MEMO

Date	29/03/2021
To	Alan Davidson from Spiire and Bronwyn Armstrong from Barwon Water
From	Fiona Sutton, Principal Ecologist
Subject	Bellarine Service Basin, Yarram Creek rehabilitation - ecological advice

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Introduction and background

The Bellarine Service Basin is a redundant water storage owned by Barwon Water located on the corner of Grubb and Swan Bay roads, Wallington, Victoria. The service basin includes a dam wall which has been installed to create a levee along the natural creek alignment, with an overflow creek diverting around the impoundment.

Barwon Water are in the early phase of a project to rehabilitate the former service basin, restore the headwaters of Yarram Creek and open up 37 hectares of new public parkland. To assist with this project, Spiire have been engaged by Barwon Water to design the reinstatement of Yarram Creek through its original alignment, a preliminary design of which is shown in Figure 1. To enhance the biodiversity values post-construction, Arcadis was engaged by Barwon Water to provide high level ecological guidance and a habitat strategy to Spiire to inform their design.

Methods

To inform the habitat strategy, Arcadis conducted a background review of relevant databases and reports to understand the species likely to occur within the study area that should be accommodated into the design habitat values. These included:

- Department of Environment, Land, Water and Planning (DELWP 2021a) NatureKit interactive map for Ecological Vegetation Class (EVC) mapping/modelling of the area (both extant and pre-1750)
- Flora and fauna records within 5 km of the study area held in the Victorian Biodiversity Atlas (VBA) online database (DELWP 2021b)
- Relevant GIS data and aerial imagery and photographs
- Previous ecological reports for the study area, including their site photographs:
  - Vegetation Assessment Bellarine Service Basin, Wallington (Okologie Consulting 2020), the EVC mapping of which is shown in Figure 2.
  - Flora and Fauna Assessment of the Bellarine Service Basin, Victoria (Ecology Partners 2008)
  - Targeted Growling Grass Frog *Litoria raniformis* survey at Bellarine Basin, Wallington, Victoria (Ecology Partners 2011)
- The preliminary design drawings produced by Spiire (2021).

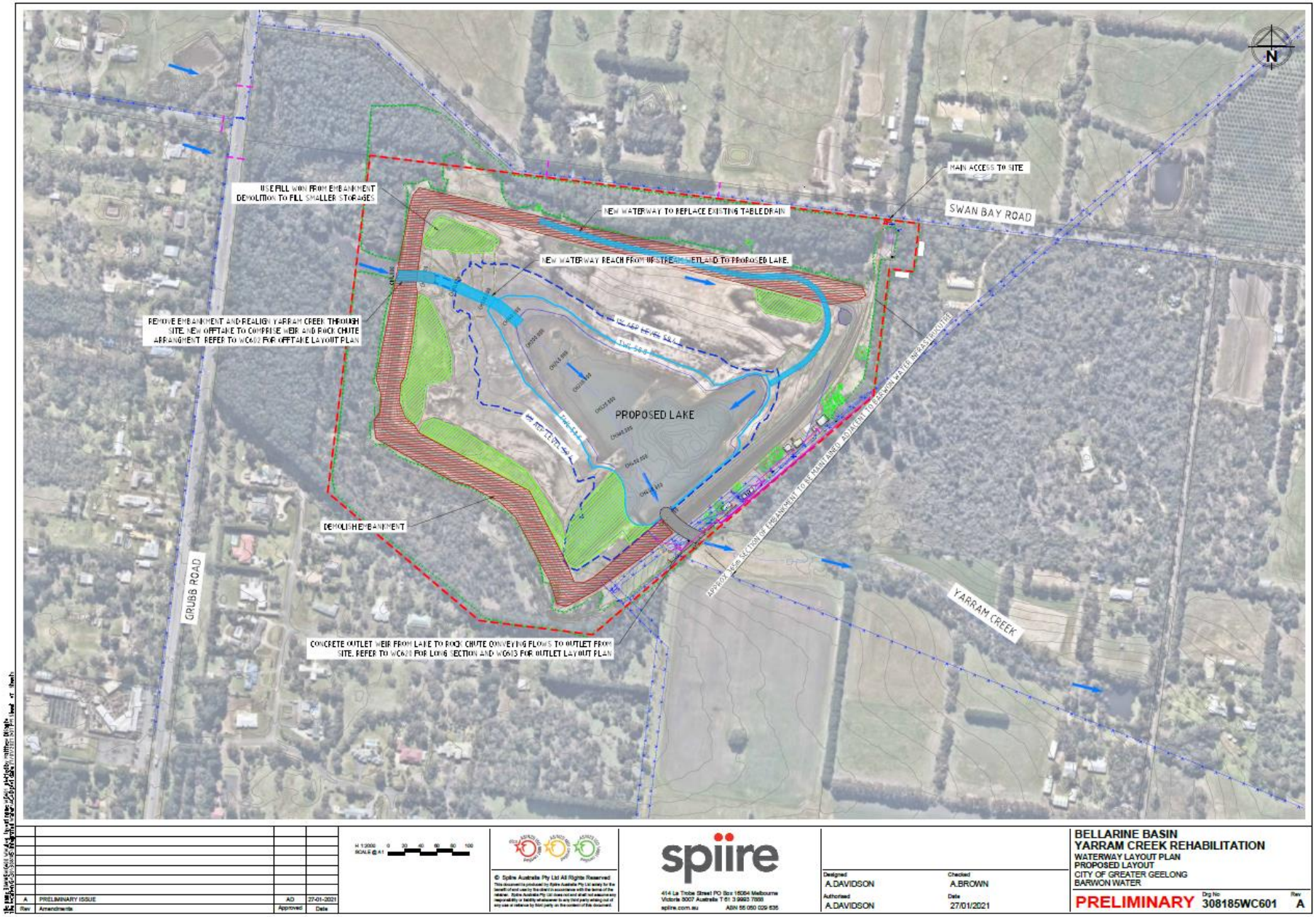

Figure 1. Preliminary design for the proposed reinstatement of Yarram Creek prepared by Spiire (2021).

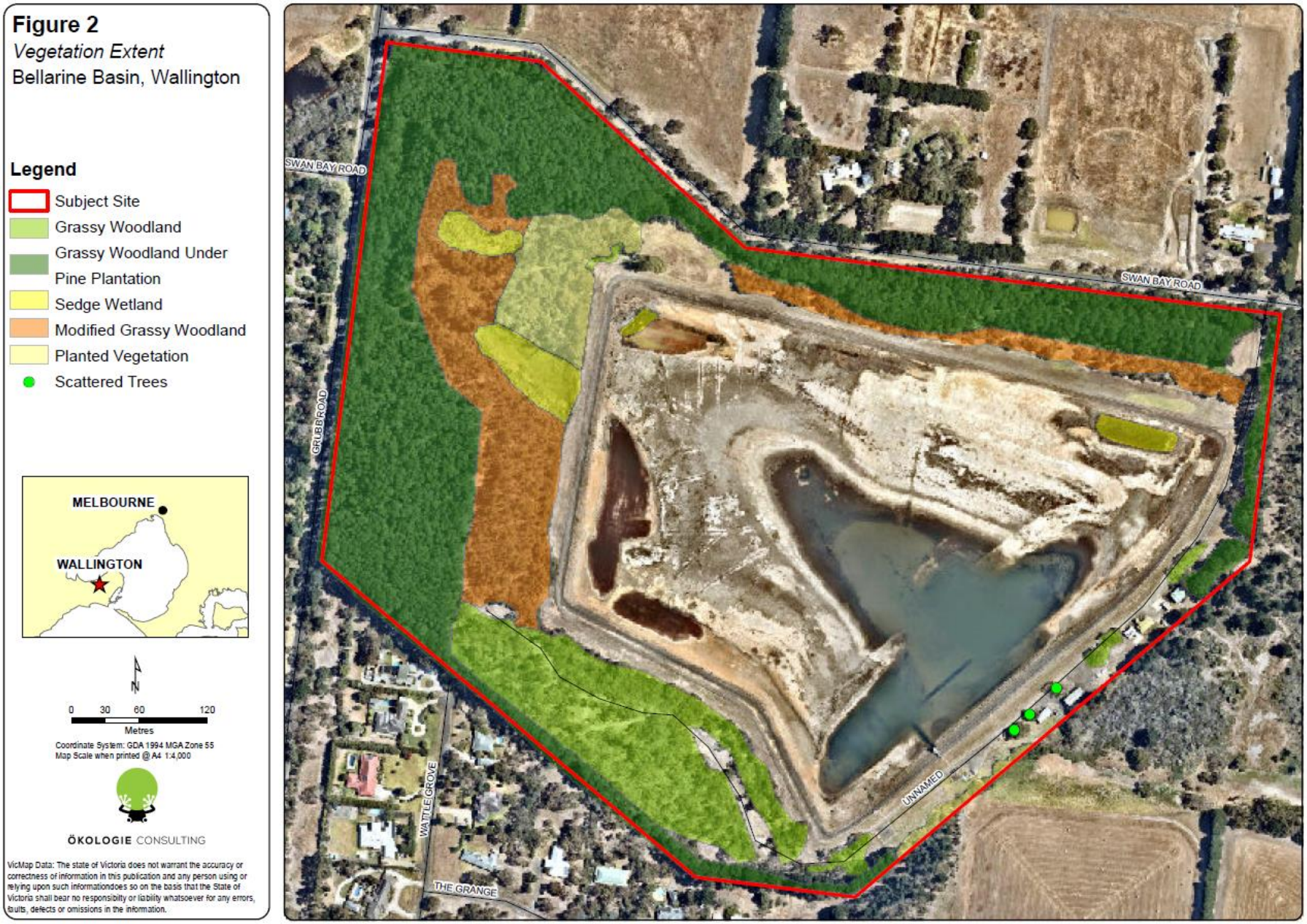

Figure 2. Ecological features mapped in 2008 by Okologie Consulting (2020).

Limitations

A number of limitations exist for this study as a site visit was not undertaken as part of the scope of works. These limitations have largely been overcome by the review of existing ecological reports and datasets, however the accuracy of these cannot be verified. As such, the recommendations in this report are high level with further investigations needed to inform the detailed design.

Ecological values onsite

Bellarine Service Basin consists of a large water body surrounded by pine plantations and native vegetation. An ecological assessment for the site, conducted in 2020 by Okologie Consulting (2020) identified the following vegetation values occurring: Grassy Woodland Ecological Vegetation Class (EVC), Sedge Wetland EVC, planted native vegetation and pine plantation areas with an indigenous ground layer (Figure 2). This differs slightly to the 2008 survey by Ecology Partners (2008) undertaken before the service basin was decommissioned and subsequently dried out. In that survey, the following EVCs were recorded: Grassy Woodland, Aquatic Sedgeland, and Sedgy Swamp Woodland. The transition of the Sedgy Swamp Wetland area into Grassy Woodland potentially indicates a drying of the vegetation along the western edge of the service basin over the past twelve years.

Threatened species identified as potentially occurring onsite by either Okologie (2020) or Ecology Partners (2008) are listed in Table 1.

Table 1. Threatened identified as potentially occurring onsite by either Okologie (2020) or Ecology Partners (2008).

Key:

EPBC Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
- E Listed as Endangered under the EPBC Act
- V Listed as Vulnerable under the EPBC Act

VROT Victorian Rare or Threatened Species as classified in the Advisory Lists (DEPI 2014, DSE 2013, 2009)
- e Classified as endangered
- v Classified as vulnerable
- nt Classified as near threatened

FFG Victorian *Flora and Fauna Guarantee Act 1988*
- F Listed as threatened under the FFG Act

Taxon name	Common name	EPBC	VROT	FFG	Comment
FLORA					
Xerochrysum palustre	Swamp Everlasting	V	v	L	Habitat present
Eucalyptus leucoxylon subsp. *bellarinensis*	Bellarine Yellow-gum		e	L	Habitat present
Coronidium gunnianum (formerly *Helichrysum* aff. *rutidolepis* (Lowland Swamps))	Pale Swamp Everlasting		v		Habitat present

Taxon name	Common name	EPBC	VROT	FFG	Comment
Acacia uncifolia	Coast Wirilda		r		Habitat present
FAUNA					
Litoria raniformis	Growling Grass Frog	V	e	L	Potentially suitable habitat in wetland communities but not recorded during targeted surveys (Ecology Partners 2011)
Pseudophryne bibronii	Brown Toadlet		e	L	Potential suitable habitat in wetland communities
Acrodipsas myrmecophila	Small Ant-blue butterfly		e	L	Potential suitable habitat in woodlands
Platalea regia	Royal Spoonbill		v		Potential suitable habitat in wetland communities
Ardea modesta	Eastern Great Egret		v	L	Potential suitable habitat in wetland communities
Botaurus poiciloptilus	Australasian Bittern	E	e	L	Potential suitable habitat in wetland communities
Spatula rhynchotis	Australasian Shoveler		v		Potential suitable habitat in wetland communities
Stictonetta naevosa	Freckled Duck		e	L	Potential suitable habitat in wetland communities
Aythya australis	Hardhead		v		Potential suitable habitat in wetland communities
Oxyura australis	Blue-billed Duck		e	L	Potential suitable habitat in wetland communities
Biziura lobata	Musk Duck		v		Previously recorded on site
Falco subniger	Black Falcon		v	L	Previously recorded on site
Pseudemoia rawlinsoni	Glossy Grass Skink		nt		Potential suitable habitat in wetland communities

The review of databases for the current study (search conducted between 18-24 March 2021, identified a very similar suite of rare or threatened species identified by Okologie (2020) and Ecology Partners (2008). The database searches were also used to determine which species (including non-threated species) might benefit from the rehabilitation works.

The site is located between two internationally significant wetlands; Swan Bay (7.2 km east) and Lake Connewarre (5.5 km west) which both form part of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar wetland (Figure 3). As such, the service basin situated between the two

Ramsar sites may provide important resting refuge as birds fly between the two significant wetlands. Ensuring the provision of suitable habitat for waterbirds is considered a priority for this project.

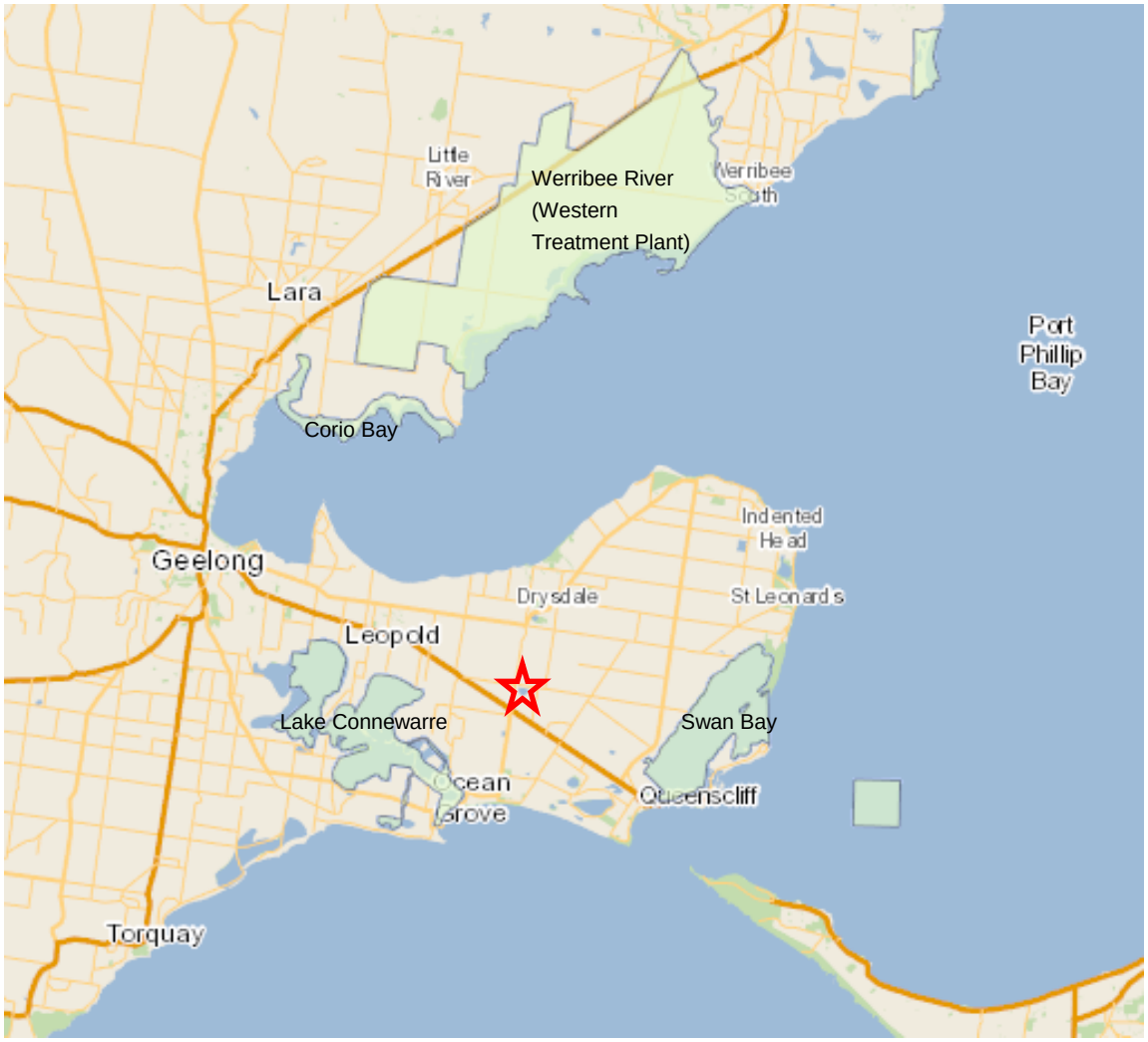

Figure 3. The location of Bellarine Service Basin (red star), situated between Lake Connewarre and Swan Bay, two internationally significant wetlands that form part of the Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar wetland.

Habitat Strategy

The ecological focus of the reinstatement of Yarram Creek, and the key objectives of this habitat strategy are to:

- Reinstate key attributes of the pre-European vegetation communities
- Provide a diversity of habitats to encourage greater biodiversity (i.e. wetlands of differing depths and frequency of inundation, and terrestrial areas with varying canopy, midstorey and ground layer structure), with a particular focus on wetland species
- Allow biofiltration of nutrients and pollutants to reduce their levels within Yarram Creek before they flow 7 km downstream into the Swan Bay Ramsar wetland

Other considerations for the project include:

- Designating part of the reserve for public use (camping area and walking trails/boardwalks), while setting aside the remainder of the reserve for nature conservation. This will provide fauna that are sensitive to human and dog disturbance with a more suitable environment to safely forage and potentially breed (depending on the species).
  - Disturbance by humans and their pets (particularly dogs) pose a significant threat to wildlife through direct predation and indirectly by reducing foraging efficiencies (particularly important for migratory birds preparing to travel long distances)
  - Restricting dog access should be carefully considered to designate the reserve as a 'no dogs' area as a priority. If this can not be achieved, then their access should be limited to on-lead only.
  - Screen sensitive ecological areas from disturbance by people and potentially their pets (if dogs are allowed access) by carefully designing wetlands and revegetation to obscure sightlines and buffer noise.
- Maximise the percentage of wetland cover across the site depending on the availability of water
- Extensive vegetated shallow wetlands to provide biofiltration and wildlife habitat, and large open water areas to accommodate Black Swan take off distances (minimum 40 m)
- Paralysis and death of wildlife (particularly water birds) due to ingestion of toxins produced by the soil bacterium *Clostridium botulinum*, a natural soil bacterium where growth is promoted through organic inputs (e.g. feeding of wildlife, fertiliser inputs) and warm stagnant water.
  - Design waterbodies to provide sufficient water aeration, circulation, and depth to help keep water temperatures stable, and thereby reducing habitat suitability for the bacterium that causes avian botulism (Wildlife Health Australia, 2019). Some waterbody edges may be deep sided, particularly at the eastern (downstream end) where ducks are most likely to be fed and hypoxia (limited oxygen) due to nutrient pollution is most likely to occur.
- Ongoing and long-term maintenance requirements of water retention facilities (e.g. vegetation management on levees, dredging of sediments)
- Structural heterogeneity of the vegetation through inclusion of other habitat elements such as litter, logs, rocks and fallen branches. This is important for providing a diversity of habitats for wildlife.
- Habitat for small birds susceptible to harassment from more aggressive birds such as Noisy Miners – this is best achieved through clustered plantings of shrubby species and tall grasses/graminoids along with course woody debris within the woodland environments
- Treeless areas for reptile and amphibian basking and Masked Lapwing breeding
- Incorporate culturally significant plants, including species of food, resources and cultural value
- Weed and pest animal invasion
- When dismantling the existing service basin batters, impacts to adjoining Grassy Woodland vegetation should be avoided to ensure indigenous trees and understorey species are not disturbed during construction

This project provides an important opportunity to monitor and measure the efficacy and effectiveness of waterway and habitat reconstruction. The information gained through monitoring of the transition will be vitally important to improving the ways in which such works are undertaken. As such, it is recommended that monitoring of the ecological values prior to and post-construction is undertaken, with the findings made available to assist other organisations attempting similar projects.

To improve habitat values onsite and accommodate flora and fauna species known to or likely to utilise the site, notably rare or threatened species, six zones of habitat are recommended for inclusion in the design of the reinstated waterway. Where possible, all of these should be incorporated into the

design, though other factors not considered here may limit their inclusion (e.g. geomorphic considerations, water inflows, financial costs). These zones represent vegetation that would have previously dominated the site, along with common wetland habitats that develop in constructed wetlands. The zones include:

1. Creekline – meandering pools and riffles
2. Open water / mudflats – from deep through to shallow with submerged vegetation and mudflats
3. Inline shallow wetlands – primarily aquatic herbland, rushland or sedgeland vegetation occurring in ephemeral, shallow, slow flowing or still water
4. Offline shallow wetlands – as per inline shallow wetlands but disconnected from Yarram Creek to provide breeding refuge for frogs from the introduced and aggressive *Mosquito Fish
5. Woodlands – eucalypt canopy with riparian margins occurring on slightly elevated dryland habitats
6. Grasslands and lawn – regularly slashed dryland area associated with the proposed camp site

Once the detailed design is finalised, an Environmental Management Plan will be required to ensure impacts to the environment and waterway are minimised during construction. It should also detail site post-construction works including revegetation (planting zonation, densities, etc.), habitat augmentation, weed control and pest animal control works.

Zone 1: Creekline – meandering pools and riffles

Zone 1	Creekline – meandering pools and riffles
Brief description and structural requirements	The ephemeral creekline should meander, producing a low gradient with low velocities which is suitable for a wide variety of wildlife and plant species. It should also include a mix of deep pools and shallow riffles to create microhabitats for a variety of aquatic life. Some areas of the creek should be shaded with trees planted nearby, while other areas should be canopy free to allow sunlight penetration throughout the year. Fish passage should be considered, as discussed below.
Overview of species targeted for habitat	Aquatic fauna including invertebrates (insects, yabbies and freshwater snails), fish, frogs and tadpoles, as well as skinks, waterbirds, and possibly Rakali.
Revegetation and supplementary plantings	Given the ephemeral nature of the waterway, the creekline will include vegetation depending on the width of the channel. More narrow channel areas will likely be bare of most vegetation, while broad flat channel areas will comprise vegetation merging toward that of the shallow wetlands (see Zone 3 below).
Habitat augmentation opportunities	The creek should include a variety of habitat features including areas of exposed sediments (sand, silt, clays) and accumulated organic material, some rocky areas with small pebbles through to large boulders, and small branches and large logs for basking and algal growth. To allow movement of fish species up and down stream of the existing service basin, fishways or fish ladders are generally recommended. No fish surveys have been undertaken within the catchment (according to VBA records; DELWP 2021a), and as such it is not clear which native fish would benefit from such passage. Further, it may be possible that the existing fish barriers onsite, and also up/downstream, present a barrier for the movement of exotic fish; opening of the barriers may impact on instream wildlife upstream. Rock chutes can generally provide fish passage if the gradient is less than 1 in 20, and large boulders are included to provide underwater baffles with slower flows providing 'rest area' stepping-stones for fish swimming upstream. Further investigation is required to inform the need for, and type of fish passage to be included and to minimise the use of the wetland by exotic fish species.
Irrigation requirements	Ephemeral waterway with low velocity and low gradient banks to maximise the area of drawdown.
Example photos	 Photo Source: Alan Davidson, Spiire.

Zone 2: Open water / mudflats

Zone 2	Open water / mudflats
Brief description and structural requirements	Large expanses of open water with or without submerged vegetation; emergent vegetation sparse or absent. Depth of water to vary from shallow (potentially exposing mudflats during periods of drawdown) to quite deep. As public access to open waterbodies is commonly a high priority, design the large lake to curve providing areas that are obscured from public view resulting in less disturbance to sensitive fauna species. Incorporation of a fully terrestrial or shallowly inundated island, if possible, would also benefit wildlife susceptible to predation by foxes and cats. The large waterbody should comprise a mix of shallow gradients to maximise vegetation/habitat diversity, and also some steep gradients to keep water temperatures stable and reduce the prevalence of the bacterium that causes avian botulism.
Overview of species targeted for habitat	Waterbirds including diving birds (grebes, cormorants, ducks), swans and pelicans, as well as fish, reptiles including skinks and turtles, invertebrates (insects, yabbies and freshwater snails and mussels) and mega and micro bats. Open water will provide foraging and or breeding habitat for a range of these species. Drawdown areas that expose mudflats would provide foraging habitat for a suite of wader birds.
Revegetation and supplementary plantings	Submerged, fully aquatic vegetation could be planted in this zone. The water level will need to be drawn down to mud to revegetate these areas, and then slowly refilled over several weeks once established.
Habitat augmentation opportunities	Large logs and/or boulders should be placed in some areas of open water where practicable (being mindful of Swan/Pelican flight paths) to provide perching spots for water birds and potentially basking Eastern Snake-necked Turtles. Nest boxes could also be placed in the wetlands targeting Australian Wood Duck, Chestnut and Grey Teals, however they will need to be accessible to allow for the removal of Common Myna nests. They should be considered an interim measure while surrounding vegetation is rehabilitated to encourage trees to grow to a size where appropriate hollows can develop for these species.
Irrigation requirements	This zone requires more or less permanent water in the deeper areas, with the edges comprising low gradients that may be drawn down to expose mud flats and to assist management of encroaching Common Reed and Cumbungi. Having low gradients for gradual drawdown provides habitat for a diverse range of flora which will occupy different portions of the drawdown zone. This in turn provides a diversity of habitat for wildlife.
Example photo	 Photo source: Alan Davidson.

Zone 3: Inline shallow wetlands

Zone 3	Inline shallow wetlands
Brief description and structural requirements	This habitat can be situated in drawdown edges of the creek and open water areas, or as side wetlands that are fed by small inlets off the creek. Shallow permanent to intermittent wetlands with low gradients to provide dense wetland vegetation cover for waterbird foraging habitat, pondlife (water beetles, tadpoles, etc.), and biofilms for water purification. If an island is possible within the large lake, this could comprise partially submerged tall sedgeland habitat suitable for waterbird breeding (e.g. Black Swan, Purple Swamp Hen). Such an island provides protection from predators and disturbance from visitors.
Overview of species targeted for habitat	Waterbirds (e.g. herons, swamp-hens), frogs, skinks and possibly Rakali (*Hydromys chrysogaster)*. Vegetated shallow wetlands will provide foraging habitat, occasional refuge, and potential breeding habitat for a range of these species.
Revegetation and supplementary plantings	Vegetation should comprise low herblands through to open rushlands and tall sedgelands that provide a diversity of habitat structures and plant species.
Habitat augmentation opportunities	Large logs and/or boulders should be placed in shallow wetlands to provide basking areas (for reptiles), perches for birds, foraging habitat, and refuge (for frogs). Some logs and/or rocks should also be submerged in the water to support algal growth to provide food for invertebrates and tadpoles. Nest boxes could be placed in the wetlands targeting Chestnut and Grey Teals, however they will need to be accessible to allow for the removal of Common Myna nests.
Irrigation requirements	This area requires shallow permanent to ephemeral water with a low gradient allowing for a large area with gradual drawdown. The ability to artificially alter the water level may assist Common Reed and Cumbungi management if they begin to encroach excessively.
Example photos	  Photo source: Okologie Consulting 2020

Zone 4: Offline shallow wetlands and depressions

Zone 4	Offline shallow wetlands and depressions
Brief description and structural requirements	As per the Shallow Wetland, however, if possible, a rainfed wetland (herbland, rushland and/or sedgeland) that should be disconnected from Yarram Creek, as well as minor rainfed depressions incorporated into new areas of the woodland/grassland. These would provide a safe refuge for breeding frogs and protection of their eggs and tadpoles from the introduced Mosquito Fish **Gambusia holbrooki* which is assumed to inhabit Yarram Creek.
Overview of species targeted for habitat	As per shallow wetlands, specifically targeting breeding habitat for frogs that is protected from *Mosquito Fish predation. Very minor rain fed shallow depressions can also be included in areas of woodland to potentially provide habitat for the threatened Brown Toadlet *Pseudophryne bibronii.* This species lives in areas that are likely to be inundated after rain, sheltering and depositing eggs in damp areas of woodland, grassland and drainage lines/ditches under leaf litter, logs, or other forms of cover, where rain provides a waterbody for the tadpoles to survive.
Revegetation and supplementary plantings	For wetland areas - as per inline shallow wetlands with a focus on low herblands and low rushlands and sedgelands, with minimal or no large robust sedges. For depressions in woodlands and grasslands – sparse vegetation consistent with the relevant EVC, with an accumulation of leaf litter and woody debris.
Habitat augmentation opportunities	As per inline shallow wetlands.
Irrigation requirements	Ensure wetlands/depressions are ephemeral and disconnected from Yarram Creek. To allow sufficent time for egg laying and tadpole metamorphosis through to frog stage, water would ideally be present for a minimum of three months in the minor depressions in drier years. For the main offline wetland, water should be present for five to nine months of the year (minimum three months in drier years). By ensuring the wetland is ephemeral, the complete drawdown will ensure that *Mosquito Fish can be removed, should they manage to enter the disconnected wetland after significant flood events. The complete drying of the wetland also limits Chytrid Fungus that requires water to survive. Chytrid Fungus is a pathogen that has devastated frog populations across Australia and caused numerous population and species declines and extinctions.
Example photos	 Photo source: Okologie Consulting (2020)

Zone 5: Woodlands

Zone 5	Woodlands
Brief description and structural requirements	Revegetation of the remnant woodland EVC(s) in terrestrial areas, to provide treed habitat, shading opportunities and screening from disturbance by people and potentially their dogs (if allowed access).
Overview of species targeted for habitat	Foraging and roosting habitat for a range of bird species including insectivorous birds, parrots and owls, and skinks and geckos.
Revegetation and supplementary plantings	Vegetation should comprise a eucalypt canopy. Other strata should be determined once the soil type and proximity to the creek is better understood. For example, if Grassy Woodland is the most suitable EVC for the conditions, there should be scattered understorey trees and a diverse grassy and herbaceous ground layer. Consideration of the cost of revegetation will also be required as grassy and herbaceous groundlayers typical of Grassy Woodland EVC are generally more costly and difficult to establish/manage than shrubby understories. Further investigation on this would be necessary. These plantings can be used to provide screening of sensitive wetland areas from the proposed campground and walking tracks. To benefit thermo-regulation of cold-blooded fauna, islands or 'fingers' of woodland can be created extending from the existing woodland and leading into the wetland areas to provide some opportunities for shading in the otherwise exposed wetland environments.
Habitat augmentation opportunities	Logs and/or rocks should be scattered throughout the woodlands (placement overseen by an ecologist) to provide foraging habitat and refuge for birds, reptiles and insects. Logs can be sourced from within the reserve (avoid taking from existing woodland EVC areas) or could be moved on site from permitted clearing sites within the vicinity of the reserve. Eucalypts, and many of the species recommended for revegetation will provide feeding resources for birds, arboreal mammals and insects, and the clusters of shrubs provide cover for small birds. Installation of log nest boxes for microbats, smaller birds (i.e. Eastern Rosellas, Musk Lorikeets, Pardalotes, Red-rumped Parrots and Kookaburras) and owls (Southern Boobook and Barn Owl) could be considered in established trees.
Irrigation requirements	Woodland areas should be maintained as terrestrial environments with very minimal or no flooding. Some riparian influence may be experienced along the lower edges adjoining the creek.
Example photos	 Photo source: Okologie Consulting (2020)

Zone 6: Grassland and lawn

Zone 6	Grassland and lawn
Brief description and structural requirements	Open grassy areas of lawn can be maintained for the proposed campground area. Native grasses should be used as a priority (e.g. Weeping Grass *Microlaena stipoides*, Wallaby Grasses *Rytidosperma* spp., Spear Grasses *Austrostipa* spp.), rather than seeding with potentially invasive exotic lawn species (e.g. Couch **Cynodon dactylon* var. *dactylon*, Kikuyu **Cenchrus clandestinum*).
Overview of species targeted for habitat	Butterflies, parrots, lapwings, small insectivorous ground foraging birds and occasionally waterbirds if the area floods. Grassland and lawn will provide foraging habitat for birds and insects as well as nesting habitat for Masked Lapwings.
Revegetation and supplementary plantings	This vegetation type may be suitable for some areas of felled pine trees. Direct seeding into well-prepared beds after excavation works are complete will require large quantities of seed; ordering this early will be essential to ensure supply. Planting of shrubs suitable for the area should be included on the edges of the grassland/lawn areas to provide an ecotone and screening as well as refuge and nesting habitat for small native birds that will utilise the grasslands (e.g. fairy-wrens, finches).
Habitat augmentation opportunities	Logs and/or rocks should be scattered throughout the grassland (placement overseen by an ecologist) and lawn area to provide foraging habitat and refuge for birds, reptiles and insects. Logs can be sourced from within the reserve (avoid taking from existing woodland EVC areas) or could be moved on site from permitted clearing sites within the vicinity of the reserve.
Irrigation requirements	Grassland and lawn areas should be maintained as terrestrial environments with virtually no flooding.
Example photos	  Photo source: left Okologie Consulting (2020); right Alan Davidson, Spiire.

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