Lowering the water level of Beaconsfield Reservoir

A desktop assessment of environmental values and potential impacts

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August 2021

Arthur Rylah Institute for Environmental Research
Unpublish Client Report

Arthur Rylah Institute for environmental research

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VICTORIA State Government | Environment, Land, Water and Planning

Acknowledgment

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond.

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Citation: Shelley, J.J., Dell, M., Howard, K.M., Macak, P.V. and Brown, G.W. (2021). Lowering the water level of Beaconsfield Reservoir: A desktop assessment of environmental values and potential impacts. Unpublished Client Report for Melbourne Water. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Front cover photo: Beaconsfield Reservoir and its wall in the distance (Phoebe Macak).

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A desktop assessment of environmental values and potential impacts

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Arthur Rylah Institute for Environmental Research
Unpublished Client Report for Melbourne Water, Department of Environment, Land, Water and Planning

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Heidelberg, Victoria

Acknowledgements

Thanks to Fin Adamson (Melbourne Water) who commissioned this project, Tarmo Raadik (Arthur Rylah Institute) who provided advice on aquatic fauna and Catherine Clowes (Dellbotany) for assistance undertaking the flora field assessment. Thanks also to Danny Rogers (Arthur Rylah Institute) for reviewing the report and Lisa Jegathesan (Dellbotany) for providing comments on the flora component.

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Summary

Context: Beaconsfield Reservoir is a decommissioned water supply located approximately 45 km southeast of Melbourne in the suburb of Officer. Melbourne Water proposes to reduce the carrying capacity of the reservoir which will result in an overall reduction of waterbody size and depth. The proposed activities will reduce the coverage of shallow water and deep, open water habitat. As the reservoir harbours flora and fauna that are, to varying degrees, reliant on the habitat provided by the waterbody, Melbourne Water engaged the Arthur Rylah Institute for Environmental Research and Dellbotany to conduct an environmental impact assessment of the proposed activities on these communities.

Aims: Collate a list of the known flora and fauna directly reliant on the reservoir (waterbirds, herpetofauna, fish, crayfish and mussels) within and close to the reservoir, assess the expected impact of the proposed activities on these communities, and propose ways in which these impacts can be mitigated.

Methods: Site visits were completed at Beaconsfield Reservoir on two occasions, on the 8th (flora and waterbirds) and 29th (flora and herpetofauna) of July 2021. Observations made during the site visits were combined with records from various online and literature sources to assess the flora and fauna values of the reservoir so that recommendations could be made as to the impact of the proposed reduction in water holding capacity. The geographic radius of these searches was dependent on the dispersal ability of the organism in question. For example, the search radius for amphibians and reptiles was 5 km, while the search radius for waterbirds, that are highly mobile, was 13 km.

Results: Few documented surveys have been conducted within the Beaconsfield Reservoir which may be partly due to the lack of public access. However, records from the reservoir, combined with those from the surrounding area, give an indication of the species that are or may be present. In total, 993 plant taxa (655 native and 338 weeds) were identified within 5 km of the reservoir. Of these 38 are listed as threatened. 65 species of waterbirds were identified within 13 km of the reservoir with 11 of these being threatened. 17 species of water-reliant reptiles and nine species of frogs were identified within 5 km of the reservoir. Respectively, one and two of these species were threatened. Finally, 13 species of fish, six species of crayfish and one species of freshwater mussel occur either in the reservoir or the connecting catchments, so may be present.

Conclusions and implications: A limitation of this study is the general shortage of survey data from the reservoir itself. Based on the data we could find, there are no fundamental issues with the proposed activities, but some species would likely be impacted, especially if the lowering of the water level occurs too quickly. The key to minimising potential disturbance to aquatic and semi-aquatic animals either using or potentially using Beaconsfield Reservoir is to minimise the disturbance to aquatic and terrestrial vegetation that provides them with critical habitat. To achieve this, it is recommended that the draw-down be conducted over at least three years to allow the emergent and submerged vegetation around the edge of the reservoir to migrate with the changing waterline. It is important also that riparian vegetation in stream reaches leading in and out of the reservoir is not significantly impacted by the activity.

The EVCs Aquatic Sedgeland, Aquatic Herbland, Riparian Scrub and Swampy Riparian Woodland will undergo changes in their areas of occupancy as a result of the proposed drawdown. The net change in area for each, 5-10 years following drawdown, can be estimated although some uncertainty remains regarding residual losses. The habitat for at least one state listed plant associated with these vegetation types will be impacted by the proposed lowering of the water level. The persistence of this and other species will rely on the persistence of existing conditions, noting that there will be inevitable compositional changes to the vegetation matrix and extent of habitat types.

We finish by providing nine recommendations to minimise the risk of impacting flora and fauna, including conducting formal surveys to increase the information available on which species are using the area.

1 Introduction

Melbourne Water proposes to reduce the carrying capacity of Beaconsfield Reservoir which will result in an overall reduction of waterbody size and depth (Table 1). Total waterbody area will decline from 70,000 m^2 to 31,000 m^2. Water depths over 1.5 m will experience the highest reduction, declining from 51,500 m^2 to 19,700 m^2 (61%). The proposed activities will also reduce the coverage of shallow water depths (< 1.5 m) from 18,500 m^2 to 11,300 m^2 (39%), although shallow waters will account for a higher proportion of the proposed reservoir. The reservoir lies within the Beaconsfield Nature Conservation Reserve (BNCR), which harbours flora and fauna that are, to varying degrees, reliant on the habitat provided by the waterbody. As such, Melbourne Water engaged the Arthur Rylah Institute for Environmental Research and Dellbotany to conduct an assessment of potential environmental impacts of the proposed activities on these communities. This report details the known flora and fauna that are dependent on the reservoir (waterbirds, herpetofauna, fish, crayfish and mussels) within the area of the BRNR, assesses the expected impact of the proposed activities on these communities, and proposes ways in which these impacts can be mitigated.

Table 1. The area and proportion of the Beaconsfield Reservoir that will have water depths greater than and less than 1.5 m, before and after the proposed lowering of the reservoir's carrying capacity. ahd = above height datum.

	Water depth less than 1.5m (m^2)	Water depth greater than 1.5m (m^2)	Total water area (m^2)	Percentage of shallow water
Current (98.5 m ahd)	18,500	51,500	70,000	26%
Proposed (94 m ahd)	11,300	19,700	31,000	36%
Total reduction (m^2)	7,200	31,800	39,000	
Percentage reduction	39%	61%	56%	

2 Methods

2.1 Study site

Beaconsfield Reservoir is located on Haunted Gully Creek, approximately 45 km southeast of Melbourne in the suburb of Officer. The reservoir is an on-stream storage, with a local catchment area of approximately 334 ha. It was constructed in 1918 as part of a new water supply scheme for the Mornington Peninsula. Water was harvested from the Bunyip River and conveyed to Beaconsfield Reservoir by the Bunyip Main Race, which was later supplemented by the construction of the Tarago Main Race. However, the reservoir was permanently disconnected from Melbourne's water supply and distribution network in 1988 and now serves as an ornamental lake. Cardinia Reservoir replaced Beaconsfield Reservoir as the regions water supply and lies approximately 6 km to the north.

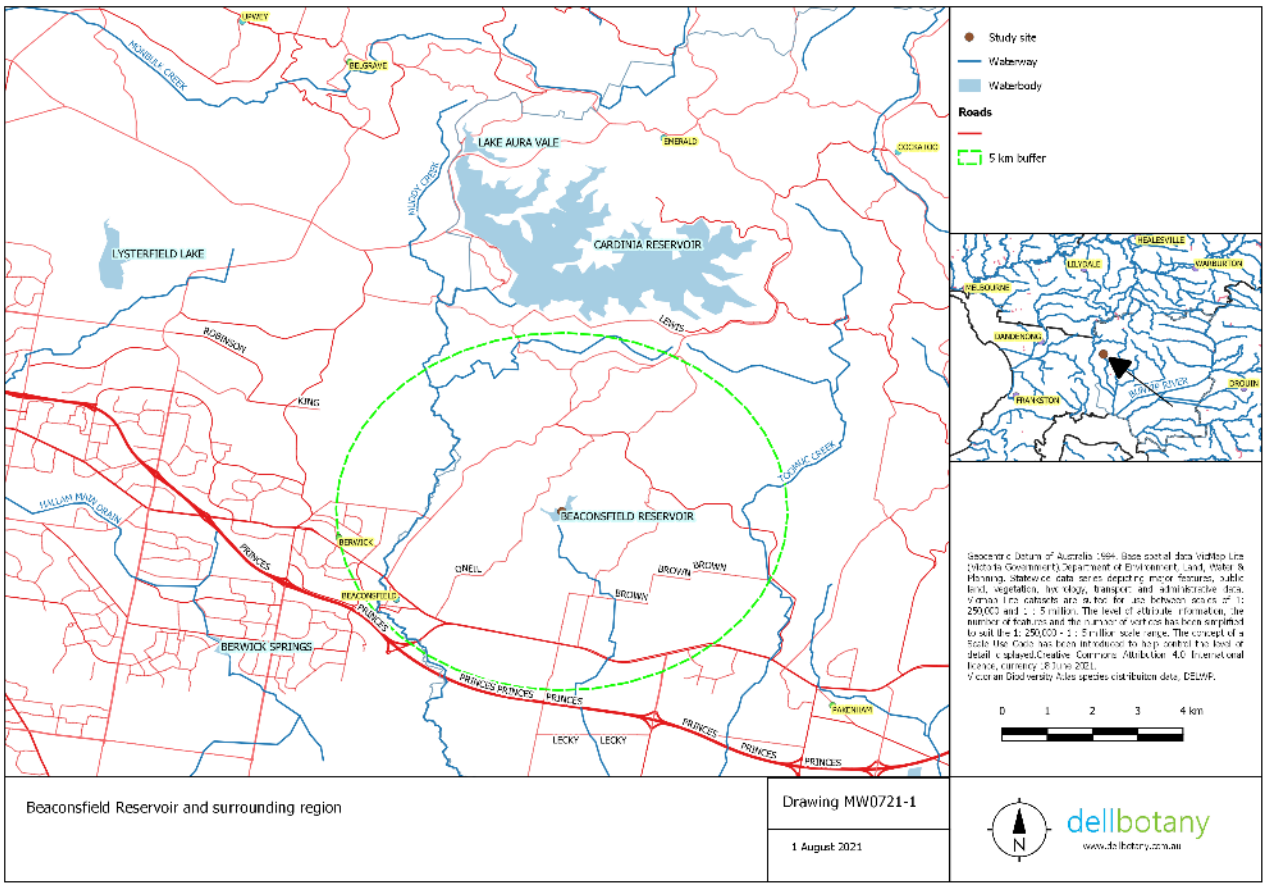

Figure 1. Beaconsfield Reservoir and the surrounding area.

2.2 Field and desktop surveys of flora and fauna

Site visits were completed at BNCR on two occasions: the 8th (flora and waterbirds) and 29th (flora and herpetofauna) of July 2021. Observations made during the site visits were combined with records from various online and literature sources to assess the flora and fauna values of the BNCR, so that recommendations could be made as to the impact of the proposed reduction in water holding capacity. The geographic radius of the desktop searches was dependant on the dispersal ability of the organism in question. For example, the search radius for amphibians and reptiles was 5 km, while the search radius for waterbirds, that are highly mobile, was 13 km to encompass two large nearby water bodies (section 2.2.2). The literature review for fish focussed on the wider stream catchment.

2.2.1 Flora

A brief inspection of vegetation and habitats within approximately 50 m of the reservoir bank was undertaken on foot. Notes were made on vegetation fringing the bank and how this may change with changes to the average water level. General notes were taken on the vegetation downstream of the reservoir wall and further upslope within BNCR, to describe its floristic composition and habitats for threatened species and

communities. A list of dominant or characteristic plant species was recorded for each Ecological Vegetation Class (EVC) and these were provisionally mapped including the extent of habitat types within 30 m of the edge of the water (Figure 2; Figure 3).

The Victorian Biodiversity Atlas (VBA) was searched for records of threatened plant species which have been previously recorded within 2 km of the BNCR. Threatened species are those listed as state threatened under the *Flora and Fauna Guarantee Act 1988* and nationally threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. A separate 5 km search was undertaken to identify any addition taxa previously recorded within the broader landscape, that may have habitat within BNCR. These taxa were then assessed for their likelihood of occurrence (low, medium, high) within BNCR, based on inference of habitat types and current understanding of extent and status of populations more broadly.

An EPBC Act Protected Matters Report (DAWE 2021) was generated for the same 5 km search area. This report identifies listed species, communities and other matters of national environmental significance which may occur within the search area.

Mapping of vegetation polygons was drafted in the field using QField v.1.9.6. Map figures were produced with QGIS v3.6.

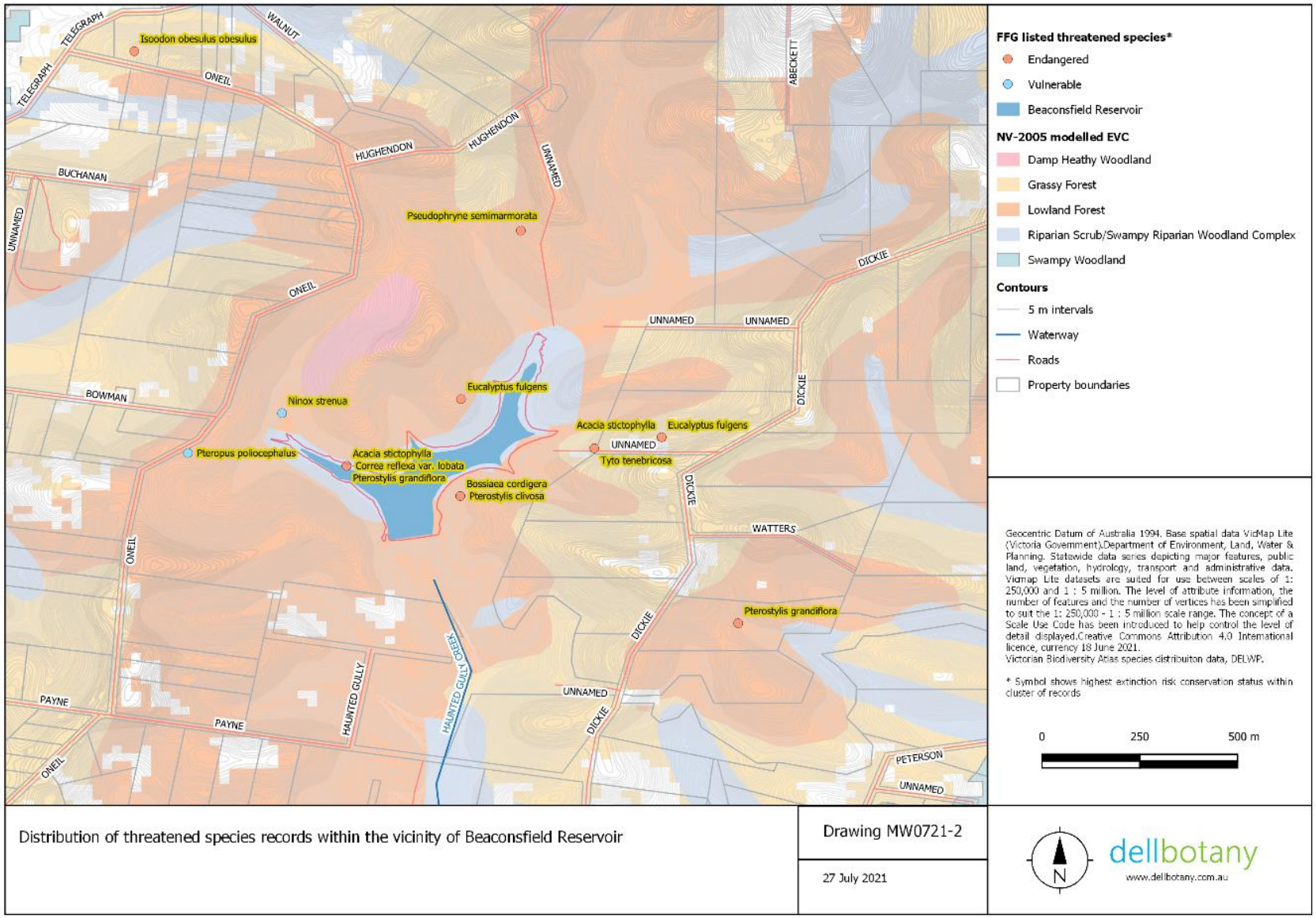

Figure 2. A map of Beaconsfield Reservoir and the immediate area showing Flora and Fauna Guarantee (FFG) Act listed species and modelled EVCs.

2.2.2 Waterbirds

During the site visit (8 July 2021) a portion of the perimeter (at the dam wall, and from the western tip along the northern edge) was explored by foot by one observer to inspect potential waterbird habitat. While slowly walking along the water's edge, binoculars and a telescope were used to opportunistically scan the band of emergent vegetation around the edge of the reservoir, including the opposite side, as well as the open waters. This was sufficient to observe the whole area of the reservoir. During the subsequent site visit (29 July 2021), opportunistic waterbird observations were noted. No formal waterbird counts were undertaken.

To form a more complete picture of waterbird species potentially using the reservoir, the Victorian Biodiversity Atlas (VBA) (DELWP 2021a) was interrogated for previous records. This included the area immediately adjacent to the reservoir to establish local use, and an area approximately 13 km within the vicinity of the reservoir that encompassed the largest waterbodies nearby (Lysterfield Lake 12 km to the north-west and Cardinia Reservoir 6 km to the north). Records from the immediate BNCR area were combined with those from a previous assessment at the site (Mueck et al. 2002) and eBird, a citizen science database (eBird 2021).

2.2.3 Herpetofauna

A site visit was conducted on 29 July 2021 and the entire perimeter of the reservoir was explored on foot to assess habitat, listen for calling frogs and opportunistically search for reptiles and frogs. As well as the main reservoir itself, the ephemeral gully lines were inspected to provide a complete overview of the site and the habitats available. Calling frogs were recorded opportunistically during the waterbird site visit on 8 July and during the site assessment on 29 July.

Records of herpetofauna within the immediate region surrounding BNCR were acquired from desktop searches of NatureKit Victoria (which displays records from the VBA), the Atlas of Living Australia (ALA), and a previous assessment by Mueck et al. (2002). The VBA and ALA search included 1 km and 5 km search radiuses to provide a list of species known to the immediate area of the BNCR and identify local species that may occupy the site. Regional species record searches in the ALA along with relevant literature reviews informed what additional species may occur at BNCR. Nomenclature follows Cogger (2018).

2.2.4 Fish, crayfish and mussels

Existing data on the distribution of aquatic vertebrates and selected invertebrates was obtained from the VBA, a fish survey of Beaconsfield Reservoir conducted by Mueck et al. (2002), a survey of Cardinia, Gum Scrub, Toomuc and Deep creeks by Close et al. (2001), and an overview of burrowing crayfish and spiny crayfish distributions produced by Horwitz (1990) and McCormack (2012) respectively. The reservoir is situated at the headwaters of Haunted Gully Creek which ultimately joins Gum Scrub Creek before flowing out into Western Port. Gum Scrub Creek likely experiences temporary surface water connectivity with Cardinia, Toomuc and Deep creeks as they run immediately parallel to each other in the lower catchment where they have been channelised for the purposes of flood mitigation. As such, we included those catchments in our literature search as they likely share fish communities, and it is possible that some of these species are in Beaconsfield Reservoir but haven't been detected.

Results

2.3 Flora

Database searches revealed 993 plant taxa that have been previously recorded within 5 km of the BNCR. This comprises 655 native taxa and 338 weed taxa. Of these 38 are listed as threatened and seven state listed taxa are regarded as being present within BNCR (Table 2).

The vegetation within the littoral zone comprises two wetland Ecological Vegetation Classes (EVCs); Aquatic Herbland and Aquatic Sedgeland. All fringing vegetation is regarded as having developed since the reservoir was constructed. The northeast arm of the reservoir was likely occupied by Swampy Riparian Woodland prior to construction but the flood zone has possibly since widened due to impeded draining around the inflow point. This area is mapped as Riparian Scrub for the purpose of the assessment, on the basis that the canopy is dominated by myrtaceous shrubs rather than eucalypts. This littoral zone nearest the northeast arm has the greatest extent of shallow water and is contiguous with riparian areas upstream that would be subject to periodic flooding. Around much of the remaining perimeter, the bank of the reservoir is steeper and there is a shorter gradient between wetland vegetation and various communities of dry foothill forest. The relevant EVCs are described below including their landscape context.

Modelled EVC mapping by DELWP (Figure 2igure 2, Figure 3) indicates that most of BNCR is occupied by Lowland Forest. A patch of Damp Heathy Woodland is modelled to occur on the western side of the reservoir and Grassy Forest is modelled on parts of the eastern and northern side. Riparian Scrub/Swampy Riparian Woodland Complex is modelled around much of the edge of the reservoir. The site assessment revealed that the composition of EVCs is generally consistent with modelling while the distributions of each EVC varies from that of the modelling. Swampy vegetation which would fall within the abovementioned complex could be placed in either Riparian Scrub or Swampy Riparian Woodland depending on interpretation. The observed structure and composition fit the benchmark of Riparian Scrub for the purpose of habitat interpretation and planning. Emergent eucalypts occur within this area. Grassy Forest examples within the reserve generally fit the benchmark description for the bioregion, while noting that drier aspects and ridges have a more drought-tolerant component of the understory vegetation compared with other examples in the bioregion.

2.3.1 Aquatic Herbland

Aquatic Herbland occurs in very narrow zones on the edge of some parts of the reservoir. Only larger patches have been mapped during this assessment. In the northeastern arm, this EVC extends to cover a broader zone where there is a larger area of shallow water. The shallow water is accessed by deer and associated soil disturbance was observed. The most developed example of Aquatic Herbland comprises a moderate–high cover of aquatic herbs amongst less dominant tussocks of sedges and rushes. Characteristic species include Swamp Club-sedge (*Isolepis inundata*), Small River Buttercup (*Ranunculus amphitrichus*), Lesser Joyweed (*Alternanthera denticulata* s.s.), Centella (*Centella cordifolia*), Swamp Crassula (*Crassula helmsii*), Common Spike-sedge (*Eleocharis acuta*), Austral Brooklime (*Gratiola peruviana*), Common Bog-sedge (*Schoenus apogon*), Australian Lilaeopsis (*Lilaeopsis polyantha*), Small Loosestrife (*Lythrum hyssopifolia*), Upright Water-milfoil (*Myriophyllum crispatum*), Streaked Arrowgrass (*Triglochin striata*), Wing Pennywort (*Hydrocotyle pterocarpa*), Weeping Grass (*Microlaena stipoides* var. *stipoides*), Joint-leaf Rush (*Juncus holoschoenus*), Finger Rush (*Juncus subsecundus*), Broad-leaf Rush (*Juncus planifolius*), with less common elements Tall Sedge (*Carex appressa*), Common Water-ribbons (*Cycnogeton procerum* s.s.), Hollow Rush (*Juncus amabilis*), Green Rush (*Juncus gregiflorus*) and Knotweed (*Persicaria* spp.). The FFG Act listed species Floodplain Fireweed (*Senecio campylocarpus*) was recorded within this EVC during the current assessment. Typical weeds include Drain Flat-sedge (**Cyperus eragrostis*), Common Feather-moss (**Eurhynchium praelongum*), Jointed Rush (**Juncus articulatus* subsp. *Articulates*) and Self-heal (**Prunella vulgaris*).

Bioregional conservation status – This EVC is not listed for the Highlands - Southern Fall bioregion but is certainly threatened given its rarity in the bioregion. DSE (2012) notes that this EVC is widespread but rare in mountains and the north-west. It is listed as endangered in six out of seven of its occupied bioregions.

2.3.2 Aquatic Sedgeland

This EVC occupies deeper water near the edge of the reservoir banks (Figure 3). There is often open shallow water between Aquatic Sedgeland and the bank, which may comprise Aquatic Herbland or a mix of ubiquitous native and weed species that are suited to regularly wet or shallow inundated clay soil. The dominant sedge is Tall Spike-sedge (*Eleocharis sphacelata*) and few other species occupy examples of this EVC at BNCR.

Bioregional conservation status – this EVC is not listed for the Highlands - Southern Fall bioregion. It is moderately common in wetlands and larger dams.

2.3.3 Riparian Scrub

Riparian Scrub at BNCR may be derived from other vegetation types or expanded since changes to hydrology following the dam construction. The rare occurrence of Swamp Gum (*Eucalyptus ovata*) on the margins of the scrub area indicates that Swampy Riparian Woodland may have once occupied the gully. Mature eucalypts are virtually absent from the mapped area (Figure 3). The EVC is otherwise dominated by medium to tall shrubs including Woolly Tea-tree (*Leptospermum lanigerum*), Manuka (*Leptospermum scoparium*), Swamp Paperbark (*Melaleuca ericifolia*), Scented Paperbark (*Melaleuca squarrosa*), Common Cassinia (*Cassinia aculeata* subsp. *aculeata*), Prickly Currant-bush (*Coprosma quadrifida*), Silver Wattle (*Acacia dealbata*), Snowy Daisy-bush (*Olearia lirata*) and Hazel Pomaderris (*Pomaderris aspera*). Patches with lower canopy cover are dominated by ferns and large graminoids including Soft Water-fern (*Blechnum minus*), Fishbone Water-fern (*Blechnum nudum*), Rough Tree-fern (*Cyathea australis*), Ground Fern (*Hypolepis* sp.), Austral King-fern (*Todea barbara*), Variable Sword-sedge (*Lepidosperma laterale* var. *majus*), Pale Rush (*Juncus pallidus*), Tall Rush (*Juncus procerus*), Sword Tussock-grass (*Poa ensiformis*) and Spiny-headed Mat-rush (*Lomandra longifolia* subsp. *longifolia*). Several forb species also occupy this EVC. Weeping Grass (*Microleana stipoides*) and bryophytes are dominant on the ground in many areas including Golden Weft-moss (*Thuidiopsis furfurosa*). Weed cover is generally low and includes Neat Feather-moss (**Pseudoscleropodium purum*), Common Blackberry (**Rubus anglocandicans*) and Ragwort (**Senecio jacobaea*).

Bioregional conservation status – Vulnerable.

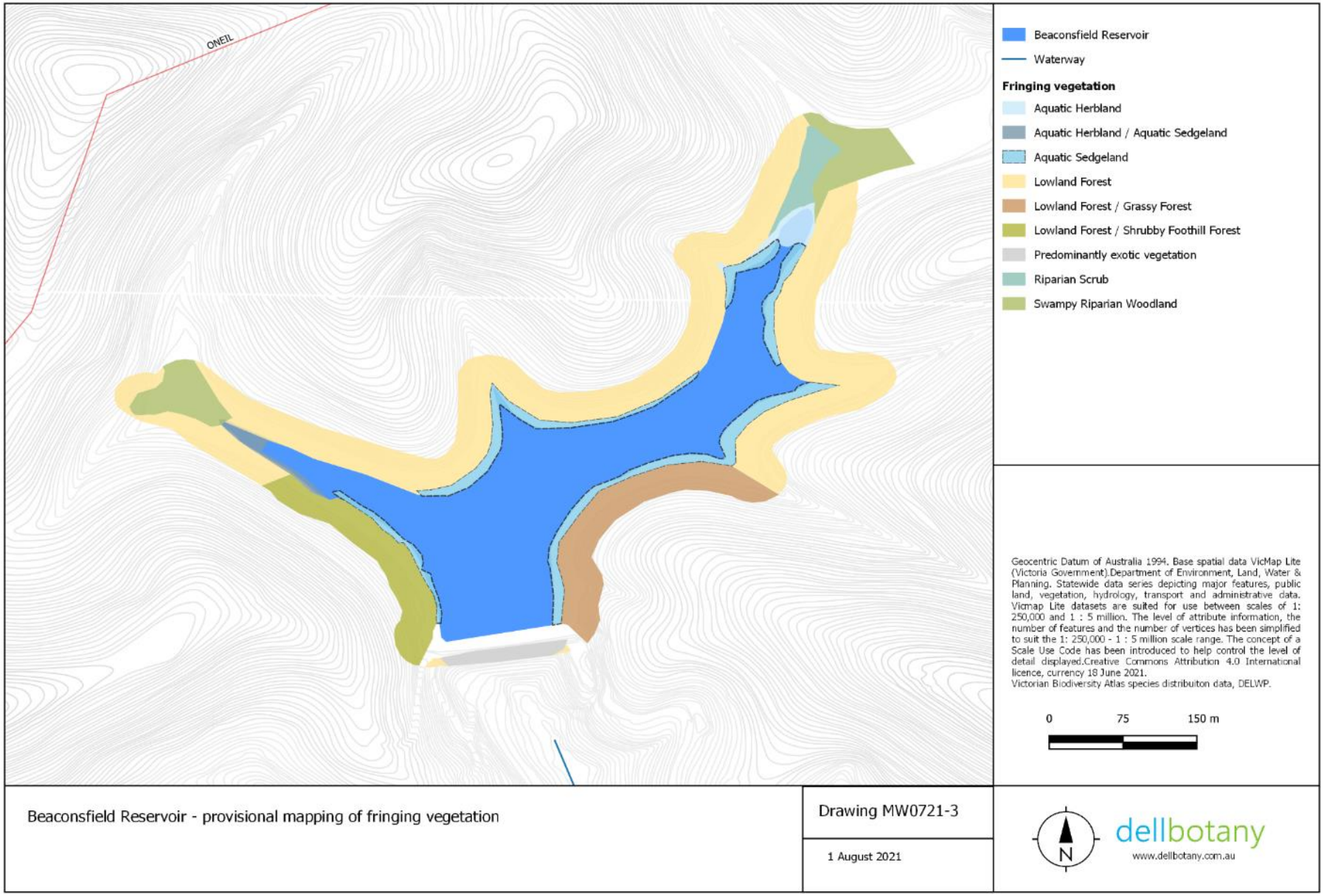

Figure 3. Ecological Vegetation Classes around Beaconsfield Reservoir.

2.3.4 Lowland Forest

Lowland Forest is the most widespread EVC which adjoins fringing vegetation around the reservoir. Its canopy is dominated by Messmate Stringybark (*Eucalyptus obliqua*), Narrow-leaf Peppermint (*Eucalyptus radiata* subsp. *radiata*) with other species variably including Mealy Stringybark (*Eucalyptus cephalocarpa* s.s.), Broad-leaf Peppermint (*Eucalyptus dives*), Green Scentbark (*Eucalyptus fulgens*) (FFG Act endangered), Bundy (*Eucalyptus goniocalyx* s.s.), with rare occurrences of Swamp Gum (*Eucalyptus ovata*). Understorey vegetation is open and shrubby including Narrow-leaf Wattle (*Acacia mucronata* subsp. *longifolia*), Prickly Moses (*Acacia verticillata* subsp. *verticillata*), Black Wattle (*Acacia mearnsii*), Silver Banksia (*Banksia marginata*), Common Heath (*Epacris impressa*), Yarra Burgan (*Kunzea leptospermoides*), Dusty Miller (*Spyridium parvifolium*), Golden Bush-pea (*Pultenaea gunnii*), Holly Lomatia (*Lomatia ilicifolia*), Trailing Ground-berry (*Acrotriche prostrata*), Forest Wire-grass (*Tetrarrhena juncea*), Thatch Saw-sedge (*Gahnia radula*), Small Grass-tree (*Xanthorrhoea minor* subsp. *lutea*), Common Tussock-grass (*Poa labillardierei*) and a suite of forb species. Weeds have low average cover and include Early Black-wattle (**Acacia decurrens*), Spanish Heath (**Erica lusitanica*), Sweet Pittosporum (**Pittosporum undulatum*), Gorse (**Ulex europaeus*) and Neat Feather-moss.

Bioregional conservation status – Least concern.

2.3.5 Grassy Forest

This EVC generally occupies west- or north-facing slopes and some ridgelines. It has a lower canopy height compared with Lowland Forest and a higher abundance of Bundy (*Eucalyptus goniocalyx* s.s.) and Broad-leaf Peppermint (*Eucalyptus dives*). The understorey vegetation is conspicuously grassy with Silvertop Wallaby-grass (*Rytidosperma pallidum*), Kangaroo Grass (*Themeda triandra*), spear grasses (*Austrostipa* spp.) and other grasses. It is otherwise moderately rich in forbs and small shrubs.

Bioregional conservation status – Vulnerable.

2.3.6 Other EVCs

Areas modelled as Damp Heathy Woodland have characteristics of that EVC yet their landscape context and plant composition also fit Lowland Forest. Mueck et al. (2002) did not consider Damp Heathy Woodland to occupy BNCR. The vegetation in question is likely too far from the reservoir bank to be considered for a more detailed impact assessment. Some areas of forest on the south-eastern side of the reservoir have a very high shrub cover and notably different composition compared with other foothill forests observed. It includes high cover-abundances of Dusty Miller, Rusty Bush-pea (*Pultenaea hispidula*) and other shrubs, while Black Sheoak (*Allocasuarina littoralis*) appears more abundant than elsewhere. There are affinities with this vegetation and Lowland Forest, but it is distinct enough that it may represent Shrubby Foothill Forest, which occurs nearby to the north at Cardinia Reservoir. The area has also been recently burnt and the high cover of some shrub species may be product of this. This shrubby community is noted here mainly for the different habitat types it provides, with consideration to a more detailed assessment of threatened species. Damp Heathy Woodland has a bioregional conservation status of Depleted and Shrubby Foothill Forest as a bioregional conservation status of Least Concern.

2.3.7 Threatened plants

Threatened plants recorded within 2 km of the reservoir body (Table 2) comprise seven state listed taxa (all endangered under the *Flora and Fauna Guarantee Act 1988*). These taxa should be considered present within BNCR for planning purposes. No EBPC Act listed plant taxa have been previously recorded within this 2 km zone. Thirty-one additional threatened taxa have been recorded or, for some EPBC taxa, are predicted to occur within a radius up to 5 km from the reservoir body. These include three EPBC Act listed taxa; Maroon Leek-orchid (*Prasophyllum frenchii*), Matted Flax-lily (*Dianella amoena*) and Clover Glycine (*Glycine latrobeana*). One EPBC Act listed taxon and six FFG Act listed taxa previously recorded from within 5 km of the reservoir have been determined as having medium or high likelihood of occurrence within habitat types found at BNCR. These are briefly discussed:

Wine-lipped Spider-orchid (*Caladenia oenochila*). This orchid has six records from the search, between 1939–2003 (DELWP 2021a). It typically occupies moist grassy foothill forests around central Victoria (VicFlora 2021). There are extensive areas of suitable habitat within BNCR, including some forest areas on lower slopes near the edge of the reservoir.

Forest Sedge (*Carex alsophila*). This sedge has one 1980 record near Officer (DELWP 2021a). It is an over-looked species which typically occupies mountain gullies, including around Gembrook, and can be locally common (VicFlora 2021). Areas of Riparian Scrub or Swampy Riparian Woodland provide suitable habitat for this species.

Austral Crane's-bill (*Geranium solanderi* var. *solanderi* s.s.). This taxon has one 2004 record to the east of Officer. Its habitat requirements are unclear due to taxonomic uncertainty involving several other related *Geranium* species. It appears to typically occupy damp areas of grassy woodland, along drainage lines or seepage areas (VicFlora 2021). This species may occupy drainage lines surrounding Beaconsfield Reservoir.

Rough Daisy-bush (*Olearia asterotricha*). This shrub has one 1980 record from Beaconsfield Upper (DELWP 2021a). This record would likely represent (*Olearia asterotricha* subsp. *lobata*) which typically occupies moist forest and swampy heathland (VicFlora 2021). Areas of Riparian Scrub at BNCR provide somewhat suitable habitat.

Long Pink-bells (*Tetratheca stenocarpa*). This shrub has one 1935 record from near Beaconsfield, however its largest population and most of its total area of occupancy occurs in forests between Emerald, Powelltown and Tarago Reservoir. It typically occupies open forests and tall mountain forests (VicFlora 2021), and there are areas of suitable habitat within BNCR. If present it is likely associated with slopes of surrounding forest rather than riparian areas.

There are a small number of other EPBC Act listed plant taxa that should be considered further, but do not appear in database searches. Round-leaf Pomaderris (*Pomaderris vacciniifolia*) is a critically endangered shrub which occupies moist forests and scrubs between Healesville, Marysville and Whittlesea, and across to Tyers-Walhalla area (VicFlora 2021). It is often associated with riparian vegetation (Patykowski et al. 2014). It has recently been re-discovered in areas of historical records between West Gippsland and Central Highlands, including Rokeby Flora and Fauna Reserve and Bunyip River Crossing Reserve. Smaller individuals can be somewhat inconspicuous in forests, and it is vulnerable to deer browsing. It is plausible that this species may occupy BNCR due to the considerable areas of suitable habitat. The orchid Green-striped Greenhood (*Pterostylis chlorogramma*) (vulnerable) typically occurs in moist areas of heathy and shrubby forest, on well drained soils (VicFlora 2021). There is ample habitat for this species at BNCR. Another orchid of similar general appearance, Tall Greenhood (*Pterostylis melagramma)*, was observed during the current site assessment. There is need to consider that if Green-striped Greenhood is present at BNCR then it may have been misidentified as Tall Greenhood. Database records of greenhoods in this group are strongly confounded by the misapplication and names and concepts. The nearest vouchered and recent records are from the southern end of Bunyip State Park (DELWP 2021a). Given the potential for Green-striped Greenhood to grow in forest near the edge of the reservoir, a targeted survey should be undertaken during its flowering period and prior to commencing work.

Mueck et al. (2003) note that habitat for two other EPBC Act listed plant taxa—River Swamp Wallaby-grass (*Amphibromus fluitans*) and Swamp Everlasting (*Xerochrysum palustre*)—occurs within BNCR and that these species might occur. River Swamp Wallaby-grass is associated with permanent swamps (VicFlora 2021) and can occupy farm dams, shallow wetlands, rivers and other waterbodies. It is recorded from a number of isolated wetlands where it may be dispersed by waterbirds, or in flood water. There is a low likelihood that it occupies such habitats in BNCR. It is generally associated with lowland areas and largely absent from the Central Highlands. The nearest records are from Lysterfield Lake area where last recorded in 1994 (DELWP 2021a). While there is some likelihood that it may occur on the fringes of Beaconsfield Reservoir, it has been determined as low predominantly due to lack of records in the bioregion. Swamp Everlasting is similarly absent from the Central Highlands (DELWP 2021a); it is unlikely to occur at BNCR due to a lack of suitable habitat and supporting records.

Table 2. Threatened plant taxa recorded within 5 km of the waterbody of Beaconsfield Reservoir.

Hydrological group: **1** – occupies riparian areas, swamps or other areas where there is permanent or periodic inundation (seasonal or other) e.g. flood zones, dam edges and similar. **2** – terrestrial areas which are subject to rainwater runoff or drainage, but without accumulating surface water. FFG and EPBC statuses – Cr – Critically endangered, En – Endangered, Vu – Vulnerable. Source VBA – Victorian Biodiversity Atlas, PMST – EPBC Protected Matters Search Tool. *Modelled likelihood of occurrence from the PMST applies to *Pterostylis cucullata*. The two subspecies in Victoria occupy quite different habitats (one coastal and the other in mountains) and as such modelling used to generate the PMST has uncertainty in this regard and given low weight in consideration of factors contributing to the likelihood assessment. **Some taxa are awaiting assessment and listing under the FFG Act due to the transitional provisions of the Act.

Common Name	Scientific Name	Year of last record	Occupancy likelihood	Search radius	Source	Hydrological group	EPBC Act status	FFG Act status
Dandenong Wattle	*Acacia stictophylla*	2006	Present	2 km	VBA	2		En
Wiry Bossiaea	*Bossiaea cordigera*	2011	Present	2 km	VBA	1,2		En
Powelltown Correa	*Correa reflexa* var. *lobata*	2006	Present	2 km	VBA	2		En
Green Scentbark	*Eucalyptus fulgens*	2006	Present	2 km	VBA	2		En
Red-tip Greenhood	*Pterostylis clivosa*	2011	Present	2 km	VBA	2		En
Cobra Greenhood	*Pterostylis grandiflora*	2006	Present	2 km	VBA	2		En
Floodplain Fireweed	*Senecio campylocarpus*	2021	Present	2 km	VBA	1		En
Round-leaf Pomaderris	*Pomaderris vacciniifolia*	-	Medium	5 km	PMST	2	Cr	Cr
Maroon Leek-orchid	*Prasophyllum frenchii*	2019	Low	5 km	VBA,PMST	1,2	En	En
Matted Flax-lily	*Dianella amoena*	2019	Low	5 km	VBA,PMST	2	En	Cr
Eastern Spider-orchid	*Caladenia orientalis*	-	Low	5 km	PMST	2	En	En
Basalt Peppercress	*Lepidium hyssopifolium*	-	Low	5 km	PMST	2	En	En

Clover Glycine	*Glycine latrobeana*	2003	Low	5 km	VBA,PMST	2	Vu	Vu
Strzelecki Gum	*Eucalyptus strzeleckii*	-	Low	5 km	PMST	2	Vu	Cr
Dense Leek-orchid	*Prasophyllum spicatum*	-	Low	5 km	PMST	2	Vu	Cr
Green-striped Greenhood	*Pterostylis chlorogramma*	-	Medium	5 km	PMST	2	Vu	En
Leafy Greenhood	*Pterostylis cucullata*	-	Low	5 km	PMST	2	Vu	En*
Swamp Fireweed	*Senecio psilocarpus*	-	Low	5 km	PMST	1	Vu	Not assessed**
White Star-bush	*Asterolasia asteriscophora* subsp. *albiflora*	1933	Low	5 km	VBA	2		Cr
Angahook Pink-fingers	*Caladenia maritima*	2000	Low	5 km	VBA	2		Cr
Wine-lipped Spider-orchid	*Caladenia oenochila*	2003	Medium	5 km	VBA	2		Cr
Winter Sun-orchid	*Thelymitra hiemalis*	2012	Low	5 km	VBA	2		Cr
Veined Spear-grass	*Austrostipa rudis subsp. australis*	2003	High	5 km	VBA	2		En
Lizard Orchid	*Burnettia cuneata*	1900	Low	5 km	VBA	1		En
Forest Sedge	*Carex alsophila*	1980	Medium	5 km	VBA	1		En
Powelltown Correa	*Correa reflexa* var. *lobata*	2014	High	5 km	VBA	2		En
Spurred Helmet-orchid	*Corybas aconitiflorus*	2008	Low	5 km	VBA	2		En
Purple Diuris	*Diuris punctata* var. *punctata*	1986	Low	5 km	VBA	2		En

Austral Crane's-bill	*Geranium solanderi* var. *solanderi* s.s.	2004	Medium	5 km	VBA	2	En
Tufted Club-sedge	*Isolepis wakefieldiana*	2004	High	5 km	VBA	1	En
Rough Daisy-bush	*Olearia asterotricha*	1980	Medium	5 km	VBA	1,2	En
Inland Red-tip Greenhood	*Pterostylis rubescens*	2003	Low	5 km	VBA	2	En
Mentone Greenhood	*Pterostylis* X *toveyana*	1900	Low	5 km	VBA	2	En
Spreading Knawel	*Scleranthus fasciculatus*	1999	Low	5 km	VBA	2	En
Long Pink-bells	*Tetratheca stenocarpa*	1935	Medium	5 km	VBA	2	En
Crested Sun-orchid	*Thelymitra* X *irregularis*	1900	Low	5 km	VBA	2	En
Slender Pink-fingers	*Caladenia vulgaris*	2004	Low	5 km	VBA	2	Vu
Sharp Greenhood	*Pterostylis* X *ingens*	1900	Low	5 km	VBA	2	Vu

2.4 Waterbirds

Waterbird habitat at the BNCR comprised small areas of exposed mud and shallow water (<30 cm deep) mainly along the western gully line of the reservoir, with waters close to the reservoir bank observed to be around 30 cm deep then dropping away. A band of Tall Spike-sedge extended around most of the perimeter (Figure 4), beyond which there was an extensive area of deep open water. Submerged aquatic vegetation was also present within the shallower waters.

Figure 4. An example of thick Tall Spike-sedge at the perimeter of Beaconsfield Reservoir

Four waterbird species were seen during the two separate site visits in 2021: one individual Little Pied Cormorant (*Microcarbo melanoleucos*) and two Australian Shelduck (*Tadorna tadornoides*) observed flying at a low height above the reservoir, an individual White-faced Heron (*Ardea pacifica*) amongst reeds close to the shore and three Hoary-headed Grebes (*Poliocephalus poliocephalus*) in the open water.

A total of 17 waterbird species have been recorded from the immediate study area (DELWP 2021a, Mueck 2002) and 65 from the wider search area (DELWP 2021a, Table 3). Seventeen of the overall number of species are listed under the Flora and Fauna Guarantee Act 1988 (DELWP 2021b), with one of these species also recorded from the study area itself (Eastern Great Egret *Ardea alba modesta*). A number of species, including several of those listed as threatened, had been recorded only a few times, many years ago (Table 3). Apart from the Eastern Great Egret, all other species recorded from the study site are relatively common.

Table 3. Waterbird species recorded from Beaconsfield Reservoir and up to 13 km within the surrounding area.

Species observed during the site visit in 2021 are marked with an ^

Common Name	Scientific Name	Recorded within study site	Number of records	Most recent record	EPBC Act Status	FFG Act Status
Lewin's Rail	*Lewinia pectoralis*		7	2019		
Buff-banded Rail	*Hypotaenidia philippensis*		19	2018		
Australian Spotted Crake	*Porzana fluminea*		20	2018		
Baillon's Crake	*Porzana pusilla*		31	2019		
Spotless Crake	*Porzana tabuensis*		24	2019		
Black-tailed Native-hen	*Tribonyx ventralis*		3	2009		
Dusky Moorhen	*Gallinula tenebrosa*	X	416	2021		
Australasian Swamphen	*Porphyrio melanotus*	X	427	2019		
Eurasian Coot	*Fulica atra*	X	401	2021		
Great Crested Grebe	*Podiceps cristatus*		28	2010		
Australasian Grebe	*Tachybaptus novaehollandiae*	X	275	2019		
Hoary-headed Grebe	*Poliocephalus poliocephalus*	X^	174	2021		
Great Cormorant	*Phalacrocorax carbo*	X	120	2019		
Little Black Cormorant	*Phalacrocorax sulcirostris*	X	193	2019		
Pied Cormorant	*Phalacrocorax varius*		28	2019		
Little Pied Cormorant	*Microcarbo melanoleucos*	X^	377	2021		
Australasian Darter	*Anhinga novaehollandiae*	X	149	2019		
Australian Pelican	*Pelecanus conspicillatus*		153	2020		
Whiskered Tern	*Chlidonias hybrida*		5	2018		
Australian Gull-billed Tern	*Gelochelidon macrotarsa*		1	2017		
Caspian Tern	*Hydroprogne caspia*		8	2018		Vu
Crested Tern	*Thalasseus bergii*		1	1975		
Silver Gull	*Chroicocephalus novaehollandiae*		243	2019		
Red-kneed Dotterel	*Erythrogonys cinctus*		23	2018		
Masked Lapwing	*Vanellus miles*	X	435	2019		
Banded Lapwing	*Vanellus tricolor*		1	1987		
Double-banded Plover	*Charadrius bicinctus*		2	2010		

Black-fronted Dotterel	*Elseyornis melanops*		122	2018		
Red-necked Avocet	*Recurvirostra novaehollandiae*		1	1972		
Common Sandpiper	*Actitis hypoleucos*		2	1998		Vu
Marsh Sandpiper	*Tringa stagnatilis*		1	2004		En
Red-necked Stint	*Calidris ruficollis*		1	2005		
Sharp-tailed Sandpiper	*Calidris acuminata*		13	2018		
Latham's Snipe	*Gallinago hardwickii*		141	2019		
Glossy Ibis	*Plegadis falcinellus*		2	2017		
Australian White Ibis	*Threskiornis molucca*		400	2019		
Straw-necked Ibis	*Threskiornis spinicollis*		318	2020		
Royal Spoonbill	*Platalea regia*		108	2019		
Yellow-billed Spoonbill	*Platalea flavipes*		42	2019		
Little Egret	*Egretta garzetta*		14	2019		
Plumed Egret	*Ardea intermedia plumifera*		3	2019		
Eastern Great Egret	*Ardea alba modesta*	X	163	2019		Vu
White-faced Heron	*Egretta novaehollandiae*	X^	468	2019		
White-necked Heron	*Ardea pacifica*		66	2021		
Nankeen Night-Heron	*Nycticorax caledonicus*	X	40	2019		
Australian Little Bittern	*Ixobrychus dubius*		6	2006		En
Australasian Bittern	*Botaurus poiciloptilus*		17	2018	En	CE
Cape Barren Goose	*Cereopsis novaehollandiae*		2	2006		
Magpie Goose	*Anseranas semipalmata*		1	1987		
Australian Wood Duck	*Chenonetta jubata*	X	501	2020		
Black Swan	*Cygnus atratus*	X^	263	2020		
Australian Shelduck	*Tadorna tadornoides*	X	33	2021		
Pacific Black Duck	*Anas superciliosa*	X	751	2021		
Chestnut Teal	*Anas castanea*		272	2019		
Grey Teal	*Anas gracilis*		181	2019		
Australasian Shoveler	*Spatula rhynchotis*		80	2019		Vu
Pink-eared Duck	*Malacorhynchus membranaceus*		26	2019		
Freckled Duck	*Stictonetta naevosa*		4	2019		En
Hardhead	*Aythya australis*		217	2019		Vu
Blue-billed Duck	*Oxyura australis*		133	2019		Vu

Musk Duck	*Biziura lobata*	91	2019	Vu
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	14	2017	En
Mallard	*Anas platyrhynchos*	20	2019	
Eastern Cattle Egret	*Bubulcus coromandus*	36	2019	
Pectoral Sandpiper	*Calidris melanotos*	1	1998	

2.5 Herpetofauna

2.5.1 Frogs

Withing the BNCR, the reservoir contains near-continuous fringing vegetation that provides suitable habitat for frogs and includes sedges, floating and submerged vegetation. The eastern arm of the reservoir also contains Aquatic Herbland and Riparian Scrub/Swampy Riparian Woodland. Shallow depressions and low-lying flood areas were located along the main gully line entering the eastern side of the reservoir, as well as a drainage line running alongside the eastern arm of the reservoir (Figure 5). These areas provide suitable breeding habitat for the Southern Toadlet (*Pseudophryne semimarmorata*). There was damage observed on the wetland fringes caused by deer in multiple locations, including pugging and wallows (Figure 6). During the two site visits only one frog species was heard calling, the Common Froglet (*Crinia signifera*), with large numbers heard near the dam wall on the western side and along the eastern arm of the reservoir.

The VBA and the ALA yielded records of seven frog species within the immediate study area (1 km) and an additional two species within 5 km (Table 4). Of the nine species, seven are common, having broad distributions throughout south-eastern Australia (Anstis 2013). The Growling Grass Frog (*Litoria raniformis*) is listed as Vulnerable nationally (EPBC Act 1999) and Threatened in Victoria under the *Flora and Fauna Guarantee Act* 1988 (DELWP 2021b). The Growling Grass Frog has been recorded at wetlands at Officer, located just within the 5 km radius from Beaconsfield NCR. The Southern Toadlet is listed as Endangered under the *Flora and Fauna Guarantee Act* 1988 (DELWP 2021b) and was last recorded at Beaconsfield in 1981 (Table 4). The majority of frog species have been recorded in the area during the last ten years. Additional anuran species that may occur in the area include Peron's Tree Frog (*Litoria peronii*) and Haswell's Frog (*Paracrinia haswelli*). Peron's Tree Frog is widespread throughout coastal and inland areas of Queensland, New South Wales and Victoria, and Haswell's Frog occurs along the New South Wales and eastern Victorian coastal areas and adjacent plateaux's (Anstis 2013). Neither species is listed as threatened within Victoria.

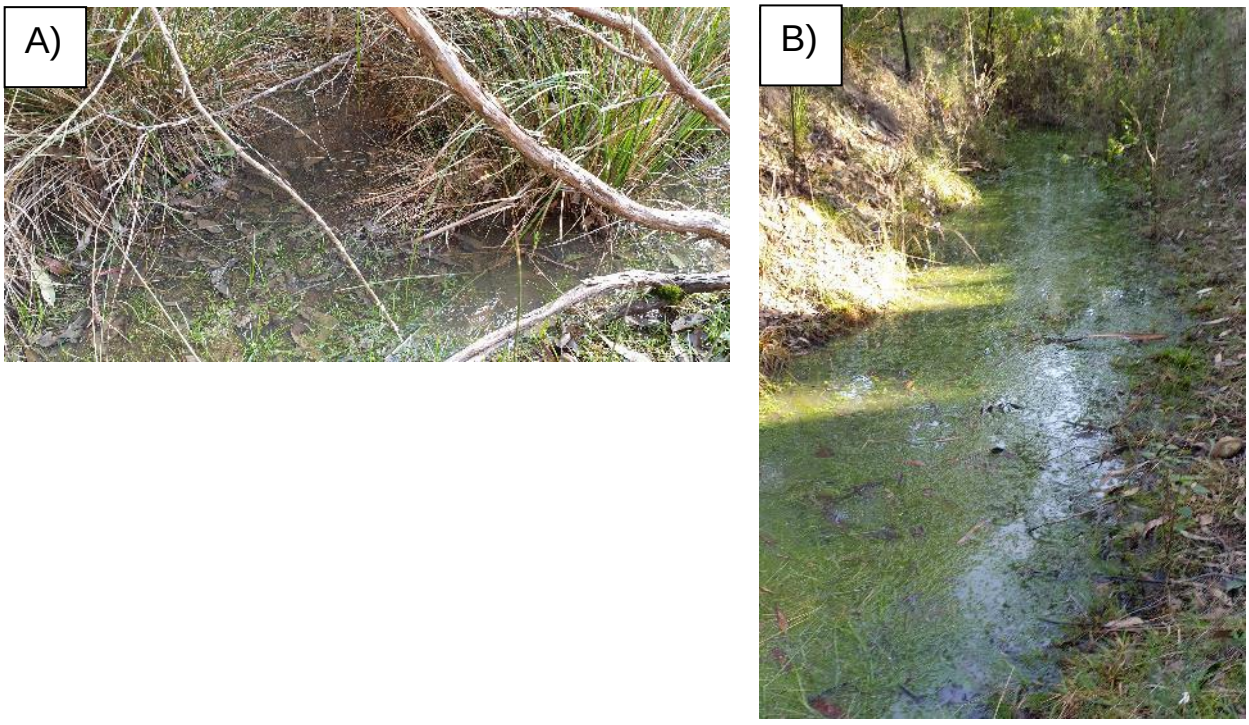

Figure 5. Shallow, inundated depression on the eastern gully line (A) and a shallowly, inundated drainage line located alongside the eastern side of the reservoir (B).

Figure 6. Damage to wetland fringes and habitat caused by deer wallowing and pugging.

2.5.2 Reptiles

Beaconsfield NCR provides a range of habitats that are suitable for reptiles, including Aquatic Herbland, Aquatic Sedgeland, Riparian Scrub, Lowland Forest and Grassy Forest.

The Victorian Biodiversity Atlas (VBA, DELWP) yielded 16 species of terrestrial reptiles and one aquatic species within a 5 km radius of the BNCR, comprising 10 skink species, two dragon species, one goanna species and four species of elapid snakes (Table 4). With the exception of the Swamp Skink (*Lissolepis coventryi*), all are typical of lowland forest (sensu lato) or riparian environments that cover the southern slopes of the GDR in southern Victoria and all have broad distributions throughout temperate south-eastern Australia (Cogger 2019, Robertson and Coventry 2019).

The aquatic Eastern Long-necked Turtle (*Chelodina longicollis*) has been recorded within 5 km of the BNCR. This species was not trapped during aquatic surveys in 2002 (Mueck 2002), although, these surveys were conducted in August when this species is relatively inactive (Chessman 1988). Given its propensity for overland migration (Chessman 1984) and movement between multiple wetlands within its home range (Roe and Georges 2007), this species may be found at Beaconsfield.

Other reptile species that may occur in the area yet are not listed in VBA records include Black Rock Skink (*Egernia saxatilis intermedia*), Red-bellied Black Snake (*Pseudechis porphyriacus*) and possibly Mountain Dragon (*Rankinia diemensis*). These species are similarly common and widespread in south-eastern Australia and have been recorded from the area around Cardinia Reservoir, approximately 6 km north of the BNCR.

Table 4. Reptile and frog species recorded within a 5 km radius of Beaconsfield Reservoir (Atlas of Living Australia) and in the immediate are (1 km).

Common name	Scientific name	Within 1 km	No. of records	Most recent record	EPBC Act Status	FFG Act Status
Reptiles						
Blotched Blue-tongued Lizard	*Tiliqua nigrolutea*		5	2014		
Eastern Blue-tongued Lizard	*Tiliqua scincoides*		2	2020		
Dark-flecked Garden Sunskink	*Lampropholis delicata*		8	2018		
Pale-flecked Garden Sunskink	*Lampropholis guichenoti*	X	18	2014		
Swamp Skink	*Lissolepis coventryi*		1	2017		En
Eastern Three-lined Skink	*Acritoscincus deperreyi*		2	1964		
Highlands Forest Skink	*Anepischetosia maccoyi*		3	1967		
Metallic Cool-skink	*Carinascincus metallicus*		2	1977		
Weasel Skink	*Saproscincus mustelinus*		8	2002		
Southern Water Skink	*Eulamprus tympanum*		3	1988		
Jacky Lizard	*Amphibolurus muricatus*		3	1988		
Lace Monitor	*Varanus varius*		1	2018		
Tiger Snake	*Notechis scutatus*		1	1988		
Eastern Small-eyed Snake	*Cryptophis nigrescens*	X	4	1988		
White-lipped Snake	*Drysdalia coronoides*		5	2008		
Lowland Copperhead	*Austrelaps superbus*		4	2014		
Eastern Long-necked Turtle	*Chelodina longicollis*		3	2010		
Amphibians						
Southern Brown Tree Frog	*Litoria ewingii*	X	132	2020		
Growling Grass Frog	*Litoria raniformis*		9	2011	Vul	Vul
Striped Marsh Frog	*Limnodynastes peronii*		44	2019		
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	X	20	2018		
Eastern Banjo Frog	*Limnodynastes dumerilii*	X	15	2019		

Common Froglet	*Crinia signifera*	X	67	2021	
Victorian Smooth Froglet	*Geocrinia victoriana*	X	14	2013	
Southern Toadlet	*Pseudophryne semimarmorata*	X	21	1981	En
Verreaux's Tree Frog	*Litoria verreauxii verreauxii*	X	37	2016	

2.6 Fish, crayfish and mussels

Mueck et al. (2002) conducted the only known survey of Beaconsfield Reservoir. Over two days they conducted a range of survey techniques including fyke and gill netting, light trapping, electrofishing, and angling. As such the species list is considered reasonably comprehensive. They found seven fish species in total. These included the native Short-finned Eel (*Anguilla australis*), Spotted Galaxias (*Galaxias truttaceus*) and Southern Pygmy Perch (*Nannoperca australis*), and the exotic Eastern Gambusia (*Gambusia holbrooki*) and Goldfish (*Carassius auratus*).

The native Common Yabby (*Cherax destructor*) and Balonne Freshwater mussel (*Velesunio ambiguus*) was also observed. Shrimp (*Paratya* sp.) were common. Further to this, the authors observed active burrows belonging to burrowing crayfish during a site visit in July 2021, that could belong to the Foothill Burrowing Crayfish (*Engaeus victoriensis*), Lowland Burrowing Crayfish (*Engaeus quadrimanus*), or Granular Burrowing Crayfish (*Engaeus cunicularius*) that occur in the area.

In the surrounding catchments, native fish including Long-finned Eel (*Anguilla reinhardtii*), River Blackfish (*Gadopsis marmaratus*), Climbing Galaxias (*Galaxias brevipinnis*), Common galaxias (*Galaxias maculatus*), Dwarf galaxias (*Galaxiella pusilla*) have been observed. Also, exotic fish including Rainbow trout (*Oncorhychus mykiss*), Roach (*Rutilis rutilis*), and Brown Trout (*Salmo trutta*). Regarding crayfish, Granular Burrowing Crayfish (*Engaeus cunicularius*), Lowland Burrowing Crayfish (*Engaeus quadrimanus*), Foothill Burrowing Crayfish (*Engaeus victoriensis*), Gippsland Spiny Crayfish (*Euastacus kershawi*), Woiwuru Spiny Crayfish (*Euastacus woiwuru*), and Yarra Spiny Crayfish (*Euastacus yarraensis*). Of these the Dwarf Galaxias (*Galaxiella pusilla*) is listed as 'Endangered' under Flora and Fauna Grantee Act (FFG Act) and 'Vulnerable' under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

While efforts were made to stock Brown Trout (*Salmo trutta*) in the reservoir in 1921 and 1923 (Barnham 2000), they do not appear to have established a self-sustaining population.

Table 5. Fish, crayfish and mussel species recorded from Beaconsfield Reservoir and the broader Cardinia Creek and Deep Creek catchments.

Migratory species that cannot form landlocked populations are not included as they would not be able to access the isolated reservoir. Species recorded within Beaconsfield Reservoir are marked with an 'X'. Burrowing crayfish are present within the study site, but the exact species is unknown, so they are marked with a question mark (?). Exotic species are indicated by an asterisk (*). Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) list of threatened fauna and Flora and Fauna Guarantee Act 1988 - Threatened List.

Common Name	Scientific Name	Recorded within study site	EPBC Act Status	FFG Act Status
Fish				
Short-finned Eel	*Anguilla australis*	X		
Long-finned Eel	*Anguilla reinhardtii*			
Goldfish*	*Carassius auratus*	X		
River Blackfish	*Gadopsis marmaratus*			
Climbing Galaxias	*Galaxias brevipinnis*			
Common Galaxias	*Galaxias maculatus*			
Spotted Galaxias	*Galaxias truttaceus*	X		
Dwarf Galaxias	*Galaxiella pusilla*		Vu	En
Eastern Gambusia*	*Gambusia holbrooki*	X		
Southern Pygmy Perch	*Nannoperca australis*	X		
Rainbow Trout*	*Oncorhychus mykiss*			
Roach*	*Rutilis rutilis*			
Brown Trout*	*Salmo trutta*			
Crayfish				
Granular Burrowing Crayfish	*Engaeus cunicularius*	?		
Lowland Burrowing Crayfish	*Engaeus quadrimanus*	?		
Foothill Burrowing Crayfish	*Engaeus victoriensis*	?		
Gippsland Spiny Crayfish	*Euastacus kershawi*			
Woiwuru Spiny Crayfish	*Euastacus woiwuru*			
Yarra Spiny Crayfish	*Euastacus yarraensis*			
Mussels				
Balonne Freshwater Mussel	*Velesunio ambiguus*	X		

3 Discussion

3.1 Plants

3.1.1 Listed communities

The Protected Matter Search Tool identified two EPBC Act listed ecological communities which may occur within the search area. These are:

- Natural Damp Grassland of the Victorian Coastal Plains
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

Neither listed community is considered likely to occur, based on the definition criteria of each (DoE 2015, TSSC 2006) and observations of communities during the site assessment for this report. The BNCR does not fall within the landscape context of the former community, which is typically lowland plains. None of the characteristic eucalypt species occur for the latter community.

There were no FFG Act listed communities observed during the site inspection. The area of Riparian Scrub (Figure 2) has affinities with the FFG Act listed community Sedge-rich *Eucalyptus camphora* Swamp, currently known only from Yellingbo Nature Conservation Reserve. Many of the flora species observed at BNCR are common to this community however the Riparian Scrub example has a different hydrology and therefore does not develop the same composition and cover of sedges and other swamp species which prefer longer intervals of inundation. It also lacks Mountain Swamp-gum based on this preliminary assessment however this species has the potential to occur in and around BNCR. Despite this, the swampy areas at the BNCR still have ecological significance for their rarity in the landscape and associated fauna habitats. It is also habitat for at least one threatened species (Floodplain Fireweed) and potentially contains others.

This preliminary assessment concludes that there are no listed ecological communities which are likely to be impacted by the proposed action.

3.1.2 Ecological Vegetation Classes (EVCs) and canopy trees

Aquatic Herbland has very limited extent on the margins of the reservoir and is the most threatened EVC with regard to the proposed lowering of the water level. It is possible that newly created areas of shallow water will provide replacement habitat for this EVC, however it should not be assumed that it will naturally establish in such areas. The depth of water is important for this EVC to establish and persist within suitable waterbodies.

Riparian Scrub also will be impacted by lowering the water level. Many of the shrub species which dominate this EVC are common and readily recruit in areas of suitable habitat. Once the dam is lowered, the creation of new areas of Riparian Scrub will likely follow. Flooding and waterlogging of soils on the inflow side of the dam will persist and will likely increase in extent if the margins have a lower gradient than previous. There is a moderate diversity of understory plants in Riparian Scrub, some of which including several fern species may be slower to colonise new areas of habitat.

Dry foothill EVCs on lower slopes, including Lowland Forest, fringe most of the waterbody. It is expected that these vegetation types will recruit into areas of exposed earth following permanent lowering of the water level, however monitoring would be required to determine the compositional changes which occur as a result. Some dieback of eucalypts may occur near the current high water level due to the rate of change to hydrological regimes. Seed dispersal and germination however is not expected to be limited due to an abundance of fertile material near the bank. There are also several species which occupy the zone nearest the edge of the bank including Messmate Stringybark, Silver-leaf Stringybark, Green Scentbark, Narrow-leaf Peppermint and Swamp Gum. This offers a level of redundancy in any one species' role to provide a tree canopy between the current and future high-water mark. Similarly, it is expected that a suite of understorey species will be suited to recruit in this space; either by vegetative spread or by seed. Regarding longer-lived perennials, it is also expected that early successional species or those which are advantaged by disturbance will be dominant over the 10 years following, including Burgan, Manuka and cassinias (*Cassinia* spp.).

Implications for impacts to trees warrant separate discussion due to their multiple ecological roles including habitat for fauna. Impacts should be considered in terms of changes to soil conditions, ambient humidity and

related changes over a 3–5 year period as the water level is lowered. It is not implied that this will lead to a water deficit in mature trees as most of these species are abundant also further upslope, away from the edge of the reservoir. Stress due to hydrological changes rather than water deficit may make some tree more susceptible to other pressures which can cause dieback. The wider influence of drought (seasonal and long-term) is also a consideration and planning may take into account how these two factors interact. Other factors such as soil instability may contribute to windthrow. There is capacity for eucalypt species to vary physiological traits in response to drought and season. Such observations have been made for Messmate Stringybark with plasticity in traits attributed to some level of resilience against drought (Pritzkow et al. 2020). Messmate Stringybark has the capacity to adapt to long-term drought by changing morphological traits (Pritzkow et al. 2021). It is conceivable that trees closer to the reservoir edge are less resilient to future long-term drought, and that the combined effects of lowering the water level and regional climate cycles may result in higher incidence of dieback in this zone. An analysis of stomatal conductance of six eucalypt species in central Victoria revealed that each species had a unique response to seasonal variation in climate, with Yellow Box (*Eucalyptus melliodora*) having the lowest level of photosynthesis rate relative to stomatal conductance and transpiration, and Bundy having the highest across all seasons (Patykowski et al. 2019). As such, the responses of trees to lowering the water level will likely vary depending on the species. Tree recruitment in the zone between new and old high-water levels has its own considerations. Eucalypt seedlings will need to compete with other species including several woody weed species which occur around the reservoir. They will also need to endure summer conditions while still at seedling stage and with limited shade.

3.1.3 Potential threats to significant flora

The following applies to significant plant species which currently occupy BNCR.

Dandenong Range Cinnamon Wattle – There are numerous reliable records of this species in the local area. It typically occupies riparian zones on hillsides in tall forest and open woodland (VicFlora 2021). Targeted searches would be required to provide further mitigation of impacts to this species' habitat, associated with lowering the water level.

Wiry Bossiaea – The habitat requirements of this shrub are varied although it is usually associated with moist drainage lines or floodplains. It occurs in heathland, heathy woodland and open forest (VicFlora 2021). Lowering of the water level may result in some sections of drainage line drying out. While habitat may be replaced over time there is high uncertainty around this. It is often very rare at a site and the BNCR population should be monitored as part of impact mitigation.

Powelltown Correa – This shrub has been recorded within BNCR and there are three records elsewhere near Cardinia Reservoir from 2006–2014. It typically occupies moist open forests which are often heathy (VicFlora 2021). Such forest types occur within BNCR including vegetation within or on fringes of riparian zones.

Green Scentbark – There are few related threats to this species as most mature individuals are well away from the bank of the reservoir. This species is not typically dependent on riparian zones or margins of waterbodies.

Red-tip Greenhood – This orchid occurs on well-drained soils, on slopes and ridges in drier open forests and woodland (VicFlora 2021). It is determined as present based on at least two reliable records from the local area. Due to its preference for drier habitats, it is unlikely to be impacted from the proposed action.

Cobra Orchid – This orchid occurs on moist, shady slopes in open forest on well-drained soils (VicFlora 2021). It is determined as present based on one reliable 2006 record within BNCR and may occupy lower slopes near the edge of the reservoir.

Floodplain Fireweed – One plant of this species was observed during a general inspection of habitats. Additional plants may be found following a targeted survey. The main threat to this species is changes to hydrology. Such changes may alter habitat conditions and make existing area of habitat uninhabitable or more prone to weed invasion. Another significant threat to this species is deer trampling, as it grows in sites which are often used for wallows.

Apart from impacts associated with lowering the water level, the next two greater threats with direct management intervention options are weed invasions and impacts from deer. Both will require a suitable level of investment in control and monitoring during and after lowering the reservoir. A detailed ecological assessment should make a determine on potential losses and gains in threatened species populations, based on a better understanding of the distribution of each within BNCR.

3.2 Waterbirds

The suitability of wetland waterbird habitat for different species is largely driven by the depth of water, and the gradient of water depth extending away from the shoreline. This influences the presence of submerged and emergent vegetation, which is used by waterbirds for foraging, either on the vegetation itself or the invertebrates that reside there, and/or shelter, and the extent of deep open water, used by species that dive (Halse et al. 1993, Marchant and Higgins 1990). Open water is the most extensive waterbird habitat present at Beaconsfield Reservoir which would suit species that forage in deep water (e.g. diving ducks). It is also likely to be used as a refuge or roosting area by waterbird species that forage in shallow water but swim further from shore when disturbed (e.g. Pacific Black Duck, Dusky Moorhen). The narrow band around the perimeter that includes the Spike-sedge would suit species that forage in relatively shallow water if <30 cm deep (shorebirds, large waders and some filter feeders). However, these species appear to be poorly represented at Beaconsfield Reservoir, perhaps because much of the shallow water is occupied by Spike-sedge, and many shorebird and waterbird species tend to avoid such tall vegetation, though it is favoured by some marsh-dwelling species such as Australasian Swamphen. The proposed draw-down of the reservoir water level, and predicted decrease in the area of shallow and deep water, may impact waterbird species that use shallow habitats, with 'winners' and 'losers' being determined by the response of vegetation to decreasing water levels. Precise impacts are therefore difficult to predict, but given the relatively steep shorelines of the reservoir, the relative area of shallow water is likely to remain small.

Species that forage in deep water include grebes, ducks and cormorants, and also the Black Swan which reaches down under the water with its long neck, all of which have been recorded at the reservoir. Only three duck species (Pacific Black Duck, Australian Wood Duck and Australian Shelduck) have been recorded at the study site, but others such as Grey Teal, Chestnut Teal and Hardhead, which represent the more commonly recorded species in the surrounding area, may also use the reservoir.

Bitterns are found in swamps and wetlands amongst tall dense vegetation such as reeds, rushes and sedges. Similarly, crakes frequent wetland areas that provide dense cover, though also forage along muddy edges (Menkhorst et al. 2019). The Tall Spike-sedge at the BNCR may provide suitable habitat for such birds, and although none of these species have been recorded on site, a small number have been recorded in the wider area.

Large waders such as ibis, spoonbills, herons and egrets forage for invertebrates such as insects, molluscs and fish in surface or shallow waters, probing mud (ibis), sweeping their bills from side to side (spoonbills), or grabbing (herons and egrets) (Marchant and Higgins 1990). Of these waders, the White-faced Heron, Nankeen Night-Heron and Eastern Great Egret have been recorded at the BNCR. There appears to be little habitat for ibis at BCNR as they largely prefer shallower water less than 30 cm deep (Pallisson et al. 2002, Rogers et al. 2019) and Beaconsfield Reservoir provides limited areas like this.

For many of the other species recorded within the wider area, Beaconsfield Reservoir does not provide suitable habitat. For example, for there is minimal habitat for shorebird species that prefer mud flats or very shallow water to forage, such as plovers, avocets and sandpipers (Marchant and Higgins 1993a), there is minimal habitat of this type.

One of the more wide-ranging species present in the area, the White-bellied Sea-eagle (not strictly a waterbird), utilises open water to hunt over the surface (Marchant and Higgins 1993b). Although this species (listed as Endangered under the FFG Act) has not been recorded from Beaconsfield Reservoir, individuals may include this site if within their foraging territory. It has been recorded at Lysterfield Lake, Cardinia Reservoir and most recently at River Gum Creek Reserve, Hampton (12 km to the east of the study area) and would likely use several of these larger bodies of water in the wider area to forage.

The restricted public access to the BNCR has likely contributed to the lack of formal records from the site; it is possible that a more diverse waterbird community uses the reservoir, particularly ducks. Other more cryptic species such as bitterns and crakes may also be present. In addition, the site visits for this current assessment took place during winter when waterbird numbers in southern Victoria are at their lowest (Rogers et al. 2019). Conducting formal waterbird surveys, particularly during spring (to capture any breeding) and late summer (to capture the highest numbers), would provide more information in this regard. The unusually wet year may also mean there is abundant waterbird habitat further inland providing more attractive foraging.

Potential adverse impacts of lowering the water level on waterbird habitat includes a loss of the area of Spike-sedge, which is particularly thick within some of the narrower arms e.g. the north-east tip, and submerged vegetation. A very slow lowering of the water level such that there is minimal loss of emergent and submerged vegetation would provide the best outcome for waterbirds that use this habitat. This is particularly the case if the area is utilised during breeding. The area of shallow and open deep water is predicted to decrease, however will still be reasonably extensive. There is the potential for areas of water <

30 cm deep e.g. along drainage lines, which would particularly benefit waders. Currently there is little evidence that large numbers of waterbirds use the reservoir, although it may be locally important, particularly during dry periods, as there are few natural wetlands in the immediate area.

There are two key large waterbodies close to the BNCR that also provide waterbird habitat: Cardinia Reservoir and Lysterfield Lake. All the species recorded using Beaconsfield Reservoir, or are likely to use it, would be able to utilise these and other local areas and it is anticipated that their habitat needs could be met outside of the study site. However, if formal surveys revealed e.g. large numbers of threatened ducks utilising the reservoir, this may warrant further consideration of how the proposed lowering of the water level could cause impacts via a reduction in available habitat or disturbance during the dam wall works. Further actions might involve ongoing monitoring or minimising disturbance during works.

3.3 Herpetofauna

3.3.1 Frogs

Frogs utilise the marginal habitats in large wetlands and reservoirs. The emergent, floating and submergent vegetation which provides habitat for both frogs and tadpoles is largely restricted to the shallower sections of Beaconsfield. Biofilm production is higher in more complex habitats such as those with aquatic plants (Gagnon et al. 2007) and tadpole diets, although they vary depending on food availability, typically consist of biofilm, with microcrustaceans and algae consumed when abundant (Ocock et al. 2018). Snags, as well as providing important habitat, also serve as a base for biofilm production (Johnson et al. 2003). Lowering the water level at Beaconsfield Reservoir, increasing the proportion of shallow water habitat whilst maintaining habitat complexity is likely to benefit the local frog community.

Two conservation listed frog species have been recorded within a 5 km vicinity of Beaconsfield NCR: the Growling Grass Frog and the Southern Toadlet. Growling Grass Frogs have been recorded on the southern side of the Princes Highway (VBA) and may not have been recorded at Beaconsfield for a variety of reasons. Firstly, although this species is highly mobile and there are numerous waterbodies between Officer and Beaconsfield NCR, Growling Grass Frogs are susceptible to population fragmentation due to urbanisation (Hale et al. 2013). Detection probabilities for Growling Grass Frogs during diurnal and nocturnal surveys vary greatly and can be quite low (0.1 and 0.696 respectively, Heard et al. 2006) and reliance on single-site visits for this species is likely to severely underestimate site occupancy (Heard et al. 2006). The two survey days conducted in August, when the species is not active, are less likely to have detected them. Lastly, in 2002 the reservoir was described as having ‘extensive areas of open water, few shallow margins, no emergent aquatic vegetation and limited fringing aquatic vegetation’ making the reservoir marginal habitat at that time (Mueck et al. 2002). Reductions in the carrying capacity of the reservoir since 2002 has lowered water levels and created more complex habitat. Growling Grass Frogs typically prefer wetlands with a range of emergent, floating and submergent vegetation (Heard et al. 2008) and it is possible, if a resident population is located nearby, that the site could be colonised. Although not detected at the site previously, the Growling Grass Frog is listed as Threatened (DELWP 2021b) so it is recommended that appropriate surveys are undertaken to determine whether the species is present.

The Southern Toadlet is listed as Endangered in Victoria (DELWP Threatened List June 2021) and was last recorded at Beaconsfield NCR in 1981. This species can be more difficult to detect and typically requires targeted surveys. The Southern Toadlet is the only species of the nine detected that lays its eggs on the ground (Anstis 2013). Unlike most spring and summer calling species, the Southern Toadlet calls in Autumn from shallow depressions in low lying flood-areas (Anstis 2013). This species is a pool breeding amphibian, reliant on damp gullies, basins and depressions that inundate in Autumn and Winter (De Angelis and Cleeland 2019). Reducing the extent of the reservoir may increase the availability of low-lying flood-areas that would have previously been permanently inundated. The proposed works will expose over 300 m of gully line that feed into the waterbody and will return sections of the gully back to its original state as an ephemeral creek line, potentially providing additional breeding habitat for the Southern Toadlet. Southern Toadlets were detected along the eastern gully line in 1981, 420 m from the current water extent. Although the habitat is still favourable for this species, impacts from feral deer were observed in the gully lines and it is recommended that this is managed irrespective of proposed changes to the reservoir water-level. Given the recent population declines and losses recorded for this species (Heatwole and Rowley 2018), it is recommended that targeted surveys are undertaken to determine if populations still persist at the NCR to ensure any potential impacts are mitigated.

3.3.2 Reptiles

The proposed works will have little impact on most of the reptile species recorded at Beaconsfield NCR as the surrounding habitat will not be disturbed. Reptile species commonly associated with watercourses include Swamp Skink, Tiger Snake and Red-bellied Black Snake, the elapid snakes because of their

predilection for frog prey (Shea et al. 1993, Aubret et al. 2006, Robertson and Coventry 2019). The diet of another elapid snake, the Lowland Copperhead, is also known to include a substantial proportion of frogs (Shine 1987). The only aquatic species recorded locally was the Eastern Long-necked Turtle and, being an opportunistic carnivore that primarily eat crustaceans, invertebrates and carrion (Chessman 1984), is typically captured in the shallower margins of wetlands (Howard et al. 2020). Given its capacity for overland migration it is likely to be recorded at the reservoir at some stage. Reductions in the water level are unlikely to impact this species.

The Swamp Skink, threatened in Victoria and categorised as Endangered under the *Flora and Fauna Guarantee Act* 1988, has been located at Cardinia Reservoir and also 3 km north west of Beaconsfield in 2017 (ALA). This species is restricted to swampy habitats that are often dominated by sedges, reeds or *Melaleuca* species (Chapple 2003, Robertson and Coventry 2019). These habitat types are represented at Beaconsfield NCR however, as stated in Mueck et al. (2002), the cover of overstorey vegetation may be too high as the forest closely abuts the reservoir edge. Riparian Scrub located at the end of the eastern arm of the reservoir is situated in a broader gully line with less canopy cover, providing more suitable habitat for Swamp Skinks. Reducing the water level may also extend the Riparian Scrub and provide additional habitat for this species.

Few terrestrial reptile species will be affected if the water level in the Beaconsfield Reservoir is lowered. Indeed, the few species that are associated with waterbodies and thus likely to be affected may benefit from (1) a likely increase in the abundance of frogs, due to a larger proportion of shallow water or damp gullies – that the resident frog assemblage is known to prefer, and (2) a potential increase in the availability of Swamp Skink habitat if water levels and fringing vegetation are managed appropriately. If the Beaconsfield Dam wall is lowered or modified then activities associated with this need to minimise any impacts to known taxa and, in particular, exclude or minimise disturbance to known and potential Swamp Skink habitat.

3.4 Fish, crayfish and mussels

Each of the fish, crayfish and mussel species occurring in the reservoir and surrounding catchment exhibit a general preference for shallow waters with abundant and diverse aquatic and terrestrial vegetation (Allen et al. 2002; Ault and White 1994; Woodward and Malone 2002; Schultz et al. 2009; McCormack 2012; Broadhurst et al. 2012). Fallen timber from terrestrial vegetation and the presence of aquatic vegetation provide refuge from predators, harbour prey items, and in the case of these native fish species (excluding eels), they are where females deposit their eggs (McCormack 2012; Humphries and Walker 2013). The diets of the local fish and crayfish populations are broad, including detritus (e.g. fallen leaves), algae, macrophytes, invertebrates, fish and fish eggs (Horwitz 1990; McDowall and Lagahetau 2001; McCormack 2012; Humphries and Walker 2013; Raadik 2014). Short-finned Eel are an exception, being predominantly carnivorous (Allen et al. 2002). So, vegetation provides habitat and supports important components of the food chain that are critical for all species and life-history stages.

Eastern Gambusia and Goldfish also occupy these habitats and compete with native species for resources (Hutchison 1991; Jones et al. 2008; Macdonald et al. 2012). Furthermore, Eastern Gambusia are highly aggressive and there is evidence that they negatively impact on several small-bodied, sedentary species such as Spotted Galaxias, Dwarf Galaxias, and Southern Pygmy Perch (Ault et al. 1994; Jones et al. 2008; Coleman et al. 2016). However, aquatic vegetation would help mediate these aggressive interactions (Ling 2004; Macdonald et al. 2012).

The proposed change in water height at Beaconsfield Reservoir is most likely to impact on fish, crayfish and freshwater mussels by changing the amount and distribution of shallow (< 1.5 m), vegetated edge habitat. While there are many other factors that may influence habitat suitability for each given species (e.g. physiochemical properties of the water, sediment type), these are not expected to change due to the proposed actions. While the reduction in water level will reduce the amount of this vegetated edge habitat, there will still be a large amount (11,300 m^2) in a continuous band around the reservoir. It is logical that a reduction in the amount of habitat will reduced the number of animals that can occupy it, but it is unknow how close to capacity current populations are. The worst-case scenario is that the species will persist in lower abundance relative to current levels due to density dependant processes, but there will still be sufficient habitat to support large numbers of each species that are easily sufficient to avoid the negative genetic implications of having small populations (e.g. Kriesner et al. 2020).

A further important consideration is the ability for these animals to move with the changing water line as the reservoir water level is reduced. If the rate at which the water level is lowered exceeds an aquatic animal's ability to move with it, they will become stranded leading to death. This would not pose a problem for fish and spiny crayfish that are highly mobile. However, fish eggs attached to vegetation would be impacted. In this instance, the galaxiids, River Blackfish, and Southern Pygmy Perch each spawn in vegetation and on woody debris during spring and would likely be affected (Allen et al. 2002). As such, water reductions during spring

that would completely expose aquatic vegetation and woody debris should be avoided. *Engaeus* spend most of their life underground in deep (> 1 m) burrows that intersect with the water table (Horwitz and Richardson 1986). While the lowering of the water height may change the current water table height surrounding the reservoir, the crayfish are still quite mobile and able to travel across land to relocate. Freshwater mussels have some ability to move horizontally to track changing water levels, but their response would be slow given they have no appendages (Lymbery et al. 2020). We anticipate a reduction of over months, rather than days, would allow for freshwater mussels to successfully migrate with the moving water line.

If the BNCR is to be opened to the public there is a serious risk that exotic species such as Carp (*Cyprinus carpio*), Roach (*Rutilis rutilis*), and trout will be illegally introduced for the purpose of recreational fishing. Such introductions would be to the detriment of the native species present, except the eels and mussels. In particular, the introduction of Rainbow Trout or Brown Trout (*Salmo trutta*) would likely eliminate any galaxiid populations present (Jones and Closs 2018; Lintermans et al. 2020). We propose three ways in which this risk can be reduced. First, educate the public on the natural values of the BNCR through the public consultation stages of this project and by placing informational signs around the BNCR on walking trails, at picnic grounds and other sites that are visible to the public. Second, restrict access to the reservoir to the daytime (i.e. by locking the gate) to deter illegal activities. Third, deter the introduction of exotic angling species (e.g. trout) by introducing a native fish put-and-take recreational fishery in conjunction with the Victoria Fisheries Authority.

3.5 Legislation and policy

3.5.1 Permitted Clearing Guidelines

Losses and gains in biodiversity values in a statewide context may be quantified using methods in the permitted clearing guidelines (DELWP 2017), including impacts to modelled threatened species habitats. This can be achieved by mapping the areas proposed to be impacted as well as areas which are likely to be gained (new areas covered by native vegetation). The net difference in parameters may assist in reporting the potential benefits to biodiversity by lowering the water level.

Planning permit requirements of Melbourne Water (e.g. Clause 52.17) or equivalent consideration for the proposed action have not been considered for this assessment, but should be undertaken for a detailed assessment.

3.5.2 Flora and Fauna Guarantee Act (FFG Act) 1988

The purpose of the FFG Act is to ‘establish a legal and administrative structure to enable and promote the conservation of Victoria's native flora and fauna and to provide for a choice of procedures which can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes’.

At least one FFG Act listed (Threatened) species of plant will be likely impacted by the proposed activity. However, the impact of the proposed activities on FFG listed fauna that may be present, is considered negligible. Impacts to protected flora will be required with consideration of generally protected flora (Section 46 of the FFG Act). Melbourne Water’s obligation under the Act will be determined by a public authority management agreement and in relation to the proposed activity. Melbourne Water must determine and document their obligations to consider potential biodiversity impacts under their public authority duty, Section 4B of the FFG Act.

3.5.3 Environment Protection and Biodiversity Conservation Act (EPBC Act) 1999

The EPBC Act provides for the listing, promotion, protection and management of matters of national environmental significance. This includes nationally listed species and communities.

The current assessment has not identified any EPBC Act listed plant species or ecological communities which have been previously recorded within the BNCR. Two plant species— Round-leaf Pomaderris and Green-striped Greenhood—have a medium likelihood of occurring based on suitability of habitats and an understanding of the current extent of occurrence for these species in Victoria. It is recommended that targeted searches are undertaken for these species within 20 m of the water edge and to within 100 m of riparian corridors (or other areas proposed to be impacted by the activity). If any EPBC Act listed species are located on site following further investigations, a decision must be made as to whether the proposed action will need to be referred to the Commonwealth. A referral may result in an action being determined a controlled action.

4 Conclusions and Recommendations

Based on the available data, there are no fundamental issues with the proposed activities at Beaconsfield Reservoir, but some species would likely be impacted, especially if the lowering of the water level occurs too quickly. The key to minimising potential disturbance to aquatic and semi-aquatic biota is to minimise the disturbance to aquatic and terrestrial vegetation that provides them with critical habitat. To achieve this, it is recommended that the draw-down be conducted over three years to allow the emergent and submerged vegetation around the edge of the reservoir to migrate with the changing waterline. A slow draw-down would also help prevent the establishment of terrestrial weed species that may impact on some amphibian and skink species.

The reduction in water-level will lead to a reduction in the overall amount of vegetated edge habitat that would intuitively reduce the carrying capacity of the reservoir for all species reliant on that vegetation. This may lead to an increase in density dependent processes such as predation and competition that would reduce the overall abundance of the resident species. However, it is beyond the scope of this report to say if this will happen and by how much. It is expected that there will still be a large, continuous ring of vegetation around the reservoir that would likely support sufficient numbers of animals to avoid negative genetic implications and reduced resilience associated with small populations. If density dependent processes were to place pressure on more mobile animals such as waterbirds, and to a lesser extent frogs, skinks and crayfish, they would be expected to relocate to nearby waterbodies. A general limitation of this report is the lack of detailed information on the species present in the BNCR. With all this in mind we make the following recommendations.

Overall:

1. Prior to commencing works, formal flora, waterbird and frogs surveys should be undertaken, including detailed mapping of EVCs and targeted surveys for species which are known or likely to occupy the site, particularly during breeding seasons or when seasonal peaks are expected. This will better inform an assessment of species that may be sensitive to degradation (flora) or habitat loss (fauna) due to a drop of water level, during earth works related to the wall, or if public amenities are developed around the BNCR. An assessment of the results of any further surveys should resolve and set out all legislative requirements relating to biodiversity, specifically in relation to the proposed activity.
2. Lowering the water level should occur over a minimum of three years. There is no reference standard for this practice, and consideration must be given to the ecological requirements of many species and communities. The three-year timeframe provides a precautionary approach and allows Melbourne Water to monitor the process and its effects on biodiversity.

Flora:

3. Undertake monitoring of impacts to flora:
    - Monitor the composition of recruiting vegetation on newly exposed earth, caused by lowering the water level.
    - Develop a design to monitor changes in native plant and weed cover-abundance over time, along a lateral gradient between the adjacent foothill vegetation and riparian zones. Changes in number of eucalypt recruits should also be included.
    - Monitor Riparian Scrub / Swampy Riparian Woodland areas for recruitment of Floodplain Fireweed and other threatened species.
    - Monitor tree canopy condition and cover using hemispherical photography or other suitable method.
4. Collect seed from Swamp Gum and Green Scentbark in the first year of lowering the water level. Store seed for propagation and use in revegetation where required.
5. Prior to any ancillary works (e.g. walking track installation), undertake spring targeted surveys for threatened species in Table 2 which are present or have a medium to high likelihood of occurrence. During the survey, map and record any new observations of threatened species (FFG Act and EPBC Act).
6. Control all woody weeds to negligible levels within 30 m of the current high-water level. Monitor for high threat aquatic weeds.
7. Repair the perimeter fence and undertake intensive deer control over the duration of lowering the water level (3–5 years) and maintain management of deer numbers. The management of deer is critical for the re-establishment and protection of native vegetation and for it to be resilient to climate and other pressures. If effective deer control is not possible, alternate measures should be taken to

protect new plants that have established long the changing waterline, such as placing guards around seedlings.

Herpetofauna:

8. If the wall is reduced, it should be assumed that frogs and skinks may be present in the rock wall and appropriate care taken when moving the rocks as part of the deconstruction.

Fish:

9. If BNCR is to be opened to the public undertake actions to reduce the likelihood of exotic fish species being introduced to the reservoir.

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