

96-166 CENTRE ROAD, NARRE WARREN

**EASTERN DWARF GALAXIAS
OFFSET MANAGEMENT PLAN**

Narre Warren Central Pty Ltd



In association with



**Brett Lane & Associates Pty. Ltd.
Ecological Research & Management**

Suite 5 61 - 63 Camberwell Road, Hawthorn, VIC 3123

P.O. Box 337, Camberwell, VIC 3124

Ph. (03) 9815 2111

Fax. (03) 9815 2685

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1. INTRODUCTION

1.1. Project Description

Narre Warren Central Pty Ltd engaged Brett Lane & Associates Pty Ltd (BL&A) and Aquatica Environmental to produce an Offset Management Plan (OMP) to account for the proposed clearing of Eastern Dwarf Galaxias (*Galaxiella pusilla*) habitat at 96-166 Centre Rd, Narre Warren (the development site).

The development site is being prepared for development for an infill residential subdivision.

1.2. Preliminary Documentation and Approvals

An *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) Referral has previously been prepared and submitted to the Department of the Environment (DoE) due to the potential impacts of the proposed development on Eastern Dwarf Galaxias (EPBC Act 2014/7380). Based on the Referral submission, the DoE determined the project was a Controlled Action due to significant impacts to Eastern Dwarf Galaxias (decision dated 12th December 2014).

The following additional documentation and approvals have also been prepared and received/approved for the project:

- Dwarf Galaxias Environmental Management Plan (BL&A 2015a): Prepared to accompany the original EPBC Act Referral.
- Dwarf Galaxias Onsite Offset Proposal (BL&A 2015b): Submitted to the DoE as part of the EPBC Act approval process. This has since been superseded by this offsite OMP and the previously-proposed onsite offset area is proposed to be developed.
- An Eastern Dwarf Galaxias Salvage and Translocation Plan (Aquatica Environmental 2015): Prepared to accompany an application for relevant state-level permits (see below).
- *Flora and Fauna Guarantee Act 1988* (FFG Act) permit to take protected fish (Permit No. 1007487): The permit was granted by the Victorian Department of Environment, Land, Water and Planning (DELWP) as part of the proposed requirement to salvage and translocate Eastern Dwarf galaxias from the development site.

1.3. Overarching OMP Objective

The successful implementation of this OMP and its proposed offset mechanisms will create a self-sustaining habitat area for Eastern Dwarf Galaxias, facilitating dispersal between an existing Melbourne Water managed Eastern Dwarf Galaxias site within the local landscape. This will result in an increased area of high quality habitat that is managed and protected for the benefit of Eastern Dwarf Galaxias in the region.

1.4. About this OMP

A brief overview of the area proposed for clearing is provided in this report including quantified loss of Eastern Dwarf Galaxias habitat and legal obligations to offset that loss. This report also details the extent, condition and design strategies of the proposed offset site at 1-39 Centre Road, Hampton Park. This site is owned by Melbourne Water and will be designed and managed as an offset site in close collaboration with Melbourne Water.

Among other content, this OMP provides details of the following:

- Location of the proposed offset site;
- Design proposal for enhancing and modifying the wetland area of the offset site;
- Hydrological requirements;
- Outline of management actions and targets;
- Maintenance, methods and frequencies for permanent protection of the offset site;
- Responsible for implementing and monitoring this OMP; and
- Timeframes for implementing the OMP.

Section 2 provides a description and background on Eastern Dwarf Galaxias, their habitat requirements, threats and current status.

Section 3 provides a description of the development site and quantifies the likely loss of Eastern Dwarf Galaxias habitat that will require offsetting.

Section 4 provides a description of the proposed offset site and an assessment of the suitability of the offset site.

Section 5 describes how the offset is to be implemented. It includes details about landowner commitments, management activities, monitoring and reporting.

This offset plan was prepared by Aaron Jenkin (Principal Ecologist at Aquatica Environmental) and a team from Brett Lane & Associates, comprising Inga Kulik (Senior Ecologist and Project Manager) and Brett Lane (Principal Consultant).

Rhys Coleman (Waterways and Wetlands Research Manager at Melbourne Water), who recently completed and published a PhD thesis on Eastern Dwarf Galaxias conservation (Coleman *et. al.* 2014), provided invaluable input to this OMP and the authors are most grateful for his timely and comprehensive advice.

2. ABOUT EASTERN DWARF GALAXIAS

2.1. Description

The Eastern Dwarf Galaxias (*Galaxiella pusilla*) is a tiny, slender, freshwater fish growing to a maximum length up to 47 millimetres for females and 37 millimetres for males (Coleman *et. al.* 2015). Like other members of the family Galaxiidae, it has all soft-rayed fins, a body lacking scales, and a single dorsal fin positioned well back on the body. Body colour is olive-amber on the dorsal surface and sides, with a silvery-white belly, while the fins are transparent (DoE 2015).

Eastern Dwarf Galaxias are a mid-water freshwater fish that spend their entire life cycle in freshwater environments. Their diet consists primarily of small aquatic macroinvertebrates. Spawning occurs in late autumn to spring (May through to October) when females lay from 65 to 250 eggs on the underside of aquatic or submerged vegetation or on hard surfaces (e.g. Saddler *et. al.* 2010). They are primarily an annual species, with adults dying after the spawning season (Humphries 1986; Coleman *et. al.* 2015).

The Eastern Dwarf Galaxias species (i.e. *G. pusilla*) has recently been revised into two separate species and now includes Eastern Dwarf Galaxias (*G. pusilla*), which occurs east of Melbourne, and the newly described Little Galaxias (*G. toourtkoourt*), which occurs west of Melbourne (Coleman *et. al.* 2015). Based on this revision, it is Eastern Dwarf Galaxias that occurs in the region and is the subject of this OMP.

2.2. Habitat

Eastern Dwarf Galaxias occur amongst marginal vegetation in still or gently flowing water of roadside ditches, swamps, and backwaters of creeks (e.g. Allen *et al.* 2002). Habitats are mostly shallow (typically 0.5–1.5 m), with still to low water velocities, partial shading (usually 10-60%), and dense vegetation cover comprising mostly emergent aquatic species (Coleman *et. al.* 2015). The waters inhabited by this species are often temporary, drying up partially or completely during summer, and are replenished by rainfall or floodwaters from watercourses during the wetter months (Backhouse and Vanner 1978).

The National Recovery Plan for Eastern Dwarf Galaxias (Saddler *et. al.* 2010) notes that Eastern Dwarf Galaxias have different habitat requirements depending on life stage and season including:

- Transient habitat: ephemeral habitat that retains water for less than one month following inundation and is mostly used by Eastern Dwarf Galaxias for dispersal.
- Spawning habitat: ephemeral habitat with abundant aquatic or submerged vegetation that retain water for 1-3 months following inundation and during the April to October breeding season.
- Short-term refuge habitat: ephemeral water bodies that retain water for more than three months but do not have the attributes to support a permanent population due to drying in lower rainfall years.
- Long-term refuge habitat: permanent water bodies that provide permanent refuge for Eastern Dwarf Galaxias populations and where source stock can disperse and repopulate transient, spawning and short-term refuge habitats (i.e. those listed above).

2.3. Distribution

Distribution of Eastern Dwarf Galaxias is disjunct and patchy, due to the nature of its lowland, shallow, swampy habitat (DoE 2015). In consideration of the revised species (see Section 2.1) Eastern Dwarf Galaxias occurs in coastal south-eastern mainland Australia, from the Mitchell River Basin to Dandenong Creek, on Flinders Island in Bass Strait and north-eastern and north-western Tasmania (Coleman *et. al.* 2015). There is also a translocated population in the La Trobe University wildlife reserve, Bundoora, in the Yarra River catchment (Westbury 1995).

The current known range of Eastern Dwarf Galaxias is not believed to overlap with that of Little Galaxias.

2.4. Threats

Key threats to Eastern Dwarf Galaxias include (DoE 2015):

- Degradation and loss of habitat caused by wetland drainage, wetland inundation, fouling by livestock, ploughing, concreting of waterways, chemical pollution and European Carp (*Cyprinus carpio*) associated degradation;
- Alteration to flow regime and reduced connectivity caused by dam and levee construction, surface and groundwater abstraction, drawdown associated with forestry/revegetation;
- Wetland drying caused by climate change, reducing suitable habitat and connectivity;
- Increased competition and predation by legally and illegally introduced aquatic species such as the Eastern Gambusia (*Gambusia holbrooki*), Brown Trout (*Salmo trutta*), Rainbow Trout (*Onykorhynchus mykiss*) and Redfin Perch (*Perca fluviatilis*)
- Illegal collection leading to localised depletions, possibly intensifying with increased community awareness.

2.5. Status

2.5.1. Legislative Status

Eastern Dwarf Galaxias is listed as 'Vulnerable' under the EPBC Act and DELWP Advisory List of Threatened Vertebrate Fauna (DEPI 2013) and is FFG Act listed. The species is also designated as 'Vulnerable' on the International Union for Conservation of Nature (IUCN) Red List of Threatened Animals (Wager 1996) and on the Australian Society for Fish Biology threatened species list (ASFB 2010). However, based on the IUCN assessment criterion and the recent revision of the species, Eastern Dwarf Galaxias should qualify as 'Endangered' (a greater level of threat) (Coleman *et. al.* 2015))

2.5.1. Regional Status

Eastern Dwarf Galaxias were likely once more widespread through the region. However, wetland modification and land uses such as wetland draining, farming and urban development have lead to a decline in much of their key habitat area (DoE 2015). Figure 1 shows the locations where Eastern Dwarf Galaxias have been previously recorded in proximity to the development and offset sites. There are no records on the offset site, with the nearest known permanent population being on the western border of the site across Hallam Road in a parcel of land owned and managed by Melbourne Water for the species.

Major threats to the Eastern Dwarf Galaxias in the region include:

- Wetland drainage;
- Alteration to the flow regime of waterways (i.e. changes to the natural flooding and drying cycles);
- Degradation and loss of habitat due to land development and lack of regeneration; and
- Introduced feral fish competitors and predators (DoE 2015).

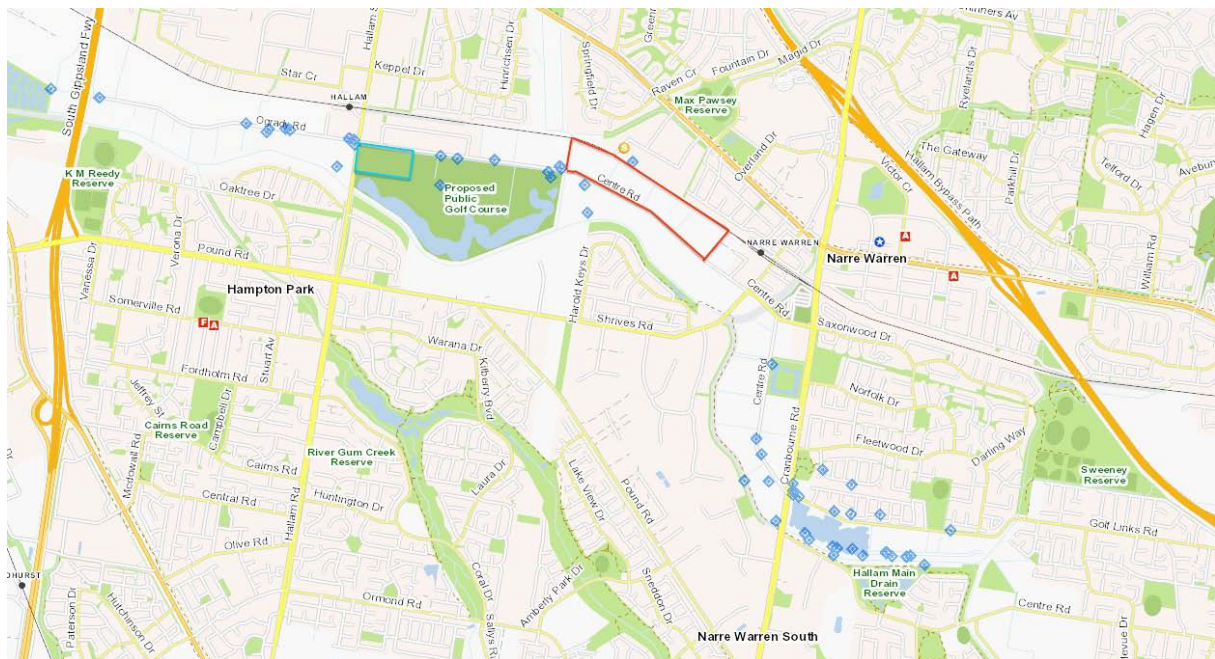


Figure 1 Eastern Dwarf Galaxias records (blue diamonds) in the vicinity of the development site (red) and offset site (blue). Source: VBA 2014

3. DEVELOPMENT SITE DESCRIPTION

The following sections describe the development (impact) site and presents results obtained during previous surveys and assessments of that site.

3.1. Development Site Key Details

Table 1 outlines the key details of the development site.

Table 1: Development site key details

Landowner of clearing site	Narre Warren Central Pty Ltd
Location and address of clearing site	96-166 Centre Road, Narre Warren
Local Government Area	City of Casey
Catchment Management Authority	Port Phillip and Westernport
Responsible Authority	City of Casey
Permit applicant	Narre Warren Central Pty Ltd
Planning Permit Number (ID)/Work Authority Number	To be advised (pending)
Date approved	To be advised

3.2. Description

The development site (Figure 2) comprises approximately 20 hectares of private land at 96-166 Centre Road, Narre Warren, approximately 37 kilometres south-east of Melbourne's Central Business District (CBD). The development site is bordered by the Pakenham (Gippsland) railway line (to the north), the Centre Road Drain (north and south channel), road and farmland (to the south), Daisies Garden Supplies and Deblin Drive (to the east) and Troups Creek East Branch (to the west).

The site supports sandy soils over clay subsoil on a flat landscape subject to periodic inundation. The site comprises cleared paddock/flats prone to waterlogging at the lower levels with Swamp Scrub along the southern and western boundary, mostly comprising Swamp Paperbark distributed along the drains parallel and perpendicular to the railway line and Centre Road.

The study area lies within the Gippsland Plain bioregion and falls within the Port Phillip and Westernport catchment and Casey City Council local government area. It is currently zoned Residential Growth Zone and is subject to Schedule 1 of the Residential Growth Zone in the Casey Planning Scheme.

Previous land use on the site has been primarily grazing, stockpiling of fill and dumping of refuse. Similarly, surrounding land use has been primarily agriculture (e.g. grazing).

A detailed site description is presented in the Flora and Fauna Report prepared by Brett Lane & Associates (BL&A 2014a, Section 5.1.1).

3.3. Status of Eastern Dwarf Galaxias on the Development Site

There is a viable population of Eastern Dwarf Galaxias on the development site with recent records in on-site drains and flooded areas along the north of the site and in some

of the north-south drains transecting the site (McGuckin 2014). There are also historical records of Eastern Dwarf Galaxias in the northern drain of Centre Road drain (BL&A 2014a). Specific details on the numbers and locations of records are presented in the Flora and Fauna Report prepared by Brett Lane & Associates (BL&A 2014a, Section 6.3).

A subsequent brief walk-over assessment of the site, undertaken by representatives from Aquatica Environmental, Melbourne Water and Narre Warren Central Pty Ltd in October 2015 as part of preparing this OMP, found the majority of the survey sites where individuals were recorded in 2014 (McGuckin 2014) had minimal surface water or were dry. At the time, Eastern Dwarf Galaxias if still present on the site would have most likely been occupying the more permanent north-south drain and/or northern drain of Centre Road drain.

3.4. Proposed Removal of Eastern Dwarf Galaxias Habitat

Based on the 2014 survey (McGuckin 2014) the development site comprises a total of approximately 0.61 hectares of Eastern Dwarf Galaxias habitat comprising:

- 0.17 hectares of primary habitat (i.e. confirmed as individuals have been recorded in that habitat); and
- 0.43 hectares of secondary habitat (i.e. habitat that was assessed as suitable for the species but no individuals have been recorded).

The proposed development of the site will result in the removal of 0.12 hectares of primary and 0.43 hectares of secondary Eastern Dwarf Galaxias habitat, out of a total of 0.56 hectares (see Figure 2).

3.5. Proposed Retention of Eastern Dwarf Galaxias Habitat

The proposed development will also retain and enhance native vegetation and remaining Eastern Dwarf Galaxias habitat along and within a drainage channel on the northern side of Centre Road and along and within the eastern most north-south channel, where the Eastern Dwarf Galaxias has been recorded (see Figure 2). These drainage lines are proposed to be retained to mitigate adverse impacts upon the Eastern Dwarf Galaxias and the Swamp Scrub vegetation within the development, however, are not considered further as part of the OMP.



Legend

- Study area
- Property boundary
- Dwarf Galaxias created habitat (swales)
- Development boundary
- Dwarf Galaxias habitat removed (primary habitat)
- Dwarf Galaxias habitat removed (secondary habitat)
- Dwarf Galaxias habitat retained (primary habitat)
- Dwarf Galaxias habitat retained (secondary habitat) - outside property

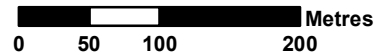


Figure 2: Dwarf Galaxias habitat retained and removed

Project: 96-166 Centre Rd, Narre Warren		
Client: Candil Holdings Ltd		
Project No.: 14090	Date: 19/10/2015	Created By: M. Ghasemi / D. Coppolino
Brett Lane & Associates Pty. Ltd. Ecological Research & Management		
Experience: Suite 5, 61 - 63 Camberwell Road Knowledge: Hawthorn East, VIC 3123 Solutions: PO Box 337, Camberwell, VIC 3124, Australia	Ph (03) 9815 2111 / Fax (03) 9815 2668 enquiries@ecologicalresearch.com.au www.ecologicalresearch.com.au	N

4. OFFSET SITE DESCRIPTION AND SUITABILITY (PART A)

The following sections describe the offset site and present results obtained during previous surveys and assessments of the site.

4.1. Offset Site Key Details

Table 2 outlines the key details of the offset site.

Table 2: Offset site key details

Landowner of offset site	Melbourne Water
Type of offset (onsite, 3 rd party)	3 rd Party
Location and address of offset site	1-39 Hallam Rd, Hampton Park
Area of offset site (ha)	3.35
Offset site number (if applicable)	n/a
Volume	TBC
Folio	TBC
Parish	TBC
Allotment	TBC
Local Government Area	Casey local government area
Responsible Authority	City of Casey
Bioregion	Gippsland Plain

Melbourne Water, owner of the site, has given permission for the site to be used for this offset.

4.1. Description of Offset Site

The offset site proposed in this OMP (Figure 3) comprises an approximately 3.35 hectare parcel of land owned by Melbourne Water and located at 1-39 Centre Road, Hampton Park. The offset site is bordered by Centre Rd to the north, Hallam Rd and a large drain to the west and grassland and constructed stormwater wetlands, owned by Melbourne Water, to the east and the south.

The offset site is located approximately one kilometre west of the development site and also lies in the Hallam Valley floodplain. Historically, the area encompassing the development and offset sites would have been part of a larger floodplain and wetland system supporting a widely distributed Eastern Dwarf Galaxias population. Agricultural and urban development and the construction of roads and drainage systems have significantly reduced the areas of wetland, effectively reducing and fragmenting the area of habitat availability and habitat/population linkage for Eastern Dwarf Galaxias.

Similarly to the development site, land use at the offset site appears to have been agriculture (e.g. grazing). Surrounding land uses support light industrial to the north, along Centre Road, and Melbourne Water owned open land to the west (existing Eastern Dwarf Galaxias managed site across Hallam Road), south (stormwater wetland system) and east (unused).

The offset site is flat with a slight wetland depression running from the western boundary along Hallam Road to the southeast corner. Based on a visual inspection the overall unconfirmed fall would be less than one metre across the entire site.

The offset site is densely vegetated with pasture grasses, weeds and wetland species on a peaty and porous topsoil. Although dry at the time of the site inspection (20 October 2015) there was clear evidence of waterlogged wetland areas and prior inundation with a number of aquatic and emergent plant species being recorded including (but not limited to) *Persicaria*, *Myriophyllum*, *Juncus* and *Phragmites* (Plate 1 and Plate 2).

The northern boundary of the site consists of a large east-west running drainage channel (Plate 3) and a levee on the offset site side of the drain, which was formed by spoil from the drain construction. There are a number of points along the levee where there is a break and a number of smaller side-channels divert off the main drain. These levee breaks deliver water to the offset area during higher flow events. There is also a large stormwater drain exit point (approximately 1500 mm pipe) that exists into the roadside drain at the main levee break point. The drain delivers stormwater from the catchment to the north of the offset site (Plate 3).

The offset site has limited connectivity and linkage to other aquatic and/or Eastern Dwarf Galaxias habitat in the area. West of the site, on the opposite side of Hallam Road, lies a Melbourne Water managed site for Eastern Dwarf Galaxias (Figure 3). This site currently has a population of the species present, however, there is no connectivity to the offset site. There are no other populations of Eastern Dwarf Galaxias that have the potential to connect to the offset site. There are also records of Eastern Dwarf Galaxias in the east-west drainage channel, but to the west of the site near the Troups Creek north-south drain and the development site.

The offset site lies within the Gippsland Plain bioregion and falls within the Port Phillip and Westernport catchment. It is currently zoned Public Use – Service and Utility (PUZ1) and is subjected to a Land Subject to Inundation Overlay (LSIO) in the Casey planning scheme.

Pre-European EVC mapping (DELWP 2015) indicates that the offset site and surrounds would have supported a mosaic of Swampy Riparian Woodland (EVC 83) and Swamp Scrub (EVC 53_61) and Plains Grassy Wetland (EVC 125) prior to European settlement based on modelling of factors including rainfall, aspect, soils and remaining vegetation.



Plate 1: Wetland area at offset site looking south east



Plate 2: Wetland area at offset site looking west



Plate 3 East-west drainage line and stormwater outlet on northern boundary of the offset site

4.1.1. Existing Eastern Dwarf Galaxias Habitat

In accordance with the key habitat types required to sustain a viable population of Eastern Dwarf Galaxias (see Section 2.2) the enhanced offset site will need to support the following habitat types:

- Permanent refuge pools;
- Shallow wetland habitat (ephemeral);
- Shallow drainage lines/connection pathways; and
- Linkages to other existing populations.

Of these habitat requirements, the offset site currently only supports shallow ephemeral wetland habitat (see Plate 1 and Plate 2). There are no refuge pools, shallow drainage lines/connection pathways or linkages to other existing populations (namely the population on the opposite side of Hallam Road).

The drain on the northern boundary of the offset site has a number of historical Eastern Dwarf Galaxias records to the west of the site, however, the drain is also likely to support Eastern Gambusia, which are one of the key threats to Eastern Dwarf Galaxias.



Legend

- Offset site boundary
- Development site
- Existing Melb Water Eastern Dwarf Galaxias site

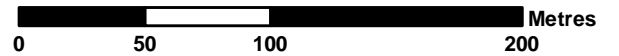


Figure 3: Offset site location

Project: 96-166 Centre Rd, Narre Warren

Client: Candil Holdings Ltd

Project No.: 14090	Date: 27/10/2015	Created By: M. Ghasemi / I. Kulik
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<p>BL&A</p> <ul style="list-style-type: none"> ● Experience ● Knowledge ● Solutions 	<p>Brett Lane & Associates Pty Ltd. Ecological Research & Management</p> <p>Suite 5, 61 - 63 Camberwell Road Hawthorn East, VIC 3123 PO Box 337, Camberwell, VIC 3124, Australia</p>	<p>Ph (03) 9815 2111 / Fax (03) 9815 2685 enquiries@ecologicalresearch.com.au www.ecologicalresearch.com.au</p>
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4.1.2. Management issues (threats)

Current management issues within the offset site are listed below. These threats must be controlled to maximise offset gains. The following threats are considered to be 'high threats' at the offset site:

- Altered hydrological regime i.e. complete habitat drying or persistent high water levels;
- Incursion by predatory/competitor fish (especially Eastern Gambusia);
- Habitat fragmentation;
- Illegal collecting; and
- Weeds (i.e. habitat encroachment).

Altered hydrological Regime

Although it is apparent that the offset site contains some areas that are moist for prolonged periods, its natural water regime has been highly modified by nearby drainage lines, levees and roads. The site is currently unable to support a viable population of the species due to drying and the lack of areas that retain permanent water.

The improved hydrology and watering regime will need to meet the basic requirements of Eastern Dwarf Galaxias, with large wetted areas during the autumn/winter breeding period and permanent refuge areas (e.g. pools) where the fish can persist during drier periods.

Incursion by Predatory/Competitor Fish

Eastern Gambusia is one of the greatest threats posed to Eastern Dwarf Galaxias and they occur in the vicinity of the offset site (e.g. northern drain, southern constructed stormwater wetland and likely other locations in close proximity to the offset site). They pose a competition and predation risk to Eastern Dwarf Galaxias due to high fecundity, similar food niche/s, aggressive behaviour and tolerance of poor water quality.

The offset site currently provides no permanent habitat for Eastern Gambusia.

The offset site design plan will need to incorporate measures to limit the ingress of Eastern Gambusia into the site, especially into the proposed permanent pools.

Habitat Fragmentation

The offset site is currently disconnected from known populations of Eastern Dwarf Galaxias. With habitat fragmentation being identified as a high threat to the species a key element of the offset site design will be facilitating the connectivity with existing species populations and/or habitat. Specifically, connectivity to the Melbourne Water managed Eastern Dwarf Galaxias site population located on the opposite side of Hallam Road to the offset site will be essential.

Illegal collecting

Illegal collection leading to localised depletions, possibly intensifying with increased community awareness, is a threat to Eastern Dwarf Galaxias populations. In its current condition (e.g. dense perimeter vegetation and ground covers) the site is relatively difficult to access. It will be difficult to mitigate illegal collecting completely, however, maintaining the offset site's dense perimeter vegetation, ensuring there is sufficient refuge (in the form of emergent vegetation and refuge pools) and not advertising the

presence of the habitat/species (similarly to the existing site across Hallam Road) should be sufficient to minimise illegal collecting.

Weeds

A wide range of common weed species are present on the offset site including Blackberry, Thistle and range of other herbaceous species. The key risk posed by weeds to eastern Dwarf Galaxias habitat is encroachment and loss of critical habitat areas resulting in lost habitat capacity (e.g. Alligator Weed).

4.2. Preliminary Offset Site Concept Design

In conjunction with Narre Warren Central, BL&A and Aquatica Environmental, Melbourne Water developed a concept design for the site taking into consideration the site attributes, offset requirements and Eastern Dwarf Galaxias habitat requirements (Figure 4). It was agreed that key to the success of the offset site and its management will be working with the existing topography, habitat, aquatic vegetation and hydrology.

The key criteria set for the concept plan were:

- Where practicable, work with the existing offset site topography, aquatic and terrestrial vegetation and landscape setting.
- Ensure that the offset requirements from the development site were achieved.
- Incorporate all key habitat types required to maintain a viable permanent population of Eastern Dwarf Galaxias.
- Ensure there are measures in place to mitigate the key issues/threats posed to the species and its successful establishment at the offset site.

The concept design has been developed to take advantage of the existing offset site landscape and proximity to the existing Eastern Dwarf Galaxias population across Hallam Road. The concept design incorporates the following key elements:

- Retention and improvement of existing shallow ephemeral wetland habitat areas;
- Construction of permanent refuge pools;
- Construction of shallow drainage lines/connection pathways (semi-formal pilot channels) to provide connectivity between the permanent refuge pools;
- Construction of a levee to prevent Eastern Gambusia ingress;
- Construction of culverts under Hallam Road to connect with the existing Eastern Dwarf Galaxias population/habitat; and
- A number of potential additional water sources (should hydrologic modelling determine necessary for sustaining permanent pools as part of more detailed design works), including construction of filtration systems to prevent Eastern Gambusia ingress.

Shallow Wetland Habitat (Ephemeral)

Much of the offset site already consists of shallow ephemeral wetland habitat, ranging from low-lying areas that may retain moisture (but not surface water) for prolonged periods (as indicated by the presence of aquatic and ephemeral plant species) to higher elevation areas that would be inundated at times of higher rainfall/flows and consist of emergent and terrestrial plant species.

The concept design (Figure 4) provides an outline of the expected overall Eastern Dwarf galaxias habitat extent (red line), thereby also indicating the likely extent of the shallow ephemeral wetland habitat (once hydrological measures are in place).

Given observations of a wide range of aquatic and ephemeral plant species on the offset site, it is expected that once a more natural hydrological regime is achieved, there will be substantial natural recruitment of aquatic and semi-aquatic vegetation. Even so, some revegetation, particularly in newly constructed refuge pools, is likely to be required.

Based on the concept design the overall area are of levee protection will be upwards of 2.4 hectares and of Eastern Dwarf Galaxias habit area upwards of 2.0 hectares. A large portion of this, if not the majority, will be shallow wetland habitat.

Permanent Refuge Pools

The concept design incorporates three refuge pools constructed to provide permanent refuge habitat (Figure 4). No such pools are currently on the site but they are an essential habitat component for maintaining a viable permanent population at the site.

The concept design includes a larger refuge pool in the centre of the offset site and two smaller pools located along the natural drainage line connecting the offset site to the existing Eastern Dwarf Galaxias site over Hallam Road. The location of the pools has been determined by the existing lower-lying areas of the site to encourage natural drainage and water collection in the pools and optimise connectivity to each pool and the culverts. In particular the two smaller pools have been placed to facilitate dispersal of Eastern Dwarf Galaxias from and/or to the existing site across Hallam Road (via the culverts).

The pools will be designed and built in conjunction with a hydrological assessment in order to achieve a normal water level between 0.5-1.0 metres and ensuring that a minimum of 0.3 metres of water is available in the driest of years.

Based on the concept design, the overall area of permanent refuge pools is expected to be between approximately 0.61 hectares at normal water level and including pilot channels and 0.13 hectares at the minimum 0.3 meters.

Shallow Drainage Lines/Connection Pathways

The concept design includes a number of shallow drains and connection pathways (i.e. semi-formal pilot channels, see Figure 4). The purpose of these channels is to direct surface flows to the pools and to enable fish passage between pools and culverts for dispersal. The channels will be set lower than the surrounding shallow wetland habitat so that water is more persistent in these channels, further facilitating fish movement between shallow wetland areas during higher water levels, pools and culverts.

Culverts/Connectivity to Neighbouring Site/Population

The concept design includes the installation of two culverts under Hallam Road. The purpose of the culverts is primarily to connect the existing Eastern Dwarf Galaxias habitat and population to the newly created habitat at the offset site. In doing this, a single larger connected population will be created, theoretically increasing the overall viability and permanence of the larger population.

A secondary consideration is that these culverts could allow additional water to enter the offset site from the existing site during periods of higher rainfall and flows, facilitating wetting of the offset site and dispersal of Eastern Dwarf Galaxias from the existing site.

The key aspects of this element of the concept design include:

- Culverts should be set at different heights to allow intermittent (and variable) wetting and fish passage during increased water levels in the existing Eastern Dwarf Galaxias habitat.
- Culvert height/s should be set such that they do not change the hydrological regime of the existing Eastern Dwarf Galaxias site (any flows should be in addition to any the existing site can take).

Levee

In order to develop the offset site as an offline wetland system for Eastern Dwarf Galaxias it will be necessary incorporate a low levee around the site to prevent the ingress of high threat fish species, such as Eastern Gambusia, during flood events. The most likely route for Eastern Gambusia invasion of the offset site is from the drain on the northern boundary and/or the constructed stormwater wetland to the south during high flows.

The levee will be constructed to encompass the north, east and south sides of the offsite, leaving the eastern side open for connectivity to the existing Eastern Dwarf Galaxias site across Hallam Road (Figure 4).

It is proposed that the level be built to a height that prevents overtopping for up to a 1 in 20 year flood event.

Water Sources

In order to achieve the required hydrological regime, it may be necessary to source additional water for the offset site. A hydrological assessment is planned to determine the specific water volume, wetting and water level requirements of the offset site, however, a number of potential water sources have been initially identified for the offset site including:

- Existing surface and ground water flows on the site (i.e. deeper pools may be able to retain surface water for extended periods);
- Stormwater from the outlet near Rimfire Drive;
- Surface water from the large drainage channel along the northern boundary of the offset site, along Centre Road;
- Surface water from the existing Eastern Dwarf Galaxias site and wetland to the west of the offset site over Hallam Road.

One, or a combination of these may be required to achieve a hydrological regime that is beneficial to Eastern Dwarf Galaxias.

4.3. Other Offset Site Design Factors

Predator Control

Eastern Gambusia is already present in the region and poses a high risk to the success of the offset site due to predation and competition.

Control measures for Eastern Gambusia are difficult in areas occupied by Eastern Dwarf Galaxias, but manual removal and water level manipulation has had some success in other locations (e.g. Melbourne Water's Hallam Valley habitat wetland). Although, key to the success of the offset site will be preventing ingress of Eastern Gambusia in the first

place. This will be achieved by the levee (as noted previously) and installation of suitable filters at water inlet points to Eastern Gambusia ingress.

Water Quality and Sediment Control

During construction of the offset site's infrastructure (e.g. pools, channel, water inlets, etc) sediment barrier fencing will be installed adjacent to areas of active construction that abut retained wetland habitat. Fencing is to comprise fine-mesh textile (e.g. Type 3 woven fabric – as per Catchments and Creeks Pty Ltd 2010) allowing water but not solid particles through. It shall be embedded 100mm into the ground to prevent sediment ingress below the fence. Posts shall support the fence at intervals not exceeding three metres.

Sediment fencing is to be installed at water inlet points and along the wetland side of any constructed levees so that sediment does not progress under the influence of gravity into the offset site.

Once new habitat features are created, the buffer between sediment fence and water body shall be planted with locally indigenous aquatic or riparian zone plants to provide an extra barrier to sedimentation. Jute matting will be used on any exposed soils.

Buffer Zone Along Hallam and Centre Roads

The vegetation along the eastern and northern sides of the offset site (Centre and Hallam Roads) ranges between about 6-10 metre wide and will be retained to provide a shelterbelt and minimise access to the offset site.

Areas of missing native vegetation within these buffers will be revegetated with Swamp Paperbark and other suitable indigenous flora (using species from the Gippsland Plain bioregion Swampy Riparian Woodland (EVC 83)/Swamp Scrub (EVC 53) Mosaic and Plains Grassy Wetland (EVC 125) (Appendix 2). The additional vegetation is likely to reduce the ingress of pollutants, sediments and litter.

Weed control will need to be implemented along the Centre Road buffer for suppression of Blackberry and other high threat weeds.

Hallam South Road Dwarf Galaxias Habitat Offset Concept Design

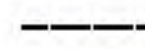
By Rhys Coleman
Melbourne Water
22 Oct 2015



Culvert



Semi-formal
pilot channel



Fence



Habitat extent



Filtration pit / drain



Refuge pool



1-in-20 levee

4.4. Meeting Commonwealth Offset Requirements

4.4.1. *Offset measures to compensate for Dwarf Galaxias habitat removal*

Proposed offset site design and measures to compensate for the loss of Eastern Dwarf Galaxias habitat from the development site are described above in Sections 4.1 to 4.2, and summarised as follows:

- Off-stream Eastern Dwarf Galaxias habitat will be created on the offset site located in the same catchment as the development site. It will include permanent refuge, breeding and dispersal habitats, connected to an existing adjacent population and will be of a proven design in providing quality Eastern Dwarf Galaxias habitat.
- The already modified hydrological regime of the offset site will be altered as to preferentially suit Eastern Dwarf Galaxias seasonal requirements and life-cycles.
- The offset site will be revegetated with an appropriate mix of aquatic and terrestrial indigenous plant species.
- Weed control, beyond that legally required, will be carried at the offset site and its boundaries along Hallam and Centre Roads (with a focus on weed species that may encroach into critical habitat zones).
- To secure these offsets, the proponent/Melbourne Water will enter into a Section 173 with the Casey City Council, whereby the existing and created Dwarf Galaxias habitat (Figure 6) within the offset area will be secured for conservation in perpetuity.

4.4.2. *How the offset measures meet the EPBC Act Environmental Offsets Policy requirements*

The offset potential of the offset was assessed in accordance with the *EPBC Act Environmental Offsets Policy* (the Policy) (DSEWPC 2012), which is accompanied by the *Offsets assessment guide* (the Guide), a pre-programmed balance sheet, which estimates impacts and offsets for threatened species and ecological communities, based on user inputs for a range of different quanta (or currencies).

It is proposed to use Dwarf Galaxias habitat area as the appropriate quantum to input into the *Offset Assessment Guide*. The area of Dwarf Galaxias habitat proposed to be removed is 0.56 hectares (rounded), including 0.12 hectares of primary habitat (where the species was actually recorded) and 0.43 hectares of secondary habitat (deemed suitable habitat but none have been recorded). Assuming an offset ratio of 4:1 (which has been acceptable in the past), the offset area required would be up to 2.24 hectares. The size of the proposed offset area is approximately 3.35 hectares, incorporating 2.4 hectares of off-stream levee-protected wetland habitat, upward of 2.0 hectares of high quality Eastern Dwarf Galaxias habitat and upward of 0.61 hectares of permanent refuge pools (depending on seasonal water height).

The eight offset principles outlined in the Commonwealth Draft Offsets Policy are met with the proposed offset scenario as detailed in Table 3.

Table 3: Meeting Commonwealth offset requirements

Commonwealth Requirement	Proposed Offset Site
Environmental offsets should be targeted to the matter protected by the EPBC Act that is being impacted	The offset site will be specifically designed to support and protect Eastern Dwarf Galaxias and their habitat and will be connected to an adjacent existing Eastern Dwarf Galaxias habitat area, managed by Melbourne Water, to form a single larger habitat area and population.
A flexible approach should be taken to the design and use of environmental offsets to achieve long-term and certain conservation outcomes that are cost effective for proponents.	A flexible offset approach is possible at this site. In collaboration with Melbourne Water and Eastern Dwarf Galaxias experts, new Eastern Dwarf Galaxias habitat will be created to support this species.
Environmental offsets should deliver a real conservation outcome.	The real conservation outcome would be the creation, protection and enhancement of the proposed approximately 3.4 hectare offset site between 2.0-2.4 hectares of Eastern Dwarf Galaxias habitat.
Environmental offsets should be developed as a package of actions - which may include both direct and indirect offsets.	The offset approach comprises a direct offset through the creation and enhancement of Eastern Dwarf Galaxias habitat. No indirect offsets are proposed.
Environmental offsets should, as a minimum, be commensurate with the magnitude of the impacts of the development and ideally deliver outcomes that are 'like for like'.	The protection of approximately 2.24 hectares (i.e. 0.56 hectare loss x4) of Eastern Dwarf Galaxias habitat will ensure a like-for-like offset within the magnitude of the impacts (e.g. four times the area proposed to be removed).
Environmental offsets should be located within the same general area as the development activity.	The offset site is located approximately 1.5 kilometres west of the development site, south of Centre Rd, both of which are within the Hallam Valley floodplain.
Environmental offsets should be delivered in a timely manner and be long lasting.	This is achieved by securing the site through a section 173 agreement and managing the site through and with Melbourne Water.
Environmental offsets should be enforceable, monitored and audited.	This is achieved by securing and managing the site, consistent with any EPBC Act and planning permit conditions.

The above table shows that, subject to approval and implementation of management practices, all eight of the Commonwealth policy targets can be met by this proposed offset site.

The offset outlined in this plan will also meet the requirements under the EPBC Act to compensate for the removal of 0.56 hectares of Eastern Dwarf Galaxias habitat at the development site.

5. OFFSET IMPLEMENTATION (PART B)

5.1. Strategy for offset site

The offset site is to be secured and managed for the purposes of conservation in perpetuity. Table 4 outlines the offset security and management responsibilities.

Table 4: Offset security and management responsibility

Who is liable/responsible for meeting offset requirements?	Narre Warren Central Pty Ltd
Type of security i.e. Planning Permit Condition, Section 69 of the <i>Conservation, Forest and Lands Act 1987 (Vic)</i> , Section 173 of the <i>Planning and Environment Act 1987 (Vic)</i> Covenant under the <i>Victorian Conservation Trust Act 1972 (Vic)</i>	Section 173 of the Planning and Environment Act 1987 (Vic)
Agreement or Planning Permit Number (ID)	To be advised
Date 10-year offset management to commence	To be advised (upon securing offset in accordance with EPBC Act conditions)
Date 10-year offset management expires	10 years from commencement date
Registered on title? (Yes/No)	Yes
Offset site management responsibility (i.e. Landowner, Authority Name)	The site is owned by Melbourne Water. Narre Warren Central Pty Ltd will be responsible for managing and maintaining the offset site for at least the first five years (in consultation with Melbourne Water), after which the handover period for managerial responsibilities will be negotiated with Melbourne Water.
Offset monitoring responsibility (i.e. Responsible Authority, DELWP)	Narre Warren Central Pty Ltd will be responsible for the monitoring commitment for at least the first five years, after which responsibility will be negotiated with Melbourne Water. Monitoring results and reports will be provided to both DoE and Melbourne Water.

5.2. Creation of Eastern Dwarf Galaxias habitat

5.2.1. Objectives

The primary objective of the offset site design is to improve the ecological values of the existing wetland for Eastern Dwarf Galaxias via the protection and enhancement of existing wetland areas and creation of connecting culverts to other Eastern Dwarf Galaxias habitat/populations, dispersal routes and permanent refuge pools.

The key approaches for improving habitat values for the Eastern Dwarf Galaxias are:

- Use engineering solutions to modify the hydrological and wetting regime of the offset site to the benefit of Eastern Dwarf Galaxias;

- Create an off-line wetland connected to existing Eastern Dwarf Galaxias habitat, vegetated to provide suitable habitat for the species;
- The enhancement of the created Eastern Dwarf Galaxias habitat within the proposed offset site through revegetation and weed control to create a range of open and shady areas suitable for the species; and
- Implement measures to mitigate the incursion of high threat fish species such as Eastern Gambusia.

The proposed design will essentially replicate the range of natural Eastern Dwarf Galaxias habitats (e.g. breeding, dispersal, refuge, etc.) and is based on the attributes of existing refuge habitat on the adjacent property and development site, but also draws broadly on attributes of other Eastern Dwarf Galaxias habitat locations (Coleman *et. al.* 2015) and other Melbourne Water constructed Eastern Dwarf Galaxias habitats.

The construction of the Eastern Dwarf Galaxias refuge habitat pools should enable the establishment of a second or expanded Eastern Dwarf Galaxias population, thereby enhancing the long-term viability of the species in the Hallam valley catchment. Proposed landscaping and revegetation of aquatic and emergent habitats is aimed to reinstate and maintain habitat for Eastern Dwarf Galaxias and to improve connectivity for this species together with other native aquatic and terrestrial species.

5.2.2. Wetland construction

To ensure the objectives are met, the wetland and Eastern Dwarf Galaxias habitat will be designed with the following features:

- Where practicable, the existing wetland habitat and overall landscape will be retained, with an improved a hydrological and wetting regime to facilitate natural regeneration of aquatic and semi-aquatic plant species.
- The Eastern Dwarf Galaxias habitat wetland will consist of “purpose built” permanent refuge pools, connected by semi-formal ephemeral pilot channels and marsh areas within the offset site, and connection to neighbouring Eastern Dwarf Galaxias habitat.
- The refuge pools will be constructed to facilitate a normal water height of between 0.5-1.0 meters and a minimum of 0.3 metres in the driest years. They will be constructed with a gentle slope of approximately 1:10, blending into the surrounding wetland areas. Each pool will have a depth and/or water level logger installed to allow easy monitoring and assessment of water height, especially in the initial years after construction.
- The connecting/semi-formal pilot channels improve hydrologic connectivity between refuge pools.
- The culverts will be constructed to a level that creates intermittent flows between the existing Eastern Dwarf Galaxias site and offset site during periods of higher rainfall and surface water flows to facilitate the creation of a functionally single, larger population.
- The boundary of the offset site (and in between refuge pools, where appropriate) will be densely planted with Swamp Paperbark to enhance overall and Eastern Dwarf Galaxias habitat and provide appropriate shelter/refuge.

The key habitat attributes for Eastern Dwarf Galaxias at the site will be a combination of permanent refuge pools surrounded by increasingly shallow periodically in-undated marsh and wetland areas. The permanent refuge pools will be heavily vegetated with aquatic and emergent plant, but not heavily shaded.

The planting density of EVC 35_61, 83 and 125 plant species (especially Swamp Paperbark) shall be most dense around the perimeter of the site (and in between refuge pools where appropriate) and least dense (e.g. sparse) around refuge pools, pilot channels and in the shallow zones.

The planting layout, species selection, and densities will be designed to maximise habitat for Eastern Dwarf Galaxias, maintain fish passage and to enhance connectivity for other native fauna (e.g. aquatic invertebrates and amphibians). The proposed wetlands, in conjunction with the pools, will provide suitable refuge, spawning and dispersal habitat.

The slope between pools is gentler to allow for establishment of more extensive areas of aquatic vegetation. An assortment of appropriate submerged and ephemeral aquatic plants with varying hydrological requirements are to be planted on pool slopes and interspersing ephemeral zones. The ephemeral zones would typically be inundated over winter/spring and provide an extension of suitable spawning habitat for Eastern Dwarf Galaxias.

Plant species will be drawn from the local native vegetation communities, Swamp Scrub (EVC 53_61), Swampy Riparian Woodland (EVC 83) and Plains Grassy Wetland (EVC 125) consistent with the objective of providing habitat connectivity opportunities for fish, amphibians and other native species.

5.2.3. Revegetation

Due to the sensitive nature of waterway environments and their ability to both transport nutrients and contaminants and act as a sink for these, particular attention is required with respect to landscape maintenance. All revegetation works will be coordinated with the weed management controls outlined in Section 5.4.2 to ensure the management of weeds within the rehabilitated habitat and wetland.

Preferred vegetation will be used in the revegetation program to outcompete weed species. Replants throughout the maintenance period will be undertaken to ensure appropriate cover is attained.

Where sites require temporary protection prior to the establishment of a vegetated layer within the newly formed pools and drainage channels, jute matting will be used. Shredded organic mulch shall not be used within waterways where there is a risk of erosion.

Where surface waters are present only Roundup Biactive® or an equivalent product will be used within one meter of the surface waters. At distances greater than one meter or where the chance of runoff can be eliminated other herbicide products may be employed in accordance with the weed management section of this plan (Section 5.4.2).

5.2.4. Hydrological Requirements

Key to the success of the offset habitat wetland will be facilitating the appropriate hydrological and watering regime for Eastern Dwarf galaxias and their range of season patterns and life cycle.

Eastern Dwarf Galaxias spawn between April and October in association with increased flows during autumn and winter. During this time it is essential that large portions of the vegetated ephemeral habitat extent (red line in Figure 4) are inundated for up to three months to allow breeding, spawning, larval development, dispersal and persistence in refuge pools when the wetland wetted areas contracts in drier months.

Similarly the refuge pool areas require enough water to ensure a normal water level of between 0.5-1.0 metres and minimum water level of 0.3 metres for refuge during the driest years.

As noted in Section 4.2, in order to achieve this hydrological regime, it may be necessary to source additional water for the offset site. Additional water sources may include:

- Existing surface and ground water flows: Specific to ensuring the refuge pools are maintained on the offset site during even the direst years, the hydrological assessment will explore the existing groundwater levels of the offset site and determine whether construction of the pools (i.e. digging into the existing topography) may allow access to sufficient water that facilitates retention of the require water level/s.
- Stormwater from the outlet near Rimfire Drive and surface water from the large drainage channel along the northern boundary of the offset site, along Centre Road: The stormwater drain initially exits into the drainage channel (see Plate 3). At this exit point there is also a break in the existing levee that will provide an entry point to the offset site for any additional flows.

A key factor in the use of this water will be preventing the ingress of Eastern Gambusia to the offset site. The concept design (Figure 4) incorporates a filter that is designed allow water infiltration to the offset site whilst preventing Eastern Gambusia ingress. The filter will likely be one or a combination of gravel/sand to ensure Eastern Gambusia cannot pass through.

- Surface water, via culverts, from the existing Eastern Dwarf Galaxias site and wetland to the west of the offset site over Hallam Road: In this scenario, water flows via the two culverts under Hallam Road, from the existing Eastern Dwarf Galaxias site on the western side of Hallam Road. Flow in addition to what the existing site requires could be directed in to the offset site to facilitate wetting and inundation.

5.3. Ongoing land-use commitments

In accordance with the prescriptions in the DoE's Environmental Offset Policy (October 2012), the landowner must forego the following entitlements in perpetuity to achieve the offsets:

- Excluding stock (unless required as part of the ecological management of the site and prior consent has been obtained from DELWP Biodiversity Services);
- Retaining all native vegetation, dead or alive including trees; and
- Foregoing entitlement to harvest timber.

Maintain the improvement gain achieved at completion of this offset plan such that:

- Weed cover of high threat species does not increase beyond the level attained at the completion of Year 10; and

- Pest animals of high threat species are controlled to the level attained at the completion of Year 10.

Any proposed uses or development of the site that conflict with the landowner commitments are not allowed under this plan.

5.4. Management actions

The managing body and/or landowner must commit to the following management actions for the 10-year life of this plan to achieve the improvement gain components of the offsets.

5.4.1. Monitoring

Monitoring is an essential component of this proposal and involves detecting changes and patterns over time. This requires identifying which parameters are to be monitored, gathering information and interpreting the information gathered. Monitoring will enable identification of problems and allow early response to any problems or threats. Monitoring is also vital for evaluating the success of the offset with regards to its stated objectives.

The monitoring program will include weeds, revegetation, Eastern Dwarf Galaxias and water quality (see following sections)

All monitoring results will be retained by the managing body and landowner, and will be principally employed to evaluate the success of the plan and inform adaptive management.

5.4.2. Weed Monitoring and Control

Weed monitoring and control will be carried out by a suitably qualified specialist contractor. The aim of the weed monitoring is to assess whether stated control targets will likely be met. Monitoring will involve estimating and documenting the percentage cover of each weed species. This will be carried out prior to commencement of the project to determine the benchmark cover of each species, then at the following intervals:

- At the completion of all construction works (including wetland construction and revegetation works);
- Six months post-construction;
- 12 months post-construction; and
- Annually in spring in years 2, 3, 4, 6 and 8.

5.4.3. Revegetation Monitoring and Works

Revegetation monitoring will be carried out by a suitably qualified Ecologist to assess whether stated targets will likely be met. Monitoring will commence at the completion of all plantings, then at the following intervals:

- At the completion of all construction works (including wetland construction and revegetation works);
- Six months post-construction;
- 12 months post-construction; and

- Annually in spring in years 2, 3, 4, 6 and 8.

Monitoring will involve assessing and documenting the following:

- Plant survival/mortality of plantings: approximate percentage and identify which species are not surviving;
- Evidence of herbivore or pathogen damage; and
- Presence and cover-abundance of introduced weeds.

5.4.4. Eastern Dwarf Galaxias Population Monitoring

Eastern Dwarf Galaxias populations have been observed to widely fluctuate over time due to climatic variations and other variables (Saddler *et al* 2010). For this reason, monitoring the status of the establishing Eastern Dwarf Galaxias population at the offset site will primarily be aimed at assessing for presence (as they enter the offset site post construction) and abundance (how many and at what life-stage). Monitoring should also be undertaken at the existing Melbourne Water site (across Hallam Road) to provide comparative assessment of population status between the existing and establishing sites.

Monitoring surveys for Eastern Dwarf Galaxias will be carried out only by a suitably experienced, qualified and approved ecologist using standard bait traps in accordance with state and commonwealth guidelines including:

- Biodiversity Precinct Structure Planning Kit (DSE 2010); and
- Survey Guidelines for Australia's Threatened Fish (DSEWPaC 2011).

Traps should be set in the refuge pools of the offset site and refuge areas of the existing site. Permanent trap locations should be established (permanent stakes) during the first survey to ensure repeatable and data comparison between surveys. The number of traps at each location should be as a minimum:

- Two smaller refuge pools on offset site – 3 traps each pool;
- Larger refuge pool on offset site – 6 traps; and
- Existing Melbourne Water site – 6 traps.

Sampling should commence approximately three months following the completion of the constructed wetland, to allow enough time for the system to start to stabilise and for fish to begin to colonise the new habitat areas. Sampling should be undertaken in the onsite constructed refuge pools and existing Melbourne Water site on the opposite side of Hallam Road.

Surveys will be undertaken on a quarterly basis for the first year, biannually for years 2-3 and then annually to year 10. Biannual surveys will be around April-May (adult survival) and November-December (juveniles) and annual surveys will be around April-May.

5.4.5. Water Quality

In unison with the Eastern Dwarf galaxias monitoring surveys, water quality monitoring will be carried out, in the onsite constructed drains and pools, adjacent drains and existing Melbourne Water site over Hallam Road on a quarterly basis for the first year, biannually for years 2-3 and then annually to year 10. The parameters to be measured will include temperature, turbidity, pH, dissolved oxygen and electrical conductivity.

The aim of the water quality monitoring is to check that water quality parameters are within the tolerances of Eastern Dwarf Galaxias.

Water quality will be assessed in conjunction with the Eastern Dwarf Galaxias surveys on a quarterly basis for the first year, biannually for years 2-3 and then annually to year 10. Biannual survey will be spring/autumn and annual surveys will be spring.

5.4.6. Adaptive management

It is recommended that the actions implemented and the timing of implementation of the OMP be based on an adaptive management approach. This approach involves monitoring the outcomes of implemented actions, evaluating the management outcomes against the stated objectives and responding by modifying management actions to meet the objectives of the Plan.

Monitoring and evaluating specific management actions needs to feed back in to management action methodology. For example, various techniques of revegetation should be used such as tube stock planting and seedling planting. Survivorship and the success rate of these techniques can then be used to direct future revegetation techniques.

Evaluation involves periodic assessments of the success of the OMP and of the success of the various methodologies and treatments applied.

The OMP will be evaluated concurrently with monitoring as follows:

- Analysis of the results of the monitoring program;
- Assessment of monitoring results against a set of predetermined success criteria which will be detailed in the OMP;
- Identification of causes of any departures from the stated objectives;
- Assessment of the methodology and cost effectiveness of the Plan; and
- Provide recommendations for future actions.

Evaluation of the OMP should provide enough information to make detailed recommendations for the future of the site. Possible recommendations may include:

- Assessment of whether to continue, repeat, revise, reschedule or discontinue the original strategy;
- Options for ongoing monitoring, maintenance and management of the OMP;
- Variables or factors that require further investigation or experimentation; and
- Identification of the personnel who will be responsible for implementation of these recommendations.

5.5. Reporting

A report will be submitted to the DoE at the completion of all works, outlining the works undertaken, current status of the offset site, including plantings, water quality and volume and occurrence of Eastern Dwarf Galaxias.

Annual monitoring reports will then be submitted in years 2, 3, 4, 5, 6 and 10. These reports will demonstrate the implementation of the design measures undertaken and the progress of the monitoring results, particularly with regards to habitat development and

the establishment of an Eastern Dwarf galaxias population on the offset site. The results of the evaluation will also be presented.

5.5.1. Management action tables

The following tables identify specific management actions and targets pertaining to the management of the proposed offset.

Table 5: Year 1 actions

Management Action	Management Action Description	Timing / Frequency	Target to be achieved	Responsible person	Completed (Yes/No)	Month and Year Completed
Weed monitoring	Estimate the following conditions: <ul style="list-style-type: none"> ▪ Overall weed cover; ▪ Determine high threat weeds; ▪ Overall high threat weed cover; ▪ cover of each high threat weed species; and ▪ cover of each high threat woody weed species. 	Commencement of plan (baseline).	<ul style="list-style-type: none"> ▪ Overall weed cover benchmark* documented; ▪ High threat weed cover benchmark* documented; ▪ Cover of each high threat weed species recorded and documented; and ▪ Cover of each high threat woody weed species recorded and documented. 	Bushland contractor Project ecologist		
Construct offset site entry/access points/s and fencing	Construct entry point/s to offset site for construction, maintenance and monitoring purposes (personnel and vehicles).	Commencement of plan.	Entry point must be secure and prevent entry of unauthorised persons.	Fencing contractor Construction contractor		
	Construct fencing around offset site.	Commencement of plan.	Fencing must prevent entry of threatening herbivores.	Fencing contractor Construction contractor		

Management Action	Management Action Description	Timing / Frequency	Target to be achieved	Responsible person	Completed (Yes/No)	Month and Year Completed
Site induction	Contractor induction for site OMP	Prior to commencing construction.	On-site meeting between a qualified ecologist and construction staff to inform them on identification, salvage procedures and translocation sites of Eastern Dwarf Galaxias; also procedures to minimise threats to its aquatic habitat, i.e. sediment barrier fencing and hazardous chemical spill protocols.	Construction contractor Project ecologist		
Offset site construction	Construct engineering solutions including pools (including install depth gauges), channels, culverts, water inlet sites, filters, etc.	Ideally summer 2015/16 when site is dry and flows are low.	Completion of all works before autumn rains.	Construction contractor		
Weed Control	High threat weed control.	Following construction completion and prior to revegetation.	<ul style="list-style-type: none"> ▪ Cover of each high threat woody weed species reduced to <1%; ▪ Cover of each high threat weed species reduced to <1%; ▪ High threat weed cover benchmark* not exceeded; ▪ Overall weed cover benchmark* not exceeded. 	Bushland contractor		
Revegetation (initial)	Order plants for revegetation.	Prior to commencing construction.	Plants ordered	Bushland contractor		
	Slash areas for revegetation.	Following weed control	Weedy vegetation height < 100mm.	Bushland contractor		
	Introduce tubestock. Use degradable weed mat where appropriate.		>75% survival of plants.	Bushland contractor		

Management Action	Management Action Description	Timing / Frequency	Target to be achieved	Responsible person	Completed (Yes/No)	Month and Year Completed
Supplementary irrigation	Supplementary irrigation if required during dry period.	Summer	As required.	Land manager / Ecologist / Melbourne Water		
Asset monitoring	Inspect and assess site for water flows, erosion and design issues.	At first seasonal rainfall/flows.	Any issues noted in a memo and addressed by appropriate party.	Construction contractor / bushland contractor and ecologist		
Eastern Dwarf Galaxias monitoring Water quality monitoring	Eastern Dwarf Galaxias: <ul style="list-style-type: none"> Assess Eastern Dwarf Galaxias presence/absence and population composition on offset site and existing site 	Quarterly for the first year, commencing 3 months after construction	Monitoring results to be documented and retained for reporting purposes. Results should also inform management approaches and techniques.	Project ecologist		
	Water <ul style="list-style-type: none"> Assess water quality at inlets and outlet to offset site, in pools and drain and at existing site. 	Upon completion of construction and then quarterly for first year				
Vegetation monitoring	Estimate the following conditions: <ul style="list-style-type: none"> Overall native vegetation cover; and Key native aquatic, emergent and terrestrial species. 	6-months post commencement 12-months post commencement	Identify species and areas for revegetation and/or additional planting.	Bushland contractor Project ecologist		

Management Action	Management Action Description	Timing / Frequency	Target to be achieved	Responsible person	Completed (Yes/No)	Month and Year Completed
Weed monitoring	Estimate the following conditions: <ul style="list-style-type: none"> Overall weed cover; Determine high threat weeds; Overall high threat weed cover; cover of each high threat weed species; and cover of each high threat woody weed species. 	6-months post commencement 12-months post commencement	Estimate overall weed cover and cover of each <i>high threat</i> weed species documented.	Bushland contractor Project ecologist		
Weed control	Weed control: <ul style="list-style-type: none"> Treat high threat weeds 	Following 6-month weed monitoring, if required Following 12-month weed monitoring, if required	<ul style="list-style-type: none"> Cover of each high threat woody weed species reduced to <1%; Cover of each high threat weed species reduced to <1%; High threat weed cover benchmark* not exceeded; Overall weed cover benchmark* not exceeded. 	Bushland contractor Project ecologist		
Reporting	Fish/water quality and weeds/vegetation monitoring reports to be prepared documenting management actions undertaken and monitoring results.	Reports due 31 st December, 2016	Reports delivered to Melbourne Water and DoE no later than three months after the due date.	Project ecologist		

* The overall weed/vegetation cover benchmark is an estimate of the overall weed/vegetation cover at the commencement of the offset plan. This informs both contractors and auditors of the plan in ensuring that overall weed/vegetation cover does not increase/decrease beyond that benchmark.

Table 6: Years 2-3 actions

Management Action	Management Action Description	Timing / Frequency	Target to be achieved	Responsible person	Completed (Yes/No)	Month and Year Completed
Vegetation monitoring	Estimate the following conditions: <ul style="list-style-type: none"> Overall native vegetation cover; and Key native aquatic, emergent and terrestrial species. 	Annually in spring	Estimate overall native species cover and cover of each species documented.	Bushland contractor Project ecologist		
Supplementary planting	Order plants for supplementary planting	Following vegetation monitoring.	Maintenance and/or increase in % cover over benchmark established in year 1.	Bushland contractor		
	Introduce supplementary tubestock. Use degradable weed mat where appropriate.	As required annually in late winter/early spring	>75% survival of plants.	Bushland contractor		
Entry and fencing infrastructure maintenance	Fence maintenance to be carried out if required	Annually if required	Integrity of fencing maintained to exclude entry to site.	Fencing contractor Construction contractor		
Weed monitoring	Estimate the following conditions: <ul style="list-style-type: none"> Overall weed cover; Overall high threat weed cover; and Cover of each high threat weed species. 	Annually in spring	Estimate overall weed cover and cover of each <i>high threat</i> weed species documented.	Bushland contractor Project ecologist		

Management Action	Management Action Description	Timing / Frequency	Target to be achieved	Responsible person	Completed (Yes/No)	Month and Year Completed
Weed Control	Control high threat weeds	Annually following weed monitoring or at specific time/season if required.	<ul style="list-style-type: none"> ▪ Cover of each high threat woody weed species reduced to <1%; ▪ Cover of each high threat weed species reduced to <1%; ▪ High threat weed cover benchmark* not exceeded; ▪ Overall weed cover benchmark* not exceeded. 	Bushland contractor		
Supplementary irrigation	Supplementary irrigation if required during dry period.	Summer	As required.	Land manager Ecologist Melbourne Water		
Eastern Dwarf Galaxias monitoring Water quality monitoring	<p>Monitoring:</p> <ul style="list-style-type: none"> ▪ Assess Eastern Dwarf Galaxias presence/absence and population composition on offset site and existing site ▪ Assess water quality at inlets and outlet to offset site, in pools and drain and at existing site. 	Biannually in spring and autumn	Monitoring results to be documented and retained for reporting purposes. Results should also inform management approaches and techniques.	Project ecologist		
Reporting	Fish/water quality and weeds/vegetation monitoring reports to be prepared documenting management actions undertaken and monitoring results.	Reports due 31 st December of year 2 and year 3.	Reports delivered to Melbourne Water and DoE no later than three months after the due date.	Project ecologist		

* The overall weed/vegetation cover benchmark is an estimate of the overall weed/vegetation cover at the commencement of the offset plan. This informs both contractors and auditors of the plan in ensuring that overall weed/vegetation cover does not increase/decrease beyond that benchmark.

Table 7: Years 4-10 actions

Management Action	Management Action Description	Target to be achieved	Responsible person	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Weed Control	Control high threat weeds.	<ul style="list-style-type: none"> ▪ Cover of each high threat woody weed species reduced to <1%; ▪ Cover of each high threat weed species reduced to <1%; ▪ High threat weed cover benchmark* not exceeded; ▪ Overall weed cover benchmark* not exceeded. 	Bushland contractor	X		X		X		
Supplementary planting	Order plants for supplementary planting	Maintenance and/or increase in % cover over benchmark established in year 1.	Bushland contractor	X		X		X		
	Introduce supplementary tubestock. Use degradable weed mat where appropriate.	>75% survival of plants.	Bushland contractor	X		X		X		
Supplementary irrigation	Supplementary irrigation if required during dry period.	Summer	Land manager Ecologist Melbourne Water	X	X	X	X	X	X	X

Management Action	Management Action Description	Target to be achieved	Responsible person	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Eastern Dwarf Galaxias monitoring Water quality monitoring	Monitoring: <ul style="list-style-type: none"> Assess Eastern Dwarf Galaxias presence/absence and population composition on offset site and existing site; Assess water quality at inlets and outlet to offset site, in pools and drain and at existing site; and Monitor in autumn prior to the breeding season. 	Monitoring results to be documented and retained for reporting purposes. Results should also inform management approaches and techniques.	Project ecologist	X	X	X	X	X	X	X
Entry and fencing infrastructure maintenance	Fence maintenance to be carried out if required	Integrity of entry and fencing infrastructure maintained to exclude entry.	Fencing contractor	X		X		X		X
Reporting	Fish/water quality and weeds/vegetation monitoring reports to be prepared documenting management actions undertaken and monitoring results.	Reports due 31 st December of year 4, 6 and 10.	Land owner / Ecologist	X	X					X

* The overall weed/vegetation cover benchmark is an estimate of the overall weed/vegetation cover at the commencement of the offset plan. This informs both contractors and auditors of the plan in ensuring that overall weed/vegetation cover does not increase/decrease beyond that benchmark.

Table 8: Action summary chart

Management Action	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Construct offset site entry/access points/s and fencing	X									
Entry and fencing infrastructure maintenance		X	X	X		X		X		X
Site Induction	X									
Offset site construction	X									
Weed monitoring	XXX Start, 6 & 12 mo	X In spring	X In spring							
Weed control	XXX Start, 6 & 12 mo	X	X	X		X		X		
Revegetation										
Supplementary irrigation (summer, if required)	X	X	X	X	X	X	X	X	X	X
Eastern Dwarf Galaxias monitoring	XXXX Quarterly	XX Biannually	XX	X Annually	X	X	X	X	X	X
Water quality monitoring	XXXX Quarterly	XX Biannually	XX	X Annually	X	X	X	X	X	X
Vegetation monitoring	XX	X In spring	X In spring							
Supplemental planting		X	X	X		X		X		
Reporting	X	X	X	X		X				X

5.5.2. Monitoring and reporting form

The Landowner or Land manager agrees to submit the Offset Site Monitoring and Report Form to the DoE as specified in Table 9.

Table 9: Offset Site Monitoring and Reporting Schedule

Year*	Year from commencement	Time of year	Monitoring Method	Person Responsible	Report due to DELWP by:
2016	1	Any	Landowner Monitoring Form	Landowner or land manager **	By 31 December 2017
2017	2				By 31 December 2018
2018	3				By 31 December 2019
2019	4				By 31 December 2020
2020	5				By 31 December 2021
2026	10				By 31 December 2027
Post 2027	As requested in writing by DoE and within a maximum 3 months of the date of issue				

* Assumes offset site works are undertaken and completed during summer 2015/16.

** Depends on who is responsible at the time.

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Appendix 1: Offset site monitoring and reporting form

Landowner of offset site	
Location and address of offset site	
Offset site number (if applicable)	
Offset plan reference number (if applicable)	
Responsible Authority	
Report No.	
Signature	
Date	

Please attach a copy of Management Action Table from the Offset Plan with information on which actions have been completed for year/s of this reporting period.

Describe specific monitoring results from surveys undertaken, survival rates of revegetation works, fencing work, success of weed and pest animal control work, successful management tools (i.e. techniques used to control weed species, protection of new plants, monitoring techniques...) and any problems or issues experienced (i.e. new infestation of weed species, storm damage to fencing...).

Provide photographs showing evidence of works.

If any agreed management actions or commitments are incomplete or have not been undertaken in the times specified explain the reasons why and what program of action/s will be undertaken to implement the action. If no action is to be undertaken please explain the reason/s and how the targets specified will be met.

Appendix 2: Ecological vegetation class information for revegetation (EVC's 53, 83 and 125)

EVC/Bioregion Benchmark for Vegetation Quality Assessment

Gippsland Plain bioregion

EVC 53: Swamp Scrub

Description:

Closed scrub to 8 m tall at low elevations on alluvial deposits along streams or on poorly drained sites with higher nutrient availability. The EVC is dominated by Swamp Paperbark *Melaleuca ericifolia* (or sometimes Woolly Tea-tree *Leptospermum lanigerum*) which often forms a dense thicket, out-competing other species. Occasional emergent eucalypts may be present. Where light penetrates to ground level, a moss/lichen/liverwort or herbaceous ground cover is often present. Dry variants have a grassy/herbaceous ground layer.

Canopy Cover:

%cover	Character Species	Common Name
50%	<i>Leptospermum lanigerum</i> <i>Melaleuca ericifolia</i>	Woolly Tea-tree Swamp Paperbark

Understorey:

Life form	#Spp	%Cover	LF code
Medium Shrub	2	10%	MS
Small Shrub	2	1%	SS
Large Herb	2	5%	LH
Medium Herb	3	15%	MH
Small or Prostrate Herb	2	5%	SH
Large Tufted Graminoid	2	10%	LTG
Large Non-tufted Graminoid	3	10%	LNG
Medium to Small Tufted Graminoid	2	5%	MTG
Medium to Tiny Non-tufted Graminoid	2	15%	MNG
Ground Fern	1	5%	GF
Scrambler or Climber	1	1%	SC
Bryophytes/Lichens	na	20%	BL

LF Code	Species typical of at least part of EVC range	Common Name
MS	<i>Coprosma quadrifida</i>	Prickly Currant-bush
MS	<i>Leptospermum continentale</i>	Prickly Tea-tree
LH	<i>Lycopus australis</i>	Australian Gipsywort
LH	<i>Lythrum salicaria</i>	Purple Loosestrife
LH	<i>Persicaria praetermissa</i>	Spotted Knotweed
MH	<i>Hydrocotyle pterocarpa</i>	Wing Pennywort
MH	<i>Stellaria angustifolia</i>	Swamp Starwort
MH	<i>Lobelia anceps</i>	Angled Lobelia
SH	<i>Crassula helmsii</i>	Swamp Crassula
LTG	<i>Juncus procerus</i>	Tall Rush
LTG	<i>Poa labillardierei</i>	Common Tussock-grass
LNG	<i>Gahnia radula</i>	Thatch Saw-sedge
LNG	<i>Phragmites australis</i>	Common Reed
LNG	<i>Baumea rubiginosa</i> s.l.	Soft Twig-rush
MTG	<i>Triglochin procerum</i> s.l.	Water Ribbons
MTG	<i>Juncus gregiflorus</i>	Green Rush
MNG	<i>Eleocharis acuta</i>	Common Spike-sedge
GF	<i>Blechnum cartilagineum</i>	Gristle Fern
SC	<i>Calystegia sepium</i>	Large Bindweed

EVC 53: Swamp Scrub - Gippsland Plain bioregion

Recruitment:

Continuous

Organic Litter:

40 % cover

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
MH	<i>Hypochoeris radicata</i>	Cat's Ear	high	low
LNG	<i>Holcus lanatus</i>	Yorkshire Fog	high	high

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EVC/Bioregion Benchmark for Vegetation Quality Assessment

Gippsland Plain bioregion

EVC 83: Swampy Riparian Woodland

Description:

Woodland to 15 m tall generally occupying low energy streams of the foothills and plains. The lower strata are variously locally dominated by a range of large and medium shrub species on the stream levees in combination with large tussock grasses and sedges in the ground layer.

Large trees:

Species	DBH(cm)	#/ha
<i>Eucalyptus</i> spp.	70 cm	15 / ha

Tree Canopy Cover:

%cover	Character Species	Common Name
20%	<i>Eucalyptus ovata</i>	Swamp Gum
	<i>Eucalyptus radiata</i> s.l.	Narrow-leaf Peppermint

Understorey:

Life form	#Spp	%Cover	LF code
Immature Canopy Tree		5%	IT
Understorey Tree or Large Shrub	4	30%	T
Medium Shrub	5	20%	MS
Small Shrub	1	1%	SS
Prostrate Shrub	1	1%	PS
Large Herb	3	5%	LH
Medium Herb	7	10%	MH
Small or Prostrate Herb	3	5%	SH
Large Tufted Graminoid	3	15%	LTG
Large Non-tufted Graminoid	1	5%	LNG
Medium to Small Tufted Graminoid	5	10%	MTG
Medium to Tiny Non-tufted Graminoid	2	10%	MNG
Ground Fern	2	10%	GF
Scrambler or Climber	2	5%	SC
Bryophytes/Lichens	na	10%	BL

LF Code	Species typical of at least part of EVC range	Common Name
T	<i>Acacia melanoxylon</i>	Blackwood
T	<i>Melaleuca ericifolia</i>	Swamp Paperbark
T	<i>Leptospermum lanigerum</i>	Woolly Tea-tree
MS	<i>Leptospermum continentale</i>	Prickly Tea-tree
MS	<i>Coprosma quadrifida</i>	Prickly Currant-bush
MS	<i>Bursaria spinosa</i>	Sweet Bursaria
LH	<i>Senecio minimus</i>	Shrubby Fireweed
MH	<i>Gonocarpus tetragynus</i>	Common Raspwort
MH	<i>Acaena novae-zelandiae</i>	Bidgee-widgee
MH	<i>Hydrocotyle hirta</i>	Hairy Pennywort
SH	<i>Dichondra repens</i>	Kidney-weed
LTG	<i>Carex appressa</i>	Tall Sedge
LTG	<i>Cyperus lucidus</i>	Leafy Flat-sedge
LTG	<i>Lepidosperma elatius</i>	Tall Sword-sedge
LTG	<i>Juncus procerus</i>	Tall Rush
LNG	<i>Phragmites australis</i>	Common Reed
MTG	<i>Themeda triandra</i>	Kangaroo Grass
MTG	<i>Lomandra filiformis</i>	Wattle Mat-rush
MNG	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass
GF	<i>Pteridium esculentum</i>	Austral Bracken

EVC 83: Swampy Riparian Woodland - Gippsland Plain bioregion

Recruitment:

Continuous

Organic Litter:

20 % cover

Logs:

20 m/0.1 ha.

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
LH	<i>Cirsium vulgare</i>	Spear Thistle	high	high
LH	<i>Sonchus oleraceus</i>	Common Sow-thistle	high	low
MH	<i>Hypochoeris radicata</i>	Cat's Ear	high	low
MH	<i>Prunella vulgaris</i>	Self-heal	high	high
LNG	<i>Holcus lanatus</i>	Yorkshire Fog	high	high
MTG	<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	high	high
MTG	<i>Briza maxima</i>	Large Quaking-grass	high	low

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EVC/Bioregion Benchmark for Vegetation Quality Assessment

Gippsland Plain bioregion

EVC 125: Plains Grassy Wetland

Description:

This EVC is usually treeless, but in some instances can include sparse River Red Gum *Eucalyptus camaldulensis* or Swamp Gum *Eucalyptus ovata*. A sparse shrub component may also be present. The characteristic ground cover is dominated by grasses and small sedges and herbs. The vegetation is typically species-rich on the outer verges but is usually species-poor in the wetter central areas.

Life forms:

Life form	#Spp	%Cover	LF code
Large Herb	3	10%	LH
Medium Herb	10	20%	MH
Small or Prostrate Herb	2	10%	SH
Large Tufted Graminoid	2	5%	LTG
Large Non-tufted Graminoid	2	10%	LNG
Medium to Small Tufted Graminoid	10	20%	MTG
Medium to Tiny Non-tufted Graminoid	4	10%	MNG
Bryophytes/Lichens	na	10%	BL
Total understorey projective foliage cover		95%	

LF Code	Species typical of at least part of EVC range	Common Name
LH	v <i>Craspedia paludicola</i>	Swamp Billy-buttons
LH	<i>Villarsia reniformis</i>	Running Marsh-flower
MH	<i>Myriophyllum crispatum</i>	Upright Water-milfoil
MH	<i>Lythrum hyssopifolia</i>	Small Loosestrife
MH	<i>Centella cordifolia</i>	Centella
SH	<i>Neopaxia australasica</i>	White Purslane
SH	<i>Myriophyllum integrifolium</i>	Tiny Water-milfoil
LTG	<i>Amphibromus nervosus</i>	Common Swamp Wallaby-grass
LNG	<i>Baumea arthropphylla</i>	Fine Twig-sedge
MTG	<i>Schoenus tesquorum</i>	Soft Bog-sedge
MTG	<i>Triglochin alcockiae</i>	Southern Water-ribbons
MTG	<i>Notodanthonia semiannularis</i>	Wetland Wallaby-grass
MTG	<i>Austrodanthonia duttoniana</i>	Brown-back Wallaby-grass
MNG	<i>Eleocharis acuta</i>	Common Spike-sedge
MNG	<i>Hemarthria uncinata</i> var. <i>uncinata</i>	Mat Grass
MNG	k <i>Eleocharis macbarronii</i>	Grey Spike-sedge
MNG	<i>Triglochin striatum</i>	Streaked Arrowgrass

Recruitment:

Episodic/Flood. Desirable period between disturbances is 5 years.

Organic Litter:

10% cover

EVC 125: Plains Grassy Wetland - Gippsland Plain bioregion

Logs:

5 m/0.1 ha.(where trees are overhanging the wetland)

Weediness:

LF Code	Typical Weed Species	Common Name	Invasive	Impact
LH	<i>Rumex conglomeratus</i>	Clustered Dock	high	high
LH	<i>Plantago lanceolata</i>	Ribwort	high	low
MH	<i>Leontodon taraxacoides</i> ssp. <i>taraxacoides</i>	Hairy Hawkbit	high	low
MH	<i>Lotus corniculatus</i>	Bird's-foot Trefoil	high	high
MH	<i>Mentha pulegium</i>	Pennyroyal	high	high
MH	<i>Centaureum erythraea</i>	Common Centaury	high	low
MH	<i>Plantago coronopus</i>	Buck's-horn Plantain	high	high
MH	<i>Hypochoeris radicata</i>	Cat's Ear	high	low
MH	<i>Anagallis arvensis</i>	Pimpernel	high	low
SH	<i>Trifolium repens</i> var. <i>repens</i>	White Clover	high	high
LTG	<i>Watsonia meriana</i> var. <i>bulbillifera</i>	Bulbil Watsonia	high	high
LNG	<i>Holcus lanatus</i>	Yorkshire Fog	high	high
MTG	<i>Paspalum dilatatum</i>	Paspalum	high	high
MTG	<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	high	high
MTG	<i>Gladiolus undulatus</i>	Wild Gladiolus	high	low
MTG	<i>Juncus articulatus</i>	Jointed Rush	high	high
MTG	<i>Lolium perenne</i>	Perennial Rye-grass	high	high
MTG	<i>Briza minor</i>	Lesser Quaking-grass	high	low
MTG	<i>Agrostis capillaris</i> s.l.	Brown-top Bent	high	high
MNG	<i>Paspalum distichum</i>	Water Couch	high	high
TTG	<i>Cyperus tenellus</i>	Tiny Flat-sedge	high	low
SNG	<i>Sisyrinchium iridifolium</i>	Blue Pigroot	high	high

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