City of Stirling
City of Choice

Careniup Wetlands Reserve Management Plan

Revision	Date	Notes
0	August 2018	Public consultation
1	March 2019	Council
2	August 2019	Environment Advisory Group
3	January 2020	Council and Public Consultation
4	November 2020	Adopted by Council
5	May 2021	Final amendments as per Council resolutions

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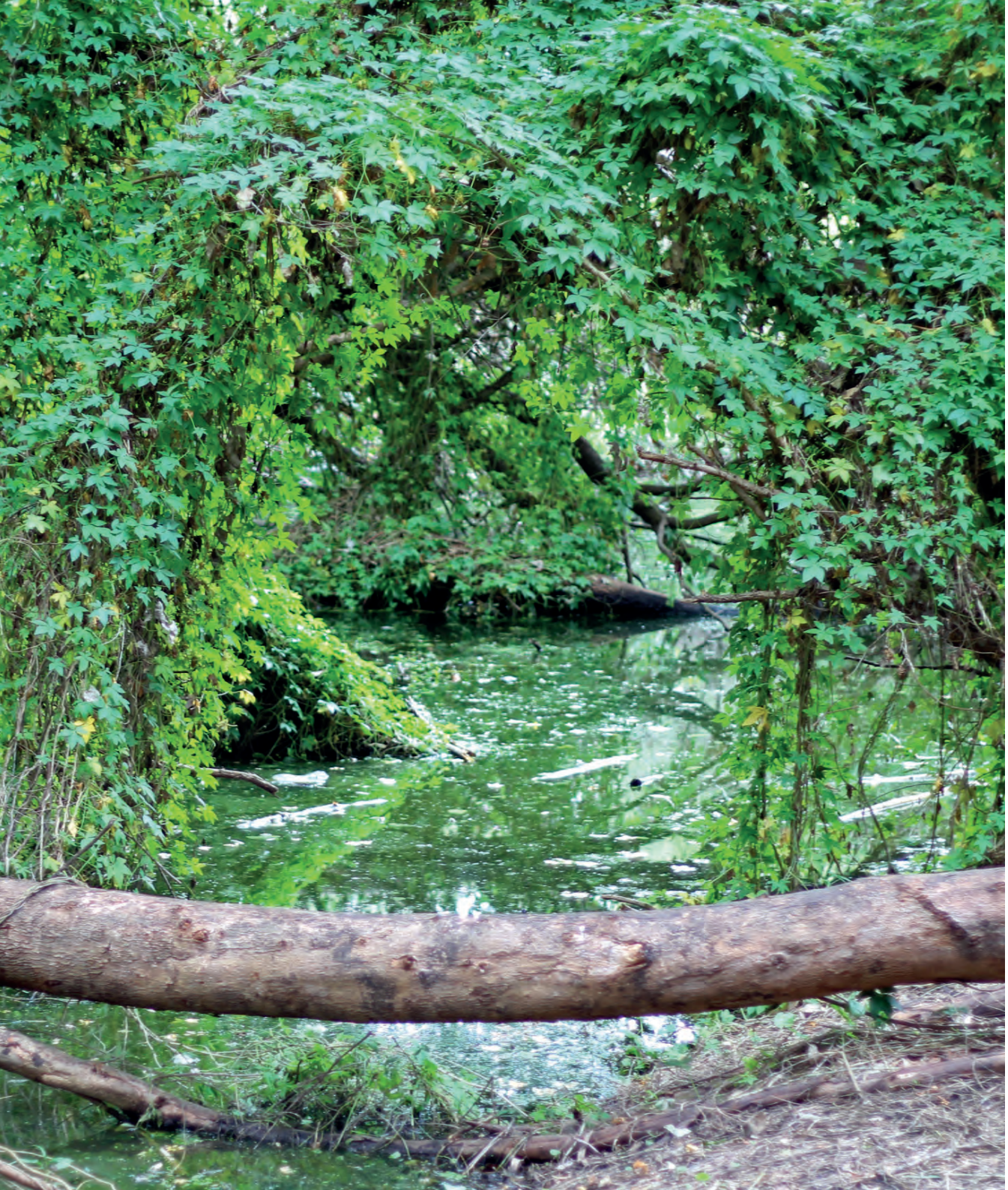

1 Introduction

1.1 Background

The area identified as Careniup Wetlands is a low-lying area within the suburb of Gwelup. Careniup Wetlands consists of a number of public open space land parcels that have been ceded to the City of Stirling over the past 25 years as individual developments have occurred.

To ensure the swamp is protected and public open space is ceded in a coordinated manner, the City's Local Planning Scheme No.3 (LPS3) identifies Careniup Wetlands as a Special Control Area. This forms the statutory backing for the formulation of a management plan for the public open space areas.

With the majority of adjacent land developed and a large portion of public open space now ceded to the City, this Management Plan has been prepared to ensure that a plan is in place to properly manage the environment into the future. This will also ensure that development of the required infrastructure is prioritised to meet the future recreational needs of the community.

1.2 Aims and Objectives

The aims of the Careniup Wetlands Reserve Management Plan are to:

- Maintain a healthy natural ecosystem within the Careniup Wetlands precinct
- Manage storm water from the surrounding catchment in accordance with best management practice standards
- Produce a network of parks, environmental experiences and amenities that will meet the local community's passive recreation needs into the future
- Produce an integrated pedestrian path network within the Careniup Wetlands precinct that connects with the broader neighbourhood path network
- Establish theme/s for an appropriate landscape character for the public open space areas in response to context, natural and cultural values and landscape management/maintenance requirements
- Develop a plan that balances conservation of the natural elements of Careniup Wetlands with the increase in recreational use of the reserve and drainage functions
- Utilise the City's resources effectively for future development and ongoing management works.

2 Planning

2.1 Planning Context

Documents, guidelines, policies and legislation relevant to the Careniup Wetlands area are outlined below.

2.1.1 Federal government

Weeds of National Significance

This is a joint initiative between the Australian, State and Territory governments to coordinate national efforts against Australia's worst invasive weed species as a part of the *Australian Weeds Strategy* (Department of Agriculture and Water Resources). A list of declared weeds was developed, according to each species' invasiveness, impacts, potential for spread, and socioeconomic and environmental impacts. Two weeds of national significance were identified in the flora survey (refer Flora Survey 4.2.2).

2.1.2 State government

Biosecurity and Agriculture Management Act 2007

The Act enforces the management of organisms identified on the Western Australian Organism List as being a declared pest. Organisms may be declared pests in particular regions and their category determines the management of the pest. Three declared pest weed species have been recorded in Careniup Wetlands (refer Flora Survey 4.2.2).

Environmental Protection Act 1986

This Act provides authority to the Environmental Protection Authority for the prevention, control and abatement of pollution and environmental harm and for the conservation, preservation, protection, enhancement and management of the environment in Western Australia. The Act requires environmental protection measures (particularly regarding acid sulfate soils) to be implemented during developments.

Contaminated Site Act 2003

The Act complements the Environmental Protection Act 1986 and requires known or suspected contaminated sites to be reported to the Department of Environmental Regulation. It includes a site classification system and a contaminated sites database which is publicly accessible. The public open space at Careniup Wetlands has two parcels of land listed on the contaminated sites register that are classified as *'remediated for restricted use'*.

Aboriginal Heritage Act 1972

The Aboriginal Heritage Act guides the protection and management of places of significance and maintains a Register of Aboriginal Sites. There are no Registered Aboriginal Sites within Careniup Wetlands. Given the major disturbance that has occurred in the Careniup Wetlands precinct and the lack of significant remnant vegetation, application of the risk assessment matrix within the Department of Aboriginal Affairs' due diligence guidelines indicated a low risk rating for places of significance.

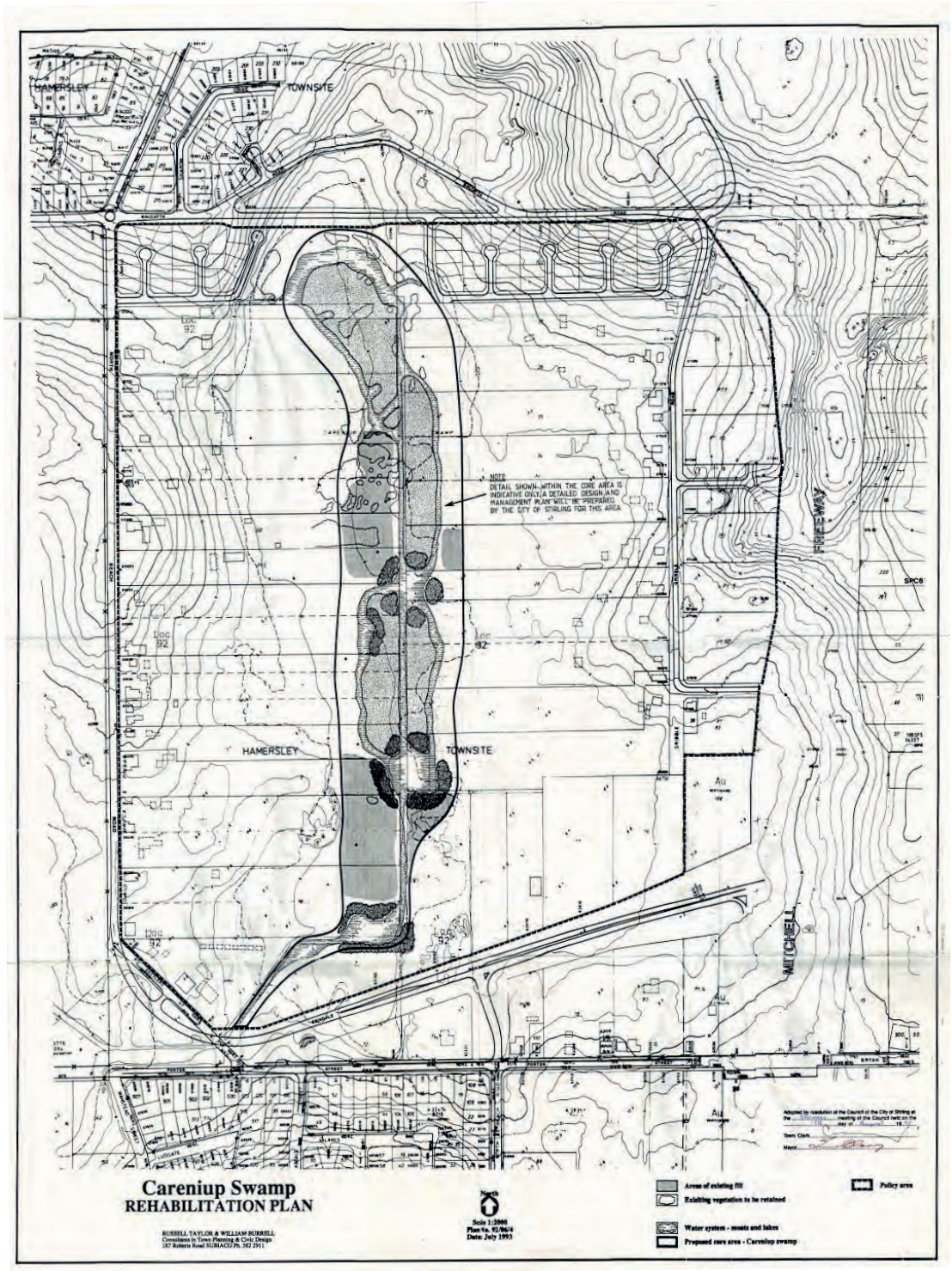

Figure 1: Careniup Swamp Rehabilitation Plan 1993 (endorsed by Council in 1995)

2.1.3 Local government

Local Planning Scheme 3

The planning scheme is the mechanism which protects Careniup Wetlands through its designation as a Special Control Area. It has shaped the reserve into its current form through the ceding of Special Control Area land as development of the surrounding properties has occurred. The Careniup Swamp Special Control Area conditions outline water quality standards, wildlife protection requirements and drainage functions.

2.2 Reserve History

The name 'Careniup' is thought to be an aboriginal name meaning "the place where bush kangaroos graze"[1].

In the early part of the 20th century, Careniup Wetlands was privately owned land, used primarily for market gardens. By 1937, it was reported that some areas previously used for market gardens were being inundated by the rising water table.

The early 1970's marked the commencement of a decrease in local water levels which continued for decades[2]. The land use adjusted and came to include residential, caravan park, equestrian centre, market garden and the storing and dumping of various materials.

The early use of the land as market gardens had resulted in broad scale clearing of the native wetlands vegetation and *Typha orientalis* (bulrush - an invasive weed), which was the dominant botanical species within the wetlands area by 1981 (refer image on page 15). By 1990, it was noted that a number of land owners had dumped imported fill into the swamp and some peat had been excavated[3].

With almost no remnant vegetation, Careniup Wetlands had a low conservation value. It was at this time that the potential of Careniup Wetlands as a unique area of public open space was recognised by the Environmental Protection Authority.

In July 1982, the Environmental Protection Authority endorsed the System 6 Study recommendations regarding Careniup Wetlands. These included protection of the wetlands in consultation with local land owners and identifying that the swamp area should be reserved as public open space[4]. It was generally acknowledged that residential development was not financially viable at that point in time, but also that the area had potential for future development.

In the early 1990s, the first residential subdivision occurred, which resulted in the creation of the northernmost portion of public open space adjacent to Balcatta Road. The City created an

1 City of Stirling and Curtin University Sustainability Policy Institute *Mooro Nyoongar Katitjin Bidi – Mooro People's Knowledge Trail* www.stirling.wa.gov.au accessed 24 June 2018

2 Environmental Protection Authority (1990) *Jenny Arnold's Perth Wetlands Resource Book – Chapter 8: Westlands of the Western Suburbs* https://library.dbca.wa.gov.au/ accessed 20 June 2018 p174

3 Environmental Protection Authority (1990) *Jenny Arnold's Perth Wetlands Resource Book – Chapter 8: Westlands of the Western Suburbs* https://library.dbca.wa.gov.au/ accessed 20 June 2018 p174

4 Department of Conservation and Environment (1983) *Conservation Reserves for Western Australia – The Darling System – System 6 Part II: Recommendations for Specific Localities* https://library.dbca.wa.gov.au/ accessed 20 June 2018 p177

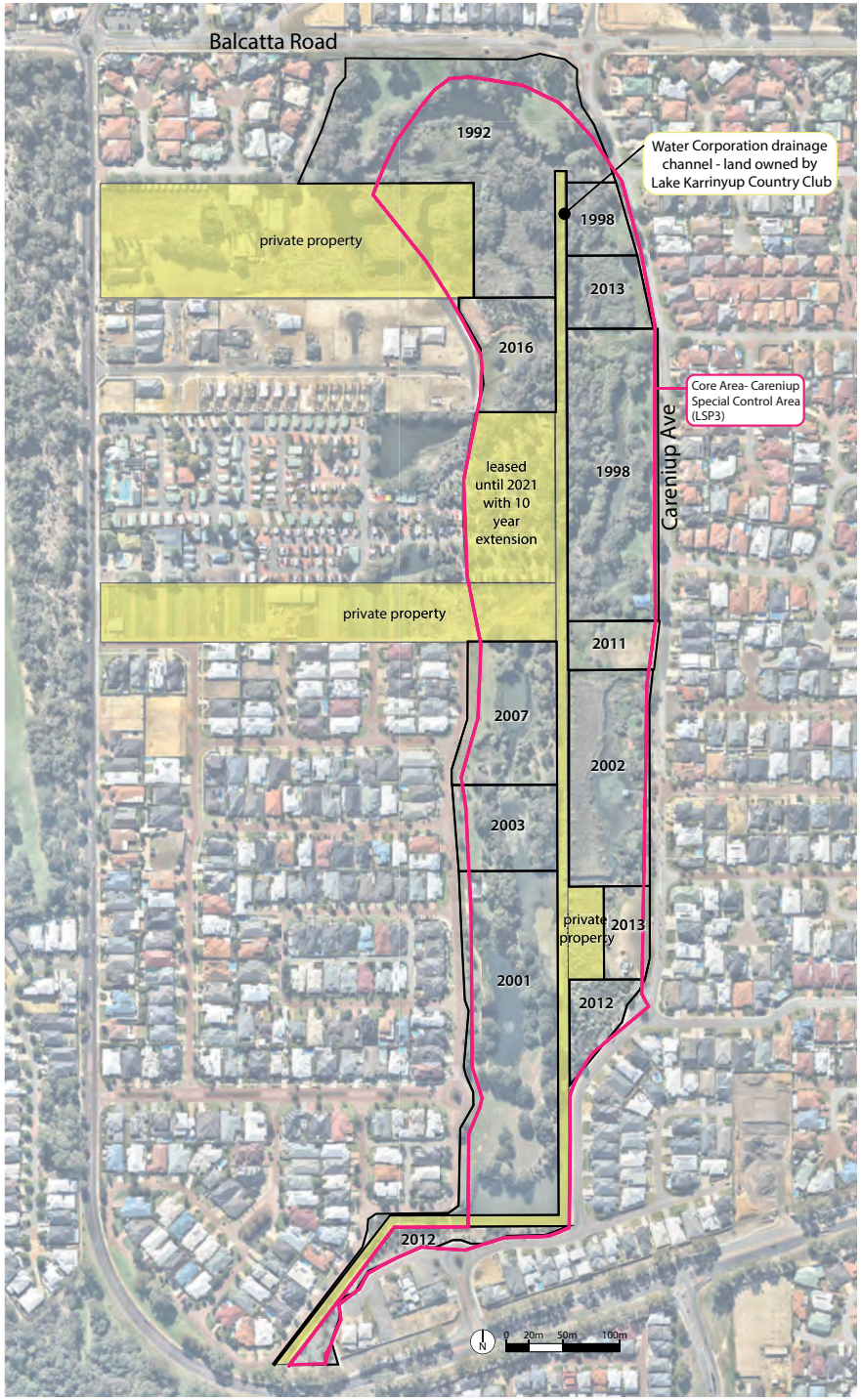

Figure 2: Public open space development at Careniup Swamp Reserve and private property within Careniup Swamp Special Control Area

indicative plan for the future development of the public open space (endorsed by Council in 1995 - refer Figure 1), which was included when the Careniup Swamp Special Control Area was created in 1996. The Special Control Area included provisions for the re-zoning from rural to residential and for the core wetlands area to be ceded to the City upon subdivision occurring.

Subsequent residential subdivision resulted in the ceding of public open space in a fragmented manner, with some land parcels being landscaped by developers and others being handed over undeveloped (refer Figure 2).

2.3 Land Tenure

Careniup Wetlands and the privately owned land within the Careniup Swamp Special Control Area consist of a number of land parcels with various owners (refer Figure 2).

563 North Beach Road

The drainage channel that bisects Careniup Wetlands is owned by Lake Karrinyup Country Club, with all management and maintenance undertaken by the Water Corporation.

Lot 15 Gribble Road

Lot 15 Gribble Road is a privately owned, land-locked parcel classified as public open space. It is entirely within the Careniup Swamp Special Control Area (Local Planning Scheme 3 stipulates that land within the Special Control Area shall be ceded to the City).

The land in question is surrounded by public open space and is dominated by weeds. The private ownership of the land will limit the City's ability to undertake weed management within the remainder of the wetlands, as the privately owned land will remain a source of weed seed.

467A North Beach Road

Karrinyup Waters Resort has ceded the required portion of their property within the Careniup Swamp Special Control Area. This area of land, which will become public open space, is currently leased back to Karrinyup Waters Resort to allow ongoing use as a caravan park. The lease expires in 2021 with the option of a 10-year extension available to the resort.

455 + 485 North Beach Road

The two remaining undeveloped lots along North Beach Road which extend into the Careniup Swamp Special Control Area are privately owned. Subdivision of these lots will require the land within the Careniup Swamp Special Control Area to be developed as public open space and ceded to the City.

2.4 Planning Recommendations

Number	Recommended Action	Details
2.1	Consider options to resolve land ownership issues of Lot 15 Gribble Road	To enable effective weed management across the reserve
2.2	Private land owners to cede land within Careniup Swamp Special Control Area as subdivision occurs	Public open space to be developed and ceded in accordance with relevant planning regulations and requirements

Careniup Swamp 10 December 1981: 'From caravan park looking north-east'

Environmental Protection Authority (1995) *File CT6/M38/1 Vol 1 Careniup Swamp Gwelup - Biological Data* https://library.dbca.wa.gov.au/static/TEB/TEB-CT6-123.pdf viewed 2 May 2018

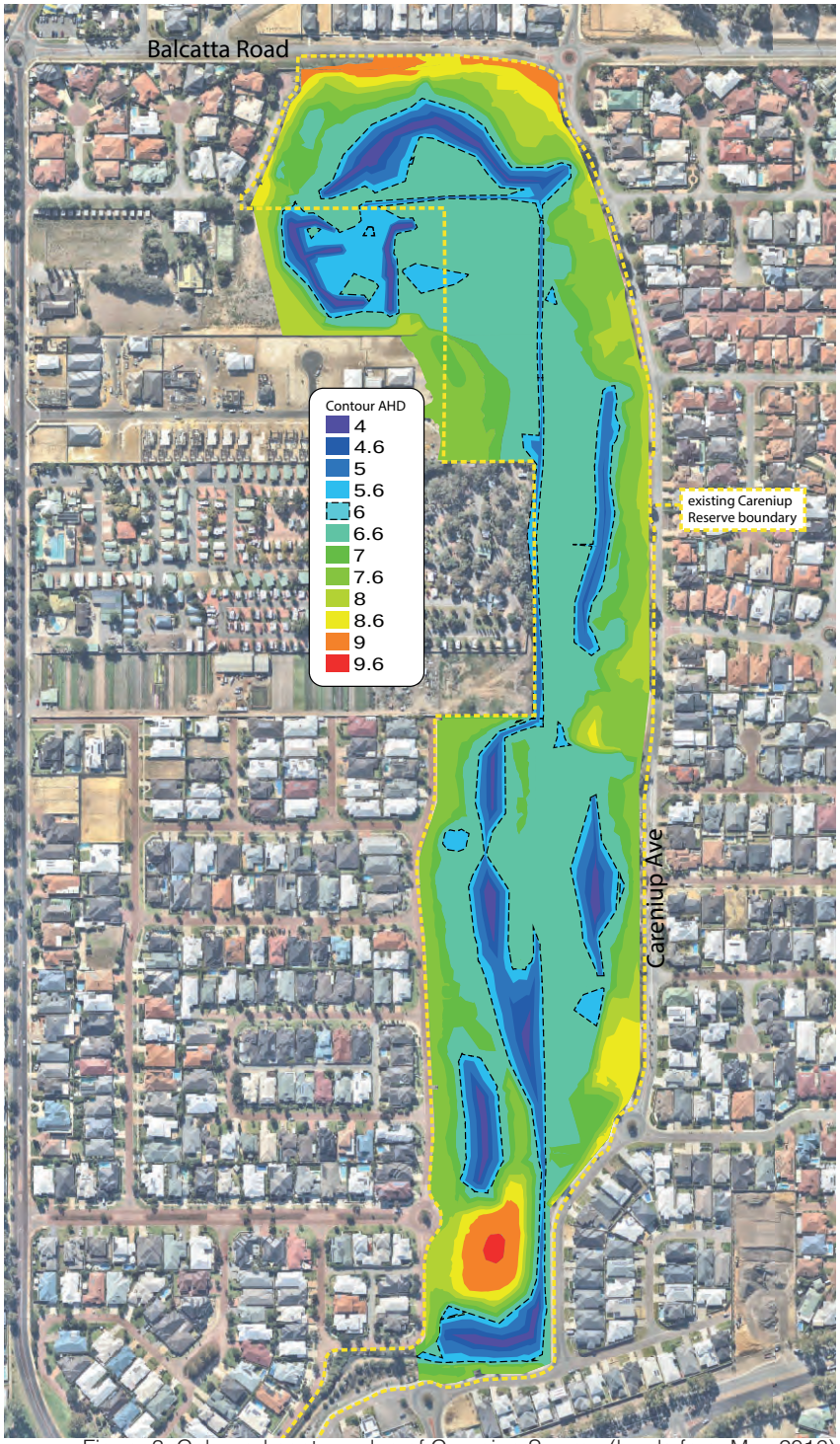

Figure 3: Coloured contour plan of Careniup Swamp (levels from May 2016)

3 Physical Environment

3.1 Landform

Careniup Wetlands is a naturally occurring low-lying area which is part of a north-south interdunal depression. The water body is a natural expression of the water table and is classified as a sumpland (seasonally inundated) basin[5] under the Department of Biodiversity, Conservation and Attractions (Parks and Wildlife Service) wetland classification system.

3.2 Linkages

The primary ecological linkage between Carine Regional Open Space and Lake Gwelup Regional Open Space is through North Beach Road and Lake Karrinyup Country Club[6]. The linkage supports upper, and middle-tier native vegetation which supports some bird, insect and animal movement. There is potential for Careniup Wetlands to act as a low-tier green belt and facilitate movement of amphibians between adjacent wetlands.

3.3 Climate

Perth is characterised by a Mediterranean climate with hot dry summers and mild wet winters. Rainfall for the past 10 years has been slightly down on the average, with the Perth weather station average yearly rainfall being 732mm and the average for the past 10 years being 703mm[7]. However, this variance would not be considered statistically significant.

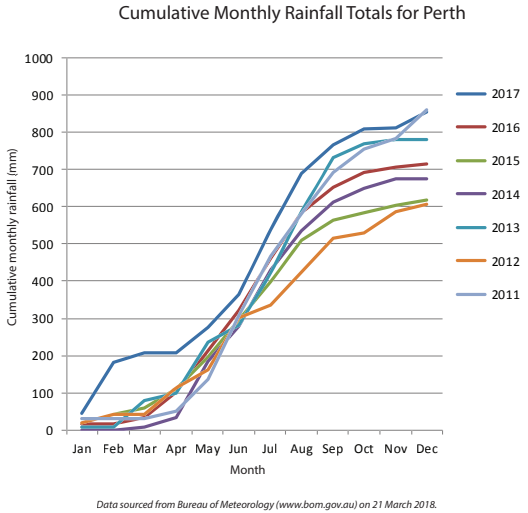

Figure 4: Cumulative monthly rainfall totals for Perth 2011-2017

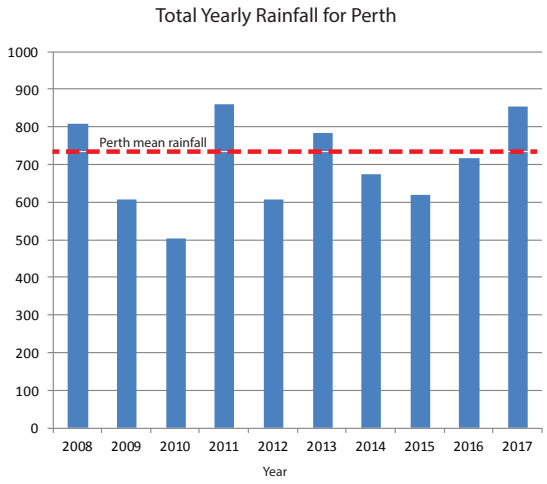

Figure 5: Total yearly rainfall for Perth 2008-2017

5 Department of Biodiversity, Conservation and Attractions *Geomorphic Wetlands, Swan Coastal Plain (DBCA-019)* https://maps.slip.wa.gov.au/landgate accessed 6 Sept 2017

6 City of Stirling (2002) *Green Plan 2 (A Strategy for the Conservation of Urban Bushlands to Promote Biodoversity)* www.stirling.wa.gov.au Section 5.9, Department of Parks and Reserves

7 Bureau of Meteorology *Climate Data Online – Monthly Rainfall Perth Metro* http://www.bom.gov.au/jsp/ncc/cdio/weatherData accessed 26 March 2018

Figure 6: Remediated sites within Careniup Swamp

3.4 Soils

Soils consist primarily of peaty clay (soil type 211Sp Cps) with sand (soil type 211Sp S7) in the periphery upland areas[8]. The swamp bed is reported to have peat deposits greater than three metres deep[9].

3.4.1 Remediated sites

Uncontrolled fill, possibly contaminated with asbestos-containing material, was used in the development of public open space during Stage 1 and Stage 2 construction of the 'Erindale Grove' estate. Two parcels of public open space developed in association with the estate have been levelled using the uncontrolled fill and were registered as contaminated sites in January 2012[10]. The sites are now classed as 'remediated for restricted use' and are determined to be suitable for use as public open space (refer Figure 6). The Department of Water and Environmental Regulation specifies that "a health and safety plan should be in place prior to any excavation below 0.1m on the site to mitigate potential human health risk from potential buried asbestos containing materials"[11]. While public health risk is minimal, fencing the sites to demarcate the extent for City officers is proposed.

3.4.2 Acid sulfate soils

Careniup Wetlands Reserve is identified as a Class 1 (high to moderate risk) area for acid sulfate soils[12]. Acid sulfate soils are naturally occurring soils that contain iron sulfides which are benign when waterlogged. When the soils are exposed to oxygen, the reaction with oxygen can produce sulfuric acid.

The peaty clay soil type that occurs across the majority of Careniup Wetlands is a potential acid sulfate soil type. Water quality testing undertaken by the City over the past 10 years has shown the pH levels in the wetlands to be consistently neutral (pH 7.5-8.1) and levels of heavy metals have been within acceptable ranges[13]. There are likely no immediate acid sulfate soil issues.

The Department of Water and Environmental Regulation requires an Acid Sulfate Soils Self-Assessment form to be submitted for developments. If there are any dewatering or drainage works proposed, or excavation of over 100m^3 of soil, an acid sulfate soils investigation will be required[14].

8 Department of Agriculture and Water Resources *Soil Landscape Mapping – Best Available (DPIRD-027)* https://maps.slip.wa.gov.au/landgate/locate/ Version 05.01 viewed 28 March 2018

9 Environmental Protection Authority (1990) *Jenny Arnold's Perth Wetlands Resource Book – Chapter 8: Westlands of the Western Suburbs* https://library.dbca.wa.gov.au/ accessed 20 June 2018 p174

10 Department of Water and Environmental Regulation *Contaminated Sites Database* Parcel Id 44138 and 44139 dow.maps.arcgis.com viewed 28 March 2018

11 Department of Water and Environmental Regulation *Contaminated Sites Act 2003 Basic Summary of Records Search Response* Lot 464 Plan 67672 www.secure.dec.wa.gov.au viewed 28 March 2018

12 Department of Environment Regulation *Acid Sulphate Soil Risk Map, Swan Coastal Plain (DWER-055)* https://maps.slip.wa.gov.au/landgate/locate/ viewed 29 March 2018

13 Department of Environment Regulation (2015) *Identification of Acid Sulfate Soils and Acidic Landscapes* 3.4 Groundwater analysis as indicators of ASS p20

14 Department of Environment Regulation (2015) *Identification of Acid Sulfate Soils and Acidic Landscapes* Table 2. Classification scheme for acid sulfate soil risk maps p14

3.5 Hydrology

3.5.1 Public Drinking Water Source protection

Careniup Wetlands is within the Gwelup Underground Water Pollution Control Area which is gazetted as a Public Drinking Water Source Area[15]. The area is classified as Priority 3, which aims to manage risk in high intensity urban areas[16]. Some protection elements may include implementing best management practices regarding potential acid sulfate soil management.

3.5.2 Groundwater levels

The Department of Water is currently implementing the Gnangara Sustainability Strategy, which takes a strategic approach to managing water allocation and aims to protect wetlands and groundwater-dependent ecosystems[17]. The groundwater levels within the Gnangara Mound had declined significantly and the Department of Water have been implementing various strategies which, in some areas, have resulted in increased groundwater levels[18].

One strategy implemented by the Department is the review of drinking water abstraction allocations that impact on wetlands. One such site was Lake Gwelup, where superficial aquifer abstraction was reduced and water levels at the lake have recovered[19]. Lake Gwelup reached capacity in 2015 for the first time since the mid 1990's and overflowed again in 2016. Appendix 1 illustrates the Gnangara Mound groundwater levels at a monitoring bore located due east of Careniup Wetlands Reserve (Gribble Road), which declined significantly in 2000-2001. The groundwater levels returned to higher levels in 2012-13, when it is assumed abstraction of groundwater by the Department of Water was reduced as a part of the *Gnangara Groundwater Areas Allocation Plan*.

3.5.3 Wetland water levels

Water levels within Careniup Wetlands are governed by the inlet/outlet levels at either end of the Water Corporation drainage channel. The wetlands receive storm water from the adjacent residential areas via several City drains, and also from the wider catchment through the Water Corporation channel. The southern inlet/outlet acts as an outlet for the majority of the year. The water within the wetland during summer flows out of this outlet and creates a slow southerly water movement to the lakes at Karrinyup Country Club. During periods of high rainfall, the Water Corporation drain brings water from Lake Gwelup and Karrinyup Country Club lakes when they overflow, and the northern weir acts as an overflow/outlet to Big Carine Lake to the north. A pump station within Carine Regional Open Space is able to send excess storm water from Big Carine Lake to the ocean outfall.

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15 Department of Environmental Regulation (2017) *Water Quality Protection Note No. 75 – Gazetted Pubic Drinking Water Source Areas* www.water.wa.gov.au Table 1: 'List of gazetted public drinking water source areas' accessed 3 April 2018

16 Department of Water (2016) *Water Quality Protection Note No. 25 – Land Use Compatibility Tables for Public Drinking Water Source Areas* www.water.wa.gov.au p3 accessed 3 April 2018

17 Department of Water (2009) *Gnangara Groundwater Areas Allocation Plan* www.water.wa.gov.au pxi accessed 3 April 2018

18 Department of Water (2015) *Gnangara Groundwater Areas Allocation Plan – Evaluation Statement 2011-2014* www.water.wa.gov.au p1 viewed 29 March 2018

19 Department of Water (2015) *Gnangara Groundwater Areas Allocation Plan – Evaluation Statement 2011-2014* www.water.wa.gov.au p3 viewed 29 March 2018

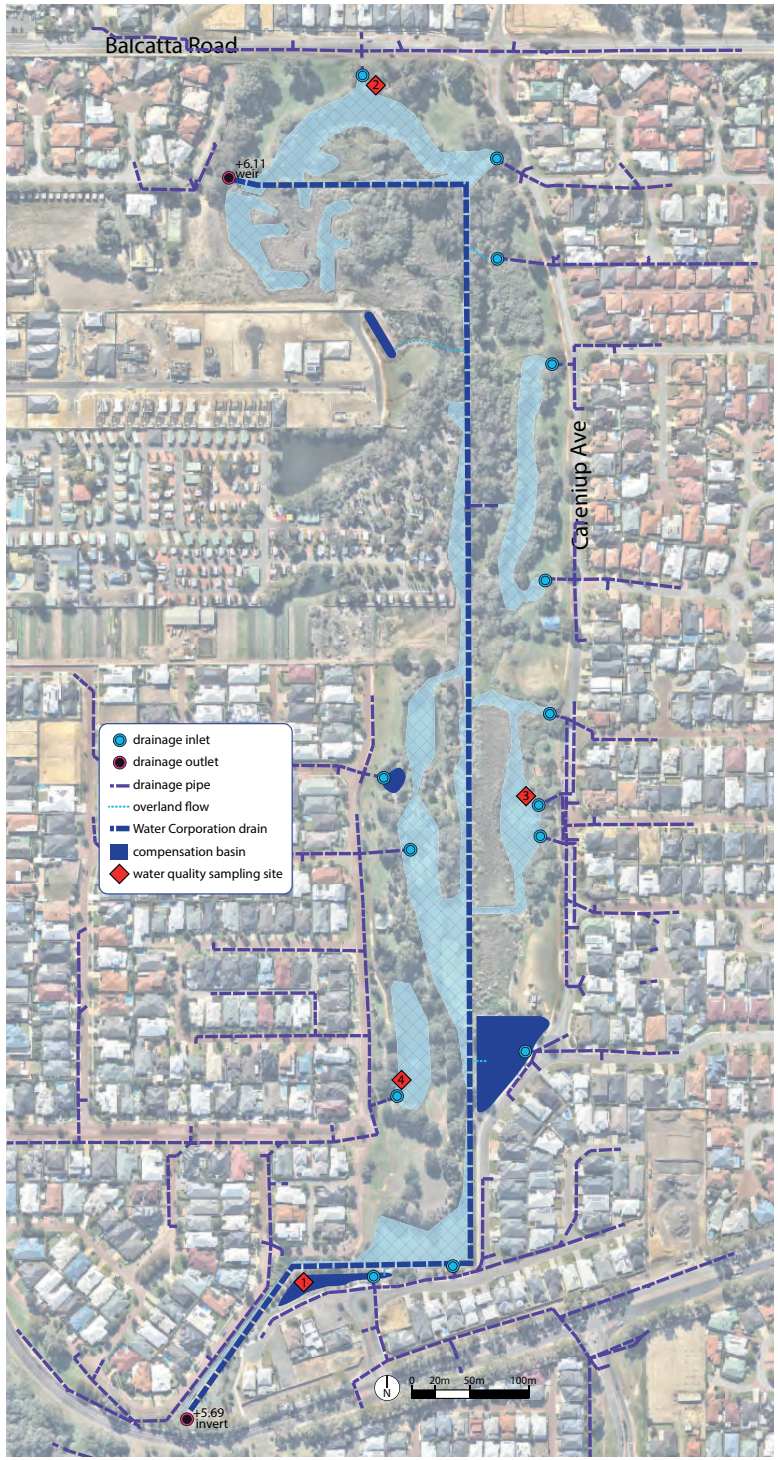

Figure 7: Drainage infrastructure and water quality testing locations

With the reduction in ground water abstraction and predetermined capacity of Careniup Wetlands, water levels in the past few years have been relatively consistent, with minor seasonal fluctuation of around 300mm (refer Appendix 1).

3.5.4 Drainage

Careniup Wetlands acts as a detention basin for the local storm water catchment. Storm water from the residential developments adjacent to Careniup Wetlands Reserve drains into the wetland via sediment traps, infiltration basins, swales and traditional pipe inlets (refer Figure 7).

With the recent increase in wetland water levels (refer Section 3.5.3) and the overflow of Lake Gwelup, there were issues with water movement within Careniup Wetlands. In recent years, there have been some instances of ground water expression within some residential lots, and large areas of Careniup Wetland were inundated for extended periods.

The City prioritised the design and installation of a subsoil drainage system and deepening of a key storm water inlet channel connection. This assisted water egress from the portion of the catchment that serviced residential lots that were subjected to groundwater expression. This work was completed in April 2017, around the same time that the Water Corporation cleared out sediment from the main drainage channel. Both of these measures have improved water flow. Monitoring of water levels is ongoing.

3.5.5 Outlet weir level

The northern drainage outlet near Carslake Grove is a brick structure that is a Water Corporation asset. It has a timber board that is able to regulate the flow into the outlet by raising it or leaving it in place. Left in place, it increases the height of the weir level by 0.23m. This height increase is enough to create inundation to a large portion of the reserve

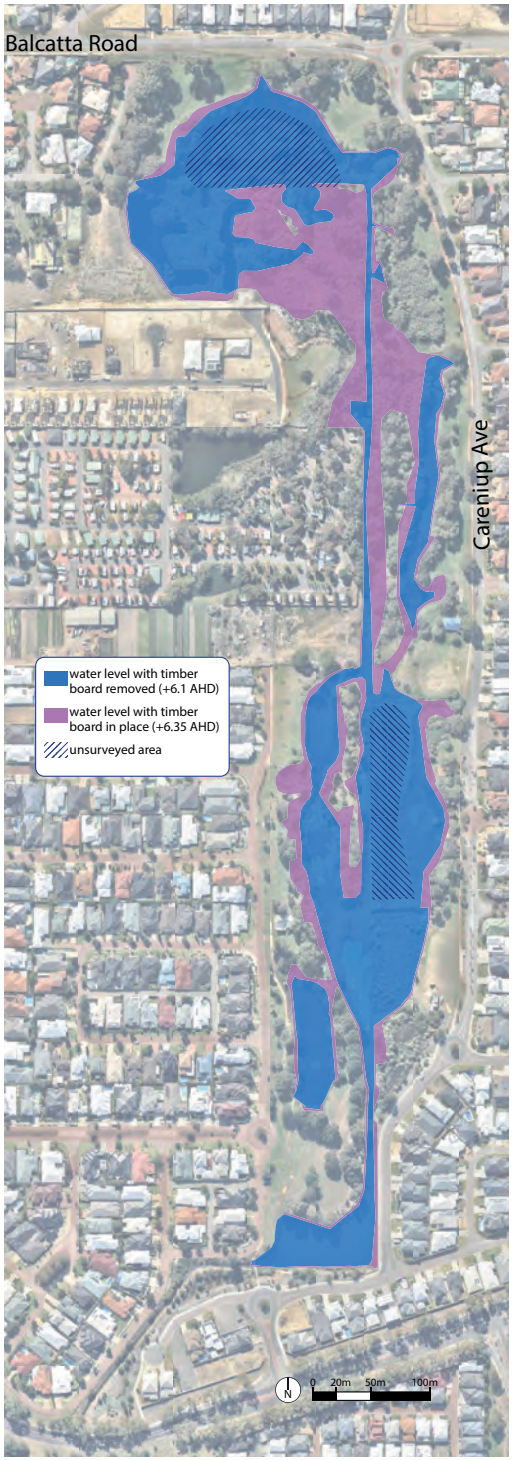

Figure 8: Inundation within Careniup Swamp

Drainage outlet adjacent to Carslake Grove that takes overflow water to Big Carine Swamp

Education program in Taupo, New Zealand

(refer Figure 8), including nearly all of the Secret Garden area. Extended periods of inundation create anaerobic conditions which can result in the decline of some plant species, including the morning glory within the Secret Garden.

The City's *Local Planning Scheme No. 3* specifies that "the lake be designed on the basis that the area has a maximum water level of RL 7.0 metres AHD and a minimum water level of RL 6.3 metres AHD"[20]. These levels were specified prior to subdivision development occurring and it is recommended that an investigation be undertaken to ascertain if these levels remain consistent with good management of the wetlands now that the bulk of the surrounding residential areas have been developed.

3.5.6 Water quality

Testing for water quality has been undertaken at Careniup Wetlands Reserve since 2006. Water quality testing is undertaken to establish base-line data and determine when further investigation is needed.

Test results are compared to the Australia New Zealand Environmental and Conservation Council guidelines for aquatic ecosystems. The guidelines aim "to maintain and enhance the 'ecological integrity' of freshwater and marine ecosystems, including biological diversity, relative abundance and ecological processes"[21]. The guidelines include 'trigger values' for various toxicants which, if exceeded, may initiate further investigation[22]. Results have been largely below the trigger values for aquatic ecosystems with the exception of aluminium, zinc and suspended solids. These elements have, on occasion, gone above the trigger levels at times attributable to events within the storm water catchment. Events that have affected water quality testing levels include subdivision development, low rainfall, high rainfall and overflow from other wetlands. The toxicity of some heavy metals, for example aluminium, is reduced in environments with neutral pH and where complexing agents, such as humic substances, are present[23]. At this stage, there are no ongoing water quality issues at Careniup. Water quality testing and monitoring of results is ongoing.

Catchment nutrient load

While nutrient levels within Careniup Wetlands are not currently excessive, it would be advantageous to be proactive regarding pollutants and nutrient input from local storm water. With the residential population within the storm water catchment increasing and further development still to occur, it is recommended that education of local residents becomes a priority to prevent pollution of Careniup Wetlands Reserve.

The education program shall include information on the following:

- The storm water system

20 City of Stirling (2017) *Local Planning Scheme No.3 – Scheme Text* part 6.2.5, p3

21 Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The Guidelines* www.agriculture.gov.au/water p3.1-2 viewed 29 March 2018

22 Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) *Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems* www.agriculture.gov.au/water p8.3-2 viewed 29 March 2018

23 Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (2000) *Australian and New Zealand guidelines for fresh and marine water quality. Volume 2, Aquatic ecosystems* www.agriculture.gov.au/water p8.3-103 viewed 29 March 2018

- The movement of refuse from street storm water drains into the conservation area
- Pollution and impacts of pollutants on conservation areas
- Methods to minimise nutrient runoff
- Minimisation of other pollutants that end up in storm water, eg, grass clippings.

Some education measures implemented by other government authorities have included installation of signage on storm water grates and gullies to remind residents of their close proximity to and potential negative impact on a sensitive conservation area.

3.5.7 Irrigation

There are three City of Stirling groundwater bores that service Careniup Wetlands Reserve for irrigation purposes. As the wetlands are within the Gwelup groundwater area, the amount of water that can be extracted via the City bores is at capacity for this area.

Irrigation at the reserve is currently prioritised to the areas of turf on the periphery of the wetlands. Some landscape garden beds that were installed with estate developments (eg, The Willows) were irrigated for establishment. The majority of these areas (including the island adjacent to The Willows) have already had this irrigation decommissioned. Landscape planted areas that are proposed to be converted to conservation planting will also have their irrigation decommissioned.

There is an area of scheme water irrigation that was installed when the Erindale Grove subdivision was constructed. The area irrigated includes trees and landscape within the reserve along Hanlin Court and Grimwood Avenue. This irrigation is proposed to be decommissioned.

3.6 Physical Environment Recommendations

Recommended actions from physical environment issues are as follows:

Number	Recommended Action	Details
3.1	Install fencing to remediated sites	Bushland fencing to be installed to remediated sites on Hanlin Court and Careniup Ave (near Jodrell Rd)
3.2	Comply with Department of Water and Environmental Regulation requirements for potential acid sulfate soil locations	Any dewatering or drainage works proposed or excavation of over 100m^3 of soil will require an acid sulfate soils investigation
3.3	Continue monitoring of water levels at Careniup Wetlands Reserve	
3.4	Continue monitoring water quality at Careniup Wetlands Reserve	
3.5	Liaise with Water Corporation regarding weir level adjustment	
3.6	Investigate whether Careniup Special Control Area provisions should be reviewed	When Local Planning Scheme 3 is reviewed, give consideration to whether the provisions at Careniup should be reviewed
3.7	Develop and implement education campaign	Provide educational material to residents on environmental issues associated with living near a conservation area
3.8	Decommission irrigation to landscape planted areas in conjunction with landscape works	Decommission irrigation to landscape planted areas as they are converted to conservation planting

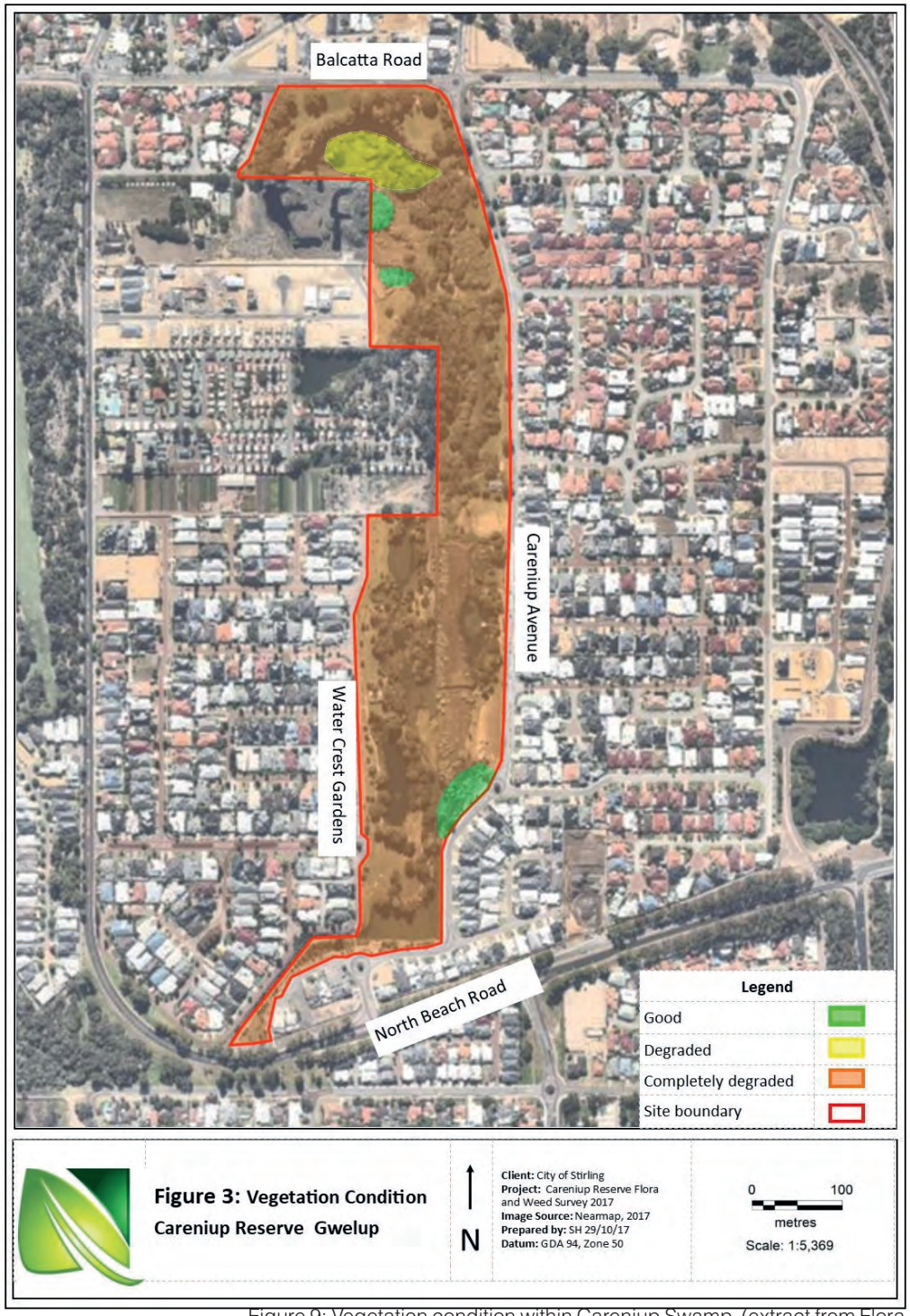

Figure 9: Vegetation condition within Careniup Swamp (extract from Flora Survey and Weed Mapping Report - Appendix 2)

4 Biological Environment

4.1 Protection

There are no 'Threatened Ecological Communities' or 'Priority Ecological Communities' identified within Careniup Wetlands Reserve. The site is not listed as 'Bush Forever'.

4.2 Vegetation

4.2.1 Native vegetation condition

Vegetation condition mapping was undertaken by Natural Area Consulting Management Services using the assessment criteria developed by Keighery[24]. Vegetation condition is a measurement of degradation of the natural vegetation complexes.

Previous land use and significant land modification have rendered much of the natural vegetation 'completely degraded' or 'cleared parkland' (93 per cent) with pockets of 'degraded' (3 per cent) and 'good' (3 per cent) vegetation (refer Figure 16). The areas rated 'good' include recently revegetated areas and the melaleuca grove within the Secret Garden. The island north of the Secret Garden was the only area that was rated as 'degraded'.

4.2.2 Flora survey

Vegetation types

Three vegetation types were identified within Careniup Wetlands Reserve. They are:

- *Typha orientalis* grassland associated with pampas grass (*Cortaderia selloana*)
- *Arundo donax* (giant reed) grassland
- *Melaleuca rhaphiophylla* and *Eucalyptus rudis* woodland over a weedy understorey.

Native species

One hundred and seventeen species were identified during the flora survey, including 34 native species (refer Appendix 2). No rare or protected species (in accordance with the Wildlife Conservation Act 1950 and Environment Protection and Biodiversity Conservation Act 1999) were identified.

Non-native species

Eighty-three species identified were not indigenous to Careniup Wetlands. This result is not unexpected given the parkland areas, which have been landscaped without a focus on local native species. 27 species have been identified as weed species, including 11 that are a very high priority.

24 Keighery, B.J. (1994) *Bushland Plant Survey - A Guide to Plant Community Survey for the Community* Wildflower Society of Western Australia

Pampas grass along the eastern edge of the main drainage channel

Pencil willows within Secret Garden area and eastern edge of bulrush smothered by morning glory

Two 'Weeds of National Significance' were recorded, which are blackberry (*Rubus laudatus*) and pencil willow (*Salix humboldtiana*). There is a significant population of blackberry at Careniup Wetlands which is rapidly proliferating and will be treated as a priority for removal. Blackberry, arum lily and one-leaf cape tulip are listed as declared pests on the Western Australian Organism List within the *Biosecurity and Agriculture Management Act 2007*. As the Blackberry is listed under the C1, C2 and C3 lists, it should be excluded and eradicated. Arum Lily (*Zantedeschia aethiopica*) and One-leaf Cape Tulip (*Moraea flaccida*) were also found within the wetlands. They are classed as C3 pests and require management to alleviate harmful impacts, reduce numbers, and contain their spread. The control of these weeds is addressed in the Weed Treatment Strategy (Appendix 3).

There are large areas of landscape planting adjacent to conservation areas throughout the Wetlands Reserve. The street frontage presents as landscape planting which blends into conservation planting. This presents maintenance issues, as landscape planting requires higher maintenance than conservation planting. There is also potential for landscape species to spread into conservation areas. It is recommended that landscape planting adjacent to conservation areas be incrementally replaced with conservation planting.

4.2.3 Culturally significant non-native vegetation

The non-native species at Careniup Wetlands are varied and unique. With the largely disturbed nature of the reserve, a number of environments have been created that have significance with the local and wider community.

Pencil willows (Salix humboldtiana 'Pyramidalis')

The planting of pencil willows was undertaken by previous land owners. The pencil willows are planted predominantly in two locations. The southern group of willows are what 'The Willows' subdivision development was named after. These line the edge of the Water Corporation channel and should be retained but restricted from spreading any further.

The other group at the northern end of the wetlands are a mature grouping planted by the previous land owner and are within the Secret Garden area. This group should be contained to the Secret Garden area.

Secret Garden area

The area commonly referred to as the 'Secret Garden' consists of an area referred to as the reed garden, and the main secret garden. The Reed Garden consists of *Arundo donax* (giant reed) grassland. The main Secret Garden area consists of *Eucalyptus rudis* (flooded gum) woodland with an under storey of *Ipomoea cairica* (morning glory) and *Typha orientalis* (bulrush). The bulrush has gradually been encroaching into the morning-glory-dominated areas of the Secret Garden to the north and the morning glory has been expanding into the bulrush areas in the south-east (refer image opposite). It is proposed to supplement the Eucalypts on site with succession planting of native species and eradicate the introduced species. Given the impact on existing trees within the area and lack of infrastructure to support the popularity of the secret garden, the area will be rehabilitated to a native landscape over the coming years. This will include removal of environmental pest species.

November 2014

May 2018

Changes within the Secret Garden from 2014-2018

Aythya australis (hardhead)

Tadorna tadornoides (mountain duck)

Chenonetta jubatta (wood duck)

Zosterops lateralis (silver eye)

Egretta alba (great egret)

Litoria moorei (motorbike frog)

Gallinula tenebrosa (dusky moorhen)

Notechis scutatus (tiger snake)

4.3 Fauna

4.3.1 Native

An inventory of native fauna likely to occur at Careniup Wetlands Reserve is listed in Appendix 4. This species list has been developed from review of the Lake Gwelup Management Plan (2015) and Carine ROS Environmental Management Plan (2010) in combination with input from City of Stirling Conservation Officers. In addition to this list, local residents have reported the presence of long-necked turtles within Careniup Wetlands. None of the species in the Careniup Swamp Native Fauna Inventory are protected via legislation. The great egret (*Egretta alba*) was previously listed as 'migratory' under the *Environment Protection and Biodiversity Conservation Act 1999,* but was removed from this list in 2016[25].

Due to previous land uses, the fragmented nature of the conservation reserve and the surrounding residential development, no native mammals of any significance are thought to be present at Careniup Wetlands.

Turtles

Local residents have reported that a turtle population exists at Careniup Wetlands Reserve. The turtle species likely to occur at this reserve is the long-neck or oblong turtle (*Chelodina colliei*). Turtles need soft, dry ground to lay their eggs and will often cross roads and lay eggs in residents' garden beds. At other reserves, soft mulch planting areas have been installed adjacent to roads to provide turtles with a softer egg-laying area. This approach within public open space areas has proven to be successful. The narrow, linear layout of Careniup does not provide many opportunities to implement this initiative, however some additional planting areas have been incorporated at the northern end of the reserve (refer to the Development Plan).

4.3.2 Non-native

Dogs

The recreational and health benefits of dog ownership are widely acknowledged. Careniup Wetlands provides many interesting environments that can be enjoyed by dogs and their owners. While dog control has not been a significant issue at Careniup Wetlands Reserve to date, issues that have become prevalent at other reserves include:

- Dog excrement not being picked up
- Vegetation damage from uncontrolled dog access in natural areas, resulting in degraded areas prone to weed invasion
- Disturbance and trampling of revegetation plantings
- Disturbance of water bird habitat

25 Commonwealth of Australia (2016) *Amendment to the list of migratory species under section 209 of the Environment Protection and Biodiversity Conservation Act 1999* https://www.legislation.gov.au/Details/F2016L01009 accessed 3 April 2018

the native swamp hen (Porphyrio chordata)

- Attacks and harassment of wildlife.

In addition to the impacts on other reserve users and the environment outlined above, dogs themselves are at risk of snake bites when forays into bush areas occur.

Careniup Wetlands does not have large areas of parkland clearly separated from conservation areas. The City's *Dog Exercise Areas Policy* aims to promote active recreation areas for use by dogs and their handlers while not negatively impacting on the community or the environment. In addition, it outlines that dogs are prohibited from being "within the high water mark, bed or water body of a lake, pond, river, creek, stream or water channel on City property"[26].

The City-managed land that currently makes up Careniup Wetlands Reserve consists of less than 35 per cent open grass parkland with the remaining land being conservation/natural area or special use (eg, the Secret Garden). With the future increase in residential density and conservation values of the reserve in mind, it is recommended that Careniup Wetlands Reserve be made an on-leash dog exercise area.

Local residents that wish to exercise their dogs off leash will have the option to use the future reserve on the corner of Balcatta Rd and Besty Entrance, diagonally opposite from Careniup Wetlands Reserve.

Cats

The Reserve is also likely to be frequented by domestic cats, which hunt and often prey on native animals, particularly birds, lizards and frogs. Other conservation reserves within the City are afforded protection from cats through their designation as a 'cat prohibited area' under the *Keeping and Control of Cats Local Law 1999*. It is recommended that Careniup Wetlands Reserve also be added as a cat prohibited area.

4.3.3 Pest control

Mosquitoes

The City investigates complaints regarding mosquitoes as they are received. To date, mosquitoes have not been identified as a significant issue at Careniup Wetlands. The City undertakes monitoring of areas prone to mosquito breeding and considers management measures accordingly. Within conservation areas, biological control such as larvae predation by frogs, fish and other insects is usually sufficient to control populations. Mosquitoes are a natural part of the Careniup Wetlands ecosystem and provide an important link in the environmental food chain.

26 City of Stirling *Dogs Exercise Areas Policy (2014)* www.stirling.wa.gov.au

Pest fish species

The introduction of exotic and aquarium fish species into the City's water bodies has been an issue at a number of wetlands reserves across the City. In 2012, an investigation into introduced fish in Perth wetlands found that the presence of introduced fish species occurred in over 80 per cent of Perth local lakes[27]. The exotic mosquito fish (*Gambusia holbrooki*) is known to be present at Careniup Wetlands Reserve but removing the species is not currently a priority for the City, given the cost of eradicating the species and the possibility of reintroduction from Lake Gwelup (where it is also present).

A public education campaign regarding disposing of unwanted pet fish responsibly and reporting suspected pests is recommended.

4.4 Fire

The Department of Fire and Emergency Services produces a map of bush fire prone areas which is updated annually. It identifies areas that are subject to or likely to be subject to bush fire attack[28] based on vegetation classification and size of the area. The map also includes buffers around bush fire prone vegetation. Careniup Wetlands Reserve is currently not identified as a 'bush fire prone area'[29].

4.5 Educational Signage

Given the diversity of biological species that frequent Careniup Wetlands Reserve, educational signage identifying them would be beneficial in increasing public knowledge. The signage is a communication tool aimed to stimulate interest in the local ecosystem and will help visitors and locals feel invested in the environment. Consideration will be given to the installation of educational signage in conjunction with construction works.

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27 Department of Industries and Regional Development (2015) *Pest Fish Prevail in Perth Lakes* http://www.fish.wa.gov.au/About-Us/News/Pages/_archive/Pest-fish-prevail.aspx accessed 3 April 2018

28 Department of Fire and Emergency Services (2018) *Mapping Standard for Bush Fire Prone Areas* https://www.dfes.wa.gov.au/waemergencyandriskmanagement/obrm/Documents/OBRM-Mapping-Standard-for-Bush-Fire-Prone-Areas.pdf accessed 18 June 2018

29 Department of Fire and Emergency Services (2018) *Map of Bush Fire Prone Areas* https://maps.slip.wa.gov.au/landgate/bushfireprone accessed 18 June 2018

4.6 Biological Environment Recommendations

Recommended actions from biological environment issues are as follows:

Number	Recommended Action	Details
4.1	Continue with staged revegetation of conservation areas	Revegetation to tie in with Weed Treatment Strategy (Appendix 3)
4.2	Implement Weed Treatment Strategy (three year program)	Refer Appendix 3 for Weed Treatment Strategy
4.3	Monitor weed populations	To determine success of Weed Treatment Strategy and adapt as necessary
4.4	Convert identified areas of landscape planting to conservation area planting	Staged removal of non-indigenous species and replacement with appropriate natives. Areas are identified in the Development Plan
4.5	Retain vegetation with cultural significance	Retain two stands of pencil willows, monitor and contain.
4.6	Gradually reduce non-native species within the Secret Garden area	Staged removal of non-indigenous species and replacement with appropriate natives.
4.7	Designate Careniup Wetlands Reserve as an on-leash dog exercise area	Amend the *Dog Exercise Areas Policy* to include Careniup Wetlands Reserve as an on-leash dog exercise area.
4.8	Designate Careniup Wetlands Reserve as a cat prohibited area	Amend the *Keeping and Control of Cats Local Law* to include Careniup Wetlands Reserve as a cat prohibited area.
4.9	Continue mosquito monitoring	Continue to monitor mosquito breeding areas
4.10	Implement education campaign	Include responsible disposal and reporting of pest fish and educational signage.

5 Social and Built Environment

5.1 Sense of place

Careniup Wetlands is highly valued by the community. The variety of spaces and environments create interesting places that serve a number of different functions, including bird watching, photography, unstructured (nature) play and walking to name a few.

5.1.1 Parkland

The portions of the reserve that are parkland areas have been developed with the subdivision of privately owned land. The areas of grass and tree planting are generally adjacent to the roadway. While the grass provides picnic and recreation space, the trees help create a sense of enclosure and screen out residential development from the interior of the reserve.

The area south of the playground on Careniup Ave has uneven ground levels that do not afford views into the wetland. The existing land form was created by the developer of the adjacent estate. Drainage channel works at the storm water inlet to the south have also added to the higher elevation within this location. The area adjacent to the main drainage channel is overgrown with grass and weeds and unable to be mown. Levelling of the area should be undertaken at the same time as weed treatment works.

5.1.2 Secret Garden

The Secret Garden is an area of mostly exotic weed incursion towards the northern end of the site. The area includes the Reed Garden which is dominated by Giant Reed, the melaleuca grove and flooded gum with morning glory understorey.

Parkland adjacent to Water Crest Gardens

Instagram photo of the Secret Garden - original photo by @andy.donaldson and reposted by @perthisok (23 March 2016) and @jetstaraustralia (9 January 2017)

andy.donaldson *'not a bad place to have lunch :)'* Instagram post www.instagram.com/andy.donaldson 16 March 2016 viewed 3 May 2018

the Reed Garden - July 2016

The Secret Garden area was relatively inaccessible and largely unknown until its location was made known to the wider community via social media. In 2015 and 2016, a large number of blogs, articles and social media posts promoted the Secret Garden. Photos and posts were shared on Instagram, Facebook and other social media platforms, with articles appearing on websites such as So Perth[30], Weekend Notes[31] and the West Australian[32].

Visitor numbers have been increasing over the years, with social media accelerating the increase over the past three years. Unfortunately, the increase in visitation has coincided with increased groundwater levels, which have inundated the Secret Garden for extended periods. These periods of inundation have resulted in the decline of some vegetation, including morning glory and flooded gums.

The attraction of the Secret Garden is predominantly the strange forms created by the morning glory growing over the trees, which create a unique landscape that has been referred to as a 'fairy garden', 'wonderland' and a 'magical' place. The flooded gums help enclose the space and filter the sunlight. Photography groups and professional and amateur photographers all utilise the area and the City has received requests to book the Secret Garden for birthday parties, weddings, photography shoots and filming.

Management of the Secret Garden

With subdivision adjacent to Careniup Wetlands Reserve still to occur and the area still being promoted on social media, visitor numbers at the Secret Garden are unlikely to decrease. The current management of the area and supporting infrastructure does not sufficiently meet the needs of visitor numbers using the Secret Garden.

The Secret Garden is unsustainable in its current condition. Either supporting infrastructure and facilities should be installed to help alleviate ongoing issues associated with the patronage, or the area should be converted to a conservation area by removing the morning glory and giant reed.

Future of the Secret Garden

At the Council meeting 17 November 2020, Council decided in favor of removing the environmental weeds in the Secret Garden area and to restore it as a conservation area. Removal of the environmental weeds will reduce

love.where.you.live *'(secret garden) We also found the infamous 'Gwelup Secret Garden'* Instragram post https://www.instagram.com/love.where.you.live 5 November 2016 viewed 1 May 2018

30 So Perth (2015) *Perth's Secret Garden Wonderland – the secret is out!* https://soperth.com.au/perths-secret-garden-wonderland-1545 14 June 2015 viewed 7 April 2016

31 Weekend Notes (2016) *Perth's Insta-Famous Secret Garden- snap this beauty for your followers* https://www.weekendnotes.com/perths-insta-famous-secret-garden/ 8 July 2016 viewed 2 May 2018

32 The West Australian (2015) *WA Hidden Treasures Now at Your Fingertips* https://thewest.com.au/news/australia/wa-hidden-treasures-now-at-your-fingertips-ng-ya-133530 5 December 2015 viewed 2 May 2018

Image of an elevated walkway in Laurance S. Rockerfeller Preserve, Wyoming

Land8: Landscape Architects Network *'How Laurance S. Rockefeller Preserve is Bringing Ecological Design Back'* https://www.land8.com 30 December 2014 viewed 6 June 2016

the Melaleuca grove - May 2017

the number of visitors at the reserve and alleviate some of the ongoing parking and management issues.

Pedestrian access

Currently access to the central Secret Garden area is through informal paths and desire lines. Seasonal inundation makes area muddy and difficult to access. It is proposed to install an elevated walkway to for the majority of visitors to the site and reduce the damage caused by informal access arrangements. The walkway will be accessible, complying with the City of Stirling *Access and Inclusion Plan*. The walkway is intended to be aesthetically complimentary and as unobtrusive as possible. It is proposed to be low to the ground and without handrails.

Final locations for a walkway would be investigated once the environmental weeds have been removed from the area, and is pending technical feasibility assessments.

Melaleuca grove

The area of swamp paperbark (*Melaleuca rhaphiophylla*) in the north-west corner of the Secret Garden area has a different atmosphere to other areas due to the combination of the native grass understorey and the density of the Paperbarks. A number of juvenile palms have seeded in this area and are identified in the Weed Treatment Strategy to be removed. Protection of these trees should be taken into account when the adjacent private lot is developed.

5.2 Reserve Name

Careniup Wetlands consists of a number of land parcels which have been ceded to the City as subdivision development has occurred. These land parcels do not have names recorded with Landgate, but the City's internal systems have a number of names listed, including Careniup Balcatta Reserve, Careniup Reserve, Water Crest Reserve and Willows Estate.

The initial consultation for the management plan included the proposed reserve name 'Careniup Swamp Reserve'. Feedback from residents

western side of the reserve - July 2017

indicated a preference for the word 'swamp' to be replaced with 'wetlands'. As a result, Council endorsed a recommendation to change the reserve name to 'Careniup Wetlands Reserve'[33]. The entire public open space bounded by Balcatta Road, Careniup Avenue, Hanlin Court, Mallee Way, Water Crest Gardens, Columbite Road and Carslake Grove will now be referred to as Careniup Wetlands Reserve.

5.3 Recreation

Careniup Wetlands is designated as a community-level public open space. The City of Stirling defines community open space as:

> *"Community open spaces serve as the recreational and social focus of a community. Residents of surrounding neighbourhoods are attracted to community open spaces due to the variety of features and facilities and opportunities to socialise. They are large enough to provide for both passive and informal active uses to occur simultaneously, while managing potential social conflict. These spaces also have value in providing 'green relief' to break up the urban form, contribute to local identity and may also incorporate natural areas that serve conservation or environmental goals."*[34]

The reserve currently meets the requirements of a community-level open space and would benefit from the inclusion of some accessible facilities such as picnic tables and drink fountains.

Walking is the most popular physical recreation activity across Australia[35], and with the lack of space for other formal recreation pursuits at Careniup Wetlands Reserve, it is likely the most popular physical recreation activity at the reserve. Other activities include dog walking, picnicking, nature interaction (bird watching) and play.

5.4 Heritage

The Department of Planning, Lands and Heritage online Aboriginal Heritage Inquiry System[36] indicated no recorded Aboriginal or other heritage sites in or immediately adjacent to Careniup Wetlands.

5.5 Art

Public art can contribute to a sense of place, promote local identity, express the values of a local community, enhance the urban environment, educate and inform. The City of Stirling has a Public Art Policy that supports the installation of public art. Consideration will be given to the incorporation of artwork within educational/interpretive signage.

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33 City of Stirling (2019) *Minutes of the Ordinary Meeting of Council 16 April 2019* Item 12.1/PS1 resolution 0419/005 p56

34 City of Stirling (2008) Public Open Space Strategy www.stirling.wa.gov.au p31

35 Australian Bureau of Statistics (2015) *4177.0 - Participation in Sport and Physical Recreation, Australia, 2013-14* www.abs.gov.au/ausstats accessed 16 April 2018

36 Department of Planning, Lands and Heritage *Aboriginal Heritage Inquiry System* https://maps.daa.wa.gov.au/AHIS accessed 16 April 2018

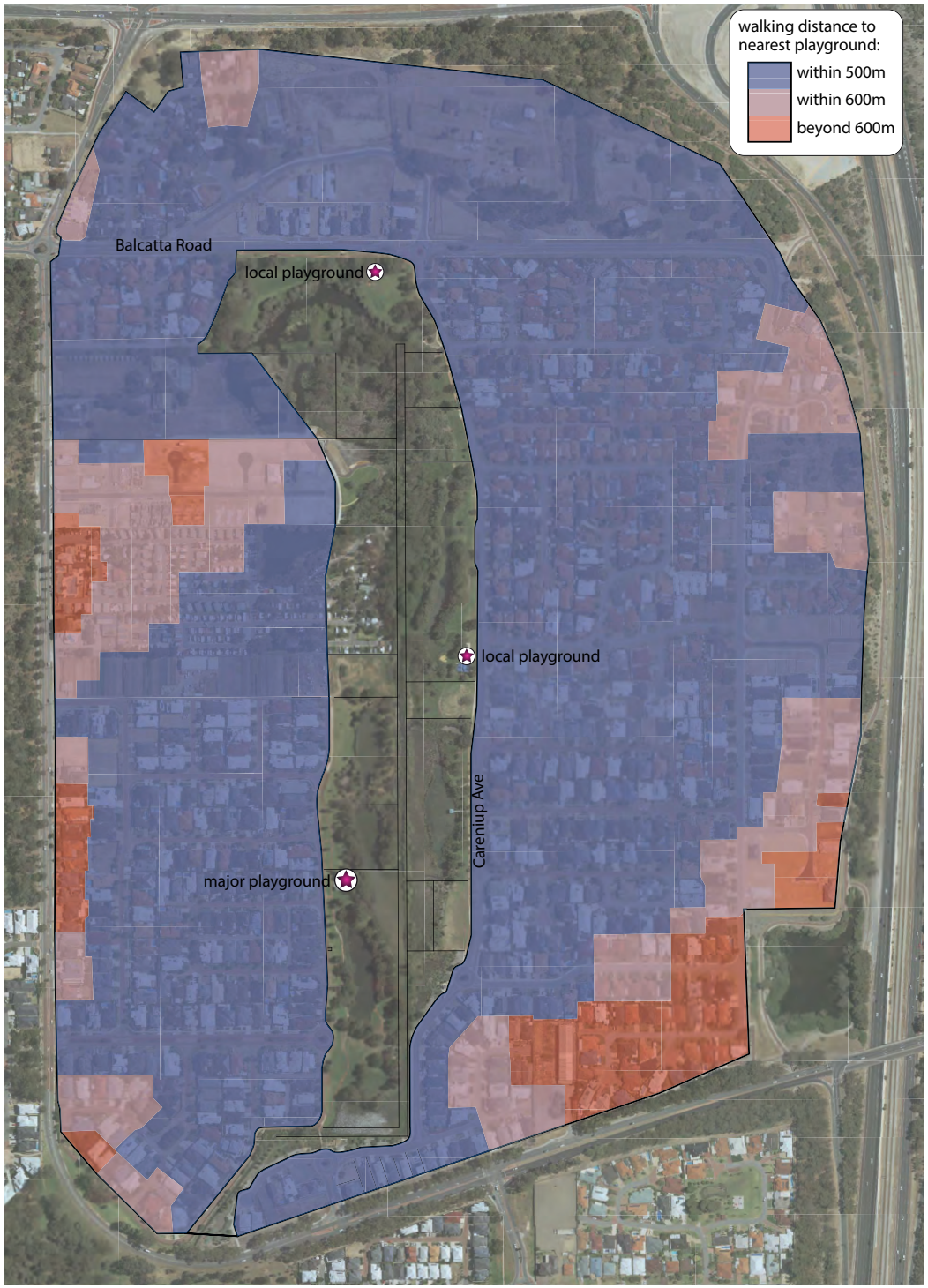

Figure 10: Walkable playground catchments for playgrounds

5.6 Anti-social Behaviour

Monitoring and reporting of anti-social behaviour is an ongoing issue. While the increase in patronage in some areas (particularly the Secret Garden) has helped deter some individuals, other forms of vandalism, such as graffiti on trees and carving names in tree trunks, is starting to occur.

Crime prevention through environmental design principles will be implemented where possible in areas that are redeveloped or where paths are installed. This includes passive surveillance considerations and maintaining sight lines to hep deter anti-social behaviour.

Anti-social behaviour witnessed by the public should be reported to the police and damage/ vandalism reported to the City of Stirling.

5.7 Infrastructure

5.7.1 Playgrounds

The City's playground policy outlines the intent that local playgrounds should be located to service a 400-500m walkable catchment for residents. The proposed playground distribution at Careniup reserve is outlined in Figure 10, along with the walkable catchments. The three playgrounds at the reserve are well distributed and much of the local area is within the 400-500m catchment of a playground.

5.7.2 Parking

There are currently 29 formalised parking bays, with space for an additional 36 cars to park informally using verge areas across Careniup Wetlands Reserve. There are currently parking issues associated with the Secret Garden area. An informal parking area which uses the existing access to the Water Corporation pump station has been created adjacent to the Secret Garden.

The construction of formalised parking areas has occurred with the development of each land parcel surrounding the reserve. The earliest subdivisions at the northern end of the site were not required to install formal parking as a part of their development.

Some sections of the reserve have been subject of ongoing issues around members of the public driving onto the reserve, particularly at the northern end of the reserve. Bollards have since been installed to control access at the northern end of the reserve. Given the lack of formalised parking installed when northern subdivisions were developed, and the lack of verge space for informal parking, additional parallel parking bays are proposed to be installed near Agnew Loop, adjacent to the central playground picnic area (near Dunlin Way) and at the north end of the reserve (Balcatta Road). Parking on the western side of the reserve shall be considered when private lots are subdivided.

Traffic calming

The City receives many requests to investigate road safety issues and construct traffic management measures on local roads, including requests for traffic calming on Careniup Avenue. All requests are subject to assessment under Council's *Traffic Management Warrants Policy*. This policy takes

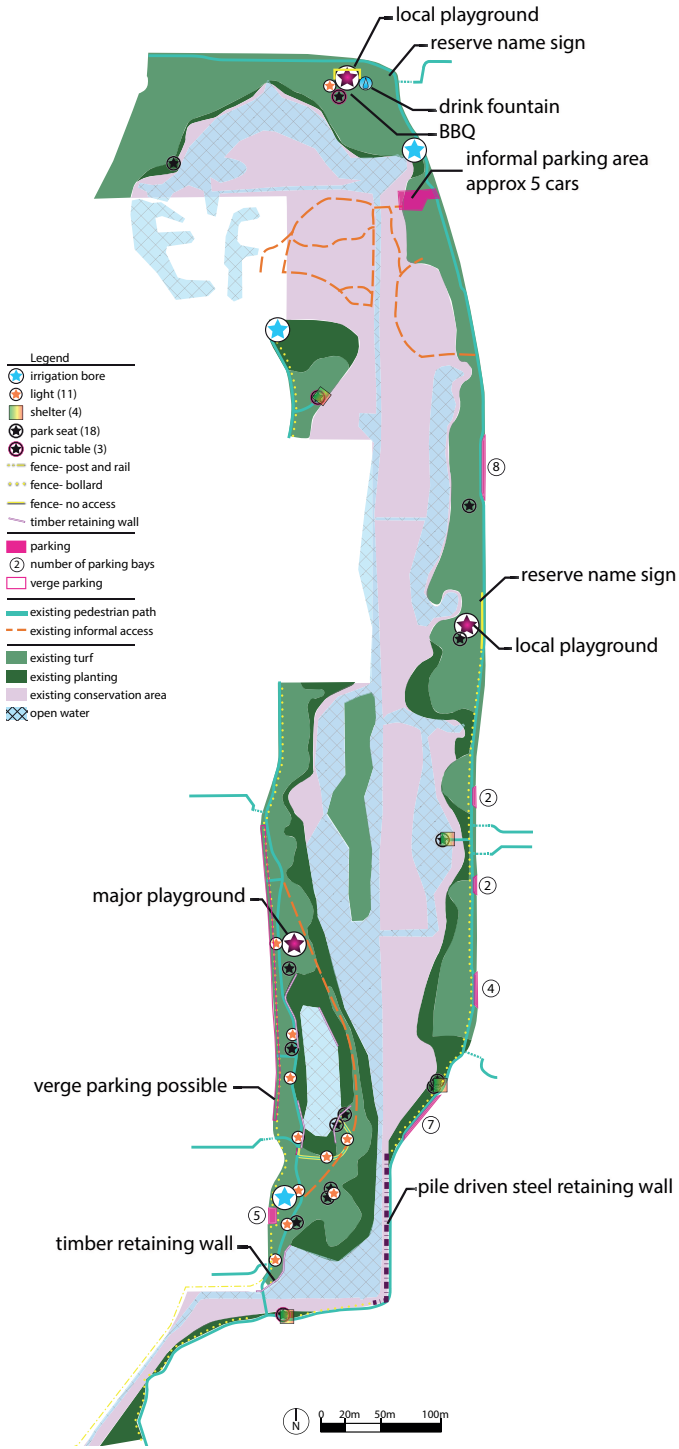

Figure 11: Existing infrastructure at Careniup Swamp Reserve

into account a range of safety and amenity factors including traffic volumes, travel speeds, crash history, road geometry, road users and activity generators. The City has a large number of projects and only limited funding resources. The policy ensures that funding is allocated to the highest priority projects that lead to identifiable safety improvements. This is considered to be best practice for determining the need for traffic management measures in a fair and equitable manner.

The City's latest traffic data from February 2018 indicates that Careniup Avenue carries approximately 1,200 vehicles per day, with 85th percentile travel speeds of 52.6 km/h and 55.8 km/h respectively recorded at two locations (ie, 85 per cent of vehicles are traveling at or below these speeds). These values are within the ranges expected for local access roads.

Crash data provided by Main Roads Western Australia (MRWA) has indicated that in the last five-year period on record, there has been only one reported crash along Careniup Avenue.

Careniup Avenue is currently considered a low priority for traffic or speed management measures. While this is not suggesting that such measures will never be implemented, it would be difficult to justify their construction when traffic and crash statistics indicate that more urgent attention is required elsewhere.

5.7.3 Access paths

Pedestrian paths throughout Careniup Wetlands Reserve consist of formalised concrete paths, informal access trails and desire lines.

The primary circulation path is the concrete path that runs along the perimeter of much of Careniup Wetlands. The proposed primary circulation path will eventually create an uninterrupted circuit of the reserve, but with some areas still to be developed and under private ownership, completion of the broader circuit will not occur for some time.

Informal access trails are maintained by the City and occur through some of the more natural areas, including access to the Secret Garden and throughout the Reed Garden. The paths are not formalised for aesthetic and experiential reasons and are intended to control public access.

Desire lines are not maintained by the City but are evidenced by lack of vegetation and compacted ground. The primary desire lines are the access between the playground and rear of the western lake on the western side of the reserve and the paths throughout the Secret Garden area (refer image opposite).

Council passed a motion in May 2017 to install path connections to all new and existing playgrounds (when they are refurbished) where there is a pathway that can connect to the neighbourhood network[37]. This will apply to all playgrounds at Careniup Wetlands Reserve and future provision is identified on the Development Plan.

Water Corporation drainage channel crossings

The main drainage channel runs north-south through Careniup Wetlands and divides the reserve centrally. There is currently only one crossing of this channel at the southern end of the reserve. There are also informal log crossings at the northern end at the Secret Garden area. Visitors have in the past made informal bridges by piling vegetation or laying planks across and in the drainage channel to create additional crossing points, which possibly contributed to reduced flow within the channel. Despite the removal of the informal crossings, they have repeatedly been reinstated.

37 City of Stirling *Minutes: Ordinary Meeting Of Council 23 May 2017 - 7.00pm* Resolution 0517/047

informal channel crossing at southern end of Secret Garden area - July 2016

Timber retaining wall adjacent to pedestrian bridge with missing and damaged panels

Access across the channel is clearly needed and should be considered as a part of a holistic pedestrian access circuit.

5.7.4 Walls

There are three types of retaining wall materials used within Careniup Wetlands Reserve:

- Jarrah retaining walls installed as a part of The Willows Estate in 2001, which line the Water Corporation channel and are also around the western lake
- Steel piling retaining wall in the south-east corner of the wetlands installed as part of Erindale Grove Estate in 2012, which supports Careniup Ave
- Natural and reconstituted limestone walls and retaining walls used within landscape areas.

Timber retaining

The jarrah retaining walls installed in 2001 are currently 17 years old. The rectangular profile and untreated nature of the sleepers reduces their expected lifespan to 15-20 years[38].

The timber retaining lines the southern end of the Water Corporation channel within the Karrinyup Country Club property. The remaining sections of timber retaining on City of Stirling reserve include the bridge abutment and channel edge treatment, as well as sections of the western lake edges. Some sleepers have failed and replacement or removal of these retaining walls will be required.

Steel retaining

Careniup Avenue between Grimwood Ave and Jodrell Rd is supported in part by a steel retaining wall. The wall was installed in 2012 as a part of the Erindale Grove subdivision and has an anticipated life expectancy of over 25 years. The wall consists of pile-driven steel sheeting with weep holes.

Limestone walls

The limestone walls at Careniup are used within the landscape for both retaining and landscape delineation. Both natural and reconstituted limestone are utilised at Careniup Wetlands. Due to the long life expectancy and the sound condition of these walls, no action is currently required.

5.7.5 Lighting

In accordance with the City's Public Open Space Strategy, 'community' classified reserves can have lighting installed for limited evening use for safety and security reasons only[39]. Areas of the reserve currently lit include the existing street lighting network which illuminates the pedestrian bridge connection between Water Crest Gardens and Mews Entrance, and bollard and pole-top lights that were installed by the developer of The Willows Estate. The lighting is utilised on sections of reserve footpath near Water Crest Gardens. These lights, which have been in place for 18 years, have reached the end of their serviceable life. They do not comply with Australian standards and

38 Forest and Wood Products Australia (2015) *Timber Service Life Design - Design Guide for Durability* www.woodsolutions.com.au p24 accessed 24 July 2018

39 City of Stirling (2008) *Public Open Space Strategy* www.stirling.wa.gov.au p47

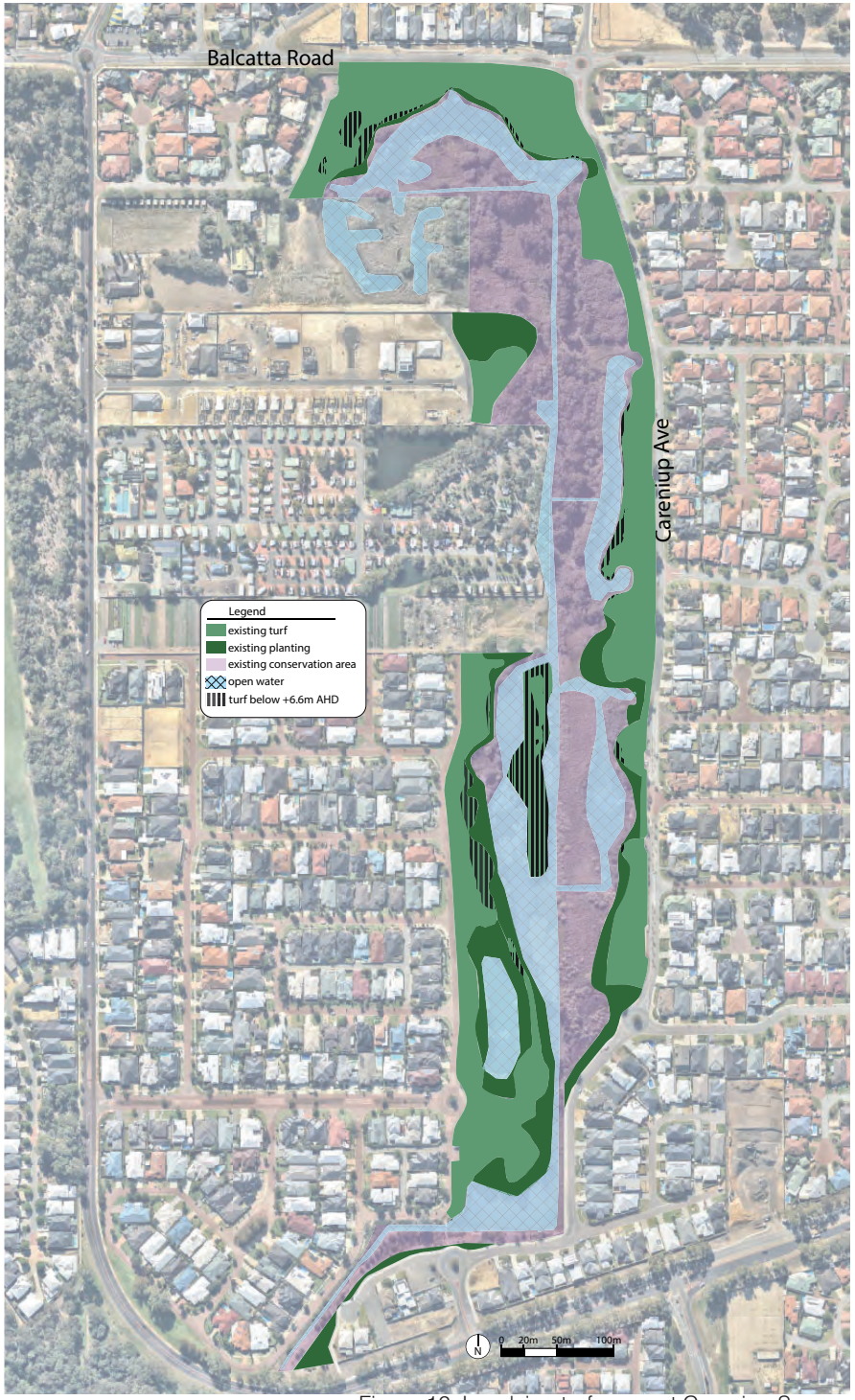

Figure 12: Low-lying turf areas at Careniup Swamp

the path bollard lights are recommended for removal and replacement. No other lighting is being recommended for this reserve.

5.7.6 Park furniture

Seating

The seats throughout Careniup Wetlands Reserve were mostly installed with the subdivision developments. As a result, the distribution of seating is ad-hoc, with some areas over-supplied and some areas under supplied. The recommendation is to review the provision of seating and ensure adequate seating is provided throughout the reserve.

Shelters

There are currently four shelters in Careniup Wetlands Reserve, located to provide shade, shelter, picnic and recreational (bird watching) functions. Given the proximity to the proposed central playground area, it is recommended that the existing timber bird-watching shelter near Sarus Rise be relocated south near Nankeen Way. This location is anticipated to have vistas over large areas of open water as well as the retained typha habitat often used for nesting.

Drink fountains

The provision of drink fountains at Careniup Wetlands Reserve is currently insufficient, with only one fountain provided at the northern playground adjacent to Balcatta Road. Additional drink fountains are proposed for the western playground and the central playground area.

Barbeques

The reserve currently has one barbeque at the northern end of the reserve next to Balcatta Road. No additional barbeque facilities are proposed.

Bins

The reserve currently has three bins on the western side of the reserve and six bins on the eastern side. Some of the bins on the eastern side are set back from the road and are not very visible to the public. Rubbish and waste disposal was mentioned as a concern by a number of residents during the public consultation process. Bin placement will be looked at as development in these areas of the reserve occurs.

5.7.7 Public toilet

The reserve currently has no public toilet facilities and its classification as a community-level public open space indicates that one should be considered. There are examples of community-level reserves within the City that have public toilets, including Millet Park, Macaulay Park and Copley Park.

The location of Careniup Swamp Reserve is within a residential area and quite isolated from any public toilet facilities. Given the number of playgrounds and the provision of long-stay picnicking facilities, it was recommended that a public toilet be considered. This was tested through the public consultation process of this management plan. Due to negative feedback from the community, the inclusion of a public toilet has been removed from the management plan.

Vegetation on the island- looking south from the northern point - March 2019

Vegetation on the island- from the proposed path location looking towards the southern half March 2019

5.8 Maintenance

5.8.1 Turf

There are a number of turf areas within the parkland that become inundated and soggy when water levels are high. These areas are all vertically within 500mm of the +6.1m AHD weir level (with the board removed, refer Section 3.5.5) and are identified in Figure 21. As these areas are too low to be maintained as turf, the recommendation is to either convert them to planting, or fill them so that the levels are raised by a minimum of 200mm.

5.8.2 Water Corporation access

The main drainage channel was cleared out in 2017 by the Water Corporation. While this work is undertaken infrequently on an as-needed basis, consideration and incorporation of access to the channel will be considered in future plans for Careniup Wetlands.

5.8.3 Island Access

The island was constructed by developers and landscaped in approximately 2005. As the City has been unable to access the island to maintain it, it has become overrun with kikuyu and other weeds such as Japanese pepper, giant reed and pampas grass and is identified as 'completely degraded' in the flora survey (refer Appendix 2: Flora Survey and Weed Mapping Report). Access to the island is essential to enable effective weed control and habitat restoration.

Rather than installing maintenance access only and having to control unauthorized access onto the island, the proposal is to combine maintenance and pedestrian access to the island into the overall reserve path network.

Given timeframes proposed in implementation of the management plan, interim maintenance access to the island to enable rehabilitation may be required.

The western lake with aerator in operation - November 2017

5.8.4 Western Lake Aerator/Fountain

The lake adjacent to Water Crest Gardens on the western side of the reserve contains an aerator that has been intermittently operational over the past ten years. A review of aerial photos over past years has shown that the operation of the fountain has had no effect on the amount of algae growth within the lake.

Local residents have expressed a desire to have the fountain operational permanently for aesthetic reasons and to control algae. The City has subsequently been renovated and is now operational.

5.9 Construction Management

Special consideration should be given to impacts on Careniup Wetlands Reserve during construction and maintenance works within the vicinity of the reserve. Construction should consider:

- Investigation of whether an acid sulfate soils investigation will be required (refer section 3.4.2)
- Investigation of whether a health and safety plan should be in place for personnel undertaking works within remediated sites (refer section 3.4.1)
- Scheduling of works (in particular works involving heavy machinery) to minimise physical impact to the reserve, particularly when water levels are high
- Minimisation of width and extent of access tracks
- Adherence to regulations requiring petroleum products and other hazardous substances to be kept 20m away from waterways
- Use of plastic lining to prevent groundwater contamination during refuelling, top-ups and oil checks
- Use of bunds to prevent wash-down water from construction equipment from contaminating conservation areas
- Use of plastic lining to prevent contamination of conservation areas with sawdust when cutting CCA-treated products.

5.10 Social and Built Environment Recommendations

Recommended actions from social and built environment issues are as follows:

Number	Recommended Action	Details
5.1	Plant additional trees	Trees to be planted along Careniup Ave to create sense of enclosure
5.2	Landscape and level area at central playground node	Adjust levels to mound area in conjunction with weed removal works
5.3	Monitor drainage channel for informal crossings	Monitor drainage channel and advise Water Corporation if blockages become apparent
5.4	Ensure protection of Melaleuca grove during future subdivision development	Subdivision plans for Lot 455 North Beach Rd to have appropriate offset to Melaleuca grove to ensure no impact to this area
5.5	Amend the City's internal systems to reflect Careniup Wetlands Reserve as the reserve name and amend existing/install signs to reflect reserve name	Reserve name change adopted by Council Resolution 0419/005
5.6	Consider installation of accessible facilities in future projects at the reserve	Accessible picnic tables, drink fountains, path installation
5.7	Repair damage and remove graffiti as soon as possible	This is to discourage future acts of vandalism/graffiti
5.8	Construct additional parking	Install additional parking to eastern side of the reserve where verge parking is restricted
5.9	Install path connections to playgrounds	To be implemented when playground assets are renewed or new reserve paths installed
5.10	Construct additional pedestrian paths throughout Careniup Swamp Reserve	To increase accessibility and improve experience. Indicative locations as per Development Plan are pending technical feasibility
5.11	Installation of drainage channel crossing from Colombite Rd to Agnew Lp	To increase accessibility and improve experience. Indicative locations as per Development Plan are pending technical feasibility
5.12	Installation of maintenance access to southern island	To increase accessibility and improve experience. Indicative locations as per Development Plan are pending technical feasibility
5.13	Investigate southern east-west crossing	To increase accessibility and improve experience. Indicative locations as per Development Plan are pending technical feasibility

5.14	Install bird watching/viewpoint seating area	Pending resolution of land ownership issues of Lot 15 Gribble Road
5.15	Remove timber retaining walls, regrade and plant as identified on Development Plan	This includes two locations on the edge of the western lake and adjacent to the pedestrian bridge
5.16	Renew timber retaining wall adjacent to footpath	Adjacent to Water Crest Gardens
5.17	Replace path lighting within Careniup Wetlands on western side of reserve	Lights are at their end of life and will be replaced
5.18	Review provision of seating along the primary circulation path	Seats to be located in the vicinity of the main path and regularly spaced
5.19	Turf areas subject to inundation to be converted to planting or levels adjusted	Areas and treatments are detailed on the Development Plan
5.20	Install additional drink fountains	Location as per the Development Plan
5.21	Maintain access to drainage channel	Consider Water Corporation access in creation of Development Plan
5.22	Incorporate construction considerations in projects and during works on site	As per Section 5.9

6 Recommendation Implementation

6.1 Recommendation Summary

Summary of all recommended actions are as follows:

Number	Recommended Action	Details
	Planning	
2.1	Consider options to resolve land ownership issues of Lot 15 Gribble Road	To enable effective weed management across the Reserve
2.2	Private land owners to cede land within Careniup Swamp Special Control Area as subdivision occurs	Public open space to be developed and ceded in accordance with relevant planning regulations and requirements
	Physical Environment	
3.1	Install fencing to remediated sites	Bushland fencing to be installed to remediated sites on Hanlin Court and Careniup Ave (near Jodrell Rd)
3.2	Comply with Department of Water and Environmental Regulation requirements for potential acid sulfate soil locations	Any dewatering or drainage works proposed or excavation of over 100m^3 of soil will require an acid sulfate soils investigation
3.3	Continue monitoring water levels at Careniup Wetlands Reserve	
3.4	Continue monitoring water quality at Careniup Wetlands Reserve	
3.5	Liaise with Department of Water and Environmental Regulation regarding weir level adjustment	
3.6	Investigate whether Careniup Special Control Area provisions should be reviewed	When Local Planning Scheme 3 is reviewed, give consideration to whether the provisions at Careniup should be reviewed
3.7	Develop and implement education campaign	Provide educational material to residents on environmental issues associated with living near a conservation area
3.8	Decommission irrigation to landscape planted areas in conjunction with landscape works	Decommission irrigation to landscape planted areas as they are converted to conservation planting
	Biological Environment	
4.1	Continue with staged revegetation of conservation areas	Revegetation to tie in with Weed Treatment Strategy (Appendix 3)
4.2	Implement Weed Treatment Strategy (three-year program)	Refer Appendix 3 for Weed Treatment Strategy
4.3	Monitor weed populations	To determine success of Weed Treatment Strategy and adapt as necessary
4.4	Convert identified areas of landscape planting to conservation area planting	Staged removal of non-indigenous species and replacement with appropriate natives. Areas are identified in the Development Plan
4.5	Retain vegetation with cultural significance	Retain two stands of pencil willows, monitor and contain
4.6	Gradually reduce non-native species within the Secret Garden area	Staged removal of non-indigenous species and replacement with appropriate natives.
4.7	Designate Careniup Wetlands Reserve as an on-leash dog exercise area	Amend the *Dog Exercise Areas Policy* to include Careniup Wetlands Reserve as an on-leash dog exercise area
4.8	Designate Careniup Wetlands Reserve as a cat prohibited area	Amend the *Keeping and Control of Cats Local Law* to include Careniup Wetlands Reserve as a cat prohibited area
4.9	Continue mosquito monitoring	Continue to monitor mosquito breeding areas
4.10	Implement education campaign	Include responsible disposal and reporting of pest fish and educational signage
	Social and Built Environment	
5.1	Plant additional trees	Trees to be planted along Careniup Ave to create sense of enclosure
5.2	Landscape and level area at central playground node	Adjust levels to mound area in conjunction with weed removal works
5.3	Monitor drainage channel for informal crossings	Monitor drainage channel and advise Water Corporation if blockages become apparent
5.4	Ensure protection of Melaleuca grove during future subdivision development	Subdivision plans for Lot 455 North Beach Rd to have appropriate offset to Melaleuca grove to ensure no impact to this area
5.5	Amend the City's internal systems to reflect Careniup Wetlands Reserve as the reserve name and amend existing/install signs to reflect reserve name	Reserve name change adopted by Council Resolution 0419/005
5.6	Consider installation of accessible facilities in future projects at the reserve	Accessible picnic tables, drink fountains, path installation
5.7	Repair damage and remove graffiti as soon as possible	This is to discourage future acts of vandalism/ graffiti
5.8	Construct additional parking	Install additional parking to eastern side of the reserve where verge parking is restricted
5.9	Install path connections to playgrounds	To be implemented when playground assets are renewed or new reserve paths installed
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5.12	Installation of maintenance access to southern island	To increase accessibility and improve experience. Indicative locations as per Development Plan are pending technical feasibility

5.13	Investigate southern east-west crossing	To increase accessibility and improve experience. Indicative locations as per Development Plan are pending technical feasibility
5.14	Install bird watching/viewpoint seating area	Pending resolution of land ownership issues of Lot 15 Gribble Road
5.15	Remove timber retaining walls, regrade and plant as identified on Development Plan	This includes two locations on the edge of the western lake and adjacent to the pedestrian bridge
5.16	Renew timber retaining wall adjacent to footpath	Adjacent to Water Crest Gardens
5.17	Replace path lighting within Careniup Wetlands on western side of reserve	Lights are at their end of life and will be replaced
5.18	Review provision of seating along the primary circulation path	Seats to be located in the vicinity of the main path and regularly spaced
5.19	Turf areas subject to inundation to be converted to planting or levels adjusted	Areas and treatments are detailed on the Development Plan
5.20	Install additional drink fountains	Location as per the Development Plan
5.21	Maintain access to drainage channel	Consider Water Corporation access in creation of Development Plan
5.22	Incorporate construction considerations in projects and during works on site	As per Section 5.9

6.2 Development Plan

6.2.1 Works prioritisation strategy

Works at Careniup Wetlands Reserve as a result of recommendations (illustrated on the Careniup Wetlands Development Plan) will be prioritised to meet current usage needs and environmental initiatives.

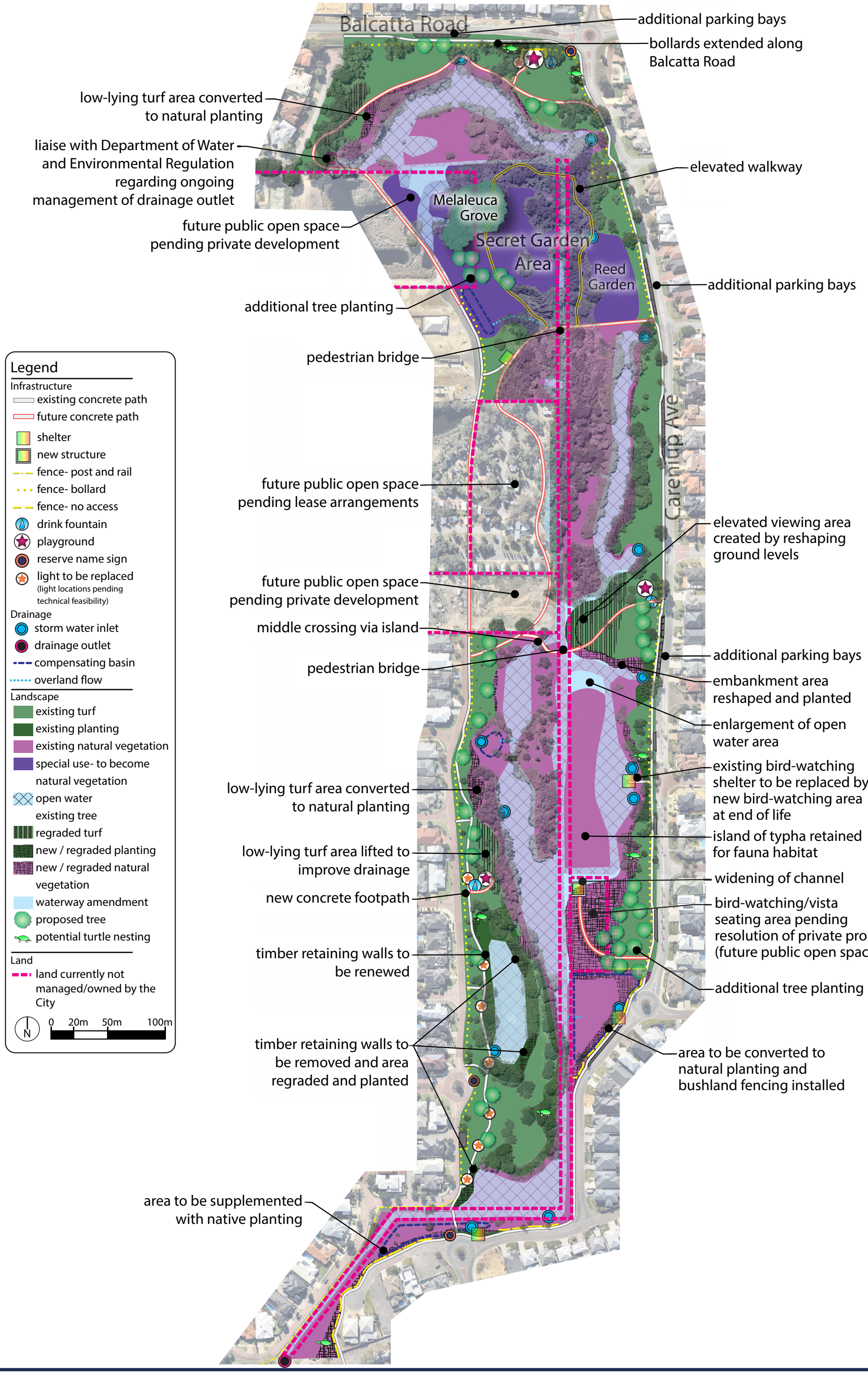
6.2.2 Project staging

Proposed implementation of works illustrated in the Development Plan is outlined as follows:

Stage 1
Install additional parking near Agnew Loop
Install additional parking to Balcatta Road
Implement Weed Management Strategy- Stage 1
Reserve name signage
Revegetation program
Installation of furniture along the primary circulation path- Stage 1
Stage 2
Implement Weed Management Strategy- Stage 2
Installation of an additional Water Corporation drainage channel crossing to connect Agnew Loop and Columbite Road
Tree planting
Staged conservation area improvements- Stage 1 (Hanlin Court) incl drink fountain
Stage 3
Implement Weed Management Strategy- Stage 3
Remove timber retaining walls, regrade and plant as identified on Development Plan
Staged conservation area revegetation- Stage 2
Stage 4
Installation of seating along the primary circulation path- Stage 2
Careniup Ave central playground area works including additional parking, earthworks, landscaping
Stage 5
Installation of additional paths throughout Careniup Swamp Reserve
Feasibility for east-west pedestrian connection across channel and island access
Staged conservation area revegetation- Stage 3 (Water Crest Gardens)

Careniup Wetlands Reserve - Development Plan

April 2021



Appendix 1: Water Level Graphs

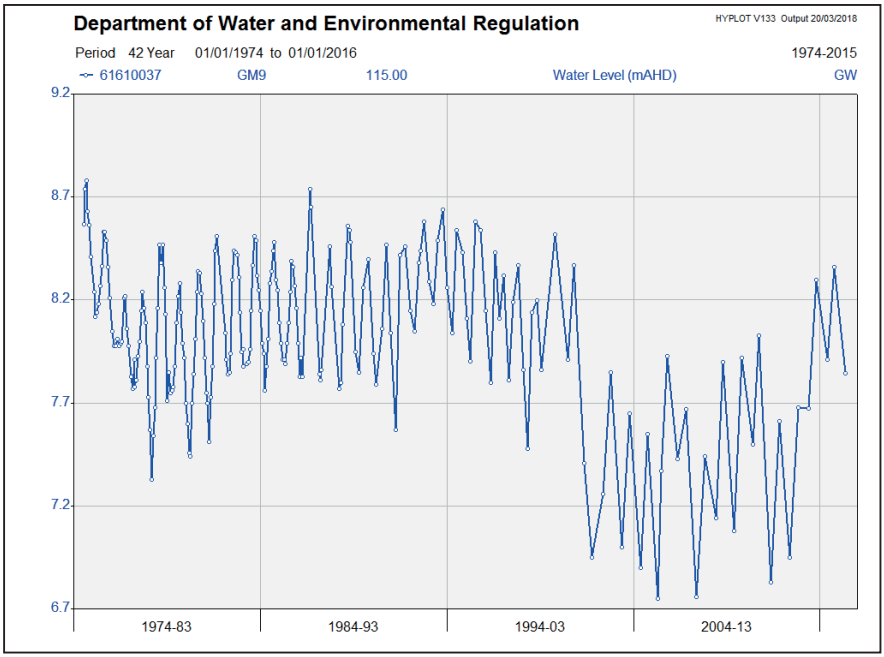


Figure 22: Gwelup groundwater levels 1974 - 2015

Department of Water and Environmental Regulation *Gwelup Monitoring Bore - GM9 Location 61610037* http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx 20 March 2018

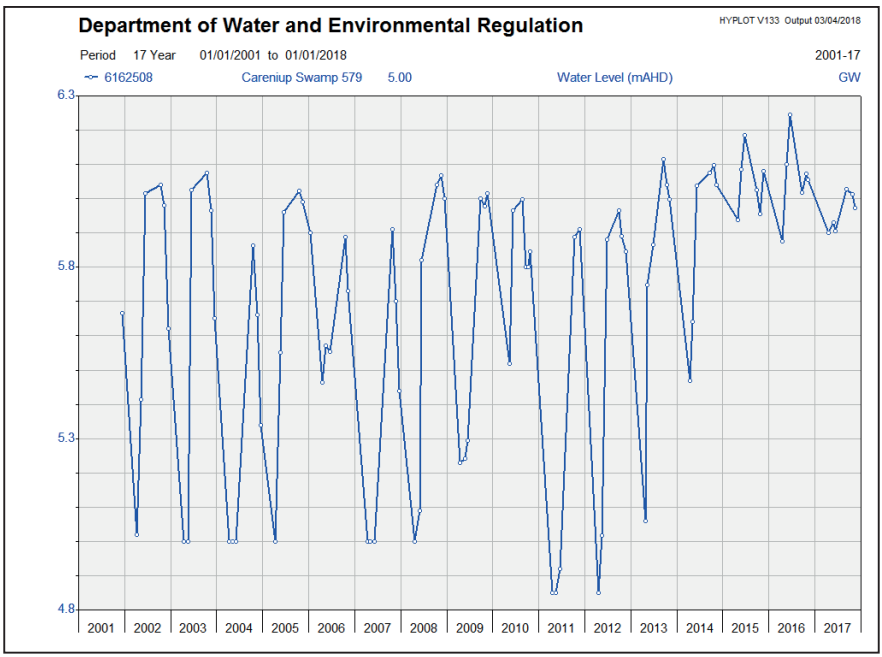


Figure 23: Careniup Swamp surface-water levels 2001 - 2017

Department of Water and Environmental Regulation *Careniup Swamp 579 Location 6162508* http://wir.water.wa.gov.au/Pages/Water-Information-Reporting.aspx 3 April 2018

Appendix 2: Flora Survey and Weed Mapping Report

Natural Area
CONSULTING MANAGEMENT SERVICES

City of Stirling

Flora Survey and Weed Mapping Report – Careniup Reserve, Gwelup

V1.1 – 25 June 2018

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Document Title	2017 10 16 NAC COS REPT Careniup Weed Mapping Report.docx
Location	\\10.0.0.210\DropBox\Drop Box\Client Folders - NAC\City of Stirling\2017 Careniup Flora Survey and Weed Mapping\Report\

Draft/Version No.	Date	Changes	Prepared by	Approved by	Status
D1	18 October 2017	New document	SB	LS	Draft for client comment
V1	09 May 2018	Minor amendments	SH	LS	Final
V1.1	25 June 2018	Minor amendments	SH	LS	Final

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1.0 Introduction

Natural Area Consulting Management Services (Natural Area) was commissioned by the City of Stirling to undertake a flora survey and mapping of weed species within Careniup Reserve, Gwelup.

1.1 Site Location

The study area includes Careniup Reserve, Careniup Balcatta Reserve, Water Crest Reserve, Willows Estate along with public and community open space areas. the site extends from Balcatta Road in the north, Careniup Avenue to the east, Hanlin Court and Grimwood Avenue to the south, and Water Crest Gardens and a portion of Columbite Road to the west (Figure 1).

1.2 Objectives and Scope

The main objectives of the flora survey and weed mapping are to:

- provide baseline data on flora species occurring and the current extent, density and status of weed infestations
- provide comprehensive flora lists with their location and management zones in accordance with the draft Management Plan for the Reserve
- provide reference for ongoing weed mapping to determine trends (increase or decline) of weed infestations including location, density and spread that can be assessed to determine the effectiveness of weed control and the conservation effort.

Figure 1: Survey Area, Careniup Reserve Gwelup

2.0 Methodology

Natural Area Botanists Sharon Hynes (day 1), Caitlyn White (day 1 and 2) and Taryn Brebner (day 2) attended the site and undertook the flora survey and weed mapping activities. The site was traversed on foot with details of the following recorded using a hand-held GPS device with MobileMap software:

- vegetation type, based on the dominant over, middle and understorey species, as described in Bush Forever Volume 2 (Table 1, Government of Western Australia, 2000)
- vegetation condition using rating scale attributed to Keighery in Bush Forever Volume 2, Government of Western Australia, 2000)
- photograph vegetation communities, examples of vegetation condition, and any declared rare or priority listed flora species and/or ecological communities
- record locations of any declared rare or priority listed flora species
- dominant and invasive weed species were recorded as a single GPS point or a density according to type and density in accordance with the DEC standard operating procedure (low <5%, medium 6-75%, high 76-100%); it was noted that weeds in nominated locations (e.g.: the Secret Garden) were to be retained for aesthetic and community interest reasons
- mapping outcomes and documenting results of the survey process in this report.

Table 1: Vegetation structural classes

Life Form/Height Class	Canopy Percentage Cover			
	100 – 70%	**70 – 30%**	**30 - 10%**	**10 – 2 %**
Trees over 30 m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland
Trees 10 – 30 m	Closed forest	Open forest	Woodland	Open woodland
Trees under 10 m	Low closed forest	Low open forest	Low woodland	Low open woodland
Tree Mallee	Closed tree mallee	Tree mallee	Open tree mallee	Very open tree mallee
Shrub Mallee	Closed shrub mallee	Shrub mallee	Open shrub mallee	Very open shrub mallee
Shrubs over 2 m	Closed tall scrub	Tall open scrub	Tall shrubland	Tall open shrubland
Shrubs 1 – 2 m	Closed heath	Open heath	Shrubland	Open shrubland
Shrubs under 1 m	Closed low heath	Open low heath	Low shrubland	Low open shrubland
Grasses	Closed grassland	Grassland	Open grassland	Very open grassland
Herbs	Closed herbland	Herbland	Open herbland	Very open herbland
Sedges	Closed sedgeland	Sedgeland	Open sedgeland	Very open sedgeland

(Source: Government of Western Australia, 2000)

Table 2: Vegetation condition ratings

Category		Description
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

(Source: Government of Western Australia, 2000)

2.1 Limitations

The timing of the survey (August) was undertaken during the optimal time to see both winter weed species, woody weeds that can be found year-round, and some of the spring annual weed species. It was close to the optimal time to see native flora species that flower during spring, noting that portions of the site were wet and may have limited the numbers of species presenting at the time.

3.0 Results

3.1 Vegetation Type

Three distinct vegetation types were identified within the Reserve (Table 3, Figure 2). Areas of open water, revegetation and parkland have not been assigned a vegetation type, but have been shown on Figure 2 for completeness.

Table 3: Vegetation types

Vegetation Type	Description	Photo
ToCs	*Typha orientalis* Grassland associated with Pampas Grass (*Cortaderia selloana*)	
Ad	*Arundo donax* (Giant Reed) Grassland	
MrEr	*Melaleuca rhaphiophylla* and *Eucalyptus rudis* Woodland over a weedy under storey	

3.2 Vegetation Condition

Vegetation condition ranged from Completely Degraded to Good, with the majority of the site classified as completely degraded (92.89%) (Table 2; Figure 3).

Table 2: Vegetation condition

Vegetation Condition	Area (ha)	Area (%)	Photo
Completed Degraded	14.51	92.89	
Degraded	0.56	3.59	
Good	0.55	3.52	
Very Good	0	0	
Excellent	0	0	
Total	15.62	100	

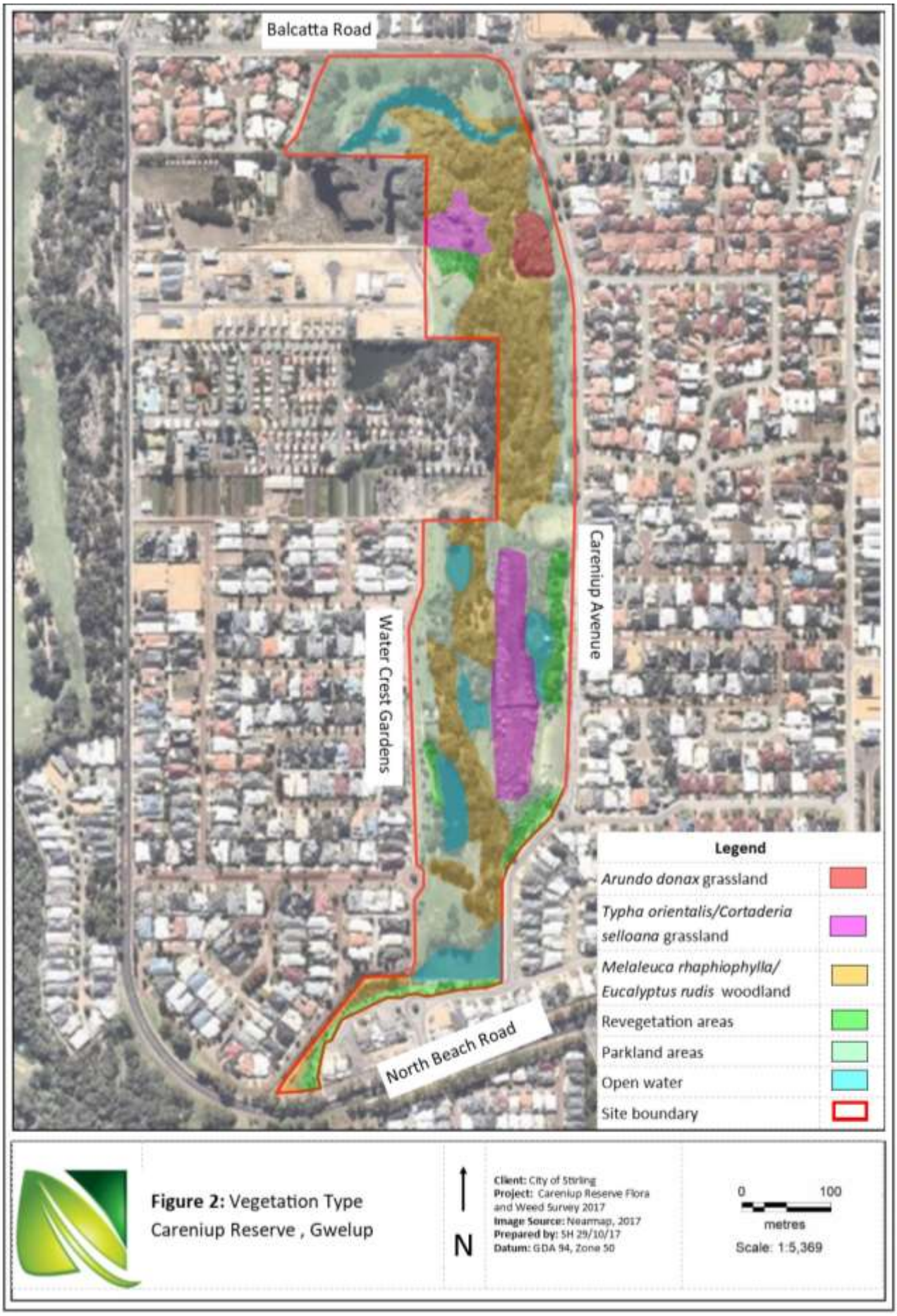
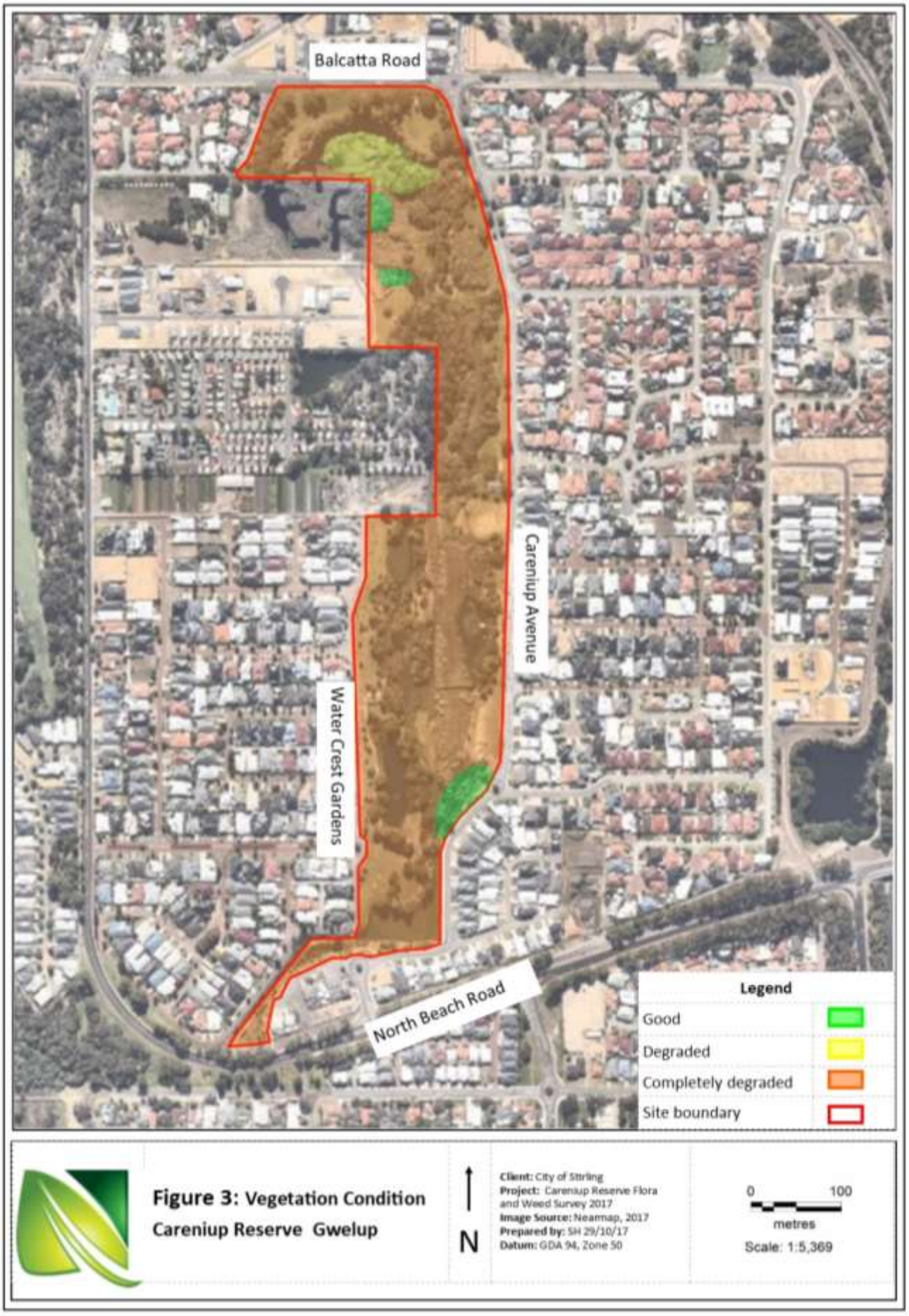


Figure 2: Vegetation Type
Careniup Reserve , Gwelup


Balcatta Road
Careniup Avenue
Water Crest Gardens
North Beach Road
Legend
Good
Degraded
Completely degraded
Site boundary
Figure 3: Vegetation Condition
Careniup Reserve Gwelup
N
Client: City of Stirling
Project: Careniup Reserve Flora and Weed Survey 2017
Image Source: Nearmap, 2017
Prepared by: SH 29/10/17
Datum: GDA 94, Zone 50
0
100
metres
Scale: 1:5,369

3.3 Native Flora Species

The flora survey identified 117 species from 43 families. Of these, 34 were native flora species from 13 families (Table 3), with none being declared rare under the *Wildlife Conservation Act 1950* (WA) or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth); none were listed as priority species under the *Wildlife Conservation Act 1950* (WA).

Table 3: Native species

Family	Species Name	Common Name
Fabaceae	*Acacia cyclops*	Coastal Wattle
Fabaceae	*Acacia saligna* (planted)	Orange Wattle
Proteaceae	*Adenanthos sericeus***	Woolly Bush
Myrtaceae	*Agonis flexuosa*	Peppermint
Proteaceae	*Banksia ilicifolia* (planted)	Holly-leaved Banksia
Cyperaceae	*Baumea articulata*	Jointed rush
Cyperaceae	*Baumea juncea*	Bare Twigrush
Cyperaceae	*Bolboschoenus caldwellii*	Marsh Club-rush
Cupressaceae	*Callitris preissii*	Rottnest Island Pine
Myrtaceae	*Calothamnus quadrifidus* (planted)	One-sided Bottlebrush
Scrophulariaceae	*Eremophila glabra* (planted)	Snakebush
Myrtaceae	*Eucalyptus rudis*	Flooded Gum
Proteaceae	*Grevillea bipinnatifida***	Fuchsia Grevillea
Proteaceae	*Grevillea thelemanniana* (planted)	
Fabaceae	*Hardenbergia comptoniana*	Native Wisteria
Lamiaceae	*Hemiandra pungens* (planted)	
Cyperaceae	*Isolepis cernua var. setiformis*	
Fabaceae	*Jacksonia furcellata*	Grey Stinkwood
Juncaceae	*Juncus pallidus*	Pale Rush
Myrtaceae	*Kunzea glabrescens* (planted)	
Araceae	*Lemna disperma*	Duckweed
Cyperaceae	*Lepidosperma gladiatum*	Coastal Sword-sedge
Myrtaceae	*Melaleuca huegelii*	Chenille Honeymyrtle
Myrtaceae	*Melaleuca lanceolata*	Rottnest Teatree
Myrtaceae	*Melaleuca preissiana*	Moonah
Myrtaceae	*Melaleuca rhaphiophylla*	
Myrtaceae	*Melaleuca sp.* (planted)	
Iridaceae	*Patersonia occidentalis* (planted)	Purple Flag
Polygonaceae	*Persicaria decipiens*	
Thymelaeaceae	*Pimelea rosea* (planted)	Rose Banjine
Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Cyperaceae	*Schoenoplectus tabernaemontani*	Lake Club Rush
Fabaceae	*Templetonia retusa*	Cockies Tongue
Lamiaceae	*Westringia dampieri* (planted)	

** non-endemic WA natives

3.4 Non-native Flora Species

A total of 83 non-native species from 38 families were recorded during the survey (Table 5). In providing this list, it is recognised that the City of Stirling will use the information to guide weed treatment within the Reserve, and that some weeds will be retained in nominated locations for aesthetic and community reasons.

Weeds of National Significance (WoNS) are species that have been identified by the Australian Government based on invasiveness, potential for range expansion, as well as environmental, social and economic impacts (Weeds Australia, 2017). Blackberry (*Rubus laudatus*) is a WoNS, and a significant population was found within Careniup Reserve during the survey. Pencil Willow (*Salix humboldtiana* 'Pyramidalis') was the second WoNS recorded on site, although this species will not be included in the priority list as the City do not want to remove it as it is a landmark within the site and is not currently recruiting or increased in density.

Three weeds are listed as declared pests on the Western Australian Organism List (WAOL) (*Biosecurity and Agriculture Management Act 2007* (WA)); two are C3 pests requiring management to alleviate harmful impacts, reduce numbers, reduce distribution or to prevent or contain their spread (*Zantedeschia aethiopica*, Arum Lily; and *Moraea flaccida*, One-leaf Cape Tulip). The Blackberry (*Rubus laudatus*) is listed under the C1, C2 and C3, which means it should be excluded and eradicated. Management categories are listed in Table 4.

Table 4: Management categories for declared plants

Category	Action
C1	**Exclusion:** includes species that are not yet established in Western Australia and control measures are to be taken to prevent them entering and establishing
C2	**Eradication:** present in low enough numbers or in sufficiently limited areas that eradication is feasible
C3	**Management:** established in Western Australia and it is feasible or desirable to manage them in order to limit damage. Control includes the prevention of population size or density increasing or moving into an area where it currently doesn't occur

Source: *Biosecurity and Agriculture Management Act 2007* (WA)

Table 5: Weed species

Family	Species Name	Common Name	BAM Act	WoNS
Fabaceae	*Acacia iteaphylla**	Flinders Range Wattle		
Araucariaceae	*Araucaria heterophylla**	Norfolk Island Pine		
Poaceae	*Arundo donax**	Giant Reed		
Poaceae	*Avena barbata**	Bearded Oat		
Plantaginaceae	*Bacopa monnieri**			
Brassicaceae	*Brassica tournefortii**	Mediterranean Turnip		
Poaceae	*Bromus catharticus**	Prairie Grass		
Myrtaceae	*Callistemon sp.**			
Brassicaceae	*Cardamine hirsuta**	Common Bittercress		
Casuarinaceae	*Casuarina glauca**			

Family	Species Name	Common Name	BAM Act	WoNS
Casuarinaceae	*Casuarina obesa**			
Poaceae	*Cenchrus clandestinus**	Kikuyu Grass		
Asteraceae	*Cirsium vulgare**	Spear Thistle		
Asteraceae	*Conyza sumatrensis**	Tall Fleabane		
Poaceae	*Cortaderia selloana**	Pampas Grass		
Asteraceae	*Cotula turbinata**	Funnel Weed		
Poaceae	*Cynodon dactylon**	Couch Grass		
Cyperaceae	*Cyperus congestus**	Dense Flat-sedge		
Cyperaceae	*Cyperus eragrostis**	Umbrella Sedge		
Poaceae	*Ehrharta longiflora**	Annual Veldt Grass		
Geraniaceae	*Erodium botrys**	Long Storksbill		
Myrtaceae	*Eucalyptus 1**			
Myrtaceae	*Eucalyptus 2**			
Euphorbiaceae	*Euphorbia terracina**	Geraldton Carnation Weed		
Euphorbiaceae	*Euphorbia peplus**	Petty Spurge		
Moraceae	*Ficus carica**	Common Fig		
Apiaceae	*Foeniculum vulgare**	Fennel		
Papaveraceae	*Fumaria capreolata**	Whiteflower Fumitory		
Aizoaceae	*Galenia pubescens**	Coastal Galenia		
Asteraceae	*Gazania rigens**			
Geraniaceae	*Geranium molle**	Dove's Foot		
Iridaceae	*Gladiolus undulatus**	Wild Gladiolus		
Araliaceae	*Hydrocotyle bonariensis**			
Asteraceae	*Hypochaeris glabra**	Smooth Catsear		
Asteraceae	*Hypochaeris radicata**	Flat Weed		
Convolvulaceae	*Ipomoea cairica**	Coast Morning Glory		
Asteraceae	*Lactuca serriola**	Prickly Lettuce		
Myrtaceae	*Leptospermum laevigatum**	Victorian Teatree		
Poaceae	*Lolium rigidum**	Wimmera Ryegrass		
Asparagaceae	*Lomandra longifolia* (landscape)*			
Fabaceae	*Lupinus cosentinii**	Blue Lupin		
Primulaceae	*Lysimachia arvensis**	Pimpernel		
Lythraceae	*Lythrum hyssopifolia**	Lesser Loosestrife		
Malvaceae	*Malva parviflora**	Marshmallow		
Fabaceae	*Medicago polymorphus**	Burr Medic		
Myrtaceae	*Melaleuca quinquenervia**			
Fabaceae	*Melilotus indicus**			
Lamiaceae	*Mentha spicata**	Spearmint		

Family	Species Name	Common Name	BAM Act	WoNS
Iridaceae	*Moraea flaccida**	One-leaf Cape Tulip	C3	
Solanaceae	*Nicotiana glauca**	Tree Tobacco		
Nymphaeaceae	*Nymphaea sp.**	Water Lily		
Onagraceae	*Oenothera drummondii**	Beach Evening Primrose		
Oleaceae	*Olea europaea**	Olive		
Orobanchaceae	*Orobanche minor**	Lesser Broomrape		
Oxalidaceae	*Oxalis pes-caprae**	Soursob		
Poaceae	*Paspalum dilatatum**			
Apiaceae	*Petroselinum crispum**	Parsley		
Araliaceae	*Phoenix canariensis**	Canary Island Date Palm		
Poaceae	*Piptatherum miliaceum**	Rice Millet		
Fabaceae	*Pisum sp.**	Pea		
Plantaginaceae	*Plantago lanceolata*	Ribwort Plantain		
Ranunculaceae	*Ranunculus trilobus**	Buttercup		
Brassicaceae	*Raphanus raphanistrum*	Wild Radish		
Euphorbiaceae	*Ricinus communis**	Castor Oil Plant		
Brassicaceae	*Rorippa nasturtium-aquaticum**	Watercress		
Rosaceae	*Rubus laudatus**	Blackberry	C1, C2, C3	Y
Polygonaceae	*Rumex crispus**	Curled Dock		
Salicaceae	*Salix babylonica**	Weeping Willow		
Salicaceae	*Salix humboldtiana 'Pyramidalis'**	Pencil Willow		Y
Anacardiaceae	*Schinus terebinthifolius**	Japanese Pepper		
Asteraceae	*Senecio vulgaris**	Common Groundsel		
Solanaceae	*Solanum nigrum**	Black Berry Nightshade		
Asteraceae	*Sonchus asper**	Rough Sowthistle		
Asteraceae	*Sonchus oleraceus**	Common Sowthistle		
Lamiaceae	*Stachys arvensis**	Staggerweed		
Caryophyllaceae	*Stellaria media**	Chickweed		
Poaceae	*Stenotaphrum secundatum**	Buffalo Grass		
Asteraceae	*Symphyotrichum squamatum**	Bushy Starwort		
Typhaceae	*Typha orientalis**	Bulrush		
Asteraceae	*Verbesina encelioides**	Crownbeard		
Fabaceae	*Vicia sativa**	Common Vetch		
Arecaceae	*Washingtonia filifera**	Cotton Palm		
Araceae	*Zantedeschia aethiopica**	Arum Lily	C3	

3.4.1 Weed Maps

Weed maps are presented in this section as follows:

- **4** and **5**: woody weeds
- **6 – 11**: low density weeds
- **12**: Morning Glory (*Ipomoea cairica*)
- **13**: *Hydrocotyle bonariensis*
- **14** and **15**: grass weeds
- **16**: large weedy grasses and rushes
- **17 – 19**: high density weeds.

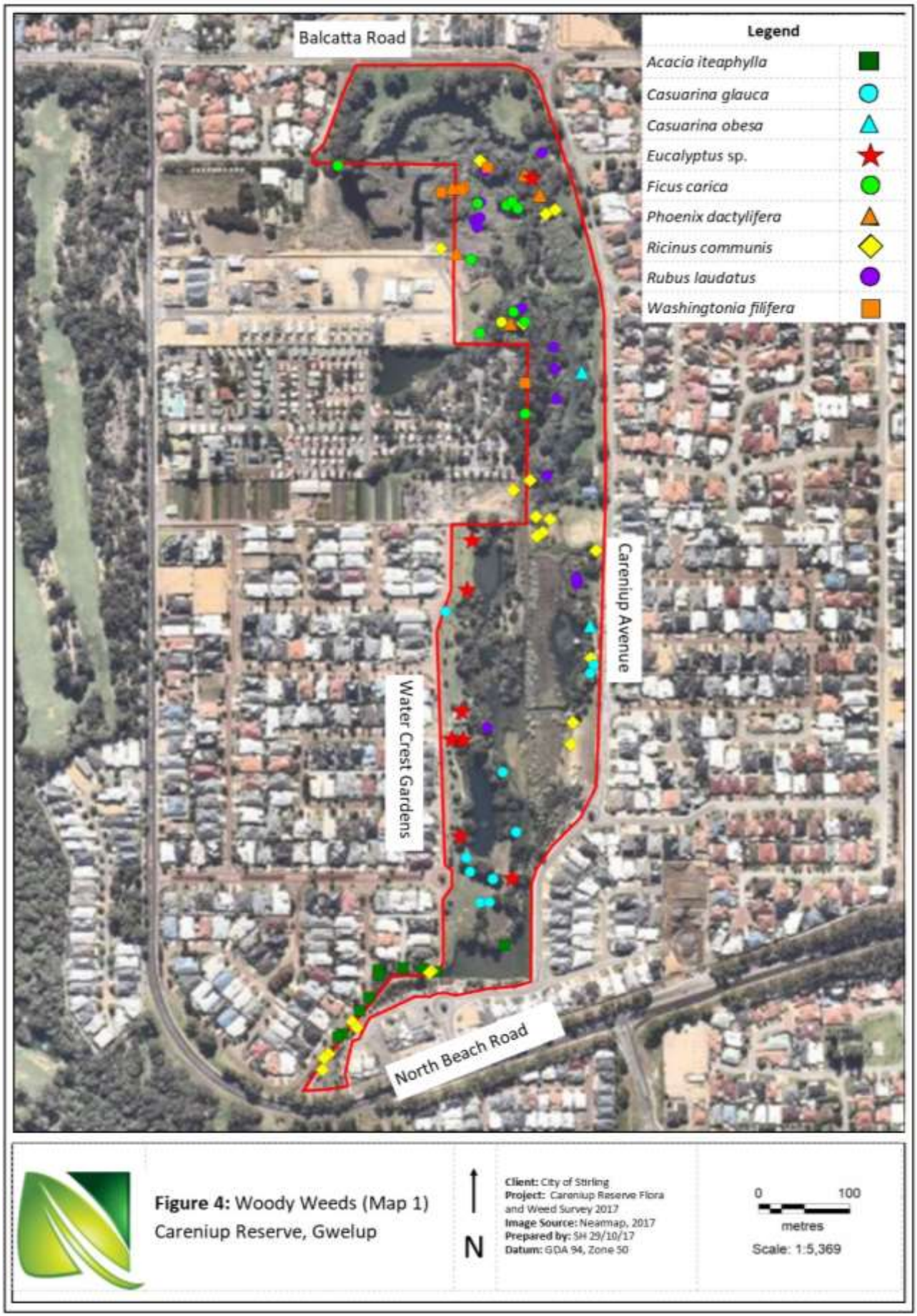


Figure 4: Woody Weeds (Map 1) Careniup Reserve, Gwelup

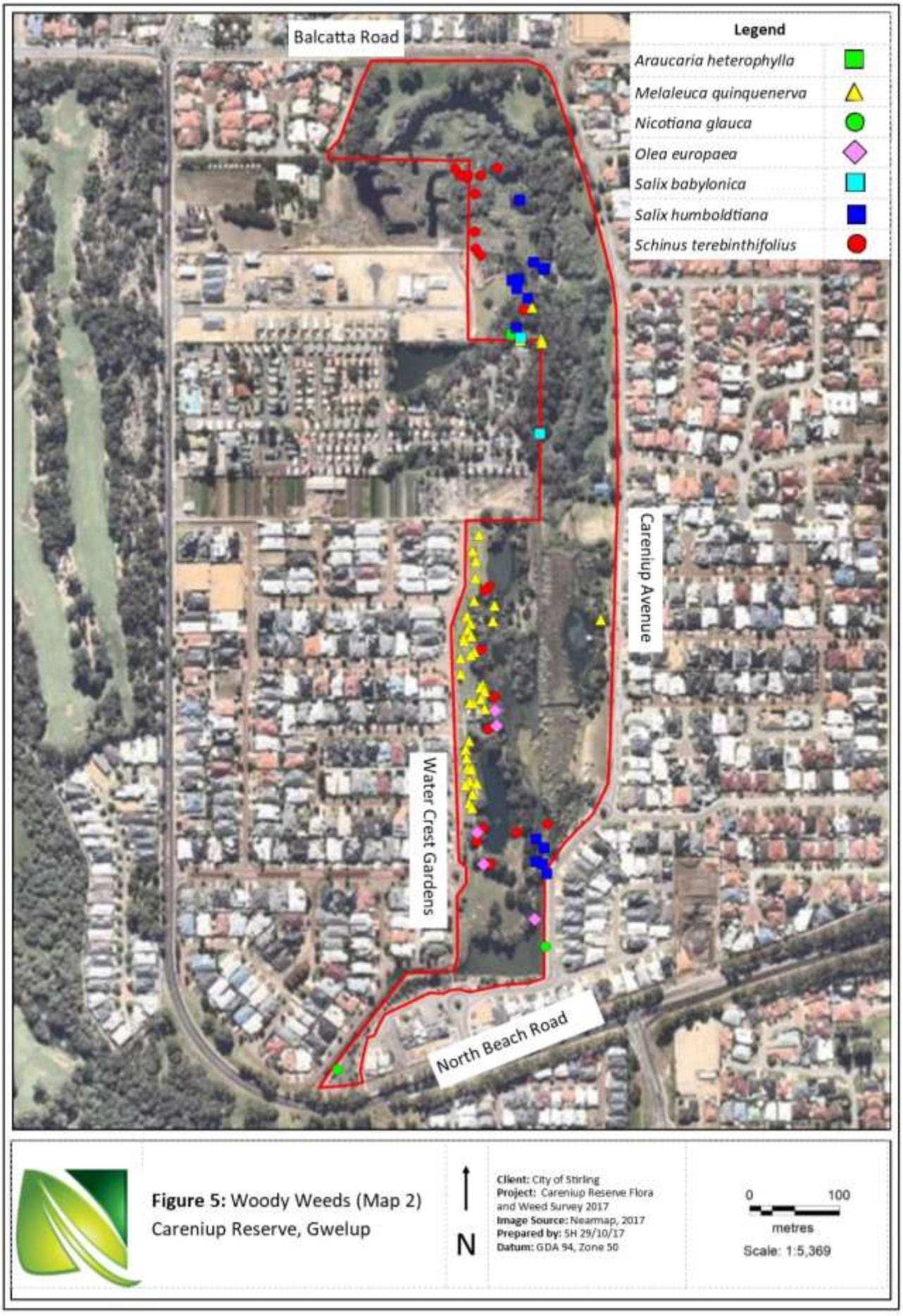


Figure 5: Woody Weeds (Map 2)
Careniup Reserve, Gwelup

Figure 6: Low Density Weeds (Map 1)
Careniup Reserve, Gwelup

Figure 7: Low Density Weeds (Map 2)
Careniup Reserve, Gwelup

Figure 8: Low Density Weeds (Map 3)
Careniup Reserve, Gwelup

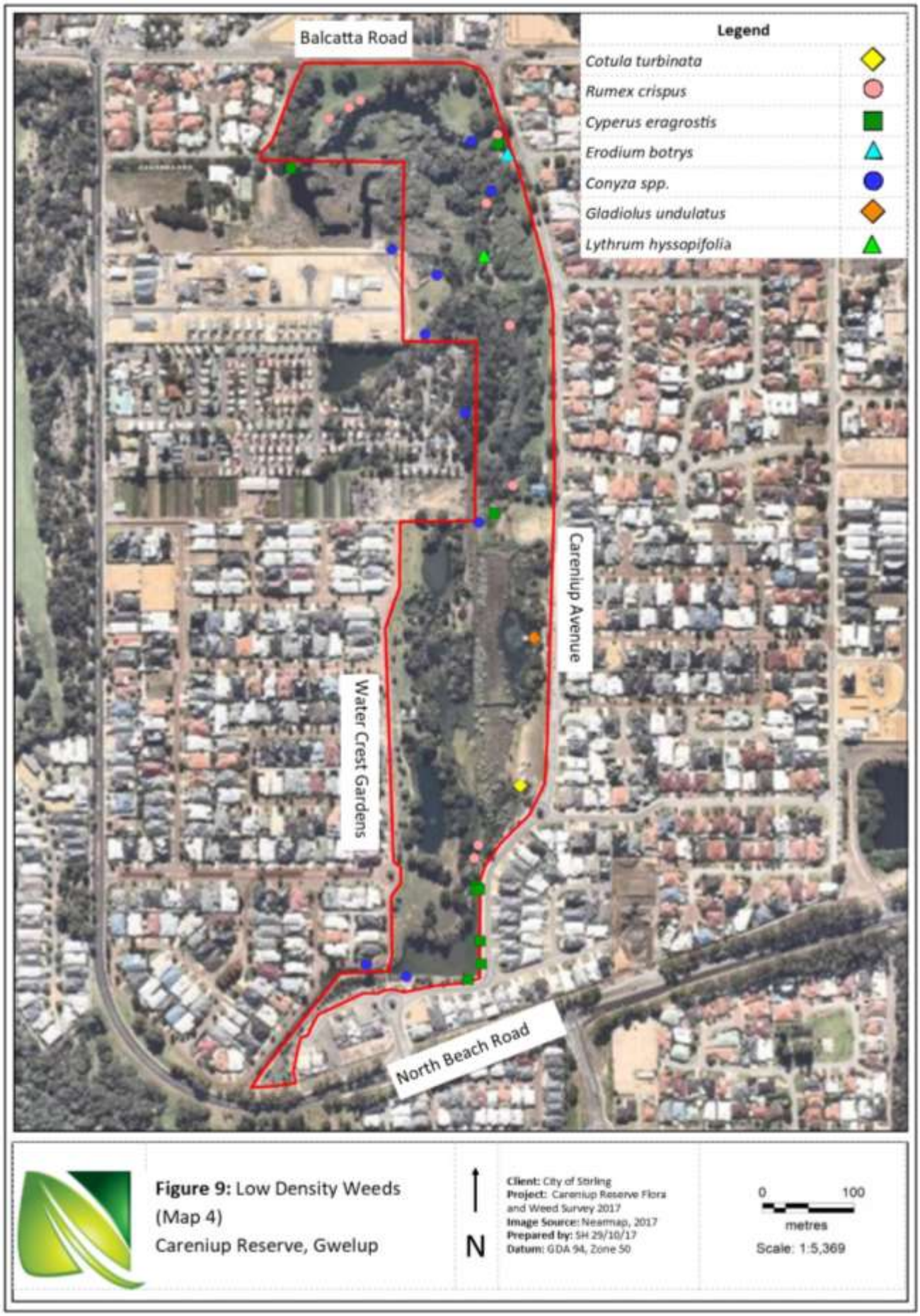


Figure 9: Low Density Weeds (Map 4)
Careniup Reserve, Gwelup

Figure 10: Low Density Weeds (Map 5)
Careniup Reserve, Gwelup

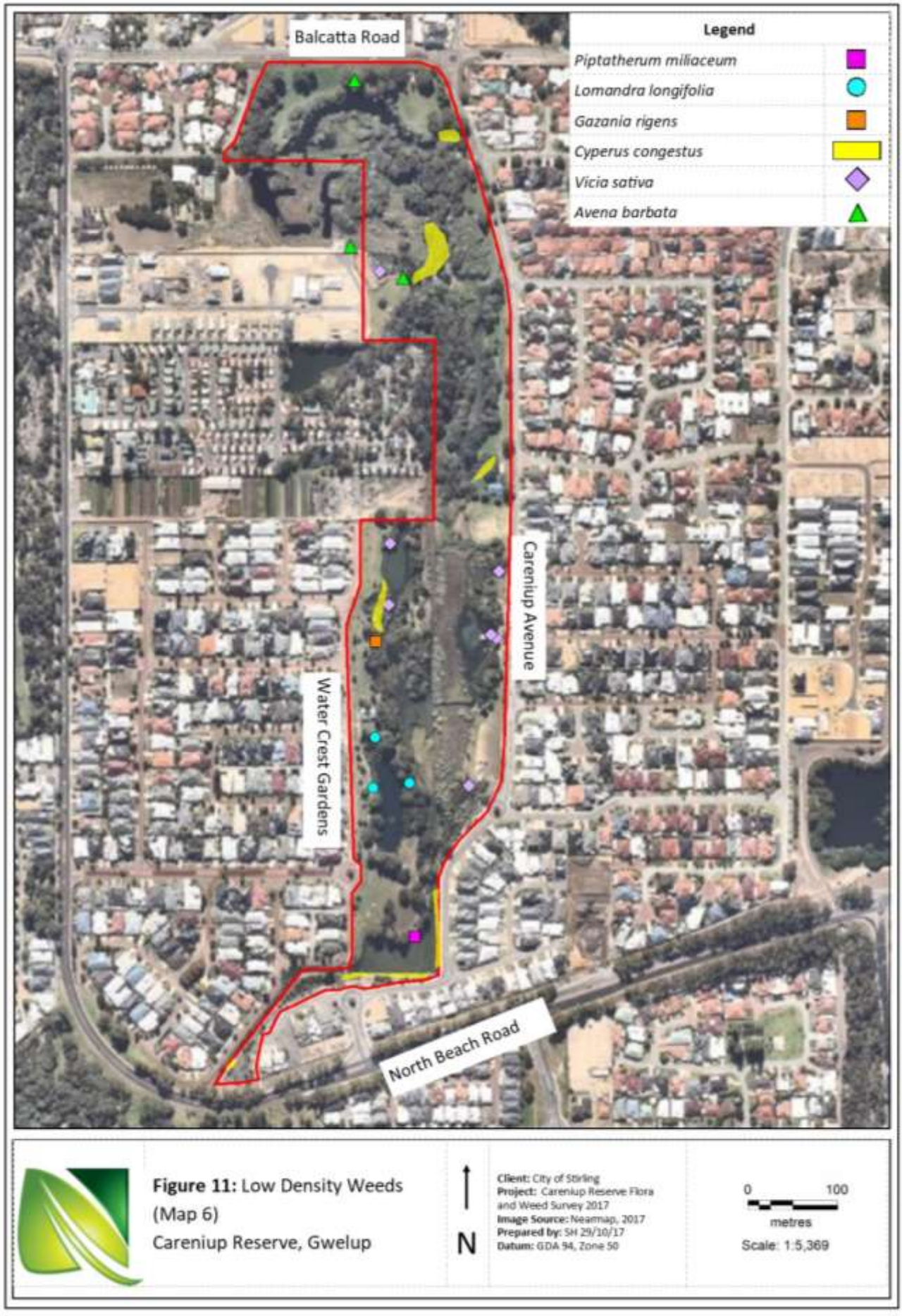

Balcatta Road
Careniup Avenue
Water Crest Gardens
North Beach Road
Legend
Piptatherum miliaceum
Lomandra longifolia
Gazania rigens
Cyperus congestus
Vicia sativa
Avena barbata
Figure 11: Low Density Weeds (Map 6)
Careniup Reserve, Gwelup
N
Client: City of Stirling
Project: Careniup Reserve Flora and Weed Survey 2017
Image Source: Nearmap, 2017
Prepared by: SH 29/10/17
Datum: GDA 94, Zone 50
0
100
metres
Scale: 1:5,369

Figure 12: Morning Glory (*Ipomoea cairica*) density Careniup Reserve, Gwelup

Figure 13: *Hydrocotyle bonariensis* density Careniup Reserve, Gwelup

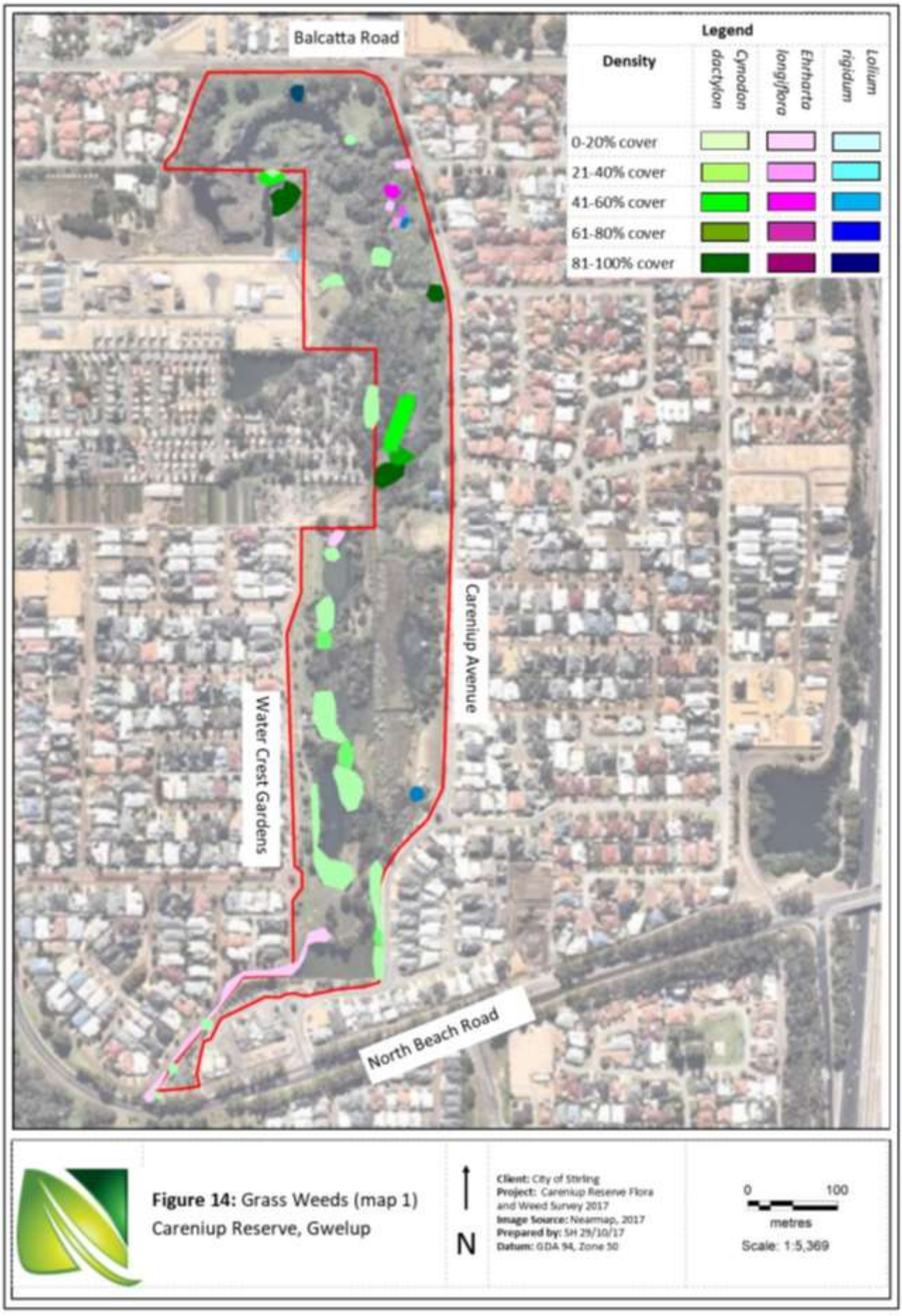


Figure 14: Grass Weeds (map 1) Careniup Reserve, Gwelup

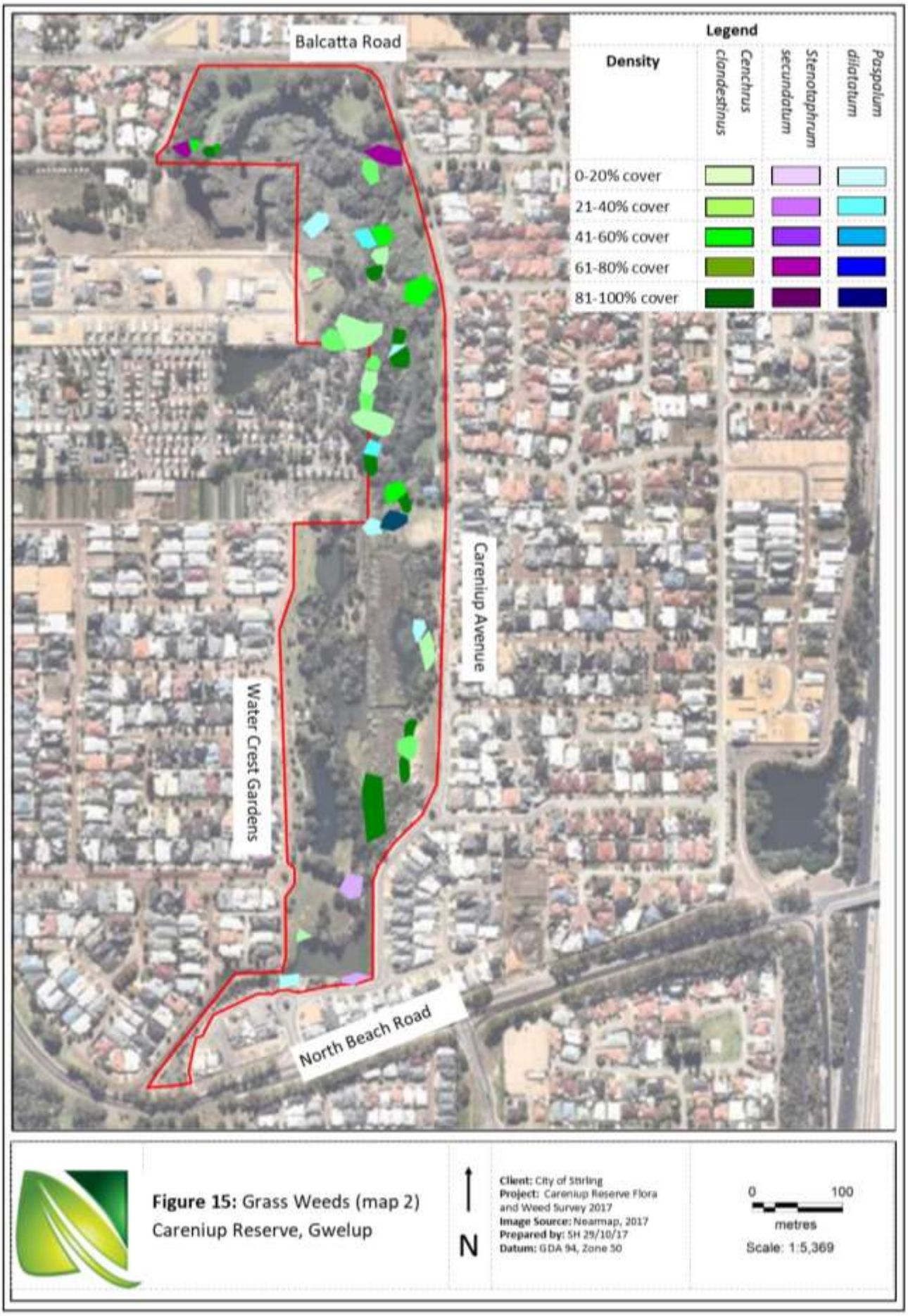


Figure 15: Grass Weeds (map 2) Careniup Reserve, Gwelup

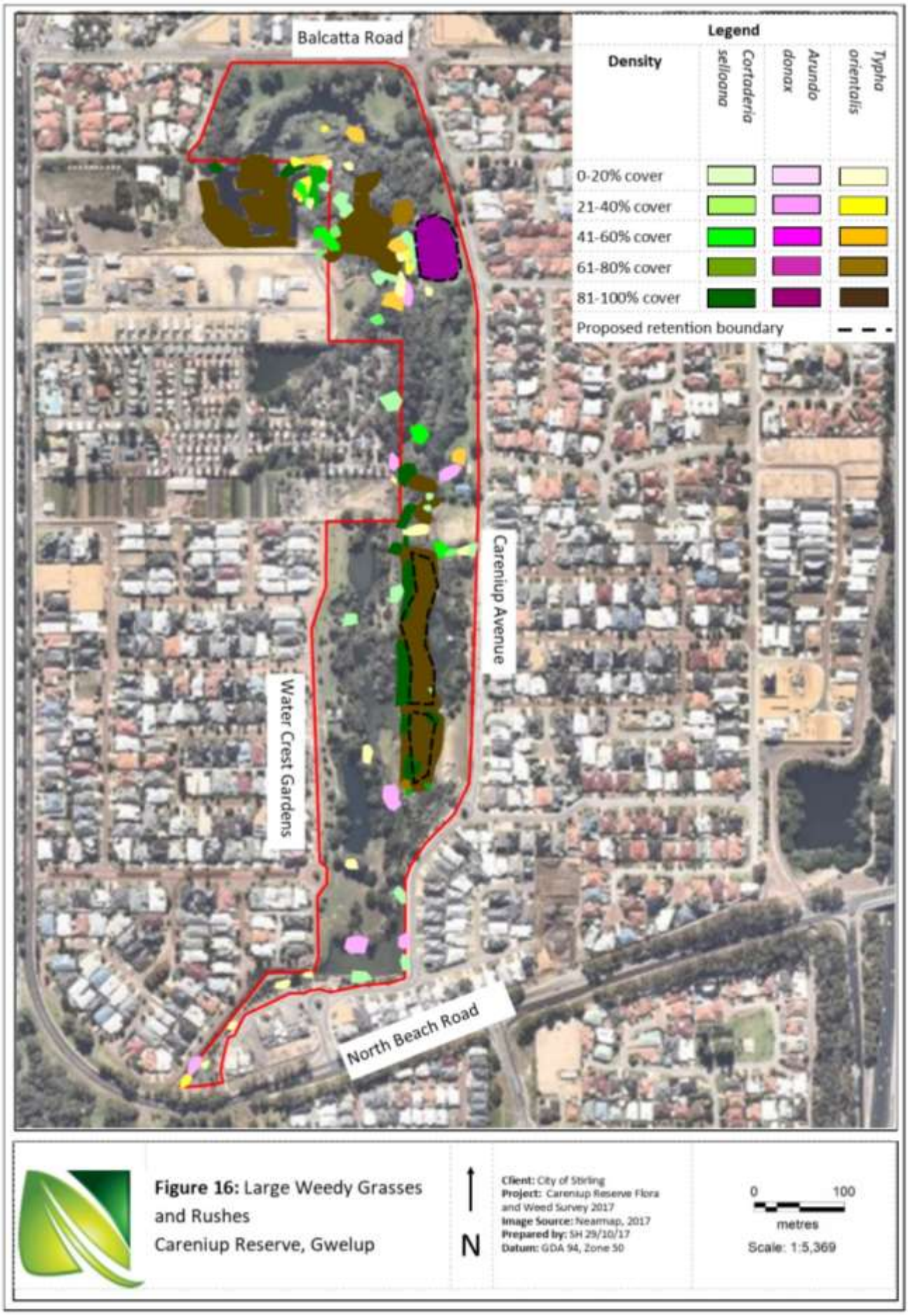


Figure 16: Large Weedy Grasses and Rushes
Careniup Reserve, Gwelup

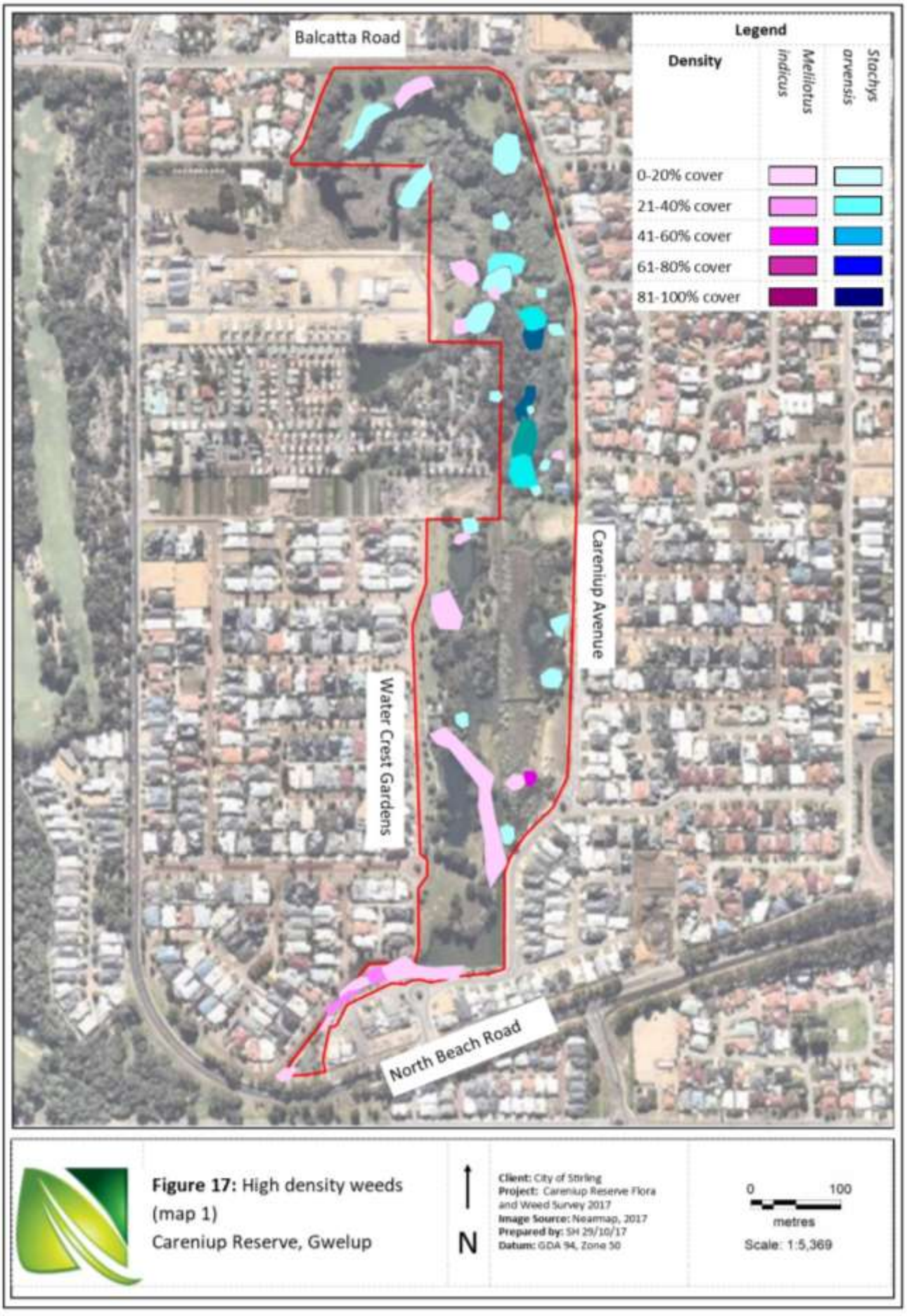


Figure 17: High density weeds (map 1)
Careniup Reserve, Gwelup

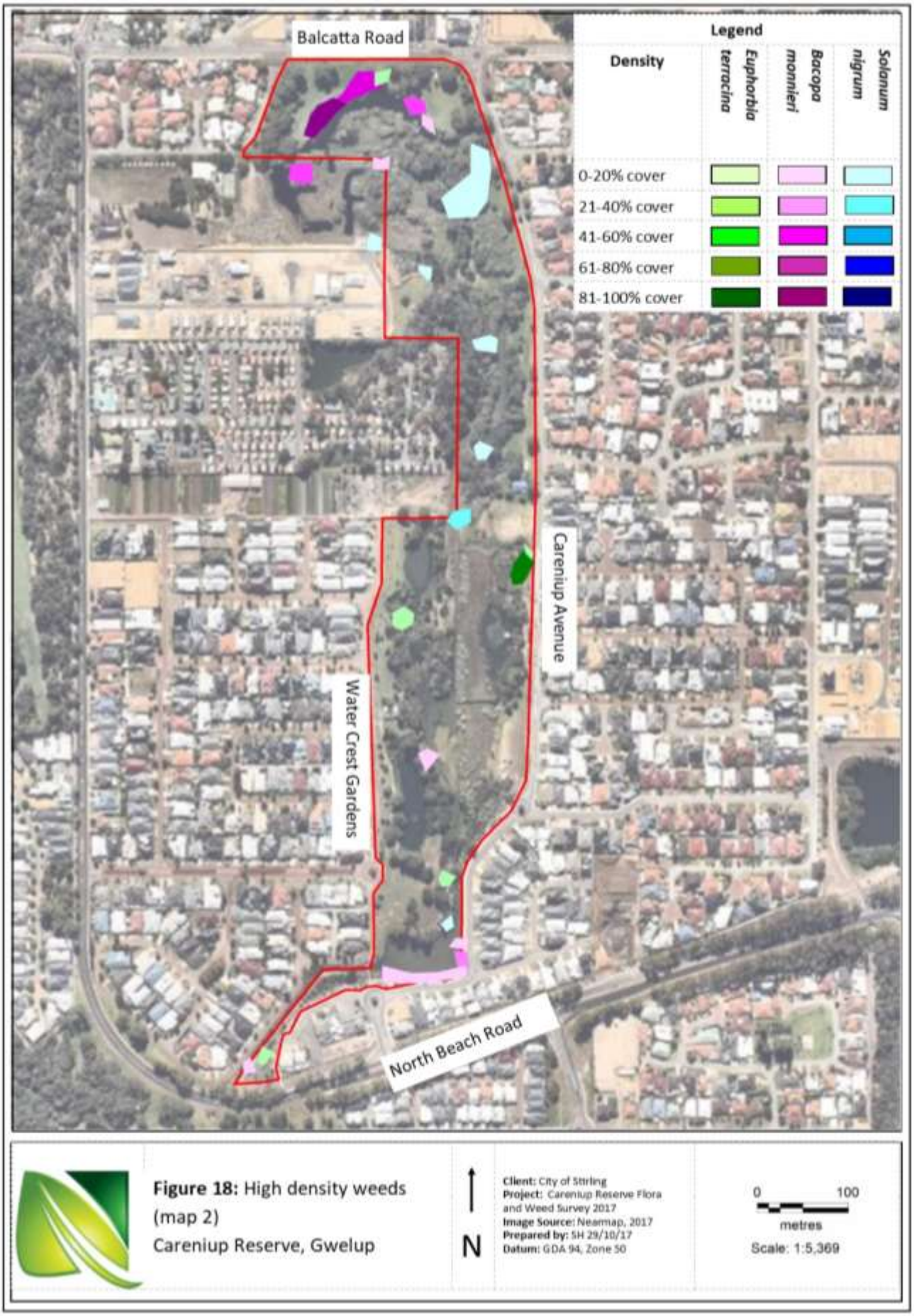


Figure 18: High density weeds (map 2)
Careniup Reserve, Gwelup

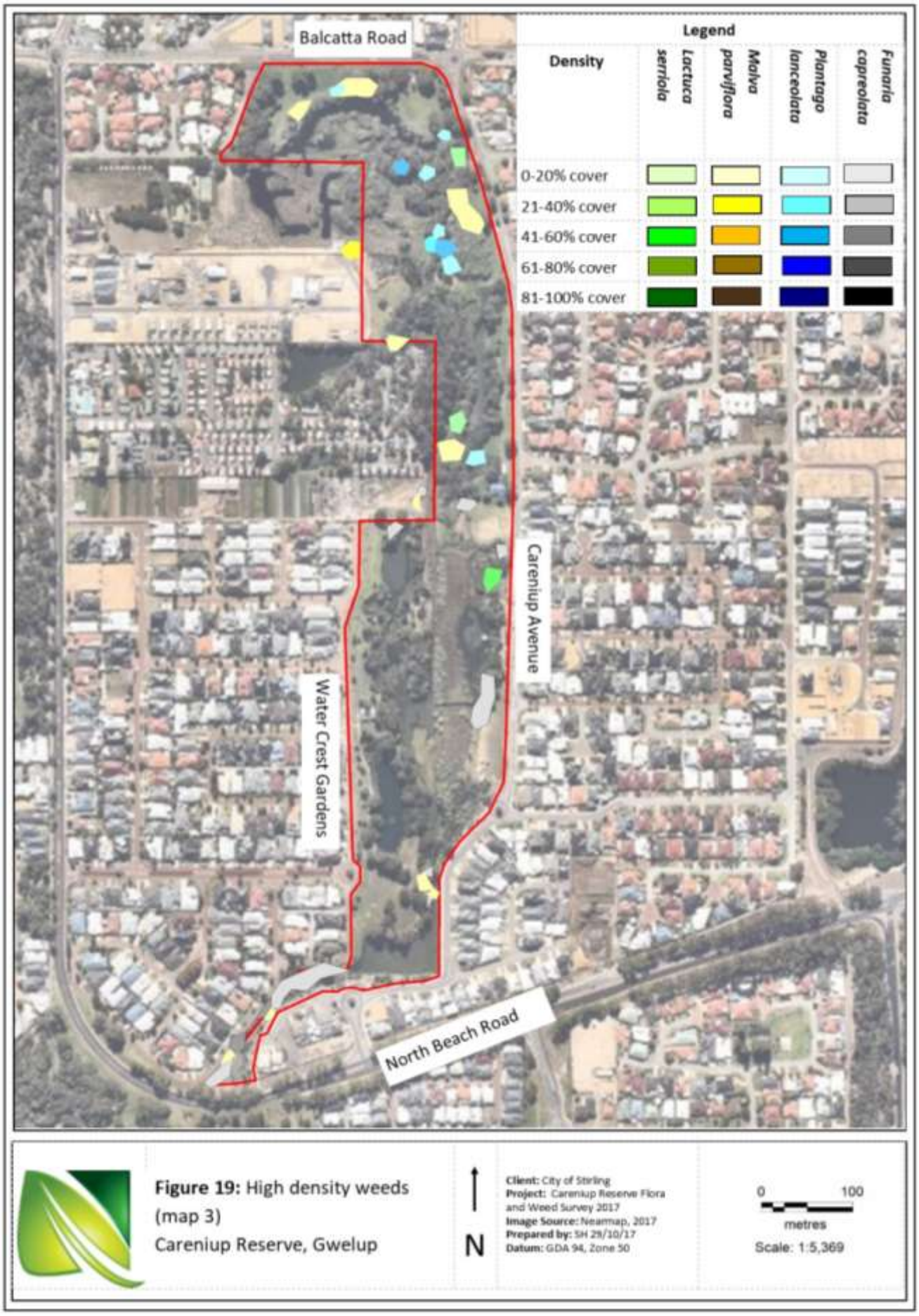


Figure 19: High density weeds (map 3)
Careniup Reserve, Gwelup

4.0 References

Biosecurity and Agriculture Management Act 2007 (WA)

Department of Agriculture and Food WA, (2017), *Western Australian Organism List*, accessed August 2017 via https://www.agric.wa.gov.au/bam/western-australian-organism-list-waol.

Department of Biodiversity, Conservation and Attractions, (2017), *FloraBase*, accessed August 2017 via https://florabase.dpaw.wa.gov.au/

Weeds Australia, (2017), *Weeds of National Significance*, accessed August 2017 via http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/lists/wons.html.

Appendix 3: Weed Treatment Strategy

City of Stirling

Careniup Reserve Weed Treatment Strategy 2021

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Location	Client Folders NAC V2\City of Stirling\Careniup Management Plan\2021				
Draft/Version No.	**Date**	**Changes**	**Prepared by**	**Approved by**	**Status**
D1	March 2021	New document	KG, JW	SH	Draft for client review and comment
D2	April 2021	Appendix 2	LP	BC	Submitted to client

Executive Summary

Natural Area Consulting Management Services (Natural Area) was commissioned by the City of Stirling to revise the Weed Treatment Strategy for Careniup Reserve, Gwelup (Natural Area, 2018). With the updated weed mapping to include the Secret Garden site as well as updating the weed species currently found within the site. Careniup Reserve includes remnant native wetland areas and surrounding parkland reserves. The remnant bushland present is in a degraded state with a high abundance of weeds, particularly in the understorey. However, these weeds have a high value for the community with the Secret Garden and the Giant Reed Garden being local tourist attractions and a sought-after landscape for photographers.

Preparation of the Weed Treatment Strategy included the following:

- on-ground weed mapping
- identifying weed treatment suites (grass, woody, herbaceous)
- prioritising weeds for control according to national, state and local weed prioritisation strategies.

The weed mapping survey confirmed:

- a total of 65 weeds species present across 37 families
- presence of two Weeds of National Significant (WoNS); Blackberry (*Rubus laudatus*) and Pencil Willow (*Salix humboldtiana* 'pyramidalis')
- presence of one declared pest, Blackberry (*Rubus laudatus*)
- 27 priority weeds species including 11 Very High and 16 High priority weed species.

Weed control should be focused on the priority weed species based on their high ecological impact ratings and potential invasiveness. An indicative three-year schedule to treat the priority weeds is outlined within this strategy.

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1.0 Introduction

Natural Area Consulting Management Services (Natural Area) was commissioned by the City of Stirling (the City) to revise and update the Weed Treatment Strategy for Careniup Reserve in Gwelup, to include the Secret Garden site and record any changes to the weed species since previous mapping in 2018 (Natural Area, 2018). Outcomes are presented in this report, along with recommendations for weed control priorities and treatment options for the various species recorded and a treatment plan.

1.1 Site

The site is approximately 15.6 ha of parkland and wetland reserve, with the site located 11 km north of Perth's Central Business District (Figure 1). The site extends from Balcatta Road in the north, Careniup Avenue to the east, Hanlin Court and Grimwood Avenue to the south, and Water Crest Gardens to the west. It includes Careniup Reserve, Careniup Balcatta Reserve, Careniup Exmouth Reserve, Water Crest Reserve, the Secret Garden, Willows Estate along with the surrounding public and community open spaces.

1.2 Weeds

Environmental weeds are flora species that occur outside their normal distribution and tend to out-compete native species. They can include species from other countries, other Australian states or other regions within Western Australia. Management of weeds often require some form of action to reduce harmful effects on the economy, the environment, human health and amenity.

Weeds are often characterised by broad ecological traits and treated accordingly:

- Grasses: grass species such as Kikuyu (*Cenchrus clandestinus*) and Couch (*Cynodon dactylon*) can be targeted with a grass selective herbicide that only target species within the Poaceae family. Grass selective herbicides can negatively affect native grasses.
- Herbaceous weeds: non-woody, non-grassy, non-bulbiferous species that can be treated with a non-selective herbicide. Some common species includes Fleabane (*Erigeron sumatrensis*) and Prickly Lettuce (*Lactuca serriola*).
- Woody weeds: species such as the Common Fig (*Ficus carica*) or weedy Acacias (*Acacia* sp.) with woody stems, can be treated with a range of methods including basal barking, stem injection or cut and paint. Treatment methods can be dependent on species characteristics as cut and paint is not the preferred treatment for suckering species.
- Geophytes: species with subterranean organs such as bulbs, corms or tubers which may function as storage organs. Both mechanical and chemical can be utilised depending on species and size of weed infestation.
- Weeds can also be described as perennial or annual, which relates to their life cycle. Annual weeds complete their life cycle in one growing season while perennials are capable of growth over a number of years and several seasons.

1.3 Objectives

The main objective of the weed treatment strategy is to provide an updated species list of weeds present within Careniup Reserve and to include additional adjacent sites, including Secret Garden. The weed treatment strategy aims to:

- identify and prioritise weed species for management
- identify weed treatment suites (e.g. grasses, geophytes, woody weeds)
- determine a three-year treatment program.

Figure 1
Careniup Reserve, Gwelup

0 100 200 m

N

Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94

2.0 Methodology

2.1 On-ground Methodology

Weed mapping was undertaken by Natural Area Botanist Taryn Brebner and assistant Karri Grant, over two days, on 17 and 18 February 2021. Weed mapping focussed on all weeds present within the reserve and was conducted in accordance with *SOP No:22.1 Techniques for mapping weed distribution and cover in bushland and wetlands* (Department of Environment and Conservation, 2011).

Weed mapping activities included:

- traversing the site on foot with weed species recorded at each reserve using a tablet device equipped with GIS mapping software (Mappt); common and scientific names were recorded along with the location in the reserve; grass weeds in managed turf areas were avoided in the mapping
- recording species density using either a point or polygon, using the Department of Environment and Conservation density categories:
    - <5%
    - 6 - 75%
    - 76 - 100%
- sampling or photographing unfamiliar species to enable later identification.

2.2 Limitation

This weed survey was undertaken during late summer, which is not the optimal time for weed mapping. Due to the timing of the survey there is the potential for some species to not be visible at the time of mapping. This can be due to certain weed species senescing during the warmer months e.g. Bridal Creeper (*Asparagus asparagoides*). Despite this limitation, Natural Area believes 80 - 90% of weed species were identified.

3.0 Results

During the survey, a total of 65 weed species from 37 families were recorded (Table 1). Of the species identified, two are classed as Weeds of National Significance (WoNS) and one is listed as a declared pest; these are:

- *Rubus laudatus* (WoNS and declared pest)
- *Salix humboldtiana 'pyramidalis'* (WoNS).

All weed species recorded during the 2021 survey have been classified by treatment suites based on their life form and growth traits and optimal treatment method (Table 1). For example, Giant Reed (*Arundo donax)* is a grass, but was classified as a woody weed as the treatment method for this species is the same as woody weeds. Overall, 33 species were classified as herbaceous weeds, 20 woody weeds, seven grasses, two geophytes and three aquatic weeds.

Table 1: Weed species list and corresponding treatment suites

Treatment Suite	Family	Species Name	Common Name
Aquatic			
	Plantaginaceae	*Bacopa monnieri*	
	Nymphaeaceae	*Nymphaea mexicana*	Yellow Waterlily
	Brassicaceae	*Rorippa nasturtium-aquaticum*	Watercress
Geophyte			
	Papaveraceae	*Fumaria capreolata*	Whiteflower Fumitory
	Oxalidaceae	*Oxalis pes-caprae*	Soursob
Grass			
	Poaceae	*Bromus catharticus*	Prairie Grass
	Poaceae	*Cenchrus clandestinus*	Kikuyu
	Poaceae	*Cynodon dactylon*	Couch
	Poaceae	*Echinochloa crus-galli*	Barnyard Grass
	Poaceae	*Lolium rigidum*	Wimmera Ryegrass
	Poaceae	*Paspalum dilatatum*	Paspalum
	Poaceae	*Stenotaphrum secundatum*	Buffalo Grass
Herbaceous			
	Chenopodiaceae	*Atriplex prostrata*	Hastate Orache
	Chenopodiaceae	*Chenopodium album*	Fat Hen
	Chenopodiaceae	*Chenopodium glaucum*	Glaucous Goosefoot
	Asteraceae	*Cirsium vulgare*	Spear Thistle

Treatment Suite	Family	Species Name	Common Name
	Rubiaceae	*Coprosma repens*	
	Cucurbitaceae	*Cucumis myriocarpus*	Prickly Paddy Melon
	Cyperaceae	*Cyperus eragrostis*	Umbrella Sedge
	Cyperaceae	*Cyperus tenuiflorus*	Scaly Sedge
	Asteraceae	*Erigeron sumatrensis*	Fleabane
	Euphorbiaceae	*Euphorbia maculata*	
	Euphorbiaceae	*Euphorbia terracina*	Geraldton Carnation Weed
	Apiaceae	*Foeniculum vulgare*	Fennel
	Asteraceae	*Gazania rigens*	
	Asteraceae	*Gazania tomentosa*	
	Asteraceae	*Helianthus annuus*	Sunflower
	Araliaceae	*Hydrocotyle bonariensis*	Largeleaf Pennywort
	Convolvulaceae	*Ipomoea cairica*	Coast Morning Glory
	Juncaceae	*Juncus microcephalus*	
	Asteraceae	*Lactuca serriola*	Prickly Lettuce
	Asparagaceae	*Lomandra longifolia*	Spiny-head Mat-rush
	Fabaceae	*Lupinus angustifolius*	Narrowleaf Lupin
	Malvaceae	*Malva parvifolia*	Marshmallow
	Fabaceae	*Melilotus indicus*	
	Lamiaceae	*Mentha x piperita var. citrata*	
	Onagraceae	*Oenothera drummondii*	Beach Evening Primrose
	Geraniaceae	*Pelargonium capitatum*	Rose Pelargonium
	Polygonaceae	*Persicaria lapathifolia*	
	Verbenaceae	*Phyla nodiflora*	
	Plantaginaceae	*Plantago major*	Greater Plantain
	Solanaceae	*Solanum nigrum*	Black Berry Nightshade
	Asteraceae	*Sonchus oleraceus*	Common Sowthistle
	Asteraceae	*Symphyotrichum squamatum*	Bushy Starwort
	Tropaeolaceae	*Tropaeolum majus*	Garden Nasturtium
	Asteraceae	*Verbesina encelioides*	Crownbeard
Woody			
	Fabaceae	*Acacia iteaphylla*	Flinders Range Wattle

Treatment Suite	Family	Species Name	Common Name
	Araucariaceae	*Araucaria heterophylla*	Norfolk Island Pine
	Poaceae	*Arundo donax*	Giant Reed
	Myrtaceae	*Callistemon 'Kings Park Special'*	Bottlebrush
	Casuarinaceae	*Casuarina glauca*	Swamp Sheoak
	Poaceae	*Cortaderia selloana*	Pampas Grass
	Moraceae	*Ficus carica*	Common Fig
	Myrtaceae	*Melaleuca quinquenervia*	
	Meliaceae	*Melia azedarach*	White Cedar
	Solanaceae	*Nicotiana glauca*	Tree Tobacco
	Oleaceae	*Olea europaea*	Olive
	Arecaceae	*Phoenix dactylifera*	Date Palm
	Platanaceae	*Platanus x hispanica*	London Plane Tree
	Euphorbiaceae	*Ricinus communis*	Castor Oil Plant
	Rosaceae	*Rubus laudatus*	Blackberry
	Salicaceae	*Salix babylonica*	Weeping Willow
	Salicaceae	*Salix humboldtiana* 'pyramidalis'	Pencil Willow
	Anacardiaceae	*Schinus terebinthifolia*	Japanese Pepper
	Fabaceae	*Tipuana tipu*	Pride of Bolivia

Giant Reed (*Arundo donax)*

Largeleaf Pennywort (*Hydrocotyle bonariensis*)

Blackberry (*Rubus laudatus*); Declared pest, WoNS

Fragrant Water Lily (*Nymphaea odorata)*

Castor Oil Plant (*Ricinus communis)*

Coast Morning Glory (*Ipomoea cairica)*

Figure 2: Examples of weed species recorded within Careniup Reserve

4.0 Weed Prioritisation

4.1 Prioritisation Strategy

To effectively manage resources and to ensure weeds are managed efficiently, weed species within Careniup Reserve have been prioritised based on the risk they pose, impacts they exert on the environment as well as utilising various local, state and national ranking and legal requirements. These include:

- Weeds of National Significant (WoNS) (Cwlth)
- Declared Pest (WA)
- Weed Prioritization Process for Swan Region (Local)
- *City of Stirling Pest Plant Act 2012* (Local).

At a national level, weeds can be listed as a WoNS and they include species that have been identified by the Australian Government based on invasiveness, potential for range expansion, as well as environmental, social and economic impacts. Blackberry (*Rubus laudatus*) and Pencil Willow (*Salix humboldtiana* 'Pyramidalis') are listed as WoNS and were recorded within Careniup Reserve during the 2018 and 2020 weed surveys.

In addition to being listed as a WoNS, Blackberry (*Rubus laudatus*) is also listed as a C3 declared pest on the Western Australian Organism List (WAOL) (*Biosecurity and Agriculture Management Act 2007* (WA), requiring management to alleviate harmful impacts, reduce numbers, reduce distribution or to prevent or contain their spread. Management categories for declared plants are outlined in Table 2.

Table 2: Management categories

Category	Action
C1	**Exclusion**: includes species that are not yet established in Western Australia and control measures are to be taken to prevent them entering and establishing
C2	**Eradication**: present in low enough numbers or in sufficiently limited areas that eradication is feasible
C3	**Management**: established in Western Australia and it is feasible or desirable to manage them in order to limit damage. Control includes the prevention of population size or density increasing or moving into an area where it currently doesn't occur

Source: *Biosecurity and Agriculture Management Act 2007 (WA)*

The Weed Prioritisation Process for Swan Region (WPPSR) (Department of Biodiversity Conservation and Attractions, 2016) is a region-specific guide that assists land managers to prioritise weed treatment, taking into consideration ecological impacts and population densities of a particular species. The WPPSR also accounts for the ability to feasibly control or eradicate a non-native weed species. The complete list of the weeds present within Careniup Reserve and their corresponding impact ratings and invasiveness are rated and outlined in Appendix 1. Of the 65 weed species present, 24 are considered to have high impact, six have medium impact, nine with low impact ratings and the remaining species underdetermined/not rated.
The *City of Stirling Pest Plant Local Law 2012* is a local Act that refers to weed species not outlined in other legislation. Caltrop *(Tribulus terrestris)* is the only weed species listed as a Schedule 1 -Pest Plant within the Act. Caltrop was not recorded within Careniup Reserve during the 2021 survey.

Natural Area has identified the following 27 weed species (Table 3) to have a high impact within Careniup Reserve and should be prioritised for weed management. These species include declared pests, WoNS and high impact rated weed species from the WPPSR. To further streamline and maximise efforts for weed management 'Very High' weed species were identified from the 27 high impact species based on various national, state and local weed prioritisations, along with species densities mapped during the 2021 weed survey. These 11 'Very High' priority species have negative ecological impacts and are currently recorded at moderate to high densities within Careniup Reserve.

Table 3: Priority weed species

Very High Priority		**High Priority**	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Acacia iteaphylla	Flinders Range Wattle	*Bacopa monnieri*	
Arundo donax	Giant Reed	*Bromus catharticus*	
Cenchrus clandestinus	Kikuyu	*Casuarina glauca*	Swamp Sheoak
Cortaderia selloana	Pampas Grass	*Erigeron sumatrensis*	Fleabane
Cynodon dactylon	Couch	*Euphorbia terracina*	Geraldton Carnation Weed
Ipomoea cairica	Coast Morning Glory	*Ficus carica*	Common Fig
Ricinus communis	Castor Oil	*Fumaria capreolata*	Whiteflower Fumitory
Rubus laudatus	Blackberry	*Hydrocotyle bonariensis*	Largeleaf Pennywort
Salix humboldtiana 'Pyramidalis'	Pencil Willow	*Pelargonium capitatum*	Rose Pelargonium
Schinus terebinthifolia	Japanese Pepper	*Phyla nodiflora*	
Stenotaphrum secundatum	Buffalo Grass	*Lactuca serriola*	Prickly Lettuce
		Lolium rigidum	Wimmera Ryegrass
		Lupinus angustifolius	Narrowleaf Lupin
		Olea europaea	Olive
		Oxalis pes-caprae	Soursob
		Paspalum dilatatum	Paspalum

5.0 Treatment and Management

5.1 Weed Treatment

Weed control should be undertaken using a combination of manual and chemical treatment methods by suitably licensed, trained, and qualified personnel. Characteristics of a particular species determine the most appropriate type of weed control methodology and can typically be found on FloraBase (DBCA, 2021). Recommended treatments for the weeds recorded within Careniup Wetland Reserve are outlined in Table 4.

Triasulfuron and Metsulfuron application should be carried out in a targeted fashion at the recommended dose to reduce the potential for residual effect in soils. Herbicides should be applied as per manufacturer's instructions. The use of herbicides for environmental weeds in bushland settings or parks is covered under Off-label Australian Pesticides and Veterinary Medicines Authority (APVMA) minor use chemical permits for environmental weeds. All herbicides used within the City of Stirling should be applied in accordance with the label or according to Off-label conditions.

Herbicide application should always be applied according to manufacturer's usage and safety specifications detailed on labels and Safety Data Sheets (SDS), which can be provided by the manufacturer or accessed online. It is noted that the majority of Careniup Reserve is in close proximity or is associated with a wetland, as such, herbicide use (including surfactants) must be taken with great care and in accordance with labels. Several different weed species can be treated simultaneously during the same weed management event.

Table 4: Weed treatment types, target species and methodology

Treatment Number	Treatment Type	Targeted Species	Application Method and Comments
1	Non-selective (Glyphosate, Glyphosate biactive)	Annual and perennial grasses, broadleaf weeds	Spot spray target species
2	Selective (Quizalofop or Fusilade)	Annual and perennial grasses	Spot spray target species (will affect native grass species)
3	Selective (Metsulfuron)	Annual broadleaf weeds and bulbs	Spot spray target species
4	Manual wiping (Glyphosate)	One-leaf Cape Tulip	Wipe leaves with wiping implement prior to or just on flowering (corm exhaustion)
5	Woody weed (Triclopyr, Picloram, Glyphosate)	Woody weeds and trees	Cut and paint or drill and fill (Method is species dependant as some are prone to suckering if disturbed e.g. Japanese Pepper)
6	Manual removal/hand weeding	Carnation weed (*Euphorbia* sp.), Fleabane (*Erigeron* sp.) and other similar species including woody weed seedlings if appropriate	Manual methods including digging by hand or machinery to remove all propagative parts of targeted weeds

Treatment Number	Treatment Type	Targeted Species	Application Method and Comments
7	Selective (Triasulfuron)	Carnation weeds (*Euphorbia* sp.), Brassicaceae weeds post emergence and other annual species	Spot spray target species

(Source: DBCA,2021 and Brown and Brooks, 2002)

5.2 Priority Weeds

This section provides information regarding recommended treatment types for the 27 priority species (Section 4.1, Table 3). Other species with the same treatment suite can be targeted in conjunction with the priority species, however optimal treatment times are based on these priority species, which may reduce effectiveness on species not identified as a priority. Treatment information can change as ongoing research identifies improved treatment methodologies. Suitable references should be regularly checked to determine preferred treatment methods. Suggested treatment methods for the priority weed species and optimal timing for herbicide application are outlined in Table 5. Very High Priority species are highlighted in red.

Table 5: Priority weed species and recommended treatments

Scientific Name	Common Name	Treatment Type	Optimal Timing
Acacia iteaphylla	Flinders Range Wattle	5,6	Mar-Jul
Arundo donax	Giant Reed	1,5,6	Herbicide: Jan- Apr Manual: Year-round
Bacopa monnieri		1,6	
Bromus catharticus		1,2	Jun- Sep
Casuarina glauca	Swamp Sheoak	5,6	Jan-Mar, Sep-Dec
Cenchrus clandestinus	Kikuyu	1,2	Nov-Jan
Cortaderia selloana	Pampas Grass	1,5,6	Herbicide: Jul- Nov Manual: Dec-May
Cynodon dactylon	Couch	1,2	Nov- Feb
Erigeron sumatrensis	Fleabane	1,6	Herbicide: Jun- Sep Manual: Year-round
Euphorbia terracina	Geraldton Carnation Weed	1,6,7	Herbicide: Jun- Aug Manual: Jun-Nov
Ficus carica	Common Fig	5,6	Dec-Feb
Fumaria capreolata	Whiteflower Fumitory	3	Jul- Sep
Hydrocotyle bonariensis	Largeleaf Pennywort	1	Aug-Dec, Mar-May
Ipomoea cairica	Coast Morning Glory	1,5,6	Year-round
Lactuca serriola	Prickly Lettuce	1,6	Sep- Nov
Lolium rigidum	Wimmera Ryegrass	1,2	Jun- Oct

Scientific Name	Common Name	Treatment Type	Optimal Timing
Lupinus angustifolius	Narrowleaf Lupin	1,3,6	Herbicide: Jul- Sep Manual: Jul- Oct
Olea europaea	Olive	5,6	Mar-May, Oct- Dec
Oxalis pes-caprae	Soursob	1,3	Jun-Jul
Paspalum dilatatum	Paspalum	1,2	Nov-Mar
Pelargonium capitatum	Rose Pelargonium	3,6	Jun-Oct
Phyla nodiflora		1	Jan-Nov
Ricinus communis	Castor Oil	5,6	Sep- Dec
Rubus laudatus	Blackberry	3,5,6	Herbicide: Aug-Jan Manual: Year-round
Salix humboldtiana 'Pyramidalis'	Pencil Willow	5,6	Year-round
Schinus terebinthifolia	Japanese Pepper	5,6	Dec-Feb
Stenotaphrum secundatum	Buffalo Grass	1,2	Nov-May

6.0 Implementation and Cost Schedule

6.1 Implementation Plan

The following weed control schedule is recommended based on the weed prioritisation strategy, noting that the scheduled timing of tasks may need to change based on seasonal variations and weather conditions.

Weeds should be treated according to priority (Very High Priority weeds treated first) with lower priority weeds being treated opportunistically or at a later stage. Several persistent weed species which are currently present in high densities within Careniup Reserve will require multiple treatments to effectively manage the populations. These species would have to be manually removed/slashed and followed up with the corresponding herbicide treatment. Several rounds of treatment may be required as infestations are large and species are likely to have extensive underground structures such as rhizomes and suckers. These species include:

- Giant Reed (*Arundo donax)*
  - Cut down mature plants close to ground level and paint with non-selective herbicide. Spot spray any regrowth at label rates.
  - If manually removing, ensure all rhizomes are removed. If excavation occurs, potential for acid sulphate soils will have to be managed.
- Pampas Grass *(Cortaderia selloana)*
  - Slash down mature plants close to ground level and spray with non-selective herbicide. Spot spray any regrowth at label rates.
  - If excavation occurs, potential for acid sulphate soils will have to be managed.
- Blackberry *(Rubus laudatus)*
  - Slash canes and treat with non-selective herbicide. Spot spray regrowth with semi-selective herbicide (Metsulfuron) at label rates.
- Coast Morning Glory (*Ipomoea cairica*)
  - Slash vines close to ground level and spot spray regrowth.
  - Scrap and paint vines for smaller patches.

A dedicated grass control program targeting high density grass weeds such as Kikuyu (*Cenchrus clandestinus*) and Couch (*Cynodon dactylon*) should be carried out to limit spread.

Monitoring of priority weeds and follow up treatments are crucial to ensure weeds are effectively managed. Succession revegetation should be considered once weeds are at a manageable level to replace fauna habitat and restore native vegetation and structure to Careniup Reserve. The proposed implementation plan is outlined in Table 6.

Table 6: Weed treatment implementation plan. Highlighted cells indicate optimal timing to carry out scheduled activities (may vary due to season/weather)

Activity	**Schedule for activity**											
2021	**Jan-21**	**Feb-21**	**Mar-21**	**Apr-21**	**May-21**	**Jun-21**	**Jul-21**	**Aug-21**	**Sep-21**	**Oct-21**	**Nov-21**	**Dec-21**
Monitoring												
Giant Reed removal (cut and paint)												
Blackberry (slash and paint)												
Pampas Grass removal (cut and paint)												
Woody Weed Removal												
Glyphosate Spray												
Metsulfuron Spray												
Fusilade Spray												
Annual Reporting												
2022	**Jan-22**	**Feb-22**	**Mar-22**	**Apr-22**	**May-22**	**Jun-22**	**Jul-22**	**Aug-22**	**Sep-22**	**Oct-22**	**Nov-22**	**Dec-22**
Monitoring												
Giant Reed follow-up treatment												
Blackberry follow-up treatment												
Pampas Grass follow-up treatment												
Woody Weed Removal												
Glyphosate Spray												

Activity	Schedule for activity											
2021	**Jan-21**	**Feb-21**	**Mar-21**	**Apr-21**	**May-21**	**Jun-21**	**Jul-21**	**Aug-21**	**Sep-21**	**Oct-21**	**Nov-21**	**Dec-21**
Metsulfuron Spray												
Fusilade Spray												
Annual Reporting												
2023	**Jan-23**	**Feb-23**	**Mar-23**	**Apr-23**	**May-23**	**Jun-23**	**Jul-23**	**Aug-23**	**Sep-23**	**Oct-23**	**Nov-23**	**Dec-23**
Monitoring												
Giant Reed removal (cut and paint)												
Blackberry (slash and paint)												
Pampas Grass removal (cut and paint)												
Woody Weed Removal												
Glyphosate Spray												
Metsulfuron Spray												
Fusilade Spray												
Annual Reporting												

6.2 Indicative Implementation Cost

Due to the size of the weed infestations and scope of works required, daily rates are provided instead of a lump sum to cater for budget flexibility and priorities for the management of Careniup Reserve. Specific quotes can be provided upon request from the City to target specific areas and priority weeds if required. Indicative costs associated with the implementation of the recommended actions within this Weed Treatment Strategy are outlined in Table 7.

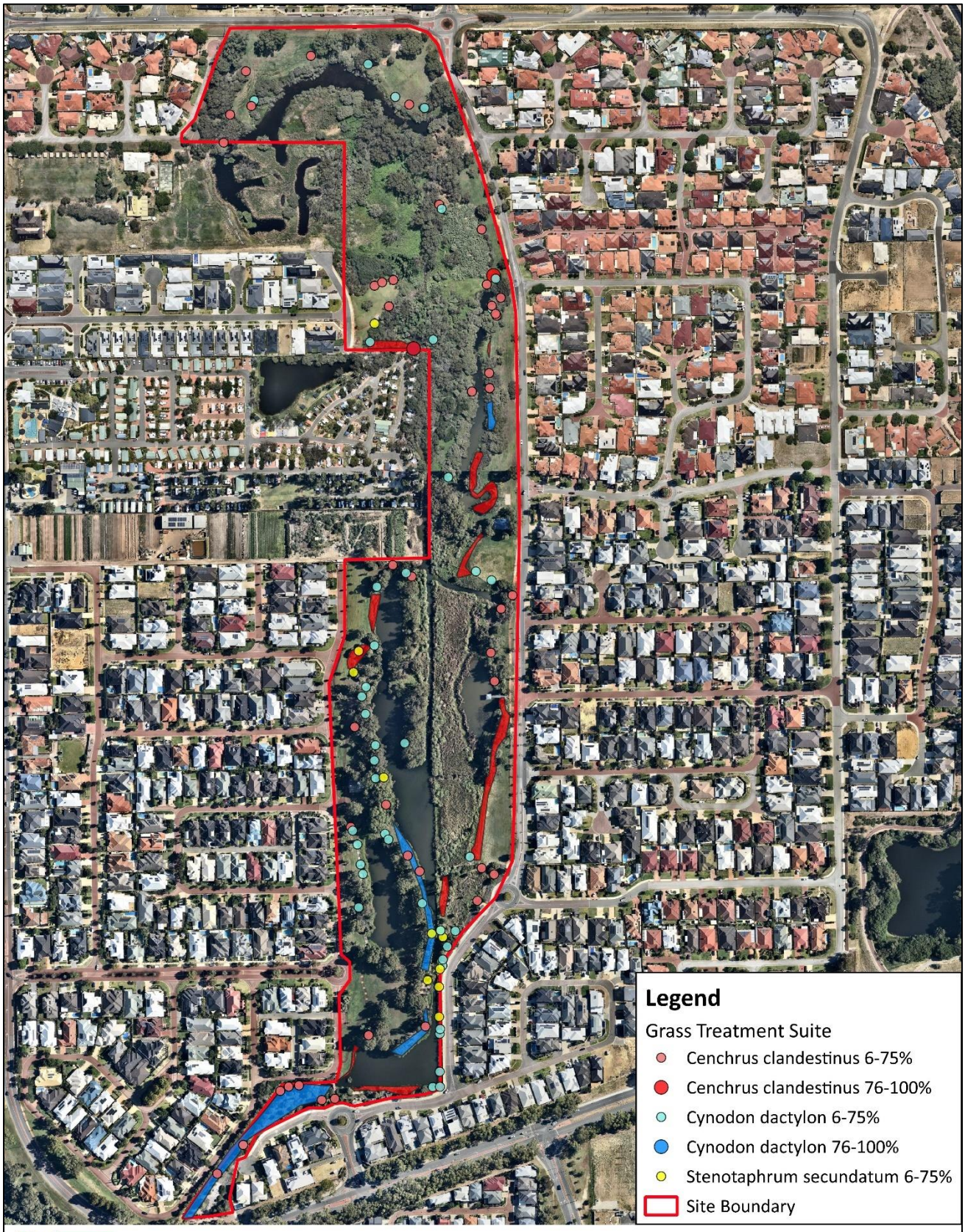
Table 7: Indicative rates for weed treatment

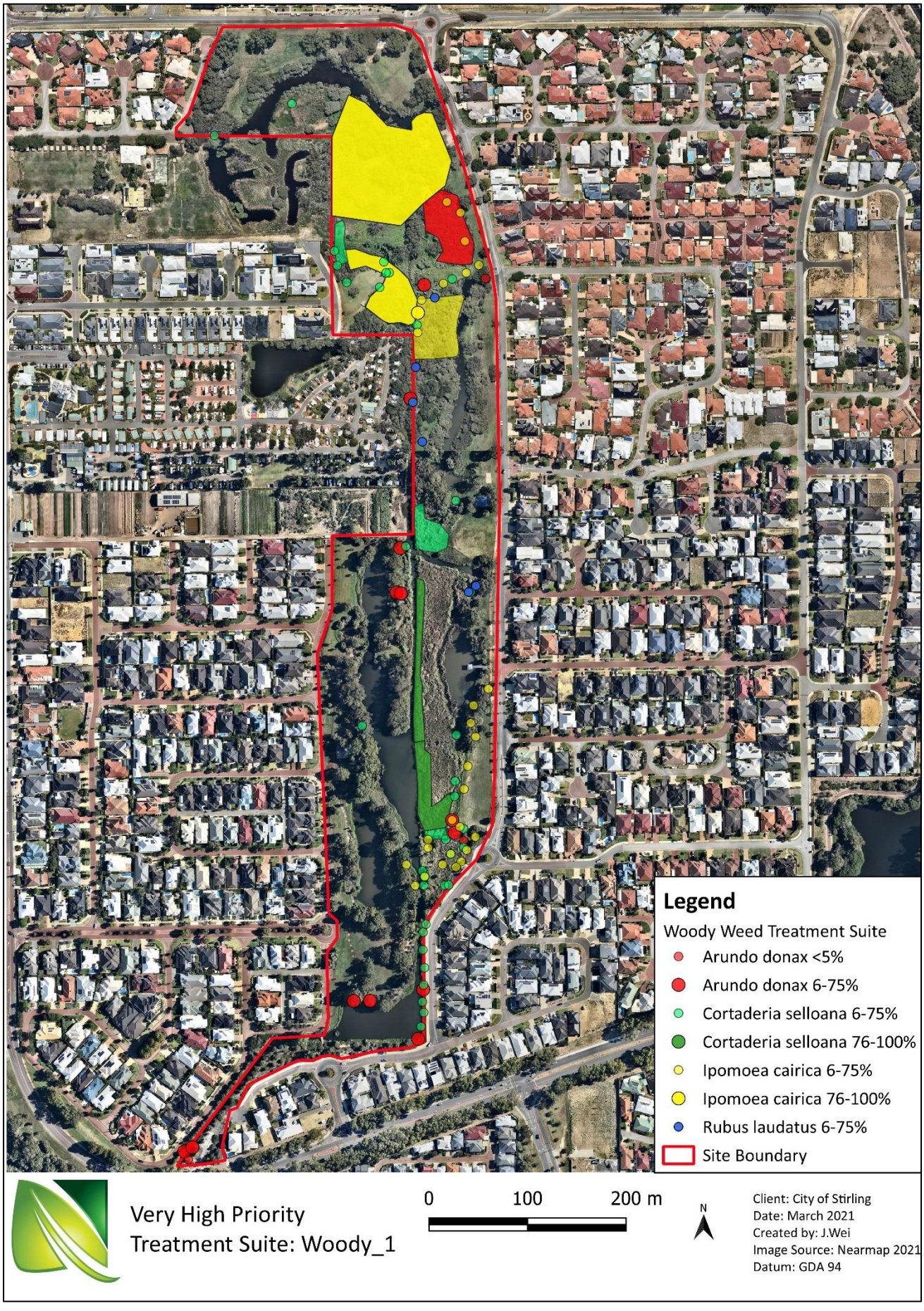
Activity	Unit	Unit Rate ($ ex GST)
Mechanical weed control		
▪ hand weeding	hr	68.00
▪ mechanical control using ride on motorised vehicles	hr	120.00
▪ mechanical weed control using motorised hand tools	hr	75.00
Chemical weed control		
▪ non-selective	Ha	1,560.00
▪ selective	Ha	1,062.50
▪ semi-selective	Ha	1,560.00
Monitoring and reporting		
▪ Monitoring	hr	120.00
▪ Reporting	hr	120.00

7.0 Weed Maps

Weed maps have been created for the weed treatment strategy for ease of reference when treatment occurs. The maps are as follows:

- Very High Priority Weeds:
  - Grass Treatment Suite
  - Woody Weeds 1 Treatment Suite
  - Woody Weeds 2 Treatment Suite
- High Priority:
  - Grass Treatment Suite
  - Woody Weed Treatment Suite
  - Herbaceous 1 Treatment Suite
  - Herbaceous 2 Treatment Suite


Legend
Grass Treatment Suite
Cenchrus clandestinus 6-75%
Cenchrus clandestinus 76-100%
Cynodon dactylon 6-75%
Cynodon dactylon 76-100%
Stenotaphrum secundatum 6-75%
Site Boundary
Very High Priority
Treatment Suite: Grass
0
100
200 m
N
Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94


Legend
Woody Weed Treatment Suite
Arundo donax <5%
Arundo donax 6-75%
Cortaderia selloana 6-75%
Cortaderia selloana 76-100%
Ipomoea cairica 6-75%
Ipomoea cairica 76-100%
Rubus laudatus 6-75%
Site Boundary
Very High Priority
Treatment Suite: Woody_1
0
100
200 m
N
Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94


Legend
Woody Weed Treatment Suite
Acacia iteaphylla <5%
Acacia iteaphylla 6-75%
Ricinus communis 6-75%
Ricinus communis 76-100%
Salix humboldtiana 'pyramidalis 6-75%
Schinus terebinthifolia <5%
Schinus terebinthifolia 6-75%
Site Boundary
Very High Priority
Treatment Suite: Woody_2
0
100
200 m
N
Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94


Legend
Grass Treatment Suite
Bromus catharticus 6-75%
Paspalum dilatatum 6-75%
Lolium rigidum 6-75%
Site Boundary
High Priority
Treatment Suite: Grass
0
100
200 m
N
Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94


Legend
Woody Weed Treatment Suite
Casuarina glauca 6-75%
Ficus carica <5%
Ficus carica 6-75%
Olea europaea <5%
Olea europaea 6-75%
Site Boundary
High Priority
Treatment Suite: Woody Weeds
0
100
200 m
N
Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94


Legend
Herbaceous Treatment Suite
Bacopa monnieri 6-75%
Erigeron sumatrensis 6-75%
Erigeron sumatrensis 76-100%
Euphorbia terracina 6-75%
Fumaria capreolata 6-75%
Pelargonium capitatum 6-75%
Site Boundary
High Priority
Treatment Suite: Herbaceous_1
0
100
200 m
N
Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94

High Priority
Treatment Suite: Herbaceous_2

0 100 200 m

N

Client: City of Stirling
Date: March 2021
Created by: J.Wei
Image Source: Nearmap 2021
Datum: GDA 94

8.0 References

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Appendix 1: Weed Prioritisation Guide

Ecological Impact		Invasiveness	
H	High	R	Rapid
M	Medium	M	Medium
L	Low	S	Slow
U	Unknown	U	Unknown

Species	Common Name	Ecological Impact	Invasiveness
Acacia iteaphylla	Flinders Range Wattle	H	R
Araucaria heterophylla	Norfolk Island Pine	U	U
Arundo donax	Giant Reed	H	S
Atriplex prostrata	Hastate Orache	U	M
Bacopa monnieri		H	R
Bromus catharticus		H	R
Callistemon 'Kings Park Special'		Not rated	Not rated
Coprosma repens	Mirror Bush	U	U
Casuarina glauca	Swamp Sheoak	H	M
Cenchrus clandestinus	Kikuyu	H	S
Chenopodium album	Fat Hen	U	R
Chenopodium glaucum	Glaucous Goosefoot	U	R
Cirsium vulgare	Spear Thistle	U	R
Cortaderia selloana	Pampas Grass	H	R
Cucumis myriocarpus	Prickly Paddy Melon	L	M
Cynodon dactylon	Couch	H	R
Cyperus eragrostis	Umbrella Sedge	U	M
Cyperus tenuiflorus	Scaly Sedge	U	M
Echinochloa crus-galli	Barnyard Grass	L	M
Erigeron sumatrensis	Fleabane	M	R
Euphorbia maculata		Not rated	Not rated
Euphorbia terracina	Geraldton Carnation Weed	H	R
Ficus carica	Common Fig	H	M
Foeniculum vulgare	Fennel	L	S

Species	Common Name	Ecological Impact	Invasiveness
Fumaria capreolata	Whiteflower Fumitory	H	R
Gazania rigens		Not rated	Not rated
Gazania tomentosa		Not rated	Not rated
Helianthus annuus	Sunflower	Not rated	Not rated
Hydrocotyle bonariensis	Largeleaf Pennywort	H	U
Ipomoea cairica	Coast Morning Glory	H	M
Juncus microcephalus		U	U
Lactuca serriola	Prickly Lettuce	H	R
Lolium rigidum	Wimmera Ryegrass	H	R
Lomandra longifolia	Spiny-head Mat-rush	Not rated	Not rated
Lupinus angustifolius	Narrowleaf Lupin	H	M
Malva parvifolia	Marshmallow	L	U
Melaleuca quinquenervia		Not rated	Not rated
Melia azedarach	White Cedar	L	M
Melilotus indicus		U	R
Mentha x piperita var. citrata		L	M
Nicotiana glauca	Tree Tobacco	L	R
Nymphaea mexicana	Yellow Waterlily	Not rated	Not rated
Oenothera drummondii	Beach Evening Primrose	U	R
Olea europaea	Olive	H	R
Oxalis pes-caprae	Soursob	H	S
Paspalum dilatatum	Paspalum	H	M
Pelargonium capitatum	Rose Pelargonium	H	R
Persicaria lapathifolia		U	U
Phoenix dactylifera	Date Palm	Not rated	Not rated
Phyla nodiflora		H	U
Plantago major	Greater Plantain	U	U
Platanus x hispanica	London Plane Tree	L	S
Ricinus communis	Castor Oil Plant	M	R
Rorippa nasturtium-aquaticum	Watercress	U	M
Rubus laudatus	Blackberry	H	M
Salix babylonica	Weeping Willow	M	S

Species	Common Name	Ecological Impact	Invasiveness
Salix humboldtiana 'pyramidalis'	Pencil Willow	M	S
Schinus terebinthifolia	Japanese Pepper	H	M
Solanum nigrum	Black Berry Nightshade	M	R
Sonchus oleraceus	Common Sowthistle	U	R
Stenotaphrum secundatum	Buffalo Grass	H	S
Symphyotrichum squamatum	Bushy Starwort	M	R
Tipuana tipu	Pride of Bolivia	Not rated	Not rated
Tropaeolum majus	Garden Nasturtium	L	M
Verbesina encelioides	Crownbeard	Not rated	Not rated

Source: Department of Biodiversity Conservations and Attractions (2016)

Appendix 2: Case Studies

Yellagonga Regional Park Rehabilitation

Water Corporation *2010 - 2014*

Project Overview

Natural Area Consulting Management Services (Natural Area) was contracted in 2010 by the Water Corporation to undertake rehabilitation works within two areas of the Yellagonga Regional Park (YRP) as part of vegetation offset site requirements following the installation of a new pipeline and drainage construction works. The rehabilitation areas are outlined in Figure 1 below and include:

- Former Poultry Farm
- Walluburnup Swamp (two zones)
  - Walluburnup East
  - Tuart Ridge

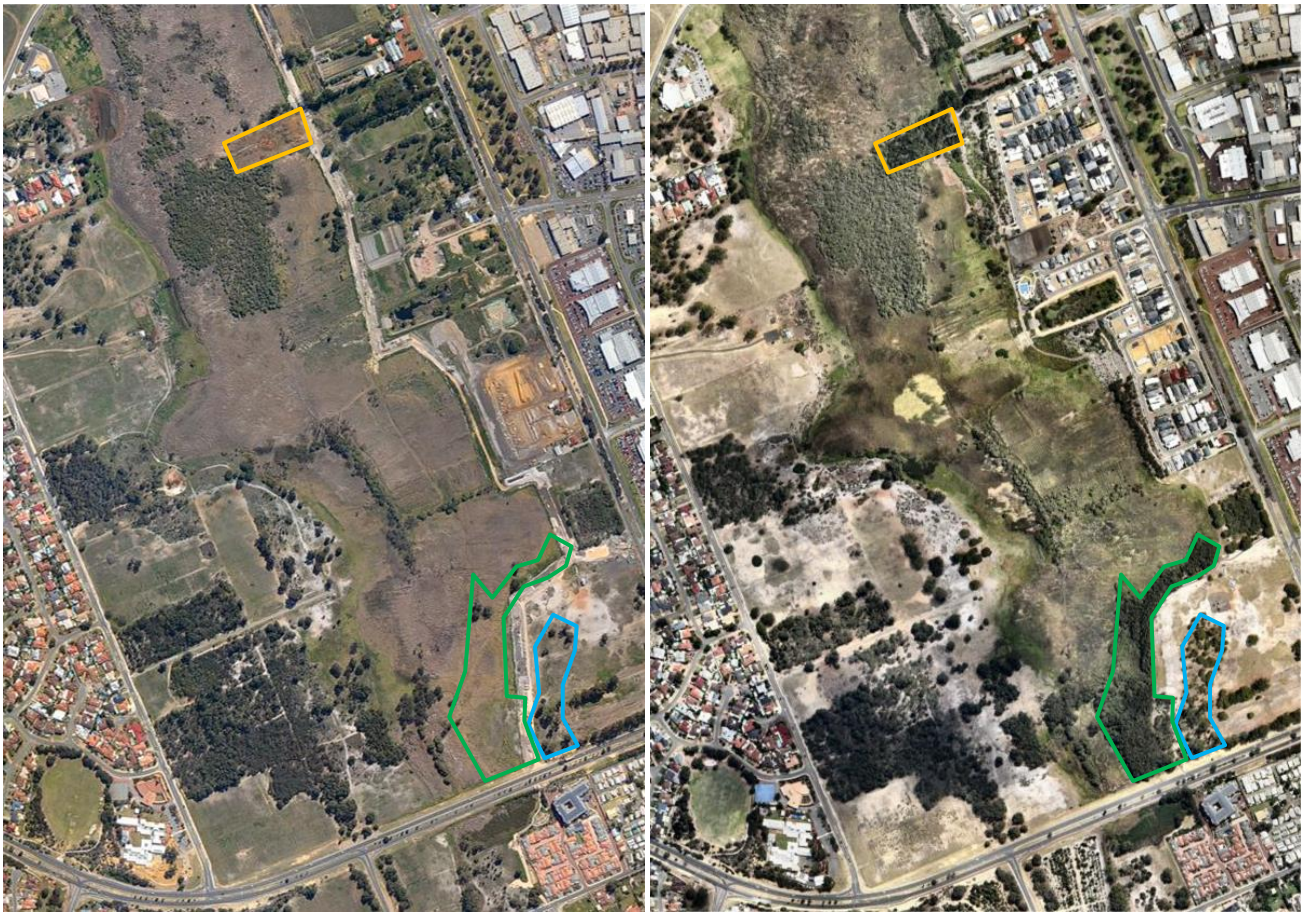

Figure 1: Before rehabilitation works commenced in 2010 (left) and current condition of rehabilitation works in 2021 (right). Former Poultry Farm (orange), Walluburnup Swamp West (green), and the Tuart Ridge (blue)

The key component of the success of the rehabilitation project was the implementation of an integrated weed control program which included herbicide application, woody weed control, slashing and manual removal. To ensure that the revegetation works had the best chance at success, weed control was

conducted over two years prior to revegetation works commencing in winter 2012. The goal was to eradicate the weed species in the area prior to planting.

Initial weed control works included treating the entire areas with Glyphosate Biactive to target Kikuyu, Typha and other herbaceous weeds that had completely covered the areas. Following the initial herbicide treatment all the weeds were slashed and follow up weed control events were undertaken to treat any regrowth in the area until planting was undertaken. Follow up weed control was undertaken for an additional two years following the revegetation works and consisted of spot spraying and hand weeding around the revegetation.

Revegetation was undertaken in winter 2012 and 2013 using over 250,000 locally native species and seed collected from within the YRP by Natural Area's licenced seed collectors. The local Friends group was involved with propagating some species for revegetation with the rest of the species being propagated by Natural Area's NIASA accredited nursery. Monitoring was undertaken twice a year for two years following the initial revegetation works with results showing a substantial reduction in the coverage of weeds and an increase in native species density and diversity.

Other major works that were undertaken during the project included:

- Removal of large non-endemic trees
- Site leveling and grading
- Installation of a pedestrian access path

Outcomes & Results

Rehabilitation works at the former Poultry Farm and Walluburnup Swamp have resulted in the areas being restored with plant communities that are self-sustaining and that approach the density, diversity and species richness of the vegetation communities that were likely present in the area prior to the area being cleared for agricultural uses.

Implementation of an extensive integrated weed management program to reduce the weed burden in the rehabilitation areas prior to revegetation works resulted in the high success rate of the revegetation works. Initial weed control works resulted in a substantial reduction in weed coverage in the offset areas from almost 100% coverage to less than 1% cover in most areas. This reduction has allowed the revegetation to quickly establish without competition from weed species resulting in over 70% coverage of native species being achieved in less than 2 years.

Through Natural Area's extensive experience in weed control, seed collection, plant propagation and revegetation the project was successfully handed the project over to Water Corporation in 2014, with all the monitoring compliance criteria being met.

Figure 2: (top) Condition of the Walluburnup Swamp offset site in 2009 prior to the commencement of weed control works and (bottom) following the completion of revegetation works in 2013

Bardon Park Rehabilitation

Department of Planning, Lands & Heritage *2016 - 2020*

Project Overview

Natural Area Consulting Management Services (Natural Area) was contracted by the Department of Planning, Lands and Heritage (DPLH) to undertake wetland rehabilitation works within Bardon Park, Maylands (Figure 1). The area outlined in orange on Figure 1 is the area managed by DPLH, the other section of the wetland was managed by the City of Bayswater.

Figure 1: Conditions of at Bardon Park prior to works commencing in 2016 (top left); during weed control works in 2018 (top right); following the installation of advanced tree stock and tubestock in winter 2019 (bottom left); and current site conditions in 2021 (bottom right)

Due to the high weed burden within the wetland at Bardon Park (Typha, Pampas Grass, Blackberry, Lantana, Morning Glory et al) an ongoing integrated weed control plan was implemented over a two-year period prior to revegetation works commencing. Due to the high weed burden and limited access into the area, small sections were targeted systematically from one end of the site to the other with an initial herbicide treatment followed by slashing.

All weeds were mulched down during the slashing works and left in-situ. Ongoing follow up herbicide treatments were undertaken regularly to target any regrowth following the initial weed control. In addition to the herbicide application and slashing works, Natural Area also undertook various woody weed control works throughout the works period to treat various Japanese Peppers and *Casuarina glauca* trees located within the wetland area.

Figure 2: Site conditions at Bardon Park prior to (top) and after slashing works (bottom)

Revegetation works commenced in winter 2019 with the installation of 340 advanced tree stock and 5,000 dryland tubestock. Over 15,000 sedges were installed in early summer 2019/20 when water levels were low. Further infill planting was also undertaken in 2020 with an additional 2,000 tubestock installed.

All plants were propagated by Natural Area's NIASA accredited nursery and installed by Natural Area's experienced environmental technicians. Revegetation works have been very successful in the area within minimal infill planting works required (Figure 3).

Figure 3: Current condition of the revegetation at Bardon Park (2021)

Outcomes & Results

To date rehabilitation works within the Bardon Park wetland area have been very successful with revegetation works resulting in high survival rates and increased density over a short period as shown in Figure 3 above. This success is a result of the implementation of an intense integrated weed management plan, ongoing weed management and installation of both advanced tree stock and tubestock at the correct times of year.

By focusing on the weed burden in the area initially over a two year period, Natural Area was able to successfully reduce the weed burden in the area to a manageable level prior to revegetation works commencing in winter 2019. This resulted in high survival rates as the revegetation was not smothered or out competed by the weeds. If the weed burden in the area was not targeted as intensely in the initial period prior to revegetation works commencing, it is likely that the survival rate of the revegetation would have been much lower with high amounts of infill planting and ongoing weed management required over several years to reach the same result.

The installation of advanced tree stock initially also increased the survival of the revegetation as the advanced tree stock was able to establish the upper storey quickly providing shelter for smaller shrubs and native fauna in the area. This was essential as the area was originally almost entirely covered with weeds, so revegetation works were required to establish quickly in order to create habitat for the native fauna in the area.

Appendix 4: Native Fauna Inventory

Careniup Wetlands Reserve - Native Fauna Inventory	
Scientific name	Common Name
BIRD	
Accipiter fasciatus	Brown Goshawk
Acrocephalus australis	Australian Reed Warbler
Acrocephalaus stentoreus	Glamorous Reed Warbler
Anas gibberifrons	Grey Teal
Anas rhynchotis	Australasian Shoveller
Anas superciloisa	Black Duck
Anhinga melanogaster	Darter
Anthochaera carunculata	Red Wattle Bird
Ardea pacifica	White-necked Heron
Aythya australis	Hardhead
Barnarbius zonarius	Port Lincoln Parrot
Bizuiura lobata	Musk Duck
Botaurus poiciloptilus	Brown Bittern
Cacatua roseicapilla	Galah
Cacatua sanguinea	Little Corella
Cacatua tenuirostris	Long-billed Corella
Cacomantis pallidus	Palid Cuckoo
Charadrius melanops	Black-fronted Dotterel
Chenonetta jubata	Wood Duck
Circus approximans	Swamp Harrier
Coracina novaehollandiae	Black-faced Cuckoo Shrike
Corvus coronoides	Australian Raven
Corvus orru	Torresian crow
Cracticus torquatus	Butcher Bird
Cygnus atratus	Black Swan
Dacelo gigas	Laughing Kookaburra
Daphoenositta chrysoptera	Varied Sittella
Egretta alba	Great Egret
Egretta garzetta	Little Egret
Egretta novaehollandiae	White-faced Heron
Elanus axillaris	Black-shouldered Kite
Elseyornis melanops	Black-fronted Dottrerel
Falco cenchroides	Nankeen Kestrel
Falco longipennis	Little Falcon
Fulica atra	Coot
Gallinula tenebrosa	Dusky Moorhen
Gallinula ventralis	Black-tailed Native Hen
Gerygone fusca	Western Greygone
Grallina cyanoleuca	Australian Magpie Lark
Gymnorhina tibicen	Australian Magpie
Haliastur sphenurus	Whistling Kite
Hieraaetus morphnoides	Little Eagle
Himantopus himantopus	Pied Stilt
Hirundo neoxena	Welcome Swallow
Lalage sueurii	White-winged Triller
Lichenostomus virescens	Singing Honeyeater
Lichmera indistincta	Brown Honeyeater
Lonchura castaneothorax	Chestnut-breasted Mannikin

Careniup Wetlands Reserve - Native Fauna Inventory	
Scientific name	Common Name
Malurus lamberti	Variegated Fairy Wren
Megalurus gramineus	Little Grassbird
Nycticorax caledonicus	Nankeen Night Heron
Oxyura australis	Blue-billed Duck
Pachycephala rufiventris	Rufous Whistler
Pardalotus striatus	Striated Pardalote
Pelecanus conspicillatus	Australian Pelican
Phalacrocorax carbo	Great Cormorant
Phalacrocorax melanosleucos	Little Pied Cormorant
Phalacrocorax sulcirostris	Little Black Cormorant
Phylidonyris nigra	White-cheeked Honeyeater
Phylidonyris novaehollandiae	New Holland Honeyeater
Platalea flavipea	Yellow-billed Spoonbill
Podiceps cristatus	Great Crested Grebe
Podiceps poliocephalus	Hoary-headed Grebe
Porphyrio porhio	Swamp Hen
Porzana tabuensis	Spotless Crake
Rallus philippensis	Buff Banded Rail
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willie Wagtail
Smicrornis brevirostris	Weebill
Streptopelia chinensis	Spotted Dove
Streptopelia senegalensis	Laughing Dove
Tachybaptus novaehollandiae	Australasian Grebe
Tadorna tadornoides	Mountain Duck
Threskiornis molucca	White Ibis
Threskiornis spinicollis	Straw-Necked Ibis
Todiramphus sanctus	Sacred Kingfisher
Trichoglossus haematodus	Rainbow Lorikeet
Zosterops lateralis	Silver Eye
AMPHIBIAN	
Crinia glauerti	Clicking Frog
Criniaa insignifera	Squelshing Froglet
Litoria adelaidensis	Slender Tree Frog
Litoria moorei	Motorbike Frog
Limnodynastes dorsalis	Western Banjo Frog
Helieoporus eyrei	Moaning Frog
REPTILE	
Demansia psammophis	Yellow Tailed Whip Snake
Pseudonaja affinis	Dugite
Notechis scutatus	Tiger Snake
Chelodina colliei	Long-neck Turtle