERGENT - EMBANKMENT ZONE					
*	**ALI pla**	*Alisma platago-aquatica*	Water plantain	1.5 x 0.4m	6 per m2	150mm pot
*	**CER dem**	*Ceratophyllum demersum*	Hornwort	3.00 x 0.20m	3 per m2	150mm pot
*	**MYR cri**	*Myriophyllum crispatum*	Upright Water-milfoil	0.25 x 0.60m	3 per m2	150mm pot
*	**POT cri**	*Potamogeton crispus*	Curly Pondweed	0.10 x 1.50m	3 per m2	150mm pot
*	**HYD sib**	*Hydrocotyle sibthorpioides*	Shining Pennywort	0.10 x 0.30m	3 per m2	150mm pot
*	**LYT sal**	*Lythrum salicaria*	Small Loosestrife	0.30 x 0.50m	3 per m2	150mm pot
*	**OTT ova**	*Ottelia ovalifolia*	Swamp Lily	1.50 x 0.90	3 per m2	150mm pot
*	**POT pec**	*Potamogeton pectinatus*	Fennel Pondweed	0.1 x 1.00m	3 per m2	150mm pot
*	**VAL ame**	*Vallisneria americana*	Ribbon-weed	1.00 x 0.30m	3 per m2	150mm pot
					Allow for 40% submergent, 20% floating and 30% emergent species.	

Species recommended for revegetation in the 'Growling Grass Frog Litoria raniformis Conservation Management Plan' Attachment C.

 # Limit use of this species as it may become invasive.

EXISTING AND NEW TERRESTRIAL AREA PLANTING NOTES:

- NO SHRUBS TO BE PLANTED WITHIN 10M OF THE WETLANDS NORMAL WATER LEVEL (OUTER EDGE OF LITTORAL ZONE).
- ALLOW FOR TUSSOCK FORMING SPECIES OF PATCHY DENSE PLANTINGS.
- FROM 10M TO 100M FROM THE WETLAND, NEW TERRESTRIAL AREAS TO BE SHORT, MOWN GRASS WITH AN OPEN STRUCTURE (20% COVER). LOW GRASS VEGETATION DOES NOT NEED TO BE NATIVE, BUT MOST NOT INCLUDE ANY INVASIVE SPECIES.
- TREES AND/OR LARGE SHRUBS MUST NOT BE PLANTED WITHIN 20M OF THE BANKS OF THE WETLANDS.

SEDIMENT/FROG EXCLUSION FENCING NOTES:

- SEDIMENT/ FROG EXCLUSION FENCING TO BE INSTALLED AROUND THE PERIMETER OF THE NO-GO-AREA TO PROVIDE A PHYSICAL BARRIER BETWEEN THE DEVELOPMENT AREA AND RETAINED HABITAT. DRIFT FENCING MUST ALSO BE USED ALONG THE EDGES OF THE CONSTRUCTED WETLANDS AND PONDS TO PREVENT GROWLING GRASS FROGS FROM ACCESSING THE DEVELOPMENT AREA DURING CONSTRUCTION.
- FENCING MUST BE CONSTRUCTED OF A CLOTH OR PLASTIC MATERIAL AND ONLY APPROPRIATE FENCING MATERIAL THAT WITHSTANDS VARIABLE WEATHER CONDITIONS OVER LONG PERIODS OF TIME MUST BE USED.
- FENCING MUST BE INSTALLED AT LEAST ONE METRE HIGH, WITH AN ADDITIONAL 0.2 METRES BURIED BELOW-GROUND. AN ADDITIONAL 0.2 METRES AT THE TOP OF THE FENCE MUST BE BENT/ ANGLED OVER AT LESS THAN 90 DEGREES TO THE VERTICAL ON THE FROG HABITAT SIDE (NOT THE EXCLUDED HABITAT SIDE) TO PREVENT FROGS FROM CLIMBING OR HOPPING OVER THE FENCE.
- REFUGIA FOR SHELTER MUST BE PLACED AT LEAST ONE METRE AWAY FROM THE FENCE AND ANY VEGETATION WITHIN ONE METRE OF THE FENCE MUST NOT EXCEED 0.5 METRES TO PREVENT FROGS FROM ESCAPING (I.E. LOW-GROWING GRASSES SHOULD BE PLANTED).
- FENCES MUST BE TAUT WITHOUT CREASES OR FOLDS.
- FENCE POSTS MUST BE INSTALLED ON THE OUTER FENCING SIDE (I.E. EXCLUDED HABITAT SIDE) AND FASTENED WITH NAILS OR SIMILAR, AND LIE FLUSH WITH FENCING MATERIAL TO PREVENT FROGS FROM CLIMBING UP POSTS AND ESCAPING OVER THE FENCE.
- THE SAFETY FENCING SURROUNDING THE QUARRY NEEDS TO FOLLOW THE ENTIRE BOUNDARY OF THE QUARRY VOID, BETWEEN THE DEVELOPMENT AND THE QUARRY VOID. IT MUST NOT GO OUTSIDE THE CURRENT DEVELOPMENT FOOTPRINT AS THIS WILL INCREASE THE TOTAL GGF HABITAT TO BE IMPACTED/OFFSET, AND ALSO NEEDS TO INCLUDE AN ACCESS POINT WHERE MAINTENANCE CREWS CAN ACCESS THE AREA FOR WEED CONTROL AND LITTER REMOVAL. SEE ATTACHED FIGURE THAT SHOWS IN GREEN THE GGF HABITAT WHICH MUST BE AVOIDED.

WARNING

BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE INDICATIVE ONLY. THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. DIAL B4 U DIG PH: 1100

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK. REPORT ALL DISCREPANCIES TO SUPERINTENDENT PRIOR TO CONSTRUCTION. FIGURED DIMENSIONS TO BE TAKEN INPREFERENCE TO SCALED DRAWINGS. ALL DRAWINGS MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT PRIOR PERMISSION FROM THE LANDSCAPE ARCHITECT.

STATUS

FOR ENDORSEMENT
NOT FOR CONSTRUCTION

NO.	REVISION	DATE
A	FOR ENDORSEMENT	01/04/2021
B	FOR ENDORSEMENT	19/04/2021
C	FOR ENDORSEMENT	24/05/2021

hansen
Level 4, 136 Exhibition Street
Melbourne VIC 3000
Tel. +61 3 9654 8844
Fax. +61 3 9654 8088
Email info@hansenpartnership.com.au
Web www.hansenpartnership.com.au

CLIENT
BOLINDA PLACE PTY LTD ATF
BOLINDA PLACE UNIT TRUST

PROJECT
75-135 Bolinda Road
Campbellfield

DRAWING TITLE
TYPICAL DETAILS
SCHEDULES AND NOTES

DRAWN	CHECKED	SCALE A1	SCALE A3
BY	CS	-	-

PLOT DATE	JOB NUMBER	CLIENT REF
	2019.417	-

DRAWING NUMBER REV

LCD-003 C

APPENDIX 2 - GROWLING GRASS FROG CONSERVATION MANAGEMENT PLAN

Final Report

Growling Grass Frog *Litoria raniformis* Conservation Management Plan for the Proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria (EPBC 2020/8748)

Prepared for

Forte Group Pty Ltd

May 2021

Ecology and Heritage Partners Pty Ltd

MELBOURNE: 292 Mt Alexander Road Ascot Vale VIC 3056 **GEELONG:** PO Box 8048 Newtown VIC 3220
BRISBANE: Level 22 / 127 Creek Street Brisbane QLD 4000 **ADELAIDE:** 8 Greenhill Road Wayville SA 5034
www.ehpartners.com.au

DOCUMENT CONTROL

Assessment	Growling Grass Frog *Litoria raniformis* Conservation Management Plan for the Proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria
Address	75-135 Bolinda Road Campbellfield, Victoria
Project number	13138
Project manager	Jeremy Coyne (Zoologist / Team Leader - Natural Heritage)
Report reviewer	Aaron Organ (Director / Principal Ecologist)
Mapping	Monique Elsley (GIS Co-Ordinator)
File name	13138_EHP_GGFCMP_Final V1_Report_25052021
Client	Forte Group Pty Ltd
Bioregion	Victorian Volcanic Plain
CMA	Port Phillip and Westernport Catchment Management Authority
Council	Hume City Council

Report versions	Comments	Comments updated by	Date submitted
01	Draft CMP		18/12/2020
Draft V1	DAWE and Forte Group Pty Ltd	JC	10/02/2021
Draft V2	DAWE	JC, AO	21/04/2021
Final V1		JC, AO	25/05/2021

Acknowledgements

We thank the following people for their contribution to the project:

- William Tan (Forte Group Pty Ltd) for project information and site access;
- John Glossop (Glossop Town Planning) and Joe Cornetta (Cornetta Partners Architects) for project information;
- Craig Czarny (Hansen Partnership Pty Ltd) for project information; and,
- Victorian Department of Environment, Land, Water and Planning (DELWP) and the Commonwealth Department of Agriculture, Water and the Environment's (DAWE) for access to online ecological databases.

Copyright © Ecology and Heritage Partners Pty Ltd

This document is subject to copyright and may only be used for the purposes for which it was commissioned. The use or copying of this document in whole or part without the permission of Ecology and Heritage Partners Pty Ltd is an infringement of copyright.

Disclaimer

Although Ecology and Heritage Partners Pty Ltd have taken all the necessary steps to ensure that an accurate document has been prepared, the company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report and its contents.

ACRONYMS AND ABBREVIATIONS

Acronym	Description
CaLP	*Catchment and Land Protection Act 1994*
CMA	Catchment Management Authority
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DELWP	Victorian Department of Environment, Land, Water and Planning
DEPI	(former) Victorian Department of Environment and Primary Industries
DoE	(former) Commonwealth Department of Environment
DoEE	Commonwealth Department of Environment and Energy
DSEWPaC	(former) Commonwealth Department of Sustainability, Environment, Water, Populations and Communities.
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EVC	Ecological Vegetation Class
FFG Act	*Flora and Fauna Guarantee Act 1988*
FIS	Flora Information System
GGF	Growling Grass Frog *Litoria raniformis*
HabHa	Habitat Hectare
NES	National Environmental Significance
NVIM Tool	Native Vegetation Information Management Tool (DELWP)
P&E Act	*Planning and Environment Act 1987*
PMST	Protected Matters Search Tool (DAWE)
VBA	Victorian Biodiversity Atlas (DELWP)

CONTENTS

1 INTRODUCTION

1.1 Project Background

Ecology and Heritage Partners Pty Ltd were commissioned by Forte Group Pty Ltd to prepare a Conservation Management Plan (CMP) for the nationally threatened Growling Grass Frog *Litoria raniformis* for the proposed commercial development at 75-135 Bolinda Road Campbellfield, Victoria (EPBC 2020/8748) (Figure 1). The site is proposed to be developed in nine stages, with construction planned to commence in June 2021. This document provides a detailed plan for the management of the existing Growling Grass Frog population and associated habitats within the study area during pre-development, development, and post-development stages.

A development plan has been prepared as part of the planning permit application for the proposed commercial development, and this plan includes the provision of a dedicated movement corridor that will be constructed to facilitate frog dispersal between the quarry void and Merri Creek. High-quality habitat within the quarry void and associated dispersal corridors within the study area will be retained and enhanced through the provision of supplementary habitat and the construction of an unbroken series of waterbodies constructed along the length of the dispersal corridor to allow unimpeded frog dispersal. These waterbodies will be designed and constructed taking into consideration the *Growling Grass Frog Habitat Design Standards* (DELWP 2017a).

1.2 Objectives

The overall aim of this CMP is to provide detailed measures to ensure the proposed activity does not have a significant impact on the Growling Grass Frog population and supporting habitat, along with ensuring the ongoing survival of Growling Grass Frog in the wider area into the future. This CMP outlines management actions to meet this objective through the protection, enhancement, and ongoing management of Growling Grass Frog habitat. The CMP also outlines monitoring requirements to ensure that the species is not adversely affected during works and following development of the site. Specifically, this CMP aims to:

- Determine what management actions are required to complete the proposed development without negatively impacting the resident Growling Grass Frog population;
- Provide a map showing the extent of current Growling Grass Frog habitat within the study area;
- Demonstrate measures taken to avoid and minimise impacts during the project planning stage;
- Provide detailed management measures to further minimise impacts on the Growling Grass Frog population during development works;
- Provide detailed management and habitat design measures which provides for the construction, maintenance and enhancement of a permanent breeding site for Growling Grass Frog including:
    - Pre-development: habitat enhancement requirements, including development design considerations; details of design, construction and location of additional habitat;
    - During development: management requirements for protecting existing habitat from sedimentation and pollution and direct disturbance that may result from development

activities; providing advice and recommendations on other habitat protection requirements, such as establishment of 'no-go' zones and clearly marked fencing; and,

- Post-development: management requirements, including vegetation, water quality, protection of habitat from current and potential future threats (such as foxes, feral and domestic cats and Eastern Gambusia).

- Outline monitoring, maintenance and reporting requirements post development; and,
- Provide the Commonwealth Department of Agriculture, Water and the Environment (DAWE) with sufficient information to continue their assessment of the referred activity (Section 1.4), and ultimately progress the approval and implementation of the management plan during development works.

The following sections detail the subject site, the project and legislative context and the key project stakeholders.

1.3 Bolinda Road Quarry

1.3.1 History of the Site and Adjacent Land

In the 1970's Bolinda Road Quarry formed part of a much larger quarry owned by Pioneer Building Products Pty Ltd (Pioneer). Clay was extracted from the Pioneer quarry for the manufacture of bricks. The land east of the site also formed part of the large quarry, until it was acquired by Hume City Council for the purpose of landfill. This area currently functions as a waste transfer station, operated by Council.

By 2002 clay resources of the site had been exhausted. Council concurred with the then owner, Bristile Ltd, that it would be inappropriate to leave the quarry hole open and unfilled, having regard to its context adjacent to residential properties, a shopping centre and industrial development. Bristile Ltd then prepared a concept plan that provided for filling the quarry hole with waste and, post filling, development of an industrial estate. The concept also proposed an open space link along the southern site boundary, providing potential access between the adjoining shopping centre and Merri Creek.

Between 2003 and 2007, Bristile Ltd, and subsequently Brickworks Ltd (which had acquired Bristile Ltd), initiated applications for approvals that would allow the site to be filled using solid inert waste. During this period, the owners continued to pump water from the base of the quarry under the provisions of an Environment Protection Authority (EPA) licence, in order to maintain the site in a safe and stable condition. The proposal to rehabilitate the quarry by landfill did not proceed and instead Brickworks decided that the quarry hole would be filled using engineered soil materials.

In 2009 Brickworks Ltd lodged an application to the (former) Department of Primary Industries (DPI) for a variation to the quarry rehabilitation requirements. This variation to WA109 was approved in November 2011 and provided for the filling of the quarry hole in two stages. The second of these stages involved filling of the waterbody, subject to approval to relocate the known Growling Grass Frog population. In the interim, in 2009, Bolinda Operations purchased the quarry from Brickworks Ltd and WA 109 was transferred accordingly. The rehabilitation requirements specified in the subsequent Work Plan provided for the quarry to be filled to pre-existing levels. However, given the proposed impacts on the existing Growling Grass Frog population, only works required to achieve a safe and stable landform, and to meet the requirements of DEDJTR were completed.

A referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC 2012/6372) covering the proposed activity was submitted on 20 April 2012 and deemed a 'Controlled Action' by DAWE [formally the Commonwealth Department of the Environment and Energy (DoEE)] on 30 May 2012 (Ecology and Heritage Partners 2012a). The initial approval conditions were provided by DAWE on 5 November 2014. A variation to the proposed action was accepted by DAWE on the 28 January 2014 and allowed for the following action within the study area:

> *'Partially filling in the waterbody and completely filling in the drainage line that has formed in the Bolinda Quarry'*.

In September 2016 Ecology and Heritage Partners was engaged by Bolinda Operations Pty Ltd to prepare a CMP for the Growling Grass Frog population at Bolinda Road Quarry, Campbellfield, Victoria (Ecology and Heritage Partners 2016). The overall objective of the CMP was to provide detailed measures to ensure the proposed activity did not have a significant impact on the resident Growling Grass Frog population and associated habitats.

Between April 2010 and January 2019 filling work were undertaken at the site to the extent of approved filling of the former quarry, in accordance with the works authority (WA109) to develop a safe and stable final landform to the satisfaction of the Victorian Department of Jobs, Precincts and Regions (DJPR). In January 2019 emergency works were undertaken under the existing works authority to address the issue of surface runoff flooding neighbouring properties to the south, adjacent to Roebourne Crescent Reserve. Following initial investigation, it was evident that the existing council drainage asset was no longer sufficient to handle the ensuing increased surface runoff resulting from the completed filling activities, and that the proponent was required under the *Water Act 1989* to implement additional measures to prevent further property damage and risk to public safety. Consequently, an open swale was excavated along the southern boundary of the study area which directs excess surface water to the east where it flows into the neighbouring property (Photograph E4).

Ecology and Heritage Partners Pty Ltd was commissioned by Forte Group Pty Ltd in November 2019 to conduct a Biodiversity Assessment for a proposed Commercial Development at the site. The purpose of the assessment was to identify the extent and type of remnant native vegetation present within the study area, determine the likely presence of significant flora and fauna species, and to discusses the potential ecological and legislative implications associated with the proposed action.

A development plan has been prepared as part of the planning permit application for the proposed commercial development, and this plan includes the provision of a dedicated dispersal corridor which will be constructed within the study area to facilitate frog dispersal between the quarry void and to the eastern boundary of the property, with the future opportunity to continue the link to Merri Creek in the east. All high-quality habitat and associated dispersal corridors within the area will be retained and significantly enhanced through the provision of supplementary habitat installation and the construction of an unbroken chain of waterbodies and wetlands constructed throughout the length of the dispersal corridor to allow unimpeded dispersal of frogs (Attachment F). These waterbodies will be designed and constructed taking into consideration the *Growling Grass Frog Habitat Design Standards* (DELWP 2017a).

Ecology and Heritage Partners has prepared a Growling Grass Frog CMP for the proposed development which includes detail on the proposed development and how project impacts to the species will be avoided and measures to ensure that the resident population at the site remains viable in the future. The proposed development will not impact any other species or ecological community listed under the EPBC Act.

The following information includes that outlined in the EPBC Act referral, as well as additional information requested by DAWE regarding impacts of the action and the strategies proposed to avoid, mitigate and/or offset those impacts. The contents page of this report provides a reference table detailing where each of the requirements of the preliminary documentation request is addressed.

1.3.2 Site Conditions

The study area is located in Campbellfield, Victoria, approximately 27 kilometres north of Melbourne (Figure 1). It is surrounded by residential, commercial and industrial land to the north, west and south, and a resource recovery centre and former landfill site to the east. Approximately 16.2 hectares in size, the study area is dominated by sloping banks of bare earth, and open areas dominated by introduced grasses and weeds. A large waterbody has formed at the lowest point of the former quarry, and aquatic vegetation within the study area is largely limited to areas on the edge of the waterbody. Merri Creek is approximately 600 meters east of the study area and approximately 850 meters east of the waterbody.

The topography of the study area in its current state is such that all surface water flows are directed away from the edge of the quarry void. The retained waterbody is located at the lowest point of the quarry void and is fed by groundwater, providing a permanent water source.

Vegetation within the study area is highly degraded and consists almost exclusively of exotic species (grasses and herbs). The only native species recorded in the study area were Common Spike Rush *Eleocharis sphacelata*, Cumbungi *Typha orientalis* and Common Wallaby-grass *Rytidosperma caespitosum* the cover of which was minimal and does not constitute a patch under the *'Guidelines for the removal, destruction or lopping of native vegetation'* (the Guidelines) (DELWP 2017b).

Growling Grass Frog has previously been recorded within, and in close proximity to the study area (e.g. as well as in the broader geographic region (Ecology and Heritage Partners 2012b). The Epping/Somerton region, north of the study area, is known to be important for the species' persistence in Melbourne's north, and subject to a Regional Conservation Strategy (Ecology Australia 2006).

High quality Growling Grass Frog breeding habitat is present within the study area in the form of the large open waterbody at bottom of the quarry. A resident population of the species is known to occur in this area (Ecology and Heritage Partners 2012a). The quarry void (Figure 2; Plate 7), is large with steep sloping banks on all sides. The northern, western and southern banks are dominated by introduced grasses, woody weeds and thistles. The presence of a permanent water source combined with fringing, aquatic and semi-aquatic vegetation such as Common Spike-rush, Cumbungi and pasture grasses provides suitable breeding and refuge habitat for the known population of Growling Grass Frog and a range of locally common frog species.

1.4 Project and Legislative Context

A project referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) covering the proposed commercial development was submitted to DAWE on 10 August 2020 and deemed a 'Controlled Action' on 4 September 2020 with reference to significant impacts on the extant Growling Grass Frog population. High quality Growling Grass Frog breeding habitat is present within the study area in the form of a large open waterbody at bottom of the quarry pit. A resident population of the species is known to occur in this area. The resident population constitutes an 'important population' in accordance with the significant impact guidelines for the species).

Based on the proposed action, all areas of high-quality breeding, foraging habitat will be retained. Only degraded and low-moderate quality terrestrial habitat that may occasionally be used for a small number of frogs during foraging and dispersal activities will be impacted.

The development of the surrounding area will create a barrier to movement between the quarry waterbody and Merri Creek to the East. To mitigate against the potential impacts (i.e. impact to terrestrial habitat and isolation) to the resident Growling Grass Frog population, habitat creation and improvement will be undertaken within the study area in three distinct offset areas. These Proposed Offset areas are described below (Table S1) and represented on Figure 3, and will provide additional breeding, dispersal and foraging habitat for Growling Grass Frog. Areas identified for habitat creation have the primary aim of ensuring there is an overall improvement for the species (i.e. provision of high-quality breeding habitat) (Appendix 2) (Figure 2).

Table S1. Offset Area breakdown

Offset Area	Description	Area of Habitat (Ha)
Offset Area 1	Terrestrial habitat within the quarry void	1.5
Offset Area 2	Wetland habitat within the movement corridor	0.39
Offset Area 3	Terrestrial habitat within the movement corridor	0.5

There will be no alteration to aquatic vegetation, wetland hydrology or introduction of additional predatory species or diseases within the quarry void where existing breeding habitat occurs. Notwithstanding this, based on an assessment against the significant impact criteria and thresholds relating to the nationally significant Growling Grass Frog (DEWHA 2009), it is considered that the proposed action will result in a significant impact to the species due to the creation of a barrier to movement between the quarry wetland and Merri Creek, and that the proposed action will be assessed by preliminary documentation.

DAWE has stipulated that the following information is required to be provided as part of the Preliminary Documentation to allow the department to re-commence their assessment of the referred and proposed action:

- Detailed information regarding the proposed action (including method, timing and stages and the finalised landscaping and building designs);
- A description of the operational requirements of the action;
- A description of surrounding land uses;
- Quantification of any potential direct and indirect impacts that may result from the proposed action;
- Detailed information regarding the mitigation and avoidance measures proposed and why each is reasonable and appropriate for this project;
- The economic and social impacts (both positive and negative) of the proposed action;
- A description of the proposed action in relation to the principles of ecologically sustainable development and the objects and requirements of the EPBC Act;

- Quantification and detailed information regarding any residual, unavoidable impact to the species; and,
- Commitments to ongoing monitoring and management to ensure a resident population persists in the quarry void in the long-term, and that permeability between the quarry void and Merri Creek is maintained.

1.5 Project Stakeholders and Previous Reports

The following stakeholders have been consulted throughout the approvals process and during preparation of this CMP: DAWE, the Victorian Department of Environment, Land, Water and Planning (DELWP) and Hume City Council. This CMP has been developed with reference to relevant research, best practice management guidelines and the following reports previously prepared for the quarry and immediate surrounds:

- EPBC Act Referral - Bolinda Road Quarry decommission, filling in waterbody and drainage line within the quarry (Ecology and Heritage Partners 2012a)
- Targeted Growling Grass Frog surveys and legislative advice for the proposed decommission of the Bolinda Road Quarry, Campbellfield, Victoria (Ecology and Heritage Partners 2012b)
- Preliminary Flora and Fauna Assessment, NRT Ltd Quarry, Campbellfield (Ecology Australia 2002)
- Seasonal Survey for Growling Grass Frog *Litoria raniformis* at the NRT Quarry, Campbellfield (Ecology Australia 2003)
- Growling Grass Frog *Litoria raniformis* Conservation Management Plan, Bolinda Road Quarry, Campbellfield, Victoria (Ecology and Heritage Partners 2016)
- Biodiversity Assessment for the proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria (Ecology and Heritage Partners 2020a)
- EPBC Act Referral - Bolinda Road Quarry development, Campbellfield, Victoria (Ecology and Heritage Partners 2020b)

In addition to reports focussing on the Bolinda Road Quarry, the literature review has included numerous reports and research papers that have either referenced the quarry or provided information specific to the retention and management of Growling Grass Frog on site.

2 GROWLING GRASS FROG

2.1 Species Profile

The Growling Grass Frog is listed as Vulnerable under the EPBC Act, Threatened under the *Flora and Fauna Guarantee Act 1988* (FFG Act), Vulnerable under the National Action Plan for Australian Frogs (Tyler 1997) and Endangered on the *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE 2013). It is one of the largest frog species in Australia, reaching up to 104 mm in length, with females usually larger (60–104 mm) than males (55–65 mm) (Barker *et al.* 1995). The species varies in colour and pattern, but is generally olive to bright emerald green, with irregular gold, brown, black or bronze spotting (Plate 1).

Growling Grass Frog is largely associated with permanent or semi-permanent still and slow flowing waterbodies (i.e. streams, lagoons, farm dams and old quarry sites) (Barker *et al.* 1995). Individuals can also use temporarily inundated waterbodies for breeding purposes providing they contain water over the breeding season (Organ 2010). The species is typically associated with waterbodies supporting an extensive cover of emergent, submerged and floating vegetation (Robertson *et.al.* 2002; Heard *et.al.* 2010).

Plate 1 Growling Grass Frog (Source: Ecology and Heritage Partners Pty Ltd)

Emergent vegetation provides basking sites for frogs and protection from predators, while floating vegetation provides suitable calling stages for adult males, breeding and oviposition (egg deposition) sites (Heard *et.al.* 2004). Terrestrial vegetation (grasses, sedges), rocks and other ground debris around a wetland perimeter also provide foraging, dispersal and over-wintering sites for frogs (Heard *et.al.* 2010). Recent studies have revealed that the spatial orientation of waterbodies across the landscape is one of the most important habitat determinants influencing the presence of the species at a given site (Robertson *et al.* 2002; Heard *et al.* 2010). Waterbodies supporting the aforementioned habitat characteristics, and which are located within close proximity to each other are more likely to support a population of Growling Grass Frog, compared with isolated sites lacking important habitat features.

Although formerly widely distributed across southern eastern Australia, including Tasmania (Littlejohn 1963, 1982; Hero *et al.* 1991), the species has declined markedly across much of its former range (Mahony 1999). Historically, this species has been recorded from most regions of Victoria, with the exception of Mallee and Alpine areas (Littlejohn 1963, 1982; Hero *et al.* 1991). The known range of this species has contracted dramatically over the past two decades and in many areas, particularly in south and central Victoria, populations have experienced serious declines and local extinctions. The key factors in decline include habitat destruction and fragmentation, drought, increased predation by vertebrate predators, and adverse impacts from the water-borne fungal pathogen *Batrachochytrium dendrobatydis*, which causes chytridiomycosis disease (Chytrid Fungus) (Heard *et.al.* 2012). This highlights the importance of preserving the species by protecting or enhancing remnant or intact habitat areas, particularly those surrounded by high density or impending development.

2.2 Local Abundance and Distribution

According to the Victorian Biodiversity Atlas (VBA) (DELWP 2020), over 200 document records of Growling Grass Frog exist within a 10 kilometre radius of the quarry, including: one (13 individuals) from 2003 within the quarry waterbody; a second from 2011, approximately 230 meters south of the quarry near Cheviot Road; and a third from 2003, approximately 220 metres north-east of the quarry near Somerset Drain. Numerous VBA records from 2009 to 2016 exist approximately 800 meters east of the quarry in, and adjacent to, Merri Creek.

In 2006, a Sub-regional Conservation Strategy for Growling Grass Frog (Ecology Australia Pty Ltd 2006) was developed for the Epping/Somerton area, the southern boundary of which is approximately 2.5 kilometres north of the quarry. This strategy includes a number of sites north of the quarry where numerous individuals have been recorded, a number of which comprise quarries that have filled with water to form permanent or semi-permanent waterbodies. Whilst outside of the sub-regional strategy's boundary, the Bolinda Road Quarry and its surrounds are identified as supporting core permanent habitat for a minor sub-population of Growling Grass Frog. Isolation from the larger northern sub-populations and the degradation of habitat through future developments are identified as constraints for the conservation of this population (pp 41, Ecology Australia Pty Ltd 2006).

A large population of Growling Grass Frog has previously been recorded at the quarry during research undertaken in 2004/05 by Dr Geoff Heard, and colleagues, from the University of Melbourne (Heard 2010; Heard pers. comm.; Hale et. al. in press). This researched revealed that there was a high level of breeding and recruitment by the species, along with evidence of high genetic diversity in the population. Dr Heard also collected swabs for Chytrid Fungus. These were later analysed (Heard *et. al*. 2012), with the results suggesting that, between 2004 and 2006, individuals at the two spring-fed quarries in the study area (one of which being Bolinda Road Quarry) displayed a statistically significant lower probability of Chytrid infection than those at other non-quarry sites in the study area (Heard *et.al.* 2012).

Targeted Growling Grass Frog surveys undertaken by Ecology and Heritage Partners within the study area in 2012 confirmed an important population of the species within the quarry (Ecology and Heritage Partners 2012b).

A diurnal Growling Grass Frog habitat assessment was undertaken on 16 February 2012. Seven sites were assessed, and this included two sites within the study area as well as five sites nearby, outside of the study area. The sites outside of the study area were assessed to determine if any suitable habitat occurs between the quarry and Merri Creek that may support a large population of Growling Grass Frogs or facilitate the movement of frogs from Merri Creek into the study area.

Nocturnal Growling Grass Frog surveys were undertaken at the seven sites on two separate evenings (7 and 16 February 2012) in accordance with the *Significant impact guidelines for the vulnerable growling grass frog (Litoria raniformis*). Surveys were conducted during the species' active season (October - March), in weather conditions considered optimal for detection (i.e. warm and humid, overnight temperature not less than 14°C, preferably post rain) and when the species was known to be active elsewhere in the region. The survey effort consisted of two Zoologists spotlighting (using a hand-held 30 watt 12 volt spotlight) in and around each of the sites searching for frogs in open water; floating, emergent and fringing vegetation; and under logs and other refuge.

Habitat quality was defined with reference to the following criteria:

- High quality habitat: Areas that currently contain, or have a high likelihood to contain important habitat attributes required by the species for breeding as well as foraging and dispersal (e.g. permanent or semi-permanent, extensive aquatic vegetation, high water quality, connected to other occupied sites, absence or low densities of predatory fish, high cover of terrestrial refuge sites).
- Moderate quality habitat: Habitat that supports one or more key habitat characteristics outlined above, but not all (for example site may be important for dispersal or foraging but not breeding).
- Low quality habitat: Sites unlikely to be used by Growling Grass Frogs for breeding and a low likelihood for dispersal due to one or more of the following; absence or lack of aquatic vegetation, low water quality, presence of predatory fish, lack or low cover of terrestrial refuge sites.
- Degraded: Areas consisting of open pasture have generally been cleared from previous land use activities and are highly modified areas dominated by exotic vegetation (i.e. open pasture) in poor condition.

Successive site visits and targeted surveys both during and following the completion of filling activities on site were conducted in May 2017, November 2017, on two occasions in December 2017 and in September 2018. The results of these surveys confirmed the persistence of the population within the waterbody, with multiple adults observed or heard calling within and surrounding the waterbody on each occasion (Ecology and Heritage Partners 2020). The resident population within the study area constitutes an 'important population' in accordance with the significant impact guidelines for the species (DEWHA 2009).

2.3 Relevant Threatening Processes

Potential threatening processes for Growling Grass Frog resulting from the proposed development come from two main sources: impacts from construction activities, and impacts resulting from the construction of a barrier to movement between the quarry waterbody and Merri Creek to the East.

2.3.1 Hydrology and Water Quality

Based on known information of water quality tolerances and preferences by Growling Grass Frog it appears that the species requires waterbodies containing low levels of nitrates, nitrides and phosphates (Ashworth 1998; Organ 2002, 2003). Water quality may be particularly important for larval development and recruitment. It should also be noted that studies have shown conflicting findings on the relationship between basic water quality parameters and wetland occupancy (Heard and Scroggie 2008). For example, Wassens (2005) found a preference for wetlands with a relatively low pH, whereas Hamer and Organ (2008) found the opposite to be the case. Similar discrepancies have been found with conductivity (Heard and Scroggie 2008), and this relationship is also confounded by the fact that conductivity may affect the prevalence of Chytrid fungus (2.3.2). Efforts to control basic water quality parameters for Growling grass Frog may be unnecessary; however, conductivity should not increase beyond the approximate limit for the species of 10000 µS/cm (Heard and Scroggie 2008).

All stormwater flow and discharge from the surrounding area will be directed away from the quarry wetland to ensure that there is no negative impact to water quality or that external contaminants are inadvertently introduced to the waterbody within the quarry void. However, construction activities associated with the development have the potential to result in release of sediment-laden runoff into the quarry wetland and the constructed wetlands within the proposed movement corridor. There is also the potential for accidental spillage of chemicals from the construction area to runoff into the wetlands. Increase in sediment input and input of toxic substances into Victorian rivers and streams due to human activities are both threatening processes under Schedule 3 of the FFG Act.

2.3.2 Chytrid fungus

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen *Batrachochutrium dendrobatidis*, commonly referred to as Chytrid fungus. Chytrid fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly the Growling Grass Frog, severely compromised (DEWHA 2006). The disease that results from Chytrid fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson 2012). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material; the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Chytrid prevalence has found to be decreased in wetlands with elevated salinity levels and higher temperatures (Heard *et al.* 2012).

2.3.3 Human Access

Human occupancy within the study area has the potential to result in disturbance by persons entering the quarry void and wetland. This may lead to the degradation of habitat in or around the waterbody due to rubbish dumping, mechanical disturbance of vegetation from trampling, and weed invasion.

The placement of walking and/or bicycle paths and trails will be prohibited within the 'no impact' buffer zone within the quarry void and the existing Growling Grass Frog habitat to minimise human disturbance in these areas. Construction activities must also be restricted in known habitat areas to minimise human and vehicular disturbance during the development study area. An exclusion zone will be implemented around the main quarry water body and associated constructed wetlands to protect the core Growling Grass Frog habitat on site.

2.3.4 Weeds

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

Consequently, a Weed Management Plan has been prepared to identify potential threats associated with pest plant species, that may impact environmental values within the study area. The Weed Management Plan provides appropriate management actions to address weed infestations and vertebrate pest species, to ensure environmental values within the study area are maintained and enhanced.

2.3.5 Noise

The distance from construction works to the quarry wetland and the topography of the quarry void is considered to provide protection for frogs from noise pollution created by construction activities. Nonetheless, noise from building and other works relating to the development will comply with the Hume City Council Building and Works Code of Practice (Hume City Council 2013), where building or other works that may produce noise can only be carried out on any land between the hours 7.00 am and 6.00 pm on weekdays, 9.00 am and 5.00 pm on Saturdays, and 12.00 noon and 4.00 pm on Sundays. Restricting noise created by building works will allow males to call to attract a mate, and thus the noise associated with construction and the future use of the area (i.e. commercial use) is unlikely to reduce breeding success by the species.

2.3.6 Light Pollution

Growling Grass Frog are a predominantly nocturnal species. Artificial light pollution may increase the risk of predation of Growling Grass Frog by foxes and Cats and may also disrupt mating activities of the species. As such, sources of artificial light from the surrounding development will be directed away from the quarry void and movement corridor. There will be no additional lighting directed towards the wetland within the quarry void or along the dispersal corridor, to allow frogs to move along the corridor undisturbed, and to avoid any negative impact caused by artificial light pollution. Overall, there are likely to be no significant impacts related to noise and light pollution associated with the project.

2.3.7 Dogs, Cats and Exotic Predators

Dogs and Cats

Unrestrained dogs *Canis vulpes* and Cats *Felis catus* have the potential to roam into Growling Grass Frog wetlands within the Precinct. Cats in particular are known to predate upon dispersing or sheltering frogs. Predation of native wildlife by the Cat is a threatening process under Schedule 3 of the FFG Act. Surrounding residential development is likely to introduce unrestrained cats that may also hunt and kill Growling Grass Frog. Therefore, Hume City Council is encouraged to implement a night-time curfew applicable to all residential properties surrounding the study area.

The entire movement corridor is to be designated a 'Dog on Leash Area' through installation of appropriate signage throughout the Area. Hume City Council must enforce all Dog on leash areas.

Eastern Gambusia

The introduced Eastern Gambusia has been identified as a possible factor in the decline of species in the "bell frog species complex", which includes Growling Grass Frog (Mahony 1999; White and Pyke 1996; Hamer *et al.* 2002) because it eats the eggs and tadpoles of these species (Morgan and Buttermer 1996). This species may reduce the potential of a site to support breeding populations, although the extent of predation depends on aquatic vegetation and habitat complexity, and waterbody permanency (Hamer *et*

al. 2002). Predation by Eastern Gambusia on tadpoles of Growling Grass Frog may be a significant threat to the species.

Red Fox

Red Fox *Vulpes vulpes* has previously been recorded within the study area and is likely to frequent the area (Ecology and Heritage Partners 2020). The species is known to hunt and eat adult members of the bell frog species complex. Feral Animal Control measures will be considered for development in the study area to reduce the population size of foxes.

2.4 Growling Grass Frog Habitat within the Study Area

The quarry void (Figure 2; Plate 2 and 3), is large with steep sloping banks on all sides. The results of previous surveys which have recorded both sub-adults and metamorphs indicate that habitat on-site is used for both breeding and recruitment. As noted in Section 2.2, the quarry provides permanent habitat for a population of Growling Grass Frog and is particularly significant given its susceptibility to further isolation from the larger northern sub-populations and habitat degradation (Ecology Australia Pty Ltd 2006).

The northern, western and southern banks of the waterbody are dominated by introduced grasses, woody weeds and thistles. The presence of a permanent water source combined with fringing, aquatic and semi-aquatic vegetation such as Common Spike-rush *Eleocaris acuta*, Cumbungi *Typha orientalis*, Fennel Pondweed *Potamogeton pectinatus* and pasture grasses provides high quality breeding and refuge habitat for the known population of Growling Grass Frog and a range of locally common frog species (Plate 5). Currently the Growling Grass Frog population on site is not managed.

The north eastern bank is partially devoid of vegetation, with a large section of rock established for structural integrity of the bank (Plate 4). This rocky bank provides suitable foraging and over-wintering sites for Growling Grass Frog. Rocks also offer important refuge from predators and provide opportunities for thermoregulation.

At the time of the assessments, the water within the Quarry void was clear, free of odour and generally free of litter. Floating aquatic vegetation is limited, and submerged vegetation largely comprises of areas of algae and Fennel Pondweed, particularly in the North East section of the waterbody. Additional refuge sites for Growling Grass Frog in the form of large logs and stumps along the northern bank of the waterbody have been provided and this is consistent with the management actions outlined in the Growling Grass Frog Conservation Management Plan (GGFCMP) (Ecology and Heritage Partners 2016) (Plate 5).

The depth of the waterbody is unknown, but it is likely that if left undisturbed, it would retain water all year round due to being fed by unconfined groundwater.

Plate 2. Waterbody within the quarry void (Ecology and Heritage Partners Pty Ltd 07/09/2018).

Plate 3. Waterbody within the quarry void and surrounding Growling Grass Frog foraging habitat (Ecology and Heritage Partners Pty Ltd 15/06/2020).

Plate 4. Rocky banks on the eastern end of the waterbody (Ecology and Heritage Partners Pty Ltd 07/09/2018).

Plate 5. Fringing and floating vegetation within the waterbody **(**Ecology and Heritage Partners Pty Ltd 07/09/2018).

The majority of surface flows in the area outside the quarry void are directed to the southern end of a study area, where a basic swale trench extends along the southern boundary of the site, carrying excess stormwater to the south east corner where it flows into the neighbouring property. In its current state this area does not constitute suitable habitat for Growling Grass Frog given there is no standing water or aquatic vegetation within the swale (Photograph E1 and E4).

The closest waterbody to the quarry is a landfill leachate pond located approximately 300 meters from the site boundary and 550 meters from the eastern edge of the quarry waterbody. Somerset Road Drain is located 670 meters north east of the quarry boundary (approximately 930 meters from the quarry waterbody) and directs stormwater from the adjacent residential, industrial and commercial landscape into Merri Creek. The entrance of the drain comprised artificially lain rocks, boulders and concrete debris over which water cascaded before entering a large pool supporting fringing and emergent aquatic vegetation. The water enters Merri Creek from this pool via a heavily vegetated drain. Approximately 500 meters from the quarry's eastern boundary, and 760 meters from the quarry waterbody, there are

two dams adjacent to one another and adjacent to Merri Creek. One acts as a sediment pond and the other a landfill leachate pond.

3 CONSERVATION MANAGEMENT PLAN

3.1 Roles and Responsibilities

Forte Group Pty Ltd and all consultants, contractors and staff associated with the development works, have a duty of care to:

- Avoid and minimise the occurrence and extent of potential impacts and threats to Growling Grass Frog individuals, populations, and the species, during the development and associated activities;
- Take all reasonable actions to protect and maintain the environment, during construction and associated activities;
- Report any issues or actions that may have potential (even if marginal) to cause or exacerbate potential impacts and threats to the Growling Grass Frog population as well as the environment; and,
- Ensure that their actions are in accordance with the relevant environmental legislation, policies, management authorisations, permits and management protocols, including this CMP.

Implementation of this CMP will require the collaboration of a range of stakeholders. The following parties will be responsible for, or may potentially become involved in the implementation and support of the plan:

3.1.1 Direct Involvement

- Forte Group Pty Ltd – Overall implementation of this CMP, including:
    - Ensure that the Growling Grass Frog population and suitable habitats are protected within the study area and connectivity is maintained for the ongoing movement of Growling Grass Frog between the wetlands within the study area and Merri Creek to the east;
    - Ensuring appropriate resources are available for the implementation of this CMP;
    - Ensuring all site personnel who are implementing the CMP are appropriately qualified and have been inducted (Section 3.2.1);
    - Providing assistance and advice to all project personnel to fulfil the requirements of this CMP;
    - Acting as the principal point of contact in relation to environmental performance;
    - Commissioning a Zoologist during salvage and relocation operations and ongoing monitoring, compliance and providing to DAWE;
    - Addressing any complaints and adopting a consistent approach to achieving the objectives of this CMP; and,
    - Liaising with relevant authorities and organisations when necessary.
- Successful wetland revegetation specialist/ contractor – Required to adhere to the recommendations of this CMP, in relation to all works within the No-Go-Area and the construction of the wetlands within the movement corridor. Any amendment to the location or

design of the habitat improvement works specified in the approved Landscape Plan would need to be discussed with a suitably qualified zoologist and the department.

- DELWP – DELWP will assess the suitability of this plan and the Landscape Plan under the FFG Act, particularly the requirements specified in the action plan developed for Growling Grass Frog.
- Experienced zoologist (in relation to Growling Grass Frog) – Will be involved during the implementation of the plan, including undertaking salvage and relocation, and the monitoring of populations and habitats prior to, during and after the decommissioning works to ensure habitats remain suitable. The zoologist is also required to provide ongoing advice in relation to on-site management issues.

3.1.2 Encouraged Involvement

- Hume City Council – Responsible for assessing the suitability of future developments (e.g. residential, industrial) in the vicinity of the study area, and would need to consider the implications of these proposals on the Growling Grass Frog population and habitats. Local authorities are also encouraged to provide assistance in the implementation of the plan, particularly in relation to the future monitoring and management of the Growling Grass Frog population and associated habitats. A strategic, broad-scale approach in the management of suitable waterbodies, dispersal corridors and frog population needs to be considered during the planning process and as part of the Former Landfill Site Masterplan (Section 3.1). Community education about the importance of the resident Growling Grass Frog population and associated habitats is also encouraged. It is important to note that future habitat improvement activities (i.e. habitat connectivity and creation of additional dedicated Growling Grass Frog wetlands) between the study area and Merri Creek will be the responsibility of Hume City Council (council own the land) and not Forte Group Pty Ltd.

3.2 Management Safeguards and Controls

3.2.1 Inductions

A suitably qualified and experienced zoologist will conduct site inductions for all persons engaged to work on site throughout the duration of the development. The induction will include the following.

- Information regarding the environmental values within and surrounding the quarry void, including the significance of the site, Merri Creek and the local region for Growling Grass Frog;
- Diagnostic, ecological and behavioural information relating to Growling Grass Frog;
- The legislative context of the proposed action;
- An outline of the Duty of Care of all persons on site to avoid and minimise the occurrence and extent of potential impacts to the environment and Growling Grass Frog;
- The key objectives and measures outlined in this CMP; and,
- The provision of an information pamphlet (Attachment A) summarising key points.

3.2.2 Contingency Plan

Should the species be encountered by persons on site other than the zoologists engaged to carry out salvage and relocation, the following protocol will apply:

- The person encountering the frog will report it to a nominated principal contact of Forte Group Pty Ltd, upon which all works will stop within the vicinity of the site. The zoologist will be contacted immediately.
- No one may attempt to capture the frog unless it is directly within harm's way. If possible, a photo of the frog will be taken and sent to the zoologist via mobile phone messaging for identification.
- If feasible, the zoologist will attend the site, and capture and relocate the frog.
- If this is not feasible, the site supervisor will use the emergency frog handling kit stored at the quarry's site office, to capture the frog and place it in the container provided, until the zoologist can attend to assess the frog and relocate it into the No-Go-Area.

The emergency frog handling kit will include:

- At least three plastic holding containers, 20 x 20 cm in size, sealable but with adequate aeration (i.e. several holes in the lid of the container to provide some air flow);
- A box of disposal latex gloves; and,
- A laminated fact sheet of how to handle and store the frog (Attachment B).

3.3 Habitat Protection

Given that the retained habitat area within Offset Area 1 (Figure 3) supports a population of Growling Grass Frog this area will be maintained to ensure conditions remain suitable for this species prior to, during and post construction works.

Protection of the existing quarry wetland and exiting terrestrial refuge site will be achieved through the re-instatement of temporary frog exclusion fencing around the outer parameter of Offset Area 1 prior to the commencement of construction to provide a physical barrier between the development area and retained habitat within the quarry void. Details of the fencing requirements are provided below (Section 5.3.8.1).

3.4 Habitat Enhancement and Creation

The existing Growling Grass Frog habitat within the quarry void will be enhanced through the provision of the following:

- The preparation of a Landscape Plan by a qualified wetland revegetation specialist and the project zoologist, and submission to DAWE for approval. The Landscape plan provides a detailed account of all habitat improvement works within the No-Go-Area (Attachment F);
- Include rock mattresses, covering minimum 20% of the bank area, as alternative refuge and overwintering sites around the wetland margin (Attachment F); and
- Weed and pest animal control.

All habitat improvement works within the No-Go-Area will be undertaken by a qualified and experienced wetland revegetation specialist/ contractor in accordance with the provisions of this CMP and the approved Landscape Management Plan (Attachment F). There will be ongoing management of threatening processes such as weed and pest animal control, and there will be no alteration to existing aquatic vegetation, or introduction of additional predatory species within the quarry void where existing breeding habitat is present.

While the existing Growling Grass Frog habitat within the quarry void will not be impacted by the development, these areas will be enhanced through the provision of supplementary terrestrial habitat (rock, logs and other ground debris) and aquatic habitat (supplementary aquatic vegetation). Habitat enhancement activities in Offset Area 1 within the quarry void will commence during the first stage of the development. Habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will also provide direct connection of suitable habitat between waterbodies within the movement corridor and the quarry wetland.

As indigenous flora provides valuable habitat for indigenous fauna, any landscape plantings that are undertaken as part of the proposed works will be conducted using indigenous species sourced from a local provenance, rather than exotic deciduous trees and shrubs. The Growling Grass Frog Habitat Design Standards (DELWP 2017a) has been reviewed to provide a list of suitable species to be used when establishing vegetation within the Growling Grass Frog habitat (Attachment C). Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog wetlands as this may shade out ponds, thus potentially rendering them unsuitable for the species and providing vantage points for predatory birds.

3.4.1 Creation of Dedicated Growling Grass Frog Wetlands

The clustering of waterbodies is an important factor in allowing Growling Grass Frog to move between waterbodies when water conditions change, and it has been shown that the likelihood of frogs occupying a particular waterbody is largely dependent upon the distance to a nearby occupied site (Hamer and Organ 2006). A development plan and Landscape Management Plan have been prepared as part of the planning permit application for the proposed development, and these plans include the provision of a series of eight permanent wetlands and ponds on the southern boundary of the study area. Habitat creation will involve the construction of Growling Grass Frog wetlands covering a total area of approximately one hectare near a focal population so that new populations can colonise and persist in these areas. Emphasis has been placed on the quality of the habitat within the corridor, which extends approximately 220 meters from the proposed sedimentation pond (wetland 1) to the property boundary (Figure 2) (Attachment F).

The creation of the dedicated wetlands will provide breeding and dispersal opportunities for the species, thus ensuring future viability of the population within the quarry, including the exchange of specimens between the quarry void and Merri Creek to the east of the site. The habitat design will broadly conform with the *Growling Grass Frog habitat design standards* (DELWP 2017a).

The dedicated Growling Grass Frog breeding wetlands identified in Figure 2 must be:

- Designed to permanently contain water utilising treated stormwater runoff from rooftops within the development;

- Supplied with the best feasible water quality consistent with Melbourne Water standard stormwater treatment practice;
- Able to be filled from the adjacent waterbody within the quarry void when required (section 3.5);
- Able to sustain appropriate vegetation to provide habitat (see below);
- Will be clay-lined to retain water with a loamy or sand-substrate topsoil;
- Include rock mattresses, covering minimum 20% of the bank area, as alternative refuge and overwintering sites around the pond margins (Plate 6, Figure 2) (Attachment F);
- Trees and/or large shrubs must not be planted within 20 metres of the banks of Growling Grass Frog wetlands as this may shade out ponds, thus potentially rendering them unsuitable for the species;
- Designed, constructed and managed so that they have predominantly comprise open water low water turbidity, be still, and have low nitrate, phosphate, and salinity levels; and,
- Be able to be drained via an effective and straightforward drainage mechanism (if constraints such as topography allow), such as a drainage valve or regulator installed to enable the water to be drained if necessary.

A typical arrangement of a Growling Grass Frog wetland is provided below (Plate 3). All Growling Grass Frog wetlands will contain appropriate water levels (i.e. some ponds with permanent water and others with variable water levels) and be constructed between 1.5 metres and 4 metres (ideally) in depth. The maximum depth will vary between wetlands depending upon the local topography constraints.

A water balance (including inflows, outflows, evaporation etc.) must be undertaken for each Growling Grass Frog wetland to determine the required depth of the open water area. The water balance will be based on historical rainfall simulation modelling over a 10-year period (i.e. 2010-2020). The minimum operating depth must be 1.5 metres over 50% of the total wetland surface area.

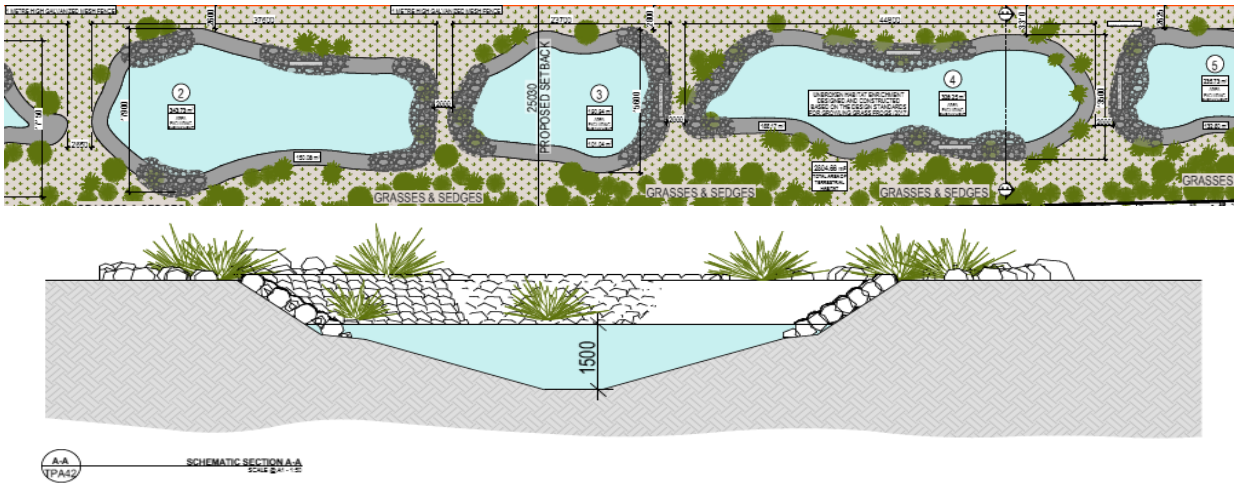


Plate 6. Rocky areas located between and around the perimeter of the wetland extending into the aquatic habitat.

Growling Grass Frog wetlands are required to support an extensive cover of aquatic and semi-aquatic vegetation, specifically to cater for an extant breeding population of Growling Grass Frog and to ensure that there is sufficient nutrient uptake to enhance water quality in wetlands. To achieve these habitat requirements, in each Growling Grass Frog wetland there will be three distinct zones (as shown in Plate 7):

- Zone 1: Littoral/ Ephemeral Wetland Zone: This zone incorporates the terrestrial planting area. Here the aim is to establish a moderate percentage cover of vegetation with bare ground areas for frog refuge occupying the margins of the pond. The margins will remain dry for extended periods, whilst the littoral/ephemeral zone will be subject to periodic inundation, and therefore must support plants able to tolerate wet conditions. A study by Heard *et al.* (2008) recorded most frogs perching on bare soil, rocks and leaf litter near the water's edge, with few occupying terrestrial vegetation stands. Their results indicated a preference for a low structural diversity in the vertical plane of terrestrial microhabitats. This zone will be created to incorporate the following structural features based on known sites where the species occurs:
    - A minimum width of five metres of ephemeral wetland zone will be created;
    - A minimum topsoil depth of 150 mm within all pond planting areas;
    - The planting area will contain floristically diverse and structurally similar vegetation planted at a nominal density of six individuals per square metre with the provision for areas of bare ground between plantings;
    - Plant species will reflect the Wet Verge Sedgeland Ecological Vegetation Class (EVC 932) and include, where appropriate, native vegetation including Common Spike-sedge (in low densities to prevent spreading), rushes *Juncus* spp and Tussock Grasses *Poa* spp. High density planting is not encouraged as Growling Grass Frog seek refuge under rocks and timber debris;
    - A selection of large concave (300-1,500 mm diameter) and small (3-5 boulders/m^2) rocks, extending at least one metre into the entry zone;
    - Rock mattresses, covering approximately 20% of the bank area, as alternative refuge and overwintering sites around the pond margins; and,
    - Rock piles and large woody debris around the outer pond margins and dense areas of rocks and logs along the banks, extending down a minimum of five metres from the water's edge. Exposed rocks retain heat more readily and are beneficial to frogs compared to cooler shaded sections (i.e. Growling Grass Frog is known to use rocks for thermoregulation). Woody debris provide additional refugia and attract invertebrate prey. The location and spacing of refugia will vary to optimise microhabitat diversity.
- Zone 2: Entry Zone - This zone incorporates part of the aquatic planting area and refers to the edge of the pond where frogs can enter the water. The zone will be subject to frequent drying and will require plant species capable of tolerating fluctuating water levels. The following structural features will be incorporated:
    - A profile length of at least one metre;
    - A shallow 1:8 grade slope containing a variety of rocks and logs from the bank, with rocks down to at least one metre below the freeboard water level; and,

  - The shallow marsh planting area will extend from 0-0.25 metres below the water level. Terrestrial and aquatic species will be planted at a density of six plants per square metre;

- Zone 3: Embankment - This zone incorporates part of the aquatic planting area and will provide a variety of aquatic vegetation, i.e. emergent (low density), submergent and floating plants (higher densities), for potential frog courtship, egg-laying, metamorphling/ tadpole cover and territorial displays. Typical aquatic vegetation will include Water Ribbon *Triglochin procerum*, Water plantain *Alisma platago-aquatica*, and submerged or floating aquatic vegetation including Floating pondweed *Potamogeton tricarinatus*, Nardoo *Marsilea drummondii*, and White Purslane *Neobassia proceriflora* (refer Attachment C). Heard *et al*. (2008) observed many Growling Grass Frog in or on mats of submergent and floating vegetation in post-breeding months. The study demonstrated that occupied microhabitats characterised by a high cover of floating vegetation over still, deep water, were more frequently occupied than high emergent or fringing cover, or high woody stem density. This zone will be created to incorporate the following structural features:
  - A profile length of at least five metres;
  - A 1:2.5 grade slope abruptly steepening (variable grade) in the final approach to the adjacent deep water zone;
  - A deep marsh planting area extending from 0.25-0.5 metres below the water level;
  - Plantings at a nominal six individuals per square metre for semi-aquatic plants (emergent species) and three individuals per square metre for aquatic species to a depth of 0.5 metres; and,
  - Within 1-3 years the zone will support at least 40% submergent, 20% floating, and 30% emergent vegetation.

Recommended species for wetland planting known to be present in Growling Grass Frog habitats are provided in Attachment C. Newly vegetated wetlands are particularly vulnerable to damage caused by species of waterfowl, from foraging, roosting and nesting. Accordingly, any newly planted vegetation will be protected by appropriate netting, to allow vegetation to establish and provide suitable habitat for Growling Grass Frog.

The wetland revegetation specialist must consider the following additional issues when developing the Landscape Plan:

- Timing of works - works will be undertaken between April and August inclusively and ideally planting should occur in late winter/ early spring, providing there is adequate rainfall;
- All works must be subject to disease control in accordance with the measures contained in Section 4.1 and the *Hygiene Protocols for the Control of Diseases in Australian Frogs* (Murray *et.al*. 2011) (Attachment D); and,
- Protective netting will be installed, where required, to prevent damage to aquatic plants by waterfowl.

The following species must not be introduced into Offset Area 2 and 3 or included in the list of suitable species to be plated in order to avoid the risk of constructed wetlands becoming choked with vegetation;

  - Narrowleaf Cumbungi *Typha domingensis*

- Broadleaf Cumbungi *Typha orientalis*
- Lesser Reed-mace *Typha latifolia*
- Common Reed *Phragmites australis*
- Tall Spike-rush *Eleocharis sphacelata*

If these species are observed within Offset Area 1 and 2 during habitat monitoring a nominated principal contact of Forte Group Pty Ltd must be notified, and a wetland revegetation specialist contractor must be engaged to remove these species so that wetlands remain clear and support open water. A suitably qualified zoologist must be notified prior to removal so that appropriate salvage and relocation activities can be assessed and implemented.

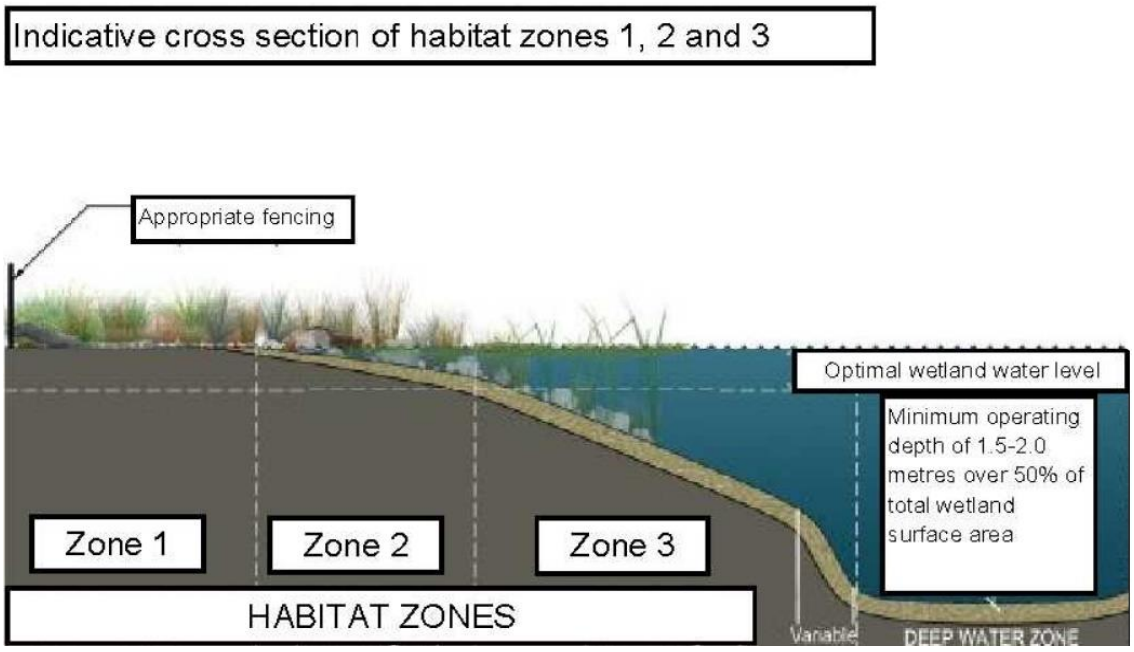


Plate 7. Growling Grass Frog wetland habitat zones

3.5 Timing of the Management Actions

Temporary frog exclusion fencing will be re-instated around the outer parameter of Offset Area 1 prior to the commencement of construction to provide a physical barrier between the development area and retained habitat within the quarry void. Habitat enhancement activities associated with Offset Area 1 within the quarry void will commence during the first stage of the development. Habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will provide direct connection of suitable habitat between proposed waterbodies within the movement corridor (Offset Area 2) and the quarry wetland.

Given Growling Grass Frogs are active in the warmer months of the year (September to March), habitat improvement activities in Offset Area 1 will be conducted outside Growling Grass Frog active breeding season and will be completed by mid-August 2021 to avoid disturbing the species' breeding activity within the quarry wetland. As this is the only known breeding habitat within the study area, prioritising this area of habitat enrichment, and avoiding land management activities during the species active season will

minimise residual impacts to the species, and allow the population in this area to benefit from habitat improvements during the 2021/22 breeding season while Offset Areas 2 and 3 are constructed and established.

The habitat corridor will be constructed during the early stages (i.e. from Stage 2 onwards) of the development to allow frogs to naturally colonise the wetlands during the species active season. Fencing will also be installed along the entire northern boundary of the dispersal corridor (i.e. along the northern boundary of Offset Areas 2 and 3) prior to the commencement of Stage 2 to prevent Growling Grass Frog from entering the development area during and after construction. Temporary frog fencing around Offset Area 1 will be decommissioned once all construction activities have been completed to allow frogs to access the entire retained terrestrial habitat within the quarry void for foraging and overwintering activities. Prior to this, permanent frog exclusion fencing will be installed around the perimeter of the quarry void (i.e. around the edge of the development area) (Appendix 1). Permanent frog fencing will remain in place along the northern boundary of the dispersal corridor to prevent frogs accessing pavement areas.

The control of pest animals such as foxes will be undertaken in accordance with local government laws and relevant legislation. Given the threat posed by feral predators such as Red Fox, an assessment of feral predators Offset Area 1 will be completed prior to the commencement of construction, and if evidence of these species are found, appropriate control measure will be implemented immediately to reduce the potential threat posed by predatory pests.

3.6 Management of Wetland Hydroperiod

The newly constructed wetlands will be hydrologically independent from Merri Creek (which aims to limit exposure to Eastern Gambusia) and will be located to facilitate connections with other Growling Grass Frog populations in the area. The wetlands will contain a drainage outlet at the lowest point of the waterbody for removing some or all water from the system. The drainage capacity is important for maintenance purposes and could be used for the removal of pest fauna species such as Eastern Gambusia.

Water levels will be actively maintained and checked monthly over the species breeding season (October to March). Depth gauges will be installed in all ponds, and wetland depth will be monitored monthly for the first two years following construction. Water levels will not be allowed to fall below 0.5 metres and will be checked every two months if water levels are shown to be relatively stable over cooler months (April-September). Water will be release from the water delivery system if levels fall below 0.5 metres within the constructed wetlands during the species active breeding season (Spring and Summer) and will be regularly filled in order to retain water over the entire breeding season. Wetlands will be drained (i.e. via a valve) and allowed to completely dry out should Eastern Gambusia be detected and/or if the water quality within the proposed wetlands is not suitable for breeding by the species. Wetlands will only be drained outside of the Growling Grass Frog active season (i.e. Spring and Summer) and will be re-filled using the water delivery system once the wetlands have completely dried and after it is confirmed that Eastern Gambusia (or other predatory fish) is not present.

Based on previous studies, fluctuating water levels and flooding are known to stimulate breeding in Southern Bell Frogs in the semi-arid region of Western NSW (Wassens 2005; author per obs.).

Although the water pumped from within the quarry wetland may result in a small (inconsequential) drawdown / reduction in the water levels this is not likely to impact the availability and quality of breeding habitat for Growling Grass Frog, particularly given that the water levels will be recharged from the groundwater aquifer.

Although the total water holding capacity in the quarry void and recharge rate from the underground aquifer are not known, it is considered that these will be sufficient to sustain water levels within the waterbody should pumping be undertaken to re-fill the holding tank or to supplement water levels in the constructed wetland within Offset Areas 2 and 3.

3.6.1 Primary Water Source

Rainwater runoff supplied from the rooftops of buildings and structures within the development will be the primary water source for the constructed wetlands along the movement corridor. The volume of runoff created by the development of this project in post-construction will be of greater volume and velocity than existing runoff under current conditions due to increase in impervious area such as rooftops and road surfaces. This is not considered to be a significant threat provided wetland designs allows for macrophyte zones and rocky batters between the constructed wetlands (Plate 6). The purpose of these areas is predominantly to decrease the velocity of the water moving through the corridor and allow suspended particles to settle out of suspension or adhere to vegetation, and nutrients to be biologically absorbed by the macrophytes.

A secondary underground drainage network will be installed via Bolinda Road to a legal point of discharge either in the north east or south east corner of the site as nominated by Melbourne Water. Major event flows will be safely conveyed through the constructed wetlands, with flows greater than the capacity of the underground drainage conveyed through the secondary underground drainage network to a legal point of discharge. This will also by-pass the macrophyte zone during flow conditions that may lead to scour and damage to the wetland vegetation.

3.6.2 Supplementary Water Source

The proposed wetlands will have a water delivery system to direct water from within the quarry void into the wetlands to ensure water levels are suitable for the species during dry periods (e.g. during drought). The design of this system is to incorporate a holding tank to be filled with water from the quarry wetland, which is controlled by a manually operated butterfly valve and discharged into Pond 1 within the constructed dispersal corridor (Figure 2). This will then flow through each corresponding wetland through a series of stormwater linkage drains between each pond.

The design of this system is to incorporate a holding tank to be filled with water from the quarry wetland, which is controlled by a manually operated butterfly valve and discharged into Pond 1 within the constructed movement corridor (figure 2) (Attachment F). This will then flow through each corresponding wetland through a series of stormwater linkage drains between each pond. The use of spring fed water from within the quarry void will maintain as many of the habitat characteristics inherent to the quarry that have resulted in the extant Growling Grass Frog population on the site, including some of the mineral content that may influence water qualities related to reduced Chytrid Fungus incidence.

3.7 Water Quality Management

Heard *et.al.* (2012b) suggests that there is likely to be something inherent in the water qualities of spring-fed quarries that limit the prevalence of Chytrid Fungus and conclude that quarries may provide important refuge for Growling Grass Frogs from this disease. As such, the use of spring fed water from within the quarry void will maintain as many of the habitat characteristics inherent to the quarry that have resulted in the extant Growling Grass Frog population on the site, including some of the mineral content that may influence water qualities related to reduced Chytrid Fungus incidence.

Growling Grass Frog are known to inhabit wetlands with salinity levels over 5mS/cm. Salinity levels taken during targeted surveys prior to quarry decommissioning were found to be between 5.06mS/cm and 5.82mS/cm (Table 1). The holding tank will be fitted with an EC meter to identify if salinity levels are unsuitable for the species. The tank will not be released into the constructed wetland if salinity levels within the tank reach >7mS/cm, and the water will be flushed through the water delivery system with freshwater from rainwater tanks collected from rooftops within the development, or supplemented water from a water truck if required.

A water quality monitoring point will be established within the quarry wetland prior to the commencement of construction and at a second site within the movement corridor (Offset Area 2) immediately following the completion of the constructed wetlands. Water quality monitoring will follow the program outlined Section 3.9.1.3, and trigger values will be established based on pre-construction water quality within the quarry wetland. Water will be released from the water delivery system if these trigger values are exceeded in order to 'flush' the system with water from within the quarry wetland.

3.8 Salvage and Relocation

The salvage and relocation of Growling Grass Frog individuals from within the Offset Area 1 prior to habitat improvement activities is proposed from an animal ethics perspective and aims to reduce the occurrence of death, injury or displacement of individuals. These activities are not considered to offset any potential impacts on the extent population and are particularly important prior to the placement of rocks and woody debris around the waterbody in Offset Area 1.

A requirement under the previously approved GGFCMP developed for the site (Ecology and Heritage Partners 2016) was the placement of sheets of tin throughout the operational area to provide temporary refuge for Growling Grass Frog in accordance with the salvage and relocation procedures (Ecology and Heritage Partners Pty Ltd 2013a). This tin currently remains in place within Offset Area 1, and as such must remain undisturbed throughout the habitat improvement activities. If it is found that the tin is located in an area where rock beaching is to be incorporated under the Land Management Plan (Appendix 1), the tin must be relocated within Offset Area 1, and salvage and relocation procedures must be initiated to reduce the occurrence of death, injury or displacement of individuals. All areas where rock beaching is to be incorporated must be identified using clearly visible timber stakes and/or bunting prior to works being carried out so that the area can be searched by a suitable qualified Zoologist and appropriate salvage and relocation protocols initiated.

The salvage and relocation measures outlined below will be undertaken both immediately prior to and during the development works, as required. Salvage measures will be undertaken by a qualified zoologist experienced with these operations. Salvage will involve a suitably qualified Zoologist actively searching

soil, vegetation and other ground debris (i.e. checking under boulders that may be shifted and under tin that is within an area where rock beaching is to be incorporated) for frogs immediately prior to, and during habitat improvement works;

3.8.1 Capture

- Frogs will only to be captured by suitably qualified and experienced zoologists, who are capable of purposeful capture that does not result in unnecessary stress, energy expenditure or injury to the fauna.
- Zoologists will change to a new pair of disposable latex gloves between each frog capture in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (section 5.1). Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are picked up.

3.8.2 Handling

- Frogs and tadpoles will only be handled by suitably qualified and experienced zoologists, and will be handled as little as possible to avoid inadvertent removal of skin secretions which can predispose them to infection.
- Zoologists will change to a new pair of disposable latex gloves between the handling of each frog and tadpole, in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (section 5.1). Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are handled.

3.8.3 Holding

- Frogs will be placed into new and clean plastic sample bags, with a 'one bag – one frog' policy, in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (Attachment D). Bags will not, under any circumstances, be reused.
- All frogs captured will be assessed for signs of injury or illness, particularly for signs of Chytrid Fungus infection, in accordance with the Hygiene Protocol (Murray *et.al*. 2011) (section 5.1). If any individuals show signs of illness, their sample bag will be clearly marked, and the necessary actions outlined in the Protocol will be implemented.
- If a large number of frogs are being captured, additional resources will be called upon to assist, so that frogs and tadpoles can be captured and released within Offset Area 1. This is to avoid individuals being held in the sample bags for any longer than necessary.

3.8.4 Transporting

- As only on-site translocation will be undertaken, the transportation of frogs will only require ferrying of individuals in their sample bags on foot across Offset Area 1.

3.8.5 Releasing

- Frogs will be released into Offset Area 1 immediately into favourable micro-habitats that afford protection from exposure and predation. Frogs will be released into areas with suitable rock,

debris and/or dense vegetation providing adequate refuge, around the perimeter of the waterbody.

- All frogs will be visually monitored after release to ensure that they do not show signs of stress or vulnerability. If individuals show such signs, they will continue to be monitored until adequate recovery is evident. If recovery does not become apparent and no signs of recovery are being displayed, the individual may be required to be re-captured and transported to a veterinarian or wildlife carer.

3.8.6 Stressed and Injured Animals

- Prior to the commencement of habitat removal and associated activities, the zoologists will locate and obtain the contact details of the closest wildlife carer and veterinarian.
- The zoologists undertaking the salvage and translocation of the frogs will be suitably qualified and experienced in recognising the indicators of mild-moderate stress in animals. Such recognition informs the judgement to intervene. The following are indicators of mild-moderate stress in animals:
- Fast and shallow breathing; and,
- Temporarily unresponsive to stimuli (listless).
- If an animal is displaying greater than one of these indicators at the same time, an extreme of one of these indicators, or one of these indicators for a prolonged time, then the zoologists will be prepared to intervene. Depending on the situation, such intervention may include:
    - Continued visual monitoring of the individual until adequate recovery is evident;
    - A pause of any activities that may cause further stress; and,
    - Re-capture of the individual and transportation to a veterinarian or wildlife carer.
- If an animal is injured or sick, the zoologist will call for a pause on any activities that may exasperate the situation and immediately make arrangements for the animal to be taken care of. Depending on the severity of injury or illness, this may mean organising the animal to be transported to a wildlife shelter for rehabilitation; or to a veterinarian for medical attention or euthanasia.
- In the event that an animal is severely injured and requires euthanasia immediately (i.e. on site) this is to be undertaken at the zoologists discretion using methods outlined in their Animal Ethics Permit.

3.8.7 Contingency Plan

- If a suitably qualified zoologist is not present during a stage of development where GGF is located on site, contractors will be required to contact a zoologist and temporarily halt works. Contractors will be made fully aware of the appearance of GGF, via a site induction by a qualified zoologist to the Project Manager and/or Contractor(s), to describe GGF and how to identify them if found during works.

- The person encountering the frog will report it to a nominated principal contact of Forte Group Pty Ltd, upon which all works will stop within the vicinity of the site. The zoologist will be contacted immediately.
- No one may attempt to capture the frog unless it is directly within harm's way. If possible, a photo of the frog will be taken and sent to the zoologist via mobile phone messaging for identification; and,
- Any specimens found in harm's way will be stored in an appropriate container and kept in a cool place out of direct sunlight until a qualified zoologist arrives.

3.9 Population and Habitat Monitoring

Appropriate survey and monitoring methods for Growling Grass Frog is an important component to effectively conserve the species (Heard *et al.* 2010). Methods based on research and commensurate with the objective (e.g. determining wetland occupation versus population size versus reproductive success) are required to adequately identify the impact of an action, along with the most appropriate management actions and the effectiveness of such actions (Heard *et al.* 2010). Such surveys will be conducted to assess the impact the development and/or monitor the suitability of a site's management regime, or to monitor the species status throughout a region (which may also relate to regional scale management strategies etc.).

3.9.1 Population Monitoring

Population monitoring will be undertaken annually during the development and for the first 10 years following the completion of construction of the Growling Grass Frog habitat areas (Offset areas 1, 2 and 3).

Each monitoring event will comprise diurnal and nocturnal surveys and will include the following (as a minimum). If, at the end of the annual monitoring the results indicate a decline in the Growling Grass Frog population or degradation of Growling Grass Frog habitat, the CMP will be re-evaluated and adapted accordingly.

Diurnal Surveys

The following will be undertaken as part of the diurnal surveys:

- Habitat assessment documenting: the type and cover of fringing, emergent, submerged and floating aquatic vegetation, and other refugia; in situ water quality; evidence of disturbance including pest animals, litter, soil disturbance and erosion.
- Active searching for frogs in and around the waterbody. The search area will extend for at least 50 meters from the edge of the waterbody and will include actively searching through aquatic and terrestrial vegetation, and under rocks, logs and other refuge.
- Dip netting for tadpoles and predatory fish.

Nocturnal Surveys

The following will be undertaken as part of the nocturnal surveys:

- At least seven nights of surveys will be conducted; at least four in the early part of the active season (to collect data when calling and mobility is high) and three later in the season (when reproductive output is greatest i.e. tadpoles, metamorphs).
- During the early part of the active season each survey will extend for at least 120 minutes. Call playback and active searching for frogs in and around the waterbody will be undertaken. The search area will extend for at least 50 meters from the edge of the waterbody, and will include actively searching through aquatic and terrestrial vegetation, and under rocks, logs and other refuge.
- During the latter part of the active season, the 120-minute survey will involve dip netting for tadpoles and metamorphs, along with active searching for metamorphs and sub-adults in and around the waterbody. The search area will extend for at least 50 meters from the edge of the waterbody, and will include actively searching as detailed above.

All surveys will be conducted in weather conditions considered optimal for detection (i.e. warm and humid, overnight temperature not less than 14°C, preferably post rain) and when the species is known to be active elsewhere (reference sites).

Tadpoles

Surveys will be undertaken annually for the first four years post-development, then in years 6, 8 and 10. Commercially-available, collapsible bait-traps constructed of nylon netting will be baited with fluorescent glow sticks, and then set at the completion of each spotlight survey, in an effort to capture tadpoles at predetermined locations. At least two traps will be set at each wetland for a minimum of two nights over the breeding period of Growling Grass Frog. Traps will be suspended (use of floats) so that at least part of the trap emerges above water-level, allowing tadpoles to breathe.

Traps will then be retrieved the following morning and checked for tadpoles and predatory fish. All tadpoles caught will be identified to species level, counted and released. Alternatively, dip nets will be used to sample for tadpoles at, or in the vicinity of sites where calling males are identified.

3.9.2 Habitat Monitoring

Monitoring of created habitats will be undertaken every six months for the first two years during the development, and annually for the first ten years following the completion of construction of the Growling Grass Frog habitat areas (Offset areas 1, 2 and 3). Several site-specific habitat variables will be assessed during the monitoring period, including:

- Wetland depth, flow, permanency and a visual assessment of water quality;
- Availability and suitability of shelter and over-wintering sites;
- Vegetation diversity, structure, composition and percentage of cover;
- Presence of introduced fish, particularly Eastern Gambusia and Goldfish;
- Presence of pollutants, rubbish and other threatening processes; and,
- A photographic reference will be taken at each wetland at a marked location so that comparisons of habitat conditions can be made over time.

3.9.3 Water Quality Monitoring

A water quality monitoring sites will be established within the quarry wetland prior to the commencement construction and at a second site within the movement corridor immediately following the completion of the constructed wetlands. Water quality sampling will adhere to the EPA's reference document: S*ampling and analysis of waters, wastewaters, soils and wastes* (EPA 2009). Water quality results will be compared to the State Environment Protection Policy (SEPP) Water for Victoria objectives (EPA 2018).

A monitoring program has been designed to identify any potential reduction in water quality if conditions deteriorate from the baseline (pre-construction) water quality conditions. Management actions will be implemented if chemical spills are detected or if there is a noticeable deterioration in water quality. Several 'Spill Response Kits' will be provided if an oil or fuel spill occurs, appropriate training will be provided on how to use the kits if a spillage occurs on site. If water quality results exceed trigger values (see below) and/or are outside SEPP objectives, appropriate measures will be implemented and correction actions (e.g. release of high quality water from the Water Delivery System will be taken to ensure the water quality is suitable for Growling Grass Frog.

Weekly monitoring will be undertaken until the water quality conditions return to background conditions or within SEPP Waters of Victoria (WoV) objectives (EPA 2003).

Site Specific Trigger Values

Trigger values will be established and based on pre-construction water quality within the quarry wetland. Given that there is no long-term water quality data for the quarry wetland the following trigger values will be used;

- If turbidity is >20% of the background condition;
- If electrical Conductivity is >1% of the background condition;
- If Dissolved Oxygen Concentration is <1% of the background condition;
- If pH ±0.5pH unit from background condition; and,
- All other water quality parameters (including any nutrients or heavy metals) have not substantially exceeded background conditions (i.e. no statistically significant difference (alpha >0.05).

Sampling frequency

Pre-construction

Water quality monitoring will be conducted on a monthly basis as soon as approvals are granted, prior to commencement of construction, to establish background conditions and appropriate trigger values at allocated sites.

During Construction

Water quality monitoring will be conducted monthly during the construction phase to ensure that water quality is maintained within the pre-construction water quality parameters of the waterway whilst also satisfying SEPP (WoV) objectives (EPA 2003). However, if trigger values are breached, then weekly water quality monitoring will be implemented until water quality conditions have returned to background conditions or within SEPP (WoV) objectives (EPA 2003).

Post-construction

Water quality monitoring will be conducted every four months for two years post-construction to demonstrate if water quality has returned/remained at background conditions. The frequency of the water quality monitoring will be reviewed after the initial two-year period and a decision will be made on whether ongoing water chemistry monitoring is required.

3.10 Annual Monitoring Reporting and Review

The following will be implemented to inform of relevant issues, milestones and habitat and population monitoring results to ensure the regulatory authorities (i.e. DELWP, DAWE) are informed of the progress of the implementation of this CMP:

A summary of the results of all monitoring procedures, habitat creation (i.e. wetlands) and any maintenance activities will be provided to DAWE on an annual basis throughout the 10 year implementation of the CMP. This annual audit will also outline the progress of the CMP implementation and identify any key issues and management responses.

Management actions may need to be amended or updated if new information becomes available, or if management actions are considered inappropriate or inadequate for the long-term persistence of Growling Grass Frog within the site. New information may become available through ongoing monitoring procedures or following review of ongoing reporting submitted to DAWE. Recommendations based on this information will be provided to the responsible land manager.

In addition to revisions triggered by adaptive management, additional changes to this CMP may be required following the EPBC Act assessment and approval process. Assuming the project is approved under the EPBC Act, conditions stipulated by DAWE may specify specific controls regarding the proposed reporting and review process, monitoring program and management activities etc.

Any proposed amendments or deviations to the actions and requirements of this CMP must be approved by DAWE, and the plan must be updated with any approved changes.

4 OFFSET CALCULATIONS

4.1 Proposed Impacts

The proposed development will result in the removal of 1.5 hectares of low quality Growling Grass Frog foraging and dispersal habitat.

4.2 Offset Calculations

Based on the EPBC Act offset calculator (DSEWPaC 2012b), the construction of 0.5 hectares of Growling Grass Frog terrestrial habitat with the movement corridor, mitigates 137.68% of the impact to remove 0.4 hectares of Growling Grass Frog habitat (Table 2). The construction of 0.39 hectares of Growling Grass Frog wetland habitat with the movement corridor, mitigates 128.45% of the impact to remove 0.35 hectares of Growling Grass Frog habitat. The protection and improvement of 1.5 hectares of Growling Grass Frog terrestrial habitat with the quarry void mitigates 141.08% of the impact to remove 0.75 hectares of Growling Grass Frog habitat. As such, 100% of the offset requirements will be met through direct offsets and are considered to be in accordance with the Commonwealth environmental offset policy (DSEWPaC 2012a).

Table 1 EPBC Act Offset Calculator.

Offset Criteria	Response	
Impact Site		
Impact Location	75-135 Bolinda Road Campbellfield, Victoria	
Habitat to be removed	1.5 hectares of low-quality Growling Grass Frog foraging and dispersal habitat.	
Habitat quality	3/10. The habitat quality in these areas is consistent with the low quality or lack of habitat in the disturbed areas outside the quarry void. Only degraded and low-moderate quality terrestrial habitat will be impacted.	
Offset Sites		
Offset location	Offset Area 1: Terrestrial Habitat Within the Quarry Void	Existing habitat within the quarry void which will be enhanced such that habitats will be augmented, and conditions are improved for Growling Grass Frog refuge, foraging and breeding purposes.
	Offset Area 2: Wetland Habitat Within the Proposed Movement Corridor	The construction of eight dedicated Growling Grass Frog wetlands across the habitat corridor which will be designed and constructed in accordance with *The Growling Grass Frog Habitat Design Standards* (DELWP 2017a).
	Offset Area 3: Terrestrial Habitat Within the Proposed Movement Corridor	The construction of Terrestrial Habitat within the movement corridor including rock beaching and native vegetation surrounding each waterbody designed and constructed in accordance with *The Growling Grass Frog Habitat Design Standards* (DELWP 2017a)
Risk-related time horizon	20 years. The land will be managed in perpetuity for conservation purposes for Growling Grass Frog.	

Offset Criteria	Response	
Time until ecological benefit	5 years. The existing habitat condition in all offset areas is expected to be improved by year 5 of the active management actions detailed in the Management Plan. Growling Grass Frog are expected to benefit from the habitat improvements within this time period, however the site will be managed according to the schedule for the full 10 years covered by the Offset Management Plan.	
Start area and quality of offset site	Offset Area 1	The 1.5 hectares within the quarry void has an assigned start quality of 5/10. This area is located around the quarry wetland and on the south eastern slopes of the quarry void (between the constructed wetlands and the quarry wetland) (Figure 2). The current quality of the habitat in this area varies and consists of areas covered by predominantly invasive weed species, and a section of rock established for structural integrity of the bank (Plate 4). This rocky bank provides suitable foraging and over-wintering sites for Growling Grass Frog. There is limited refuge habitat on the southern slopes of the quarry void, and the quality of the foraging and refuge habitat reduces relative to the distance from the main quarry wetland.
	Offset Area 2	The 0.39 hectares of proposed wetland habitat within the movement corridor has an assigned start quality of 3/10. In its current state this area does not constitute suitable habitat for Growling Grass Frog given there is no standing water, native or aquatic vegetation within or adjacent to the area. Given the degraded and highly modified condition of these areas, they are not considered to provide important or limiting habitat for the species.
	Offset Area 3	The 0.5 hectares of proposed terrestrial habitat within the movement corridor has an assigned start quality of 3/10. In its current state this area does not constitute suitable habitat for Growling Grass Frog given there is no standing water, native or aquatic vegetation within or adjacent to the area. Given the degraded and highly modified condition of these areas, they are not considered to provide important or limiting habitat for the species.
Risk of loss without offset	25%. Without protection and ongoing management as an offset site, there is a degree of uncertainty regarding the future condition and sustainability of the habitat within the property. As the broader property and surrounding area is zoned Industrial 1 zoning, there is a risk that the population of Growling Grass Frog will be isolated and lost through lack of habitat management and land use in Council managed properties to the east. Lack of weed and predator control will negatively impact growling Grass Frog and reduce the quality of the overall breeding and foraging habitat, as European Fox have been previously observed within the study area, and excessive weed growth can smother frog habitat, rendering it unsuitable as a breeding and /or foraging site. Lack of active management will also allow for unauthorised access and the dumping of rubbish within the quarry void, which has been a significant issue to date.	
Future quality without offset	Offset Area 1	4/10. Without protection as an offset site there is uncertainty regarding the future condition of the site. Without increased management as an offset, a reduction in quality over time is likely due to continued pest and weed encroachment, as well as perennial weeds that exist elsewhere within the broader property and a lack of land management. Lack of weed and predator control will negatively impact Growling Grass Frog and reduce the quality of the overall breeding and foraging habitat available for the species.

Offset Criteria	Response	
	Offset Area 2 and 3	2/10. Given these areas do not currently support suitable foraging or breeding habitat for the species, without protection as an offset site there is uncertainty regarding the future condition of the site. Without increased management as an offset, a reduction in quality over time is likely due to continued pest and weed encroachment, as well as perennial weeds that exist elsewhere within the broader property and a lack of land management. Lack of weed and predator control will negatively impact growling Grass Frog and reduce the quality of the overall habitat for the species.
Risk of loss with offset	2%. There is a 2% chance that the Growling Grass Frog population will be lost with the offset being protected and managed in accordance with the GGFOMP placed on-title. The creation of dedicated Growling Grass Frog waterbodies within the proposed movement corridor and the improvement of terrestrial habitat within the quarry void will improve the overall quality and sustainability of the habitat and population of Growling Grass Frog, as these dedicated areas will support key habitat features required by the species, and will be constructed at strategic locations (i.e. along the movement corridor and between the quarry wetland and the movement corridor) to provide additional breeding habitat and ensure that dispersal opportunities throughout the local area (within and between the site) is maintained. In addition, created waterbodies will be secured in perpetuity, protected from the surrounding industrial land uses, and will be managed in accordance with a suitable management regime detailed in the GGFCMP. Further, habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will provide direct connection between the suitable habitat within the movement corridor and the quarry wetland (Figure 2).	
Future quality with offset	6/10. There is a high level of confidence that the future quality of the Growling Grass Frog offset site within all offset areas will increase through the active implementation of the various actions outlined in the GGFCMP. There is a high likelihood that the management actions provided in the GGFCMP will lead to an increase in the species' habitat quality, site occupancy and population size. The management actions outlined in this Plan are well known and proven, and therefore there is a high likelihood that the quality of the habitat will improve in the future (DEWHA 2009). The area within the quarry void is believed to be able to achieve a one point increase due to the connectivity to the proposed wetlands within the movement corridor, and the additional habitat enrichment to be provided in the form of supplementary habitat installation (i.e. logs, rocks), weed and pest animal control, and supplementary fringing and aquatic vegetation planting. The area within the movement corridor is believed to be able to achieve a minimum of a three point increase due to the construction of eight dedicated Growling Grass Frog wetlands and associated surrounding terrestrial habitat across the movement corridor, which will be designed to improve habitat connectivity within and adjacent to the study area (i.e. Merri Creek to the east). The wetlands will incorporate breeding and foraging habitat specifically designed and managed for the Growling Grass Frog (Figure 2). In its current state this area does not constitute suitable habitat for Growling Grass Frog. Therefore, the construction of additional breeding and foraging habitat represents a significant improvement in the quality of the available habitat for the species in these areas. The established wetlands will be hydrologically independent from Merri Creek (which aims to limit exposure to Eastern Gambusia; a known threatening process for the species) and will be located to facilitate connections with other Growling Grass Frog populations in the area. The wetlands will contain a drainage outlet for removing some or all water from the system. The drainage capacity is important for maintenance purposes and could be used for the removal of pest fauna species such as Eastern Gambusia. The proposed wetlands will have a water delivery system to direct water from within the quarry void into the wetlands to ensure water levels are suitable for the species during dry periods (e.g.	

Offset Criteria	Response
	during drought). The design of this system is to incorporate a holding tank to be filled with water from the quarry wetland, which is controlled by a manually operated butterfly valve and discharged into Pond 1 within the constructed dispersal corridor (Figure 2). This will then flow through each corresponding wetland through a series of stormwater linkage drains between each pond. The existing wetland in the quarry void in its current state contains areas of shallow water supporting emergent vegetation, particularly along the north eastern banks of the waterbody (Photograph E2). Minor fluctuations in the water level may have the added benefit of stimulating emergent vegetation growth due to elevated solar radiation and water temperature, which can also increase tadpole development. Warm water resulting from fluctuating water levels also increases the productivity of wetlands, which in turn provides additional food resources such as invertebrates for Growling Grass Frog populations and providing additional foraging habitat along newly exposed shallow banks (DELWP 2017a). The offset site is to be secured and managed for conservation purposes in perpetuity, with implementation of a management plan incorporating weed and predator control and regular monitoring, aiming to enhance the sustainability of the population at the site biodiversity.
Confidence in result	80-90%. Confidence in applied scores is relatively high due to careful consideration of the offset site, existing condition and commitment of the landholder to manage threats through conservation works. The site will be protected through a Section 173 Agreement under the *Planning and Environment Act 1987* with Council. Council undertakes a quality assurance process for all offset sites to ensure the landowner agreements address the management commitments in the plan. Further, the site will be secured via a Trust for Nature covenant under the *Victorian Conservation Trust Act 1972* within 24 months post approval of the referral.

Table 2: Breakdown of offset assessment calculation

Site	Description	Area to be offset (Ha)	Quality	Area of Habitat (Ha)	Start Quality	Future quality	% of impact offset	Minimum (90%) direct offset requirement met?
Offset Area 1	Terrestrial habitat within the quarry void	0.75	3	1.5	5	6	141.08%	Yes
Offset Area 2	Wetland habitat within the movement corridor	0.35	3	0.39	3	6	128.45%	Yes
Offset Area 3	Terrestrial habitat within the movement corridor	0.4	3	0.5	3	6	137.68%	Yes

5 RISK MANAGEMENT AND CONTINGENCY PLANNING

This section identifies a range of management actions to ensure that the retained habitat area is maintained to appropriate standards. If any of these circumstances arise, this section outlines the management responses required in order to ensure habitat within the site continues to support the species. Adaptive management is paramount to the successful implementation of this CMP and ongoing persistence of the Growling Grass Frog population.

It should be noted that this section does not aim to identify an exhaustive list of possible stochastic events and subsequent resolutions, but a select number of key issues based on existing knowledge gained through the implementation of other Growling Grass Frog CMPs across the greater Melbourne region.

Some issues that are likely to require contingency measures are provided.

5.1 Disease Transmission and Spread

There is evidence to suggest that the decline of many frog species in Australia and elsewhere could be related to the disease caused by the water-borne fungal pathogen, commonly referred to as Chytrid Fungus. Chytrid Fungus is a major threat to amphibian populations in Australia, with at least one species driven to extinction and populations of other threatened species, particularly *L. raniformis*, severely compromised (DEWHA, 2006). The disease that results from Chytrid Fungus infection causes significant physical and physiological problems for frogs, such as skin flaking, reduced food intake, cardiac arrest and mortality (Peterson 2012). Infection of amphibians with the fungus is listed as a 'key threatening process' under the EPBC Act.

There is an inherent risk of spreading the fungus within and between areas in the landscape by the movement of infected frogs and tadpoles, water, soil and vegetative material; the outcome of which can be extremely deleterious if it is introduced into Growling Grass Frog populations presently free of the disease. Human activities and movements can exasperate the risk of disease spread, and as such hygiene protocols for vehicles, equipment, footwear, handling, holding and transporting of frogs and tadpoles are paramount.

Such hygiene protocols will be implemented throughout the construction works. The Hygiene Protocol (Murray *et.al*. 2011) will be used to guide best practice Chytrid management. This document is provided as Attachment D, and includes, but is not exclusive to the following.

- All footwear and equipment (e.g. nets, buckets, callipers, headlamps, waders), will be thoroughly cleaned and disinfected before entering and exiting the quarry, and between sites including between the site of salvage and No-Go-Area;
- Any equipment used to handle frogs and tadpoles will be cleaned and disinfected between each sample;
- The tyres of all vehicles will be cleaned and disinfected before entering and exiting the quarry void and construction area of the movement corridor (if required);
- The tyres/tread and other parts of machinery and plant (e.g. the excavator bucket; pumps) involved in the habitat construction and associated activities, will be cleaned and disinfected before entering the construction area of the movement corridor;

- A new pair of disposable latex gloves will be used between each frog and tadpole. Gloved hands will be dipped in the local water in the immediate area so that loss of skin secretions is minimised when frogs are picked up;
- Frogs will be placed into new and clean plastic sample bags, with a 'one bag– one frog' policy. Bags will not, under any circumstances, be reused; and,
- Disinfection methods will follow the procedures outlined in the Hygiene Protocol.

5.2 Population Decline

Local frog populations are known to vary on spatial and temporal scales depending upon habitat conditions at a particular site. For the site as a whole, regular population monitoring will determine if the Growling Grass Frog population is in a state of decline or no longer present. Obvious causes of decline will be rectified if possible and as close as possible to the time of detection. Some of these actions may include:

- Habitat augmentation, such as the installation of additional rocks and other refuge features;
- Planting of additional vegetation, or conversely, removal of wetland vegetation (if it is smothering the waterbody);
- Identification and removal of barriers to dispersal; and,
- Increasing the intensity of feral animal controls.

5.3 Degradation of Habitat

The degradation of Growling Grass Frog habitats can occur through a wide range of active and passive processes. Typical processes contributing to habitat degradation include:

- Lack of adequate maintenance;
- Ongoing erosion and sedimentation;
- Chemical and/or hard rubbish influx following flood events;
- Increased weed encroachment into areas of indigenous or planted terrestrial and aquatic vegetation
- Vegetation trampling, removal and/or dieback; and,
- Low water levels and/or poor water quality.

Significantly degraded habitat is unlikely to support Growling Grass Frog, reducing the dispersal and breeding opportunities which would normally be facilitated by areas of non-degraded habitat. Any evidence of habitat degradation will be noted as part of the monitoring program (Section 2.4.4) and management response actions will depend on the type of process that is causing a reduction in overall habitat quality for Growling Grass Frog. Potential processes leading to habitat degradation and possible responses are detailed in the following sections.

5.3.1 Erosion and sedimentation

- Installation and routine maintenance of sediment and erosion controls in key areas;

- Installation of rock banks, boulders and logs to stabilise soils in affected areas; and,
- Increase maintenance and monitoring operations in affected areas until problem areas are improved.

5.3.2 Chemical and/or hard rubbish influx following flood events

- Engage a specialist contractor, as required, to clean up contaminants such as oil spills, etc.;
- Chemical treatments (for rectifying acidity or alkalinity);
- Inspection of all drainage points leading to the waterbody for chemical spills, leaks, and rectify where necessary; and,
- Once-off intensive hard litter removal (if required between normal maintenance schedules).

5.3.3 Vegetation dieback

- Increase maintenance and monitoring operations in affected areas; and,
- Replace dead vegetation as required.

5.3.4 Unauthorised site access and significant dumping of hard rubbish

- Maintenance of protective fencing and addition of signage; and,
- Once-off intensive hard litter removal (if required between normal maintenance schedules).

5.3.5 Management and Maintenance

The ongoing maintenance of ponds and wetlands, particularly the maintenance of aquatic vegetation diversity and structure and terrestrial habitats will be essential to ensure these habitat types become and remain suitable for the species. Once established, ponds and wetlands are expected to be self-sustaining. Maintenance of created habitats will be implemented every six months for the first two years post habitat and vegetation installation, and on an annual basis thereafter.

- If necessary, additional plants will be planted to ensure that waterbodies and terrestrial habitats remain suitable;
- Additional refuge sites such as rocks, logs and dense low-lying vegetation will be added if it is considered during site monitoring, that the area of shelter is insufficient;
- Routine maintenance of grassed areas within Offset Area 3 around the periphery of the waterbodies;
- Wetlands will be kept free of predatory fish, such as Eastern Gambusia and Redfin. The ongoing monitoring program will identify invaded ponds and subsequently instruct managers that draining is required;
- Where possible, weeds will be controlled by hand or with the use of implements. Alternatively, a frog sensitive herbicide (non-residual herbicide) will be selectively used. The use of other herbicides or pesticides within, or in close proximity to ponds, wetlands/waterways, shelter sites and likely dispersal areas will be prohibited;
- Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from wetlands/waterways and ponds. The removal of rubbish is particularly important over the first

few years during pond and wetland establishment, however refuge habitat such as woody debris and tin must remain in place, as covered in section 3.8; and,

- Where relevant gross pollutant traps and/or sediment filters will be checked every 6 months and cleaned when required, particularly after heavy rain or storm events.

The ongoing maintenance of ponds and wetlands/waterways is to be conducted: in particular the maintenance of aquatic vegetation diversity and structure and terrestrial habitats this will be essential to ensure these habitat types become and remain suitable for the species. Once established, ponds and wetlands/waterways are expected to primarily be self-sustaining.

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

- Maintenance of created habitats will take place every six months for the first two years post habitat and vegetation installation, and on an annual basis thereafter;
- If necessary, additional plants will be planted to ensure that waterbodies and terrestrial habitats remain suitable;
- Additional refuge sites such as rocks, logs and dense low-lying vegetation will be added if it is considered, during site monitoring, that the area of shelter is insufficient;
- Routine maintenance of grassed areas within the reserve area around the periphery of the waterbodies;
- The control of pest animals such as foxes and cats will be undertaken in accordance with local government laws and relevant legislation;
- Wetlands will be kept free of predatory fish, such as Eastern Gambusia and Redfin, where possible. The ongoing monitoring program will identify invaded ponds and subsequently instruct managers that draining is required;
- Where possible, weeds will be controlled by hand or with the use of implements. Alternatively, a frog sensitive herbicide (non-residual herbicide) will be selectively used. The use of other herbicides or pesticides within, or in close proximity to ponds, wetlands/waterways, shelter sites and likely dispersal areas will be prohibited;
- Building material and other unwanted materials (e.g. plastic, polystyrene) will be removed from wetlands/waterways and ponds. The removal of rubbish is particularly important over the first few years during pond and wetland establishment; and,
- Where relevant gross pollutant traps and/or sediment filters will be checked and, if necessary, subsequently cleaned, particularly after heavy rain or storm events.

5.3.6 Long Term Wetland Maintenance

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

Clean-out will only be undertaken once ponds and wetlands have been assessed by a water quality expert and it is determined that sediment build-up and organic matter has accumulated to the point necessary

to require clean-out. Clean-out will be undertaken in a staged approach (i.e. cleaned out gradually over a couple of years).

Prior to wetland clean-out, a suitably qualified zoologist will be consulted to give advice in relation to the appropriateness of such actions in terms of the potential impacts the operations may have on tadpoles in ponds and/or resident frog populations. Wetlands and ponds must be re-established with a diversity of wetland plants and refuge sites if these habitat features are disturbed during the draining process.

5.3.7 Pest Fish Management

In areas that are subject to routine flooding, where the incursion of fish is unavoidable, the provision and maintenance of dense submerged and floating aquatic vegetation can increase Growling Grass Frog recruitment and survival rates by providing a greater amount of submerged cover for eggs and tadpoles. While it is preferred that all waterbodies be kept fish-free, in an urban setting the introduction of fish through routine flood events, dispersal of fish eggs by birds or artificial introduction by residents, is highly likely. However, if Eastern Gambusia is observed within Offset Area 2, protocols outlined in Section 3.6 will be implemented that may include draining the wetland outside of the Growling Grass Frog active season (i.e. Spring and Summer) to remove this species from the wetland system.

5.3.8 Habitat Protection and Management

5.3.8.1 Sediment/ Frog Exclusion Fencing

Temporary frog exclusion fencing will be re-instated around the outer parameter of Offset Area 1 prior to the commencement of construction to provide a physical barrier between the development area and retained habitat within the quarry void. Habitat enhancement activities associated with Offset Area 1 within the quarry void will commence during the first stage of the development. Habitat improvements directly surrounding the quarry wetland and on the south eastern slopes of the quarry void will provide direct connection of suitable habitat between proposed waterbodies within the movement corridor (Offset Area 2) and the quarry wetland. An example of suitable frog exclusion fencing is shown in Plate 8. The following controls apply to the installation of sediment/ frog exclusion fencing:

- Fencing must be constructed of a cloth or plastic material and only appropriate fencing material that withstands variable weather conditions over long periods of time must be used;
- Fencing must be installed at least one metre high, with an additional 0.2 metres buried below-ground. An additional 0.2 metres at the top of the fence must be bent/ angled over at less than 90 degrees to the vertical on the frog habitat side (not the excluded habitat side) to prevent frogs from climbing or hopping over the fence;
- Refugia for shelter must be placed at least one metre away from the fence and any vegetation within one metre of the fence must not exceed 0.5 metres to prevent frogs from escaping (i.e. low-growing grasses will be planted).
- Fences must be taut without creases or folds;
- Fence posts must be installed on the outer fencing side (i.e. excluded habitat side) and fastened with nails or similar, and lie flush with fencing material to prevent frogs from climbing up posts and escaping over the fence; and,
- Regular inspection of the fencing is required to ensure its effectiveness, including:

- Inspections of fencing between May and August, prior to Growling Grass Frog breeding season and the repair or replacement of any damaged or ineffective material;
- Maintenance of vegetation within one metre of fencing at less than 0.5 metres high; and,
- Removal of any litter or other debris caught in fencing which could assist frogs to climb over.

Plate 8. Example of suitable frog exclusion fencing

5.3.8.2 Safety Fencing

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

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

5.3.9 Trenching

Any trenches left open overnight must be backfilled in intervals of approximately 10 metres, in order to provide temporary escape ramps for any fauna which may fall in. If trenches are left open overnight, checks for trapped fauna must be made in the morning, prior to any works commencing on-site. Fauna salvage activities must be undertaken by a qualified fauna handler, under a current Management Authorisation.

5.3.1 Signage

Temporary signage will be installed along the perimeters of all existing Growling Grass Frog wetlands in order to:

- Prevent accidental entry by construction personnel; and,

- Discourage vegetation trampling, introduction of fish into wetlands or waterways, rock disturbance and rubbish ingress by construction workers during the construction phase.

All signage will be maintained until construction works are complete.

Permanent signage will be installed along the perimeters of the quarry void and at key locations along the Growling Grass Frog movement corridor in order to:

- Educate residents residing in the relevant Precincts about the presence of Growling Grass Frog;
- Discourage vegetation trampling, rock disturbance and rubbish ingress and, prohibit rubbish dumping within the Conservation Area; and,
- Advise of pet restrictions within wetland areas/ on-lead areas for dogs.

5.3.2 Pest Plant Control

The control of pest plants within rehabilitated areas is a major requirement for management, as habitat within the site is under continual pressure from the invasion of introduced grasses and weeds (e.g. African Boxthorn *Lycium ferocissimum*). Excessive weed growth can smother and reduce the quality of frog habitat for breeding and foraging. In order to control and/or eradicate these weed species, particularly within the habitat improvement areas adjacent to the waterbody, several on-going techniques can be used, including physical removal, brush cutting and herbicide application. Herbicide must only be applied to weeds by using the spot-spraying technique, in order to prevent off-target issues.

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

The following controls apply to all on-site weed control works:

- Weed management must be undertaken throughout all open space areas, with particular attention given to vegetated areas which are not subject to routine maintenance;
- Any weed control works must be completed in a manner that minimises soil disturbance;
- Herbicide use must be minimised to avoid adverse effects on frogs and invertebrates;
- Where herbicide application is necessary, waterway sensitive products such as Roundup Bioactive®, Weedmaster Duo® or Weedmaster 360® must be employed, without the addition of surfactant;
- Where herbicides are used, selective application is preferable to broad area application;
- Non-residual herbicides must not be used;
- Pest plants that reproduce sexually (by seed) must be controlled before seeds ripen; and,
- Weed control works must be monitored regularly to assess their effectiveness and follow-up / evaluation works must be completed. With any weed control works it is important to establish a cover of native species as soon as possible to occupy the newly vacated environment. While native species will naturally re-colonise such areas, so will exotic species if weed seed is present in soil.

The following species must not be introduced into Offset Area 2 and 3 or included in the list of suitable species to be plated in order to avoid the risk of constructed wetlands becoming choked with vegetation;

- Cumbungi
- Common Reed
- Tall Spike-rush

If these species are observed within Offset Area 1 and 2 during habitat monitoring a nominated principal contact of Forte Group Pty Ltd must be notified, and a wetland revegetation specialist contractor must be engaged to remove these species so that wetlands remain clear and comprise predominantly open water. A suitably qualified zoologist must be notified prior to removal so that appropriate salvage and relocation activities can be assessed and implemented.

5.3.3 Habitat Maintenance

Maintenance of the retained habitat area is to be undertaken as the need is identified through monitoring, with particular focus on the maintenance of aquatic vegetation diversity and structure, and terrestrial habitats. Maintenance activities will be essential to ensure the habitat area remains suitable for Growling Grass Frog. Once habitat improvement works are complete, it is considered that the retained waterbody will primarily be self-sustaining and not require significant interventionist management, including the regulation of water levels.

Overall habitat conditions for Growling Grass Frog will be maintained within the site through the identification of issues during the monitoring program and through the implementation of suitable rectification measures. A summary of general maintenance requirements include:

- Regularly consult an experienced zoologist for maintenance issues that could impact on the Growling Grass Frog population and associated habitat;
- Undertake routine monitoring to investigate the success of aquatic and terrestrial plant establishment and weed densities;
- Replace any failed plantings;
- Control any weeds invading terrestrial habitat by hand, or spot treatment methods with frog sensitive herbicides;
- Revise mitigation and monitoring measures in agreement with responsible authorities, if necessary; and,
- Monitor the level of any public disturbance in and around *L. raniformis* habitat and manage accordingly (e.g. fencing repairs and signage).

5.4 Habitat Connectivity Surrounding the Study Area

Aside from providing stormwater conveyance and conservation functions, the retained waterbody and constructed wetlands within the movement corridor will provide an opportunity for Hume City Council to link the site with additional high quality habitat across land to the east of the study area. In 2009, the high-level Bolinda Road Former Landfill Site Masterplan (Meinhardt 2009) was developed for the former landfill site located approximately 180 metres east of the quarry. The Masterplan supported the ongoing waste management activities and the development of a Public Open Space area (approximately nine

hectares) at the site (Figure 1). In 2011, a draft Masterplan (Meinhardt 2011) was prepared for the development of the open space reserve, which will form the biggest Council-managed reserve in Campbellfield. Council are in the process of finalising the Masterplan, however, Council's current timeframe for the development of the area is not known. Given that the Masterplan has not been finalised, there is an opportunity for Council to integrate the retained waterbody and proposed movement corridor and improve habitat links between the quarry wetland, existing dams to the east and Merri Creek. Further, the initial timeframe for the development of the reserve was indicated as being completed in 2015, therefore there is opportunity for council to consider development of the area concurrently with the proposed action to work towards a common goal of providing an unbroken Growling Grass Frog dispersal corridor between the study area and Merri Creek for the overall benefit of the species.

Wetlands created within a suitable distance to the east of the quarry are likely to be colonised by Growling Grass Frog and form an important link with Merri Creek, provided they contain the necessary habitat characteristics such as suitable size, patches of emergent and submerged vegetation, have good water quality, provide a diversity of pond habitats and are not disconnected from the existing populations by significant barriers. A variety of wetlands would provide the most suitable habitat opportunities for Growling Grass Frog (i.e. some with permanent water for habitat connectivity, and others with an ephemeral water level to increase the likelihood that they are free of predatory fish [e.g. Eastern Gambusia]). Given that Growling Grass Frog is known to use Merri Creek as a dispersal corridor, suitable habitat created along this watercourse is also likely to be colonised. Through the design, construction and establishment of aquatic vegetation in wetlands, and ongoing maintenance and management, there is a significant opportunity for Council to increase the overall quality of Growling Grass Frog habitat in and surrounding the study area. This will contribute to the long-term viability (population processes) of local populations.

REFERENCES

Ashworth, J.M. 1998. An appraisal of the Conservation of Litoria raniformis (Kefferstein) in Tasmania. University of Tasmania March 1998. Unpublished Masters Thesis.

Barker, J., Grigg, G.C. & Tyler, M.J. 1995. A Field Guide to Australian Frogs. Surrey Beatty & Sons. New South Wales.

DELWP 2017a. Growling Grass Frog Habitat Design Standards, Melbourne Strategic Assessment. Published document prepared by the Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DELWP 2020. Victorian Biodiversity Atlas. Sourced from GIS layers: "VBA_FLORA25", "VBA_FLORA100", "VBA_FAUNA25", "VBA_FAUNA100". Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

DEWHA 2006. Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis. Department of Environment, water, Heritage and the Arts. Commonwealth of Australia, ACT.

DEWHA 2009. Significant impact guidelines for the vulnerable growling grass frog (*Litoria raniformis*. Nationally threatened species and ecological communities EPBC Act policy statement 3.14. Department of Environment, Water, Heritage and the Arts. Commonwealth of Australia, Canberra.

DSE 2013. Advisory List of Rare or Threatened Fauna in Victoria. Victorian Department of Sustainability and Environment.

DSEWPaC 2012a. *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy (October 2012). Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPaC 2012b. Offsets Assessment Guide: For use in determining offsets under the *Environment Protection and Biodiversity Conservation Act 1999* (2 October 2012). Microsoft Excel spreadsheet developed by the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Ecology and Heritage Partners 2012a. EPBC Act Referral - Bolinda Road Quarry decommission, filling in waterbody and drainage line within the quarry. Unpublished report prepared for Bolinda Operations Pty Ltd.

Ecology and Heritage Partners 2012b. Targeted Growling Grass Frog surveys and legislative advice for the proposed decommission of the Bolinda Road Quarry, Campbellfield, Victoria. Unpublished report prepared for Bolinda Operations Pty Ltd.

Ecology and Heritage Partners Pty Ltd 2013a. Growling Grass Frog Salvage and Translocation Plan for the Bolinda Road Quarry, Campbellfield, Victoria. Unpublished report prepared for Bolinda Operations Pty Ltd.

Ecology and Heritage Partners 2016. Growling Grass Frog *Litoria raniformis* Conservation Management Plan, Bolinda Road Quarry, Campbellfield, Victoria.

Ecology and Heritage Partners 2020a. Biodiversity Assessment for the proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria. Report prepared for Forte Group Pty Ltd.

Ecology and Heritage Partners 2020b. EPBC Act Referral - Bolinda Road Quarry development, Campbellfield, Victoria, EPBC 2020/8748. Unpublished report prepared for Forte Group Pty Ltd.

Ecology Australia 2002. Preliminary Flora & Fauna Assessment, NRT Ltd quarry, Campbellfield. Compiled by KLM Gerner Consulting Group. Unpublished Report completed for NRT Ltd.

Ecology Australia 2003. Seasonal survey for Growling Grass Frog *Litoria raniformis* at the NRT quarry, Campbellfield. Compiled by KLM Gerner Consulting Group. Unpublished Report completed for NRT Ltd.

Ecology Australia 2006. Sub-regional conservation Strategy for the Growling Grass Frog – Epping/Somerton, Victoria. Ecology Australia Pty Ltd for Department of Primary Industries.

EPA 2009. *Sampling and analysis of waters, wastewaters, soils and wastes*, Publication Number: IWRG701, Environmental Protection Agency, Victoria.

EPA 2018. State Environment Protection Policy: Water for Victoria. Environment Protection Authority Victoria, Melbourne.

Heard, G., Scroggie, M., Clemann, N., and Ramsey, D. In press. Wetland characteristics influence disease risk for a threatened amphibian. Ecological Applications. http://dx.doi.org/10.1890/13-0389.1

Hale, J.M., Heard, G.W., Smith, K.L., Parris, K.M., Austin, J.J., and Melville, J. 2013. Structure and fragmentation of growling grass frog metapopulations. *Conservation Genetics* 14: 313-322

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.

Hamer, A.J. and Organ, A. 2006. Distribution, Habitat Use, Movement Patterns and Conservation Management of the Growling Grass Frog Litoria raniformis through the Pakenham area, Pakenham, Victoria. Unpublished report for the Department of Sustainability and Environment (Ecology Partners, Brunswick).

Heard, G., Robertson, P. and Scroggie, M.P. 2008. Microhabitat preferences of the endangered Growling Grass Frog Litoria raniformis in southern Victoria. Australian Zoologist 34(3): 414-425.

Heard, G.W. 2010. Pattern, process and the conservation of threatened amphibian metapopulations. PhD thesis, La Trobe University, Melbourne.

Heard, G.W., Robertson, P. and Scroggie, M. 2004. The ecology and conservation status of the Growling Grass Frog Litoria raniformis within the Merri Creek corridor. Wildlife Profiles Pty. Ltd. and Arthur Rylah Institute for Environmental Research.

Heard, G.W., Scroggie, M.P. and Clemann, N., 2010. Guidelines for managing the endangered Growling Grass Frog in urbanising landscapes. Technical Report Series 208. Arthur Rylah Institute for Environmental Research, Heidelberg.

Heard, G.W., Scroggie, M. and Clemann, N. 2012. Correlates and consequences of chytridiomycosis for populations of the Growling Grass Frog in peri-urban Melbourne. Report to the Victorian

Department of Sustainability and Environment. Arthur Rylah Institute for Environmental Research, Heidelberg.

Hero, J.M., Littlejohn, M. and Marantelli, G. 1991. Frogwatch Field Guide to Victorian Frogs. Department of Conservation and Environment, East Melbourne.

Littlejohn, M.J. 1963. Frogs of the Melbourne area. Victorian Naturalist. 79:296-304.

Littlejohn, M.J. 1982. Amphibians of Victoria. Victorian Yearbook. 85:1-11.

Meinhardt 2009. Former landfill at Bolinda Road, Campbellfield - Masterplan for future waste management uses. Unpublished report for Hume City Council.

Meinhardt 2011. Draft Bolinda Road Open Space Masterplan. Unpublished report for Hume City Council.

Morgan, L.A. and Buttermer, W.A. (1996). Predation by the non-native fish *Gambusia holbrooki* on small *Litoria aurea* and *L. dentata* tadpoles. *Australian Journal of Zoology* 30:143-149.

Murray, K., Skerratt, L., Marantelli, G., Berger, L., Hunter, D., Mahony, M. and Hines, H. 2011. Hygiene protocols for the control of diseases in Australian frogs. A report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Organ A. 2002. Warty Bell Frog *Litoria raniformis* ecological advice for the proposed Edgars Road extension, Epping Victoria. Unpublished report prepared for VicRoads (Biosis Research Pty Ltd.)

Organ A. 2003. Conservation strategy for the Warty Bell Frog *Litoria raniformis* at the proposed Edgars Road extension, Epping, Victoria. Unpublished report prepared for VicRoads (Biosis Research Pty Ltd.)

Organ, A. 2010. Growling Grass Frog *Litoria raniformis* monitoring over the 2009/10 breeding period, Western Treatment Plant, Werribee, Victoria. Ecology and Heritage Partners Pty. Ltd. unpublished report for Melbourne Water Corporation.

Pyke, G.H. 2002. A review of the biology of the southern bell frog Litoria raniformis (Anura: Hylidae). Australian Zoologist 32: 32748.

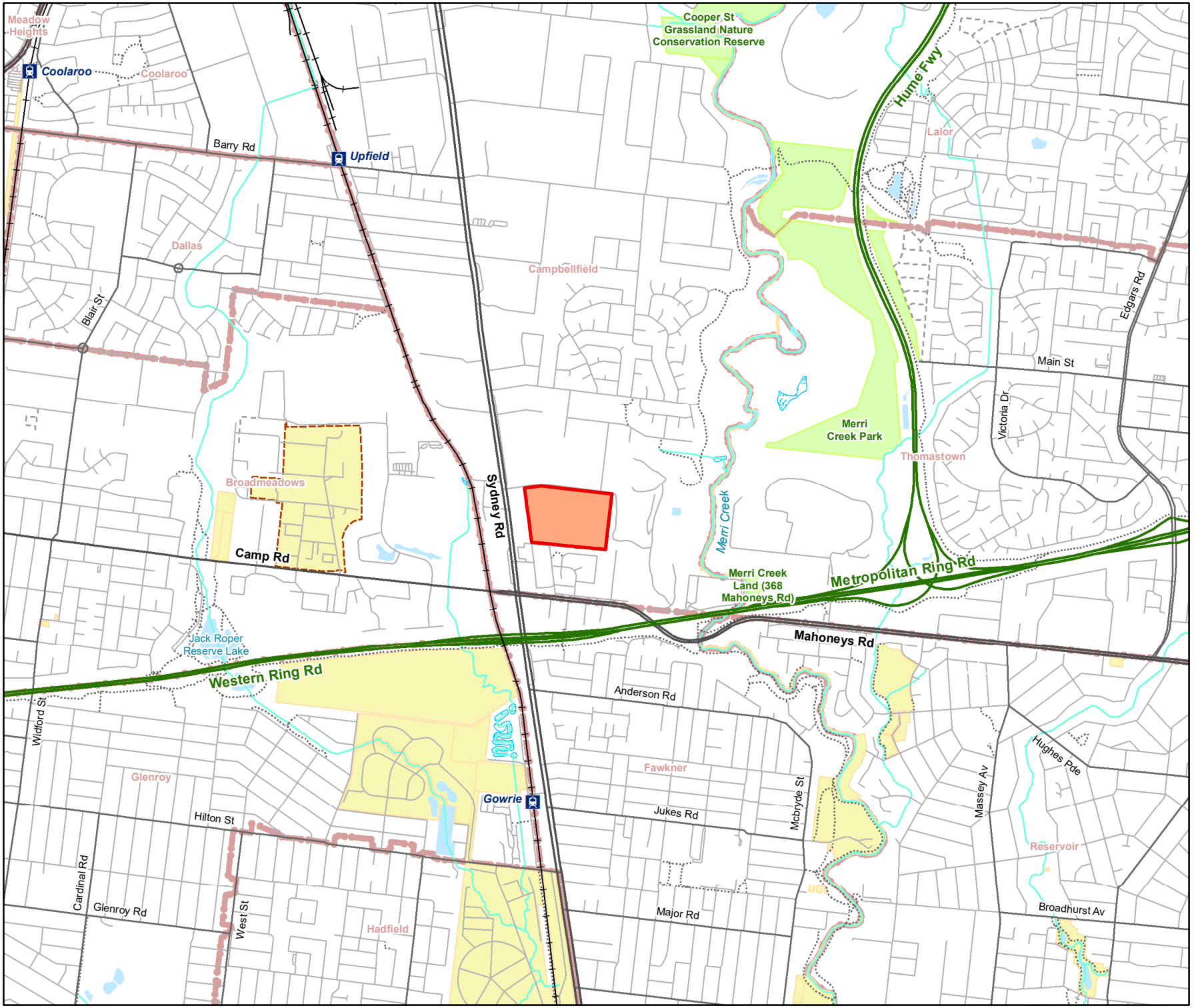
Robertson, P., Heard, G. and Scroggie, M. 2002. The Ecology and Conservation Status of the Growling Grass Frog Litoria raniformis within the Merri Creek Corridor. Interim Report: Distribution, Abundance and Habitat Requirements. Report produced for the Department of Natural Resources and Environment.

Tyler, M.J. 1997. The Action Plan for Australian Frogs. Wildlife Australia: Canberra

Wassens, S. 2005. *The use of Space by the Endangered Southern Bell Frog* Litoria raniformis *in the Semi-Arid Region of New South Wales, Australia.* PhD Thesis, Charles Sturt University, Wagga Wagga, NSW.

White A. W. & Pyke G.H. 1996. Distribution and conservation status of the green and golden bell frog *Litoria aurea* in New South Wales. *Australian Zoologist* 30: 177-189.

FIGURES



Legend

- Study Area
- Railway
- Freeway
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Walking Track
- Minor Watercourse
- Permanent Waterbody
- Wetland/Swamp
- Parks and Reserves
- Commonwealth Land
- Crown Land
- Localities

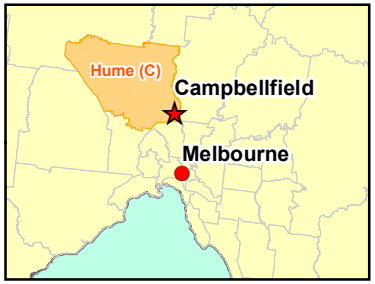


Figure 1

Location of the study area

Biodiversity Assessment for 75 Bolinda Road, Campbellfield

N

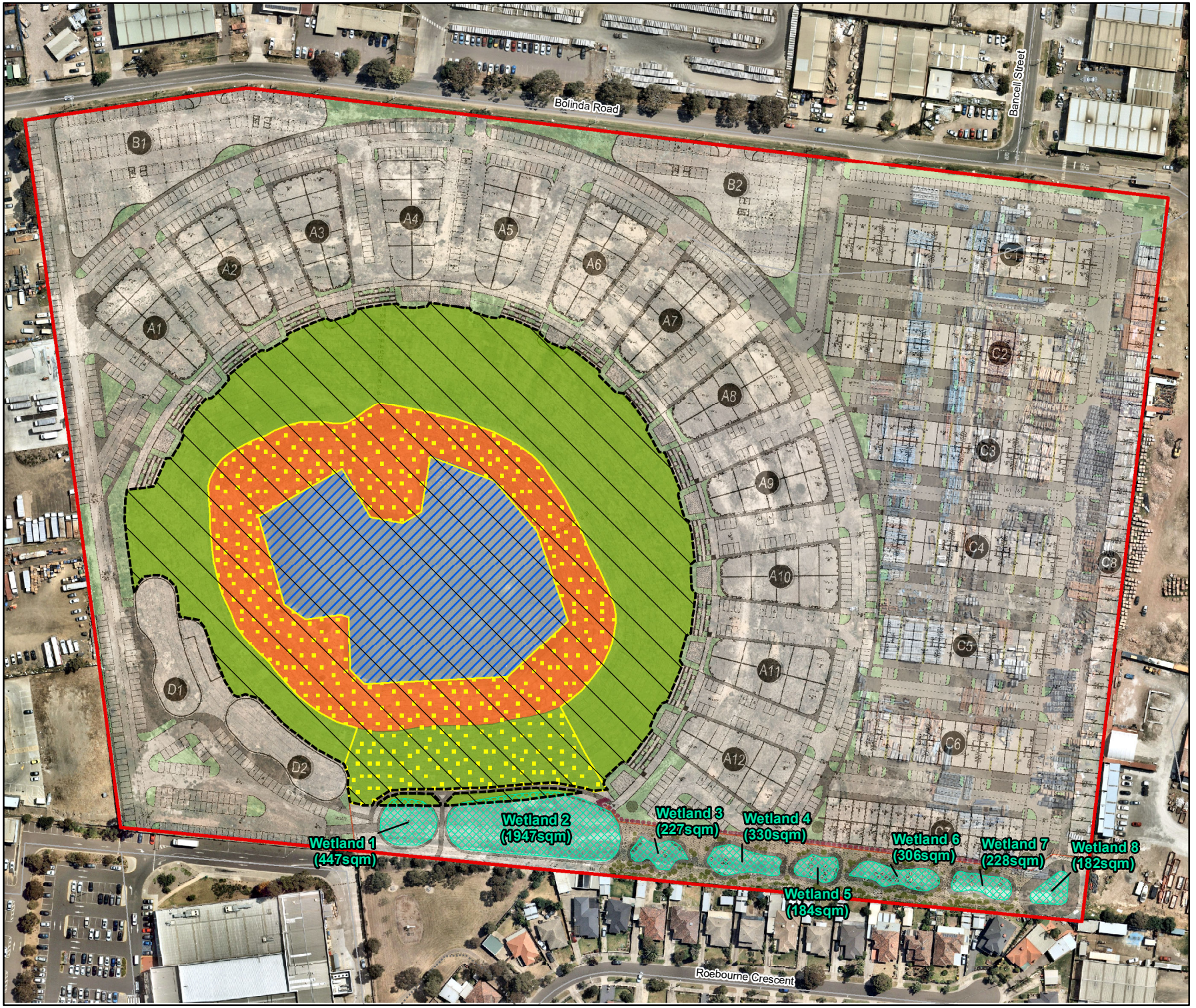
0 500 1,000

Metres

Map Scale: 1:30,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.



Legend

- Study Area
- High quality Growling Grass Frog foraging habitat
- Growling Grass Frog dispersal and foraging habitat
- Known Growling Grass Frog breeding habitat
- Proposed Constructed Wetland
- Area of habitat enrichment (1.5ha)
- No-go zone

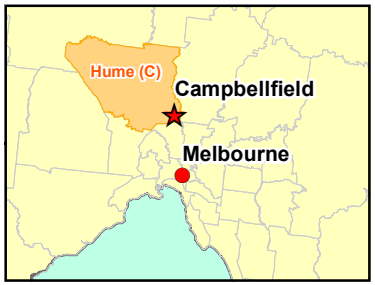


Figure 2

Ecological features

Biodiversity Assessment for 75 Bolinda Road, Campbellfield

N

0 30 60

Metres

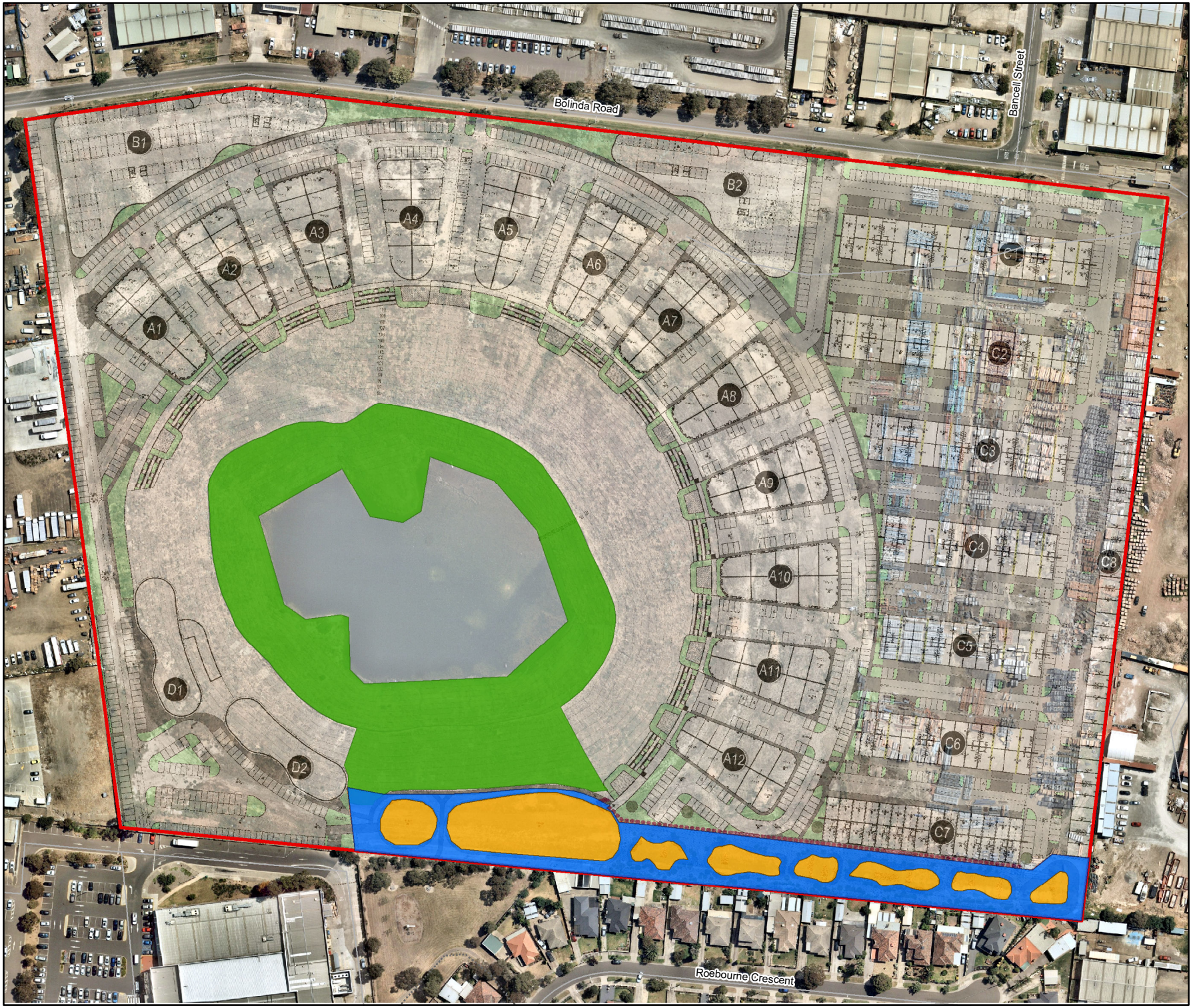
Map Scale: 1:2,300 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

13138_Fig02_EcoFeat_G20 10/02/2021 melsley

Aerial source: Nearmap 2019



Legend

- Study Area
- Offset Area 1
- Offset Area 2
- Offset Area 3

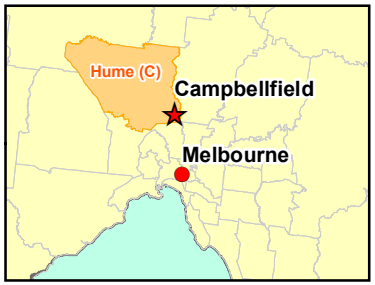


Figure 3

Propose Offset Areas

75 Bolinda Road, Campbellfield

N

0 30 60

Metres

Map Scale: 1:2,300 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

13138_Fig01_PropOS_G20 15/04/2021 melsley

Aerial source: Nearmap 2019

ATTACHMENTS

Attachment A - Induction Pamphlet

Staff and contractor induction: Growling Grass Frog at the Bolinda Road Quarry

Background

Growling Grass Frog is listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and threatened under the Victorian *Flora and Fauna Guarantee Act 1988*. The species is also protected under the *Wildlife Act 1975*.

This species of frog has been recorded at the Bolinda Road Quarry, including in moderate numbers (seven individuals) in February 2003, in high numbers (101 individuals) in 2004/2005, in low numbers (two individuals) in February 2012 and moderate numbers (~20 individuals) in October 2013.

Partial filling of the quarry and landscaping works are required in order to decommission the site and provide a safe and stable landform. As a result, extensive measures to avoid and minimise the occurrence and extent of potential impacts to Growling Grass Frog individuals, populations, and the species, that may be associated with the proposed action, are required. One of these measures is to undertake the salvage and translocation of individuals from the disturbance footprint, during all activities related to habitat removal and earthworks.

Both Commonwealth and State referral authorities are involved in this project, and it is imperative that all persons working at the Bolinda Road Quarry, during the aforementioned activities, assume a duty of care to avoid and minimise impacts to Growling Grass Frog.

Species description

Growling Grass Frogs:

- Are bright emerald to dull green frog, with brown to gold blotches and a warty back (Plate 1 and Plate 2);
- Can vary in size from 55 – 100 mm depending upon maturity;
- Are active during the months of September to April, and generally inactive during the rest of the year (hiding under logs and rocks, in soil cracks, in dense vegetation);
- Make a distinctive call, resembling 'growling' or a far-off motorbike, between October and December;
- Can be found in a range of habitats including, creeks, drainage lines, wetlands, dams, quarry holes; and
- Can move quite long distances during the active season (e.g. 2 km);

MELBOURNE 292 Mount Alexander Road Ascot Vale Vic 3032
PH (03) 9377 0100 F (03) 9377 0199

GEELONG PO Box 8048, Newton Vic 3220
PH (03) 9377 0100 F (03) 9377 0199

ABN 65 685 233 760

Plate 1. Growling Grass Frog *Litoria raniformis*

Plate 2. Growling Grass Frog *Litoria raniformis*

Salvage and Translocation

At least two zoologists will be on site during initial disturbance associated with each filing stage. The zoologists will guide all persons managing and undertaking these activities, and will salvage and translocate any individuals encountered. No persons other than the zoologists are to intervene with the salvage and translocation activities, unless specifically requested to do so by the zoologists.

What to do if you find a Growling Grass Frog

Should a Growling Grass Frog be encountered by persons on site other than the zoologists engaged to carry out the salvage and translocation, the following protocol applies:

1. The person encountering the frog will report it to the site supervisor, upon which a stop works will be initiated. The zoologist will be contacted immediately.
2. No one may attempt to capture the frog unless it is directly within harm's way. If possible, a photo of the frog will be taken and sent it to the zoologist via mobile phone messaging for identification.
3. If feasible, the zoologist will attend the site, and capture and relocate the frog, in accordance with all procedures and protocols outlined in the Salvage and Translocation Plan.
4. If this is not feasible, the site supervisor will use the emergency frog handling kit available at the quarry's site office, to capture the frog and place it in the container provided, until the zoologist can attend to assess the frog and relocate it.
5. The emergency frog handling kit will include:
    - At least 3 plastic holding containers, 20 x20 centimetres in size, sealable but with adequate aeration (i.e. several holes in the lid of the container to provide some air flow);
    - A box of disposal latex gloves;
    - A laminated fact sheet of how to handle and store the frog.

Contacts at Ecology and Heritage Partners Pty Ltd for this project are: Chad Browning, Consultant Zoologist, 03 9377 0100 or 0488 496 111 or Aaron Organ, Director, 03 9940 1411 or 0425 873 159

Attachment B - Frog Handling Kit Fact Sheet

Emergency Growling Grass Frog (GGF) Handling Kit and Instructions

Growling Grass Frogs are only to be captured and placed in to the container provided if it is in harm's way and/or if the project zoologist has instructed you to do so.

Step 1 Is it a GGF?

Is it a bright emerald to dull green frog, with brown to gold blotches and a warty back?

Is it between 55 – 100 mm?

Does it look something like this?

Step 2 Call the project zoologist

Ecology and Heritage Partners Pty Ltd 03 9377 0100; Chad Browning 0488 496 111 or Aaron Organ, 0425 873 159

Step 3 Capture the GGF

Put on a new pair of disposal gloves.

Take the plastic holding container provided with you.

Capture the frog and immediately place it in the holding container.

Place the lid on the holding container, if possible, place a small amount of plant material from where you captured the frog into the container.

Step 4 Store the GGF

Place the container with the frog in a cool, dark environment, completely out of harm, until the zoologist arrives.

Do not store the frog for any greater than 2 hours.

Step 5 Dispose equipment

Dispose of the gloves and the plastic holding container used.

Ensure that there are enough provisions for another event.

Inventory of the Handling Kit

At least 3 plastic holding containers, 20x20 centimetres in size, sealable but with adequate aeration (i.e. several holes in the lid of the container to provide some air flow).

A box of disposal latex gloves.

This laminated fact sheet of how to handle and store the frog.

ATTACHMENT C - WETLAND VEGETATION SPECIES

Table C1: Species List of Recommended Plants for Revegetation

Botanical Name	Common Name
Fringing and emergent	
Calystegia sepium	Large Bindweed
Carex appressa	Tall Sedge
Carex fascicularis	Tassel Sedge
Carex gaudichaudiana	Fen Sedge
Crassula helmsii	Swamp Crassula
Epilobium billardierianum	Smooth Willow-herb
Glyceria australis	Australian Sweet-grass
Lachnagrostis filiformis	Common Blown-grass
Lycopus australis	Australian Gypsywort
Melaleuca ericifolia	Swamp Paperbark
Poa labillardierei var. *labillardierei*	Common Tussock-grass
* *Potamogeton ochreatus*	Blunt Pondweed
Ranunculus amphitrichus	Running Marsh Flower
Emergent	
Alisma plantago-aquatica	Water Plantain
Amphibromus fluitans	River Swamp Wallaby-grass
Baumea articulata	Jointed Twig-sedge
Cladium procerum	Leafy Twig-sedge
* *Eleocharis acuta*	Common Spike-sedge
Juncus amabilis	Hollow-rush
Juncus gregiflorus	Green Rush
Juncus procerus	Tall Rush
Juncus sarophorus	Broom Rush
Persicaria decipiens	Slender Knotweed
Persicaria praetermissa	Spotted Knotweed
Persicaria subsessilis	Hairy Knotweed
Ranunculus inundatus	River Buttercup
Schoenoplectus tabernaemontani	River Club-sedge
Submergent	
Ceratophyllum demersum	Hornwort
Myriophyllum caput-medusae	Coarse Water-milfoil
Myriophyllum crispatum	Upright Water-milfoil

Botanical Name	Common Name
Myriophyllum simulans	Amphibious Water-milfoil
Potamogeton crispus	Curly Pondweed
Floating Submergent	
Carex gaudichaudiana	Fen Sedge
Hydrocotyle sibthorpioides	Shining Pennywort
Lythrum salicaria	Small Loosestrife
Neopaxia australasica	White Purslane
* *Ottelia ovalifolia*	Swamp Lily
Potamogeton ochtreatus	Blunt Pondweed
Potamogeton pectinatus	Fennel Pondweed
Rumex bidens	Mud Dock
* *Triglochin procerum*	Water Ribbon (emergent form)
* *Vallisneria americana*	Ribbon-weed
Villarsia reniformis	Running Marsh Flower

* Indicates highly desirable vegetation for Growling Grass Frog

Limit use of this species, as it may become invasive

ATTACHMENT D - BEST PRACTICE GUIDELINES FOR THE MANAGEMENT OF CHYTRID FUNGUS (MURRAY *ET.AL*. 2011)

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

JCU JAMES COOK UNIVERSITY

A REPORT FOR THE AUSTRALIAN GOVERNMENT DEPARTMENT OF SUSTAINABILITY, ENVIRONMENT, WATER, POPULATION AND COMMUNITIES

Hygiene protocols for the control of diseases in Australian frogs

June 2011

Prepared by:

[1]Kris Murray, [1]Lee Skerratt, [2]Gerry Marantelli, [1]Lee Berger, [3]David Hunter, [4]Michael Mahony and [5]Harry Hines

Author Affiliations

[1] School of Public Health, Tropical Medicine and Rehabilitation Sciences, James Cook University, Queensland
[2] Amphibian Research Centre, PO Box 1365 Pearcedale, Victoria 3912
[3] Environment Protection and Regulation, New South Wales Office of Environment and Heritage
[4] School of Environmental and Life Sciences, The University of Newcastle, NSW
[5] Ecological Assessment Unit, Conservation Management Branch, Queensland Parks and Wildlife Service

The authors gratefully acknowledge:

Chris Banks, Dr John Clulow, Dr Graeme Gillespie, Professor Rick Speare and Russel Traher,for their contributions to components of the original project resulting in the production of this final report.

Cover photo: *Taudactylus eungellensis* – Eungella day frog. K. Murray

© Commonwealth of Australia (2011).

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government or the Minister for Sustainability, Environment, Water, Population and Communities. While reasonable efforts have been made to ensure that the contents of this publication are factually correct, the Commonwealth does not accept responsibility for the accuracy or completeness of the contents, and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication.

This work is copyright. You may download, display, print and reproduce this material in unaltered form only (retaining this notice) for your personal, non-commercial use or use within your organisation. Apart from any use as permitted under the Copyright Act 1968, all other rights are reserved. Requests and enquiries concerning reproduction and rights should be addressed to Department of Sustainability, Environment, Water, Populations and Communities, Public Affairs, GPO Box 787 Canberra ACT 2601 or email public.affairs@environment.gov.au.

Funding for this project (Procurement Reference Number: 1011-1151) was provided by the Australian Government Department for Sustainability, Environment, Water, Population and Communities. This project progresses the implementation of the *Threat abatement plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis* (Commonwealth of Australia, 2006).

This report should be cited as:

> Murray, K., Skerratt, L., Marantelli, G., Berger, L., Hunter, D., Mahony, M. and Hines, H. 2011. Hygiene protocols for the control of diseases in Australian frogs. A report for the Australian Government Department of Sustainability, Environment, Water, Population and Communities.

Table of Contents

Hygiene protocols for the control of diseases in Australian frogs

1. Who should use this document?

- This protocol is intended for use nationally by conservation agencies, zoos, scientific research staff, industry organisations (e.g., the pet industry), wildlife consultants, fauna surveyors, students, frog keepers, wildlife rescue and carer groups, frog interest groups/societies and other key interest groups who regularly deal with or are likely to encounter frogs.

- This protocol outlines the expectations of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) regarding precautionary procedures to be employed when working with frogs in Australia. The protocols were developed in collaboration with recognised experts in the fields of wildlife health, husbandry, research and conservation. The intention is to promote implementation of hygiene procedures by all individuals working with Australian amphibians.

- DSEWPaC recognises that some variation from the protocol may be appropriate for particular research and frog handling activities. Such variation should accompany any licence applications or renewals submitted to the relevant regulatory bodies for independent consideration. Variations should follow a risk analysis process which broadly involves hazard identification, risk assessment, risk management and risk communication.

Where *ex-situ* activities are proposed, these guidelines should be used in conjunction with the "**Guidelines for captive breeding, raising and restocking programs for Australian frogs**", which can be found here: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11**.**

2. Objectives

The objectives of the hygiene protocols are to:

- Improve the control of diseases in Australian frogs
- **Improve preparedness for an emergency response** to new amphibian disease incursions in Australia
- **Recommend best-practice procedures** for personnel, researchers, consultants and other frog enthusiasts or individuals who handle frogs
- **Suggest workable strategies** for those regularly working or considering working in the field with frogs or where frogs may exist
- **Provide background information** and guidance to people who provide advice or supervise frog related activities
- **Inform regulatory bodies and animal care and ethics committees** for their consideration when granting permit approvals

3. Introduction

Amphibians have declined globally. In the first global amphibian assessment, at least 43% of amphibian species with sufficient data were found to have declined in recent decades, 34 species were extinct and a further 88 were possibly extinct (Stuart et al. 2004). In 2010, approximately 30% of amphibians were threatened globally (http://www.iucnredlist.org/documents/summarystatistics/2010_4RL_Stats_Table_1.pdf).

Diseases are responsible for many amphibian declines and extinctions and their risk needs to be addressed. Laurance et al. (1996) first proposed the 'epidemic disease hypothesis' to account for Australian amphibian declines. Shortly after, an unknown chytridiomycete fungus was seen infecting the skin of sick and dying frogs collected from montane rain-forests in Queensland and Panama during mass mortality events associated with significant population declines (Berger et al. 1998; Longcore et al. 1999). The fungus was subsequently found to be highly pathogenic to amphibians in laboratory trials by inducing development of skin pathology, morbidity and mortality similar to that seen in the wild frogs. The disease was called chytridiomycosis and the fungus described as a new species *Batrachochytrium dendrobatidis* (Bd), also known as the amphibian chytrid fungus.

Bd has been found infecting over 350 species in two amphibian orders (Anura and Caudata) from all continents where amphibians occur (http://www.bd-maps.net/). Sixty-three (~28%) of Australia's 223 (as listed by IUCN 2008) amphibian species are now known to be wild hosts for Bd (Murray et al. 2010a; Murray et al. 2010b), and over half of Australia's species may be naturally susceptible to Bd in the wild (Murray et al. 2011; Murray and Skerratt in press).

While the discovery of chytridiomycosis has sparked renewed appreciation for the role that diseases can play in threatening wildlife populations and species, it is not the only disease currently affecting amphibians, nor is it likely to be the last. Ranavirus, for example, has been observed to induce mass mortality events in frog and salamander populations in the UK and North America. In response to these global threats, the World Organisation for Animal Health (OIE) has listed both chytridiomycosis and ranavirus as "notifiable" diseases to help control their spread. Similarly, numerous conferences and reports have been assembled to produce standards in managing diseases in wild and captive amphibian populations. Together, these measures highlight the importance of developing **agreed hygiene protocols for the control of diseases in Australian frogs**. This document fulfils this role.

4. Key disease issues in amphibian populations

Here we review the most significant diseases of amphibians, including some that have zoonotic potential and some that have not been detected in Australia. There are many described diseases of amphibians but only a few are known to be an important threat to wild amphibians or other taxa including humans. Some become an issue in captive amphibian populations where management is inadequate. As research on this topic is limited, there are also likely to be many unknown diseases of amphibians which may pose a risk. Disinfection methods have not been validated for all pathogens. Any risk management strategy to minimise the impact of diseases of amphibians should take into account this uncertainty. For detailed reviews see Hemingway et al. (2009) and Berger et al (2009) for diseases in wild populations and Wright and Whitaker (2001) that also includes diseases in captivity.

4.1. Fungi

4.1.1. *Batrachochytrium dendrobatidis*

Batrachochytrium dendrobatidis (Bd) is a fungal pathogen capable of driving amphibian species to perilously low numbers or extinction. In Australia, the oldest record of Bd is from a museum frog specimen collected in south-east Queensland near Brisbane in 1978 (Department of the Environment and Heritage 2006a), which coincides with sudden frog declines in a number of species and two species extinctions in the region (Berger et al. 1998; Hines et al. 1999). Subsequent amphibian declines in central coastal Queensland (1985-86) and the Wet Tropics (1990-95) suggest that *B. dendrobatidis* spread north to its current northern limit at Big Tableland near Cooktown (Laurance et al. 1996; Berger et al. 1999; Skerratt et al. 2010). In southern Australia, the spread of *B. dendrobatidis* is poorly documented but its distribution extends down the entire east coast to Tasmania (first detected in 2004) (Obendorf and Dalton 2006; Pauza and Driessen 2008). Two separate foci occur in other states, one in southwest Western Australia, where the earliest record dates to 1985, and another around Adelaide in South Australia (earliest record 1995) (Murray et al. 2010a). The Northern Territory is currently considered amphibian chytrid free (Skerratt et al. 2008; Skerratt et al. 2010; Murray et al. 2011).

In the majority of infected animals for most of the time, clinical signs of chytridiomycosis are absent. The period of showing signs is typically short and mostly limited to those amphibians that die. Central nervous system signs predominate, including behavioural change, slow and uncoordinated movement, abnormal sitting posture, tetanic spasms, loss of righting reflex and paralysis. Skin changes associated with chytridiomycosis are typically microscopic and not detectable at the clinical level with any degree of confidence, although abnormal skin shedding occurs (skin shed more frequently and in smaller amounts) and erythema (tissue reddening) of ventral surfaces and digits may be seen. For what to do if you encounter a sick or dead amphibian in Australia, see section 6.7. below. For a detailed factsheet about chytridiomycosis, see the Australian Wildlife Health Network website (http://www.wildlifehealth.org.au/AWHN/FactSheets/Fact_All.aspx).

4.1.2. *Mucor amphiborium*

This fungus is an important cause of morbidity and mortality in platypus in Tasmania and amphibians are a potential reservoir host (Gust et al. 2009). Amphibian mucormycosis is a systemic disease caused by the fungus, *Mucor amphibiorum*. Severely infected amphibians have fungi disseminated through their internal organs and skin. The fungi incite formation of granulomas that consist of inflammatory cells and fibrous tissue. At postmortem, the liver contains small pale nodules up to about 5 mm in diameter and usually in massive numbers. These nodules can also be seen in other organs such as the kidney, lung, mesentery, urinary bladder, subcutaneous sinuses and skin. The microscopic fungi are found inside these nodules. *M. amphibiorum* is a primary pathogen and can infect normal amphibians, but in the wild it appears to cause only sporadic infections. Possibly the usual inoculating dose in the wild is not high enough to cause epidemic disease. In captivity it can cause fatal outbreaks in collections. For more information on mucormycosis, see http://www.jcu.edu.au/school/phtm/PHTM/frogs/mucor/mucoramphibiorum.htm.

4.1.3. Oomycetes

Water moulds (family Saprolegniaceae, phylum Oomycota) are ubiquitous in surface water. High levels of infection with *Saprolegnia ferax* caused mortality of Western toad (*Bufo boreas*) egg masses in northwestern United States and were sufficient to affect local populations (Kiesecker et al. 2001). Epidemics may be associated with fish stocking or environmental cofactors.

4.2. Viruses

There are a number of viruses that are known to cause disease and mortality in amphibians, including ranaviruses, frog erythrocytic virus, Lucké tumor herpesvirus, herpes-like virus of skin, calicivirus and leucocyte viruses (Hemingway et al. 2009). In Europe and America the most important of these for their ability to cause mass mortalities and potentially population declines are the ranaviruses (Hyatt et al. 2000). Ranaviruses have been identified in a range of ectothermic vertebrates, including fish, amphibians (frogs, toads, salamanders) and reptiles (lizards, turtles, snakes). Some species can infect a broad host range across all these taxa.

Ranaviral disease is an emerging infectious disease overseas as it is being detected over an increasing geographic range and in more species (Hemingway et al. 2009). While ranaviral disease in wild amphibians has not been frequently observed in Australia, antibodies to ranaviruses have been detected widely (NSW, Qld, NT) in cane toads (*Bufo marinus*) (Zupanovic et al. 1998). Bohle iridoviris (BIV) was first found causing death in wild caught metamorphs of *Limnodynastes ornatus* and has since been detected in wild, moribund adult *Litoria caerulea* from Townsville and captive juvenile *Pseudophryne coriacea* from Sydney (Speare et al. 2001; Cullen and Owens 2002). Laboratory studies in Australia have also shown that cane toads (*Bufo marinus*) and a range of native frogs are susceptible to BIV (Speare et al. 2001). Tadpoles appear the most susceptible, while juvenile frogs were more susceptible than adults. Data on the geographical origin and time of emergence or introduction of ranaviruses in Australia is not known. Ranaviruses not currently found in Australia can cause disease in native Australian amphibians in experimental challenges; for example, Venezuelan Guatopo virus was able to kill *Litoria caerulea* in experimental trials (http://www.jcu.edu.au/school/phtm/PHTM/frogs/otherdiseases-viruses.htm). We need to prevent the introduction of pathogenic ranaviruses into Australia.

Clinical signs of acute ranaviral disease may be seen in tadpoles, metamorphs, juveniles and adults. In general, amphibians infected with ranavirus may show decreased activity, ascites (accumulation of fluid in the peritoneal cavity), anasarca (accumulation of serous fluid in various tissues and cavities of the body), skin ulceration, focal and systemic haemorrhages and death. For what to do if you encounter a sick or dead amphibian in Australia, see section 6.7. below. For a detailed factsheet about ranaviral disease, see the Australian Wildlife Health Network website (http://www.wildlifehealth.org.au/AWHN/FactSheets/Fact_All.aspx).

4.3. Bacteria

The range of bacteria reported as causing disease in amphibians is small. Bacterial septicaemia can cause significant disease in captivity. Infection with Aeromonas spp., non-haemolytic group B Streptococcus, Flavobacteria and chlamydia have caused outbreaks in captive amphibians and Mycobacteria can cause chronic problems. Another group of bacteria can be carried by amphibians with minimal effect and are potentially capable of causing

infections in humans (zoonotic diseases). Salmonella and Leptospira are in this category and are a potential risk to humans, livestock and domestic pets, see below.

4.4. Myxozoa

Myxosporean parasites (*Myxidium* spp.) in the brain and liver of declining Australian frogs, the Green and Golden Bell frog (*Litoria aurea*) and the Southern Bell frog (*Litoria raniformis*), have recently been reported to be associated with disease and may have a significant impact on wild frogs (Hartigan et al. 2011).

4.5. Mesomycetozoa

Ichthyophonus sp. occurs the USA where it is often an incidental finding in tadpoles, frogs and salamanders but may cause morbidity and mortality. It infects muscles and adult frogs with massive infections become lethargic and emaciated. Massive acute lethal infections with numerous mortalities occur infrequently in ranid larvae (D. Green, unpubl., Mikaelian et al. 2000)

4.6. Alveolates

A *Perkinsus*-like organism is a major cause of mortality events in tadpoles in the US. Occurs predominantly in tadpoles of *Rana* spp. and may cause mortality rates of 80-99% in a pond over the course of 2-6 weeks (Davis et al. 2007). Weakly swimming, bloated and floating tadpoles are found.

4.7. Zoonotic Diseases

Guidelines for preventing human exposure to amphibian disease are available at the Centre for Disease Control website- http://www.cdc.gov/healthypets/animals/reptiles.htm

4.7.1. *Salmonella*

Amphibians may carry pathogenic *Salmonella* species, but rarely show signs of disease (Anver and Pond 1984). Prevalence of salmonellas isolated in clinically normal amphibians is generally greater than 10% and bacterial levels can be high (Sharma et al. 1974). In Australia, *Salmonella* were isolated from 12.7% (19/150) of *B. marinus* collected from the wild and 9 serotypes were identified. All nine had previously been isolated in Australia from humans and livestock (O'Shea et al. 1990). An outbreak of gastroenteritis in humans near Rockhampton possibly originated from green tree frogs (*Litoria caerulea*) contaminating drinking water in rainwater tanks (Taylor et al. 2000). Some strains of salmonellae are cosmopolitan while others are not found in Australia, but could be imported.

4.7.2. *Leptospira*

Leptospira are spirochaetal bacteria that usually invade the kidney of vertebrates and are excreted in the urine. Humans and domestic animals are susceptible to various strains of *Leptospira* usually from the species *Leptospira interrogans*. Serious acute and chronic disease occasionally with death can result. Little is known about the occurrence of *Leptospira* in amphibians, and on their significance as reservoir hosts for leptospirosis in humans. No studies appear to have been done on leptospires in amphibians in Australia. However in

Barbados, toads (*Bufo marinus*) and frogs (*Eleutherodactylus johnstonei*) were found to be reservoirs for serovars of *Leptospira* pathogenic to humans (Gravekamp 1991).

4.7.3. *Spirometra erinacei*

The adult stage of the tape worm *Spirometra erinacei* inhabits the small intestine of carnivores such as the cat, dog, fox and dingo. The first larval stage occurs in copepods and the second larval stage (spargana) are long, flat white worms that can infect amphibians and other vertebrates in muscles and under the skin. Sparganosis occurs in around 5% of Australian frogs and heavy burdens are associated with severe disease (Berger et al. 2009). Sparganosis is a public health problem in Asia, usually occurring as subcutaneous or intramuscular infections. Humans become infected by drinking water with infected copepods, eating undercooked frogs, and the worms can also migrate from frog flesh into skin wounds

5. National and border biosecurity

Unregulated trade in animals, as well as unintentional shipment, is suspected to have been a major contributor to the spread of emerging infectious diseases such as chytridiomycosis (Skerratt et al. 2007). There are numerous bodies and regulatory levels that attempt to provide guidance about how to minimise the risk of pathogen spread and transmission in amphibians.

5.1. World Organisation for Animal Health (OIE)

The World Organisation for Animal Health (OIE) lists key diseases as "notifiable" to promote the reporting and management of diseases among member countries. Preventing the spread of amphibian diseases across international borders is important, and both chytridiomycosis (Article 8.1.1) and ranavirus (Article 8.2.1:) are now listed as notifiable diseases in the OIE Aquatic Animal Health Code (http://web.oie.int/eng/normes/fcode/). To access these codes, follow these links:

- **Chytridiomycosis**: http://web.oie.int/eng/normes/fcode/en_chapitre_1.8.1.pdf
- **Ranavirus**: http://web.oie.int/eng/normes/fcode/en_chapitre_1.8.2.pdf

The codes outline recommendations for the "**Importation or transit of *aquatic animals and aquatic animal products* for any purpose from a country, zone or compartment"**:

- **Provided commodities are treated in a manner that inactivates the disease agent (Bd or ranaviruses),** Competent Authorities should not require any disease conditions when authorising the above activities, regardless of the disease status of the exporting country
- However, in cases where it could otherwise reasonably be expected that commodities pose a risk of Bd or ranavirus transmission, a risk assessment should be carried out in accordance with the recommendations in the Aquatic Code. The exporting country would then be notified of the outcome of the risk assessment before trade commences.

.

Where commodities do not meet this condition and/or a reasonable risk remains, there are additional requirements that depend on the disease status of the country, zone or compartment.

Freedom from disease:

Importation of live aquatic animals from a country, zone or compartment declared free from disease (Bd or ranavirus) requires an **international aquatic animal health certificate** issued by the Competent Authority confirming disease free status.

- A country may make a **self declaration of freedom from disease** (Bd or ranaviruses) if one of the following conditions is met:

    1. It has no amphibians or other susceptible species AND basic biosecurity conditions have been continuously met for a period of 2 years
    2. There has been no observed occurrence of the disease for at least the past 10 years despite conditions that are conducive to its clinical expression AND basic biosecurity conditions have been continuously met for a period of 10 years
    3. Targeted surveillance has been in place for at least the past 2 years without detection of disease (Bd or ranaviruses) AND basic biosecurity conditions have been continuously met for a period of 2 years
    4. For a country that previously made a self declaration of freedom from disease, it may regain that status after detection of the disease if the affected area was declared an infected zone and a protection zone was established AND infected populations have been destroyed or removed from the infected zone by means that minimise the risk of further spread of the disease AND the appropriate disinfection procedures have been completed AND if the conditions of 3.) above are met.

- A zone or compartment may also be declared free from disease by the Competent Authority if it meets similar conditions to the above. Where a zone or compartment extends over more than one country, declarations must be made by all the Competent Authorities involved.

- A disease free status can be maintained if basic biosecurity conditions are continuously maintained. Targeted surveillance may be discontinued provided conditions that are conducive to clinical expression of disease exist. However, in infected countries and in all other cases where conditions are not conducive to clinical expression of disease, zones or compartments can only maintain a disease free status if targeted surveillance is maintained.

Unknown or known infected country, zone or compartment:

For the importation of live aquatic animals and aquatic animal products for any purpose (e.g., aquaculture, processing for human consumption, use in animal feed, agricultural, laboratory, zoo, pet trade, industrial or pharmaceutical use):

In general, the Competent Authority of the importing country should

- require an **international aquatic animal health certificate** stating the commodities have been appropriately treated to inactivate disease agents
- OR undertake a risk assessment and apply appropriate risk mitigation measures

The risk assessment and risk mitigation measures will vary with purpose of the importation or transit of commodities. Please see the Aquatic Code at the links provided above for more details.

5.2. AUSVETPLAN and AQUAVETPLAN

In Australia, management of animal disease emergencies normally defaults to protocols outlined in the Australian Veterinary Emergency Plan (AUSVETPLAN - http://www.animalhealthaustralia.com.au/programs/eadp/ausvetplan/ausvetplan_home.cfm) or the Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN - http://www.daff.gov.au/animal-plant-health/aquatic/aquavetplan). However, few of the diseases for which specific plans have been developed concern diseases of free-ranging wildlife. No amphibian diseases are currently included in AUSVETPLAN or AQUAVETPLAN.

5.3. Key Threatening Process and Threat Abatement Plan (TAP)

Chytridiomycosis was listed as a Key Threatening Process in Australia in 2002. A Threat Abatement Plan (TAP) for infection of amphibians with chytrid fungus resulting in chytridiomycosis was subsequently prepared by representatives of the Commonwealth Government. These documents can be accessed here:

- **Key Threatening Process:** http://www.environment.gov.au/biodiversity/threatened/ktp/frog-fungus.html
- **TAP:** http://www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid.html
- **TAP Background document:** http://www.environment.gov.au/biodiversity/threatened/publications/tap/pubs/chytrid-background.pdf

Recommendation 1.1.3 of the TAP proposes that a risk-based approach be used for chytridiomycosis using AUSVETPLAN as a model (Department of the Environment and Heritage 2006b). However, this has not progressed. Nation-wide mapping protocols and disease risk models have been developed as suggested in the TAP and should serve as the basis for cost-sharing arrangements between states and for setting research and management priorities (Skerratt et al. 2008; Murray et al. 2010a; Murray et al. 2010b; Skerratt et al. 2010; Murray et al. 2011). Implementing this step remains a priority.

5.4. Biosecurity Australia

Risk analysis performed by Biosecurity Australia in **"Quarantine requirements for the importation of amphibians or their eggs into zoological facilities"** and **"Quarantine requirements for the importation of amphibians or their eggs for laboratory purposes"** (Animal Biosecurity Policy Memorandum 2003/26) does not list chytridiomycosis as a risk since it is endemic in Australia. However, this disregards the risk of importation into chytrid free areas or the introduction of novel strains. Although chytridiomycosis is not specifically mentioned, the general hygiene strategies recommended should still prevent the release of imported strains of *B. dendrobatidis* during the initial two years. After two years the amphibians can be released without testing for *B. dendrobatidis*. However, if being released into a chytrid free area, the same requirements imposed on Australian bred amphibians under the Threat Abatement Plan would apply.

Risk analysis performed by Biosecurity Australia in **"Quarantine requirements for the importation of amphibians or their eggs into zoological facilities"** and **"Quarantine requirements for the importation of amphibians or their eggs for laboratory purposes"** (Animal Biosecurity Policy Memorandum 2003/26) mentions ranaviruses:

- "The veterinary certificate must… certify that… for both live amphibians or amphibian eggs…, as far as can be determined, no case of ranavirus infection (including frog virus 3, Redwood Park virus, Regina ranavirus), or ranid herpesviruses has been diagnosed at the premises of origin during the 12 months prior to certification."

Importation of amphibians must meet the requirements of two Commonwealth departments, 1) Department of Agriculture, Fisheries and Forestry (DAFF) and 2) the DSEWPaC. The relevant documents can be accessed here:

- **DAFF:**
  Zoological facilities - http://www.jcu.edu.au/school/phtm/PHTM/frogs/aqis/2003-26a.pdf
  Laboratory purposes - http://www.jcu.edu.au/school/phtm/PHTM/frogs/aqis/2003-26b.pdf
- **DSEWPaC:** http://www.environment.gov.au/biodiversity/wildlife-trade/index.html. This site also has the requirements for export of amphibians from Australia.

6. Hygiene management

Hygiene management issues can be broadly classed into *in-situ* (field based) and *ex-situ* (facility based) categories. While general **isolation and disinfection** hygiene management principles apply to both, greater detail on '**Guidelines for captive breeding, raising and restocking programs for Australian frogs'** can be found here: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11.

6.1. In-situ (site) hygiene management

Individuals studying frogs often travel and collect samples of frogs from multiple sites. Numerous hygiene guidelines for handling wild frogs exist, including Daszak et al. (2001), NSW NPWS (2008), NWHC (2001), Speare et al. (2004) and CCADC (2008). Most recently, Phillott et al. (2010) provide a detailed review and synthesis of hygiene considerations that aim to minimise the risk of exposure of amphibians to pathogens in field studies.

It is important to recognise that humans may aid in the:

- **transmission** (passing of disease from an infected to an uninfected individual), and
- **spread** (movement of disease geographically)

of diseases, within and among amphibian populations For researchers working with amphibians or within areas where amphibians may occur, the risk of disease transmission within these habitats and the spread of disease among populations may be increased due to:

- **movement** of frogs or personnel between isolated areas of habitat or between captive husbandry and laboratory facilities and the field
- **handling** of amphibians

It is therefore essential that personnel working with amphibians or within amphibian habitats take care to minimise disease transmission and spread. In order to do this, it is important that frog workers recognise the boundaries between sites/populations.

This is especially important where **rare, geographically restricted or threatened amphibian species** are concerned and when the spread of diseases can have serious consequences for species survival.

Phillott et al. (2010) recommend that field researchers evaluate their activities to determine the relative risk of pathogen transmission and spread compared with background levels (i.e., the risk posed by other mechanisms of disease transmission or pathogen dispersal) and implement appropriate strategies to minimise this risk during field studies. For a **hygiene protocol checklist and suggested field kit** see section 7. The risk of transmission and spread should also be evaluated by researchers, animal ethics committees and government agencies issuing permits.

6.1.1. Defining a site

Defining the boundary of a site may not be straightforward. In some places, the boundary between sites will be obvious but in others it may not. Undertaking work at a number of sites or conducting routine monitoring at a series of sites within walking distance creates obvious difficulties with boundary definitions. It is likely that defining the boundary between sites will differ among localities.

In general:

- watershed and geographical barriers should be used to designate separate sites
- river/stream tributaries should be considered separate sites
- wetlands, ponds, lakes etc. separated by dry land should be considered separate sites
- upstream locations separated by considerable distance (e.g., 500 m) should be considered separate sites
- any obvious break, barrier or change in habitats should be treated as separate sites, particularly if there is no known interchange of frogs between sites

6.1.2. Determining the order of visitation of multiple field sites

When a field trip encompasses several field sites, or a number of locations are being visited in succession, the order of visitation should be determined according to the presence of known pathogens and diseases.

- **Areas known to be absent of disease should be visited first, followed by areas of unknown status, followed by known infected areas**

6.1.3. On-site hygiene

When travelling from site to site it is recommended that the following hygiene precautions be taken to minimise the possibility of transfer of disease from personnel, footwear, equipment and/or vehicles. A list of suitable disinfectants, their required concentrations and exposure times for various purposes is summarised by Phillott et al. (2010) and is reproduced in Table 1 below.

Personnel

- **Hands, arms, knees etc. should be cleaned to remove debris and washed** or wiped with a suitable disinfectant. It is preferable to do this before entering the vehicle or moving to another site.

Footwear and clothing

- **Footwear must be thoroughly cleaned and disinfected** at the commencement of fieldwork and between each sampling site. This can be achieved by initially scraping boots clear of mud and standing the soles in a disinfecting solution. The remainder of the boot should be rinsed or sprayed with a disinfecting solution. Clothing that has significant contact with frogs and the environment should also be subjected to changing or cleaning

Disinfecting solutions should be prevented from entering any water bodies. Several changes of footwear/clothing bagged between sites might be a practical alternative to on-site cleaning. In high value sites, dedicated equipment and clothing stored at the entry to the site may be desirable. (e.g., in a lockbox)

Equipment

- Equipment such as nets, balances, callipers, bags, scalpels, headlamps, torches, wetsuits and waders etc. that are used at one site must be **cleaned and disinfected** before re-use at another site
- Disposable items should be used where practical/possible

Non-disposable equipment should be used only once during a particular field exercise and disinfected later or disinfected at the site between uses using procedures outlined below in Table 1.

Vehicles

Transmission of disease from vehicles is generally unlikely to be a problem. However, if a vehicle is used to traverse a known frog site and could result in mud and water being transferred to other bodies of water or frog sites, then wheels and tyres should be cleaned and disinfected. This is particularly important where vehicles are used in areas not normally frequented by other vehicles. Disinfection should be carried out at a safe distance from water bodies to minimise the risk of chemical contamination.

6.1.4. Principles of cleaning and disinfection

Designing an effective disinfection protocol requires understanding of the properties of disinfectants and target pathogens, and practical consideration of the equipment or processes requiring disinfection. As well as understanding the efficacy of various disinfecting processes, it is important to consider the safety of any disinfection protocol to the environment and the animals on which they will be used. Key distinctions include:

- **Cleaning**: The physical removal of all visible organic and inorganic debris from items
- **Disinfection:** A physical (e.g., UV light) or chemical (e.g., bleach) process to reduce the numbers and/or viability of microorganisms (e.g., bacteria, fungi or viruses) on an object, surface or material
- **Sterilization:** A physical or chemical process that removes all microorganisms from an object, surface or material

Thorough cleaning and disinfection reduces most of the risk of transferring amphibian pathogens. Sterilization of objects is labour intensive and less practical for most routine applications.

Cleaning alone does not render an object free of pathogens. However, it is important to thoroughly clean objects prior to disinfection or sterilization.

- Thorough cleaning physically removes many or most pathogens that are trapped in organic debris
- Thorough cleaning makes successful disinfection more likely
- Cleaning allows disinfectants to directly contact the surfaces of an object
- Warm or hot water improves the ability to remove organic materials from objects
- Regular cleaning of all items used should be performed
- Use of detergents aid cleaning by loosening organic material from the surface of objects and help to break apart biofilms of microorganisms that can resist disinfection
- Thorough rinsing of detergents from objects is essential after cleaning

Disinfection of an item by application of an appropriate chemical agent after cleaning reduces pathogen numbers and viability and minimises potential for disease transmission. Things to consider include:

- **Efficacy of the disinfectant and the type of pathogens that must be eliminated.** For example, some microorganisms such as Mycobacterium spp. or Cryptosporidium spp. are very resistant to most common disinfectants
- **The potential for toxicity to amphibians that are exposed to the disinfectant.** Amphibians are very sensitive to some disinfectant residues and thorough rinsing of all disinfectants is required after use
- **Concerns about human exposure to disinfectants and about discharge of disinfectants into the environment**
- **Safety for use on different materials.** Some disinfectants may be corrosive to materials or tools used in amphibian facilities
- **Ease of use and disposal**
- **Cost**

Table 1. Disinfection strategies suitable for killing *Batrachochytrium dendrobatidis, Mucor amphibiorum* and ranaviruses in field studies. From Phillott et al. (2010) and Webb et al. (submitted).

Application	Disinfectant	Strength	Time	Target pathogen
Surgical equipment and other instruments (e.g. scales, callipers)	Benzalkonium chloride	1 mg ml–1	1 min	*B. dendrobatidis*
	Ethanol	70%	1 min	*B. dendrobatidis* Ranaviruses
Collection equipment and containers	Sodium hypochlorite (bleach contains 4% sodium hypochlorite)	1%	1 min	*B. dendrobatidis*
		3%	1 min	Ranaviruses
	Path X or quaternary ammonium compound 128	1 in 500 dilution	0.5 min	*B. dendrobatidis*
		1 in 100 dilution	10 min	*M. amphibiorum*
	Trigene	1 in 5000 dilution	1 min	*B. dendrobatidis*
	F10	1 in 1500 dilution	1 min	*B. dendrobatidis*
	Virkon	2 mg ml–1	1 min	*B. dendrobatidis*
		1%	1 min	Ranaviruses
	Nolvasan	0.75%	1 min	Ranaviruses
	Potassium permanganate	1%	10 min	*B. dendrobatidis*
	Complete drying		>3 h	*B. dendrobatidis*
	Heat 60°C		30 min	*B. dendrobatidis* Ranaviruses
	Heat 37°C		8 h	*B. dendrobatidis*
	Sterilising UV light		1 min	Ranaviruses only
Footwear	Sodium hypochlorite (bleach contains 4% sodium hypochlorite)	1%	1 min	*B. dendrobatidis*
		3%	1 min	Ranaviruses
	Path X or quaternary ammonium compound 128	1 in 500 dilution	0.5 min	*B. dendrobatidis*
		1 in 100 dilution	10 min	*M. amphibiorum*
	Trigene	1 in 5000 dilution	1 min	*B. dendrobatidis*
	F10	1 in 1500 dilution	1 min	*B. dendrobatidis*
	Phytoclean (30% benzalkonium chloride)	0.075%	1 min	*B. dendrobatidis*
		5%	1 min	*M. amphibiorum*
	Complete drying		>3 h	*B. dendrobatidis*
Cloth (e.g. carry bags, clothes)	Hot wash 60°C or greater		30 min	*B. dendrobatidis* Ranaviruses

6.2. Handling of frogs in the field

The spread of pathogens may occur as a result of handling frogs. In addition to spreading disease among captured frogs, handling may stress animals making them more susceptible to infection from other sources or more likely to succumb to infection.

- **Capture, handling and housing of wild amphibians should be minimised or avoided where possible**
- Where handling is necessary, care must be taken to ensure individuals do not have their exposure to pathogens elevated over their background exposure levels.

Direct transfer of pathogens during capture and handling of successive adult amphibians can be reduced by using:

- **single-use gloves** (latex, nitrile or vinyl), and/or
- **single-use lightweight plastic bags**
- **adequate cleaning of hands and handling equipment**

Many researchers use disposable plastic bags to catch and/or restrain frogs followed by handling/processing with disposable gloves. As some tadpoles may suffer lethal effects when exposed to latex, nitrile or vinyl gloves (Cashins et al. 2008), researchers should only use gloves that have been proven or rendered safe (e.g., by rinsing with water) for the study species.

In situations **where gloves are not available or suitable:**

- hand washing with 70% ethanol (allowing hands to dry) between handling individual frogs is acceptable (note, repeated use on human skin is not recommended). Alcohol is toxic to frogs so hands must be washed thoroughly in water after treatment with alcohol
    - If 70% ethanol is not available or suitable, the minimum treatment is hand-washing in the water to which the amphibian is normally exposed.

In situations **where amphibians must be held temporarily:**

- Individuals should be housed in **single-use containers (e.g. plastic bags) or in containers disinfected** between each animal
- Adults should not be held in groups
- Tadpoles from the same water body may be housed for short periods in a common container, although overcrowding should be avoided

Longer holding times (>60 min) will require changes to water and the provision of appropriate food (>24 h). Tadpoles should always be treated with care to prevent damage on capture and with movement of water within holding containers. If animals must be removed from the field for greater periods and later returned, it should always be to the same site.

6.3. Housing frogs and tadpoles

- **Frogs and tadpoles should only be removed from a site when absolutely necessary.**

Detailed **'**Guidelines for captive breeding, raising and restocking programs for Australian frogs' can be found at: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11. See also 'A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs**'** (Pessier and Mendelson 2010) at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf#search=%22amphibian%22

When frogs or tadpoles are to be collected and held for a period of time, the following measures are recommended:

- Isolate animals obtained at different sites
- Aquaria set up to hold frogs should not share water, equipment or any filtration system. Splashes of water from adjacent enclosures or drops of water on nets may transfer pathogens between enclosures
- Ensure that tanks, aquaria and any associated equipment are disinfected prior to housing frogs or tadpoles
- Tanks and equipment should be cleaned, disinfected and dried after frogs/tadpoles are removed

6.4. Marking, invasive and surgical procedures

Strict hygiene standards must be maintained during amphibian marking procedures including implanting internal radio transmitters, passive integrated transponder (PIT) tags, visible implant alphanumeric (VIA) tags, visible implant elastomer (VIE) tags and toe tipping or clipping.

Due to the high permeability of amphibian skin, special disinfectants are required.
The **only suitable, commercially available preparation for disinfecting wounds** is:

- **Bactine®** spray (active ingredient 0.14% w/w benzalkonium chloride and 2.6% w/w lidocaine hydrochloride in a non-alcohol base)
- **Chlorhexidine** (0.75% diluted from 2% Nolvasan®) is also suitable for surgical disinfection
- Alcohol, phenol and iodine based disinfectants **should not be used** because they are potentially toxic and can destroy mucus and wax that prevent dehydration and microbial infection of amphibian skin. Contrary to the recommendations of previous hygiene protocols, Betadine® or other povidone-iodine products are not recommended for use as disinfectants for amphibians until species-specific toxicity has been determined (Phillott et al. 2010).

Toe tipping (removal of most distal phalange) or toe clipping (amputation of a greater proportion of the digit):

- should occur through the **interphalangeal joints**

- Scissors should be **sterilised in 70% ethanol** and dried before use on frogs in the field
- For studies in which diagnostic testing of disease is important, the diagnostic test step (e.g., swabbing for Bd) should be undertaken before any other processing step to minimise the potential for false-positives due to cross contamination

PIT, VIE and VIA tags should be inserted with a **sterile, single-use applicator**.

6.4.1. Sealing wounds

- A c**ryanoacrylate** compound such as Vetbond® (active ingredient n-butyl cryanoacrylate) as a tissue adhesive after toe tipping or clipping is recommended. Vetbond® can also be used to seal incisions made during subdermal injection of VIA, VIE and PIT tags
- A disinfectant such as **Bactine**® should be applied before the adhesive to avoid trapping microbes
- Less expensive industrial adhesives ('superglues') should not be used as a replacement for surgical tissue glues

However, this procedure may only be possible in larger amphibians. In smaller animals, it can be difficult to isolate toes for application and internal marking devices such as PIT tags may be unsuitable. Moisture can interfere with setting times and adhesion so care must be taken to ensure setting has occurred before release. Problems may be experienced in their application to stream- or pond-dwelling amphibians, but can be avoided by using a small piece of sterile absorbent dressing to draw surplus water from the wound before application of the adhesive (Phillott et al. 2010).

6.4.2. Equipment

- Equipment used in marking or surgery should be appropriately **disinfected**
- Disposable sterile instruments should be used where practical/possible
- Instruments should be disinfected or changed in between each frog
- All used **disinfecting solutions, gloves and other disposable items should be stored in a sharps or other waste container and disposed of or sterilised appropriately** at the completion of fieldwork
- Disinfecting solutions must not come into contact with frogs or be permitted to contaminate any water bodies

6.5. Return of captive animals to the wild

- In general, if wild frogs or tadpoles are housed for any period of time in a captive situation (e.g. laboratory, zoo or captive breeding facility), **they should not be returned to the wild**

Exceptions to this can occur if they have been kept in isolation, their captive history is free of undiagnosed morbidity or mortality and they have had rigorous pathogen screening before release. This is usually beyond the means of most studies.

Detailed **'**Guidelines for captive breeding, raising and restocking programs for Australian frogs' can be found at:

http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11. See also 'A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs' (Pessier and Mendelson 2010) at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf#search=%22amphibian%22

6.6. Displaced frogs

- **Displaced frogs should be treated as if they are infected and should not be transported anywhere for release to the wild**

Displaced frogs are native frog species and introduced cane toads (*Bufo marinus*) that have been unintentionally transported from one place to another. This may typically occur with the transport of fresh produce and landscaping supplies. 'Banana Box' frog is the term used to describe several native frog species (usually *Litoria gracilenta, L. fallax, L. caerulea, L. rubella, L. infrafrenata* and *L. bicolor*) commonly transported in fruit and vegetable shipments and landscaping supplies. There is risk of spread of disease if these frogs are transferred from place to place.

When encountering a displaced frog:

- Contact a **licensed wildlife carer** organisation to collect the animal. The frog may then undergo a quarantine period along with an approved disinfection treatment
- Post-quarantine, and dependant on local state legislation and policies, the frog may be transferred to a **licensed frog keeper** once permission from the relevant regulatory body has been received. Licensed carer groups are to record and receipt frogs obtained and disposed of in this way.
- Frogs held by licensed frog keepers are **not to be released to the wild** except with relevant regulatory body approval

Displaced frogs may also be made available to recognised institutions for research projects, display purposes or offered to a museum as scientific specimens once approval has been provided by the relevant regulatory body.

- **Frogs encountered on roads, around dwellings and gardens or in swimming pools should not be considered as displaced frogs unless they are of a species not local to the area**

Local frogs encountered in these situations should be assisted off roads, away from dwellings, or out of swimming pools preferably to the nearest area of vegetation or suitable habitat.

6.6.1. Cane toads

Cane toads are known amphibian disease carriers and should not be knowingly transported or released to the wild.

If a cane toad is discovered it should be humanely euthanized in accordance with the recommended Animal Welfare procedures. Care should be taken to avoid euthanasia of native species due to mistaken identity.

6.7. Sick and dead animals

Dead amphibians or live animals showing clinical signs of disease must be regarded as having a high infection risk to healthy animals and rigorous hygiene measures are required.

- **Sick and dead frogs should be collected and sent for disease diagnosis**

No effective and practical field treatment for chytridiomycosis has been demonstrated. Similarly, no treatment regimes for ranaviral infection of frogs have been described. The collection of sick and dead frogs for expert diagnosis may improve disease surveillance activities, which can help detect disease introduction and enable emergency responses. It is also useful to assess the risk of pathogen transmission to other individuals or spread to other populations. A procedure for the preparation and transport of a sick or dead frog is given below. Adherence to this procedure will ensure the animal is maintained in a suitable condition for pathological examination and assist determining the extent of the disease and the number of species affected. For more information about sick and dead amphibians, see http://www.jcu.edu.au/school/phtm/PHTM/frogs/pmfrog.htm.

Collection:

- Do not use bare hands to handle sick or dead frogs
- Disposable gloves should be worn when handling sick or dead frogs
- New gloves and a clean plastic bag should be used for each frog specimen to prevent cross-contamination
- If the frog is dead, keep the specimen cool and preserve as soon as possible to avoid decomposition

Preserving specimens:

- Specimens can be **preserved/fixed in 70% ethanol or 10% buffered formalin**
- Cut open the belly and place the frog in about 10 times its own volume of preservative
- Where no preservative is available, **specimens can also be frozen**. If numerous frogs are collected, some should be preserved and some should be frozen. Portions of a dead frog can also be sent for analysis (e.g., a preserved foot, leg or a portion of abdominal skin)

Transportation:

- **If the frog is alive and likely to survive transportation**, place the frog into either a moistened cloth bag with some damp leaf litter or into a plastic bag with damp leaf litter and partially inflated before sealing
- Remember to **keep all frogs separated** during transportation
- **If the frog is alive but unlikely to survive transportation** (death appears imminent), euthanize the frog and place the specimen in a freezer or preservative. Once frozen/preserved the specimen is ready for shipment
- **All containers should be labelled** showing at least the species (if known), date and collection location
- Preserved samples can be sent in jars or wrapped in wet cloth, sealed in bags and placed inside a padded box
- Send frozen samples in an esky with dry ice

- Place live or frozen specimens into a small Styrofoam esky. Seal esky with packaging tape before sending
- Send the package by courier and declare any hazardous or flammable contents (e.g., 70% ethanol)

7. Hygiene protocol checklist and field kit

The following checklist and field kit are designed to assist with minimising the risk of transferring pathogens between frogs and sites in field studies (follows NSW 2008)

Have you considered the following questions before handling frogs in the field:

- Has your proposed field trip been sufficiently well planned to consider hygiene issues?
- Have you considered the boundaries between sites (particularly where endangered species or populations at risk are known to occur)?
- Have footwear disinfection procedures been considered and a strategy adopted?
- Have you planned the equipment you will be using and developed a disinfection strategy?
- Are you are planning to visit sites where vehicle disinfection will be needed? If so, do you have a plan to deal with vehicle disinfection?
- Have handling procedures been planned to minimise the risk of frog to frog pathogen transmission?
- Do you have a planned disinfection procedure to deal with equipment, apparel and direct contact with frogs?

If you answered NO to any of these questions please re-read the relevant section of the *Hygiene Protocols for the Control of Disease in Australian Frogs* and apply a suitable strategy.

Field hygiene kit

When planning to survey frogs in the field a portable field hygiene kit should be assembled to assist with implementing the hygiene protocols. Recommended contents of a field hygiene kit would include:

- Plastic box to store field equipment
- Small Styrofoam esky
- Disposable gloves
- Disinfectant spray bottle (atomiser spray) and/or wash bottle for disinfectants
- Disinfecting solutions
- Scraper or scrubbing brush for cleaning mud off footwear, vehicles etc.
- Bucket for mixing disinfecting solutions and soaking
- Plastic bags, large and small for hygienic temporary animal handling/holding
- Sharps or other container for safe waste disposal
- Materials for dealing with sick and dead frogs (see section 6.7.)

Detailed 'Guidelines for captive breeding, raising and restocking programs for Australian frogs' can be found at: http://www.environment.gov.au/biodiversity/invasive/projects/index.html#threat-10-11. See also 'A Manual for Control of Infectious Diseases in Amphibian Survival Assurance Colonies and Reintroduction Programs' (Pessier and Mendelson 2010) at: http://www.cbsg.org/cbsg/workshopreports/26/amphibian_disease_manual.pdf#search=%22amphibian%22

8. Important Australian contacts

8.1. Sick and dead frogs

To arrange receipt and analyse sick and dead frogs, make contact with experts at any of the organisations below prior to dispatching package:

Australian Registry of Wildlife Health
Taronga Conservation Society,
Australia
PO Box 20
MOSMAN NSW 2088
Phone: 02 9978 4749

School of Public Health, Tropical Medicine and Rehabilitation Sciences
James Cook University
Douglas Campus
TOWNSVILLE QLD 4811
Phone: 07 4796 1735

School of Biological Sciences
University of Newcastle
CALLAGHAN NSW 2308
Phone: 02 4921 6014

9. References

Anver, M. R. and C. L. Pond (1984). Biology and diseases of amphibians. Laboratory Animal Medicine. B. J. C. J. G. Fox, F. M. Loew. New York, Academic Press**:** 427-447.

Berger, L., J. E. Longcore, R. Speare, A. Hyatt and L. F. Skerratt (2009). Fungal Diseases in Amphibians. Amphibian Biology, Volume 8 Amphibian Decline: Disease, Parasites, Maladies, and Pollution. H. Heatwole and J. W. Wilkinson, Surrey Beatty & Sons. NSW.

Berger, L., R. Speare, P. Daszak, D. E. Green, A. A. Cunningham, C. L. Goggin, R. Slocombe, M. A. Ragan, A. D. Hyatt, K. R. McDonald, H. B. Hines, K. R. Lips, G. Marantelli and H. Parkes (1998). "Chytridiomycosis causes amphibian mortality associated with population declines in the rain forests of Australia and Central America." Proceedings of the National Academy of Sciences of the United States of America 95(15): 9031-9036.

Berger, L., R. Speare and A. Hyatt (1999). Chytrid fungi and amphibian declines: Overview, implications and future directions. Declines and Disappearances of Australian Frogs. A. Campbell. Canberra, Environment Australia**:** 23-33.

Cashins, S., R. Alford and L. F. Skerratt (2008). "Lethal effect of latex, nitrile, and vinyl gloves on tadpoles." Herpetological Review 39: 298-301.

CCADC (2008). "Decontamination protocol to reduce the risk of spreading infectious amphibian diseases in freshwater systems. (California Centre for Amphibian Disease Control). www.ccadc.us/docs/DeconForProfessionals.pdf."

Cullen, B. R. and L. Owens (2002). "Experimental challenge and clinical cases of Bohle iridovirus (BIV) in native Australian anurans." Diseases of Aquatic Organisms 49(2): 83-92.

Daszak, P., A. A. Cunningham and H. A.D. (2001). Draft guidelines for international translocation of amphibians with respect to infectious diseases. Attachment 6. In: Speare R and Steering Committee of Getting the Jump on Amphibian Disease. Developing management strategies to control amphibian diseases: Decreasing the risks due to communicable diseases. School of Public Health and Tropical Medicine, James Cook University: Townsville. 2001: 150-156.

Davis, A. K., M. J. Yabsley, M. K. Keel and J. C. Maerz (2007). "Discovery of a novel alveolate pathogen affecting southern leopard frogs in Georgia: Description of the disease and host effects." Ecohealth 4(3): 310-317.

Department of the Environment and Heritage. (2006a). "Background document for the Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis." from http://www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid/pubs/chytrid-background.pdf.

Department of the Environment and Heritage. (2006b). "Threat Abatement Plan: Infection of amphibians with chytrid fungus resulting in chytridiomycosis." 2007, from http://www.environment.gov.au/biodiversity/threatened/publications/tap/chytrid.html.

Gravekamp, C., Korver, H., Montgomery, J., Everard, C.O., Carrington, D., Ellis, W.A., Terpstra, W.J. (1991). "Leptospires isolated from toads and frogs on the Island of Barbados." Zentralblatt fur Bakteriologie 275: 403-411.

Gust, N., J. Griffiths, M. Driessen, A. Philips, N. Stewart and D. Geraghty (2009). "Distribution, prevalence and persistence of mucormycosis in Tasmanian platypuses (Ornithorhynchus anatinus)." Australian Journal of Zoology 57(4): 245-254.

Hartigan, A., I. Fiala, D. I, M. Jirků, B. Okimoto, K. Rose, D. N. Phalen and Š. J. (2011). "A suspected parasite spill-back of two novel Myxidium spp. (Myxosporea) causing

disease in Australian endemic frogs found in the invasive cane toad." PLoS One 6: e18871.
Hemingway, V., J. Brunner, R. Speare and L. Berger (2009). Viral and bacterial diseases of amphibians. Amphibian Biology, Volume 8 Amphibian Decline: Disease, Parasites, Maladies, and Pollution. H. Heatwole and J. W. Wilkinson, Surrey Beatty & Sons. NSW.
Hines, H., M. Mahony and K. McDonald (1999). An assessment of frog declines in wet subtropical Australia Declines and Disappearances of Australian Frogs. A. Campbell. Canberra, Environment Australia**:** 44-63.
Hyatt, A. D., A. R. Gould, Z. Zupanovic, A. A. Cunningham, S. Hengstberger, R. J. Whittington, J. Kattenbelt and B. E. H. Coupar (2000). "Comparative studies of piscine and amphibian iridoviruses." Archives of Virology 145(2): 301-331.
Kiesecker, J., A. R. Blaustein and C. L. Miller (2001). "Transfer of a pathogen from fish to amphibians." Conservation Biology 15: 1064-1070.
Laurance, W., K. McDonald and R. Speare (1996). "Catastrophic declines of Australian rain forest frogs: support for the epidemic disease hypothesis." Conservation Biology 10: 406-413.
Longcore, J. E., A. P. Pessier and D. K. Nichols (1999). "*Batrachochytrium dendrobatidis gen et sp nov*, a chytrid pathogenic to amphibians." Mycologia 91(2): 219-227.
Mikaelian, I., M. Ouellet, B. Pauli, J. Rodrigue, J. C. Harshbarger and D. M. Green (2000). "Ichthyophonus – like infection in wild amphibians from Québec, Canada." Diseases of Aquatic Organisms 40: 195-201.
Murray, K. A., R. Retallick, K. McDonald, D. Mendez, K. Aplin, P. Kirkpatrick, L. Berger, D. Hunter, H. B. Hines, R. Campbell, M. Pauza, M. Driessen, R. Speare, S. J. Richards, M. Mahony, A. Freeman, A. D. Phillott, J.-M. Hero, K. Kriger, D. Driscoll, A. Felton, R. Puschendorf and L. F. Skerratt (2010a). "The distribution and host range of the pandemic disease chytridiomycosis in Australia spanning surveys from 1956 to 2007." Ecology 91(5): 1557.
Murray, K. A., R. W. R. Retallick, R. Puschendorf, L. F. Skerratt, D. Rosauer, H. McCallum, L. Berger, R. Speare and J. VanDerWal (2011). "Assessing spatial patterns of disease risk to biodiversity: implications for the management of the amphibian pathogen, *Batrachochytrium dendrobatidis*." Journal of Applied Ecology 48(1): 163-173.
Murray, K. A., D. Rosauer, H. McCallum and L. F. Skerratt (2010b). "Integrating species traits with extrinsic threats: closing the gap between predicting and preventing species declines." Proceedings of the Royal Society B-Biological Sciences Published online October 27 2010(doi:10.1098/rspb.2010.1872).
Murray, K. A. and L. F. Skerratt (in press). "Predicting wild hosts for amphibian chytridiomycosis: integrating host life-history traits with pathogen environmental requirements." Human and Ecological Risk Assessment.
NSW, N. P. a. W. S. (2008). Hygiene protocol for the control of disease in frogs. Threatened Species Management**:** Information Circular No. 6. 200: p 218.
NWHC (2001). "Toe-clipping of frogs and toads standard operating procedure no. 110. NWHC (National Wildlife Health Center), Madison, WI www.nwhc.usgs.gov/publications/amphibian_research_procedures/toe_clipping.jsp.".
O'Shea, P., R. Speare and A. D. Thomas (1990). "Salmonellas from the cane toad, Bufo marinus." Australian Veterinary Journal 67: 310.
Obendorf, D. and A. Dalton (2006). "A survey for the presence of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) in Tasmania." Papers and Proceedings of the Royal Society of Tasmania 140: 25-29.
Pauza, M. and M. Driessen (2008). Distribution and potential spread of amphibian chytrid fungus *Batrachochytrium dendrobatidis* in the Tasmanian Wilderness World Heritage

Area, Biodiversity Conservation Branch, Department of Primary Industries and Water, Tasmania.
Pessier, A. and J. R. Mendelson (2010). A manual for control of infectious diseases in amphibian survival assurance colonies and reintroduction programs. Apple Valley, MN, IUCN/SSC Conservation Breeding Specialist Group: .
Phillott, A. D., R. Speare, H. B. Hines, E. Meyer, L. F. Skerratt, K. R. McDonald, S. D. Cashins, D. Mendez and L. Berger (2010). "Minimising exposure of amphibians to pathogens during field studies." Diseases of Aquatic Organisms.
Sharma, V. K., Y. K. Kaura and I. P. Singh (1974). "Frogs as carriers of Salmonella and Edwardsiella." Antonie von Leeuwenhoek 40: 171-175.
Skerratt, L. F., L. Berger, H. B. Hines, K. R. McDonald, D. Mendez and R. Speare (2008). "Survey protocol for detecting chytridiomycosis in all Australian frog populations." Diseases of Aquatic Organisms 80(2): 85-94.
Skerratt, L. F., L. Berger, R. Speare, S. Cashins, K. R. McDonald, A. D. Phillott, H. B. Hines and N. Kenyon (2007). "Spread of chytridiomycosis has caused the rapid global decline and extinction of frogs." Ecohealth 4(2): 125-134.
Skerratt, L. F., K. R. McDonald, H. B. Hines, L. Berger, D. Mendez, A. Phillott, S. D. Cashins, K. A. Murray and R. Speare (2010). "Validation of the mapping protocol for *Batrachochytrium dendrobatidis* in Queensland, Australia " Diseases of Aquatic Organisms 92: 117-129.
Speare, R., L. Berger, L. F. Skerratt, R. Alford, D. Mendez, S. Cashins, N. Kenyon, K. Hauselberger and J. Rowley (2004). Hygiene Protocol for handling amphibians in field studies. A. D. Group. Townsville, James Cook University**:** 4.
Speare, R., o. G. t. J. o. A. D. Core Working Group and o. G. t. J. o. A. Steering Committee (2001). Developing Management Strategies to Control Amphibian Diseases: Decreasing the Risks Due to communicable Diseases. S. C. o. G. t. J. o. A. D. (eds Speare R. Townsville, School of Public Health and Tropical Medicine, James Cook University.
Stuart, S. N., J. S. Chanson, N. A. Cox, B. E. Young, A. S. L. Rodrigues, D. L. Fischman and R. W. Waller (2004). "Status and trends of amphibian declines and extinctions worldwide." Science 306(5702): 1783-1786.
Taylor, R., D. Sloan, T. Cooper, B. Morton and I. Hunter (2000). "A waterborne outbreak of Salmonella Saintpaul." Communicable Diseases Intelligence 24: 336-340.
Webb, R., A. Philips, L. Berger, J. Connolly and R. Speare (submitted). "Controlling the spread of wildlife diseases: In vitro efficacy of disinfectants against the pathogenic fungi Batrachochytrium dendrobatidis and Mucor amphibiorum." Diseases of Aquatic Organisms.
Wright, K. M. and B. R. Whitaker (2001). Amphibian Medicine and Captive Husbandry. Malabar, Florida, Krieger Publishing.
Zupanovic, Z., G. Lopez, A. D. Hyatt, B. Green, G. Bartran, H. Parkes, R. J. Whittington and R. Speare (1998). "Giant toads Bufo marinus in Australia and Venezuela have antibodies against 'ranaviruses'." Diseases of Aquatic Organisms 32(1): 1-8.

ATTACHMENT E - SITE PHOTOGRAPHS

Photograph E1 – Existing drainage line on the southern boundary of the study area looking east.

Photograph E2 – Existing waterbody within the quarry void containing high quality breeding habitat and areas of emergent vegetation in foreground.

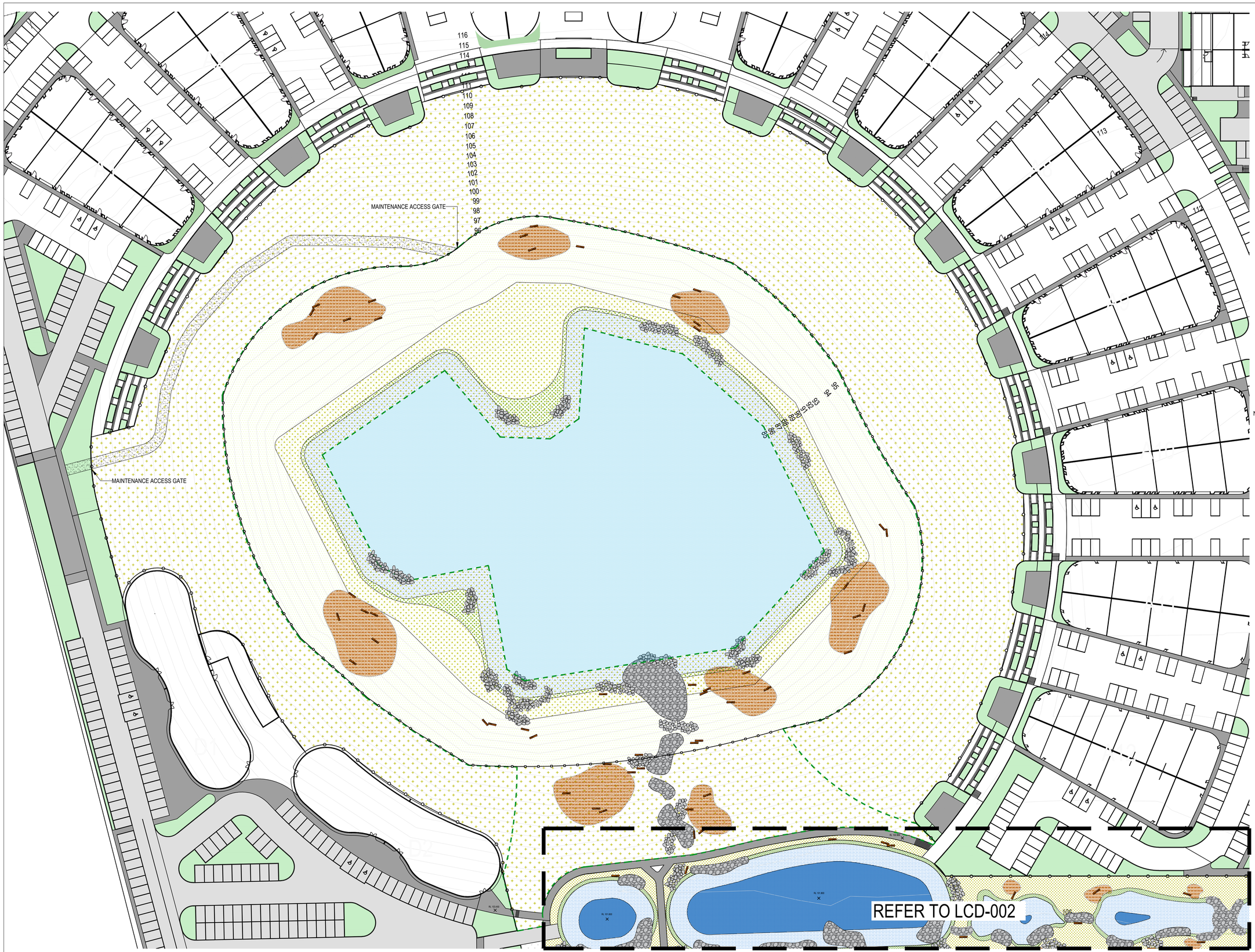
Photograph E3 – Storage facility and stand-off area in the east of the study area (Ecology and Heritage Partners Pty Ltd 23/09/2020).

Photograph E4 – Existing drainage line on the southern boundary of the study area looking west.

Photograph E5 – Degraded Growling Grass Frog foraging and dispersal habitat in the east of the study area (Ecology and Heritage Partners Pty Ltd 23/09/2020)

Photograph E6 – Introduced grass and weed species within the study area (Ecology and Heritage Partners Pty Ltd 11/03/2020).

ATTACHMENT F – LANDSCAPE MANAGEMENT PLAN



WARNING

BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE INDICATIVE ONLY. THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. DIAL B4 U DIG PH: 1100

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK. REPORT ALL DISCREPANCIES TO SUPERINTENDENT PRIOR TO CONSTRUCTION. FIGURED DIMENSIONS TO BE TAKEN INPREFERENCE TO SCALED DRAWINGS. ALL DRAWINGS MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT PRIOR PERMISSION FROM THE LANDSCAPE ARCHITECT.

STATUS

FOR ENDORSEMENT
NOT FOR CONSTRUCTION

NO.	REVISION	DATE
A	FOR ENDORSEMENT	01/04/2021
B	FOR ENDORSEMENT	19/04/2021
C	FOR ENDORSEMENT	24/05/2021

LEGEND

REFER TO PROPOSED PLANT SCHEDULE ON LCD-003.

- EXTENT OF HIGH QUALITY HABITAT AREA ENRICHMENT 1.5HA
- EXISTING GROWLING GRASS FROG TERRESTRIAL ZONE - DISPERSAL AND FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- EXISTING HIGH QUALITY GROWLING GRASS FROG TERRESTRIAL ZONE - FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- NEW FRINGING AND EMERGENT - LITTORAL AND EPHEMERAL ZONE
- NEW EMERGENT - ENTRY ZONE
- NEW SUBMERGENT AND FLOATING SUBMERGENT - EMBANKMENT ZONE
- NEW WETLAND DEEP WATER ZONE
- NEW TERRESTRIAL ZONE - SHORT, MOWN GRASS WITH AN OPEN STRUCTURE (20% MAX COVER), WITH PATCHES OF DENSE TUSSOCK PLANTING
- EXISTING QUARRY VOID WATER BODY TO BE RETAINED AND PROTECTED
- ROCK MATTRESSING/PILES
- AREA OF LARGE WOODY DEBRIS (WITHIN LITTORAL/EPHEMERAL ZONE)
- WOOD LOGS/ RECYCLED TIMBER SLEEPERS
- LARGE CONCAVE ROCKS (300-1500mm DIAMETER)
- SMALL CONCAVE ROCKS (3-5 BOULDERS / m^2)
- SEDIMENT/FROG EXCLUSION FENCING TO BE INSTALLED AROUND THE PERIMETER OF THE NO-GO AREA
- TEMPORARY FROG EXCLUSION FENCING
- PROPOSED FOOTPATH
- EXTENT OF MAINTENANCE ACCESS PATH

Level 4, 136 Exhibition Street
Melbourne VIC 3000
Tel. +61 3 9654 8844
Fax. +61 3 9654 8088
Email info@hansenpartnership.com.au
Web www.hansenpartnership.com.au

hansen

CLIENT

BOLINDA PLACE PTY LTD ATF
BOLINDA PLACE UNIT TRUST

PROJECT

75-135 Bolinda Road
Campbellfield

DRAWING TITLE

QUARRY VOID
LANDSCAPE PLAN

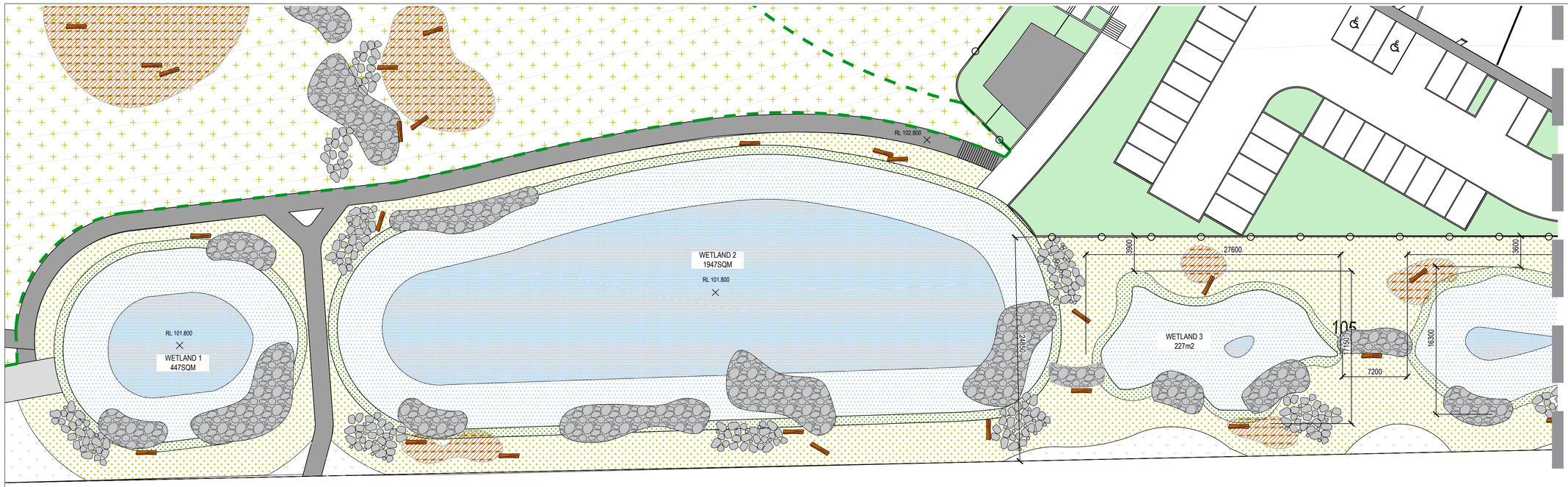
DRAWN	CHECKED	SCALE A1	SCALE A3
BY	CS	1:500	1:1000

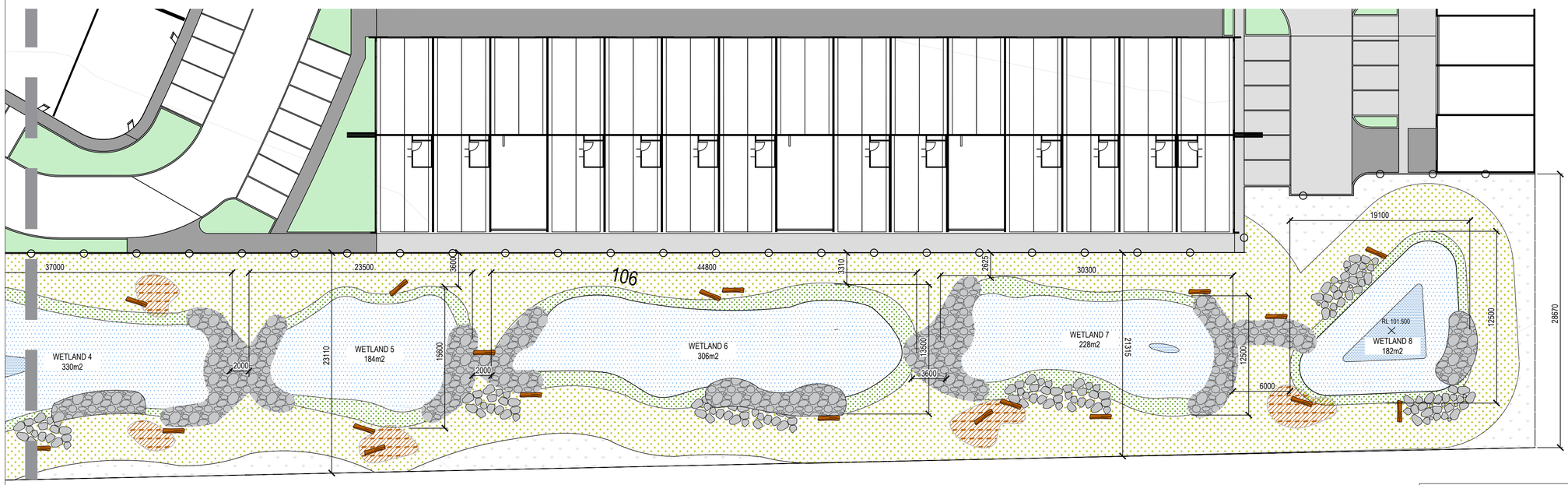
5 0 10 20 30m

PLOT DATE	JOB NUMBER	CLIENT REF
	2019.417	-

DRAWING NUMBER REV

LCD-001 C





ROCK PILE NOTES:

- ROCK PILES AT LEAST ONE METRE DEEP MUST BE CONSTRUCTED ADJACENT TO THE WETLAND MARGIN USING A VARIETY OF ROCK SIZES BETWEEN 10CM - 1M IN DIAMETER.
- ROCK PILES IN/ADJACENT TO THE DISPERSAL CORRIDOR PONDS SHOULD BE STACKED HIGH (1-1.5M).

WARNING

BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE INDICATIVE ONLY. THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. DIAL B4 U DIG PH: 1100

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK. REPORT ALL DISCREPANCIES TO SUPERINTENDENT PRIOR TO CONSTRUCTION. FIGURED DIMENSIONS TO BE TAKEN INPREFERENCE TO SCALED DRAWINGS. ALL DRAWINGS MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT PRIOR PERMISSION FROM THE LANDSCAPE ARCHITECT.

STATUS

FOR ENDORSEMENT
NOT FOR CONSTRUCTION

NO.	REVISION	DATE
A	FOR ENDORSEMENT	01/04/2021
B	FOR ENDORSEMENT	19/04/2021
C	FOR ENDORSEMENT	24/05/2021

LEGEND

REFER TO PROPOSED PLANT SCHEDULE ON LCD-003.

- EXTENT OF HIGH QUALITY HABITAT AREA ENRICHMENT 1.5HA
- EXISTING GROWLING GRASS FROG TERRESTRIAL ZONE - DISPERSAL AND FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- EXISTING HIGH QUALITY GROWLING GRASS FROG TERRESTRIAL ZONE - FORAGING HABITAT TO BE RETAINED, PROTECTED AND ENHANCED
- NEW FRINGING AND EMERGENT - LITTORAL AND EPHEMERAL ZONE
- NEW EMERGENT - ENTRY ZONE
- NEW SUBMERGENT AND FLOATING SUBMERGENT - EMBANKMENT ZONE
- NEW WETLAND DEEP WATER ZONE
- NEW TERRESTRIAL ZONE - SHORT, MOWN GRASS WITH AN OPEN STRUCTURE (20% MAX COVER), WITH PATCHES OF DENSE TUSSOCK PLANTING
- EXISTING QUARRY VOID WATER BODY TO BE RETAINED AND PROTECTED
- ROCK MATTRESSING/PILES
- AREA OF LARGE WOODY DEBRIS (WITHIN LITTORAL/EPHEMERAL ZONE)
- WOOD LOGS/ RECYCLED TIMBER SLEEPERS
- LARGE CONCAVE ROCKS (300-1500mm DIAMETER)
- SMALL CONCAVE ROCKS (3-5 BOULDERS / m^2)
- SEDIMENT/FROG EXCLUSION FENCING TO BE INSTALLED AROUND THE PERIMETER OF THE NO-GO AREA
- TEMPORARY FROG EXCLUSION FENCING
- PROPOSED FOOTPATH
- EXTENT OF MAINTENANCE ACCESS PATH

Level 4, 136 Exhibition Street
Melbourne VIC 3000
Tel. +61 3 9654 8844
Fax. +61 3 9654 8088
Email info@hansenpartnership.com.au
Web www.hansenpartnership.com.au

hansen

CLIENT

BOLINDA PLACE PTY LTD ATF
BOLINDA PLACE UNIT TRUST

PROJECT

75-135 Bolinda Road
Campbellfield

DRAWING TITLE

WETLAND CORRIDOR LANDSCAPE PLAN

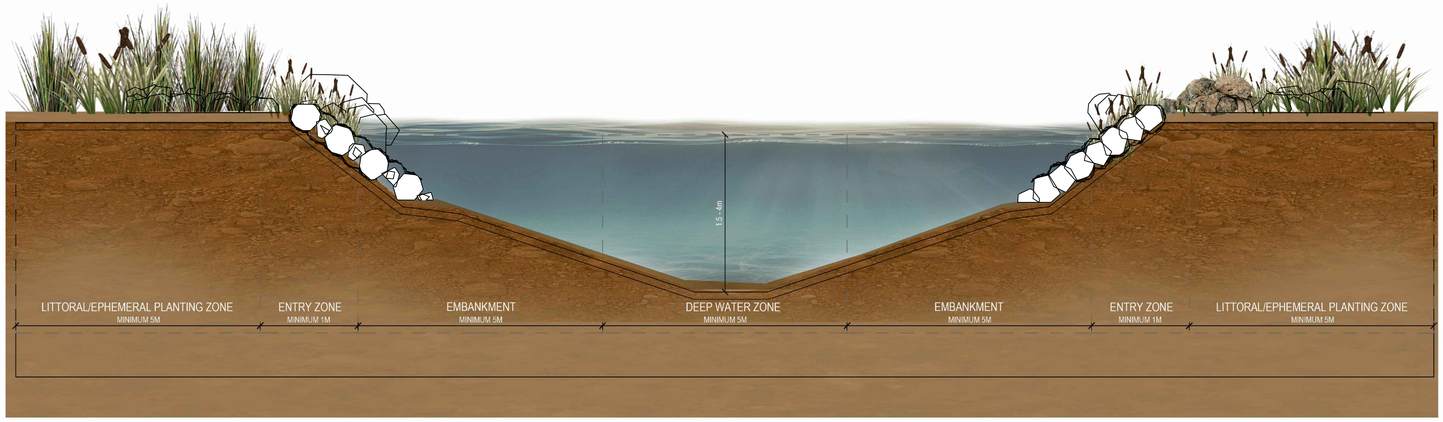
DRAWN	CHECKED	SCALE A1	SCALE A3
BY	CS	1:250	1:500

0 8 16m
2 12

PLOT DATE	JOB NUMBER	CLIENT REF
	2019.417	-

DRAWING NUMBER REV

LCD-002 C



01 TYPICAL WETLAND CROSS SECTION
SCALE 1: @A1 1: @A3

PROPOSED PLANTING SCHEDULE - QUARRY VOID AND WETLAND

	Code	Botanical Name	Common Name	Typical height x Width (m)	Spacing	Installed Size
	FRINGING AND EMERGENT - LITTORAL/EPHEMERAL ZONE					
*	**CAR app**	*Carex appressa*	Tall Sedge	1.00 x 0.50m	6 per m2	150mm pot
*	**CRA hel**	*Crassula helmsii*	Swamp Crassula	0.30 x 4.00m	6 per m2	150mm pot
*	**EPI bill**	*Epilobium billardierianum*	Smooth Willow-herb	1.00 x 0.35m	6 per m2	150mm pot
*	**POA lab**	*Poa labillardierei var. labillardierei*	Common Tussock-grass	1.20 x 0.50m	6 per m2	150mm pot
*	**POT och**	*Potamogeton ochreatus*	Blunt Pondweed	4.00 x 0.08m	6 per m2	150mm pot
					Allow for areas of bare ground between plantings.	
	EMERGENT - ENTRY ZONE					
*	**AMP flu**	*Amphibromus fluitans*	River Swamp Wallaby-grass	0.25 x 0.50m	6 per m2	150mm pot
*	**BAU art**	*Baumea articulata*	Jointed Twig-sedge	1.50 x 2.50m	6 per m2	150mm pot
*	**JUN ama**	*Juncus amabilis*	Hollow-rush	1.20 x 0.50m	6 per m2	150mm pot
*	**PER dec**	*Persicaria decipiens*	Slender Knotweed	0.30 x 0.50m	6 per m2	150mm pot
	SUBMERGENT AND FLOATING SUBMERGENT - EMBANKMENT ZONE					
*	**ALI pla**	*Alisma platago-aquatica*	Water plantain	1.5 x 0.4m	6 per m2	150mm pot
*	**CER dem**	*Ceratophyllum demersum*	Hornwort	3.00 x 0.20m	3 per m2	150mm pot
*	**MYR cri**	*Myriophyllum crispatum*	Upright Water-milfoil	0.25 x 0.60m	3 per m2	150mm pot
*	**POT cri**	*Potamogeton crispus*	Curly Pondweed	0.10 x 1.50m	3 per m2	150mm pot
*	**HYD sib**	*Hydrocotyle sibthorpioides*	Shining Pennywort	0.10 x 0.30m	3 per m2	150mm pot
*	**LYT sal**	*Lythrum salicaria*	Small Loosestrife	0.30 x 0.50m	3 per m2	150mm pot
*	**OTT ova**	*Ottelia ovalifolia*	Swamp Lily	1.50 x 0.90	3 per m2	150mm pot
*	**POT pec**	*Potamogeton pectinatus*	Fennel Pondweed	0.1 x 1.00m	3 per m2	150mm pot
*	**VAL ame**	*Vallisneria americana*	Ribbon-weed	1.00 x 0.30m	3 per m2	150mm pot
					Allow for 40% submergent, 20% floating and 30% emergent species.	

Species recommended for revegetation in the 'Growling Grass Frog Litoria raniformis Conservation Management Plan' Attachment C.

 # Limit use of this species as it may become invasive.

EXISTING AND NEW TERRESTRIAL AREA PLANTING NOTES:

- NO SHRUBS TO BE PLANTED WITHIN 10M OF THE WETLANDS NORMAL WATER LEVEL (OUTER EDGE OF LITTORAL ZONE).
- ALLOW FOR TUSSOCK FORMING SPECIES OF PATCHY DENSE PLANTINGS.
- FROM 10M TO 100M FROM THE WETLAND, NEW TERRESTRIAL AREAS TO BE SHORT, MOWN GRASS WITH AN OPEN STRUCTURE (20% COVER). LOW GRASS VEGETATION DOES NOT NEED TO BE NATIVE, BUT MOST NOT INCLUDE ANY INVASIVE SPECIES.
- TREES AND/OR LARGE SHRUBS MUST NOT BE PLANTED WITHIN 20M OF THE BANKS OF THE WETLANDS.

SEDIMENT/FROG EXCLUSION FENCING NOTES:

- SEDIMENT/ FROG EXCLUSION FENCING TO BE INSTALLED AROUND THE PERIMETER OF THE NO-GO-AREA TO PROVIDE A PHYSICAL BARRIER BETWEEN THE DEVELOPMENT AREA AND RETAINED HABITAT. DRIFT FENCING MUST ALSO BE USED ALONG THE EDGES OF THE CONSTRUCTED WETLANDS AND PONDS TO PREVENT GROWLING GRASS FROGS FROM ACCESSING THE DEVELOPMENT AREA DURING CONSTRUCTION.
- FENCING MUST BE CONSTRUCTED OF A CLOTH OR PLASTIC MATERIAL AND ONLY APPROPRIATE FENCING MATERIAL THAT WITHSTANDS VARIABLE WEATHER CONDITIONS OVER LONG PERIODS OF TIME MUST BE USED.
- FENCING MUST BE INSTALLED AT LEAST ONE METRE HIGH, WITH AN ADDITIONAL 0.2 METRES BURIED BELOW-GROUND. AN ADDITIONAL 0.2 METRES AT THE TOP OF THE FENCE MUST BE BENT/ ANGLED OVER AT LESS THAN 90 DEGREES TO THE VERTICAL ON THE FROG HABITAT SIDE (NOT THE EXCLUDED HABITAT SIDE) TO PREVENT FROGS FROM CLIMBING OR HOPPING OVER THE FENCE.
- REFUGIA FOR SHELTER MUST BE PLACED AT LEAST ONE METRE AWAY FROM THE FENCE AND ANY VEGETATION WITHIN ONE METRE OF THE FENCE MUST NOT EXCEED 0.5 METRES TO PREVENT FROGS FROM ESCAPING (I.E. LOW-GROWING GRASSES SHOULD BE PLANTED).
- FENCES MUST BE TAUT WITHOUT CREASES OR FOLDS.
- FENCE POSTS MUST BE INSTALLED ON THE OUTER FENCING SIDE (I.E. EXCLUDED HABITAT SIDE) AND FASTENED WITH NAILS OR SIMILAR, AND LIE FLUSH WITH FENCING MATERIAL TO PREVENT FROGS FROM CLIMBING UP POSTS AND ESCAPING OVER THE FENCE.
- THE SAFETY FENCING SURROUNDING THE QUARRY NEEDS TO FOLLOW THE ENTIRE BOUNDARY OF THE QUARRY VOID, BETWEEN THE DEVELOPMENT AND THE QUARRY VOID. IT MUST NOT GO OUTSIDE THE CURRENT DEVELOPMENT FOOTPRINT AS THIS WILL INCREASE THE TOTAL GGF HABITAT TO BE IMPACTED/OFFSET, AND ALSO NEEDS TO INCLUDE AN ACCESS POINT WHERE MAINTENANCE CREWS CAN ACCESS THE AREA FOR WEED CONTROL AND LITTER REMOVAL. SEE ATTACHED FIGURE THAT SHOWS IN GREEN THE GGF HABITAT WHICH MUST BE AVOIDED.

WARNING

BEWARE OF UNDERGROUND SERVICES. THE LOCATIONS OF UNDERGROUND SERVICES ARE INDICATIVE ONLY. THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. DIAL B4 U DIG PH: 1100

CONTRACTOR TO VERIFY ALL DIMENSIONS ON SITE BEFORE COMMENCING WORK. REPORT ALL DISCREPANCIES TO SUPERINTENDENT PRIOR TO CONSTRUCTION. FIGURED DIMENSIONS TO BE TAKEN INPREFERENCE TO SCALED DRAWINGS. ALL DRAWINGS MAY NOT BE REPRODUCED OR DISTRIBUTED WITHOUT PRIOR PERMISSION FROM THE LANDSCAPE ARCHITECT.

STATUS

FOR ENDORSEMENT
NOT FOR CONSTRUCTION

NO.	REVISION	DATE
A	FOR ENDORSEMENT	01/04/2021
B	FOR ENDORSEMENT	19/04/2021
C	FOR ENDORSEMENT	24/05/2021

hansen
Level 4, 136 Exhibition Street
Melbourne VIC 3000
Tel. +61 3 9654 8844
Fax. +61 3 9654 8088
Email info@hansenpartnership.com.au
Web www.hansenpartnership.com.au

CLIENT
BOLINDA PLACE PTY LTD ATF
BOLINDA PLACE UNIT TRUST

PROJECT
75-135 Bolinda Road
Campbellfield

DRAWING TITLE
TYPICAL DETAILS
SCHEDULES AND NOTES

DRAWN	CHECKED	SCALE A1	SCALE A3
BY	CS	-	-

PLOT DATE	JOB NUMBER	CLIENT REF
	2019.417	-

DRAWING NUMBER REV

LCD-003 C

APPENDIX 3 - STORMWATER MANAGEMENT STRATEGY

ECOLOGY
ENGINEERING
DESIGN

E2DESIGNLAB

75 – 135 Bolinda Road

Stormwater Management Strategy

March 2020

Melbourne
Tenancy 4
Level 9 Carlow House
289 Flinders Lane
Melbourne VIC 3000
PO Box 19
Darling South VIC 3145
P +61 (0) 3 9654 7274

Brisbane
8A Princhester Street
West End QLD 4101
PO Box 5945
West End QLD 4101
P +61 (0) 7 3255 1571

Kunshan, China
505 Baitang Road
Zhoushi Town
Jiangsu Province

info@e2designlab.com.au
www.e2designlab.com.au

This document has been prepared solely for the benefit of the client and is issued in confidence for the purposes only for which it is supplied. Unauthorised use of this document in any form whatsoever is prohibited. No liability is accepted by e2designlab or any employee, contractor, or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the document may be made available to other persons for an application for permission or approval to fulfil a legal obligation.

Document Control Sheet	
Report Title	75 – 135 Bolinda Road Stormwater Management Strategy: SWMS
Version	02
Author(s)	Aaron Dowling, Shaw Abrey
Approved by	Gary Walsh
Signed	
Date	10/03/2020
Distribution	William Tan, Mark Huang

Revision	Date	Approved	Details of Revision
1	10/03/2020	GW	Stormwater Management Strategy Report
2	24/03/2020	AD	Final

CONTENTS

List of Figures

List of Tables

1. Introduction

1.1 Background

Forte Group Pty Ltd has engaged E2Designlab to undertake a Stormwater Management Strategy to support a planning permit application for the development of 75 – 135 Bolinda Road, Campbellfield Figure 1. The aim of this report is to illustrate that the proposed development descriptions set out in the planning application will perform to deliver the objectives listed in Table 1 below:

Table 1 – Planning scheme policy objectives to inform the SWMS report

Clause:	Policy:	Objectives:
CL 22.19	*Industrial Stormwater Planning Policy* (**Hume Planning Scheme**)	Ensure compliance with the requirements for suspended solids (80%), total phosphorus (45%) and total nitrogen (45%), as set out in the *Urban Stormwater Best Practice Environmental Management Guidelines*, CSIRO (1999).
CL 53.18	*Stormwater management in Urban Development* (**Victorian Planning Provisions**)	To ensure that stormwater in urban development, including retention and reuse, is managed to mitigate the impacts of stormwater on the environment, property and public safety, and to provide cooling, local habitat and amenity benefits.

The subject property is located approximately 16 km north of the Melbourne CBD and is zoned IN1Z (Industrial 1) in the Hume Planning Scheme. The site consists of a single parcel identified as Lot 7 LP5314, council property number 513946 (Figure 1).

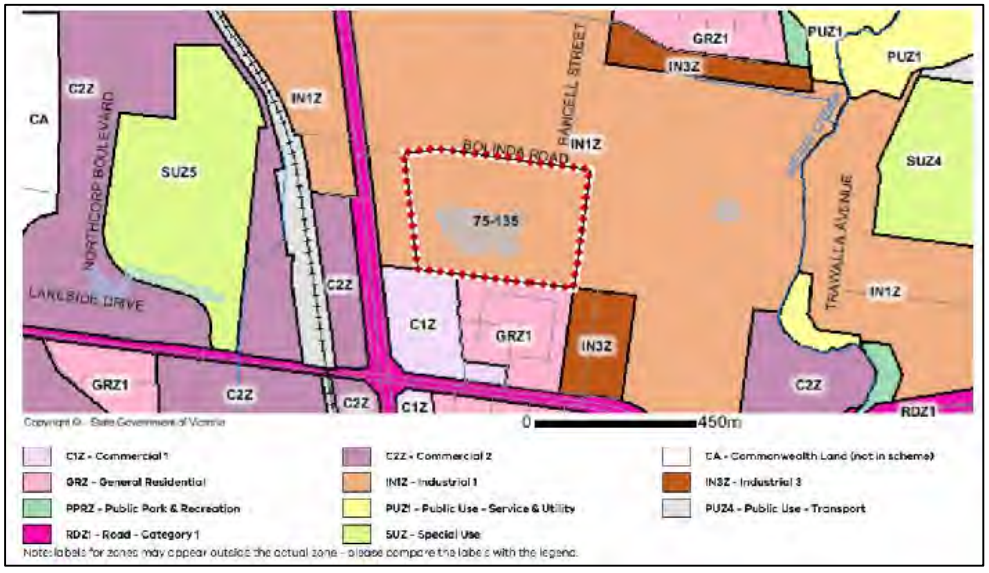


Figure 1 - Slades Beverages landholding in the Hume Planning Scheme

1.2 Site Overview

The proposed development site, identified as *SWMS* in Figure 2, is a decommissioned quarry site with key features including:

- A large quarry pit located in the western portion of the property. It is known to contain a viable population of the protected Growling Grass Frog (*Litoria raniformis*) (GGF);
- The Merri Creek located approximately 600 m from the eastern property boundary;
- The Bolinda Road Resource Recovery Facility (BRRRF) located to the east of the site, between Merri Creek and the development site;
- Runoff from a large portion of the site discharges generally to the south. This causes regular flooding on residential properties located along the southern property boundary. There is no formal stormwater system along this boundary and in the south east corner of the site.
- Runoff from a smaller portion of the site discharges into the existing Council drainage network across Bolinda Road.

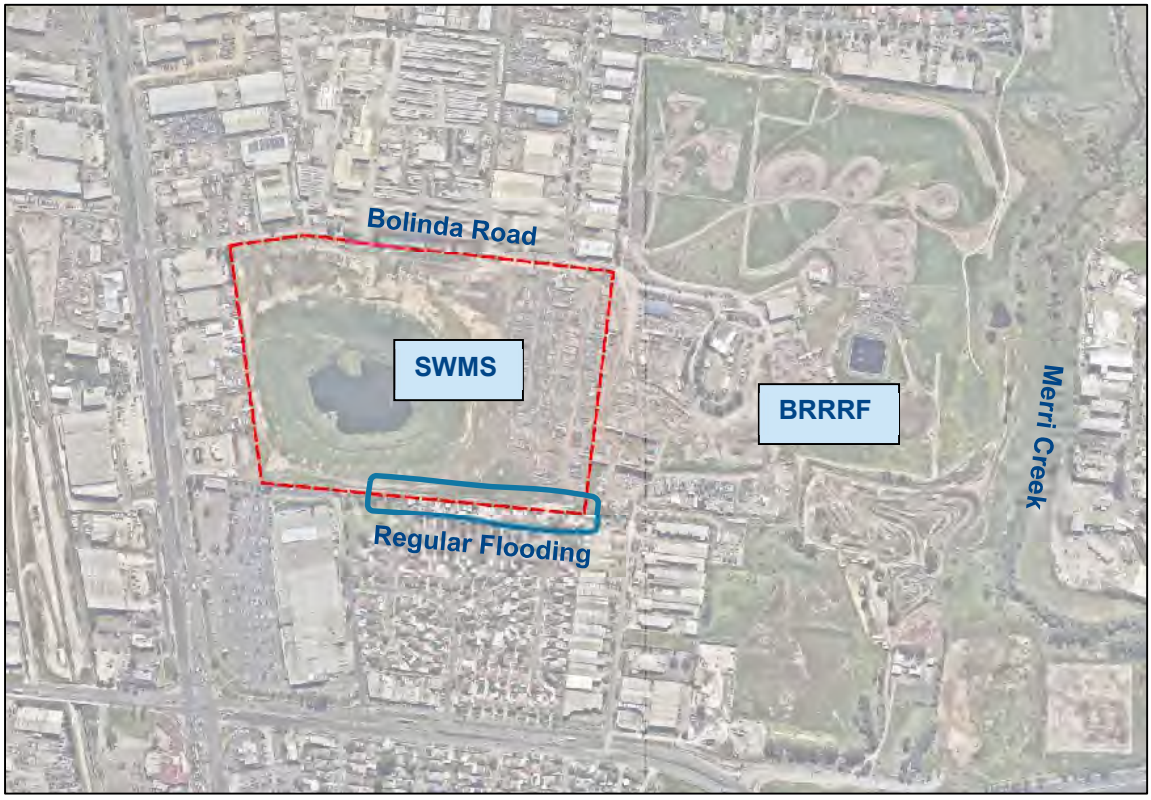


Figure 2 - Stormwater management strategy and site context

2. Land Use

The development of 75 – 135 Bolinda Road will include a range of built forms including workshops/studios, commercial buildings, warehouses and retail buildings. A summary of the proposed land use types and associated fractions impervious are provided in Table 2 and Figure 3 below.

Table 2 - Land use summary post-development

Masterplan Ref	Proposed Land Use	Area (ha)	Fraction impervious
A	Workshop/studio (A1 – A4)	1.54	0.9
C	Warehouses (C1 – C6)	2.16	0.9
D	Retail (D1 and D2)	0.29	0.9
B	Carparks, roads, commercial (B1 – B2) and balance	7.72	0.8
QP	Quarry pit	4.47	0.05
Total (incl. quarry pit)		**16.18**	**0.62**

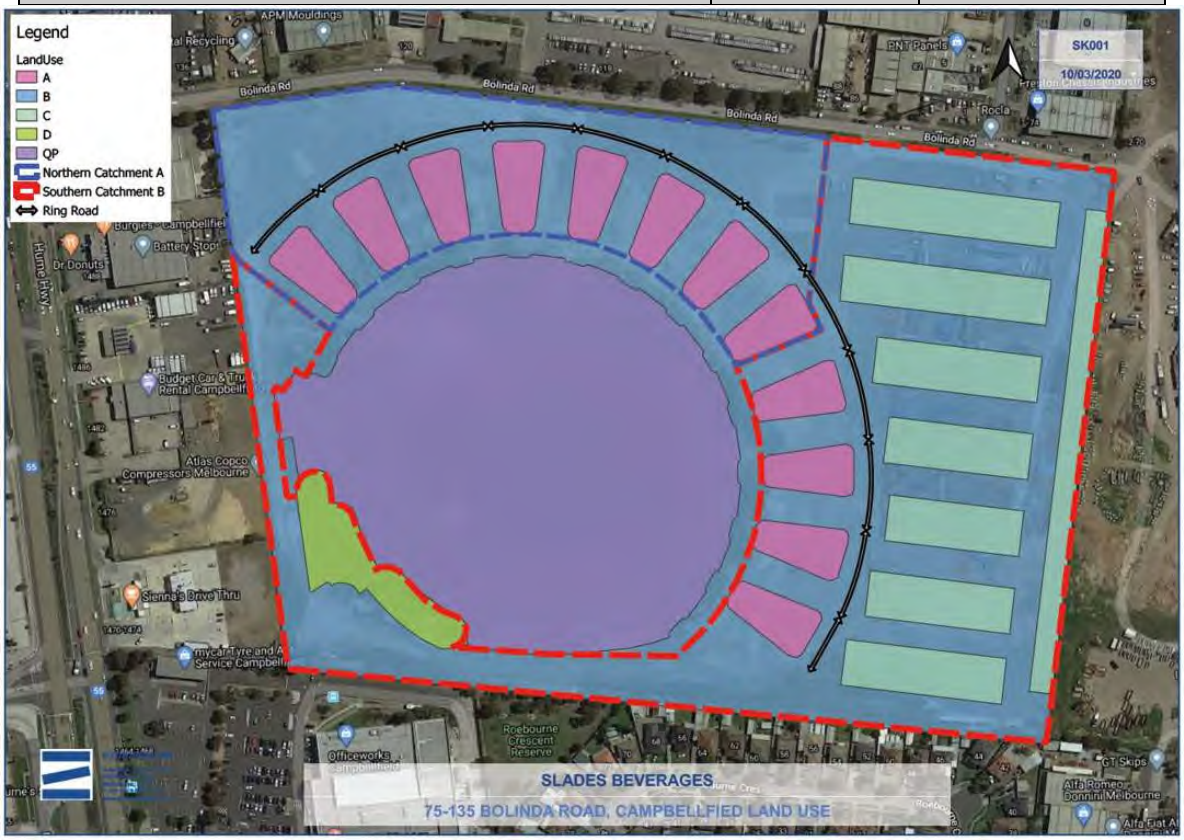


Figure 3 - Proposed development types

3. Hydrology and Hydraulics

3.1 Objectives

The following hydrologic and hydraulic objectives are relevant to the development of 75 – 135 Bolinda Road.

3.1.1 Flood Protection

1% AEP flood protection must be achieved for both the proposed development, and properties downstream from the subject site. This is achieved by providing adequate flood flow conveyance and retention assets to ensure :

- safe conveyance of flood flows through the development, ensuring properties will not experience inundation in the Q100 storm event and adequate freeboard is provided to adjacent properties. Refer to Section 3.5 for flood safety assessments.
- no adverse flooding impacts are experienced by downstream landowners as a result of the proposed development. The developer is required to provide storage and regulated discharge of flood flows from the site. This will be achieved in a combination of underground and above ground storage of peak flood flows (up to and including the 1% AEP storm event).

3.1.2 Protection of Stormwater Quality Assets

A proposed retarding basin will incorporate stormwater quality treatment measures within its base to mitigate ecological impacts on the downstream waterway. Stormwater quality measures will incorporate suitable high-flow bypass systems, ensuring the infrastructure remains robust and unaffected by flood flows.

3.2 Catchment Definition

3.2.1 Existing Conditions

The topography of the site excluding the quarry pit generally slopes to the south east corner of the property. Using the detailed feature survey data for the site, an existing conditions catchment plan was determined (Figure 4). Subcatchment details are summarised in Table 3 .The existing fraction impervious is estimated to be 5% across the site. No external catchment flows enter the subject site.

Figure 4 – Existing conditions catchment plan

Table 3 – Existing catchment details

Catchment		Area (ha)
A	North west catchment	0.45
B	North catchment [1]	0.81
C	North east catchment [2]	0.57
D	South east catchment	6.71
E	Quarry pit	7.63

For the purposes of the Stormwater Management Strategy, it is assumed that the existing Council drainage system has capacity to convey the flows from the property under existing conditions, assuming a 5% impervious fraction.

3.2.2 Developed Conditions

The developed conditions catchment plan (Figure 5) is informed by the site masterplan (Appendix A), design spot levels and existing stormwater infrastructure. Generally, the proposed development will direct stormwater flows in the following manner:

- A portion of the development will drain to the north via the existing Bolinda Road stormwater network (Catchment A), while the balance of the site drains to the south east corner of the property (Catchment B);
- North Catchment A flows (with streetscape WSUD assets described in Section 4) are detained within a subsurface storage system (RB2 and 1% AEP pipe) to mitigate peak flows prior to discharging across Bolinda Road into the existing stormwater network;
- South Catchment B will comprise both e*astern and western* catchments. Peak flows during major storm events will be detained in a retarding basin (which will also accommodate a constructed wetland within its base- see Section 4);

[1] Sub-catchment B discharges into the existing 900 mm stormwater pipe to the north of Bolinda Road
[2] Sub-catchment C discharges into the two stormwater pipes to the east of the existing 900 mm stormwater pipe reach

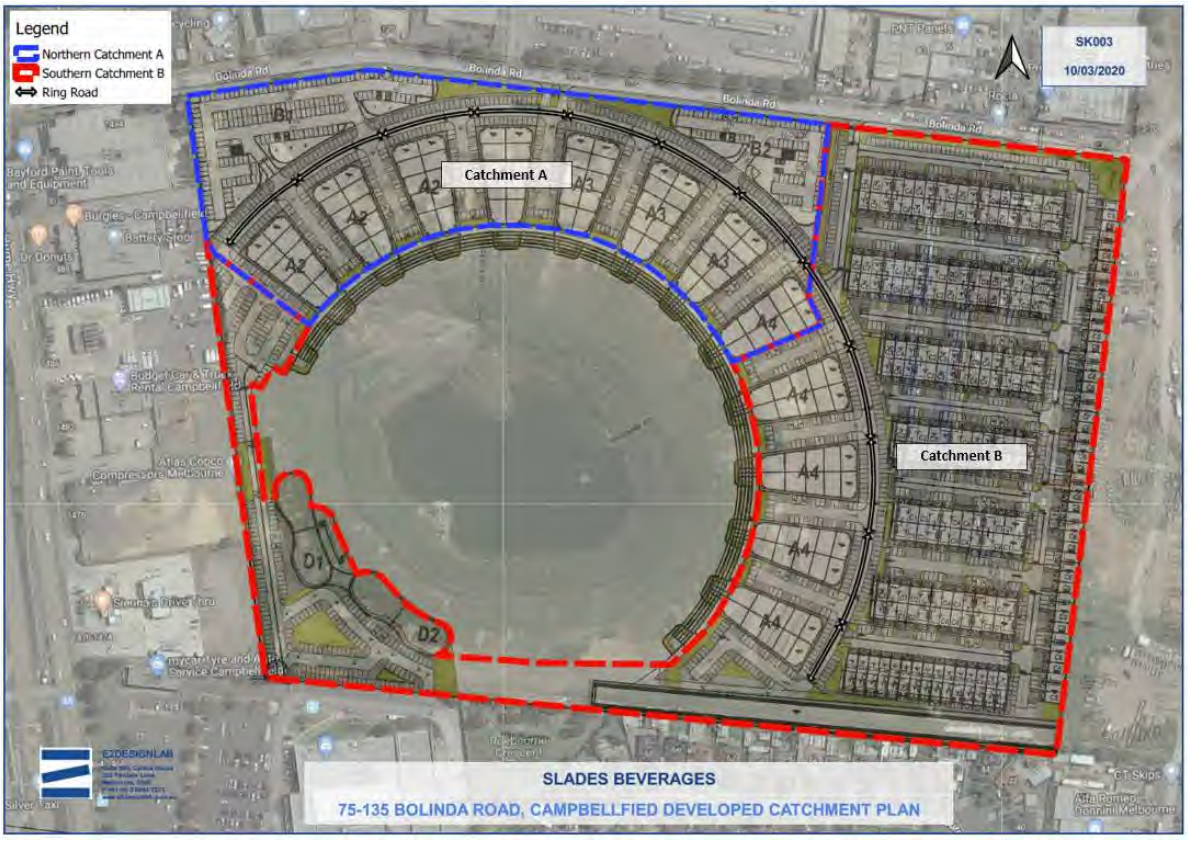


Figure 5 - Developed conditions catchment plan

The infrastructure response relating to stormwater management for hydrology (as outlined above) consists of:

Catchment A

- Minor flows conveyed from buildings, carparks and roadways to the ring road via 10% AEP pipes, where required;
- Major stormwater pipe main along the ring road (1% AEP capacity) and subsurface storage (RB2) for conveyance and retardation of stormwater flows from the *Bolinda Catchment*, prior to discharging from the site;

Catchment B

- Underground pipe drainage system (10% AEP capacity) for conveyance of low flows from the South Catchment into the retarding basin.
- Retardation basin (RB1) located on the southern property boundary;
- Roadways are used for conveyance of gap flows into the retardation basin;
- Muliti-purpose linear open space corridor located along the southern property boundary; incorporating an overland flow path to convey gap flows into the retarding basin.
- Outfall pipe (1% AEP capacity) from RB1 to the east to daylight flows on the adjacent waste recovery facility; toward Merri Creek.

It should be noted that the multi-purpose linear open space corridor along the southern property boundary also provides a Growling Grass Frog habitat pond and preserves ecological connectivity between the quarry pit and eastern property boundary (see Section 5).

3.3 Calculation of Peak Flows

The following section refers to the local catchment design flows. A range of flow calculations are required to inform several elements of the Stormwater Management Strategy including the sizing of stormwater quality treatment assets and overland flows path flood safety criteria checks and external flows that must be conveyed through the site. The relevant flow locations are identified in Figure 6, with a summary of the flows calculated provided in Table 4, consistent with the *Australian Rainfall and Runoff 2019* (ARR19) *guidelines*. Defining developed catchment areas was dictated by the following parameters:

- required drainage infrastructure cover;
- invert level of incoming pipes, including 1% AEP (Catchment A only)
- practical fill levels for the state and
- proposed design elevation (spot levels)

Figure 6 – Site catchment plan with relevant flow locations

Table 4 – Design flow summary

Flow Location (Figure 6)	Catchment Description	Development	AEP [%]	Flow [m^3/s]
1	Western Catchment	Post	1%	0.35
			10%	0.26
			4EY	0.06
2	RB1 Inflow Confluence of Eastern and Western Catchment (Catchment B)	Post	1%	1.92
			10%	1.51
			4EY	0.36
3	Eastern Catchment	Post	1%	1.69
			10%	1.28
			4EY	0.32
4	Property Boundary Discharging from the south east corner of the site (Catchment B)	Pre	1%	0.66
		Post	1%	0.42
			10%	0.26
			4EY	0.05
5	Catchment A point of discharge (Bolinda Road)	Pre	1%	0.09
		Post	1%	1.16

3.4 Minor Drainage System

The minor drainage system consists of pits and pipes to capture and convey all stormwater runoff generated across the site catchments for rainfall events up to and including the 10% Annual Exceedance Probability (AEP) design storm. Drainage is facilitated by road cross fall into conventional gully pits, which subsequently drain via the underground pipe network to water sensitive urban design treatment elements, before being discharged off site via either

- the existing Council drainage network (Catchment A); or
- a proposed pipeline that extends into the eastern neighbouring property (Catchment B)

As the localised catchments have an area less than 60 hectares, the system will be designed in accordance with Hume City Council design standards.

3.5 Overland Flow Path Flood Safety Assessment

The primary objective of the major drainage system is to provide 1% AEP flood protection for allotments within and adjacent to the development and to prevent adverse impacts to neighbouring properties from development activity. This ensures the overland flows can be safely conveyed through the development without threatening the health and safety to occupants.

Flows up to and including the 1% AEP storm event are managed throughout the site via a series of overland flow paths. The road reserves are to be designed to safely convey gap flow in accordance with Melbourne Water's overland flow flood safety criteria.

The Melbourne Water website gives guidance on appropriate flood safety criteria to adopt for urban streets acting as an overland flow path. The applicable criterion is:

1. $V_{av}.d_{av}$ must be less than 0.35 m^2/s;
2. d_{av} must be less than 0.3 m.

Where V_{av} and d_{av} is the average velocity and average depth of flow through the critical road cross section respectively. Gap flows are defined as the portion of the 1% AEP flow that will be conveyed via a roadway. Where the underground pipe system is sized for the 10% AEP event, the gap flow will be equal the 1% AEP peak flow rate minus the pipe capacity.

The critical road cross section and direction of overland flows are identified in Figure 7 below.

Figure 7 - Overland flow directions and critical road cross sections

The critical road cross section is selected based on where gap flows are expected to be greatest. This approach ensures a 'worst case' for assessing against the floodway safety criteria. Roads running perpendicular to the quarry pit are to be graded towards the ring road and then along the ring road, consequently avoiding urban runoff inflow into the quarry pit. This arrangement thereby protects Growling Grass Frogs from the detrimental impacts of urban runoff for all events up to and including the 1% AEP storm event. Consideration of GGF habitat is discussed further in Section 5.

A typical 16 m wide road cross section has been created in HECRAS with a Manning's roughness coefficient of 0.02 for the roadway and 0.05 for nature strip. A 3.5m wide single lane road pavement is assumed for each direction with an average crossfall of 5% and kerb height of 180mm. A longitudinal grade of 1% is assumed. Adoption of this sample road geometry is considered conservative for assessing floodway safety criteria as the actual road cross sections are likely to be considerably larger and/or rougher due to the presence of car parks and buildings.

3.5.1 Typical Roadway Section – Critical Section

The identified critical road cross section for the proposed development site is to be no less than a standard 16m wide road cross section. The peak 1% AEP for the cumulative Eastern Catchment will not exceed 1.69 m^3/s (from Table 4). The underground pipe drainage system is sized to convey the 10% AEP flow of 1.28 m^3/s, leaving a maximum of 0.41 m^3/s overland flow. Figure 8 shows the results of the HECRAS model.

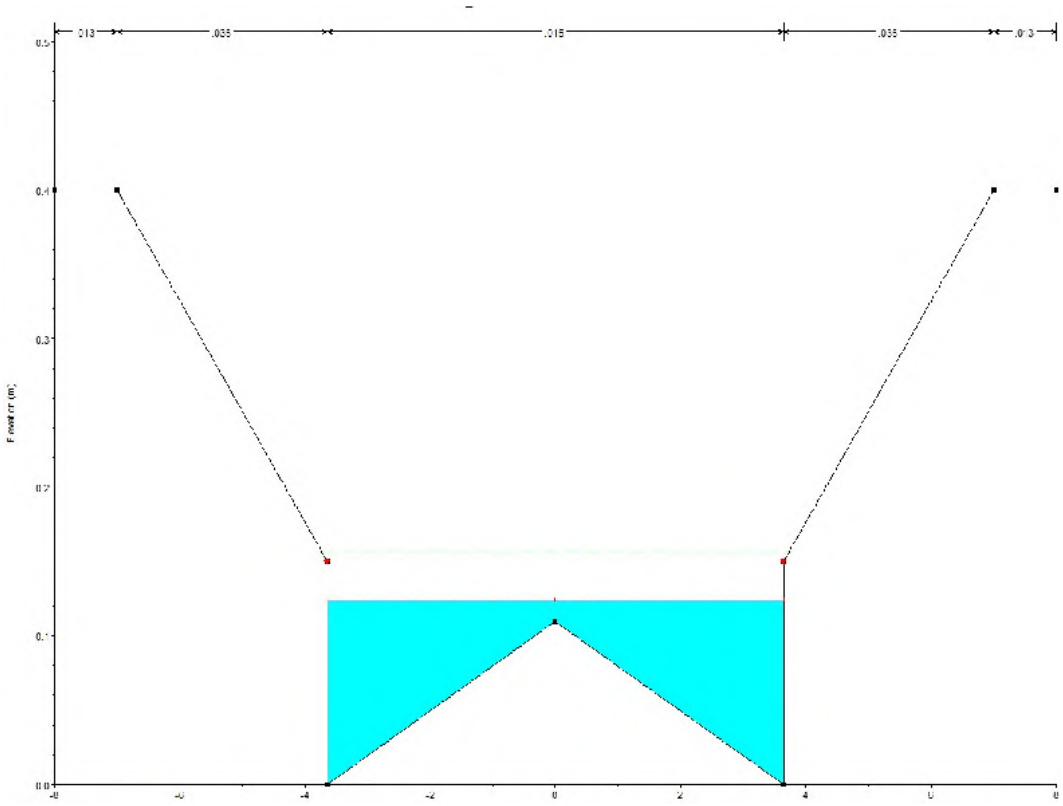


Figure 8 - Critical Road Cross Section 1 results

The calculated values for Cross Section 1 are:

- Flow depth = 0.12 m
- Flow Velocity = 0.82 m/s
- Depth x Velocity = 0.10 m^2/s

Therefore, all flood safety criterion is met for the identified critical cross section.

3.6 Retarding Basin 1 (RB1) Design –Catchment B

The retardation basin was designed such that the surrounding residents and the proposed development have immunity up to the 1% AEP storm event and a minimum of 600mm freeboard is achieved to all adjacent property floor levels. RB1 design considerations include:

- The basin will be constructed in cut adjacent to the quarry pit and Roebourne Crescent Reserve on the south boundary of the property;
- The base of RB includes sufficient area for a constructed wetland, including an inlet pond and macrophyte zone sized to meet Best Practice (BPEM) standards; and all required maintenance access (see Section 4);
- The basin will interface with the surrounding landscape with batters of varying steepness, up to a maximum of 1 in 1 slope. This can be achieved through a combination of dense planting of terrestrial vegetation and terraced retaining walls;

- The basin performance is simulated by routing the 1% AEP storm event through the retardation basin (RB1) using a calibrated RORB hydraulic model. Details of the hydrologic model calibration, configuration and run parameters is provided in Appendix B;
- The basin provides 2700 m^3 of storage in the 1% AEP storm event with water in the basin rising to 1.1m depth;
- At least 600 mm of freeboard is achieved between the modelled 1% AEP event and all adjacent allotment floor levels;
- detention of smaller more frequent storm events will occur via extended detention in the proposed constructed wetland system;
- The design of the retarding basin will contribute to appropriate habitat areas for the existing Growling Grass Frog population, encouraging connectivity between the quarry pit and the site boundary.

A summary of the key features of the retarding basin (RB1) are provided in Table 5. The full design plan and calculations is provided in Appendix D.

Table 5 – RB1 Design Summary

Retarding Basin (RB1) Design Summary		
Base level (avg)	101.8	m AHD
Spillway level	102.9	m AHD
Max batter slope	1 in 1	[m/m]
Critical storm duration (1% AEP)	1.5	hrs
Peak discharge – existing (1% AEP)	0.66	m^3/s
Peak discharge – developed (1% AEP)	1.92	m^3/s
Peak discharge with retardation (1% AEP)	0.42	m^3/s
Peak water level (1% AEP)	102.9	m AHD
Peak storage volume	2700	m^3
Outlet configuration	525mm dia RCP	
Outlet invert level	101.8	m AHD
Outlet pipe slope	1 in 500	[m/m]

3.7 Underground Detention Storage Design – Catchment A

Flows generated by Catchment A to Bolinda Road will be adequately retarded such that the existing capacity of the stormwater network along Bolinda Road and downstream is not exceeded. Design of the underground storage basin (RB2) gives regard to the following design considerations:

- The invert level of the existing 900 mm stormwater pipe on the north side of Bolinda Road is used to determine the total area of Catchment A;

- It is assumed that the existing Council pipe infrastructure currently has capacity to convey the existing catchment of approximately 0.81 ha of the site (Figure 4);
- Backwatering within the proposed 1% AEP stormwater pipes will contribute to the subsurface storage requirement;
- Additional storage in an underground cell is required to ensure the capacity of the downstream stormwater network capacity is not exceeded.

The design of the Bolinda Road storage basin is informed by using Boyd's Formula for storage calculation:

$$S_{max} = V_1 \left(1 - \frac{Q_p}{I_P}\right)$$

- $S_{max} \rightarrow Maximum\ volume\ of\ storage\ (m^3)$
- $V_1 \rightarrow Volume\ of\ inflow\ flood\ (m^3)$
- $Q_p \rightarrow Peak\ discharge\ of\ outflow\ hydrograph\ (m^3/s)$
- $I_P \rightarrow Peak\ discharge\ of\ inflow\ hydrograph\ (m^3/s)$

Calculation of the required storage is provided in Appendix E.

It is found that a minimum volume of approximately 730 m^3 is required to retard the 1% AEP storm event to replicate existing catchment conditions. Table 6 provides key design parameter for the underground storage system.

Table 6 – RB2 design summary

Retarding Basin (RB2) Design Summary – sub-surface storage		
Total Storage Requirement	731	m^3
Approximate Storage in Proposed Stormwater Network	145	m^3
Minimum Additional Storage Required	586	m^3
Storage Base Area	500	m^2
Storage Top Area	1500	m^2
Storage Depth	0.65	m

Installation of a single shallow cell proprietary product, such as the SPEL Stormchamber or similar, will achieve the subsurface storage requirements for the catchment.

3.8 South East Catchment B Outfall

Retarding Basin RB1 discharges to the south east corner of the site via a 525mm pipe outlet and a dedicated Growling Grass Frog habitat pond (Refer to Appendix D) This arrangement ensures that the existing flooding issues experienced by properties adjacent to the south east boundary of the site are addressed with the proposed drainage system design.

No formal drainage infrastructure currently exists downstream of the south east property low point. In order to provide a free draining outfall for the development of Catchment B it is proposed to extend the 525mm pipe outfall approximately 300m into the adjacent property (the Council-owned Bolinda Road Resource Recovery Facility - BRRRF). This enables the pipe outlet to 'daylight' into the form of an open drain and also alleviate the existing flooding conditions of properties on Roebourne Crescent. The pipe alignment has been chosen to integrate with general intentions for GGF corridor connectivity within the existing BRRRF site. The alignment of the last section of this pipe can be adjusted if planning for drainage and GGF connectivity within the BRRRF progresses within a suitable timeframe for site development. This planning involves issues much broader than the development team can respond to, but the proposed response does not narrow options for this future connection.

The proposed outlet pipe of the retarding basin and frog pond is shown conceptually in Figure 9 below.

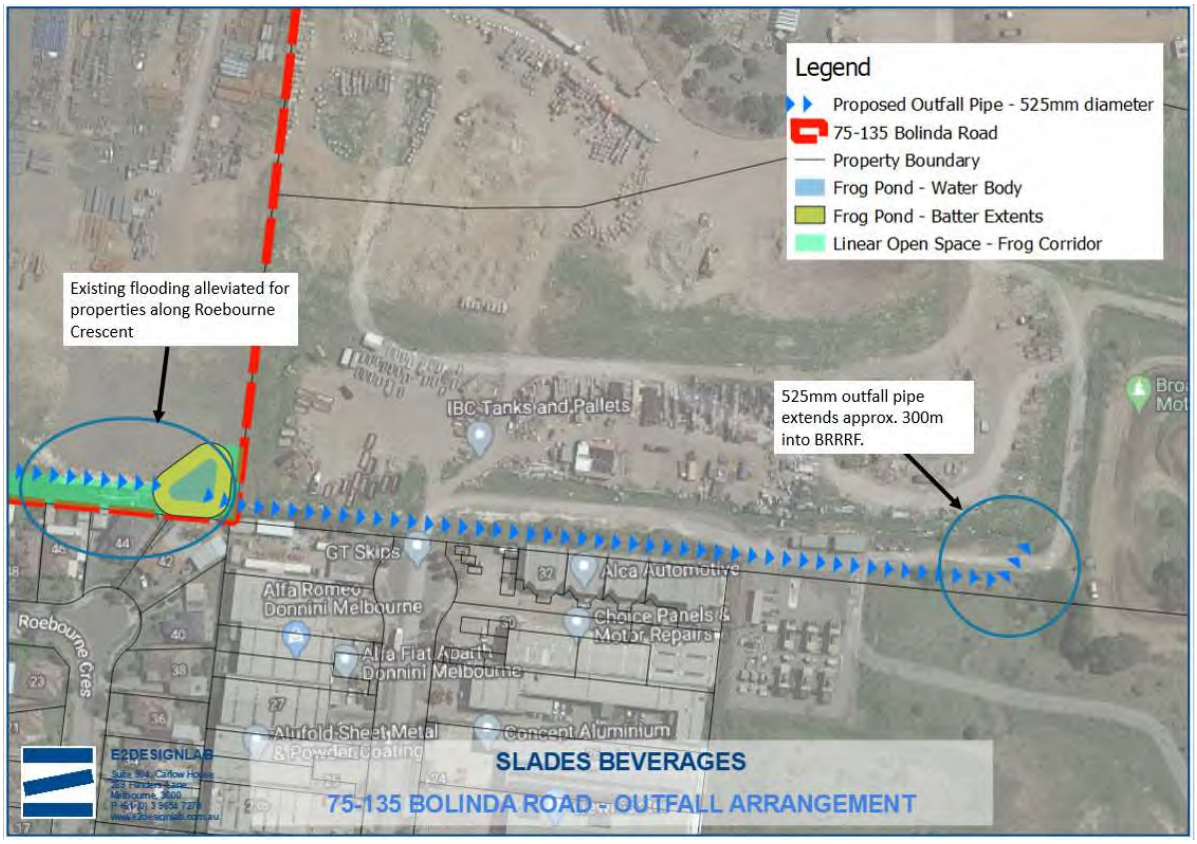


Figure 9 - Catchment B outfall arrangement

4. Stormwater Quality

Stormwater quality for the proposed development will be addressed using a range of typical Water Sensitive Urban Design measures. In summary, the strategy incorporates distributed streetscape raingardens to treat Catchment A and an end of line constructed wetland system to treat flows from Catchment B. These elements are summarised in Table 7 and detailed in the following sections.

Table 7 - Site based design consideration

Stormwater Management Strategy		
Total catchment area (Catchment A)	3.5	ha
Total area of filter media required (Catchment A)	260	m^2
Total catchment area (Catchment B)	7.59	ha
Total wetland, inlet pond and retardation basin footprint	0.36	ha

4.1 Catchment A (North)

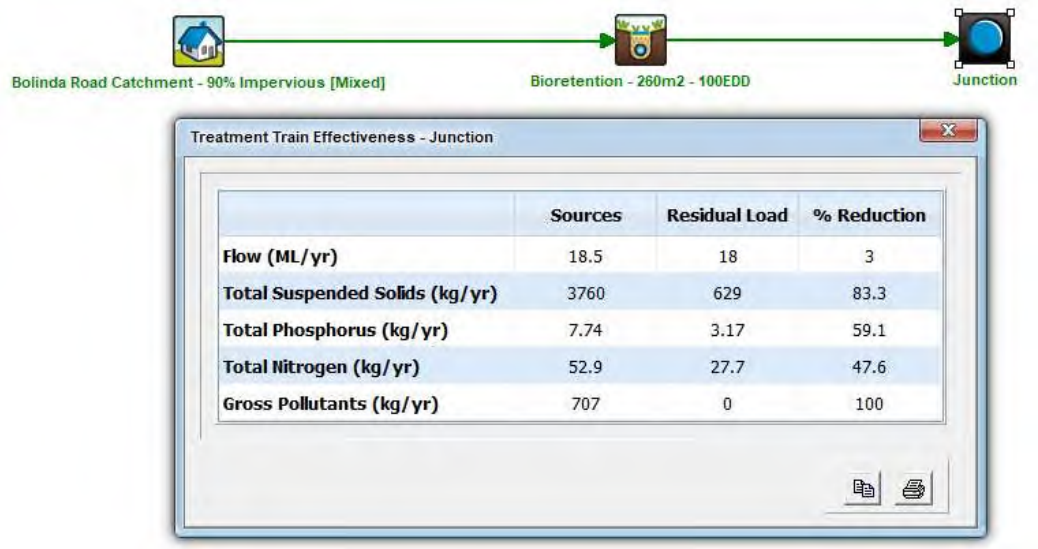
Catchment A consists of approximately 3.5 ha of the proposed development that will require treatment prior to discharging north across Bolinda Road. Stormwater quality objectives will be met by using streetscape based WSUD elements to capture and treat urban runoff before flows enter the major drainage system. These WSUD elements will be raingardens (bioretention systems) dispersed within the streetscape (see Figure 17) and will receive runoff from adjacent pavement during frequently occurring storm events for treatment prior to discharge into the major stormwater network.

A MUSIC model was produced to estimate the total required filter media area required to meet BPEM prior to discharging into the existing stormwater network. A total of 260 m^2 of filter area is required to treat Catchment A to Best Practice.

It is proposed to partition the treatment system into 26 raingardens that are incorporated into the urban design of the streetscapes, vegetated verges and carparks. Each system includes:

- a minimum of 10m^2 filter surface area
- a maximum catchment of 1,400 m^2
- a subsurface drainage layer and an overflow / bypass system that connects into the site's downstream stormwater drainage system.

The MUSIC model configuration and treatment performance is shown in Figure 10.



	Sources	Residual Load	% Reduction
Flow (ML/yr)	18.5	18	3
Total Suspended Solids (kg/yr)	3760	629	83.3
Total Phosphorus (kg/yr)	7.74	3.17	59.1
Total Nitrogen (kg/yr)	52.9	27.7	47.6
Gross Pollutants (kg/yr)	707	0	100

Figure 10 – Catchment A MUSIC model layout and treatment performance

Figure 11 shows an example of an urban streetscape raingarden (bioretention system) and Table 8 summarises the key design parameters for these within Catchment A.

Figure 11 - Example of a streetscape bioretention system

Table 8 – Raingarden (RG1) Design Summary

Raingardens (RG1)		
Raingarden Filter Media Surface Area (minimum)	10	m^2
Total Filter Media Surface Area (minimum)	260	m^2
Filter Media Depth	0.5	m
Hydraulic Conductivity	100	mm/hr
Extended Detention Depth	0.1	m
TN Content of Filter Media	800	mg/kg
Orthophosphate Content of Filter Media	55	mg/kg

The proposed configuration of raingardens dispersed within Catchment A is shown in Figure 17 in Appendix C. It should be noted that an underground 'end of pipe' pollutant removal proprietary product can easily be incorporated into this site layout to address any shortfall in treatment performance if other design objectives or requirements communicated by Council during detailed design impact the number or sizes of these raingardens.

4.2 Catchment B (South)

Catchment B consists of approximately 7.59 hectares of the proposed development that requires treatment to Best practice standards prior to discharge offsite. Water quality objectives will be met by constructing a wetland treatment system in the base of the proposed retarding basin RB1. The constructed wetland treatment train consist of:

- Coarse sediment basin inlet pond; and
- Macrophyte zone tertiary treatment

4.2.1 Coarse Sediment Treatment (Sediment Basin – SB1)

Catchment flows initially enter a sediment basin (inlet pond). The size of this sediment basin has been calculated to capture coarse sediments prior to discharging into the wetland macrophyte zone. A compliant basin design must also be set low enough in the landscape to enable gravity inflows from its catchment and be sufficiently wide to minimise velocities.

The sediment basin was iteratively designed using Fair and Geyer Equation such that 95% of coarse sediments are removed from the 4EY stormwater flows prior to discharging into the constructed wetland macrophyte zone. Design calculations used to inform sizing the basin are provided in Appendix D (Table 12). Features of the proposed sediment basin design include:

- The sediment basin is configured such that 1EY stormwater flows are diverted into the constructed wetland;
- The basin is sized to remove at least 95% of coarse sediments from the 4EY flows generated from the eastern and western catchments post-development;
- The normal water level of the sediment basin is set to ensure catchment flows can be conveyed into the basin via underground pipes whilst maintaining adequate cover and enough height for storage requirements;
- The 1% AEP and 4EY velocities do not exceed the 0.5 m/s and 0.05 m/s (respectively) limit over both the sediment basin and macrophyte zone (refer Appendix D, Table 13). As the available area is limited, the width of the system is set to the minimum allowable width without exceeding this velocity constraint (minimum width = 21.00 m);
- Although safe batters (1:5) are provided below the waterline around the basin to a depth of 350mm, this basin will require fencing to prevent public egress ;
- The basin is designed such that a cleanout is required approximately once every 21 years;

- The sediment dewatering area is sized to dewater all excavated sediment piled to a maximum of 0.5 m high (minimum required area = 58 m^2); and
- The standing water body is located more than 15 meters from the nearest road reserve and the sediment dewatering area is more than 25 meters from the nearest residential property.

Table 9 provides the key design features of the proposed sediment basin.

Table 9 - Sediment basin (inlet pond) design summary

Sediment Basin (Inlet Pond)		
Normal Water Level, NWL	101.8	m AHD
Top Extended Detention, TED (Depth = 350 mm)	102.15	m AHD
Inlet Pond Volume	438	m^3
Inlet Surface Area	400	m^2
Permanent Pond Depth, d_p	1.5	m
Sediment Storage Depth, d^*	1	m

4.2.2 Macrophyte Zone Treatment (W1)

The wetland macrophyte zone is sized to meet targets as set out in Table 1.

Performance of the wetland with regards to meeting *BPEM* requirements is verified by the associated MUSIC model. The footprint of both the inlet pond and wetland were integrated with the proposed design surface and includes consideration of batters at a 1 to 1 slope. Care has been taken to ensure an efficient treatment asset is proposed that provides adequate treatment to meet all *BPEM* target reductions and services the full extent of Catchment B.

The MUSIC model treatment performance for the proposed constructed wetland is shown in Figure 12 below.

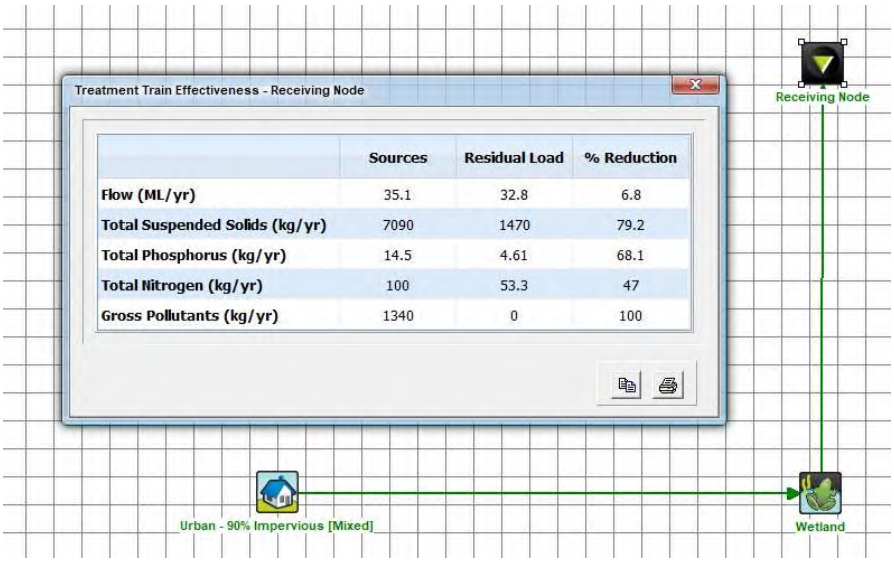


Figure 12 - MUSIC Model Performance

Design features of the proposed stormwater management strategy are provided in Table 10, with the design plan and associated calculations presented in Appendix D.

Table 10 - Constructed Wetland Macrophyte Zone Design Summary

Wetland Macrophyte Zone		
Normal Water Level, NWL	101.8	m AHD
Depth Below NWL	Varies (0.15 – 1.2)	m
Macrophyte Zone Treatment Area	1800	m^2
Extended Detention Depth, Edd	0.35	m
Macrophyte Planting (80%)	1440	m^2
Open Water (20%)	360	m^2

5. Ecological Protection

The quarry pit has a confirmed viable population of Growing Grass Frogs (GGF) (*Litoria raniformis*), a species that is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and endangered on the *IUCN Red List* (Last Assessed: 30 April 2004). As such, the species is to be treated with national environmental significance. *EPBC Act* policy statement 3.14 describes the species as dependent on a matrix of aquatic and terrestrial habitat for breeding, foraging, shelter and dispersal. Principal threats to GGF are habitat loss, degradation and modification, fragmentation and isolation of populations and the introduction of predators and diseases. Uncontrolled development has the potential to contribute to these threats by impacting:

- Draining, infilling or changes to flooding patterns of permanent and non-permanent water bodies, or their adjoining watercourses and surrounding water bodies
- Alterations of wetland hydrology, diversity and structure
- Deterioration of water quality and any introduction of pollutants and biocides
- Construction of barriers that limit frog movement between waterbodies

Several components of the stormwater management strategy were proposed to ensure no adverse impacts on the Growling Grass Frogs population following development. Such components include:

- Diversion of urban runoff into WSUD treatment systems and then off-site rather than into the quarry pit, ensuring no additional pollutants contaminate the habitat values following development
- The proposed stormwater system to be configured immediately adjacent to the rim of the quarry pit to promote connectivity and frog movement from the quarry pit
- Rock swale extending from the treatment system to a proposed frog pond located at the south east corner of the land parcel, therefore promoting connectivity to the eastern property boundary, towards Merri Creek.

The interventions proposed in this Stormwater Management Strategy support the preservation of GGF habitat within the quarry pit and promotes GGF mobilisation and connectivity with the Merri Creek corridor.

6. Conclusion

The development proposed by Forte Developments in the suburb of Campbellfield is required to meet the best practice standards as specified by the City of Hume, Victorian Planning Authority (Table 1) and Melbourne Water.

The Stormwater Management Strategy (*SWMS*) for Catchment B generally includes:

- pipe drainage infrastructure to convey the 10% AEP design flows, therefore minimising nuisance flooding occurrences in regular rainfall events;
- gap flows, i.e. the difference between the 1% AEP design flows and the pipe flows will be safely conveyed through the development within the roadways;
- the proposed development layout will achieve relevant freeboard requirements for allotments, protecting people, property and the adjacent residents from the 1% AEP flood levels associated with the overland flows in road and drainage reserves;

A site drainage outfall to the south services Catchment B (7.59 ha). Elements of the strategy specific to Catchment B include:

- catchment runoff directed to an 'end of pipeline' constructed wetland located in the base of retarding basin (RB1) for stormwater quality treatment in accordance with Best Practice targets; and
- the constructed wetland will be located adjacent to the rim of the quarry pit along the southern property. The wetland will connect to a dedicated frog pond via an open space corridor to promote Growling Grass Frog movement connectivity to the eastern property boundary.

A site drainage outfall to the north services Catchment A (3.5 ha). Elements of the strategy specific to Catchment A include:

- An underground detention basin configured to limit the site's peak discharge during a 1% AEP storm event: this peak discharge being limited to that of the undeveloped catchment before being discharging into the existing Bolinda Road stormwater network.
- distributed raingarden systems for stormwater quality treatment in accordance with Best Practice targets.

Appendix A - Development Masterplan

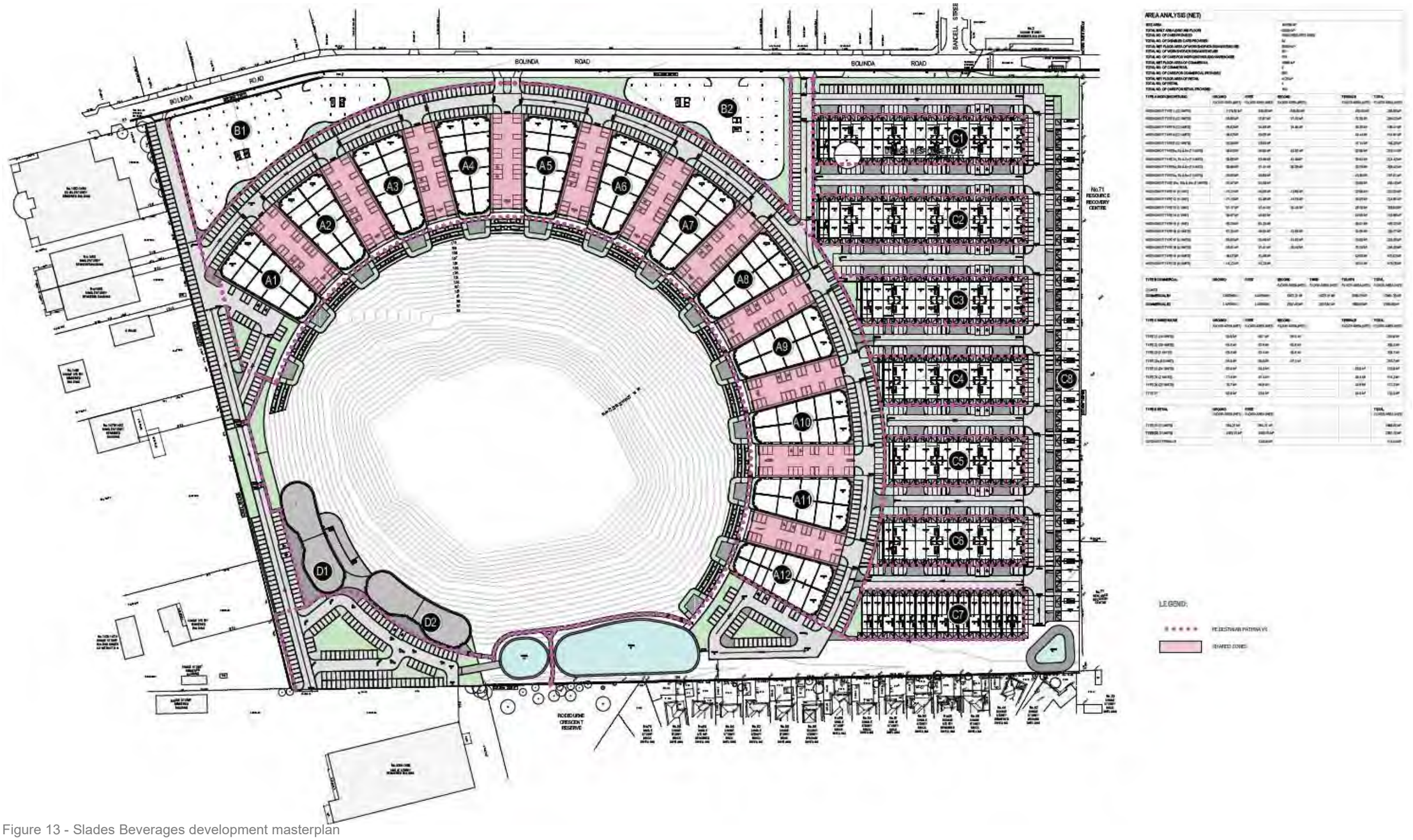


Figure 13 - Slades Beverages development masterplan

Appendix B – Flow Calculations

- An existing conditions RORB model was developed for the 75 – 135 Bolinda Road land parcel. Here the site was divided into sub-catchments areas for both the eastern and western catchment, with a fraction impervious of 5% to represent the undeveloped land use. Type 1 reaches (natural reaches) were assigned to each sub-catchment, routing flows towards the south east corner of the site.
- In the absence of flow gauge data from the site, an estimation of pre-developed flow for a 1% AEP storm event (catchment = 7.59 ha) was calculated using the Nikoloau/vont Steen equation (rural catchment): (consistent with Melbourne Water's guidance note for modelling consistent with ARR 2019)

$$Q_{1\%} = 4.67\ A^{0.763} = 4.67\ (0.0759)^{0.763} = 0.65\ m^3/s$$

- This was compared to the rural rational method hand calculation:
  - Time of concentration ~ 17.5 minutes
  - Fraction impervious = 0.05
  - I 10 1 = 28.2 mm / hr
  - $Q_{1\%} = 0.62\ m^3/s$
- An existing conditions RORB model was run using an initial estimate for Kc, assuming the eastern and western catchments drain to property low point located at the south east corner of the site. Results were compared to the Nikoloau/vont Steen (N/vS) flow for the 1% AEP storm event at the assigned legal point of discharge. An iterative approach was taken whereby the Kc value was changed until that the RORB model flow matched that from the N/vS equation. A Kc value of 0.625 resulted in a RORB flow within 1% of the N/vS flow estimation for an urban catchment.

Table 11 – RORB Calibration to Nikoloau/vont Steen equation

$Q_{1\%} = 4.67\ A^{0.763}$ $\quad A \rightarrow km^2$

		Catchment Area:	0.07593266 km^2	
Calibration				
Run	Kc [-]	Nikoloau/vont Steen equation m^3/s	RORB Discharge m^3/s	%
1	0.800	0.653	0.539	17%
2	0.750	0.653	0.5664	13%
3	0.650	0.653	0.6391	2%
4	0.600	0.653	0.6801	4%
5	0.625	0.653	0.6596	1%

Southern Drainage – Catchment B – RORB Methodology (refer to Figure 14, Figure 15 and Figure 16)

- An existing model was produced based on the following assumptions and considerations:
    - all reaches were defined as natural reaches;
    - 3.5 ha of the site will drain via the existing stormwater network along Bolinda Road;
    - sub-catchments were defined as mostly uniform areas to best represent the routing within the development drainage system;
    - reach lengths are defined as the distance between the centroids of each adjoining sub-catchment;
- As the catchment is ungauged, the existing conditions model was calibrated using the following approach:
    - Nikoloau/vont Steen (N/vS) equation for a rural catchment was used to determine a 1% AEP flow estimate for the land parcel;
    - flow estimate from the N/vs equation were within 4.5% of the traditional rural rational method hand calculation for the site;
    - an iterative approach was taken whereby the RORB coefficient – kc – was modified until routed flows were within 1% of the Q100 (1% AEP) estimate from the N/vS equation
- Once the kc value was calibrated (kc = 0.625), the reach types from the existing model were modified to best represent the behaviour of an urban catchment in high (1% AEP – Figure 14) and frequent flow conditions (4EY and 10% AEP – Figure 15);

Northern Drainage – Catchment A (refer to Appendix C, Figure 17)

- An estimate of catchment flows was calculated using a rural rational method approach;
- Time of concentration was approximated using Adam's Method;
- Existing condition catchment flows were compared to the Nikoloau/vont Steen Equation (rural catchment) (catchment area = 0.81 ha), assuming a 5% fraction impervious;
    - Rural rational method – 1% AEP = 0.09 m^3/s
    - Nikoloau/vont Steen (rural catchment) – 1% AEP = 0.12 m^3/s
- Post-developed catchment flows were compared to the Nikoloau/vont Steen Equation (urban catchment) (catchment area = 3.5 ha), assuming a 90% fraction impervious;
    - Rational method – 1% AEP = 1.16 m^3/s
    - Nikoloau/vont Steen (urban catchment) – 1% AEP = 0.95 m^3/s
- The total require sub-surface storage was estimated using Boyd's Formula. The volume of the proposed 1% AEP stormwater network was calculated and subtracted from the total required storage (Appendix E).

Figure 14 - RORB post-development catchment plan – 1% AEP storm event

Figure 15 - RORB post-development catchment plan – 4EY and 10% AEP storm events

Figure 16 - RORB existing conditions catchment plan

Appendix C – Catchment A Treatment Configuration

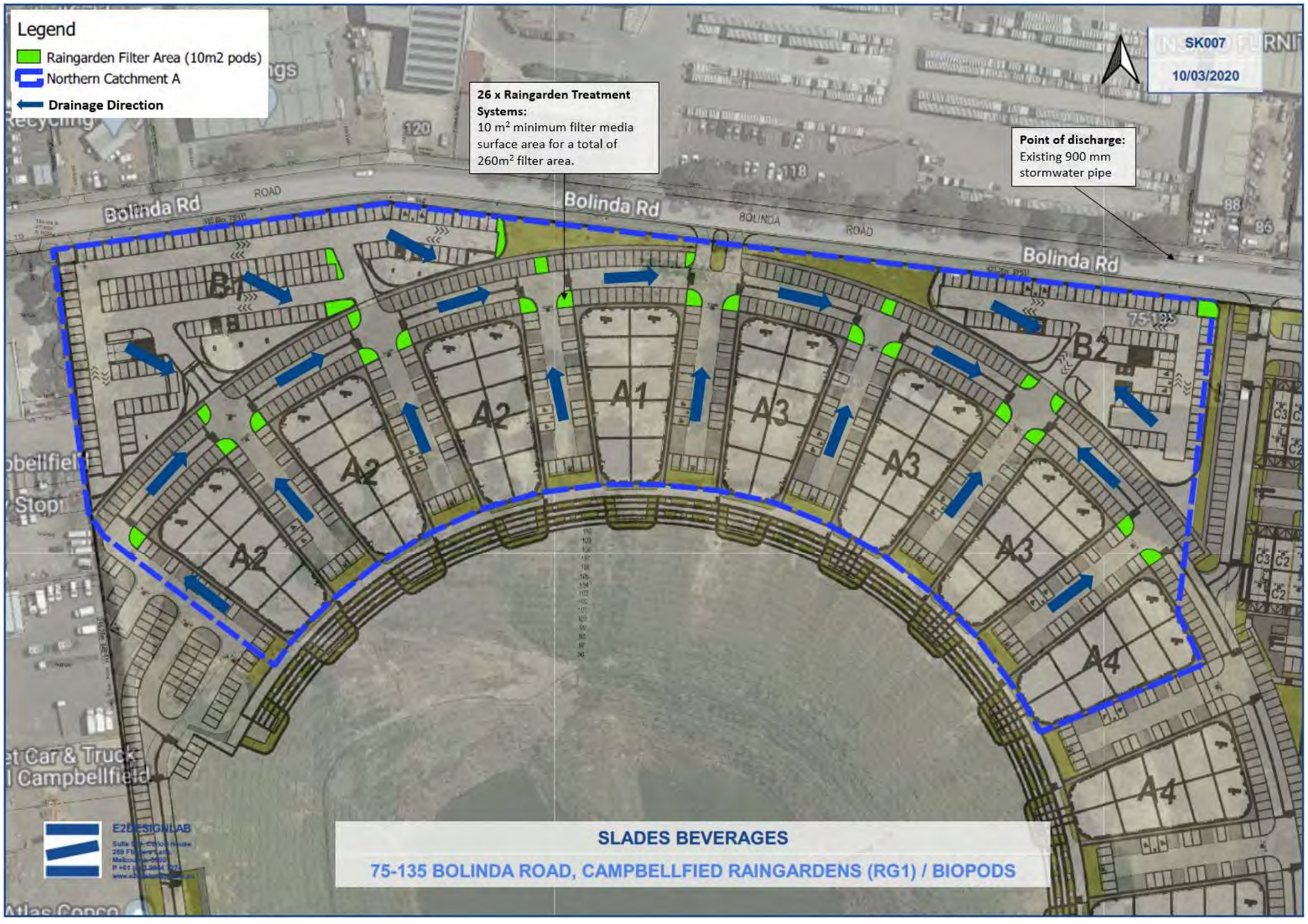


Figure 17 – Catchment A (north catchment) treatment configuration

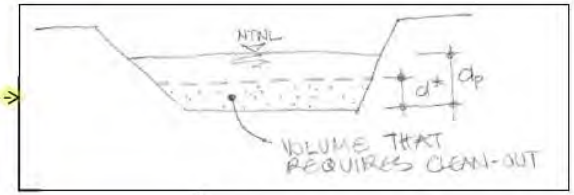
Appendix D – Catchment B Treatment and Conveyance Configuration

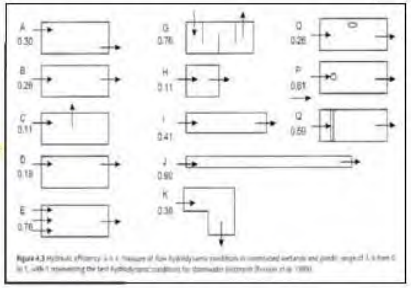
Figure 18 - Wetland layout plan

Table 12 - Inlet pond sizing

Project:	Bolinda Road	
Date:	2/03/2020	
Designer:	SA/AD	
		cell for data entry
		cell contains formula
		cell contains result and comment
	Sediment Basin	
Q (1 in 3 month) (m3/s)	0.360	
Area (ha)	7.59	
	22.22%	
Basin Parameters		
d_e	0.35	Extended detention depth
d_p	1.50	Depth of permanent pool (m)
d*	1.00	Sediment storage depth
λ	0.11	Hydraulic efficiency -> 0.11 - 0.9 (see Fig. 4.3 right)
n	1.12	Turbulence parameter
v_s	0.011	Settling velocity of target sediments (m/s)
Q	0.360	Design flow (m^3/s)
P_w	20.0	Width of permanent pool water surface (m)
P_L	20.0	Length of permanent pool water surface (m)
A	400.0	Area of permanent pool water surface (m^2)
Basin Efficiency		
R	95.5%	Target sediment capture efficiency (%)
Scour Check		
v	0.04	Scour velocity over top storage volume during peak design flow event (m/s)
		*tested up to 5year flows that comply with scouring check
Storage Volume & Clean-out Frequency		
C_a	7.59	Contributing atchment area (ha)
L_o	1.6	Sediment loading unit rate (m^3/ha/yr) -> Willing and Partners 1992
s	2	Sediment basin side batter slope
	324	Storage volume top area
A_B	196	Sediment basin base area (m^2)
S_t	257.3	Storage volume available (m^3)
F_r	21.18	Clean-out frequency (yrs)
Sediment Drying Area		
Vol	29.0	Volume of accumulated sediment over 5 years (m3)
Area	58.0	Minimum area required for sediment drying (m2)

12.14923 sediment loading rate

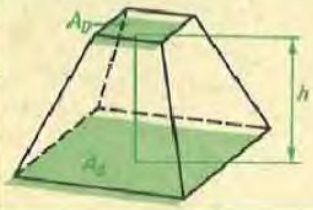




$$(\lambda = 1 - 1/n);\ n = \frac{1}{1-\lambda}$$

$$R = 1 - \left[1 + \frac{1}{n} \times \frac{v_s}{Q/A} \times \frac{(d_e + d_p)}{(d_e + d^*)}\right]^{-n}$$

$$V = \frac{1}{3} h \left(A_G + \sqrt{A_G A_D} + A_D\right)$$



$$S_t = C_a \times R \times L_0 \times F_r$$

Table 13 - Wetland velocity check

Use this spreadsheet to check wetland velocity thresholds in Melbourne Water Deemed to Comply Criteria
MZ10 - Velocity through macrophyte zone Q3month < 0.05 m/s
MZ10 - Velocity through macrophyte zone Q100 < 0.5 m/s
MZ4 - Length of macrophyte zone > 4 times width
SP3 - Velocity through sed pond Q100 < 0.5 m/s

Legend	
	Input values
	Calculated values
	Default value - alter if required
	Check cell - result is OK
	Check cell - result is NOT OK

Asset Reference	Sediment Basin	
	Q3 month	Q100
Flow (m^3/s)	0.36	1.92
Sediment Basin		
Surface Area at NWL (m^2)	400	400
NWL (m AHD)	201.15	201.15
TED (m AHD)	201.50	201.65
Flow Depth above NWL (m)	0.35	0.50
Avg Batter Slope above NWL (1 in)	1	1
Width at NWL (m)	20.0	8.0
Top Width of flow (m)	20.7	9.0
Average flow width (m)	20.4	8.5
Flow area (m^2)	7.1	4.3
Flow Velocity (m/s)	0.051	0.452
Length to Width Ratio (1:)	1.0	
Macrophyte Zone		
Surface Area at NWL (m^2)	1800	1800
NWL (m AHD)	201.05	201.05
TED (m AHD)	201.40	201.40
Flow Depth above NWL (m)	0.35	0.50
Avg Batter Slope above NWL (1 in)	1	1
Width at NWL (m)	20.0	8
Top Width of flow (m)	21	9
Average flow width (m)	20	9
Flow area (m^2)	7.1	4.3
Flow Velocity (m/s)	0.051	0.452
Length to Width Ratio (1:)	4.5	
Wetland flow path length (m)	90	

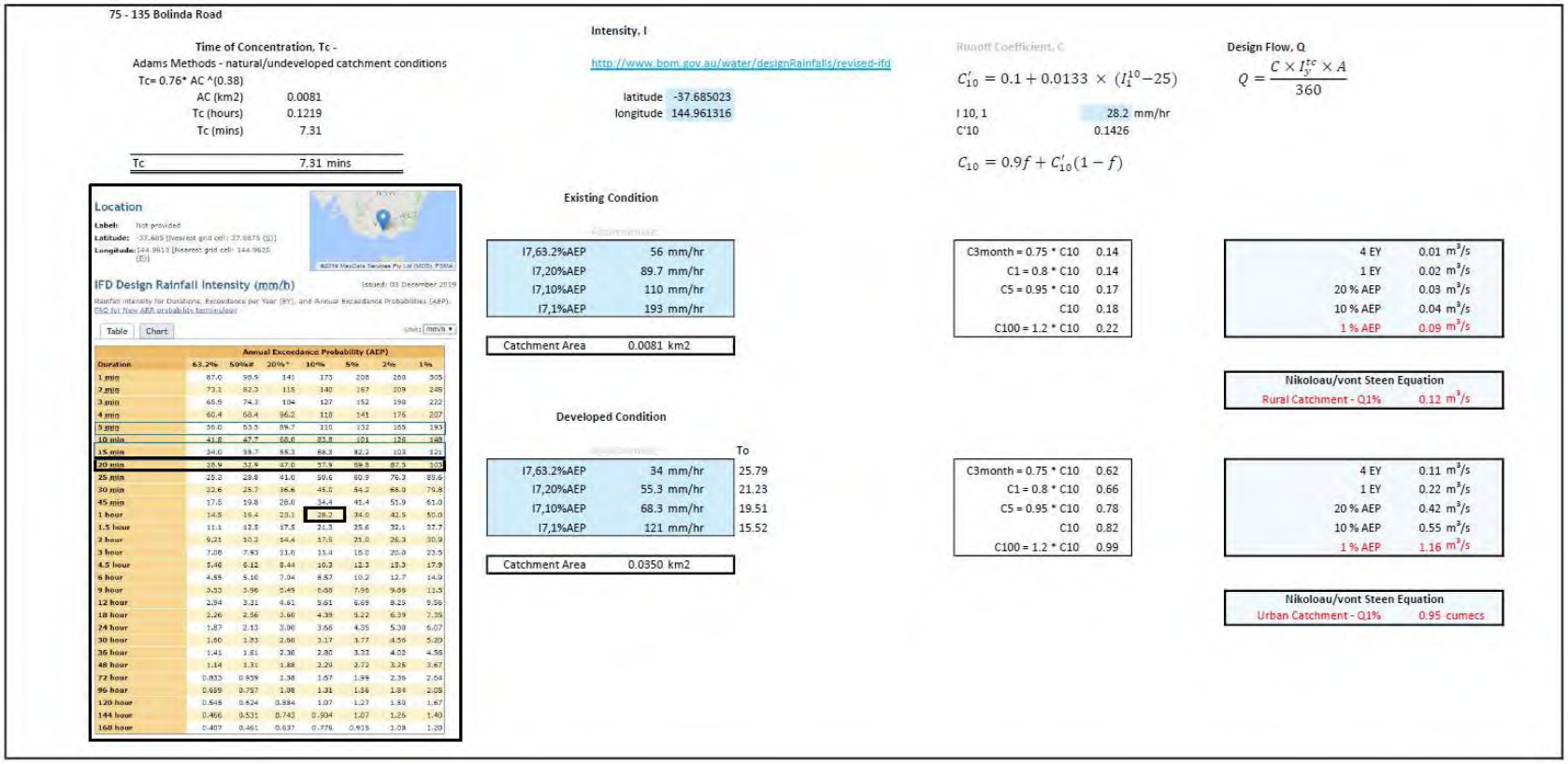
Notes:
Sediment Basin NWL sits a minimum of 100mm above the Macrophyte Zone NWL as per MW Standard Drawing 7251/12/001

Table 14 - Retarding basin design – stage storage relationship

Height [m]	Volume to height [m^3]
2	5069.267
1.9	4789.517
1.8	4512.582
1.7	4238.454
1.6	3967.125
1.5	3698.587
1.4	3432.833
1.3	3169.853
1.2	2909.64
1.1	2652.186
1	2397.483
0.9	2145.523
0.8	1896.299
0.7	1649.801
0.6	1406.022
0.5	1164.954
0.4	926.589
0.3	690.919
0.2	457.937
0.1	227.633
0	0

Appendix E – Bolinda Road Underground Storage Calculations

Table 15 - Catchment A flow calculations



75 - 135 Bolinda Road

Time of Concentration, Tc -
Adams Methods - natural/undeveloped catchment conditions
Tc= 0.76* AC ^(0.38)

AC (km2)	0.0081
Tc (hours)	0.1219
Tc (mins)	7.31
Tc	7.31 mins

Intensity, I

http://www.bom.gov.au/water/designRainfalls/revised-ifd

latitude	-37.685023
longitude	144.961316

Runoff Coefficient, C

$$C'_{10} = 0.1 + 0.0133 \times (I_1^{10} - 25)$$

I 10, 1	28.2 mm/hr
C'10	0.1426

$$C_{10} = 0.9f + C'_{10}(1 - f)$$

Design Flow, Q

$$Q = \frac{C \times I_y^{tc} \times A}{360}$$

Location

Label: Not provided
Latitude: -37.685 [Nearest grid cell: -37.6875 (S)]
Longitude: 144.9613 [Nearest grid cell: 144.9625 (E)]

IFD Design Rainfall Intensity (mm/h)

Issued: 03 December 2019

Rainfall intensity for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

Table | Chart | Units: mm/h

Annual Exceedance Probability (AEP)

Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	87.0	99.9	141	173	208	269	305
2 min	73.1	82.3	115	140	167	209	245
3 min	65.9	74.2	104	127	152	190	222
4 min	60.4	68.4	96.2	118	141	176	207
5 min	56.0	63.5	89.7	110	132	165	193
10 min	41.8	47.7	68.6	85.8	101	126	148
15 min	34.0	38.7	55.3	68.3	82.2	103	121
20 min	28.9	32.9	47.0	57.9	69.8	87.5	103
25 min	25.2	28.8	41.0	50.6	60.9	76.3	89.6
30 min	22.6	25.7	36.6	45.0	54.2	68.0	79.8
45 min	17.5	19.8	28.0	34.4	41.4	51.9	61.0
1 hour	14.5	16.4	23.1	28.2	34.0	42.5	50.0
1.5 hour	11.1	12.5	17.5	21.3	25.6	32.1	37.7
2 hour	9.21	10.3	14.4	17.5	21.0	26.3	30.9
3 hour	7.06	7.93	11.0	13.4	16.0	20.0	23.5
4.5 hour	5.46	6.12	8.44	10.3	12.3	15.3	17.9
6 hour	4.55	5.10	7.04	8.57	10.2	12.7	14.9
9 hour	3.53	3.96	5.49	6.68	7.96	9.86	11.5
12 hour	2.94	3.31	4.61	5.61	6.69	8.29	9.66
18 hour	2.26	2.56	3.60	4.39	5.22	6.39	7.35
24 hour	1.87	2.13	3.00	3.66	4.35	5.30	6.07
30 hour	1.60	1.83	2.60	3.17	3.77	4.56	5.20
36 hour	1.41	1.61	2.30	2.80	3.33	4.02	4.56
48 hour	1.14	1.31	1.88	2.29	2.72	3.26	3.67
72 hour	0.833	0.959	1.38	1.67	1.99	2.39	2.64
96 hour	0.659	0.757	1.09	1.31	1.56	1.84	2.09
120 hour	0.548	0.624	0.884	1.07	1.27	1.53	1.67
144 hour	0.466	0.531	0.743	0.904	1.07	1.26	1.40
168 hour	0.407	0.461	0.637	0.776	0.915	1.09	1.20

Existing Condition

I7,63.2%AEP	56 mm/hr
I7,20%AEP	89.7 mm/hr
I7,10%AEP	110 mm/hr
I7,1%AEP	193 mm/hr

Catchment Area	0.0081 km2

C3month = 0.75 * C10	0.14
C1 = 0.8 * C10	0.14
C5 = 0.95 * C10	0.17
C10	0.18
C100 = 1.2 * C10	0.22

4 EY	0.01 m³/s
1 EY	0.02 m³/s
20 % AEP	0.03 m³/s
10 % AEP	0.04 m³/s
1 % AEP	0.09 m³/s

Nikoloau/vont Steen Equation	
Rural Catchment - Q1%	0.12 m³/s

Developed Condition

		To
I7,63.2%AEP	34 mm/hr	25.79
I7,20%AEP	55.3 mm/hr	21.23
I7,10%AEP	68.3 mm/hr	19.51
I7,1%AEP	121 mm/hr	15.52

Catchment Area	0.0350 km2

C3month = 0.75 * C10	0.62
C1 = 0.8 * C10	0.66
C5 = 0.95 * C10	0.78
C10	0.82
C100 = 1.2 * C10	0.99

4 EY	0.11 m³/s
1 EY	0.22 m³/s
20 % AEP	0.42 m³/s
10 % AEP	0.55 m³/s
1 % AEP	1.16 m³/s

Nikoloau/vont Steen Equation	
Urban Catchment - Q1%	0.95 cumecs

Table 16 - Catchment A storage requirements - Boyd's Formula calculation

Temporary Retarding Basin Storage Sizing Using Boyds Formula

Existing Flow	0.09 m^3/s	Qp	Req. Outflow
Developed Flow	1.16 m^3/s	Ip	Peak Inflow
Retardation Required	1.07 m^3/s		
Catchment Area	3.50 ha		
C100	0.99		

$$S_{max} = V_1 (1 - Q_p/I_p)$$

S_{max} = Maximum Volume of temporary Storage (m^3)
V_1 = Volume of inflow flood (m^3)
I_p = Peak discharge of inflow hydrograph (m^3/s)
Q_p = Peak discharge of outflow hydrograph (m^3/s)

Storm Duration	100yr Intensity (mm/hr)	Ip	Qp	V1	Smax
5	193	1.86	0.09	278	264
10	148	1.42	0.09	427	399
15	121	1.16	0.09	524	481
20	103	0.99	0.09	594	538
25	89.6	0.86	0.09	646	576
30	79.8	0.77	0.09	691	606
45	61	0.59	0.09	792	665
60	50	0.48	0.09	865	696
90	37.7	0.36	0.09	979	725
120	30.9	0.30	0.09	1070	731
180	23.5	0.23	0.09	1220	713
270	17.9	0.17	0.09	1394	633
360	14.9	0.14	0.09	1547	532
540	11.5	0.11	0.09	1792	268
720	9.56	0.09	0.09	1986	-45
1080	7.35	0.07	0.09	2290	-756
1440	6.07	0.06	0.09	2522	-1540
1800	5.2	0.05	0.09	2700	-2377
2160	4.56	0.04	0.09	3240	-2852
2880	3.67	0.04	0.09	3789	-4335
4320	2.64	0.03	0.09	4574	-7612

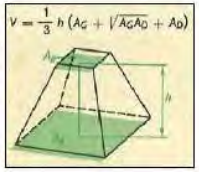
Total Storage Required	731 m3

Pipe Network Capacity		
Pipe dia (mm)	Reach Length (m)	Volume (m3)
400	50	6.283185307
525	50	10.82376844
600	50	14.13716694
750	50	22.08932335
750	50	22.08932335
825	50	26.72808125
525	50	10.82376844
900	50	31.80862562
	Total	145

Required storage	586 m^3

Storage Volume Achieved	
h	0.65 m
Ag	1500 m2
Ad	500 m2
V	621 m3

$$V = \frac{1}{3} h \left(A_G + \sqrt{A_G A_D} + A_D\right)$$



APPENDIX 4 - Wetland Species

Table A1: Species List of Recommended Plants for Revegetation

Botanical Name	Common Name
Fringing and emergent	
Calystegia sepium	Large Bindweed
Carex appressa	Tall Sedge
Carex fascicularis	Tassel Sedge
Carex gaudichaudiana	Fen Sedge
Crassula helmsii	Swamp Crassula
Epilobium billardierianum	Smooth Willow-herb
Glyceria australis	Australian Sweet-grass
Lachnagrostis filiformis	Common Blown-grass
Lycopus australis	Australian Gypsywort
Melaleuca ericifolia	Swamp Paperbark
Poa labillardierei var. *labillardierei*	Common Tussock-grass
* *Potamogeton ochreatus*	Blunt Pondweed
Ranunculus amphitrichus	Running Marsh Flower
Emergent	
Alisma plantago-aquatica	Water Plantain
Amphibromus fluitans	River Swamp Wallaby-grass
Baumea articulata	Jointed Twig-sedge
Cladium procerum	Leafy Twig-sedge
* *Eleocharis acuta*	Common Spike-sedge
Juncus amabilis	Hollow-rush
Juncus gregiflorus	Green Rush
Juncus procerus	Tall Rush
Juncus sarophorus	Broom Rush
Persicaria decipiens	Slender Knotweed
Persicaria praetermissa	Spotted Knotweed
Persicaria subsessilis	Hairy Knotweed
Ranunculus inundatus	River Buttercup
Schoenoplectus tabernaemontani	River Club-sedge
Submergent	
Ceratophyllum demersum	Hornwort
Myriophyllum caput-medusae	Coarse Water-milfoil
Myriophyllum crispatum	Upright Water-milfoil
Myriophyllum simulans	Amphibious Water-milfoil
Potamogeton crispus	Curly Pondweed

Botanical Name	Common Name
Floating Submergent	
Carex gaudichaudiana	Fen Sedge
Hydrocotyle sibthorpioides	Shining Pennywort
Lythrum salicaria	Small Loosestrife
Neopaxia australasica	White Purslane
* *Ottelia ovalifolia*	Swamp Lily
Potamogeton ochtreatus	Blunt Pondweed
Potamogeton pectinatus	Fennel Pondweed
Rumex bidens	Mud Dock
* *Triglochin procerum*	Water Ribbon (emergent form)
* *Vallisneria americana*	Ribbon-weed
Villarsia reniformis	Running Marsh Flower

Notes: * Indicates highly desirable vegetation for Growling Grass Frog, # Limit use of this species, as it may become invasive

APPENDIX 5 - WEED MANAGEMENT PLAN

Draft Report

Weed Management Plan, Proposed Commercial Development at 75-135 Bolinda Road, Campbellfield, Victoria

Prepared for

Forte Group Pty Ltd

December 2020

Ecology and Heritage Partners Pty Ltd

MELBOURNE: 292 Mt Alexander Road Ascot Vale VIC 3056 **GEELONG:** PO Box 8048 Newtown VIC 3220
BRISBANE: Level 22, 127 Creek Street Brisbane QLD 4000 **ADELAIDE:** 8 Greenhill Road Wayville SA 5034
CANBERRA: PO Box 6067, O'Connor ACT 2602 **SYDNEY:** level 5, 616 Harris Street, Ultimo, NSW, 2007: **www.ehpartners.com.au**

DOCUMENT CONTROL

Assessment	Weed Management Plan
Address	75-135 Bolinda Road Campbellfield, Victoria
Project number	13138
Project manager	Jeremy Coyne (Zoologist / Team Leader - Natural Heritage)
Report Author	Jack Pascoe (Field Ecologist / Botanist)
Report reviewer	Aaron Organ (Director / Principal Ecologist)
Mapping	Monique Elsley (GIS Coordinator)
File name	13138_EHP_WMP_BolindiaRd_DRAFT_08122020
Client	Forte Group Pty Ltd
Bioregion	Victorian Volcanic Plains
CMA	Port Phillip and Western Port
Council	Hume City Council

Report versions	Comments	Date submitted
Draft	Report sent to client	08/12/2020

DRAFT

Copyright © Ecology and Heritage Partners Pty Ltd
This document is subject to copyright and may only be used for the purposes for which it was commissioned. The use or copying of this document in whole or part without the permission of Ecology and Heritage Partners Pty Ltd is an infringement of copyright.

Disclaimer
Although Ecology and Heritage Partners Pty Ltd have taken all the necessary steps to ensure that an accurate document has been prepared, the company accepts no liability for any damages or loss incurred as a result of reliance placed upon the report and its contents.

CONTENTS

DRAFT

1 INTRODUCTION

1.1 Background

Ecology and Heritage Partners Pty Ltd was engaged by Forte Group to prepare a Weed Management Plan (WMP) for a proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria. The preparation for this report is in response to the request for further information from the Department of Agriculture, Water and the Environment (DAWE) dated 16 September 2020.

Forte Group, are currently responsible for the management of 75-135 Bolinda Road Campbellfield, Victoria. Intensive management of the site is planned to be be undertaken for a minimum of three years following completion of the development, followed by arrangements with relevant organisations (for example, Merri Creek Management Committee, Hume City Council) to manage the sites thereafter. If these arrangements are unsuccessful, a further eight years of management will be arranged (e.g. using a contractor experienced in such projects). Once established, arrangements for the management of the movement corridor in the Council's open-space to be absorbed into the greater open-space management by Hume City Council will be sought.

1.2 Weed Management Plan Objectives

The objectives of the WMP are to provide for the:

- Identification of potential threats associated with pest plant and animal species, that may impact environmental values within the study area; and,
- Implementation of appropriate management actions to address weed infestations and vertebrate pest species, to ensure environmental values within the study area are maintained and enhanced.

1.3 Study Area

The study area is located in Campbellfield, Victoria, approximately 27 kilometres north of Melbourne (Figure 1). It is surrounded by residential, commercial and industrial land to the north, west and south, and a former landfill site to the east. Approximately 16 hectares in size, the study area is dominated by sloping banks of bare earth, introduced grasses and weeds. A large waterbody has formed at the lowest point of the former quarry, and aquatic vegetation within the study area is largely limited two small discrete areas on the edge of the waterbody. Merri Creek is approximately 600 meters east of the study area and approximately 850 meters east of the waterbody.

The topography of the study area in its current state is such that all surface water flows are directed away from the edge of the quarry void. The retained waterbody is located at the lowest point of the quarry void, which is fed by groundwater, providing a permanent water source.

According to the Department of Environment, Land, Water and Planning (DELWP) NatureKit Map (DELWP 2020a), the study area occurs within the Victorian Volcanic Plain bioregion. It is located within the jurisdiction of the Port Philip and Westernport Catchment Management Authority (CMA) and the Hume City Council municipality.

DRAFT

2 MANAGEMENT ISSUES

Several potential threatening ecological processes and management issues exist across the study area, including invasive flora, and the protection and rehabilitation (including natural regeneration) of remnant vegetation on-site.

2.1 Weeds

Dominant weed species identified throughout the study area include Artichoke Thistle *Cynara cardunculus L*, and African Boxthorn *Lycium ferocissimum* additional species are listed in Appendix 1. African Boxthorn is recognised as Weed of National Significance (WoNS) with Artichoke Thistle and African Boxthorn listed as declared noxious weeds under the *Catchment and Land Protection Act 1994* (CaLP Act) due to their ability to cause environmental and economic harm.

It should be noted that all land managers/persons are required under the CaLP Act to prevent the growth and spread of a Regionally Controlled weed (C) for which they are responsible. Land managers that do not control these species may be issued with a Land Management Notice or Directions notice that requires specific control work to be undertaken. Failure to comply with the conditions of a Notice may result in court action and fines or the issuing of an infringement notice and fine (Department of Primary Industries (DPI).

Sections 70, 70A and 71 of the CaLP Act for all declared noxious weeds, irrespective of category or region, prohibits the:

- Transport of a noxious weed or its propagules within Victoria.
- Deposition on land of a noxious weed or its seeds (DPI 2008a).

2.1.1.1 Priorities for weed management

While some weed species may not currently exist within the study area, they may exist elsewhere within the property parcel and additional weeds may not have been recorded due to the 'snap-shot' nature of the site assessment.

This information provides a comprehensive guide for all weeds in the event they begin to grow within the study area, if not already. Priorities for weed management are shown in Table 1 and have been based on the following criteria:

Threat Level

- High: Rapidly spreading species with the potential for high ecological impacts.
- Moderate: Moderately spreading species with the potential for high ecological impacts.
- Low: Slow spreading species with the potential for high ecological impacts.

Infestation Level

- High: Weed infestation over large areas across the site.
- Moderate: Weed infestation over moderate areas on the site.
- Low: Localised weed infestation across the site.

DRAFT

Control Priority

- High priority: Issue poses a high level of threat to ecological values and needs to be addressed immediately and on a frequent basis.
- Moderate priority: Issue has a high to moderate threat level and needs to be addressed in the short-term or on a regular basis.
- Low priority: Issue has a medium to low threat level, or low likelihood of occurrence, and needs to be addressed on an irregular basis.

Table 1. Priority weeds known to occur within the study area.

Scientific Name	Common Name	Weed Classification (PPWCMA)	Threat Level	Control Priority
Cynara cardunculus	Artichoke Thistle	C	High	High
Lycium ferocissimum	African Boxthorn	C, WONS	High	High

Notes: C = Regionally Controlled weed, WONS = Weeds of National Significance.

2.1.2 Protection of Remnant Vegetation

Scattered occurrences of remnant native vegetation were identified within the study area (Ecology and Heritage Partners 2020). These occurrences of native vegetation including scattered tussocks or singular specimens within the study area are considered medium to low value ecological value, however works must be conducted in manner to retain these smaller areas of native vegetation where practicable.

2.2 Pest Animals

One pest animal (European Rabbit *Oryctolagus cuniculus*) listed under the CaLP Act was detected within the study area. Red Fox *Vulpes vulpes* is also likely to use the study area during foraging activities, which may pose a threat to the extant population of Growling Grass Frog, listed as endangered in Victoria and vulnerable nationally (Tyler 1997). The species is also listed as a threatened taxon under the EPBC Act and the Victorian Flora and Fauna Guarantee Act 1988 (FFG Act). Overall the species is of national conservation significance.

DRAFT

3 MANAGEMENT ACTIONS

The following management actions and performance measures are detailed below to protect and enhance the study area, and to ensure the long-term functionality of the site in the future.

3.1.1 Weed Control

Ongoing weed control is the primary management issue within the study area. Weed control objectives are to eliminate woody weeds and other high threat weeds such as (but not limited to), Artichoke Thistle from the site, and to control all other weed populations to manageable levels (ideally <1% cover).

Weed control works should be carried out by an experienced contractor. Licensed weed control contractors will have a greater ability to make appropriate decisions on which technique to use based on individual situations and the targeted species. Contractors will also need to be aware of the potential for new outbreaks of weed species not recorded in this assessment and implement appropriate weed control techniques as necessary.

Several management techniques are recommended to control weeds, including physical removal, brush cutting and herbicide application. In most cases, herbicide will only be applied to weeds by using the spot-spraying technique, to prevent damage to non-target species. A summary of weed management techniques for weeds including noxious weeds (i.e. listed under the CaLP Act) and WONS is provided in Appendix 2, Table A2. The cover of Boxthorn within the study area is low and native fauna is unlikely to be impacted by its removal thus weed control actions does not need to be staged removal or occur after planting, it may occur as soon as reasonably practicable.

To minimise the risk of weed seed ingress and spread, all vehicles and plant must be free of weed material (e.g. seeds, propagules) prior to accessing the site. The presence of weeds should be identified during regular monitoring events and follow up treatment applied. The manual removal of weeds is the preferred method of eradication but where impracticable the spraying of an appropriate natural herbicide such as pine oil could be used to treat grasses and herbaceous weeds, ensuring there is no off-target damage.

Actions

- Undertake weed control works prior to flowering and setting seed;
- Eliminate all listed noxious weeds, WONS and other woody weeds;
- Where appropriate, promote persistence and expansion of indigenous flora species; and,
- Monitor for the occurrence of new weeds or the further spread of current weeds.

Performance Indicators

Key performance indicators for weed management include:

- Meeting the requirements of the CaLP Act in relation to control of listed noxious weeds within the study area;
- No new significant weed invasions occur in the study area;
- Establishment of photo-points throughout the site in consultation with Council so that changes in extent of weed infestation can be documented over time;

DRAFT

3.2 Pest Fauna Species

Control measures for European Rabbit and Red Fox are provided below (Table 2).

3.2.1 European Rabbit

Management measures commonly adopted to eradicate or control European Rabbits are provided below (Tables 2).

Table 2. European Rabbit control methods.

Method	Comments	Timing of action
Warren fumigation	In the event that warren networks are identified, this method may be employed. This must only be undertaken by a suitably experienced and licenced operator after the completion of a risk assessment and deployment of appropriate safety measures.	If warren networks are located, they must be fumigated just before the start of the rabbit breeding season.
Warren ripping	In order to avoid impacts on native vegetation communities, ripping would be constrained to areas on non-native vegetation.	Appropriate actions all year
Netting	Night netting is an effective method, particularly in situations where rabbits are leaving cover to feed in areas of open space.	Appropriate actions all year
Baiting	This must be undertaken by a suitably experienced and licenced operator after the completion of a risk assessment and deployment of appropriate safety measures.	Appropriate actions all year

3.2.2 Red Fox

Strategies for the management measures commonly adopted to control Red Foxes is provided in Table 3. The most effective fox control is achieved during late winter and spring, as foxes are less mobile given they are rearing young and food demands are high at this time of year. Fumigation and den destruction are most effective during August and September, within 10 weeks of cubs being born.

Table 3. Red Fox control methods.

Method	Comments	Timing of action
Fumigation and den destruction	If completed at appropriate times, fumigation and den destruction can be effective in reducing fox numbers. This must only be undertaken by a suitably experienced and licenced operator after the completion of a risk assessment and deployment of appropriate safety measures.	Fumigation should be conducted in August and September
Trapping	Only cage traps must be used to control Red Foxes. Foxes are known to be extremely trap-shy thus this method should not be solely relied upon. Trapping must only be undertaken by a suitably experienced and licenced operator after the completion of a risk assessment and deployment of appropriate safety measures.	This action can occur all year round.

DRAFT

3.3 Pre-construction

The following needs to be considered as part of the pre-construction activities within the study area:

- Pest plant control contractors with demonstrated experience working in ecologically sensitive environments will be engaged to undertake pest plant control;
- If invasive fauna are found to be inhabiting the site a qualified and experienced Pest Controller will be engaged to address the infestation;
- If European Rabbit or Red Fox warrens are identified within the site must be collapsed post the removal of topsoil to ensure that invasive species do not take up residence;
- A wash down area will be established within the study area for periodic cleaning of excess soil and organic matter to avoid the spread of noxious weeds and soil pathogens. Contaminated water from the wash down area should not be discharged into drainage lines or flow into areas of environmental sensitivity. Sediment from the wash down area should be retained in wash down bays and prevented from spreading over the site. Sediment and wash down water may not leave the site until decontaminated; and,
- All equipment and machinery to be thoroughly cleaned off site prior to commencing works.

Actions to limit the spread of diseases and pest plant species will follow best-practice protocols as detailed in the *Summary of State and Territory Noxious Weeds Legislation (AWC 2008), Victorian Pest Management – A Framework for Action: Weed Management Strategy (DNRE 2002), Weeds of National Significance (WONS) Strategies(DEPI 2008b)* and *Developing and Implementing a Weed Management Plan (CRC 2004)*. These protocols address the potential spread of weeds and plant disease.

3.4 During Construction

The following should be considered during construction:

- Machinery, vehicles and equipment initially coming onto the site are required to be cleaned of excess soil and organic matter by high pressure air or water spray jets at a wash down bay which is to be established at the entrance to the site. Vehicles and machinery are to be checked thoroughly for contaminants prior to entering the site. The wash down bay must include rumble strips;
- Rumble strips will be installed at entry and exit points to reduce the spread of pest plants and disease;
- All machinery and vehicles not exiting the construction zone will be set down in a designated area each evening. These vehicles and machinery will be washed down and offsite once per week;
- Before exiting the construction zone, all machinery, vehicles, equipment and footwear will also be washed and disinfected at designated wash down bays by high pressure air or water spray jets;
- Imported soil (if required) will be certified as “weed-free”;
- All waste will remain within the footprint of the site until such time as it can be taken to a legal disposal site;
- All efforts must be made to minimise waste and recycle all recyclable products; and,

DRAFT

- Should any waste spillage occur it must be cleared immediately and where applicable recycled, or sent to the appropriate, registered disposal site.

3.5 Post-construction

Ongoing pest plant control will be carried out by qualified pest plant control contractors, to the satisfaction of the responsible authority (Hume City Council). The pest plant control contractors and the Environmental Manger will continue to monitor the site on a minimum quarterly basis to identify the establishment of new weeds and implement control actions accordingly.

DRAFT

4 MONITORING

Vehicles and machinery are to be checked on a weekly basis to ensure they remain clean of excess soil and organic matter. Vehicles and machinery must be checked and cleaned on every entry and exit. A logbook will be maintained at the wash-down area. All machinery and vehicle wash-downs will be logged, including:

- Date;
- Time;
- The name of the person undertaking the washdown;
- Description (whether machinery, a vehicle or equipment);
- Identification (registration, serial number);
- Origin (where the machinery, vehicle, piece of equipment or personnel has come from);
- Destination (where the machinery, vehicle or equipment is going to);
- Sign off that a check (for attached soil, dust or weed propagules) has been undertaken; and
- Physical removal of soil and debris methods undertaken.

DRAFT

5 RESPONSIBILITIES AND TIMEFRAMES

5.1 Responsibilities

The relevant landowner is responsible for all management actions descriptions in this plan.

5.2 Performance Indicators

Key performance indicators for pest plant and animal management include:

- Meeting the requirement of the CaLP Act in relation to the control of listed plants and animals within the study area;
- WoNS must be eradicated (<0% cover abundance) within the study area;
- Introduced plants and animal species do not increase above current levels;
- Successfully control of pest plant and animal species within the study area within the specified management timeframe; and,
- No new significant pest species invasions occur in the study area.

5.3 Timeframes

A work schedule for the above management actions is provided below (Table 4).

Table 4. Work schedule of management actions.

Management action	Timing of action
Implement weed control program	Actions to be completed pre, during and post construction phases, ideally at the recommended time for the species and chosen method. Monitoring to be ongoing and undertaken biannually to the satisfaction of the responsible authority.
Implement pest animal control program	Actions to be completed pre, during and post construction phases, ideally at the recommended time for the species and chosen method. Monitoring to be ongoing and undertaken biannually to the satisfaction of the responsible authority.

DRAFT

REFERENCES

AWC 2008. Summary of State and Territory Noxious Weeds Legislation. Australian Weeds Committee.

CRC 2004. Developing and Implementing a Weed Management Plan. CRC for Australian Weed Management and Commonwealth Department of the Environment and Heritage.

DNRE 2002. Victorian Pest Management – A Framework for Action: Weed Management Strategy. Department of Natural Resources and Environment, Victoria.

DPI 2008a. Declared Noxious Weeds – Listed by Common Name. Landcare Notes. Department of Primary Industries, East Melbourne, Victoria.

DPI 2008b. Weeds of National Significance (WONS) Strategies. Department of Primary Industries and Fisheries, Queensland Government.

DELWP 2020a. Native Vegetation Information Management Tool [www Document]. URL: https://nvim.delwp.vic.gov.au. Victorian Department of Environment, Land, Water and Planning, Melbourne, Victoria.

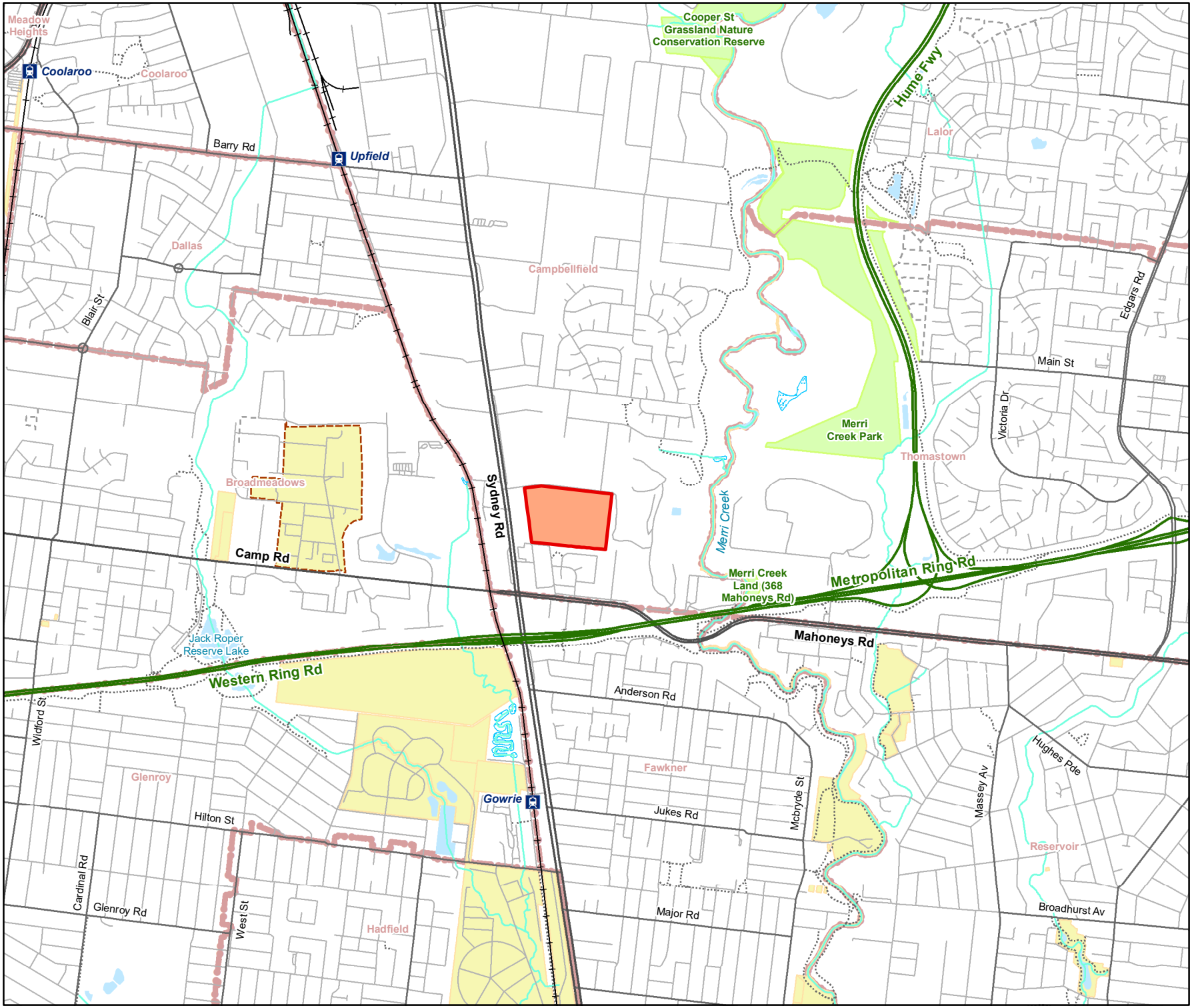
Ecology and Heritage Partners 2020. Biodiversity Assessment for the proposed Commercial Development at 75-135 Bolinda Road Campbellfield, Victoria. Unpublished Report, Melbourne, Australia.

Tyler, M.J. 1997. The Action Plan for Australian Frogs. Wildlife Australia: Canberra, ACT.

DRAFT

FIGURES

DRAFT



Legend

- Study Area
- Railway
- Freeway
- Major Road
- Collector Road
- Minor Road
- Proposed Road
- Walking Track
- Minor Watercourse
- Permanent Waterbody
- Wetland/Swamp
- Parks and Reserves
- Commonwealth Land
- Crown Land
- Localities

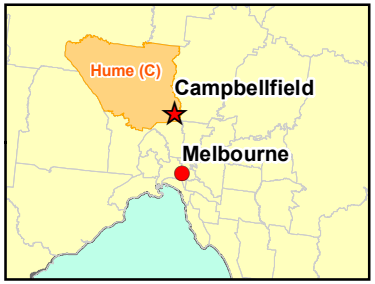


Figure 1

Location of the study area

Biodiversity Assessment for 75 Bolinda Road, Campbellfield

0 500 1,000
Metres

Map Scale: 1:30,000 @ A4
Coordinate System: GDA2020 MGA Zone 55

ecology & heritage partners

VicMap Data: The State of Victoria does not warrant the accuracy or completeness of information in this publication and any person using or relying upon such information does so on the basis that the State of Victoria shall bear no responsibility or liability whatsoever for any errors, faults, defects or omissions in the information.

APPENDICES

DRAFT

APPENDIX 1

Appendix 1 – Exotic Flora List

Legend:

***** Listed as a noxious weed under the CaLP Act;

w Weed of National Significance;

Table A1.1. Exotic Flora recorded within the study area.

Scientific Name	Common Name	Notes
NON-INDIGENOUS OR INTRODUCED SPECIES		
Aster subulatus	Aster-weed	-
Brassica spp.	Wild Mustard	-
Cenchrus clandestinus	Kikuyu	-
Cynara cardunculus subsp. flavescens	Artichoke Thistle	*
Helminthotheca echioides	Ox-tongue	-
Lycium ferocissimum	African Box-thorn	w *
Malva spp.	Mallow	-
Medicago rugosa	Medic	-
Phalaris aquatica	Toowoomba Canary-grass	-
Plantago lanceolata	Ribwort	-
Portulaca oleracea	Common Purslane	-
Stellaria media	Chickweed	-

DRAFT

APPENDIX 2

Appendix 2 – Weed control methods and targets

Table A2. Weed control method and targets, all weeds.

Scientific Name	Common Name	Control Method	Threat Level	Control Priority	Goal (cover)
Aster subulatus	Aster Weed	HP	High	Medium	Eliminate (<1%)
Brassica spp.	Wild Mustard	SS, HP,SL	High	High	Eliminate (<1%)
Cenchrus clandestinus	Kikuyu	SS, M	Medium	High	Eliminate (<1%)
Cynara cardunculus subsp. flavescens	Artichoke Thistle	SS, M	High	High	Eliminate (<1%)
Helminthotheca echioides	Bristly ox tongue	SS, M	High	High	Eliminate (<1%)
Lycium ferocissimum	Boxthorn	CP	High	High	Eliminate (0%)
Malva sp.	Mallow	SS, HP	High	High	Eliminate (<1%)
Medicago rugosa	Medic	SS, HP	Medium	Medium	Eliminate (<1%)
Phalaris aquatica	Bulbous Canary -Grass	SS, HP,M	High	High	Eliminate (<1%)
Plantago lanceolata	Ribwort	SS	Low	Low	Reduce (<5%)
Portulaca oleracea	Common Purslane	SS, HP	Low	Low	Reduce (<5%)
Stellaria media	Chickweed	SS, HP	Medium	Medium	Eliminate (<1%)

Notes: CP = Cut and Paint; SS = Spot Spray; HP = Hand Pull; SL = Slash/Brush cut; M = Mechanical Removal.

DRAFT

APPENDIX 6 – OFFSET ASSESSMENT CALCULATION

Offset calculator for terrestrial habitat within the quarry void (Offset Area 1)

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community Clear row	No		Area			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat Clear row	Yes	A total of 1500 square meters of low quality foraging and dispersal habitat will be removed around the rim of the quarry void	Area	0.75	Hectares	
			Quality	3	Scale 0-10	
			Total quantum of impact	0.23	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees Clear row	No					
Condition of habitat Change in habitat condition, but no change in extent Clear row	No					
Threatened species						
Birth rate e.g. Change in nest success Clear row	No					
Mortality rate e.g Change in number of road kills per year Clear row	No					
Number of individuals e.g. Individual plants/animals Clear row	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				Risk-related time horizon (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset									
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0								
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)									
Threatened species habitat																				
Area of habitat	Yes	0.23	Adjusted hectares	Existing habitat within the quarry void which will be enhanced such that habitats will be augmented, and conditions are improved for Growling Grass Frog refuge, foraging and breeding purposes.	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	1.5	Risk of loss (%) without offset	25%	Risk of loss (%) with offset	2%	0.35	70%	0.24	0.23	141.08%	Yes		Cost estimation from a summary of wetland construction costs/unit area, including annual maintenance, sourced from numerous developments around SE Australia (unpublished summary).
									Future area without offset (adjusted hectares)	1.1	Future area with offset (adjusted hectares)	1.5				0.32				
					Time until ecological benefit	5	Start quality (scale of 0-10)	5	Future quality without offset (scale of 0-10)	4	Future quality with offset (scale of 0-10)	6	2.00	80%	1.60	1.58				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Offset calculator for wetland habitat within the movement corridor (Offset Area 2)

Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community Clear row	No		Area			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat Clear row	Yes	A total of 1500 square meters of low quality foraging and dispersal habitat will be removed around the rim of the quarry void	Area	0.35	Hectares	
			Quality	3	Scale 0-10	
			Total quantum of impact	0.11	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees Clear row	No					
Condition of habitat Change in habitat condition, but no change in extent Clear row	No					
Threatened species						
Birth rate e.g. Change in nest success Clear row	No					
Mortality rate e.g Change in number of road kills per year Clear row	No					
Number of individuals e.g. Individual plants/animals Clear row	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				Risk-related time horizon (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset		Risk of loss (%) with offset									
									Future area without offset (adjusted hectares)	0.0	Future area with offset (adjusted hectares)	0.0								
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)									
Threatened species habitat																				
Area of habitat	Yes	0.11	Adjusted hectares	Habitat corridor will consist of a chain of approximately 4517m2 of waterways along the alignment and an additional 4413m2 of terrestrial habitat including extensive native plantings and rock beaching to provide suitable habitata for GGF.	Time over which loss is averted (max. 20 years)	10	Start area (hectares)	0.39	Risk of loss (%) without offset	25%	Risk of loss (%) with offset	2%	0.09	80%	0.07	0.07	128.45%	Yes		Cost estimation from a summary of wetland construction costs/unit area, including annual maintenance, sourced from numerous developments around SE Australia (unpublished summary).
									Future area without offset (adjusted hectares)	0.3	Future area with offset (adjusted hectares)	0.4				0.13				
					Time until ecological benefit	5	Start quality (scale of 0-10)	3	Future quality without offset (scale of 0-10)	2	Future quality with offset (scale of 0-10)	6	4.00	80%	3.20	3.17				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

Offset calculator for terrestrial habitat within the movement corridor (Offset 3)

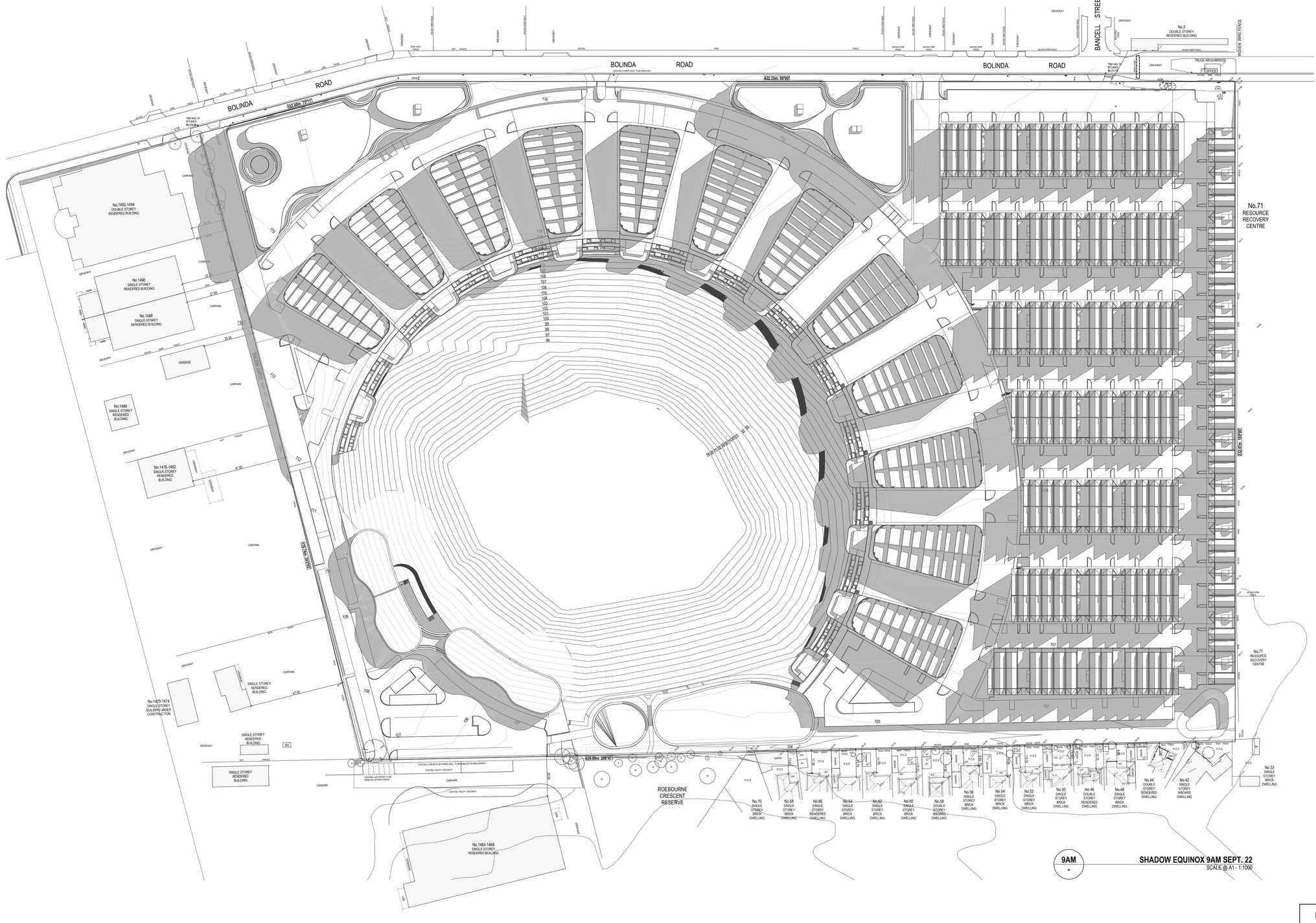
Impact calculator

Protected matter attributes	Attribute relevant to case?	Description	Quantum of impact		Units	Information source
Ecological communities						
Area of community Clear row	No		Area			
			Quality			
			Total quantum of impact	0.00		
Threatened species habitat						
Area of habitat Clear row	Yes	A total of 1500 square meters of low quality foraging and dispersal habitat will be removed around the rim of the quarry void	Area	0.4	Hectares	
			Quality	3	Scale 0-10	
			Total quantum of impact	0.12	Adjusted hectares	
Protected matter attributes	**Attribute relevant to case?**	**Description**	**Quantum of impact**		**Units**	**Information source**
Number of features e.g. Nest hollows, habitat trees Clear row	No					
Condition of habitat Change in habitat condition, but no change in extent Clear row	No					
Threatened species						
Birth rate e.g. Change in nest success Clear row	No					
Mortality rate e.g Change in number of road kills per year Clear row	No					
Number of individuals e.g. Individual plants/animals Clear row	No					

Offset calculator

Protected matter attributes	Attribute relevant to case?	Total quantum of impact	Units	Proposed offset	Time horizon (years)		Start area and quality		Future area and quality without offset		Future area and quality with offset		Raw gain	Confidence in result (%)	Adjusted gain	Net present value (adjusted hectares)	% of impact offset	Minimum (90%) direct offset requirement met?	Cost ($ total)	Information source
Ecological Communities																				
Area of community	No				Risk-related time horizon (max. 20 years)		Start area (hectares)		Risk of loss (%) without offset Future area without offset (adjusted hectares)	0.0	Risk of loss (%) with offset Future area with offset (adjusted hectares)	0.0								
					Time until ecological benefit		Start quality (scale of 0-10)		Future quality without offset (scale of 0-10)		Future quality with offset (scale of 0-10)									
Threatened species habitat																				
Area of habitat	Yes	0.12	Adjusted hectares	Existing habitat within the quarry void which will be enhanced such that habitats will be augmented, and conditions are improved for Growling Grass Frog refuge, foraging and breeding purposes.	Time over which loss is averted (max. 20 years)	20	Start area (hectares)	0.5	Risk of loss (%) without offset Future area without offset (adjusted hectares)	25% 0.4	Risk of loss (%) with offset Future area with offset (adjusted hectares)	2% 0.5	0.12	70%	0.08	0.08 0.17	137.68%	Yes		Cost estimation from a summary of wetland construction costs/unit area, including annual maintenance, sourced from numerous developments around SE Australia (unpublished summary).
					Time until ecological benefit	5	Start quality (scale of 0-10)	3	Future quality without offset (scale of 0-10)	2	Future quality with offset (scale of 0-10)	6	4.00	80%	3.20	3.17				
Protected matter attributes	**Attribute relevant to case?**	**Total quantum of impact**	**Units**	**Proposed offset**	**Time horizon (years)**		**Start value**		**Future value without offset**		**Future value with offset**		**Raw gain**	**Confidence in result (%)**	**Adjusted gain**	**Net present value**	**% of impact offset**	**Minimum (90%) direct offset requirement met?**	**Cost ($ total)**	**Information source**
Number of features e.g. Nest hollows, habitat trees	No																			
Condition of habitat Change in habitat condition, but no change in extent	No																			
Threatened species																				
Birth rate e.g. Change in nest success	No																			
Mortality rate e.g Change in number of road kills per year	No																			
Number of individuals e.g. Individual plants/animals	No																			

APPENDIX 7– SHADING PROFILES



CORNETTA PARTNERS ARCHITECTS
183 WESTON STREET BRUNSWICK EAST 3057
p (03) 9489 1299
e info@cparchitects.com.au
w cparchitects.com.au

Revision
--

Client
FORTE GROUP

Project
MULTI UNIT DEVELOPMENT
95-135 BOLINDA ROAD
CAMPBELLFIELD

Drawing Title
SHADOW DIAGRAMS 9:00am SEPT. 22
TOWN PLANNING APPLICATION

Scale
1:1000 @ A1

Drawn
E.P. & J.D.

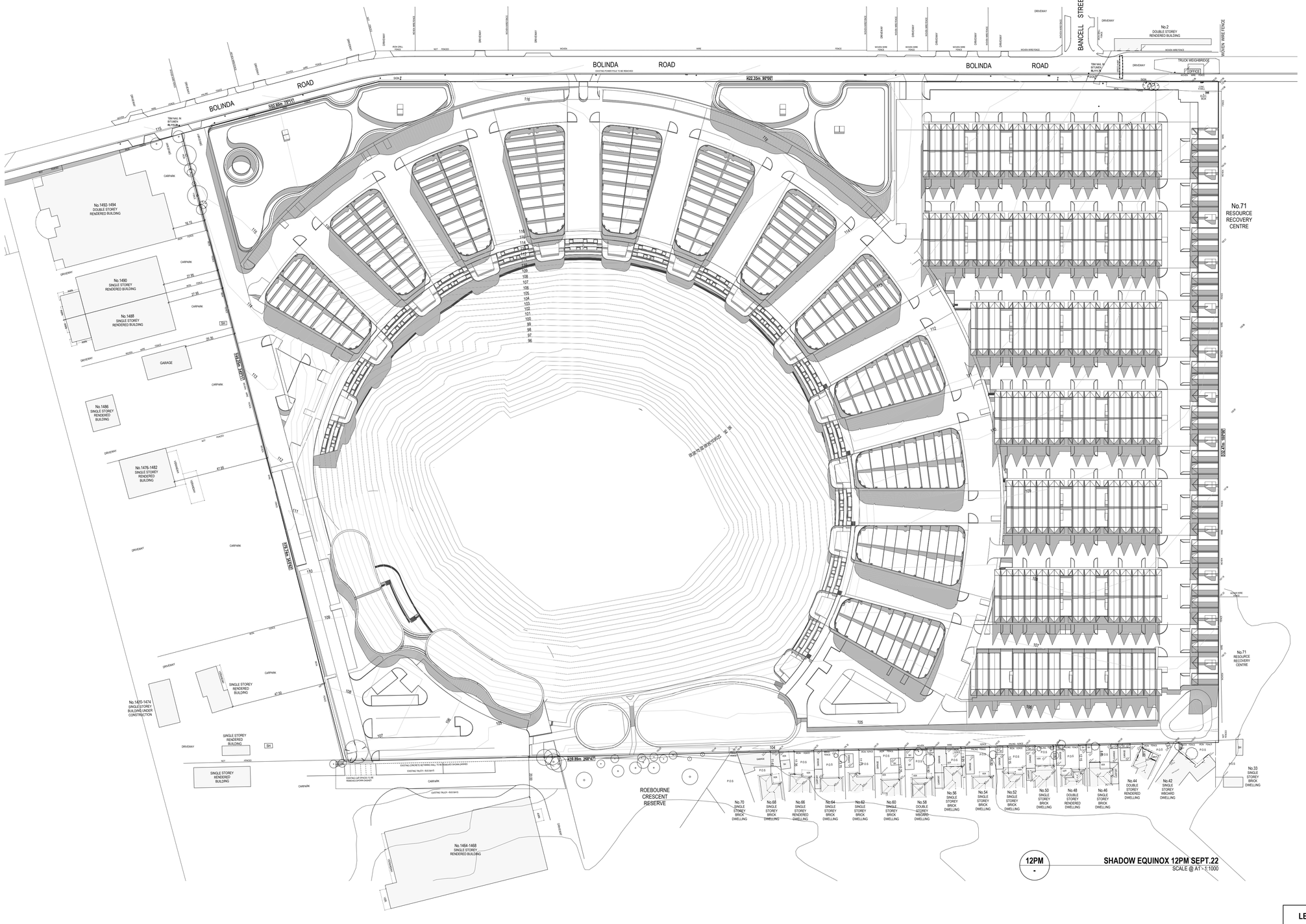
Job No.
19-13

Date
27.03.2020

Drawing No.
TPA37

Revision
REV A

N



12PM
-

SHADOW EQUINOX 12PM SEPT.22
SCALE @ A1 - 1:1000

LEGEND

EXTENT OF SHADOWS CAST BY PROPOSED DEVELOPMENT.

CORNETTA PARTNERS ARCHITECTS
183 WESTON STREET BRUNSWICK EAST 3057
p (03) 9489 1299
e info@cparchitects.com.au
w cparchitects.com.au

Revision
--

Client
FORTE GROUP

Project
MULTI UNIT DEVELOPMENT
95-135 BOLINDA ROAD
CAMPBELLFIELD

Drawing Title
SHADOW DIAGRAMS 12:00pm SEPT. 22

TOWN PLANNING APPLICATION

Scale
1:1000 @ A1

Drawn
E.P. & J.D.

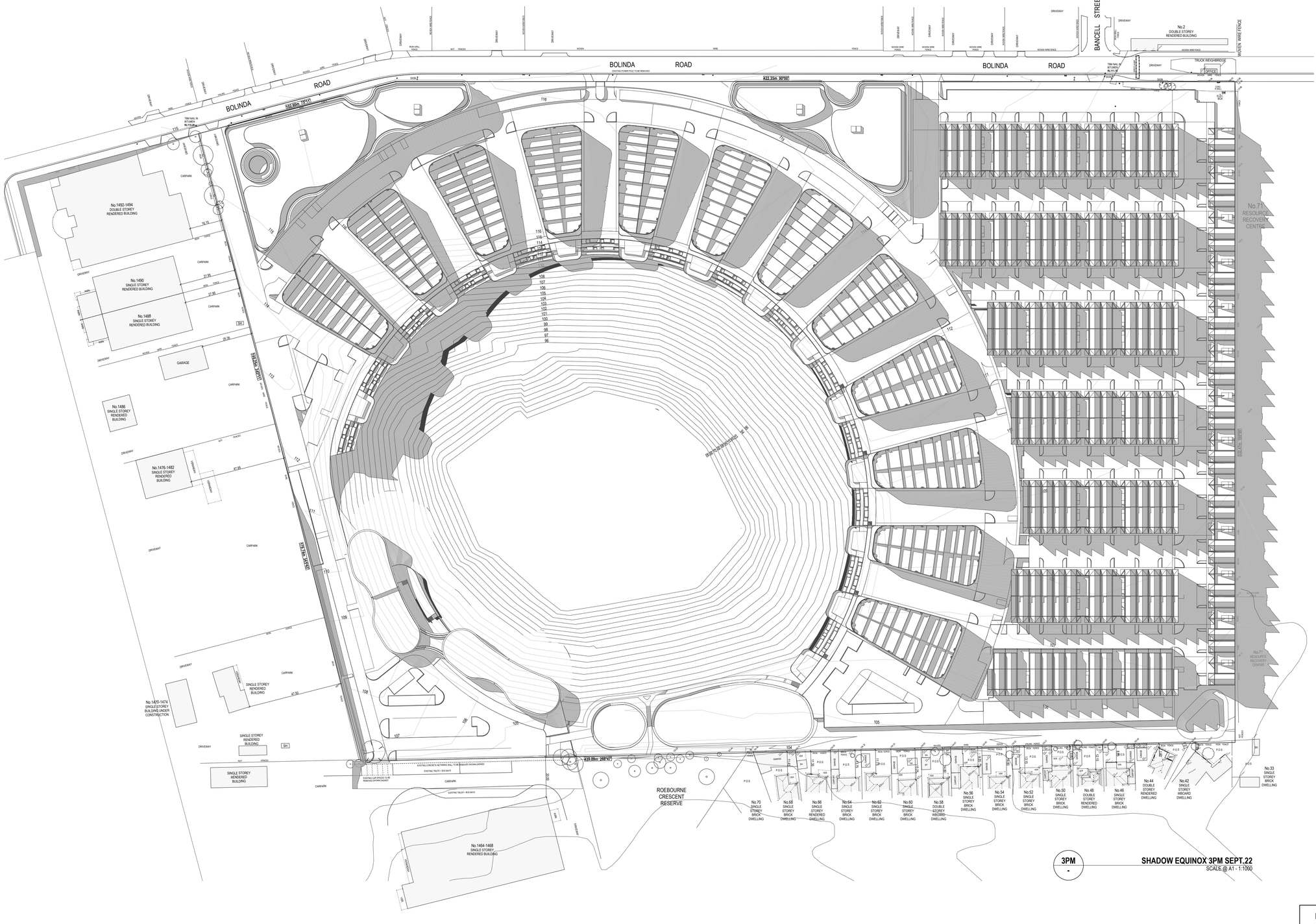
Job No.
19-13

Date
27.03.2020

Drawing No.
TPA38

Revision
REV A

N



LEGEND

EXTENT OF SHADOWS CAST BY PROPOSED DEVELOPMENT.

CORNETTA PARTNERS ARCHITECTS

183 WESTON STREET
BRUNSWICK EAST 3057

p (03) 9489 1299
e info@cparchitects.com.au
w cparchitects.com.au

Revision
--

Client
FORTE GROUP

Project
MULTI UNIT DEVELOPMENT
95-135 BOLINDA ROAD
CAMPBELLFIELD

Drawing Title
SHADOW DIAGRAMS 3:00pm SEPT. 22

TOWN PLANNING APPLICATION

Scale
1:1000 @ A1

Drawn
E.P. & J.D.

Job No.
19-13

Date
27.03.2020

Drawing No.
TPA39

Revision
REV A

N