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Carine ROS

Environmental Management Plan - Final

City of Stirling

science+design

Document Status

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Ecoscape would like to acknowledge the input of the following staff of the City of Stirling, who contributed to this Management Plan:

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Acronyms

Carine ROS Environmental Management Plan

AASS	Actual Acid Sulfate Soil
AHIS	Aboriginal Heritage Inquiry System
ANZECC	Australia and New Zealand Environmental and Conservation Council
ARRPA	Agriculture and Relate Resources Protection Act
ASS	Acid Sulfate Soil
BOM	Bureau of Meteorology
CALM	Department of Conservation and Land Management
CW	Category Wetland
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DEWHA	Department of Environment, Water, Heritage and Arts
DIA	Department of Indigenous Affairs
DOW	Department of Water
DRF	Declared Rare Flora
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EPBC	Environmental Protection Bioversity Conservation
EPP	Environmental Protection Policy
ESA	Environmentally Sensitive Area
EWCP	Environmental Weeds Census and Prioritisation
EWSWA	Environmental Weed Strategy of Western Australia
FCT	Floristic Community Type
FESA	Fire and Emergency Services Authority
GIS	Geographical Information Systems
GPS	Global Positioning Satellite
GWA	Government of Western Australia
HCA	Heritage Council of Australia
IUCN	International Union for the Conservation of Nature and Natural Resources

MSDS	Material Safety Data Sheet
NRM	Natural Resources Group
PASS	Passive Acid Sulfate Soil
PDWSA	Public Water Drinking Supply Area
PEC	Priority Ecological Community
ROS	Regional Open Space
SES	State Emergency Services
TEC	Threatened Ecological Community
UFI	Unique Feature Identifier
WAM	Western Australian Museum
WAPC	Western Australian Planning Commission
WONS	Weeds of National Significance
WRC	Water and Rivers Commission

Summary

Carine ROS Environmental Management Plan

Carine Regional Open Space (ROS) is a Reserve of approximately 87 ha vested in the City of Stirling. The Reserve is protected for conservation under state policies as it contains wetland and bushland communities which host an impressive range of fauna species, some of which are declared as significant. Carine ROS is also the site of a wide range of popular social and recreational activities, including horse riding, cycling, cricket, playgrounds and skateboarding.

The multiple uses of the Reserve risk impacting on its long term sustainability and values. The following Environmental Management Plan was developed to provide a balance between conserving ecological significant natural areas whilst accommodating and enhancing the social recreational uses.

The following report first discusses the local, state and federal government policies and documents which relate to the legal management of Carine ROS. It then highlights the unique threats and opportunities with the physical, biological and social environments of the Reserve. A management framework has been developed for directing site specific activities within the Carine ROS over the coming five years. A total of 11 integrated strategies have been developed to manage all of the identified features and issues.

A total of 79 recommendations are made in this environmental management plan, which are summarised in **Table 1**.

Table 1: Summary of recommendations for Carine ROS EMP

NUMBER	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY	SUCCESS INDICATOR
1.	**Management Framework**			
1.1	Manage Carine ROS in accordance with appropriate uses and priorities in terms of landuses, zones and sites.	High	City of Stirling	System in place to conduct all management activities within Carine ROS by using the recommended framework and considering land use, zones and sites as identified in Table 15, Figure 4 and Map 9.
1.2	Establish or use physical barriers such as paths, kerbing or fences to delineate boundaries of landuses and zones where appropriate.	High	City of Stirling	Map of Carine ROS indicating delineation of land uses, zones and site boundaries using physical barriers for boundaries.
2.	**Acid Sulphate Soils**			
2.1	Undertake ASS Risk assessment for Carine ROS.	High	City of Stirling	Map indicating locations and distributions of ASS and PASS in Carine ROS.
2.2	Ensure no ground disturbances occur in areas having AASS or PASS, or if they are, appropriate mitigation measures are put in place.	High	City of Stirling	A procedure in place to consult the ASS map prior to any ground disturbance activity.
2.3	Monitor surface and groundwater levels.	High	City of Stirling	A system in place to monitor surface and groundwater levels.
3.	**Hydrology**			
3.1	Remove lawn from areas not being used for recreation and revegetate with local native species.	Moderate	City of Stirling	Lawn removed and revegetation works completed in areas not being used for recreation, as indicated in Map 10.
3.2	Stop irrigating revegetated areas once native revegetation has established.	Moderate	City of Stirling	Irrigation stopped in areas that had lawn removed and native vegetation established..
3.3	Assess and adapt irrigation system to prevent over-spraying into bushland areas.	Moderate	City of Stirling	Status of irrigation system's over-spraying known and ,if required, adjusted.
3.4	Convert some of the underground drains into outlet streams with settlement ponds to filter incoming water.	High	City of Stirling	Outlet streams and settlement ponds constructed.
3.4	Extend the outlet stream from Small Carine Swamp to large Carine Swamp and revegetate with local wetland plants.	Moderate	City of Stirling	A revegetated outlet stream connecting both Swamps.
3.6	Remove the sandbar at Little Carine Swamp	High	City of Stirling	Sandbar removed
3.7	Install more sewerage overflow tanks to prevent any future spills of sewerage into the wetlands.	High	Water Corporation	Sewerage tanks installed.
4.	**Weed Control**			
4.1	Develop a weed management strategy/ plan so as to provide clear weed control aims, objectives and operational guidance. Monitoring should be part of this strategy/ plan.	High	City of Stirling	A weed management strategy/ plan developed to effectively reduce weed cover and diversity.
5.	**Revegetation**			
5.1	Revegetate the different management zones of the reserve using a wide variety of appropriate native plant species of local provenance.	High	City of Stirling	Revegetation activities completed in management zones using plants species presented in Appendix Four
5.2	Consider reducing the amount of lawn areas in low to moderate impact recreation zones and revegetating with appropriate local species.	High	City of Stirling	Revegetation works completed in former lawn areas in low to moderate impact zones.
5.3	Consider planting areas near public facilities with local aesthetic plant species.	Low	City of Stirling	Areas near public facilities planted with local aesthetic plant species.
5.4	Promote Tuarts in Bushland and Transition Zones.	Moderate	City of Stirling	Tuart seedlings or saplings planted in Bushland and Transition Zones.
5.5	Promote regionally significant sedge species around wetlands.	High	City of Stirling	Clumps of regionally significant sedge species planted around wetlands.

NUMBER	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY	SUCCESS INDICATOR
6.	**Rehabilitation**			
6.1	Promote local plant species that have fauna habitat value in Conservation zones.	High	City of Stirling	Revegetation activities completed in conservation zones that used fauna attracting plant species as indicated in Appendix Four.
6.2	Place nesting boxes, logs and timber around Bushland and Transition zones.	Low	City of Stirling	Logs and timber placed around Bushland and Transition zones.
6.3	Improve entrance to fauna tunnel to encourage wildlife.	Moderate	City of Stirling	Entrance remounted with soil and screening plants established around entrance to fauna tunnel.
7.	**Native Fauna**			
7.1	Determine what other significant fauna species may be inhabiting or visiting Carine ROS by surveys.	High	City of Stirling	List prepared of what significant fauna species may be inhabiting or visiting Carine ROS and their significance ratings.
7.2	Determine whether *Lomandra* species is a habitat for Graceful Sun Moth. If so, arrange for a Graceful Sun Moth survey for March 2011.	High	City of Stirling	Status determined of whether the Reserve serves as habitat for the Graceful Sun Moth.
7.3	Educate the public if they encounter any snakes, avoidance is the best practice.	Moderate	City of Stirling	Signs erected to educate public in how to manage any snakes that they encounter.
7.4	Educate the public as to why they should not feed native wildlife, particularly birds.	Moderate	City of Stirling	Signs erected to educate public why they should not feed native wildlife.
7.5	Educate the public how to live with magpies.	High	City of Stirling	Signs erected to educate public in how to live with magpies.
8.	**Non-native Fauna**			
8.1	Conduct control measures to reduce fox populations and monitor.	High	City of Stirling	Foxes caught in or near Carine ROS.
8.2	Liaise with Karrinyup Golf Course and City of Joondalup to integrate fox control activities.	High	City of Stirling	Plan developed that integrates the City's and the Karrinyup Golf Course's fox control activities.
8.3	Educate neighbouring residents of the importance of properly securing their bird food (eg for chickens) in sealed containers so not to encourage growth of rodent populations.	Low	City of Stirling	Local residents informed of the importance of securing bird food in sealed containers.
8.4	Determine what introduced birds species are present in Carine ROS and investigate appropriate management options for each bird species.	Moderate	City of Stirling	List of introduced birds species. Suitable management options for introduced birds determined and enacted upon.
8.5	Monitor and arrange for the removal of any non-native bees hives that may form in the future.	High	City of Stirling	No hives of non-native bee hives present in Carine ROS.
8.6	Investigate methods of management or control of Mosquito Fish within wetlands.	Moderate	City of Stirling	Suitable management options for eradicating Mosquito Fish determined and enacted upon.
8.7	Complete fencing in Conservation areas to reduce access to dogs.	Moderate	City of Stirling	Fencing completed around Conservation areas.
8.8	Inform public of: • the potential impacts their pets may have on native wildlife and vegetation • the need to keep their dogs on a leash when walking them though areas near vegetation • "leash free" areas for dogs to exercise in (eg ovals).	High	City of Stirling	Public informed of the importance of managing their pets in Carine ROS.
8.9	The Riding School is to continue to keep their horses out of areas containing native vegetation.	Moderate	Riding School	No horses from the Riding School entering the Reserve.
8.10	The Riding School is to ensure that all horse manure is regularly disposed off site at a designated disposal area.	Moderate	Riding School	System in place for regular removal of horse manure at a designated disposal area.

NUMBER	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY	SUCCESS INDICATOR
9.	**Plant Diseases**			
9.1	Continue to conduct hygiene practices to reduce risk of spreading diseases in Carine ROS.	High	City of Stirling	All Natural Areas staff educated and practicing hygiene when entering and leaving Carine ROS.
9.2	Ensure all incoming materials come from certified disease free sources.	High	City of Stirling	System in place to ensure all incoming materials come from certified disease free sources.
9.3	Educate the public of the threat of dieback and how they may assist in minimising the risk.	High	City of Stirling	Public informed of the threat of dieback and how they may assist in minimising the risk.
9.4	Conduct annual dieback assessments of all City reserves.	High	City of Stirling	A system developed to conduct annual dieback assessments of reserves within the City of Stirling.
9.5	Continue to train Natural Areas staff in knowing how to identify and manage any disease outbreaks.	High	City of Stirling	All Natural Areas staff trained in knowing how to identify and manage any disease outbreaks.
10.	**Fire**			
10.1	Ensure that Revegetation and Rehabilitation activities do not increase the fire risk of Carine ROS.	Moderate	City of Stirling	Planting programs produced that recognise the importance to not significantly increase the fuel loads or amount of ignitable vegetation within Carine ROS.
10.2	Ensure that all flammable substances on site are either replaced with non-flammable options or have safety controls to minimise risk.	High	Carine Sporting Clubs	Either: • no flammable substances stored in sporting clubs • flammable substances have adequate safety controls.
10.3	Ensure adequate fire suppression equipment is accessible in case of a fire outbreak in the sporting clubs.	High	Carine Sporting Clubs	Adequate fire suppression equipment in place and readily accessible in sporting clubs.
10.4	Educate and involve neighbouring residents in the values of Carine ROS and in fire prevention and fire preparation.	High	City of Stirling	Neighbouring residents educated in values of Carine ROS and in fire prevention and preparation methods.
10.5	Continue to conduct weed control to reduce fire ignition risk and fuel loads in Carine ROS.	Moderate	City of Stirling	A weed management plan/ strategy developed to reduce the fire ignition risk and fuel loads of Carine ROS.
10.6	Monitor changes in Carine ROS and adjust fire preparation and prevention activities accordingly.	Moderate	City of Stirling	System in place to regular monitor Carine ROS and adjust prevention and preparation according to any changes.
10.7	Investigate and record any fire outbreak incidence.	Moderate	City of Stirling	Records kept of any fire outbreaks in Carine ROS.
10.8	Restrict access of public to any burnt areas.	High	City of Stirling	System in place to restrict public from accessing any burnt areas.
10.9	Rescue and treat any fauna injured from a fire.	Moderate	City of Stirling	All fauna injured from a fire are rescued and treated.
10.10	Monitor a burnt site and adjust management practices to promote its recovery.	High	City of Stirling	System in place to monitor any burnt site and apply/ adjust management practices to promote its recovery.

No.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY	SUCCESS INDICATOR
11.	**Access and Infrastructure**			
11.1	Install new parking facility in south-west zone of site, entering of Okely Road, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling	New parking facility in south-west zone of site.
11.2	Implement storm water management in all new car parks and integrate into existing storm water management systems.	Moderate	City of Stirling	Storm water management in place for new car parks.
11.3	Upgrade surface treatments in car parks where required.	Moderate	City of Stirling	Surface treatment in car parks completed.
11.4	Consider installing infrastructure to deter antisocial behaviour in carp parks at night.	Moderate	City of Stirling	Antisocial infrastructure installed.
11.5	Investigate lighting options along primary paths through the Reserve (CPTED).	Moderate	City of Stirling	Works implemented to improve lighting along primary paths throughout Carine ROS.
11.6	Implement a path hierarchy to clearly and consistently define pedestrian, cycle ways and shared use paths within the Reserve, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling	Path hierarchy defined and established.
11.7	Realign paths to avoid conflict between user groups, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling	Paths realigned in manner that will avoid conflict between user groups.
11.8	Amalgamate 'cycle only' and pedestrian paths where appropriate to create a dual use path across site, linking to external path and cycle networks, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling	New amalgamated dual use paths.
11.9	Upgrade all primary and secondary paths to a standard that will enable universal access across the site, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling	Primary and secondary paths upgraded.
11.10	Increase the scope of the secondary path network to allow greater interaction and exploration of the wetland ecology, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling	Realignment of secondary paths in wetland zones.
11.11	Install bollards at all main intersections of primary and secondary paths to manage safety concerns.	High	City of Stirling	Bollards installed at main intersections of primary and secondary paths.
11.12	Create 'eco-zones' along pathways to vary and enhance the visitor's experience. This can be achieved by diversifying planting (through density, placement and species selection).	Moderate	City of Stirling	Eco-zones established along pathways.
11.13	Complete all unfinished fencing in the southern part of the Reserve consistent in character with the existing timber post and rail fencing.	High	City of Stirling	Fencing completed in southern part of Reserve.
11.14	Implement an effective signage strategy, as per the adopted Carine ROS Master Plan of 2003. (City of Stirling has currently engaged consultants to address this issue)	High	City of Stirling	Signage strategy completed.
11.15	All vandalised signs to be cleaned or replaced.	Moderate	City of Stirling	Vandalised signs cleaned or replaced.
11.16	Upgrade and relocate existing benches and install additional benches, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling	Benches realigned and new benches installed.
11.17	Increase number of doggie and litter bins and dog 'waste' bag dispensers across Reserve.	Moderate	City of Stirling	New bins and dog waste bag dispensers installed.
11.18	All vandalised bins to be cleaned and/ or replaced where necessary.	Moderate	City of Stirling	Vandalised bins cleaned or replaced.
11.19	Increase number of BBQ facilities across Reserve at key locations, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling	More BBQ facilities installed.
11.20	Install bird hides for public use, as per the adopted Carine ROS Master Plan of 2003.	Low	City of Stirling	Bird hides constructed.
11.21	Install securable boardwalk through wetland, as per the adopted Carine ROS Master Plan of 2003.	Low	City of Stirling	Boardwalk installed in wetland.
11.22	Provide new disabled toilet facilities, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling	Disable toilet facilities installed.
11.23	Consider installing toilets near playgrounds, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling	Decision made whether to install toilets near playgrounds.

NUMBER	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY	SUCCESS INDICATOR
12.	**Education and Interpretation**			
12.1	Prepare an interpretation plan to identify and communicate the values of the area, consider including interpretive artworks.	High	City of Stirling	Interpretive plan prepared.
12.2	Install signage at strategic locations to encourage public participation and appreciation of the wetland. Develop signage of an appropriate size and format to inform visitors of the facilities and activities on offer.	Moderate	City of Stirling	Education signage installed.
12.3	Enable school groups and local community groups to access the site and the proposed boardwalks as educational excursions.	Low	City of Stirling	School and local community groups visiting Carine ROS for education excursions.
12.4	Research the history and heritage of Carine ROS.	Moderate	City of Stirling	A document written that details the history and heritage of Carine ROS.
12.5	Seek interest in the establishment of a “Friends of Carine ROS” group	Moderate	City of Stirling	Friends of Carine ROS group established.

1.0 Introduction

Carine ROS Environmental Management Plan

1.1 Background

Carine Regional Open Space (hereafter Carine ROS) is a reserve of approximately 87 ha vested in the City of Stirling. It is bounded by Beach Road to the north, Reid Highway to the south, Okely Road to the west and Monyash Road to the east and is surrounded by residential properties (**Figure 1**).

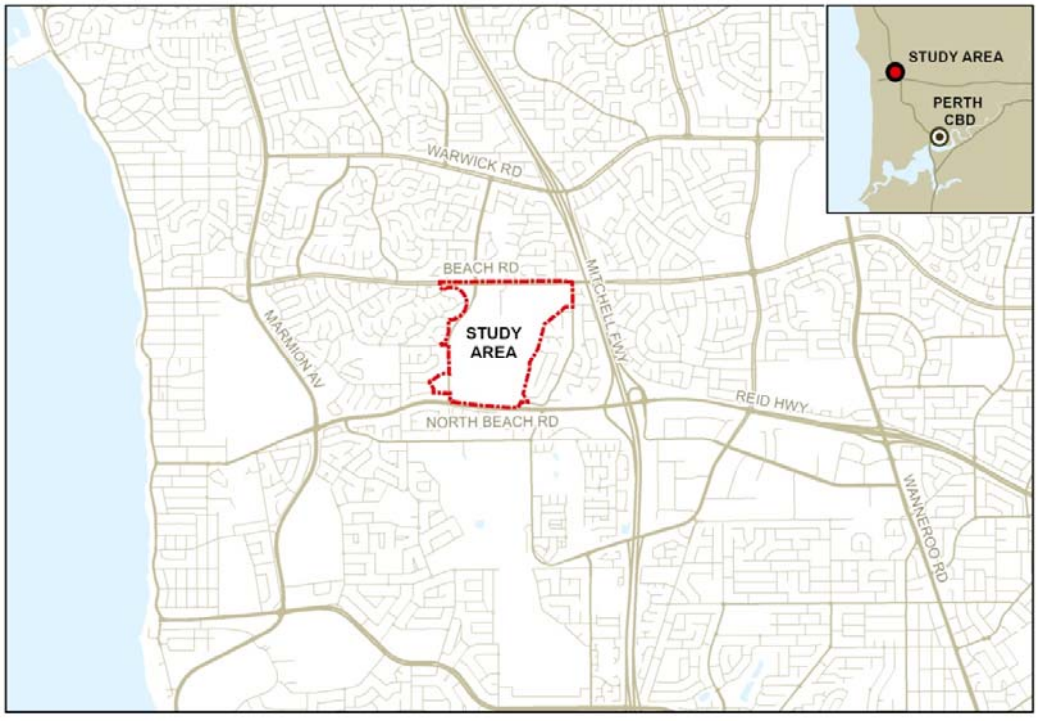

Figure 1: Location of Carine ROS

The Reserve is protected for conservation under state policies as it contains wetland and bushland communities which host an impressive range of fauna species including birds, amphibians and reptiles, some of which are declared as significant by the Department of Environment Water Heritage and Art's *Environmental Protection and Biodiversity Conservation Act 1999*.

Carine ROS is an important place for the local community. It plays a significant social, recreational, educational and conservational role within the broader community. The Reserve's natural environment offers a vital element in defining the identity of Carine and has the potential to set a benchmark for the integration of community public open space, nature reserves and recreational facilities within the Perth Metropolitan Area. Public open space not only contributes to the ecological sustainability of an area, but it also has the potential to improve the physical and psychological health of patrons, and strengthen and unite the local community through a sense of shared ownership. The Carine ROS has the potential to become a symbol of the vitality and character of the community, providing identity to the cultural heritage, flora, vegetation and fauna of the area (**Figure 2**).

Figure 2: Carine ROS

The multiple uses of the Reserve risks impacting on its long term sustainability and value. To date, the City has developed a greening plan and master plan to help direct principles in managing the Reserve. A management plan was also produced by Dames and Moore in 1988, however this plan needs to be reviewed and updated.

1.2 Aims and Objectives

The following document is an Environmental Management Plan (EMP) for Carine ROS.

The aims of the EMP are to:

- provide a balance between conserving and enhancing where necessary the ecological significant natural areas whilst accommodating and enhancing the social recreational uses
- formulate appropriate strategies for managing the various and unique environmental and social features of the Reserve.

The objectives of the EMP are to:

- provide a balance between conservation and recreation
- take into account the regional significance of the Reserve
- focus on ecological sustainability
- incorporate integrated catchment management principles
- involve the public in shared ownership, responsibility and management.

2.0 Planning Context

Carine ROS Environmental Management Plan

2.1 Introduction

To ensure this EMP complements other management initiatives, relevant documents, guidelines and policies were reviewed and brief outlines of these documents are given below.

2.2 Local Government

2.2.1 Land tenue and vesting

The entire reserve is vested within the City of Stirling for the purpose of conservation, recreation and education.

2.2.2 Relevant policies and documents

Local Biodiversity Strategy (2010)

The Local Biodiversity Strategy is a plan for the protection and management of natural areas within the City of Stirling on public and private lands regardless of land tenure. It adopts a comprehensive approach to the assessment of biodiversity condition in bushlands, wetlands, coastal dunes and other natural areas and develops site specific conservation programmes aimed at improving biodiversity. Quite importantly it advocates strengthened legislative mechanisms to ensure that these areas are protected from future threats and disturbances and loss of biodiversity values.

Dames and Moore (1988) *Carine Lake Region Open Space Reserve Management Plan*

This document was the previous management plan for Carine ROS. It discussed environmental and social factors significant to the reserve and provided strategies for future developments.

City of Stirling (Draft) *Public Open Space Strategy*

The City contains around 50 sports reserves and over 400 parks. The City's public open space strategy (POS) is to develop and manage these areas, including Carine ROS, to satisfy current and future recreational needs in an equitable and sustainable manner.

City of Stirling (2002) *Green Plan 2*

Green Plan 2 is a strategy to conserve regionally as well as locally significant areas of native bushland within the City of Stirling. The strategy aims to ensure the long-term sustainability of these areas by a system of management based on detailed on-site assessment of conservation needs and prescriptions assigned to bushland categories.

Under Green Plan 2, Carine ROS is classified as a Group B reserve that is only partially occupied by bushland. These reserves are considered strategic to the ecological linking with Group A reserves. Further planting was recommended wherever possible on developed parkland and bushland areas of Group B reserves such as Carine ROS.

City of Stirling (2003) *Carine Regional Open Space Master Plan*

The City has developed a Master Plan for Carine ROS. The Plan addresses placement of various infrastructure and planting works to meet recreation and conservation needs.

City of Stirling (2008) *Water Smarts Parks Strategy*

The City has developed a water wise strategy to reduce the impact on groundwater supplies. The strategy involves using appropriate water techniques in its parks and reserves to ensure the recreational areas are fit for purpose with minimal water use. The plan discusses the use of categorising parks and reserves into "hydrozones" and "ecozones" to help direct watering requirements.

City of Stirling (2009) *Local Government Property Local Law*

The Local Government Property Local Law ensures the protection of local assets by the removal of biohazards through the removal of weeds and overhanging trees/limbs. Additionally, the maintenance of firebreaks ensures property and local areas are protected. Under this local law, the lighting of fires is prohibited unless a permit as been obtained for special purposes (e.g. for a BBQ)

2.3 State Government

2.3.1 Relevant policies and documents

Department of Agriculture and Food Western Australia *Agricultural and Related Resources Protection Act* (ARRPA) 1974

The act lists species of plants not native to Western Australia that are known to be a significant threat to the environment. Any of the listed weed species observed in a property must be controlled. Three such weed species have been recorded in Carine ROS (**Table 12** in **Section 4.2.2**).

The Western Australian *Environmental Protection Act (1986)*

This Act provides authority to the Environmental Protection Authority (EPA) for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with the foregoing in Western Australia.

Environmental Protection Authority *Environmental Protection Policy (EPP) for Swan Coastal Plain Lakes (1992)*

The wetlands in Carine ROS are identified as an EPP Lake in Miscellaneous Plan No. 1815. As such it is an offence to fill, drain, excavate, pollute or clear any lakes identified without the authorisation of the EPA.

Government of Western Australia *Bushfires Act (1954)*

The State Act is to make better provision for diminishing the dangers resulting from bush fires, for the prevention, control and extinguishment of bush fires.

Government of Western Australia *Aboriginal Heritage Act (1972)*

Aboriginal Sites, regardless of whether they are registered or not, are protected under the Aboriginal Heritage Act (1972):

- Section 5 of the Act defines sites as places of importance where objects connected with traditional life have been left, stored or taken from; ceremonies have been conducted; some ethnographic interest
- Section 15 of the Act requires that findings be reported
- Section 17 of the Act makes it an offence to excavate, destroy, damage, conceal or in any way alter any Aboriginal site
- Section 18 of the Act establishes the conditions for certain uses of land affected by the Act.

There are no known aboriginal sites recorded within Carine ROS.

Western Australian Planning Commission (2000) *Bush Forever*

Bush Forever replaces the System 6 recommendations as a blueprint for conservation of bushland of regional significance in the Perth Metropolitan Region. Bush Forever was prepared by the Department of Environment Protection, Ministry for Planning, Department of Conservation and Land Management (CALM) and the Water and Rivers Commission. It was endorsed by Cabinet and supported by the EPA as the principle mechanism to identify and protect regionally significant bushland in the Perth Metropolitan Region. Carine ROS is recorded as being a Bush Forever site 203 (Carine Swamps, Carine).

Western Australian Planning Commission (2004b) ***Planning Bulletin 64: Acid Sulphate Soils***

Portions of the Reserve are mapped as having a high risk of actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) at less than 3m from the surface. As such a Preliminary Site Investigation (PSI) is required in accordance with Department of Environment Guidelines if:

- any dewatering works are proposed
- greater than or equal to 100 m^3 is proposed to be excavated where the surface level is less than or equal to 5m AHD
- more than or equal to 100 m^3 is proposed to be excavated where surface elevation is greater than 5m AHD and the depth of excavation is greater than or equal to 2m.

Western Australian Planning Commission (2004a) ***Biodiversity Planning Guidelines.***

These guidelines are designed to provide Local Governments and their communities with a clear picture of where the Perth Metropolitan Region is positioned in regards to its biodiversity resource and values. These guidelines provide a four-phase local biodiversity planning process culminating in the preparation and implementation of a Local Biodiversity Strategy to assist Local Governments to:

- determine the protection status of all Locally Significant Natural Areas (LSNAs)
- formalise policies and processes to ensure biodiversity considerations are integrated into their assessment of development proposals and construction activities
- develop and provide incentives to encourage private land conservation
- plan for the management of local reserves and other Local Government lands to conserve biodiversity.

The guidelines and resulting strategies focus on Local Natural Areas and other natural areas that occur within Local Government reserves. Local Natural Areas are natural areas that exist outside of Bush Forever Sites and the CALM Managed Estate and Regional Parks. A key focus is to protect the more common natural areas rather than the rare and threatened.

Western Australian Planning Commission (2004) ***Policy 2.8: Bushland Policy for the Perth Metropolitan region (Draft)***

The Reserve is classed as a significant conservation site under the Western Australian Planning Commission (2004) *Policy 2.8: Bushland Policy for the Perth Metropolitan region (Draft).*

2.4 Federal Government

2.4.1 Relevant policies and documents

Department of Environment Water Heritage and Arts *Environmental Protection and Biodiversity Conservation Act (1999)*

Carine ROS Reserve is identified by the Government of Western Australian (2002) as being subject to the *Environment Protection and Biodiversity Conservation Act* (1999) (EPBC Act).

Under the EPBC Act, approval is required for actions that are likely to have a significant impact on: a matter of national environmental significance. The EPBC Act contains several compliance and enforcement mechanisms. These include court injunctions, required environmental audits, strict civil and criminal penalties, remediation of environmental damage, liability of executive officers, publicising contraventions.

3.0 Physical Environment

3.1 Topography

Carine ROS varies slightly in site elevation. The lowest sections are where the two wetlands reach the water table. The highest part is along the southern portion of the western side, which rises gently by 10m above the wetland. The remainder of the site is relatively flat.

The variation in topography of the reserve is presented in **Map 1** in **Appendix One**.

3.2 Geology

3.2.1 Landforms

The major landform in the Reserve is the Spearwood Dunes System (McArthur & Bettenay 1960; Seddon 1972). In this system, the dunes are of variable topography and occur near the coast. The surface soils have been leached over time, moving the carbonate below, forming layers of hard, compact limestone. The sands are yellow-brown and still contain an appreciable level of iron.

3.2.2 Soil Landscapes

The Department of Agriculture and Food (DAFWA 2007) *Soil Subsystems dataset* Soil units was consulted to determine the soil landscapes of Carine ROS. The wetlands were categorised as Peaty Clay. The remainder of the Reserve was Sand, except for the tip of the southeast corner, which was limestone. The descriptions of the soil landscapes are presented in **Table 2**. The distribution of the soil landscape is illustrated in **Map 2** in **Appendix One**.

Table 2: Mapped soil landscapes in Carine ROS (DAFWA 2007)

Soil unit	Description
211Sp_ S7	SAND - pale and olive yellow, medium to coarse-grained, sub-angular to sub-rounded quartz, trace of feldspar, moderately sorted, of residual origin.
211Sp_ LS1	LIMESTONE - light, yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin. Minor heavy minerals.
211Sp_ Cps	PEATY CLAY - dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin.

3.2.3 Acid Sulphate Soils

Actual Acid Sulphate Soils (AASS) are generally naturally occurring soils containing sulfides that have reacted with oxygen to produce acids. Passive Acid Sulphate Soils (PASS) contain sulfides that have not reacted with oxygen, usually due to being permanently waterlogged. They produce acids when exposed to air by excavation, filling, creation of artificial water courses, or groundwater abstraction/dewatering.

The impacts associated with acid sulfate soils can be associated with the increase in acidity and/or the release of heavy metals into the environment. This can result in:

- wetland degradation
- localised reduction in habitat and biodiversity
- deterioration of surface and groundwater quality
- loss of groundwater for irrigation
- increased health risks associated with arsenic and heavy metals contamination in surface and groundwater, and acid dust
- risk of long-term infrastructure damage through corrosion of sub-surface pipes and foundations by acid water
- invasion by acid tolerant water plants and dominance of acid tolerant plankton species causing loss of biodiversity.

The wetland areas are declared to have a high risk of AASS and PASS generally occurring less than 3m from the surface. The rest of the Reserve is declared to have a low to no risk of AASS or PASS generally occurring in depths more than 3m. The locations of the high risk ASS soils are presented in **Map 3** in **Appendix One**.

3.3 Hydrology

3.3.1 Groundwater

Water Levels

There are five bore pumps which extract groundwater to irrigate the Reserve. Groundwater levels at the bores fluctuate during the year as a result of rainfall and seasons, however levels have been relatively stable over the last decade (Zoccoli pers comm.). A sample of groundwater level data is presented in **Table 3**.

Table 3: Groundwater levels of bore pumps in Carine ROS

Bore	Location	Data 1	Data 2
Carine Beach	Corner Beach Rd & Okely Road	1999: 2.7m	2007: 2.8m
Carine Duffy	Corner Northwest Beach Rd & Duffy Rd	2006: 3.0m	2009: 6.2m
Carine Equestrian	In front of Equestrian School	2003: 3.1m	2007: 3.1m
Carine Okely	Corner Okely Rd & Osmaston Rd	2004: 10.0m	2008: 9.4m
Carine Monyash	Monyash Rd	1999: 2.2m	2005: 4.4m

Public Drinking Water Source

Landgate (2010) online database *WA Atlas* indicates that the groundwater below Carine ROS is not part of a Public Water Drinking Supply Area (PDWSA).

3.3.2 Surface Water

Wetland Water Levels

The wetland water levels are known to fluctuate as a result of seasons and climate. In the remote case of flooding from local heavy rains, the Water Corporation may lower the lake levels through an existing pump station located near the southwest corner of the Reserve. Water can be directed out to the ocean through an underground pipe from Big Carine Swamp.

Water Quality

The quality of the surface water has been tested since at least 2006 in three wetlands and compared to the Australia New Zealand Environmental and Conservation Council (ANZECC) guidelines (**Table 4**). Although the measurements have varied over time and at times some parameters exceeded ANZECC trigger values for aquatic ecosystems, the water quality within the Reserve has generally been within or near the ANZECC guidelines for aquatic ecosystems. Full details of the parameter levels are presented in **Appendix Two**.

Table 4: Water quality of Carine ROS wetlands 2006 to 2009

Parameter	ANZECC Trigger Value	2006		2007		2008		2009	
		Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring
pH	7.0 - 8.5	7.9	-	7.5	8.1	7.4	8.0	7.7	7.8
Electrical conductivity (EC)	0.3-1.5 mS/ cm	1.0	-	0.3	0.6	0.2	1.1	0.4	1.1
Total Suspended Solids (TSS)	6.0 mg/ L	13	-	18	75	4	4	6	12
Total Nitrogen	1.50 mg/L	0.83	-	1.80	2.11	0.64	0.87	1.07	1.12
Ammonium (NH_4^+)	0.04 mg/ L	0.03	-	0.48	0.01	0.03	0.00	0.05	0.01
Nitrogen oxides (NO_x)	0.10 mg/ L	0.02	-	0.47	0.00	0.02	0.00	0.03	0.00
Total Phosphorus (TP)	0.06 mg/ L	0.12	-	0.25	0.20	0.10	0.07	0.05	0.09
Filterable Reactable Phosphate (FRP)	0.03 mg/ L	0.03	-	0.13	0.04	0.03	0.01	-	-
Sulphate (SO_4)	(none) mg/L	240.4	-	19.0	87.0	18.0	290.0	402.3	214.7

Figures in red exceed ANZECC trigger values

Over the previous 3 years, acidity levels have been within ANZECC standards. Electrical conductivity has been mostly within ANZECC levels. Total Suspended Solids (TSS) have been above the ANZECC trigger values for most of the period, except in 2008 and early 2009.

Total nitrogen (TN) levels have been slightly above ANZECC trigger values in 2007. Ammonium (NH_4^+) and nitrogen oxides (NO_x) were particularly high in autumn 2007. This is thought to have been the result of a sewerage overspill.

Total phosphorus (TP) levels have been over the ANZECC trigger values for almost the entire period. The filterable reactable phosphate levels (FRP) were also over ANZECC trigger values in 2007.

Although not a component of ANZECC guidelines, sulphate (SO_4) levels were also examined. SO_4 levels have fluctuated greatly, with lowest levels in autumns of 2007 and 2008 and highest in autumn 2009.

Drainage

Carine ROS is the natural drainage point in the area. The Cities of Stirling and Joondalup installed eight underground drains to direct seepage and groundwater from the surrounding lands into the Reserve's wetlands. Two of the drains have drainage pits whilst the other drains open directly into the wetlands. Silt has built up at around the drain at the corner of Beach Road and Duffy Road and formed a dam in Little Carine Swamp. An outlet stream also occurs on the south-west corner of Small Carine Swamp, however this ends halfway towards Large Carine Swamp.

The locations of the drains and open stream are presented in **Map 4** in **Appendix One**.

3.3.3 Irrigation

Bores

The five bore pumps are licensed from the Department of Water (DOW). The City may only extract a certain volume of water from these bores per year, as to the conditions of the licence. The extraction of the groundwater does not affect the lake levels, as the bores are accessing the metropolitan aquifer beneath the Carine ROS, which are separate from the surface lake water.

Hydrozones

As part of the City's Water Smart Parks Strategy, the Reserve has been divided into different "hydrozone" areas, according to their specific land use and watering requirements. In order of decreasing watering needs, these hydrozones are:

- Active sporting fields
- Recreation areas
- Parklands
- Not irrigated.

Irrigation practices are regularly adapted to ensure that minimal watering is given to each particular hydrozone, ensuring that that section's vegetation is still fit for its purpose. Watering is attuned for different watering times (eg 15 to 30 minutes) and days of the week to account for seasonal change (eg winter versus summer) and weather patterns (eg recent rainfall). Watering is conducting in the evenings to reduce the loss of water to transpiration (Low pers comm.).

The locations of the hydrozones are presented in **Map 5** of **Appendix One**.

3.4 Wetlands

3.4.1 Existing Wetlands

The Reserve contains two wetlands:

- **Big Carine Swamp:** (UFI 8180), 24.8 ha in size and located in the southern half of the Reserve.
- **Little Carine Swamp:** (UFI 8189), 5.0 ha in size and located in the north east corner of the Reserve.

3.4.2 Wetland Function and Values

Wetlands are one of the most notable features of the Swan Coastal Plain. Apart from channel wetlands (such as rivers and streams), the majority of Swan Coastal Plain wetlands are groundwater dependant in their natural form. These wetlands occur where the ground surface intersects the groundwater table. Due to variations in topography and geomorphology, these wetlands vary from deep, permanent wetlands to shallow seasonal wetlands, through to wetlands with little or no surface water where the water table is at or slightly below the ground surface.

Wetlands perform a number of ecological, hydrological and social functions. Ecologically wetlands provide:

- food webs
- drought refuges for waterbirds
- summer feeding areas for trans-equatorial wading birds
- habitats for plants, animals and communities that are considered to be rare or restricted occurrence or distribution
- limited capacity to assimilate nutrients, pollutants, sediment and litter
- an index of environmental quality (EPA 1993).

Hydrologically, wetlands also play a flood control function by acting as a compensation or retention basin. The vegetation fringing lakes and wetlands partially act as filters that assimilate nutrients, sediments and pollutants from adjacent land surface runoff (EPA 1993).

Wetlands can play a variety of social functions. There can be historical or archaeological values such as aboriginal sites. There are nature studies, education values and access to wildlife values, such as bird watching. And there is also an overall aesthetic consideration to the local community (EPA 1993).

Wetlands in the Swan Coastal Plain have been classified by Hill et al (1996a) as being *Conservation, Resource Enhancement* or *Multiple Use*, according to their functions and attributes. Management priorities for these categories are outlined in **Table 5**.

Table 5: Management categories and objectives and recommendations for change

Category	Wetland description	Management Priorities
Conservation (C category) wetlands	Wetlands which support high levels of attributes and functions	To preserve wetland attributes and functions through reservation in parks, crown reserves, state owned land and protection under environmental protection policies
Resource Enhancement (R category) wetlands	Wetlands which have been partly modified but still support substantial functions and attributes	To restore wetlands through maintenance and enhancement of wetland functions and attributes by protection in crown reserves, state or local government owned land and by environmental protection policies, or in private property by sustainable management
Multiple Use (M category) wetlands	Wetlands with few attributes which still provide important wetland functions	Use, development and management should be considered in the context of water (catchment/strategic drainage planning), town (land use) and environmental planning through landcare

(Hill et al. 1996a)

The recommended separation and management to mitigate potential impacts (threatening processes) for Conservation Category Wetlands (CCWs) are presented in **Table 6**. These recommended practices are adopted by WAPC (2005) *Draft Guideline for Determination of Wetland Buffer Requirements*. It should be noted that some of the management actions are recommendations and are dependant on local site conditions (eg fencing may restrict local fauna).

Table 6: Recommended separation and management for CCWs

Key Threatening Process	Recommended Separation and/or management	Separation area management
Alteration to the water regime	Regulation of groundwater abstraction as catchment management measure	• Area to be vegetated with deep-rooted perennial vegetation • Preferably native plant communities • 6m firebreak minimum, inside of fence • Fence to limit vehicle stock, exotic fauna access • Clear perimeter outside of fence (path, firebreak, road. • Fire control to maintain habitat and species diversity • Minimise track access/clearing, maximise native vegetation • Management for water quality outcomes as required
Habitat modification	• 100 m weed infestation • Up to 100 m for bird habitat dependent on extent of use • 6-50 m firebreak • Fence for controlling exotic fauna access • ≥100 m to minimise edge effects	
Inappropriate recreational use	• ≥50 m to improve aesthetics • ≥50 m for barrier • Fence, paths for controlling access	
Diminished water quality	• Drainage inflows eliminated or managed • Where a proposal may affect wetland water quality, particularly through un-channelised flow, detailed site specific work should be undertaken to determine the specific separation measures required, including management measures	

(WAPC 2005)

3.4.3 Wetland Significance

International Significance

Carine ROS is listed under the DEWHA *EBPC Act 1999* as a Wetland of Internal Significance, as it is a location for several migratory bird species.

Wetlands of international importance are identified as **Ramsar** sites (1996-2007). A convention on wetlands, known as the Ramsar convention, was signed in Ramsar, Iran 1971. The purpose of this convention was to support wise use of wetlands. Those designated Ramsar wetlands are sites containing representative, rare or unique wetland types or those that are important for conserving biological diversity to the List of Wetlands of International Importance. These sites need to be managed to ensure their special ecological values are maintained or improved (DEWHA 2009).

Australia currently has 65 Ramsar sites which cover about 7.5 million hectares. These wetlands are protected through a variety of legislation, policies, management plans and education programs. The EPBC Act is Federal legislation which aims to protect Ramsar wetlands by applying consistent management principles between the Commonwealth and the States (Department of Environment Water Heritage and Arts 2009). Western Australia has 12 Ramsar wetlands. The DEC has the main role in recommending suitable wetlands to the State Government for inclusion on the List of Wetlands of International Importance (DEC 2009b).

The Ramsar convention's strategic framework and guidelines (Ramsar 2006) identifies the importance of smaller sites which are also important in maintaining habitat or ecological communities. Protection of small sites is necessary as they are more likely to be vulnerable to outside impacts.

The criteria for identifying Ramsar sites is outlined in **Table A3.1** in **Appendix Three**.

State Significance

As a result of the Internal Significance rating, the wetlands are also declared as Environmentally Sensitive Areas (ESA) under the GWA (2005) *Environmental Protection* (*Environmentally Sensitive Areas*) *Notice*. An ESA defines those areas where priority flora and fauna species, wetlands or Threatened Ecological Communities (TECs) are likely to occur and as such are subject to strict land clearing regulations.

The *Geographical Atlas* (DEC 2008b) also defines both swamps UFIs 8180 and 8189 as *Conservation Category* Wetlands (CCW). The conservation status means these wetlands have a high degree of naturalness with a management priority directed towards enhancing the natural features of the wetland (Hill et al. 1996b). A 50m buffer from each wetland boundary is recommended for preserving the wetlands from habitat modification unless a site-specific buffer requirement determines the site suitability for a small buffer distance (EPA 2008).

Regional Significance

The site is of regional significance as it is one of the few remaining areas in the metropolitan region containing a significant area of remnant native vegetation.

Land near foreshores is important in the protection of waterways. It acts as a buffer, filtering excess nutrients and pollutants, as well as providing food and habitat to a variety of animal species. Waterways also provide one of the main opportunities for ecological linkages in developed areas, therefore it is desirable to increase the foreshore reserve width to enhance connectivity between remnant vegetation (EPA 2005).

4.1 Vegetation

4.1.1 Vegetation Condition

Vegetation condition is a measure of the degree to which vegetation has been degraded. This measure is based on the proportion of weeds and the degree to which the vegetation structure (i.e. height and density of vegetation layers) has been modified.

The vegetation condition mapping was undertaken by Ecoscape using the standardised scale shown in **Table 7**.

Table 7: Criteria Used for Vegetation Condition Assessment (Keighery 1994)

Condition	Keighery Criteria
Pristine	No obvious signs of disturbance
Excellent	Vegetation structure intact, disturbance only affecting individual species and weeds are non-aggressive species
Very Good	Vegetation structure altered, obvious signs of disturbance e.g: repeated fires, aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure altered, obvious signs of disturbance. Retains basic vegetation structure or ability to regenerate it. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Requires intensive management. The presence of very aggressive weeds at high density, partial clearing, dieback, logging and grazing.
Completely Degraded	Vegetation structure is no longer intact and the area is completely or almost completely without native flora.

As shown in **Table 8** most of the vegetation within the Reserve is degraded as a result of a prolonged period of disturbance in the form of weed invasion and possible clearing. Field survey rated 18.1% of the vegetation as being in Good condition, the remainder was rated as Degraded or less. The distribution of vegetation condition is presented in **Map 6** in **Appendix One**.

No bushland condition rating was undertaken in 1988 so changes in condition over the last 13 years cannot be directly compared.

Table 8: Extent of Vegetation by Condition in Carine Open Space Reserve

Keighery Condition	Area (ha)	%
Pristine	0	0%
Excellent	0	0%
Very Good	0	0%
Good	6.3	18.1%
Degraded	28.1	81.6%
Completely Degraded	0.1	0.3%
TOTAL	**34.4**	**100**

4.1.2 Vegetation Complexes

Vegetation types are grouped into vegetation complexes on the basis of patterns in soil and geomorphology (ie vegetation types 'are grouped [into complexes] by where they occur rather than by having some characteristic such as the same dominant species in common or a majority of species in common' (Trudgen 1996).

Heddle, Loneragan and Havel (1980) mapped and described the vegetation of the Darling System in Western Australia, according to a system of twenty eight complexes, each with shared distinctive characteristics such as flora species composition, soil types and landform. A total of two of the Heddle et al (1980) vegetation complexes are known to occur in the Reserve:

- **Herdsman Complex** - Sedgelands and fringing woodland of *Eucalyptus rudis* - *Melaleuca* species
- **Karrakatta Complex–Central and South** - Predominantly low open forest of *Eucalyptus gomphocephala* - *Eucalyptus marginata* - *Corymbia calophylla* and woodland of *Eucalyptus marginata* - *Banksia* species

An indication of the extents, and examples, of these complexes on the Swan Coastal Plain are given in **Table 9**.

Table 9: Vegetation Complexes recorded in Carine ROS Reserve

Vegetation Complex	Typical Vegetation	Area uncleared on Swan Coastal Plain[1]	Area in secure tenure on Swan Coastal Plain[1]	Other Examples[2]
Karrakatta Central & South	• Tuart - Jarrah – Marri low open forest • Jarrah – Banksia woodland	14 729 ha	1 254 ha	Wireless Hill
Herdsman	• Sedgelands • Flooded Gum - Melaleuca woodlands fringing lakes	2 875 ha	952 ha	Lake Joondalup Star Swamp

[1] EPA (2003) [2] Powell & Emberson, (1996)

It should be noted that the vegetation complex descriptions are general only and as such, some species mentioned in the complex name may be absent in certain locations.

4.1.3 Vegetation Communities

As part of the City's development of the Local Biodiversity Strategy, Mattiske (2008) conducted a *Natural Areas Initial Field Assessment* in the reserve, which included recording the species composition and structure of vegetation communities with 10 x 10 m quadrats. A total of seven communities were recorded. Their community descriptions are presented in **Table 10.**

Table 10: Vegetation Communities of Carine ROS Reserve (Mattiske 2008)

Quadrat	Community Description
1	***Corymbia calophylla* Tall Open Forest** over *Macrozamia riedlei* Tall Open Shrubland over *Acacia saligna* Open Shrubland over *Lepidosperma longitudinale* Very Open Sedgeland
2	***Melaleuca rhaphiophylla* Low Open Forest** over *Centella asiatica* Herbland and *Lepidosperma longitudinale* Open Sedgeland
3	***Typha orientalis* Closed Sedgeland** over **Cynodon dactylon* Very Open Grassland
4	***Schoenoplectus validus* Closed Sedgeland** over **Cynodon dactylon* Open Grassland
5	***Eucalyptus rudis**, Melaleuca rhaphiophylla, Banksia littoralis* **Low Closed Forest** over *Acacia saligna* Tall Open Shrubland
6	***Eucalyptus gomphocephala* Woodland** over *Jacksonia furcellata*, *Xanthorrhoea preissii* Tall Open Scrub over **Pelargonium capitatum* Very Open Herbland
7	***Corymbia calophylla, Eucalyptus gomphocephala* Woodland** over *Banksia grandis* Low Open Woodland over *Jacksonia furcellata* Tall Shrubland over *Grevillea vestita* Shrubland over **Pelargonium capitatum, *Acetosa vulgaris* Open Herbland and *Dianella revoluta*, *Ficinia nodosa* Very Open Sedgeland and **Avena barbata* Very open Grassland.

Shortened community description in bold print

* indicates weed species

As the document did not contain a map indicating their distributions, a map was constructed using these descriptions during a rapid field assessment. The interpretation is illustrated in **Map 7** in **Appendix One**.

4.1.4 Significant Vegetation

State Significance

Bush Forever

WAPC (2000) *Bush Forever Volume 1* states that the Reserve is Bush Forever Site No. 203 (Carine Swamps, Carine) The Implementation Recommendation for this site states:

> *Site with Some Existing Protection; the existing care, control and management intent of the reserve is endorsed. The purpose of the reserve should be amended to include conservation and appropriate mechanisms applied in consultation with the management body.*

As the entire Reserve is listed as Bush Forever, it is also declared as an ESA under the GWA (2005) *Environmental Protection* (*Environmentally Sensitive Areas*) *Notice*. An ESA defines those areas where priority flora and fauna species, wetlands or TECs are likely to occur and as such are subject to strict land clearing regulations.

Significant Ecological Communities

TECs are categorised at both State level (DEC 2008c) and Commonwealth level (DEWHA 1999), while Priority Ecological Communities (PECs) are also classed at State level (DEC 2008). The status of the State and Commonwealth ratings are summarised in **Tables A3.2 to A3.4** in **Appendix Three**.

WAPC (2000) does not list any PECs or TECs within the Carine ROS.

Local and Regional Significance

The amount remaining of Heddle et al (1980) complexes found in the Reserve are summarised below in **Table 11.**

Table 11: Vegetation Complexes in the Carine Open Space Reserve (Heddle* et al *1980)

Vegetation Complex	Area remaining in Swan Coastal Plain		Area remaining in Carine ROS	
	ha	%	ha	%
Karrakatta Complex–Central and South	6,275	18	9.8	>0.01
Herdsman Complex	2,017	31	96.1	>0.01

EPA (2003) defines several levels to describe the status of a vegetation complex within the metropolitan region and southwest. These are:

- **Threshold level** – 30% of the pre-clearing extent is the level at which species loss appears to accelerate exponentially at an ecosystem level
- **Endangered level –** 10% of the original extent is regarded as being a level representing "endangered".

The Karrakatta Complex – Central and South has approximately 18% of its original area remaining in the Swan Coastal Plain. This complex is above the Endangered level but below the Threshold level.

The Herdsman Complex has approximately 31% of its original area remaining in the Swan Coastal Plain. This complex is just above the Threshold level.

4.2 Flora

4.2.1 Native Flora

Flora Inventory

A total of 45 native species have been recorded within Carine ROS (Fames and Moore 1988, Mattiske 2008) which are listed in **Appendix Four**. In terms of growth form, there were:

- 12 tree species
- 4 large shrub species (>1m high)
- 3 small shrub species (<1m high)
- 8 herb species
- 4 climber and groundcover species
- 14 sedge and rush species.

No native grass species were recorded.

Significant Flora

State and Federal Significance

Flora species require Declared Rare Flora (DRF) or Priority conservation status where populations are geographically restricted or threatened by local processes. Flora are classified and protected at a federal level through the Australian Government (1999) under the *EPBC Act (1999).* There are five categories of protected flora covering the federally listed species, which are described in **Table A3.5** in **Appendix Three**.

The DEC also enforces regulations under GWA's *Wildlife Conservation Act* (*1950)* to conserve DRF and protect significant populations. Rare flora species are gazetted under Sub-Section 2 of Section 23F of the *Wildlife Conservation Act (1950)*, thereby making it an offence to remove or damage rare flora without Ministerial approval. All Declared and Priority flora are listed in DEC (2008a) *Declared Rare and Priority Flora List*. There are six categories of priority flora covering these listed species, which are described in **Table A3.6** in **Appendix Three**.

A review of the previous management plan, DEHWA *Protected Matters Search Tool,* WAPC (2000) and Mattiske (2008) indicated that that there were no State or Federally listed significant flora species known to occur in the Reserve.

Local and Regional Significance

Eucalyptus gomphocephala (Tuart) is restricted to the limestone soils along the SCP. The species is an important source of food and shelter for many local invertebrate and vertebrate fauna species. The distribution of this species is currently in decline (Florabank 2010).

Schoenoplectus validus (Lake Club-rush) and *Baumea articulata* (Jointed Rush) are sedges that occur in fresh or brackish swamps and lake borders within the Perth region. They both offer important habitats for water birds. *Baumea articulata* is an aquatic species where as *S. validus* is tolerant of water logging for several months, meaning they occupy different positions in wetland (Florabank 2010).

4.2.2 Weeds

Weed Inventory

A weed species inventory was compiled by referring to:

- Dames and Moore (1988) *Carine Lake ROS Management Plan*
- Mattiske (2008) *Initial Field Assessment*.

A total of 58 weed species have been recorded as being present in Carine ROS. It should be noted that four species listed in the 1988 Management Plan have not been observed in the Reserve in recent years. It is possible that that these weed species have been successfully eliminated in Carine ROS since the release of the 1988 Management Plan. A detailed site survey is required to confirm whether these weed species are still present.

The full weed species inventory is presented in **Appendix Four**.

Significant Weed Species

Methodology

Each weed species was assigned a priority rating according to their deemed threat level:

- *High Priority* - need to have immediate targeted strategies developed and implemented
- *Moderate Priority* - should be targeted to enhance the site condition if there are any resources available after controlling the high priority weed species
- *Low Priority* - should be controlled as part of non-target or site-focused maintenance weed strategies if there are any resources available after controlling the high and moderate priority weed species.

The priority ratings of each weed species were determined after examining:

- the ratings under the *Environmental Weed Strategy of Western Australia* (EWSWA) by the Department of Conservation and Land Management (CALM 1999)
- the ratings under the *Environmental Weed Census and Prioritisation* (EWCP) by the Swan Natural Resource Management (Swan NRM 2008)
- the ratings under Dixon and Keighery (1995) *Recommended methods to control specific weed species*

- whether it was listed under the DAFWA (1976) *Agricultural and Related Resources Protection Act* (ARRPA)
- whether it was listed as a *Weed of National Significance* (WONS) (Weed Australia 2008)
- its local significance to the natural areas.

It should be noted that a weed species may differ in its priority status as a result of its local significance. For example, a weed species may be more invasive and dominant in a wetland community than in a sandy upland community. Therefore this species should be regarded as a higher priority to control in reserves containing wetlands than in reserves containing only upland vegetation.

The full methodology for determining the priority of each weed species and associated calculations are presented in **Appendix Five.**

Results

The prioritisation process determined that:

- 17 weed species were considered to be High Priority to control
- 25 weed species were considered to be Moderate Priority to control
- 17 weed species were considered to be Low priority to control.

The High Priority weed species in this reserve are summarised in **Table 12**. The final priority ratings for all of the weed species is presented in **Table A5.2** in **Appendix Five**.

Table 12: Known High Priority weeds of Carine ROS

Scientific Name	Common Names	WONS	ARRPA
Acetosella vulgaris	Sorrel		
Avena barbata	Bearded Oat		
Bromus diandrus	Great Brome		
Carpobrotus edulis	Pigface		
Cynodon dactylon	Couch		
Euphorbia terracina	Geraldton Carnation Weed		
Lagurus ovatus	Hares Tail Grass		
Lantana camara	Lantana	*	P1
Paspalum dilatatum	Paspalum		
Paspalum distichum	Water Couch		
Pelargonium capitatum	Rose Pelargonium		
Pennisetum clandestinum	Kikuyu		
Phyla nodiflora	Carpet Weed		
Stenotaphrum secundatum	Buffalo Grass		
Tamarix aphylla	Tamarisk		P1
Typha orientalis	Bullrush		
Zantedeschia aethiopica	Arum Lily		P1, P4

4.3 Fauna

4.3.1 Native Fauna

Recorded Fauna

An inventory of native fauna known or thought to occur in Carine ROS after consulting Dames and Moore (1988), Mattiske (2008) and DEWHA (2010) *Matters of Environmental Significance Search Tool*.

The inventory is summarised as **Table A4.3** in **Appendix Four**.

Birds

There was a total of 52 native bird species identified as likely to occur in the local area of the study site. Five of these species have some level of conservation significance, including Carnaby's and Baudin's Black-Cockatoos which are listed under the *EPBC Act (1999)* and *Wildlife Conservation Act (1950)*. These two species may visit Carine ROS although the Reserve:

- contains few Marri and Banksia trees which are a known food source for these species
- contains little native vegetation associated with these species.

Mammals

No native mammals have been recorded in Carine ROS. The Chuditch (*Dasyurus geoffroii)* is recorded by DEWHA as possibly occurring in the area, however it is highly unlikely to be present as:

- this species has not been sighted or recorded in the Reserve
- the Reserve's vegetation is degraded
- the Reserve is surrounded by urban development and major roads, reducing the change of new populations entering the Reserve.
- foxes and domestic pets may have preyed upon and eliminated existing populations.

Reptiles

No eptiles were observed during the site survey, however locals reported Dugites (*Pseudonaja affinis*) and Tiger Snakes (*Notechis scutatus*) as being common (Dames and Moore 1984). The site is likely to contain a suite of common reptiles such as bobtail lizards, skinks and dragon lizards. The local area has a range of habitats that could support populations of these species and is likely to do so. Predation by introduced predators such as the European Red Fox and the domestic cat may impact heavily on the abundance of reptiles. Predation rates increase due to disturbance and clearing of vegetation and therefore population numbers for the reptiles may be reduced. The surrounding residential areas and major roads also prevent more reptiles form entering the Reserve.

Amphibians

A total of 6 frog species were identified within the Reserve by Dames and Moore (1984):

- Slender Tree Frog (*Litoria adelaidensis*)
- Motorbike Frog (*Litoria moorei*)
- Western Banjo Frog (*Limnodynastes dorsalis*)
- Moaning Frog (*Heleioporus eyrei*)
- Clicking Frog (*Criniaa glauerti*)
- Squelshing Froglet (*Crinia insignifera*).

These species predominantly require dense litter for shelter and due to the degraded nature of the site would be restricted to the areas of good or better bushland condition. These species would be under pressure from introduced predators to maintain their populations, however they were identified as being common and widespread by Dame and Moore (1988).

The common Long-necked Tortoise (*Chelodina oblonga*) was also recorded as present in the reserve (Dame and Moore 1984).

Significant Fauna

State and Federal Significant Fauna

The conservation status of fauna species is assessed the Commonwealth's *EPBC Act (1999)* and the State's *Wildlife Conservation Act* (*1950)*. The significance levels for fauna used in the *EPBC Act (1999)* are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN).

The *Wildlife Conservation Act* (*1950)* uses a set of Schedules but also classifies species using some of the IUCN categories. These categories provide special protection to listed fauna definitions are shown in **Tables A3-5, A3-7 and A3-8** in **Appendix Three.**

In Western Australia, the DEC has produced a supplementary list of Priority Fauna, listed using priority codes, which are species that are not considered Threatened under the *Wildlife Conservation Act* but for which the DEC feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. It is important to recognise that such Priority Lists have no statutory standing, but are used to assist DEC when considering which fauna are most in need of more surveys or other investigations, in order to establish their status in the wild.

The Priority Fauna List for Western Australia includes taxa organised by priority codes that either:

- have recently been removed from the schedule of threatened fauna
- have a restricted range, are uncommon or are declining in range and/or abundance, but which do not meet the criteria for inclusion on the schedule of threatened fauna
- have been nominated for consideration for the schedule of threatened fauna and for which there is insufficient information for the advisory committee to make an assessment of their status
- are otherwise worthy of inclusion on such a list, as determined by DEC.

The Priority Fauna List for Western Australia is reviewed by DEC whenever new information on relevant taxa becomes available. Taxa are removed from the list by DEC as they cease to meet the requirements identified above.

A review of the Dames and Moore (1988), WAPC (2000) and Mattiske (2008) reports indicated that seven Scheduled or Priority Fauna species are known to or may occur in the Reserve (**Table 13**).

Table 13: Significant fauna species that may potentially occur at Carine ROS

Scientific name	Common Name	EPBC Act	Wildlife Act
Bird			
Ardea alba	Great Egret	Migratory	
Ardea ibis	Cattle Egret	Migratory	
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Endangered
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Endangered
Merops ornatus	Rainbow Bee-eater	Migratory	
Mammal			
Dasyurus geoffroii	Chuditch	Vulnerable	Vulnerable
Arthropod			
Synemon gratiosa	Graceful Sun Moth	Endangered	

Descriptions of the conservation significant fauna species are presented.

Great Egret (*Ardea alba*)

Great Egrets occur throughout most of the world. They are common throughout Australia, with the exception of the most arid areas. They prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. They can be seen alone or in small flocks, often with other Egret species, and roost at night in groups. Due to the wetlands in the Reserve it is likely this species is a seasonal visitor. The Great Egret is listed as Migratory under the *EPBC Act 1999.*

Cattle Egret (*Ardea ibis*)

The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures. It has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. The Cattle Egret is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation. It is likely an over flying species, visiting the Reserve seasonally. The Cattle Egret is listed as Migratory under the *EPBC Act 1999*.

Baudin's Black-Cockatoo (***Calyptorhynchus baudinii)***

Baudin's Black-Cockatoo occurs in high-rainfall areas, usually at sites that are heavily forested and dominated by *Corymbia calophylla* (Marri) and Eucalyptus species, especially *E. diversicolor* (Karri) and *E. marginata* (Jarrah). It is claimed that the range of the species during the non-breeding season is determined by the distribution of Marri, and that nesting is confined to areas in which Karri occurs (Saunders 1974). Habitat for this species was identified in the Reserve. The Baudin's Black-Cockatoo is listed as Vulnerable under the *EPBC Act 1999* and Endangered under the *Wildlife Protection Act 1950*.

Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)

Carnaby's Black-Cockatoo mainly occurs in uncleared or remnant native eucalypt woodlands, especially those that contain Salmon Gum (*Eucalyptus salmonophloia*) and Wandoo (*E. wandoo*), and in shrubland or kwongan heathland dominated by *Hakea, Dryandra, Banksia* and *Grevillea* species. It is a seasonal visitor to plantations of exotic pines (*Pinus* spp.), and sometimes occurs in forests containing Marri (*Corymbia calophylla*), Jarrah (*E. marginata*) or Karri (*E. diversicolor*). This species therefore is considered likely to visit the Reserve. The Carnaby's Cockatoo is listed as Endangered under the *EPBC Act 1999* and Endangered under the *Wildlife Protection Act 1950*.

Rainbow Bee-eater (*Merops ornatus*)

This species can be found all across Australia, except Tasmania and far south west of the mainland. It forages aerially for insects and nests in burrows in the ground (Higgins 1999). It occurs in habitats that provide suitable soil for nesting and a tall stratum of vegetation for perching. This species breeds nesting in small holes excavated in sandy banks or flat sandy surfaces and is listed. The Rainbow Bee-eater as *Migratory* under the *EBPC Act 1999*.

Chuditch (*Dasyurus geoffroii*)

The Chuditch is now known only from Western Australia where it predominantly occurs in Jarrah (*Eucalyptus marginata*) forest (Australian Government 2008). Chuditch have never been recorded in pure Karri (*E. diversicolor*) forest (Orell & Morris 1994). As the majority of the Reserve is wetland vegetation and there is minimal cover for mammals it is very unlikely that the Chuditch is present in the Reserve. The Chuditch is listed as Vulnerable under the *EPBC Act 1999* and Vulnerable under the *Wildlife Protection Act 1950*.

Graceful Sun Moth (*Synemon gratiosa*)

The two Lomandra species (*L. hermaphrodita* and *L. maritima*) are known habitat plants for the Graceful Sun Moth. The 1988 management plan states that a Lomandra species occurs in the Reserve, however the particular species is currently unknown. Further identification of this species is required to determine whether the Graceful Sun Moth may utilise the Reserve as breeding habitat. The Graceful Sun Moth is listed as Endangered under the *EPBC Act 1999*.

Fauna Tunnel

A fauna tunnel links the southern side of the Reserve under Reid Highway and provides a passageway for fauna in and out of the Reserve. However the usefulness of this passageway is unknown, as there have been no sightings of animals using it. Also, the tunnel entrance is openly exposed and is constructed from building materials, rather than soils and plants, which would deter native animals from approaching it (**Plate 1** in **Appendix Seven**).

Overabundant Fauna

Some native species have greatly increased in population size as a result of European settlement and have become overabundant, putting pressure on the environment and possibly affecting nearby residents. The Australian Raven (*Corvus coronoides*) is overabundant in the Reserve. The species have been observed eating other birds' eggs and hatchlings in several reserves (Taylor pers com).

Species that have not previously been recorded in Carine ROS, but that may be present in the future are:

- kangaroos (*Macropus fuliginosus*), which have been recorded in nearby Karrinyup Golf Course, Star Swamp and Beach Marmion
- Correllas (*Cacatua pastinator*), which are considered overabundant in the Perth region
- Rainbow Lorikeets (*Trichoglossus haematodus*), which are exotic to Western Australia and are overabundant in the Perth region.

The City is currently working with the DEC to control Corella population numbers. This is an ongoing exercise.

4.3.2 Non-native Fauna

Feral Fauna

Feral Animals are generally regarded as naturalised domestic species such as the turtle dove, or species that were introduced for recreational purposes, like the fox, that have escaped or been released and gone wild. Feral animals are often significant pests to agriculture and the ecological values of the areas that they inhabit. Some feral animals prey on native species, others compete for food and shelter or destroy habitat, and can spread diseases. In Australia, feral animals have few natural predators or fatal diseases and some have high reproductive rates. As a result, their populations are not naturally limited and they can multiply rapidly if conditions are favourable.

Several feral fauna have been identified in Carine ROS, and are discussed below.

European Red Foxes (*Vulpes vulpes*)

Foxes pose a threat to many native fauna species. Foxes tend to occupy distinct areas, called home ranges, from which they exclude other foxes entering (although home ranges can overlap). Fox numbers are therefore relatively stable, except when animals are removed and there is an influx of new individuals. The size of a home range is determined by food and resources but can typically range from 280 to 1600 ha (Western Australian Department of Agriculture 2004).

European Honey Bees (*Apis mellifera*)

There are currently several honey bee hives located in hollows of trees in the southern section of the Reserve. Honeybees can have a negative impact on the environment by:

- competing for nesting places, such as tree hollows and nesting boxes
- competing with native bees and honeyeaters for food
- being less efficient in cross-pollinating native plants, thereby reducing plant reproduction (Burbidge 2004; Burgman & Lindenmayer 1998).

Mosquito Fish/ (*Gambusia holbrooki*)

Mosquito Fish were introduced into Australia from America in the 1920's to control mosquitoes. However, there is evidence that native fish are more effective at controlling mosquitoes than Mosquito Fish, and that Mosquito Fish have contributed to a reduction in the number of some native fish and frog species (Streamwatch 2009).

Mosquito Fish are aggressive predators, and they impact on the environment through:

- attacking, killing and eating small native fish, water bugs, frog eggs and tadpoles
- competing for food with native fish, eating their eggs and killing infant fish
- displacing many of the native fish (Streamwatch 2009).

Rodents (*Mus musculus* and *Rattus rattus*)

The House Mouse (*Mus musculus*) and Rat (*Rattus rattus*) can impact the local vegetation by depleting native seed banks. They can also affect native fauna populations by competing with other animals for food and nesting places and transmit diseases to native fauna. Rats are also predatory and may prey on reptiles and birds (Lapidge et al. 2004) .

Domestic Pigeons (*Columba livia*), and Spotted Turtle Doves (*Streptopelia chinensis* and *S. senegalensis*)

Domestic Pigeons, Spotted Turtle Dove and Laughing Turtle Doves are all common introduced species that inhabit Australia's metropolitan areas. They pose as pests as they may compete with native birdlife for food and nesting sites and may feather mite disease.

Domestic Fauna

Pets

Carine ROS is frequently used by the public to exercise their pet dogs. Dogs are often off their leashes and can easily enter native vegetation areas. Also neighbouring residents have pet cats which may enter the Reserve.

It is acknowledged that domestic pets such as Cats and Dogs are often important companions to people, however these pets can have quite significant impacts on native fauna. Domestic cats may predate native wildlife, such as birds, amphibians and lizards. Dogs can also do damage if they not are not leashed while being exercised within the Reserve. They can disturb native animals and spoil the native vegetation and habitat, crushing reed beds and disturb hiding and nesting habitat of water birds and aquatic wildlife.

Horses

The Riding for the Disabled Association of Western Australia has an Equestrian School located along the eastern boundary of Carine ROS. Horse riding is conducted on an oval and horses are kept in an on-site enclosure.

Horses may have potential impacts on the adjacent bushland and wetlands. The horses need to be kept retained within the oval and enclosure areas, otherwise they may trample vegetation and graze revegetation efforts. The off-site disposal of horse manure is also important, as it may contain weed seeds from feed, threatening bushland surrounding the Riding School. Horse manure is also high in nutrients, which may leach into the wetlands, promoting eutrophication.

4.4 Plant Diseases

4.4.1 Plant Disease Threats

There are three main diseases that threaten the natural values of Carine ROS, which are outlined below.

Dieback (*Phytophthora cinnamomi*)

There are 15 *Phytophthora* species in Western Australia. These are soil-borne water moulds that kill a wide selection of plant species of the south west of Western Australia. As *Phytophthora* is a parasite, it requires a living host on which to feed and extracts its food by a mass of thread-like mycelium, which forms the body of the organism. *Phytophthora* is a water mould that kills its host by girdling the base of the stem, destroying the roots and depriving the plant access to nutrients and water. The most significant *Phytophthora* species is *Phytophthora cinnamomi*. The life cycle of this *Phytophthora* requires moist, non-alkaline conditions that favour survival, sporulation and dispersal (Murray 1997).

Honey Fungus (*Armillaria luteobubalbina*)

Armillaria luteobubalbina (Honey Fungus), is a toadstool-producing parasitic fungus that lives off both live and dead hosts and is native to Western Australia. It commonly occurs in the south-west of the state and unlike *Phytophthora cinnamomi* is not restricted by soil or landform types. It occurs in woodlands, forests, scrublands and parks on a wide variety of eucalypts and other plants such as *Acacia, Agonis, Banksia, Bossiaea, Grevillea, Hakea, Trymalium* and *Xanthorrhoea*. In some circumstances it can act as a virulent parasite that kills hosts including tuarts (Bougher & Syme 1998), jarrah, marri, wandoo and many understorey species. Deaths may occur as either single plants or as multiple deaths (Bailey 1995). The infection is caused by the aerial dispersion of spores, or through mycelium in root systems. Infection entry points for the spores may be provided by wounds caused by fire, broken limbs and insect damage.

Aerial Canker

Aerial Cankers are diseases caused by a group of largely air-dispersed fungi (including *Cryptodiaporthe melanocraespida* and *Zythiostroma* and *Diplodena* species) that affect the State's flora in the south-west. Occurrence of the disease is dependent on a combination of a susceptible host, infective pathogen, infection site (e.g. pre-existing wounds) and favourable environmental conditions. Under suitable conditions the disease can cause the death of plants within 2 years (Murray 1997). Aerial canker kills twigs in the lower crown and causes lesions called cankers in the bark of the main stem and roots. Severe cankers can cause death in parts of the plants above the canker. The fungus usually enters the plant through an existing wound (insect attack or wind damage). Healthy trees not subject to stress are unlikely to be severely affected (Bailey 1995).

4.4.2 Disease Status

There are no known plant diseases recorded in Carine ROS. However, the Reserve has not been formally assessed as no symptoms of diseases have been observed to warrant such an assessment (Crews pers comm.).

To date a few reserves within the City have been identified or suspected of having dieback. There has only been one recorded case of honey fungus in the City, which has been removed. There has been no known infestations of aerial canker within the City (Woods pers comm.).

4.4.3 Current City Management Practices

All natural areas staff have completed environmental specific training which includes knowing the differing forms of dieback. Field staff continually monitor all of the City reserves for signs of disease or tree decline. Any identified or suspected disease infection is reported to the Natural Areas Supervisor who then investigates the matter. The Supervisor may seek specialist advise if required. If a disease is confirmed or still suspected, all natural areas staff are notified and management practices are applied according to the disease type within that reserve.

Before leaving a reserve known to or suspected of having dieback, the Natural Areas staff inspect and clean all vehicles, footwear and equipment of any soil deposits using dieback cleaning products.

To further minimise risk of disease introduction, the City of Stirling nursery have become accredited by the Nurseries and Gardening Industry Association of Western Australia. Part of this accreditation is for the City to adhere to hygiene and quality standards.

4.5 Fire Risk

The Reserve was assessed to determine the type and variation of bushland fire risk to human life, property, ecological and social values.

4.5.1 Fire Risk Hazard Assessment

A Fire and Emergency Service Authority (FESA 2004) *Type 3 Bush Fire Hazard Assessment* was conducted on the Reserve. This detailed, site specific level of assessment required for applications for planning approval.

The native vegetation, parkland and additional trees throughout and surrounding the Reserve were all categorised according to their:

- vegetation structure (fuel load)
- proximity to residential housing
- general ground slope.

The categories allow the Reserve to be rated to four levels of bush fire hazard risk as defined by FESA (2004) – Low, Medium, High and Extreme. A table summarising the allocation of fire hazard levels is presented in **Table A3.9** in **Appendix Three**.

Just over 80% of the reserve was rated as a Low risk, as a result of low fuel loads, gentle slopes and distance from residential housing. Just under 7% was rated as a Moderate Risk. These were densely planted trees near the Reserve's boundaries. Approximately 13% of the Reserve was rated as a High Risk, which included the bushland surrounding the Equestrian Club, the vegetation in and surrounding Little Carine Swamp and trees near the Crick Clubhouse (**Table 14).** The distributions of the Fire Hazard Risk areas are illustrated in **Map 8** in **Appendix One.**

Table 14: Extent of Fire Risk Hazards in Carine Open Space Reserve

Fire Risk Hazard	Area	%
Extreme	0	0
High	13.1	13.3
Moderate	6.5	6.6
Low	78.6	80.1

4.5.2 Seasonality of Fire Risk

Carine ROS is hottest, driest and windiest in summer (Bureau of Meteorology 2010). This time year is considered high risk for bushfires, as the vegetation and ground litter has dried, therefore encouraging ignition risk. The wind speed is higher in the afternoons, which exacerbates the risk as it encourages any fire outbreak to spread faster across the bushland. Conversely, the lowest risk time of the year and day is in winter mornings, when there is the most rainfall, coolest temperature and lowest wind speeds.

5.0 Social and Built Environment

5.1 A Sense of Place

Carine ROS is an important place for the local community. The Reserve's natural environment offers a vital element in defining the identity of Carine and has the potential to set a benchmark for the integration of community public open space, nature reserves and recreational facilities within the Perth metropolitan area. Carine ROS not only contributes to the ecological sustainability of the area, it also has the potential to be a key contributor to the aesthetic and physical character of the surrounding suburb and broader community, providing identity to the cultural heritage, flora, vegetation and fauna of the area.

Public open space is often appreciated for the recreational opportunities it provides. The Carine ROS offers a multitude of active recreational opportunities (both organised sports and individual exercise) through its numerous ovals, skate park and tennis courts; as well as passive recreational opportunities such as walking, jogging and cycling.

Aside from being a visual and recreational asset to the community, Carine ROS also has the potential to contribute to broader community objectives such as:

- public health (both physical and psychological)
- youth development (eg the various sporting facilities and skate park)
- job opportunities (maintenance)
- community building, particularly through possible social and cultural events.

5.2 History and Heritage

5.2.1 History

The two swamps were named by R. Quinn in a survey of the area in 1865. The Hamersley family bought the surrounding lands in 1837. Much of the land remained undeveloped until the 1960s, where a few market gardens were established around the swamps. Some remnant fencing and other infrastructure from the market gardens still exist in-situ to represent these times (City of Stirling 2010). In turn, the suburb of Carine was named after the swamps in 1973 (Landgate 2010).

5.2.2 Heritage

The Department of Indigenous Affairs (DIA 2010) online *Aboriginal Heritage Inquiry System* (AHIS) and the Australian Heritage Council (AHC 2010) online *Australian Heritage Database* indicated no recorded aboriginal or other heritage sites in or immediately adjacent to the Reserve.

5.3 Access and Infrastructure

The current and planned access and infrastructure for Carine ROS is presented in the City's Master Plan (**Figure 3**).

Parking

The current parking facilities at Carine ROS are sufficient for the current usage of the site and range from good condition to partially degraded in quality. Existing parking facilities include:

- a main car park at the north west boundary off Okely Road providing access to the playing fields and the northern zone of the Reserve and playground
- a series of car parks off Beach Road that directly access the playing fields, sporting facilities and northern wetland zone
- a car park at the north east boundary off Monyash Road servicing the playing fields, equestrian centre and northern wetland
- a car park on the south eastern boundary with access off Monyash Road which provides access to the playing fields and the southern zone of the Reserve.

5.3.1 Access Paths

Paths and tracks through the Reserve service a number of functions from management and maintenance to facilitating and controlling community access. The current path network can be classified as either primary, secondary or informal. The path network around the Reserve is frequently used and is popular with both cyclists and pedestrians.

Primary: Primary paths are located at the perimeter of the Reserve, crossing through the Reserve in the northern zone between the two wetland bodies and provide partial access around the southern wetland. They link directly to the parking facilities and infrastructure, playgrounds and the equestrian school. The primary access ways are characterised by concrete paths that vary in colour/ material and quality, with some portions along the south western end of the Reserve significantly degraded. There is a "cycle-only" concrete path that runs from the northern carpark on Monyash Road across to the Okely Road car park.

Secondary: The secondary paths provide access through rehabilitation zones and areas surrounding the south of the wetland and are constructed from compacted limestone.

Informal: The informal paths are defined by desired movement and usage, not material. Informal paths are generated through public use and can be found as tracks across grasslands surrounding the northern wetland and through open grasslands along Monyash Road.

LANDSCAPE FEATURES

- Proposed Green Belt Tree Plantings
- Planted and Remnant Trees set in Parkland
- Remnant Native Bushland
- Wetland Associated Trees and Shrubs
- Plane trees gifted by the City Of Perth (1980)
- Bushland Regeneration
- Freeway and Drainage retention Basin Revegetation
- Native and Introduced Reeds and Rushes
- Irrigated Lawn
- Seasonal Mown Grass
- Seasonal Open Water
- Proposed Excavated Open Water
- Existing Contours

CIRCULATION

- Adjacent Roads
- Existing Car Parking
- Perth Bicycle Network (3.5m wide Red Asphalt Dual use path)
- Shared paths (Shared by pedestrians and cyclists) 3.0m wide Concrete Paths
- Pedestrian Footpaths (2.0m wide concrete path)
- Shared paths (2.5m wide Stabilised Limestone Paths Shared by pedestrians and cyclists)
- Pedestrian Bush Paths (2.0m wide Stabilised limestone Paths)
- Boardwalk
- Proposed Parking
- Access Points
- Bus Stops

STRUCTURES

- Proposed Gazebo
- Equal Access Public Toilets
- PS Pump station
- Bore
- Emergency phone
- Regional Play Equipment
- Local Play Equipment
- Parks Maintenance Compound
- Sculpture / Art Installation

LIGHTING / SIGNAGE

- Practice Lights
- Existing Park Security Lighting
- Proposed Park Security Lighting
- Primary Entry Statement
- Secondary Entry
- Information Boards

PARK FURNISHINGS

- Litter Bins
- Park Benches
- Picnic Tables
- Park Shelters
- BBQ's with lighting
- Drinking Fountain
- Doggie Litter Bins

SPORTS FACILITIES

- Baseball Fields
- Cricket Wickets
- Foot Ball Ovals
- Athletics
- Practice Nets
- Skate Facility
- Hit up Wall
- Dog Training and Obedience
- Horse Riding
- 1 Carine Hall and Change Rooms and future toilets extension
- 2 Monyash Hall and change rooms
- 3 Riding for the Disabled Facilities Complex
- 4 Storage Building

0 50 100 150 metres

The Carine Regional Open Space Master Plan has been prepared by the City Of Stirling to guide the ongoing improvements to Carine Regional open space for the years ahead.

In preparing the final plan Council addressed in a considered and balanced manner all the submissions received during the Preliminary Master Plan public consultation period. Council resolved to endorse the subsequent recommendations made by the City to amend the Preliminary Master Plan and directed that this amended plan be adopted and made available for public information.

The City Of Stirling is currently using the Master Plan as a basis for the preparation of an implementation strategy to assist determining funding and programming of future works. Once completed the implementation strategy will be submitted to council for endorsement.

City of Stirling
City of Choice

Carine Regional Open Space
Master Plan - 2003

Carine ROS EMP Figure 3

PREPARED BY PARKS AND RESERVES DEPARTMENT. AUGUST 2003

5.3.2 Fencing

The existing fencing across the Reserve is predominantly timber post and rail fencing which is used to restrict access to areas of rehabilitation around the wetlands and to define and enclose the adjoining equestrian school. Steel hand rails have been installed at cross-over points in the northern zone of the Reserve where a path crosses over a water way next to the equestrian school.

Wire mesh fencing has been utilised along the southern boundary interface to Reid Hwy and steel 'pool' fencing prevents access into storm water drains located in this area.

New limestone retaining walls and a fauna tunnel have also recently been installed at the Reid Hwy boundary maintaining an important fauna corridor link to the Reserve and public open spaces south of Reid Hwy.

5.3.3 Signage

Signage at Carine ROS is currently lacking a cohesive strategy in both the information conveyed and the locality of the signs. In many instances there is excessive directional and regulatory signage, particularly at key intersections in the northern zone of the Reserve (**Plate 2** in **Appendix Seven**).

Most of the signage at the Reserve is directory, with only limited regulatory and informative signs. There are no interpretive or educational signs within the Reserve, and a significant amount of the existing signage has been vandalised or damaged (**Plate 3** in **Appendix Seven**).

5.3.4 Infrastructure

All of the existing infrastructure and buildings within the reserve are easily accessible by road and car parks. At present there is adequate seating located at regular intervals along the primary path network. The existing seating consists of timber and steel bench seats with backs. Most of these bench seats do not have any shade and are often faced towards the vegetation rather than across fields (**Plate 4** in **Appendix Seven**). However, the facing of the benches seats towards the vegetation may be preferable to bird watchers.

Picnic facilities at the Reserve are characterised by timber and steel table and bench seating integrated with a timber shade structure. There are a limited numbers of these picnic facilities, predominantly located in the northern area of the Reserve in the vicinity of the playgrounds, northern playing fields and northern wetland. Barbeque facilities can be found adjacent to the picnic tables in the playground areas.

5.4 Fire Management

5.4.1 Fire History

Carine ROS has a history of fires being deliberately lit. The last instance was on 24th December 2007, where all the vegetation communities were damaged.

5.4.2 Actions

The City undertakes several fire prevention and preparation activities, which are described below.

Fire History Records

The City maintains a history record of all fire outbreaks in the City. The Natural Areas Supervisor records details of a fire outbreak, using photos, maps and notes. Information collected includes date, area, cause and response. Infrastructure that has been damaged by the fire and required repairs are also reported.

Fire and Emergency Services (FESA)

The City invites FESA each year before summer to review and update the Fire Response Plan for key conservation reserves within the City of Stirling, including Carine ROS. Any immediate actions identified by FESA (eg fire break and access track maintenance) are carried out immediately after the assessment.

City Rangers

The City Rangers play several key roles in fire management:

- to act as a point of contact for ratepayers to report fire incidents
- to alert FESA to come and attend to the fire
- to monitor sites after a fire to ensure that re-flaring does not occur
- to conduct after hours and weekend patrols to ensure that unauthorised entry into bushland/ wetland areas do not occur.

Fire Fighting

All fire fighting within the City of Stirling is undertaken by local fire stations, the closest being Duncraig Fire Station. If more personnel are needed, the Osborne Park and Malaga Fire Stations and even the local State Emergency Services (SES) may also be requested. There is no volunteer fire fighting group in the City. The City is not responsible for combating any fire outbreaks. However, the City does provide a support role by having water tankers on standby in case they are needed.

Weed Control

The City's Natural Areas staff currently conduct weed control activities to reduce fire ignition risk and fuel loads. These activities include targeting:

- winter grasses and summer grasses in bushland areas
- Pampas Grass in wetland areas
- Bulrush along selected stretches of the wetland fringe.

5.4.3 Access

Carine ROS has three entrances along the northern and eastern perimeters (**Figures 2** and **3**). Pathways and open grasslands allow emergency vehicles unrestricted access throughout the Reserve. There is only limited 1.5m high fencing in the bushland areas which may restrict vehicles but not personnel.

5.4.4 Sport Clubs

Fire suppression equipment

The Carine Reserve Main Hall has four fire extinguishers:

- the kitchen (2.7kg)
- the bar (4.5kg)
- the meeting room (4.5kg)
- the Hall (4.5kg)

At present it is unknown what fire suppression equipment is provided in the Monyash Guide Hall or Equestrian Club buildings.

Flammable substances

It is currently unknown whether there are flammable substances kept in the Reserve's buildings or how they are stored.

6.0 Plan for Management

Carine ROS Environmental Management Plan

6.1 Management Framework

6.1.1 Objectives

The objectives of the Management Framework are to:

- reduce or minimise areas where responsibilities, objectives and practices may conflict, particularly in conservation and recreation
- aid in the development of specific management practices appropriate to the different features of the Reserve, which aim to both enhance and converse the biodiversity of Carine ROS.

6.1.2 Issues

Vegetation Degradation and Decline

The vegetation within Carine ROS is severely degraded in both condition and biodiversity. Immediate management is required to reverse the decline of the vegetation to restore its local, regional and international natural values.

Site Complexity

Carine ROS is a large site which is diverse in natural and social features and landuses. Therefore it can be difficult to develop strategies and coordinate actions in the Reserve to address issues which will not conflict with other issues. It is also difficult to direct where in the Reserve certain works are to start and stop. A framework is therefore required that can divide the Reserve into specific sections according to their particular site features and management issues. Management actions may then be developed and implemented within particular sections which will not conflict with the features of the other sections.

6.1.3 Strategy

A three tiered hierarchy of management areas is used as the basis for planning in this management plan. These are (from broadest to most specific):

- **Land Use** - a management framework at a conceptual level on the basis of broadly identifying the Reserve's main functions
- **Zones** - a basis for developing management strategies on the basis of areas defined by relatively uniform management practices
- **Sites** - a basis for detailed planning of areas targeted for specific works.

The 1988 Management Plan embraced a similar concept through the inclusion of maps of intended land use activities and characteristics across the Reserve which equate to landuses. There was no equivalent to zones or sites in the 1988 Plan as it did not address management of the Reserve to this level of detail.

The interfaces between the different Landuses, Zones and Sites need to translate into precise, distinct, uncomplicated and easily discernible boundaries. This will aid the City in determining where the management practices are to start and stop. Physical features such as pathways and fences may serve as such boundaries as shown in **Map 9** in **Appendix Three** to indicate the recommended Landuse and Zone areas.

Management Framework

Carine ROS was separated according to its primary land uses:

- Conservation
- Recreation.

Each Landuse was then further partitioned into Zones according to the main attribute, allowing to further direct specific practices into appropriate areas.

The Conservation Landuse was separated according to its vegetation type:

- Bushland
- Transition
- Wetland.

The Recreation Landuse was separated by its intensity of social use:

- High Use
- Moderate use
- Low use.

The City may now further separate each Zone into Sites to address specific features or issues relating to an exact location. For example, certain areas may require fauna habitat to be installed or monitored for specific weed species. Examples of features and management issues that should be considered when dividing Zones into Sites are presented in **Table 15**. The following management strategies (**Section 6.2** to **6.12**) indicate which Land use and Zones the strategy is applicable to.

The process of separating the Landuses into Zones and Sites is summarised in **Figure 4**.

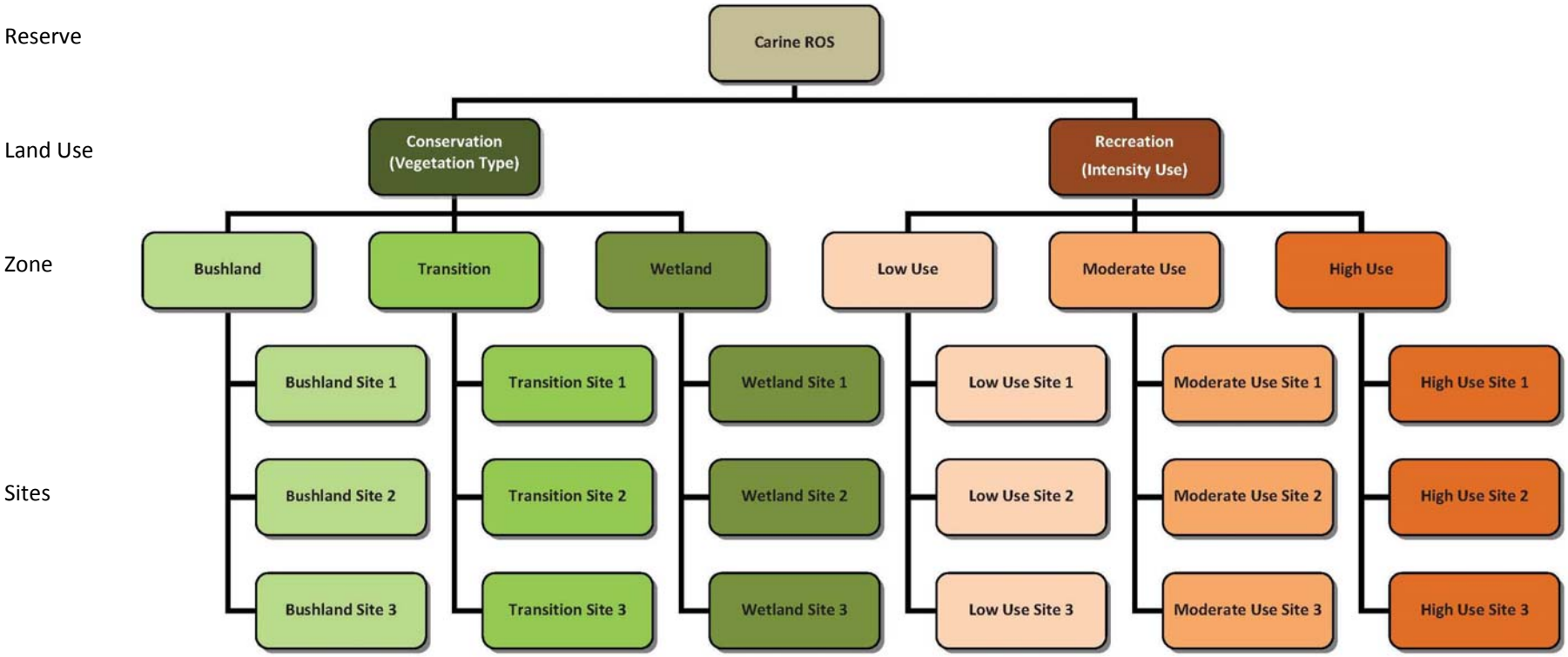

Figure 4: Management Framework for Carine ROS

Table 15: Issues and Features within Landuse and Zones

Land Use	Conservation	Recreation Land
Main Attribute	Vegetation Types: Bushlands, Transition and Wetland	Intensity of Use: Low Use, Moderate Use, High Use
Issues and Features	• Acid sulphate soils • Biodiversity • Education & Interpretation • Fauna habitat • Fire Management • Hydrology • Native & non-native fauna • Plant Diseases • Revegetation & Rehabilitation • Significant flora and fauna • Soil type • Vegetation community • Vegetation structure • Topography • Water quality and quantity • Weed control	• Access • Biodiversity • Education and Interpretation • Hydrozones • Infrastructure • Recreation Activity • Topography • Visual Amenity • Weed Control • Shade

6.1.4 Recommendations

1.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
1.1	Manage Carine ROS in accordance with appropriate uses and priorities in terms of landuses, zones and sites.	High	City of Stirling
1.2	Establish or use physical barriers such as paths, kerbing or fences to delineate boundaries of landuses and zones where appropriate.	High	City of Stirling

6.2 Acid Sulphate Soils

6.2.1 Objective

The objective of the Acid Sulphate Soils Strategy is to:

- ensure that land containing ASS is managed to minimise potential adverse effects on the natural and built environments.

6.2.2 Applicable Land Uses and Zones

- Conservation (Wetland)

6.2.3 Issues

ASS Exposure

WAPC (2000b) states that the Carine ROS wetlands are thought to likely contain high risk ASS. If present, the soils in the wetlands are currently inundated by water and therefore inert. However, if the soils are exposed to the oxygen in the air, it may trigger sulphuric acid production, increasing the acidity levels of the soil and water. The two likely risks of exposure may come from disturbance of the wetland soils and falling groundwater levels.

6.2.4 Strategy

Site Investigation

The City needs to authorise a Preliminary Site Investigation (PSI) to determine whether the wetlands contain actual or passive ASS. If any such soils are detected, their distributions should be mapped if intending to disturb the soil.

Site Works

If the wetlands are found to contain active or passive ASS, the City should ensure that any future works conducted in or immediately surrounding the wetlands should be managed so that they do not disturb any areas containing AASS or PASS. This includes the following works proposed in the City's 2003 *Carine ROS Master Plan:*

- Big Carine Swamp
    - the excavation of the northern end to provide an open water habitat
    - installing a boardwalks, bird viewing platforms and hides
    - installing art works and sculptures
    - upgrading drainage outlets
- Small Carine Swamp
    - The construction of viewing decks and Gazebo
    - Stormwater settlement ponds and wetland filter beds
    - Works to the pedestrian bridge over the outlet stream.

Monitoring

The City cannot prevent any significant decline in ground water levels caused by seasonal and climate change. If the wetlands do contain ASS, the City should continue to monitor both the ground and wetland water levels to detect any such decline and determine whether any AASS or PASS may become exposed.

6.2.5 Recommendations

2.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
2.1	Undertake ASS Risk assessment for Carine ROS	High	City of Stirling
2.2	Ensure no ground disturbances occur in areas having AASS or PASS, or if they are, appropriate mitigation measures are put in place	High	City of Stirling
2.3	Monitor surface and groundwater levels.	High	City of Stirling

6.3 Hydrology

6.3.1 Objectives

The objectives of the Hydrology Strategy are to:

- protect and manage surface and groundwater to maintain biological and social values of the wetlands and Reserve
- help minimise water use within the Reserve without affecting social functions (eg playing fields)
- conserve the wetland vegetation
- reduce the risk of water quality being degraded.

6.3.2 Applicable Land Uses and Zones

- Conservation (Wetland, revegetated Transition, revegetated Bushland)
- Recreation (High Use, Moderate Use, Low Use)

6.3.3 Issues

Wetland Water Levels

The report determined two risks with the Reserve's wetland water levels:

1. The wetland vegetation and fauna are adapted to fluctuating water levels. However, a prolonged drought or sudden excessive water level increase (eg significant sudden rainfall) may be detrimental to the environment.
2. Declining water levels threaten the biological values of the wetlands and exposure of acid sulphate soils.

Irrigation Practices

Over 60 ha of the Reserve contains lawn, which require more watering than local native flora species. Such a large irrigated area may put pressure on local water sources. It is also possible that the irrigation systems may be over-spraying into bushland areas, resulting in a waste in water. It must be questioned whether the amount of water irrigated in the Reserve may be reduced without impacting the public's recreation needs.

Drainage

The report identified three items concerning drainage within Carine ROS:

1. There is no filtering process to minimise the entry of any contaminant that may be present in the incoming water from any of the underground stormwater drains.
2. The outlet stream extending from Little Carine Swamp does not properly connect to Big Carine Swamp and is mostly overcome with weeds.
3. An opportunity exists to improve the visual amenity of outlet streams and drainage pits.

Little Carine Swamp Sandbar

Silt has built up around the drain at the corner of Beach Road and Duffy Road and formed a sandbar in Little Carine Swamp. The sandbar currently allows for unauthorised persons, foxes and cats access to the island, endangering the wildlife that nest on the island. The sandbar is also acting like a dam, causing the water to stagnate and encourage algal blooms and mosquito breeding.

Sewerage

The Carine wetlands were contaminated in 2007 from a sewerage overspill. The local sewerage may overspill again and further degrade the wetland ecology.

6.3.4 Strategy

Wetland Water Levels

As discussed in **Section 6.2.4**, the City cannot prevent any decline in the wetland water levels and can only monitor for variation in water levels. If after excessive rainfall, the heightened water levels in Big Carine Swamp are thought to impact the wetland environment, the City may request the Water Corporation to activate the station pump to drain the wetland to an acceptable level.

Irrigation Practices

There are two stages to reduce the amount of irrigation required in Carine ROS without impacting on the social values of the recreational areas, which are described below.

1. Identify Ecozones

A total of 5.3 ha of lawn area within Carine ROS has been identified as not being directly used in recreation activities and therefore the lawns could be removed and revegetated with local native plant species that correspond with their plant communities (**Map 10**).

2. Adjust Hydrozones

As discussed in **Section 3.3.4**, the City already conducts hydrozoning as part of its Water Smart Parks Strategy. Areas that have been recommended as ecozones should continue to be watered until the planted native vegetation have established. These areas should then be included as part of the "Not irrigated" hydrozone and no longer be watered.

The hydrozones should then be reassessed to determine whether some areas may be downgraded (eg the grassed area east of Little Carine Swamp may be downgraded from "Recreation" to "Parkland").

The current irrigation systems should be also assessed to determine whether any over-spraying occurs into bushland. Any systems that do result in over-spraying should be adjusted to prevent further water loss.

Drainage

Some of the underground drains may be converted into outlet streams with settlement ponds to slow the intake of stormwater. Likewise the outlet stream extending from Little Carine Swamp could be extended to directly connect with Big Carine Swamp to assist with the flow of seasonal water.

Along with the two existing drainage pits, the outlet streams and settlement ponds may then be revegetated with appropriate wetland species which may act as biological filters, extracting incoming nutrients and pollutants and improving the quality of the water entering the wetland system.

Three suggested underground drains to be converted are indicated as A, B and C on **Map 4** in **Appendix One**. Drains A and B, located on the eastern and north-eastern areas of the Reserve respectively, were originally proposed in the City's (2003) *Carine ROS Master Plan* to be converted into outlet streams with settlement ponds. Drain C is an additional drain that could likewise be converted. The City may also consider converting some of the other underground drains into outlet streams to increase the amount of incoming stormwater being naturally filtered.

The construction of the streams and ponds may be done in an aesthetic manner. The City should consider factors such as the stream alignment, size and shape of the ponds and planting design to improve the social function of the site.

Section 6.2.4 discussed that the wetlands may contain ASS. The City needs to ensure that any drain conversion will not result in the exposure of active or passive ASS.

Little Carine Swamp Sandbar

The silt sandbar in Little Carine Swamp should be removed to restrict access to the island and maintain water flow around the island.

Sewerage

Water Corporation should install more sewerage tanks to prevent further spills of sewerage into the wetland system.

6.3.5 Recommendations

3.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
3.1	Remove lawn from areas not being used for recreation and revegetate with local native species.	Moderate	City of Stirling
3.2	Stop irrigating revegetated areas once native revegetation has established	Moderate	City of Stirling
3.3	Assess and adapt irrigation system to prevent over-spraying into bushland areas.	Moderate	City of Stirling
3.4	Convert some of the underground drains into outlet streams with settlement ponds to filter incoming water.	High	City of Stirling
3.5	Extend the outlet stream form Small Carine Swamp to large Carine Swamp and revegetate with local wetland plants.	Moderate	City of Stirling
3.6	Remove the sandbar at Little Carine Swamp.	High	City of Stirling
3.7	Install more sewerage overflow tanks to prevent any future spills of sewerage into the wetlands.	High	Water Corporation

6.4 Weed Control

6.4.1 Objectives

The objectives of the Weed Control Strategy are to:

- identify and control existing populations of high priority weeds species
- prevent introduction of additional weed species
- prevent encroachment of weeds into bushland areas
- improve bushland and wetland condition
- assist revegetation
- improve fauna habitat
- improve visual amenity
- reduce costs of ongoing maintenance.

6.4.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (High Use, Moderate Use, Low Use)

6.4.3 Issues

Weed Inventory and Mapping

The weed inventory compiled is incomplete and out of date. Some of the weed species may no longer exist in the Reserve, while other unrecorded species may be present. Also, the location and distribution of weed species are unknown. A proper assessment of the site is required to determine:

- what species are present
- their location, size and spatial distribution
- their level of threat to the Reserve
- their current population size and spatial distribution.

Priority Weed Species

Also, out of the 59 species recorded or thought to occur in the Reserve, a total of 17 weed species were identified as High Priority to control. The location and distribution of these weed species are not currently known.

Optimal Control Times

Most weed species have optimal times of the year when they should be controlled. Weed control operations are best conducted targeting many species as possible during their optimal times to reduce the number of site visits required. This would reduce the need for management and minimise the costs and resources.

It is more important to target all high priority weed species during these operations, and only include moderate and low priority weed species if resources allow.

Weed Control Methods

Certain weed control methods may harm the public and the environment, in particular certain types of herbicides and surfactants. As such all methods will need to be examined and harmful methods restricted.

Monitoring Weeds

It should be noted that weed management issues of Carne ROS will change over time. Some causes for this change are listed below:

1. Optimal times for controlling weeds may change as a result of local changes. For example, early winter rainfall or a fire may trigger weed seed germination, requiring control times to be conducted sooner than anticipated.
2. The removal and/or reduction of some weed species may remove pressure on other weed species, potentially allowing them to invade and become dominant.
3. New weed species may be introduced to the Reserve.
4. The location and distribution of weed species will change as a result of seasonal change, their ability to invade and dominate an area and success of weed control operations.

The City should continue to monitor the Reserve and adjust their weed control operations accordingly.

6.4.4 Strategy

Weed Surveys

The City will need to organise a survey of the reserve to:

- determine what weed species are present
- map the location and distribution of weed species.

The ideal time for a weed survey is between August and September, when seedlings and bulbous plants have emerged and grown to a size that makes them identifiable, however this time may vary as result of local weather patterns. Also, it is possible some weed species may not be identifiable during these months. The City's Natural Areas staff should continue to observe weed plants in the Reserve throughout the year during other work operations and include any new observed weed species to the inventory.

Weed Mapping

Weed species should be mapped according to whether they are distinct individuals (eg trees) or populations (eg grasses). Distributions of populations should be recorded by either using a GPS handheld unit to trace the perimeter of each population or by marking boundaries on printed aerial photographs of the Reserve. The densities of each weed population are classed by the percentage weed cover or abundance. A suggested percentage class system is presented:

- *Trace* - <1% cover/ abundance
- *Low* – 1-10% cover/ abundance
- *Moderate* – 11-50% cover/ abundance
- *High* - >50% cover/ abundance.

Priority Species

Resources should be first focused on controlling High Priority weeds, as these are considered the most invasive and threatening to the Reserve. However, other weed species should not be excluded from control activities if there are enough resources available.

In general:

- High Priority weed species should be targeted first
- Moderate Priority weed species should be controlled opportunistically if resources allow after targeted control of High Priority Weeds
- Low Priority weed species should be controlled opportunistically if resources allow after control of Moderate and High Priority Weeds.

It should also be noted that as weed control of priority species progresses, other weed species which previously may not have been rated as high, may become more important. Therefore, it is important to keep weed control programmes flexible and updated according to monitoring data to ensure that as bushland condition changes and weed species dominance changes, the control activities are adjusted accordingly.

Also, any new weed species identified in the Reserve should be prioritised according to the process outlined in **Appendix Five** and targeted according to their final rating and available resources.

Optimal Control Times

The optimal control times for targeting the known weed species was determined using the methodology presented in **Appendix Five.** It was determined that the most efficient times to target all of the known high priority weed species are June and October. These months are also suitable for targeting almost all of the Moderate and Low Priority weed species.

It should be noted that the weed survey will result in a different inventory than the one presented it this report, which may affect the recommended activity times. Any new identified weed species will need to have their optimal control times determined using the same methodology. The months may need to be adjusted to accommodate the change in the inventory to aid in targeting the new weed species and removing weed species determined to no longer occur.

Weed Control Methods

A range of weed control methods have been presented in **Appendix Six** for all weed species known or thought to occur in Carine ROS. The City should consult the following resources to determine appropriate control methods for any new weed species that is observed in Carine ROS:

1. Brown and Brooks (2002) *Bushland Weeds*
2. Dixon and Keighery (1995) *Recommended methods to control specific weed species*
3. Moore and Wheeler (2008) *Southern Weeds and their control.*

Depending on the type of weed species and the nature of infestation, the City should always consider using manual control methods first before using herbicides. For example, individual plants or small populations of non-bulbous weed species may be easily removed manually, whereas large populations of grass or bulbous weeds may only be controlled effectively with herbicide.

The City follows best practice guidelines to protect both public and environmental health. Chemical weed control is used for particular weed species in a manner that minimises any impact on the environment. Signs are erected on site to notify the public when herbicide spraying is in progress. The Herbicide register is consulted and listed residents contacted before spraying works commence.

If herbicides are required, The City should use the least harmful herbicide recommended. The City should also conduct herbicide works during optimal times using minimal recommended concentrations. This will decrease the amount of harmful chemicals used, minimising the impact of herbicides within the Reserve.

Surfactants should not be used with the herbicide treatments near or in the wetlands. Many common herbicides such as Roundup® contain NPE surfactants which are known to affect the development of amphibian species, which can lead to a decline or even loss of such fauna species (Mann 2000). Herbicides not containing NPE surfactants, such as Bioactive®, are strongly recommended.

Monitoring Weeds

Frequency of Monitoring

It is recommended that the quadrats be monitored every year and updating of records should occur as often is as practicable to assess the success of weed control programs.

The City's Natural Areas staff should continue monitoring the Reserve throughout the year. They should:

- assess the success of previous weed control efforts
- detect any changes in weed species presence and distributions
- determine whether the control times and methods of weed programmes need to be adjusted
- identify any new weed species.

Monitoring Criteria

When monitoring the site, the following strategies should be adopted:

1. Establish monitoring quadrats in areas subject to weed control programs to record the effectiveness of control methods.
2. Monitor any change in distribution of the High Priority species.
3. Monitor for establishment of any new weed species.

Performance Criteria

In order to determine the effectiveness of any weed control programme, there needs to be a method of determining success and ongoing progress. The following performance criteria could be used or adapted, based on the monitoring data collected:

1. Control/ eradicate at least one third of the High Priority weed species from the site over the next five years.
2. Reduce the area of all High and Moderate priority weed infestations by 50% over five years.
3. Reduce the total number of weed species in the area by at least 50% over five years.

Although not appropriate as performance criteria, other information can be recorded to assist in an overall view of the effectiveness of weed control activities within the site:

1. *The number of new weed species recorded* – it is expected that, initially, new weed species may be recorded as these species may not have been identifiable at the time of the field survey. Over time, it is anticipated that the number of new species recorded should plateau, and then the total number of weed species decrease.

2. *Any new infestations of High Priority species* – this information can be used to determine source areas for new infestations, and, assessed against the number of hours spent on its control, allow an analysis of the success of control of particular species.

Weed Mapping

Weed species maps should be updated to reflect changes in presence and distribution of weed populations. This will help direct future weed control operations in the timing and targeting of particular weed species. The frequency of mapping of each weed species should be conducted according to their threat to the Reserve's native vegetation and invasive ability. In general:

- High Priority weed species that have the potential to expand rapidly should be mapped each year.
- High Priority weed species that do not expand as rapidly should be mapped every two years.
- Moderate Priority weed species should be mapped as resources allow.
- Low Priority weed species usually do not require to be mapped unless they are considerable sized populations.

Use of Monitoring Data

Monitoring data is useful not only for determining the success of weed control activities, but also for planning weed control activities from year to year. In order for monitoring data to be useful, it needs to be fed back to the managing agencies. That is, any work undertaken in the field, whether it be actual weeding or monitoring of previous weed control sites, should be fed back into a central management system to ensure efforts are being focussed where they are most needed and to ensure the groups are aware of each others' activities.

6.4.5 Recommendations

4.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
4.1	Develop a weed management strategy/ plan so as to provide clear weed control aims, objectives and operational guidance. Monitoring should be part of this strategy/ plan.	High	City of Stirling

6.5 Revegetation

6.5.1 Objectives

The objectives of the Revegetation Strategy are to:

- improve the vegetation condition
- reinstate indigenous flora and vegetation communities where they have been disturbed and/ or depleted
- increase native flora biodiversity
- improve the resilience and vibrancy of native vegetation
- conserve local provenance
- improve the self-recruitment potential of native vegetation
- improve visual amenity
- reduce the amount of watering.

6.5.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (Moderate Use, Low Use)

6.5.3 Issues

Biodiversity

The report determined 3 issues in terms of plant biodiversity:

1. The vegetation condition in Carine ROS is highly degraded and contains a low biodiversity value.
2. The hydrology and topography within Carine ROS is variable across the site. This gradient would result in variation in species and community distribution (eg from wetland to bushland).
3. The importance to preserve provenance (local genetics) of local native plant species when conducting revegetation work.

Ecozones

Each of the management zones, whether conservation or recreation, may vary in their revegetation needs. For example, revegetating a parkland zone may require planting dense rows of small aesthetic shrubs and herbs near pathways and installing widely spaced trees further away from the path. Likewise, a wetland zone may need to be planted with a mosaic of different sedges and rushes to promote different bird habitats. Revegetation efforts require a guide to assist in the selection of appropriate plant species and revegetation design within each zone.

The management framework in **Section 6.1.3** separated Carine ROS into Land Uses and Zones using fences and paths as boundaries (**Map 9**). As a result, some of the areas currently contain lawn are now classified as Conservation areas. These areas should have the lawns removed and restored to the designated Conservation Zone.

As discussed in **Section 6.3.3**, the report has identified many areas within the Reserve that are not subject to high intensity recreation use. Most of these areas are currently covered in lawn. There is an opportunity to reduce the amount of lawn cover and replace with native species. Some of these areas may be infilled and still remain as part of the Recreation Land use, while other areas may be fully restored and become part of the Conservation Land Use.

Also, several small areas have been identified near public facilities (eg car parks, buildings) that may be revegetated with aesthetic local native species. This will both increase the level of native vegetation and decrease watering requirements and lawn maintenance.

Vegetation Community Mapping

One of the factors that may assist revegetation design of conservation areas is the distribution and composition of existing vegetation communities. However, it should be noted that the Vegetation Community map (**Map 7**) was constructed using descriptions by Mattiske (2008) during a rapid site assessment. As such this map may be inaccurate in indicating the exact boundaries of these communities.

Significant Species

The report identified three native species of regional significance which also have fauna habitat value. Revegetation work should promote these species in appropriate sites to enhance these values.

6.5.4 Strategy

Biodiversity

The City should conduct revegetation works to increase biodiversity values. Revegetation work will need to direct species to appropriate revegetation zones to ensure a higher rate of survival. By identifying which species are appropriate for each zone, it will also encourage plant survival and a higher level of biodiversity.

A list of local species that may be used in revegetating Carine ROS is presented in **Table A4.1** in **Appendix Four**. Each species have been allocated as being appropriate for each management zone. The City should ensure that only recommended plant species are planted in each zone.

It is recognised that the required revegetation works will need a large amount of propagules (eg seed, tubestock). It is important that all of the propagules are sourced from local vegetation to preserve the local genetics (provenance). As outlined in the City's *Green Plan 2*, the City has designated the municipality into eight provenance zones according to their soil type and will only use the seed stock sourced from a matching zone in revegetating a reserve. Since Carine ROS is designated as party of Zone D (Low Lying - Grey Black Sands), the City will only use seed soured form Zone D to revegetate the Reserve.

Vegetation Communities

A more detailed site assessment is required to determine and map the exact boundaries of the different vegetation communities. This will aid in selecting appropriate plant species for revegetating specific sites.

Ecozones

Ecoscape has identified a number of areas, called "ecozones", which may be revegetated. These are where the Conservation Land Use has degraded and lawn areas which could be restored to the original vegetation communities. The Recreation Land Use areas which are not being actively used by the public and could either be:

- infilled with local native species to improve the visual amenity and reduce lawn cover.
- restored and become part of the Conservation land Use.

These types of ecozones are presented in **Map 10** in **Appendix One**.

Several specific areas that may be revegetated include:

- the outlet stream between the two lakes
- the burnt bushland north of the pumping station off Okely Road
- Little Carine Swamp island and the surrounding waterway.

Each ecozone may need to be subdivided into Sites, according to their unique features, some of which are presented in **Table 16** in **Section 6.1.3**. A revegetation design may then be developed and appropriate plant species used to suit each site's features.

Infill planting

The City should also consider landscaping small areas near public facilities with aesthetic local native species. This will improve the visual amenity of the area as well as increase the abundance of local native flora.

Suggested sites to be revegetated are presented in **Map 10, Appendix One**.

Significant Flora

Eucalyptus gomphocephala (Tuart) should be:

- included in any revegetation work in the Transition or Bushland zones that require overstorey species
- excluded from any works that require the removal of overstorey species.

Revegetation works in the wetland zones should promote using the sedge species *Schoenus validus* and *Baumea articulata* to increase their presence. It should be noted that these species have specific growing requirements. The City will need to ensure that these species are planted in sites of appropriate inundation and water logging.

6.5.5 Recommendations

5.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
5.1	Revegetate the different management zones of the Reserve using a wide variety of appropriate native plant species of local provenance.	High	City of Stirling
5.2	Consider reducing the amount of lawn areas in low to moderate impact recreation zones and revegetating with appropriate local species.	High	City of Stirling
5.3	Consider planting areas near public facilities with local aesthetic plant species.	Low	City of Stirling
5.4	Promote Tuarts in Bushland and Transition Zones.	Moderate	City of Stirling
5.5	Promote regionally significant sedge species around wetlands.	High	City of Stirling

6.6 Rehabilitation

6.6.1 Objectives

The objectives of the Rehabilitation Strategy are to:

- increase fauna habitat, therefore increase diversity and numbers of native fauna
- improve the connectivity of the Reserve to nearby natural areas
- optimise the use of resources by prioritising areas for rehabilitation
- improve ecological health
- increase diversity through encouraging ecological niches/ habitats.

6.6.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (Moderate Use, Low Use)

6.6.3 Issues

Plant Species

Rehabilitation primarily involves ensuring there is adequate presence of ideal plant species to provide food and refuge for animals. This is particularly important for Carine ROS, as it serves as a "stepping stone" greenway across Perth's northern suburbs, particularly to listed bird species. Rehabilitation requires that the correct plant species are chosen to attract and cater for both existing and visiting fauna.

Fauna Habitat

Whilst adequate in overstorey cover, the Bushland and Transition areas contain very little understorey shrubs and ground covers, depriving local fauna of shelter and food resources.

The wetland areas, particularly Big Carine Swamp, have been identified as an important resource for a wide variety of local and international bird species. However Big Carine Swamp is currently dominated by weed Bulrush (*Typha orientalis*) which is limiting the variety of habitats for these bird species.

Fauna Tunnel

The fauna tunnel under Reid Hwy is not constructed correctly to attract use by native animals, in particular the Long Necked Tortoise. Further works should be directed to make the tunnel more accessible for native animals.

6.6.4 Strategy

Plant Species

The Revegetation Species List (**Table A4.5** in **Appendix Four**) indicates which local native species:

- are appropriate for planting in each vegetation type
- have fauna habitat or fauna attracting value.

Rehabilitation efforts should promote species within the vegetation types that have fauna habitat value.

Bushland and Transition Areas

The Bushland and Transition areas currently contain adequate overstorey for fauna habitat which provide a variety of refuge niches for many vertebrates and invertebrate species. The City should attempt to retain old mature trees in these areas as they are of high habitat value (eg nesting hollows).

Rehabilitation efforts in these zones should promote understorey flora species to provide screening and food sources for native birds and invertebrates.

In addition, additional items may be strategically placed around the Bushland and Transition areas to provide shelter for fauna. This may include:

- logs and timber for invertebrates as well as larger fuana such as snakes and lizards
- nesting boxes for birds.

Wetlands

Rehabilitation efforts in the wetlands should focus on reducing the presence of Bulrush and provide a diversity of habitats in Big Carine Swamp for native bird species.

The City's (2003) Carine Master Plan (**Figure 2**) indicates excavation works in the northern portion of Big Carine Swamp. This excavation will offer an open water source for the birds. It will also improve the visual amenity of the area, as it will open views to the public.

The Bulrush should be cleared across much of this wetland and replaced with other reeds and sedge species, such as *Schoenus. validus* and *Baumea articulata.* This will provide a range of screening/ open habitats to suit different bird species.

It should be noted that while Bulrush is recognised as an aggressive weed species in Big Carine Swamp, the species also offers a type of habitat suitable for some bird species. As such this species should not be eradicated, rather restricted to smaller areas.

Fauna Tunnel

The City should conduct some site works to the entrance of the fauna tunnel to attract native animals. The rock ramp should be removed and replaced with a larger soil ramp and planted with native ground cover species to stabilise the soil. A dense shrubland should be planted between the tunnel and the nearby native vegetation to provide screening. A sign should also be placed nearby informing the public of the tunnel and asking them not to scare animals in the area.

6.6.5 Recommendations

6.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
6.1	Promote plant species that have fauna habitat value in Conservation zones	High	City of Stirling
6.2	Place nesting boxes, logs and timber around Bushland and Transition zones.	Low	City of Stirling
6.3	Improve entrance to fauna tunnel to encourage wildlife.	Moderate	City of Stirling

6.7 Native Fauna

6.7.1 Objective

The objective of the Native Fauna Strategy is to:

- conserve locally occurring and significant native fauna by:
  - conserving and maintaining habitat required by local and significant native fauna
  - reducing predation pressure by feral fauna such as cats and foxes.

6.7.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (High Use, Moderate Use, Low Use)

6.7.3 Issues

Significant Fauna

State and federally listed conservation significant fauna species are thought likely to occur within Carine ROS. Significant species identified in previous reports for the area have been listed below:

- Great Egret *(Ardea alba)*
- Cattle Egret *(Ardea ibis)*
- Baudin's Black-Cockatoo *(Calyptorhynchus baudinii)*
- Carnaby's Black-Cockatoo *(Calyptorhynchus latirostris)*
- Rainbow Bee-eater (*Merops Ornatus*)
- Chuditch *(Dasyurus geoffroii)*
- Graceful Sun Moth *(Synemon gratiosa).*

The inventory of significant native fauna is not complete. A detailed assessment is still required to determine what other native fauna may be present to develop appropriate fauna management and rehabilitation strategies.

Graceful Sun Moth Habitat

Carine ROS could potentially serve as habitat for the *Endangered* Graceful Sun Moth (*Synemon gratiosa*). This moth species uses two species of *Lomandra* for breeding (*Lomandra hermaphrodita* and *Lomandra maritima)*. A *Lomandra* species is known to occur in the Reserve however, its exact identification is unknown. This will need to be assessed with regard to any future works within the Reserve.

Habitat

The vegetation within Carine ROS is degraded and contains few plants that may provide food and shelter for native animals.

Fauna Predation

Native fauna populations are threatened by feral and introduce fauna through:

- predation (eg foxes and cats)
- reduction of habitat and food sources (eg rabbits, bees, pigeons).

Public Actions

The report identified two issues with public actions:

1. Snakes and other local animals may appear "dangerous" by the public and harmed or killed out of unnecessary 'fear".
2. Members of the public feed birds within the Reserve, especially ducks. This practice may harm birdlife, as:
    - the food offered is not appropriate for a bird's diet, causing health problems
    - it may promote some bird species that do eat food offered by visitors and displace other bird species
    - it may increase the nutrient levels of the waterways, resulting in eutrophication which promotes algal blooms. Such blooms may produce toxins which would pose a health risks to the public and wildlife
    - contributes to aggressive behaviour by bird species.

6.7.4 Strategy

Significant Fauna

A review of the DEC's Threatened and Priority Fauna database should determine what other significant fauna may occur in the Reserve. This should be followed by a field assessment, to confirm the presence of the species residing or visiting the Reserve and their habitat requirements. This field assessment should be a Level 2 Fauna Survey, as interpreted from the EPA (2004) *Guidance Statement 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia.* Once all significant fauna species have been identified, fauna management and rehabilitation practices should be modified to conserve these species and improve their habitats.

Graceful Sun Moth Habitat

The City should determine what *Lomandra* species is present in the Reserve. If it is one of the two species known to be used by the Graceful Sun Moth, the City should arrange for a Graceful Sun Moth survey to be conducted in March 2012. If it is determined that this species uses the site for breeding, existing *Lomandra* populations should be protected and more plants established to encourage further breeding.

Habitat

Rehabilitation for native animals is addressed in **Section 6.6.4**.

Fauna Protection

Feral fauna control is addressed in **Section 6.8.4**.

Public Actions

The City should educate the public:

- to avoid any snakes they encounter
- as to why they should not feed native wildlife, particularly birds
- how to live with magpies.

Possible methods of informing the public include signs and leaflets. The City Rangers could also educate any public member sighted feeding wildlife.

6.7.5 Recommendations

7.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
7.1	Determine what other significant fauna species may be inhabiting or visiting Carine ROS by surveys.	High	City of Stirling
7.2	Determine whether *Lomandra* species is a habitat for Graceful Sun Moth. if so, arrange for a Graceful Sun Moth survey for March 2011.	High	City of Stirling
7.3	Educate the public if they encounter any snakes, avoidance is the best practice	Medium	City of Stirling
7.4	Educate the public as to why they should not feed native wildlife, particularly birds	Medium	City of Stirling
7.5	Educate the public how to live with magpies.	High	City of Stirling

6.8 Non-native Fauna

6.8.1 Objectives

The objectives of the Non-native Fauna Strategy are to:

- help conserve locally occurring and significant fauna
- maintain and where possible increase availability of fauna habitat
- reduce risks and impacts from pests and non-local fauna on native fauna and associated habitat.

6.8.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (High Use, Moderate Use, Low Use)

6.8.3 Issues

Feral Fauna

The report identified the following issues regarding feral fauna:

1. Foxes are known to enter the Reserve from surrounding areas. One of the most likely entrances is the Reid Hwy fauna tunnel.
2. Rats and mice have been reported to occur in Carine ROS.
3. Introduced bird species (eg pigeons and turtle doves) may compete with native birds for food and nesting places.
4. A number of bee hives have been observed in around Big Carine Swamp.
5. The introduced mosquito fish (*Gambusia* sp.) has been reported as present in the waterways.

Domestic Fauna

The report identified the following issues regarding domestic fauna:

1. Pets (especially dogs and cats) may kill wildlife. Dogs can also crush the reed beds and disturb hiding and nesting habitat of water birds and aquatic wildlife.
2. Horses from the Riding School need to be kept out of bushland areas, otherwise they may graze in revegetating areas and trample vegetation.
3. Horse manure may contain weed seeds from feed, threatening bushland surrounding the Riding School. It is also high in nutrients, which may leach into the wetlands, promoting eutrophication.

6.8.4 Strategy

Feral Fauna

European Red Fox

The City currently maintains the services of a professional pest control expert who is appropriately licensed by the DEC to reduce fox populations within the City's municipal boundaries. The latest assessment determined that foxes use but do not live in Carine ROS. Foxes that intrude on the Reserve are thought to originate from Karrinyup Golf Course and possibly from the City of Joondalup (Animal Pest Management Services 2005).

The following points are considered when deciding fox control actions in Carine ROS:

- Poisoned baits are not used.
- Trapping is only conducted:
    - using only soft padded foot clamps
    - in areas away from the public
    - where traps are inspected daily in case pets or other fauna become trapped.
- The fauna tunnel may serve as a possible bottle neck in capturing foxes.
- Any captured foxes should be put down in a humane manner.
- An effective method is for the professional pest control expert to survey all the reserves in the City for den sites and to fumigate them at time of breeding.

The City has maintained a database of fox records since 2006.

An effective method of lowering the impacts of foxes on native fauna is to reduce their foraging efficiency. In environments with dense vegetation or extensive wetlands, prey are less likely to be caught by foxes. Thus providing a continuous canopy and a thick understorey of shrubs reduces the risk of fox predation upon native animals (Environment Australia 1999).

Fox control methods require monitoring as more foxes may invade the Reserve. An effective method of fox monitoring is through using trail (motion sensitive) cameras near "choke points".

Rats and Mice

Rodents are normally controlled using trapping and chemical poisoning in domestic situations. However, these methods are time consuming and highly expensive to apply in bushland areas. Also, rodenticides are non-specific toxins and can pose a significant risk to non-target animals, including native fauna (Lapidge et al. 2004).

The best method of controlling mice and rat populations is prevent any food sources, such as grains, from being accessible to the rodents. The City should educate neighbouring residents of the importance of properly securing their bird food (eg for chickens) in sealed containers.

Introduced Birds

The City should investigate whether any other introduced bird species are present in Carine ROS, other than the Domestic Pigeon and Spotted Turtle Doves. Appropriate management options and species specifications should then be developed for all introduced bird species.

European Bees

The City employs a qualified pest controller to visit the Reserve and eradicate known European bee hives. The City's Natural Areas staff will continue to monitor and arrange for the removal of any other non-native bees hives that may form in the future.

Mosquito Fish

The City should investigate methods of management or control of Mosquito Fish within wetlands.

Pets and Horses

Fencing

Fencing should be completed around the native bushland areas to reduce access to dogs.

Dogs

The City should adopt a policy that dogs must be kept on a leash unless in designated "leash free" dog obedience and training areas, which is presented in **Figure 3** in **Section 5.2**.

Public Education

The City should inform the public of:

- the potential impacts their pets may have on native wildlife and vegetation in Carine ROS
- the need to keep their dogs on a leash when in the Reserve and may only be let off their leash in the dog obedience and training areas.

Methods of informing the public may include the use of signs and leaflets. City Rangers may also inform members of the public using the Reserve.

Horses

The Riding of the Disabled Association should continue to keep their horses out of areas containing native vegetation and to ensure that all horse manure is regularly disposed of offsite in certified disposal facilities. No riding is allowed anywhere on the Reserve outside the training area, especially on grassed areas and along shared paths and walk trails.

6.8.5 Recommendations

8.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
8.1	Conduct control measures to reduce fox populations and monitor.	High	City of Stirling
8.2	Liaise with Karrinyup Golf Course and City of Joondalup to integrate fox control activities.	High	City of Stirling
8.3	Educate neighbouring residents of the importance of properly securing their bird food (eg for chickens) in sealed containers so not to encourage growth of rodent populations	Low	City of Stirling
8.4	Determine what introduced birds species are present in Carine ROS and investigate appropriate management options for each bird species.	Moderate	City of Stirling
8.5	Arrange for the eradication of European bee hives monitor and arrange for the removal of any other non-native bees hives that may form in the future.	High	City of Stirling
8.6	Investigate methods of management or control of Mosquito Fish within wetlands.	Moderate	City of Stirling
8.7	Complete fencing in Conservation areas to reduce access to dogs.	Moderate	City of Stirling
8.8	Inform public of: • the potential impacts their pets may have on native wildlife and vegetation • the need to keep their dogs on a leash when walking them though areas near vegetation • "leash free" areas for dogs to exercise in (eg ovals).	High	City of Stirling
8.9	The Riding School is to continue to keep their horses out of areas containing native vegetation.	Moderate	City of Stirling
8.10	The Riding School is to ensure that all horse manure is regularly disposed off site.	Moderate	City of Stirling

6.9 Plant Disease

6.9.1 Objectives

The objectives of the Plant Disease Strategy are to:

- reduce the risk of dieback and other diseases being introduced into the Reserve
- prevent further spread of the disease if it becomes established.

6.9.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)

6.9.3 Issues

Prevention

Once introduced, dieback cannot be eliminated from an area. Other diseases may inflect severe damage on the native vegetation before being controlled. Therefore the most important action for disease management is prevention. The Disease Management Strategy should focus on minimising the risk of introducing diseases to the Reserve.

Management

Two issues were identified in regard to disease management:

1. The City of Stirling does not currently have a system to routinely carry out dieback assessments of its reserves.
2. Even if an infection is detected and prevention actions are out in place, there is still a risk that diseases may enter Carine ROS. Actions are required to either remove the disease or minimise the risk of it spreading further in the Reserve or into other natural areas.

6.9.4 Strategy

Prevention

Human activity is perhaps the biggest factor contributing to the spread of plant diseases. Infected soil can be moved around the Reserve on vehicles or bikes, footwear, animal movements, road construction and earth moving equipment. It should be noted that the City cannot police against the spread of dieback, but can only provide facilities to minimise the spread.

There are two main types of human activity in Carine ROS:

- onsite maintenance activities by ground personnel
- recreation and social activities by the general public.

Ground Personnel

The City's Natural Areas staff are given appropriate equipment to prevent diseases from being introduced into the Reserve. The staff continue to inspect and clean all footwear, equipment and vehicles before going to the Reserve. Plant cutting equipment such as secateurs are always cleaned before being used on a plant.

All incoming materials may potentially contain disease. Therefore the City ensures that materials only come from disease free sources, such as certified nurseries and mulch suppliers.

Any contractors who need to access the Reserve should also be made aware of the disease risk and what management measures are required to prevent the introduction and spread of dieback.

General Public

The public may unknowingly introduce disease into Carine ROS. To minimise this risk, the public should be informed through the use of signs of the threat of these diseases and what they may do to assist in reducing the risk. Suggestions for how they may minimise the risk include:

- not leaving the pathways in the conservation areas
- not allowing pets to enter the conservation areas
- not dumping any material that may contain soil into the Reserve
- not cutting any plants in the Reserve.

Management

A formal system is required to conduct annual dieback assessments of all reserves in the City of Stirling. This system may be combined with the City's strategy for interpretation and treatment of dieback.

The City's Natural Areas staff should continue to be trained in:

- identifying any disease outbreak
- knowing how to control the outbreak or minimise its spread.

Traffic should be minimised in known infected areas to resist spread. Footwear and vehicles should be cleaned before entering and leaving the site (Hussey & Wallace 2003).

6.9.5 Recommendations

9.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
9.1	Continue to conduct hygiene practices to reduce risk of spreading diseases in Carine ROS.	High	City of Stirling
9.2	Ensure all incoming materials come from certified disease free sources.	High	City of Stirling
9.3	Educate the public of the threat of dieback and how they may assist in minimising the risk	High	City of Stirling
9.4	Conduct annual dieback assessments of all City reserves.	High	City of Stirling
9.5	Continue to train Natural Areas staff in knowing how to identify and manage any disease outbreaks.	High	City of Stirling

6.10 Fire

6.10.1 Objectives

The objectives of the Fire Strategy are to:

- ensure protection of human life
- ensure protection of property
- ensure protection of ecological integrity and biological values
- help reduce the risks and impacts fires
- help direct post-fire recovery.

6.10.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (High Use, Moderate Use, Low Use).

6.10.3 Issues

Fire Risk

The Reserve has a history of regular fire outbreaks, particularly when the Bulrush stands are dry. Potential fire hazards may threaten human life, property, native wildlife and vegetation. An effective fire strategy is required to protect these values. While the 1988 management plan does have a fire strategy, it is outdated and incomplete. A more up to date and comprehensive strategy is needed for this Reserve, which discusses:

- how to prevent or minimise the risk of a fire outbreak
- how to prepare for a fire outbreak
- how to manage the site's recovery after a fire.

6.10.4 Strategy

Fire Prevention

The following actions will be required to minimise the risk of a fire outbreak occurring in Carine ROS:

- Reduce the amount of ignitable material and fuel loads present in and around the Reserve (including bulrushes in Big Carine Swamp).
- Restrict activities that may cause ignition of a fire.
- Educate and involve the local community
- Have annual meetings with FESA to ensure fire breaks comply with safety standards.

Prescribed Burning

Prescribed burning is a commonly used practice in the Swan Coastal Plain for reducing fuel loads in vegetated areas. Fuel reduction involves reducing fuel levels to a point where any potential fire can be controlled by fire fighting crews on a normal summer day (Wychery & Robley 1983). Fuel reduction burns are typically carried out in the form of *mosaic burning*, in small sections at a time.

However, prescribed burning should not be conducted in certain circumstances. Mosaic burning is impractical in small stands of vegetation. It may be dangerous to burn areas containing particularly large fuel loads as the fire will be difficult to control. Smoke generated from any prescribed burning may be wind blown into adjacent residential areas.

It is also unknown what impact fires will have on the ecology of Carine ROS. Species composition may change, promoting fire adapted species while declining non-fire adapted species. Populations of any significant flora may be impacted or even destroyed.

Prescribed burning is therefore not recommended for the Carine ROS Reserve.

Revegetation and Rehabilitation

While the revegetation and rehabilitation strategies encourage planting more vegetation into the Reserve, it should be noted that excessive planting of trees and large shrubs may increase the fire risk hazard of an area by increasing the fuel loads. Planting programmes need to be developed for each zone to improve the Reserve's environmental and social values, but not to an extreme that will increase the zone's fire hazard rating.

Fire Legislation

Fire restriction legislation and practices are currently in place to minimise fire outbreaks in the Reserve. The City's Thoroughfares and Public Places Local Law does not permit fires to be lit in the Reserve. Also, the Local Government Property Law does not allow any fires unless a permit has been obtained for special purpose. Only gas barbeques may be allowed.

Sporting Clubs

The City should discuss with the building managers how to minimise the risk of fire outbreak occurring from sporting activities. Items include identifying whether any:

- flammable substances are kept in the Reserve (eg fuel)
- activities may pose a fire risk (eg barbecues).

Management practices must be put in place for any identified risk item to either:

- replace it with an item or activity that is less fire hazardous where possible
- minimise the risk by setting a variety of safety controls.

Community Involvement

The City's Ranger Services and FESA should be actively engaged with the adjoining residential community about the fire management of Carine ROS. It is considered important that local residents are kept informed of:

- the ecological and social value of the Reserve
- the risk of fire to the Reserve
- the need, due to proximity of the built environment to the bushland, to be fire aware and prepared
- the City's plans and activities in relation to protecting the Reserve
- the community's role in reducing the fire threat and risk to the built environment and to the Reserve.

Within the framework of a communication/engagement programme, adjoining residents could be provided available information, including pamphlets provided by FESA, to assist them in their own fire prevention. Relevant pamphlets are available from FESA's Community Development unit's Resource Officer.

The City's Ranger Services should educate the local residents about the ecological and social importance and fire risk of Carine ROS so they may become interested in the care and management of the Reserve. Information and action plans may be provided in the form of public meetings, leaflets and fridge magnets. The residents can play a role in fire prevention and preparation by:

- talking to their children
- surveillance of Carine ROS and reporting any:
    - suspicious behaviour to the City
    - reporting any smoke or lit fires by ringing 000.

Fire Preparation

It should be acknowledged that while fire prevention efforts may greatly reduce the risk of a fire outbreak, it cannot totally eliminate the risk. The following preparation actions are therefore necessary to protect human life and residential properties and minimise the impact on the values of the Reserve:

- Reduce the risk of fire spreading across the Reserve
- Have access and infrastructure items in place to suppress fire
- Have a process to report fire to fire authorities
- Consider promoting local native species that that are fire retardant within their community types
- Monitor the Reserve for changes in fuel loads and ignition risk
- Educate the local community.

Weed Management

The City's Natural Areas staff should continue to conduct weed control to reduce the fire ignition risk and fuel loads.

Fire Retardant Flora

Revegetation of the Reserve should promote plant species that are resistant to fire ignition. A total of four of the forty five species currently recommended in this report for revegetation are known to be fire retardant (Zanthorrhoea Nursery 2000). These species should be promoted in revegetation work areas known to be of *High* or *Extreme* fire risk within the Reserve to reduce ignition risk and spread of fire. The species are listed below:

- *Acacia cyclops* (Coastal Wattle)
- *Acacia saligna* (Orange Wattle)
- *Patersonia occidentalis* (Purple Flag)
- *Kennedia prostrata* (Running Postman).

Monitoring

It must be noted the fire risk hazards and vegetation communities are expected to change across Carine ROS over time as weed control measures should decrease fire ignition risk and revegetation strategies may increase fuel loads. Annual or biannual site assessments may be required to update the fire risk component of the Fire Strategy.

Community Involvement

In addition to their role in the prevention of fire, the residential community within and adjacent to the Reserve, should be provided information regarding the reduction of fire risk to their properties. The City should facilitate the distribution to adjoining resident's appropriate information that is readily available from FESA. Two pamphlets on fire preparation are currently available from FESA.

Post fire Recovery

Post-fire recovery actions should be directed towards minimising any threats resulting from a fire outbreak and to assist in the recovery of the Reserve. Actions are outlined below:

- FESA should investigate the cause of the fire.
- FESA and the City should restrict access to the public in burnt areas for safety and recovery reasons.
- DEC should rescue any injured fauna.
- The City should monitor the site and direct any maintenance, including:
    - conducting weed control to prevent weed invasion into burnt areas
    - consider possible revegetation if burnt area is too damaged to recover.

Access and Safety to Public

Any damaged fencing should be replaced or repaired as soon as possible following fire. If substantial areas have been burnt, prominent signage should be erected to explain the damage caused by fire, and the risks associated with trespassing in the burnt areas of the study site.

Any burnt branches that overhang pathways should be removed for safety reasons.

Fauna

Following a serious fire and clearance for entry by the local fire brigade, the site should be immediately searched and any injured fauna rescued and treated by qualified carers that are approved by the DEC. Animals may be released back into the study site once the bushland is deemed to have enough suitable habitat and refuge.

Post-Fire Monitoring

It should be remembered that although the fire risk hazard of an area is initially negligible after a fire, this status can quickly increase over the following years as fuel load and ignitable plant materials return. Future monitoring should continue to assess the fire risk hazard of burnt areas and adjust the management actions as appropriate.

Weeds and native vegetation regrowth throughout the burnt areas should be monitored. Monitoring should include the establishment of fixed random quadrats in each burnt vegetation community. Each quadrat should be recorded using a GPS. Photos should be taken of each quadrat at the time of monitoring to establish a visual record. Records of native and weed species, their numbers and health and any general observations should also be recorded.

Weed Control

Prevention of weed invasion is the most urgent requirement following fire within the bushland. Increased nutrients and light, together with decreased competition from native vegetation, will enhance weed growth. Any increase in the presence of weeds will degrade the condition of the bushland and also increase fire ignition risk. The City should target any weeds that germinate after fire to significantly reduce the weed population of the Reserve.

Weeds should be targeted during regeneration following fire, with options such as spraying or hand weeding to be considered, as appropriate. Any weed control should follow the Weed Control Management Strategy described in **Section 6.4**. Weed control should target the source of the returning weeds – germinating seeds, resprouting plants or both.

Existing weed maps should also be updated on the basis of observations and actions on specific weeds species. These maps should be regularly updated to show changes in weed dynamics over time. This will assist in determining whether the weed control strategies are successful and to identify any new weed populations that may emerge. In addition, GPS readings should be recorded for areas that have been controlled for monitoring purposes.

Revegetation

Natural regeneration should be monitored post-fire. Depending on the intensity and/or frequency of fire, or other factors, natural regeneration may be inhibited. An intense fire may sterilise areas through the death of existing vegetation and destruction of the seed bank. In such a case, direct seeding or revegetation with local provenance tubestock should be considered. Any revegetation work should follow the Revegetation and Rehabilitation recommendations outlined in **Sections 6.5 and 6.6**.

6.10.5 Recommendations

10.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
10.1	Ensure that Revegetation and Rehabilitation activities do not increase the fire risk of Carine ROS.	Moderate	City of Stirling
10.2	Ensure that all flammable substances on site are either replaced with non-flammable options are have safety controls to minimise risk.	High	Carine Sporting Clubs
10.3	Ensure adequate fire suppression equipment is accessible in case of a fire outbreak in the sporting clubs.	High	Carine Sporting Clubs
10.4	Educate and involve neighbouring residents in the values of Carine ROS and in fire prevention and fire preparation	High	City of Stirling
10.5	Continue to conduct weed control to reduce fire ignition risk and fuel loads in Carine ROS.	Moderate	City of Stirling
10.6	Monitor changes in Carine ROS and adjust fire preparation and prevention activities accordingly.	Moderate	City of Stirling
10.7	Investigate and record any fire outbreak incidence.	Moderate	City of Stirling
10.8	Restrict access of public to any burnt areas.	High	City of Stirling
10.9	Rescue and treat any fauna injured from a fire.	Moderate	City of Stirling
10.10	Monitor a burnt site and adjust management practices to promote its recovery.	High	City of Stirling

6.11 Access and Infrastructure

6.11.1 Objectives

The objectives of the Access and Infrastructure Strategy are to:

- provide access for public use of the Reserve
- provide access for local authorities for management of the Reserve
- provide access for fire and emergency services
- preserve and enhance the character of the Reserve
- improve safety.

6.11.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (High Use, Moderate Use, Low Use).

6.11.3 Issues

Parking

The current parking facilities are adequate to service the northern zone of the Reserve and the associated playing fields. However, there is a need to increase the access to the southern zones, particularly off Okely Road which serves as a primary access point to the Reserve. Existing parking at Carine ROS restricts access to the potential amenity of the south western area of the Reserve in particular to the exploration of the ecology of the wetlands.

None of the existing parking facilities engage storm water detention practices and there are several storm water outlets charging straight into the wetland. This is a missed opportunity in illustrating and educating the public on water sensitive urban design and consideration should be given to upgrading car parks to utilise these principles.

The car park adjacent to the disabled riding centre has reported to regularly been the site of “burn outs” late at night, disrupting the local residents. Currently there is no infrastructure present to deter this antisocial behaviour.

Access Paths

At present there is no definitive access hierarchy within the site, making it difficult to differentiate bicycle, pedestrian or shared usage paths. This becomes increasingly dangerous at intersections between bicycle and pedestrian paths. There are two major cross over points for pedestrian and cycle paths and there are no visible measures to reduce the speed at which people negotiate these points. Both intersections pose safety concerns and excessive signage (both post and ground surface) only adds to the confusion and potential danger for users.

The existing pathways in the Reserve vary in the quality of condition, with large areas found to be degraded and in disrepair. This not only presents a safety concern, but also greatly restricts universal access within the site.

The existing "cycle only" path spans a short length of the Reserve from the northern car park on Monyash Road, across to the Okely Road car park. This cycle path serves as a thoroughfare cutting across the Reserve rather than providing a scenic route to explore the site, and does not connect to the existing cycle network that runs along the southern Reid Highway boundary.

Fencing

At present there are large sections of incomplete post and rail fencing within the Reserve, particularly along the wetland fringe in the southern zone of the site. This creates ambiguity in regards to access and presents a threat to the flora and fauna as well as to the safety of visitors.

Signage

Excessive signage throughout the Reserve creates unnecessary visual clutter, detracting from the visual amenity of the site. Information is duplicated across various forms of signage, creating confusion. This is counterproductive and increases the opportunity for vandalism.

At present, there are no illustrative signs depicting the site and the facilities on offer, limited signage describing appropriate behaviour within the Reserve, and inadequate signage describing the flora and fauna of the site and the role and significance of the wetland. This presents a missed opportunity in engaging the wider public in a greater understanding of the Reserve and what it has to offer.

Infrastructure

The report identified five issues in relation to the pedestrian infrastructure of the site:

- While the number of seating and picnic tables was found to be generally sufficient, they were generally located with a lack of shade and poor aspect (view).
- Furniture throughout the site requires maintenance, with many of the bins within the Reserve showing signs of damage and/ or vandalism.
- Additional public toilets will be required to service the increased numbers of visitors to the site.

- There are no toilets near the playgrounds and playgrounds near Okely Drive, making it difficult for parents to take their children to the toilet.
- A high patronage of 'dog walkers' within the Reserve and insufficient provisions of dog waste collection bags results in matter remaining unattended.

6.11.4 Strategy

The Reserve has the potential to accommodate many passive and active recreational uses such as walking, cycling, sporting activities, fauna observation and community education. Addressing issues relating to current access and infrastructure will aid in future development and growth of the site.

Parking

Effective usage of the Reserve and wetlands of Carine ROS can be increased by improving accessibility by providing new parking services to the south west area of the site off Okely Road and up grading existing parking facilities to manage storm water.

All car parks should be clearly sign posted at main roads and/ or at their point of entry, and surface treatments upgraded where required. Storm water management and associated plantings should be incorporated in all new parking facilities and integrated into the existing infrastructure.

Some infrastructure should be installed to deter antisocial behaviour in the car park near the disabled riding school. Suggestions of infrastructure include an entry gate to be locked each night, traffic islands and speed bumps. The City should consider which infrastructure is appropriate.

Access Paths

Paths and tracks through the Reserve and wetland zone enable a number of functions from management and maintenance to facilitating and controlling community access. Effective access paths allow the community to access the Reserve and appreciate its natural features. Thoughtful design and maintenance of these paths can help reduce the environmental impacts associated with access to natural areas.

The existing network of tracks and paths should be consolidated and enhanced with a view to expanding the existing level of access whilst reducing the environmental impact of increased future use. The visitor experience of the site can be enhanced through diversified planting and alignments of pathways. Desire lines, key site features, and management needs should all play a key role in defining the layout of new paths and trails.

A consistent character for the various access paths is required to clarify the intended usage of the each path type. This can be achieved through the creation of a path hierarchy where pedestrian, cycle ways and shared use paths become clearly and uniformly defined across the site. An engineer may realign the paths to avoid conflict between user groups.

There is potential to convert the existing cycle way into a dual use path and extend it through a larger portion of the site, linking it to the popular Perth Bicycle Network and connecting the site to the greater metro area.

It is recommended that primary access paths be finished in concrete, and that new secondary 'pedestrian only' access ways be created in crushed limestone to navigate through more ecologically sensitive areas closer to the wetland. Speed control measures should be implemented at intersections of paths to aid in identifying potential hazards and preventing accidents.

There is an opportunity to create a series of boardwalks across the wetland that are secure (can be locked and only accessible by appointment or at set times). Such boardwalks would provide an invaluable tool in educating the public on the role of the wetland and the associated flora and fauna. The City will endeavour to ensure that installation of the boardwalk will not result in the disturbance of the wetland ecology.

The creation of additional access points at strategic locations (particularly along Okely Road) will link existing public open spaces, paths and cycle ways adjacent to the Reserve, facilitating connectivity to the greater area.

Fencing

In order to maintain the character of the Reserve, all new fencing should be consistent with the existing timber post and rail fencing. Any incomplete fencing should be completed as a priority to maintain a clear definition for users as to the accessible and inaccessible areas within the Reserve, minimising ambiguous spaces or inappropriate behaviours.

Signage

Signage can present an invaluable tool in informing, educating and influencing the behaviour of visitors to the Reserve. It is envisaged that installing signage at key locations may encourage public interest in the site.

It is important to refine the deliverable information so that it is succinct and to determine the most effective placement of signage for optimal exposure. At present there is a significant need for a consistent signage scheme to be implemented at Carine ROS.

Five measures that could be taken through an effective signage scheme are described below:

- Information boards installed at parking facilities that serve as entrance signage and provide directional and regulatory information. These signage boards should provide information as to the name of the Reserve and the managing authority, where facilities are located and inform the public about what activities are permitted.
- Interpretive signage located around the Reserve at strategic points of interest that provide information about animals, birds and the history of the site.
- Illustrative key site maps located around the Reserve that graphically represent the entire site and key points of interest, attractions and facilities. These should be located at all parking facilities and at any main junction points within the site.
- Signs depicting prohibited access and behaviours should be placed in key locations around the Reserve to promote an environment for the community to enjoy and increase awareness of the importance of the wetland.
- In areas where numerous signs/information is required, signage should be amalgamated into one clear information board in strategic locations clearly visible to visitors, minimising visual clutter, maintenance requirements and the opportunity for vandalism.

Infrastructure

There is the potential to create desirable nodes or destinations for visitors to the Reserve through considered placement of seating and picnic facilities in areas of high visual amenity, offering suitable shade and accessibility. Picnic facilities should be located in strategic positions that are easily accessible (physically and visually) from car parks and paths but also accentuate the natural beauty of the wetland and Reserve. Locations that provide optimum views and highlight key features of the Reserve but do not infringe upon the natural habitats of the local flora or fauna are desirable.

Several of the benches need to be relocated into more ideal positions (eg under shade of a tree) and their aspect reoriented to face more scenic views. An additional two new benches are also recommended:

- one along the eastern side of the cricket ground
- one along the eastern side of the baseball field.

The recommended locations of additional benches and aspects for all of the benches are presented in **Figure 5**.

Bins and signage should not only be grouped within the vicinity of picnic facilities and benches, but also located at regular intervals throughout the Reserve in an integrated approach that minimises the impact on the visual amenity of the site and provides ease of access for maintenance. Whilst the Master Plan has taken this into account, an additional two litter bins and one doggie bin are recommended around Big Carine Swamp to further improve refuse disposal (**Figure 5**).

Figure 5: Recommended locations and aspects of Benches and Bins for Carine ROS

The City should consider the types of the toilet facilities available. The facilities should cater for both the general public and for the disabled. The City should also consider the location of the toilets. While there are currently no toilets near playgrounds, it is not generally advised to install any new toilets near these locations, as it may lead to an increase in undesirable behaviour and safety risk to children.

Visitor safety and antisocial behaviour such as vandalism can also be addressed through the design and layout of infrastructure and facilities. This can be achieved through the implementation of basic crime prevention through environmental design (CPTED) strategies, such as provision of adequate lighting and good levels of passive surveillance. The installation of infrastructure and implementation of CPTED strategies needs to be carefully considered to be consistent with the character of the Reserve and ensure that the visitor experience is not diminished.

It is noted that extra lighting may disturb wildlife behaviour within the Reserve. As such it should be installed in a manner that will minimise any effect on the wildlife, such as using less lights or facing the light away from vegetation.

It should be noted that the Master Plan recognises the opportunity to install a series of boardwalks and bird 'hides' so that visitors can safely and responsibly gain a greater appreciation for the wetland system and value of the Reserve. Increasing community interaction facilitates in building and strengthening mutually beneficial relationships between the Reserve and community groups, leading to a greater sense of ownership and value the Reserve can hold within the community.

6.11.5 Recommendations

11.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
11.1	Install new parking facility in south-west zone of site, entering of Okely Road, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling
11.2	Implement storm water management in all new car parks and integrate into existing storm water management systems.	Moderate	City of Stirling
11.3	Upgrade surface treatments in car parks where required.	Moderate	City of Stirling
11.4	Consider installing infrastructure to deter antisocial behaviour in carp parks at night.	Moderate	City of Stirling
11.5	Investigate lighting options along primary paths through the Reserve (CPTED).	Moderate	City of Stirling
11.6	Implement a path hierarchy to clearly and consistently define pedestrian, cycle ways and shared use paths within the Reserve, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling
11.7	Realign paths to avoid conflict between user groups, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling
11.8	Amalgamate 'cycle only' and pedestrian paths where appropriate to create a dual use path across site, linking to external path and cycle networks, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling
11.9	Upgrade all primary and secondary paths to a standard that will enable universal access across the site, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling
11.10	Increase the scope of the secondary path network to allow greater interaction and exploration of the wetland ecology, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling
11.11	Install bollards at all main intersections of primary and secondary paths to manage safety concerns.	High	City of Stirling
11.12	Create 'eco-zones' along pathways to vary and enhance the visitor's experience. This can be achieved by diversifying planting (through density, placement and species selection).	Moderate	City of Stirling
11.13	Complete all unfinished fencing in the southern part of the Reserve consistent in character with the existing timber post and rail fencing.	High	City of Stirling
11.14	Implement an effective signage strategy, as per the adopted Carine ROS Master Plan of 2003. (City of Stirling has currently engaged consultants to address this issue)	High	City of Stirling
11.15	All vandalised signs to be cleaned or replaced.	Moderate	City of Stirling
11.16	Upgrade and relocate existing benches and install additional benches, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling
11.17	Increase number of doggie and litter bins and dog 'waste' bag dispensers across Reserve.	Moderate	City of Stirling
11.18	All vandalised bins to be cleaned and/ or replaced where necessary.	Moderate	City of Stirling
11.19	Increase number of BBQ facilities across Reserve at key locations, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling
11.20	Install bird hides for public use, as per the adopted Carine ROS Master Plan of 2003.	Low	City of Stirling
11.21	Install securable boardwalk through wetland, as per the adopted Carine ROS Master Plan of 2003.	Low	City of Stirling
11.22	Provide new disabled toilet facilities, as per the adopted Carine ROS Master Plan of 2003.	High	City of Stirling
11.23	Consider installing toilets near playgrounds, as per the adopted Carine ROS Master Plan of 2003.	Moderate	City of Stirling

6.12 Education and Interpretation

6.12.1 Objectives

The objectives of the Education and Interpretation Strategy are to:

- educate the public as to the social and environmental values of the Reserve
- inform the public as to what the City of Stirling is doing to conserve and enhance these values
- increase the sense of community ownership in the site.

6.12.2 Applicable Land Uses and Zones

- Conservation (Bushland, Transition, Wetland)
- Recreation (High Use, Moderate Use, Low Use).

6.12.3 Issues

Public Education

Several issues were determined in terms of education and interpretation:

1. There is little knowledge at present on the history and heritage of the area.
2. Community participation and awareness on environmental and cultural issues is a key component in the capacity of our society to manage our environment.
3. The Carine ROS currently accommodates many passive recreational activities such as walking, cycling and fauna observation and provides numerous sporting facilities.
4. Lack of public education about the social and ecological significance of the Carine ROS may hinder the value the Reserve holds within the community and lead to inappropriate behaviour and activities that may be harmful to both visitors and the Reserve.
5. There is capacity to help the public appreciate the values of the site and thereby contribute to its conservation values.
6. There are no current educational strategies in place and the only informative signage at the Reserve is limited to brief outlines of restricted access and behaviours around the wetland, many of which have been vandalised.

Community and Shareholders

Community involvement in revegetation, arson surveillance and maintenance programs has the potential to foster a sense of shared ownership of the Reserve, which can lead to improved responsible use and management of the site.

6.12.4 Strategy

Public Education

An Education and Interpretation Plan could be developed to help inform the community of the Reserve's social and environmental values. The plan could be based around themes as they provide continuity in the stories which reinforces people's memories of the facts and stories presented. Subjects for interpretation may include:

- local site history
- social linkages to nearby natural areas
- flora and vegetation
- fauna (particularly the diverse birdlife which live in and visit the wetland)
- the activities of community groups
- the dynamics of the wetland.

This education could be achieved by installing interpretive panels strategically around the Reserve with information that need not be changed frequently (eg maps and the values of the wetland) as well as a panel that can be periodically updated with current information such as the activities of the Council.

Possible locations of the signs include the proposed bird watching facilities and boardwalks. Interpretive signage at these points offering clear illustrative information about the environment and history would aid in further enhancing this experience for visitors and reduces the risk of inappropriate behaviour and harmful activities. Maps and or illustrative plans at key locations around the Reserve encourage further exploration of the site by providing important information about the facilities on offer and potential activities and points of interest for visitors.

Whilst there is much environmental information on the Reserve, there is currently very little known of its local historical significance. More research is required to discover the Reserve's history and heritage values so it may be included in the Education and Interpretation Plan.

Excursions should be encouraged for school children and the local community to use the educational facilities. However, any such excursions should be done in a manner that does not impact on and degrade the environmental values of the reserve.

Community

The public should be encouraged to engender a spirit of care and sense of ownership amongst the community. This would increase the level and quality of information available to the community on the cultural heritage, flora, vegetation communities and fauna of the reserve. One such method is to encourage the public to participate in the management and maintenance of the Reserve (eg a volunteer "Friends of Carine ROS" group).

6.12.5 Recommendations

12.	RECOMMENDATIONS	PRIORITY	RESPONSIBLE PARTY
12.1	Prepare an Education and Interpretation plan to identify and communicate the values of the area, consider including interpretive artworks.	High	City of Stirling
12.2	Install signage at strategic locations to encourage public participation and appreciation of the wetland. Develop signage of an appropriate size and format to inform visitors of the facilities and activities on offer.	Moderate	City of Stirling
12.3	Enable school groups and local community groups to access the site and the proposed boardwalks as educational excursions.	Low	City of Stirling
12.4	Research the history and heritage of Carine ROS.	Moderate	City of Stirling
12.5	Seek interest in the establishment of a "Friends of Carine ROS" group	Moderate	City of Stirling

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Appendix One: Maps

Carine ROS Environmental Management Plan

Map 1

August 2010

Carine Open Space Environment Management Plan

Topography of Carine ROS

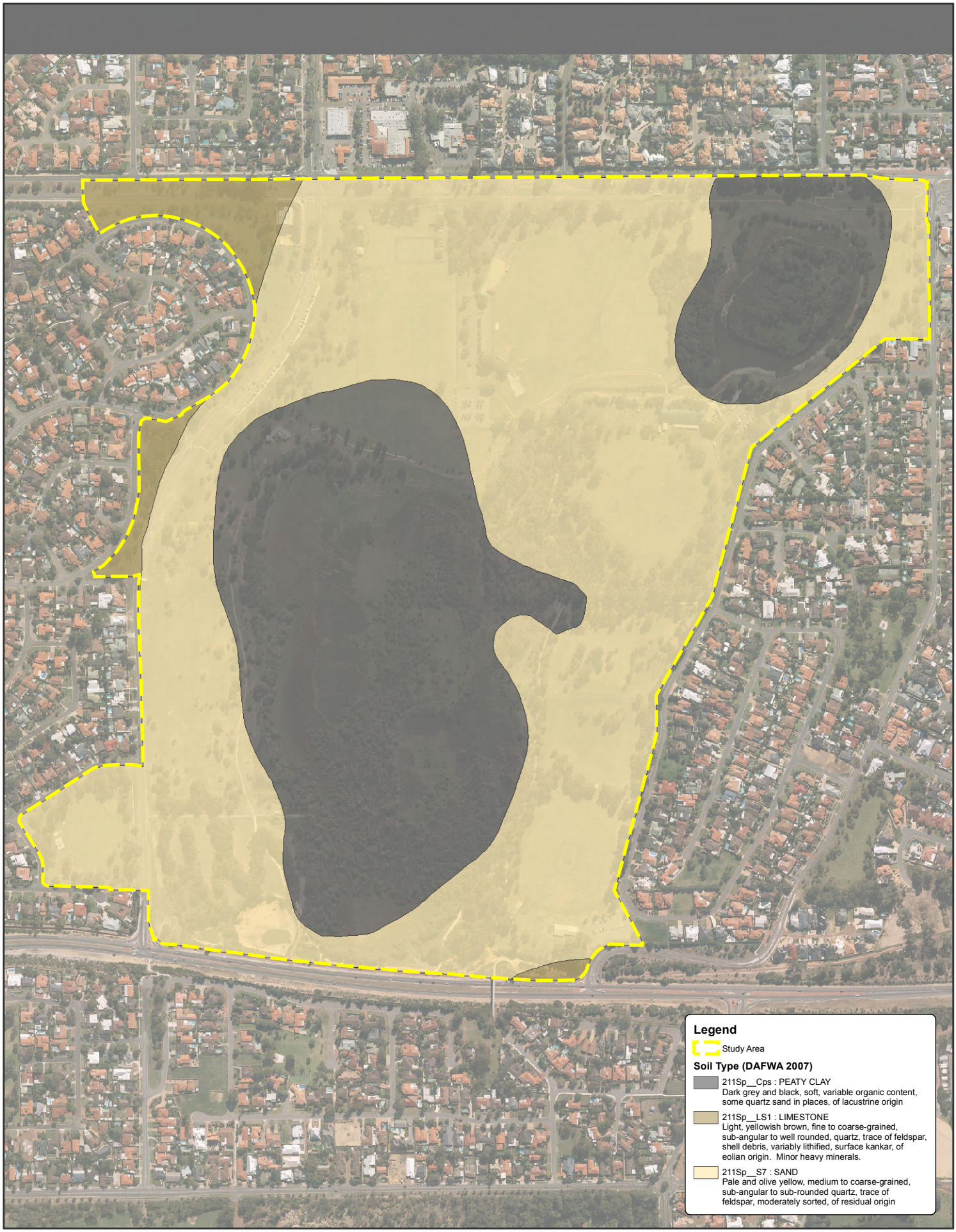
prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

ecoscape



Map 2

August 2010

Carine Open Space Environment Management Plan

Soil Landscape of Carine ROS

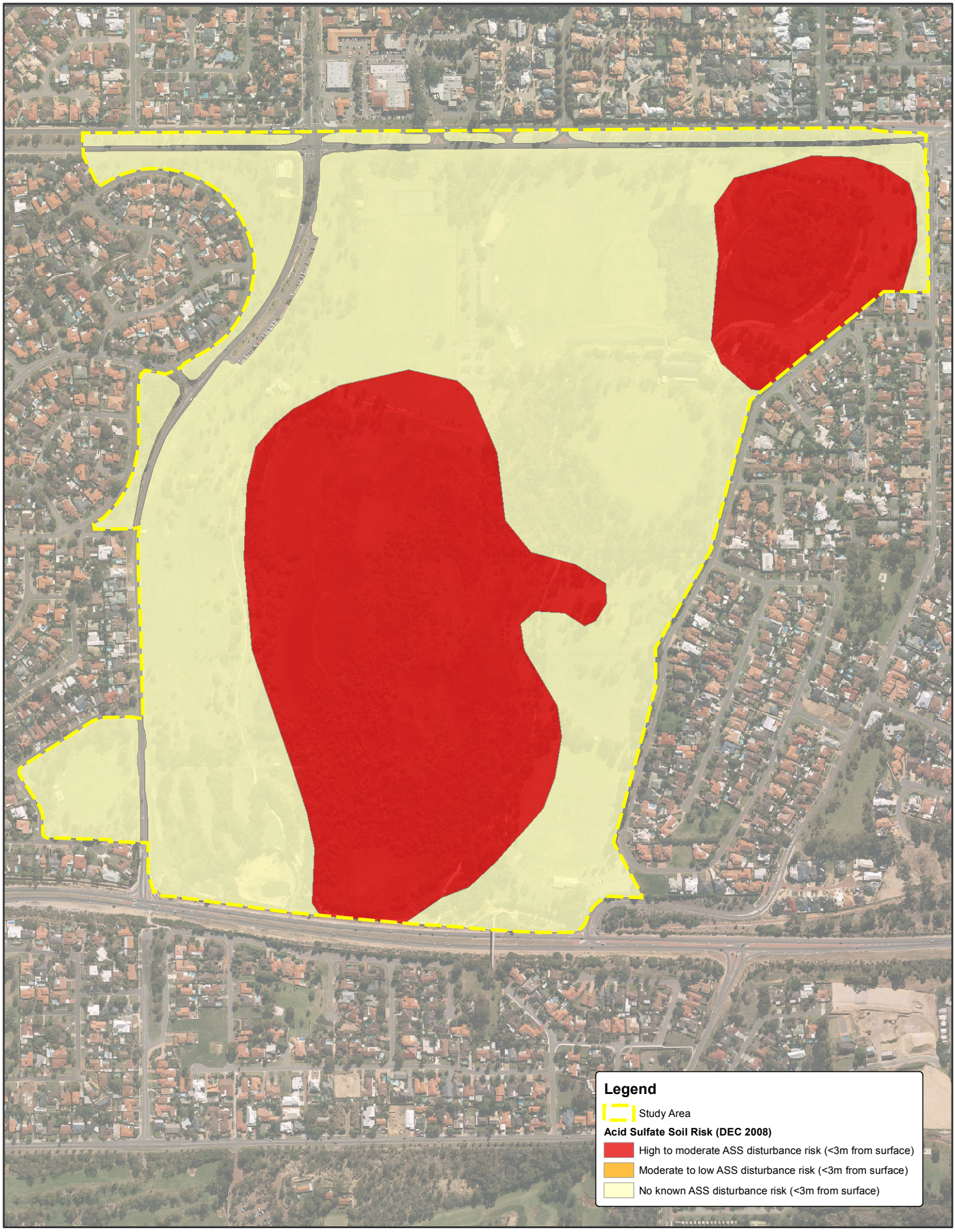
prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

ecoscape



Map 3

August 2010

Carine Open Space Environment Management Plan

Acid Sulfate Soils of Carine ROS

prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

ecoscape

Map 4

August 2010

Carine Open Space Environment Management Plan

Drainage of Carine ROS

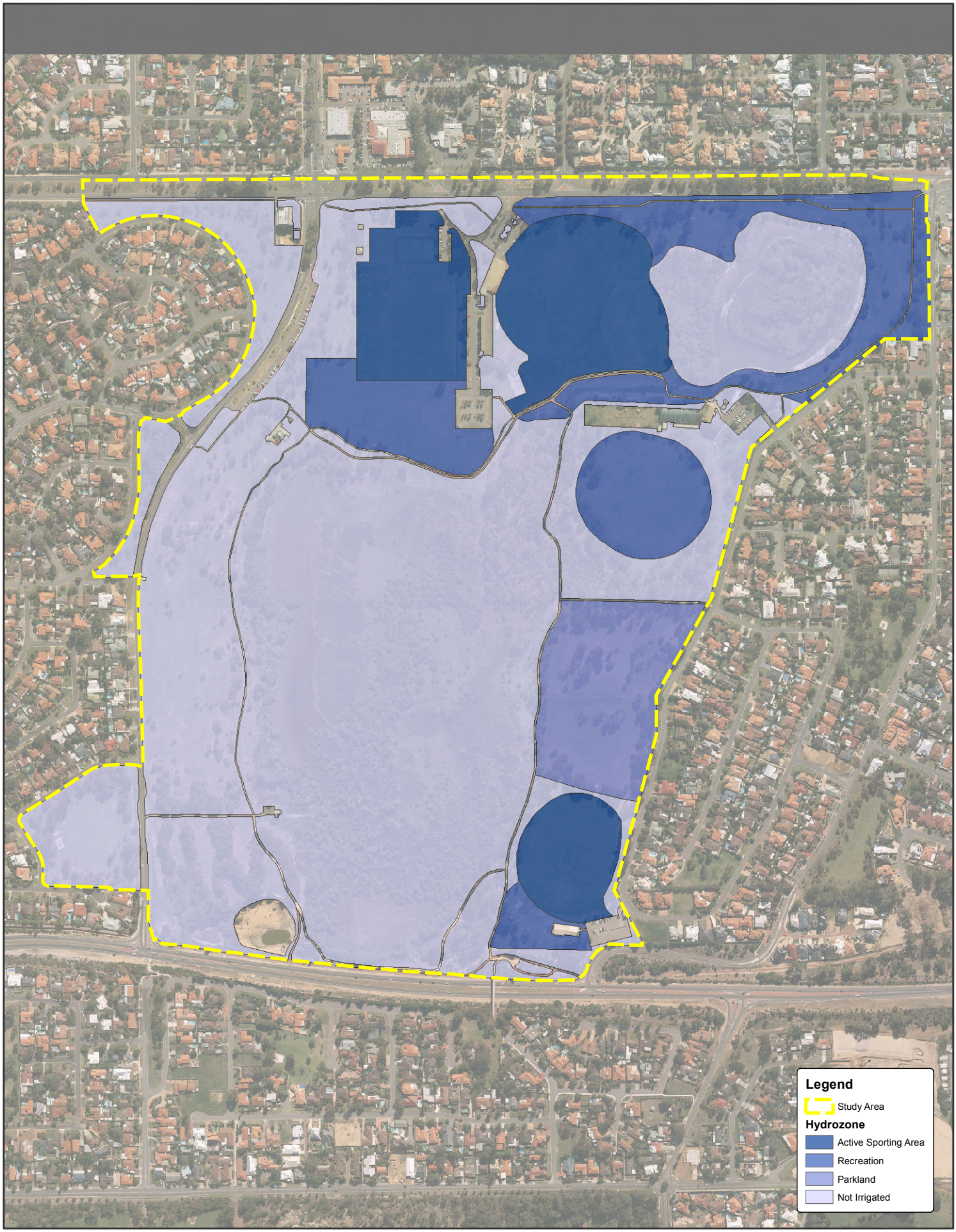
prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

ecoscape



Map 5

August 2010

Carine Open Space Environment Management Plan

Hydrozones of Carine ROS

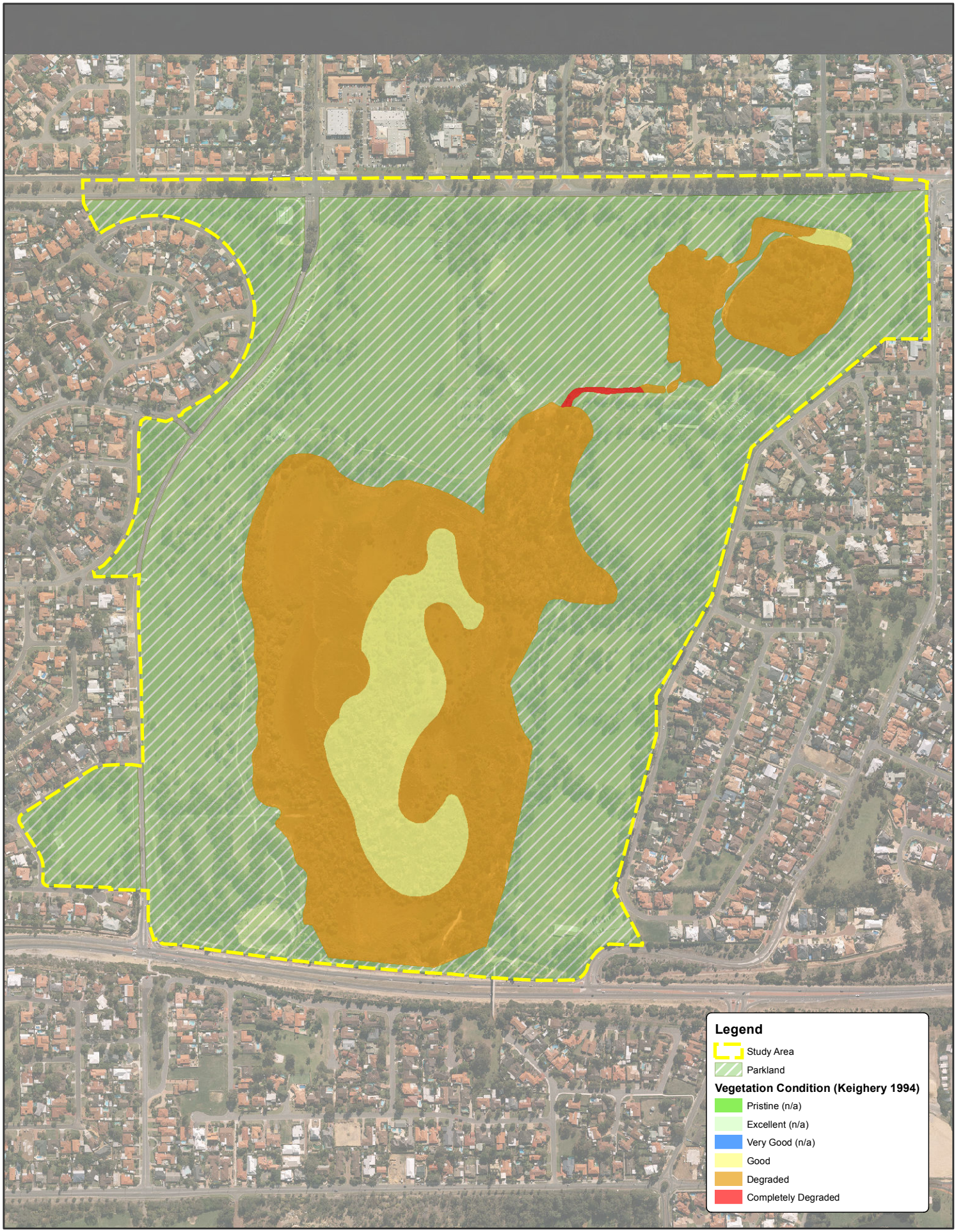
prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

ecoscape



Map 6

August 2010

Carine Open Space Environment Management Plan

Vegetation Condition of Carine ROS

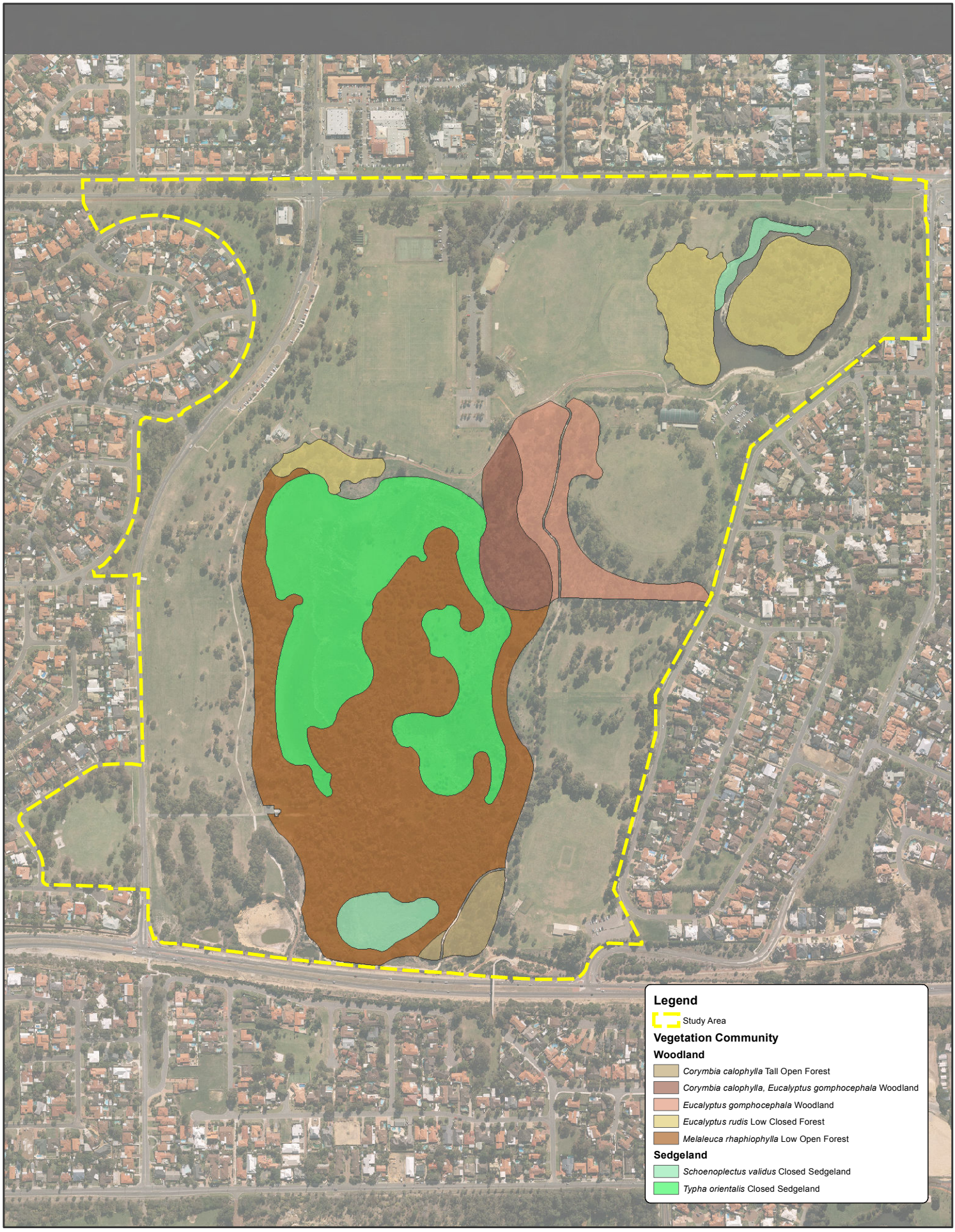
prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

ecoscape



Map 7

August 2010

Carine Open Space Environment Management Plan

Vegetation Communities of Carine ROS

prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

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Map 8

August 2010

Carine Open Space Environment Management Plan

Bush Fire Hazard Assessment of Carine ROS

prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,243 @ A4

Project No. 2454-10

ecoscape

Map 9

August 2010

Carine Open Space Environment Management Plan

Landuse and Zones of Carine ROS

prepared for City of Stirling

0 50 100 150 200 250 Metres

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Project No. 2454-10

ecoscape

Map 10

August 2010

Carine Open Space Environment Management Plan

Ecozones of Carine ROS

prepared for City of Stirling

0 50 100 150 200 250 Metres

1:7,250 @ A4

Project No. 2454-10

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Table A2.1: Water Quality Data of Carine ROS 2006-2009

Wetland	ANZECC	2006		2007		2008		2009	
	Trigger Value	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring
pH									
Carine Wetlands 1		7.9			7.6	7.3	7.5	7.3	7.5
Carine Wetlands 2	7.0 - 8.5	7.9			8.3	7.5	8.6	8.0	7.9
Carine Wetlands 3		8.0		7.5	8.4	7.4	7.9	7.9	8.0
Average		**7.9**		**7.5**	**8.1**	**7.4**	**8.0**	**7.7**	**7.8**
Dissolved oxygen									
Carine Wetlands 1		5							
Carine Wetlands 2	90 - 120	6.5							
Carine Wetlands 3		7.6							
Average		**6.4**							
Electrical conductivity (EC)									
Carine Wetlands 1		0.51			1.10	0.22	1.68	0.37	2.02
Carine Wetlands 2	0.3-1.5 mS/ cm	1.92			0.34	0.22	1.07	3.3	0.66
Carine Wetlands 3		0.62		0.25	0.45	0.16	0.60	.561	0.72
Average		**1.0**		**0.3**	**0.6**	**0.2**	**1.1**	**0.4**	**1.1**
Total Suspended Solids (TSS)									
Carine Wetlands 1		32.6			220	8	4	5	25
Carine Wetlands 2	6	1.5			4	2	4	6	6
Carine Wetlands 3		5.5		18	2	2	5	7	6
Average		**13.2**		**18.0**	**75.3**	**4.0**	**4.3**	**6.0**	**12.3**
Total Nitrogen									
Carine Wetlands 1		1.3			4.6	1.2	1.3	0.8	2.0
Carine Wetlands 2	1.5mg/L	1.1			1.4	0.6	1.0	1.8	1.0
Carine Wetlands 3		0.1		1.8	0.3	0.2	0.3	0.6	0.4
Average		**0.8**		**1.8**	**2.1**	**0.6**	**0.9**	**1.1**	**1.1**
NH4+									
Carine Wetlands 1		0.00			0.00	0.02	0.01	0.00	0.01
Carine Wetlands 2	0.04 mg/ L	0.10			0.01	0.01	0.01	0.00	0.01
Carine Wetlands 3		0.00		0.48	0.00	0.06	0.00	0.15	0.00
Average		**0.03**		**0.48**	**0.01**	**0.03**	**0.00**	**0.05**	**0.01**
Nox									
Carine Wetlands 1		0.00		0.47	0.00	0.00	0.00	0.00	0.00
Carine Wetlands 2	0.10 mg/ L	0.00			0.00	0.00	0.00	0.00	0.00
Carine Wetlands 3		0.06			0.00	0.05	0.00	0.10	0.00
Average		**0.02**		**0.47**	**0.00**	**0.02**	**0.00**	**0.03**	**0.00**
Total Phosphorus									
Carine Wetlands 1	0.06 mg/L	0.25			0.40	0.17	0.14	0.15	0.19
Carine Wetlands 2		0.06			0.18	0.11	0.04	0.00	0.05
Carine Wetlands 3		0.04		0.25	0.02	0.02	0.02	0.00	0.02
Average		**0.12**		**0.25**	**0.20**	**0.10**	**0.07**	**0.05**	**0.09**
Filterable Phosphorus									
Carine Wetlands 1		0.04			0.03	0.01	0.03		
Carine Wetlands 2	0.03 mg/ L	0.02			0.08	0.07	0.00		
Carine Wetlands 3		0.02		0.13	0.00	0.00	0.00		
Average		**0.03**		**0.13**	**0.04**	**0.03**	**0.01**		
Sulphate									
Carine Wetlands 1		87.6			200	24	530	55	500
Carine Wetlands 2		582			16	22	290	1100	100
Carine Wetlands 3		51.6		19	45	8	50	52	44
Average		**240.4**		**19.0**	**87.0**	**18.0**	**290.0**	**402.3**	**214.7**

Table A3.1: Criteria for identifying Wetland of International Importance (Ramsar 2006)

Groups		Criteria
Group A: Sites containing representative, rare or unique wetland types		**Criterion 1:** contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
Group B: Sites of international importance for conserving biodiversity	species and ecological communities	**Criterion 2:** supports vulnerable, endangered, or critically endangered species or threatened ecological communities.
		Criterion 3: supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
		Criterion 4: supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
	waterbirds	**Criterion 5**: regularly supports 20,000 or more waterbirds.
		Criterion 6: regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
	fish	**Criterion 7:** supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.
		Criterion 8: an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
	other taxa	**Criterion 9:** regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Table A3.2: Definitions and criteria for PECs

Criteria	Definition
Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, state forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities, but do not meet adequacy of survey requirements, and / or are not well defined, and appear to be under threat from known threatening processes.
Priority Three	i. Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or; ii. Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; iii. Communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities, but do not meet adequacy of survey requirements and / or are not well defined, and known threatening processes exist that could affect them.
Priority Four	Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. a. ***Rare***. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change These communities are usually represented on conservation lands. b. ***Near Threatened***. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. c. Ecological communities that have been removed from the list of threatened communities during the past five years.
Priority Five	*Conservation Dependent Ecological Communities* Ecological Communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Table A3.3: Definitions and criteria for TECs

Criteria	Definition
Presumed Totally Destroyed (PD)	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant and either of the following applies (A or B): A) Records within the last 50 years have not been confirmed despite thorough searches of known or likely habitats or B) All occurrences recorded within the last 50 years have since been destroyed
Critically Endangered (CR)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future. This will be determined on the basis of the best available information, by it meeting any one or more of the following criteria (A, B or C): A) The estimated geographic range, and/or total area occupied, and/or number of discrete occurrences since European settlement have been reduced by at least 90% and either or both of the following apply (i or ii): i) geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is imminent (within approximately 10 years); ii) modification throughout its range is continuing such that in the immediate future (within approximately 10 years) the community is unlikely to be capable of being substantially rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the immediate future (within approximately 10 years); ii) there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes; iii) there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes. C) The ecological community exists only as highly modified occurrences that may be capable of being rehabilitated if such work begins in the immediate future (within approximately 10 years).
Endangered (EN)	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B, or C): A) The geographic range, and/or total area occupied, and/or number of discrete occurrences have been reduced by at least 70% since European settlement and either or both of the following apply (i or ii): i) the estimated geographic range, and/or total area occupied and/or number of discrete occurrences are continuing to decline such that total destruction of the community is likely in the short term future (within approximately 20 years); ii) modification throughout its range is continuing such that in the short term future (within approximately 20 years) the community is unlikely to be capable of being substantially restored or rehabilitated. B) Current distribution is limited, and one or more of the following apply (i, ii or iii): i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years); ii) there are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes; iii) there may be many occurrences but total area is small and all or most occurrences are small and/or isolated and very vulnerable to known threatening processes. C) The ecological community exists only as very modified occurrences that may be capable of being substantially restored or rehabilitated if such work begins in the short-term future (within approximately 20 years).
Vulnerable (VU)	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future. This will be determined on the basis of the best available information by it meeting any one or more of the following criteria (A, B or C): A) The ecological community exists largely as modified occurrences that are likely to be capable of being substantially restored or rehabilitated. B) The ecological community may already be modified and would be vulnerable to threatening processes, is restricted in area and/or range and/or is only found at a few locations. C) The ecological community may be still widespread but is believed likely to move into a category of higher threat in the medium to long term future because of existing or impending threatening processes.

Table A3.4: EPBC Act categories for TECs

EPBC Act Category	Definition
Critically Endangered (CR)	An ecological community that is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered (EN)	An ecological community that is not critically endangered, and is facing a very high risk of extinction in the wild in the new future.
Vulnerable (VU)	An ecological community that is not critically endangered or endangered, and is facing a high risk of extinction in the medium-term future.

Table A3.5: EPBC Act categories for species

EPBC Act Category	Definition
Extinct	A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time: (a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or (b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	A native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
Endangered	A native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium term future, as determined in accordance with the prescribed criteria.
Conservation Dependent	A native species is eligible to be included in the conservation dependent category at a particular time if, at that time: (a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or (b) the following subparagraphs are satisfied: (i) the species is a species of fish; (ii) the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised; (iii) the plan of management is in force under a law of the Commonwealth or of a State or Territory; (iv) cessation of the plan of management would adversely affect the conservation status of the species.

Table A3.6: DEC Definitions of Declared Rare and Priority Flora

Code	DEC Rating	Definition
R	Declared Rare Flora - Extant Taxa	Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X	Declared Rare Flora - Presumed Extinct Taxa	Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
1	Priority One - Poorly known Taxa	Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral animals, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
2	Priority Two - Poorly Known Taxa	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
3	Priority Three - Poorly Known Taxa	Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but are in need of further survey.
4	Priority Four - Rare Taxa	Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Table A3.7: DEC Definitions of Priority Fauna

Code	DEC Rating	Definition
1	Priority One - Taxa with few, poorly known populations on threatened lands	Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
2	Priority Two - Taxa with few, or poorly known populations on conservation lands	Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
3	Priority Three - Taxa with several, poorly known populations, some on conservation lands	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
4	Priority Four - Taxa in need of monitoring	Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
5	Priority Five - Taxa in need of monitoring	Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table A3.8: DEC schedules and definitions for declaration of specially protected fauna

Schedule	Definition
Schedule 1	Fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection
Schedule 2	Fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection
Schedule 3	Birds that are subject to an agreement between the Governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction, are declared to be fauna that is in need of special protection
Schedule 4	Declared to be fauna that is in need of special protection, otherwise than for the reasons mentioned in Schedules 1 to 3 (mentioned above)

Table A3.9: Type 3 Bushfire Hazard Assessment Hazard Levels (adapted from FESA 2001)

Vegetation Type	Fire hazard in relation to distance from predominant vegetation and slope							
	<15m		15-40m		40-100m		>100m	
	>10^0	<10^0	>10^0	<10^0	>10^0	<10^0	>10^0	<10^0
Forest	Extreme	Extreme	High	High	Medium	Medium	Low	Low
Woodland	Extreme	Extreme	High	High	Medium	Low	Low	Low
Tall Shrub	Extreme	Extreme	High	High	Medium	Low	Low	Low
Low Shrub	High	Medium	Medium	Low	Low	Low	Low	Low
Open Woodland/Shrubland	Medium	Medium	Low	Low	Low	Low	Low	Low
Grassland	Medium	Low	Low	Low	Low	Low	Low	Low

Table A4.1: Native Flora Inventory

Species		Landuse and Zones				Feature		
		Conservation						
Scientific name	**Common name**	**Wetland**	**Transition**	**Bushland**	**Recreation**	**Fauna attracting**	**Regionally Significant**	**Fire retardant**
Trees								
Acacia cyclops	Coastal Wattle			*	*	*		*
Acacia saligna	Orange Wattle		*	*		*		*
Banksia attenuata	Slender Banksia			*	*	*		
Banksia grandis	Bull Banksia			*	*	*		
Banksia littoralis	Swamp Banksia	*	*			*		
Banksia menziesii	Firewood			*	*	*		
Corymbia calophylla	Marri			*		*		
Eucalyptus gomphocephala	Tuart		*	*	*	*	*	
Eucalyptus marginata	Jarrah			*		*		
Eucalyptus rudis	Flooded Gum	*	*			*		
Melaleuca rhaphiophylla	Swamp Paperbark	*	*		*	*		
Myoporum caprarioides	Slender Myoporum	*	*					
Large Shrubs (>1m high)								
Jacksonia furcellata	Grey Stinkwood		*	*				
Jacksonia sternbergiana	Stinkwood		*	*				
Macrozamia riedlei	Zamia Palm			*	*			
Xanthorrhoea preissii	Grasstree			*	*	*		
Small Shrubs (<1m high)								
Acacia pulchella	Prickly Moses		*	*	*	*		
Grevillea vestita				*	*	*		
Hakea prostrata	Prostrate Hakea		*	*		*		
Herbs								
Dianella revoluta	Blueberry Lilly			*	*			
Hibbertia hypericoides	Yellow Buttercups			*	*			
Hibbertia sp.				*	*			
Meionectes brownii	Swamp Raspwort	*	*					
?Leucopogon sp.			*					
Lomandra sp.				*		*		
Opercularia hispidula	Stinkweed		*	*				
Patersonia occidentale	Purple Flag			*	*			*
Climbers & Groundcovers								
Cassytha ?racemosa	Dodder Laurel		*	*				
Hardenbergia comptoniana	Native Wisteria			*	*			
Centella asiatica	Centella	*						
Kennedia prostrata	Running Postman			*	*	*		*
Sedges and Rushes								
Baumea ?acuta	Twig-rush	*						
Baumea articulata	Jointed Rush	*				*	*	
?Bolboschoenus caldwellii	Marsh Club-rush	*						
Carex sp.		*						
Cyperus ?tenuiflorus	Leaf-rush	*						
Ficinia nodosa	Knotted Club-rush	*						
Juncus sp.		*						
Lepidosperma ?effusum	Sword-sedge	*						
Lepidosperma gladiatum	Coast Sword-sedge	*						
Lepidosperma longitudinale	Pithy Sword-sedge	*						
Polygonum salicifolium	Slender Knotweed	*						
Schoenoplectus validus	Lake Club-rush	*				*	*	
Schoenus sp.		*						
Typha ? domingensis	Cumbungi	*						
TOTAL		**20**	**14**	**24**	**16**	**19**	**3**	**4**

Table A4.2: Weed Species Inventory

Scientific Name	Common Names	Presence
Acetosella vulgaris	Sorrel	
Arctotheca calendula	Cape Weed	
Asparagus officinalis	Asparagus	Unlikely
Avena fatua/ barbata	Wild Oat	
Briza maxima	Blowfly Grass	
Bromus catharticus	Prairie Grass	
Bromus diandrus	Great Brome	
Carpobrotus edulis	Pigface	
Chenopodium album	White Goosefoot	
Chenopodium ambrosioides	Mexican Tea	
Chenopodium macrospermum		
Cirsium vulgare	Spear Thistle	
Citrullus lanatus	Wild Melon	
Conyza bonariensis	Flaxleaf Fleabane	
Cynodon dactylon	Couch	
Digitaria sanguinalis	Summer Grass	
Ehrharta longiflora	Annual Veldgrass	
Euphorbia terracina	Geraldton Carnation Weed	
Ficus carica	Edible Fig	Unlikely
Foeniculum vulgare	Fennel	
Fumaria capreolata	Whiteflower Fumitory	
Fumaria officinalis		
Gladiolus sp.		
Hypochaeris glabra	Flat Weed	
Hypochaeris radicata	Flat Weed	
Juncus articulatus		
Lagurus ovatus	Hares Tail Grass	
Lantana camara	Lantana	
Lupinus cosentinii	Western Blue Lupin	
Lythrum hyssopifolia	Lesser Loosestrife	
Malva parviflora	Small Flowered Marsh	
Medicago polymorpha	Burr Medic	
Melilotus albus		
Melilotus indicus	King Island Melilot	
Mentha suaveolens		
Oenothera sp.	Evening Primrose	
Orobanche minor	Lesser Broomrape	
Oxalis pes-caprae	Soursob	
Paspalum dilatatum	Paspalum	
Paspalum distichum	Water Couch	
Pelargonium capitatum	Rose Pelargonium	
Pennisetum clandestinum	Kikuyu	
Persicaria sp.	Knotweed	Possible
Phyla nodiflora	Carpet Weed	
Phytolacca octandra	Ink Weed, Red Ink Plant	
Raphanus raphanistrum	Wild Radish	
Ricinus communis	Castor Oil Plant	
Rumex crispus	Curled Dock	
Solanum linnaeanum		
Solanum nigrum	Black Nightshade	
Sonchus asper	Prickly Sowthistle	
Sonchus oleraceus	Common Sowthistle	
Stenotaphrum secundatum	Buffalo Grass	
Symphyotrichum squamatum	Bushy Starwort	
Tamarix aphylla	Tamarisk	
Trifolium sp.		
Typha orientalis	Bullrush	
Vitis vinifera		Unlikely
Zantedeschia aethiopica	Arum Lily	Unlikely

Table A4.3: Native Fauna Inventory of Carine ROS

Scientific name	Common Name	EPBC	DEC
BIRDS			
Acrocephalaus stentoreus	Glamorous Reed Warbler		
Anas gibberifrons	Grey Teal		
Anas platyrhynches	Mallard		
Anas superciloisa	Black Duck		
Anthochaera chrysoptera	Little Wattlebird		
Anthus novaeseelandiae	Richards Pipit		
Ardea alba	Great Egret	Migratory	
Ardea ibis	Cattle Egret	Migratory	
Ardea novaehollandiae	White-faced Heron		
Barnarbius zonarius	Port Lincoln Parrot		
Bizuiura lobata	Musk Duck		
Brown Bittern	Botaurus poiciloptilus		
Cacatua sanguinea	Cockatoo		
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Vulnerable	Endangered
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Endangered	Endangered
Chennibetta jubata	Wood Duck		
Climacteris rufus	Rufus Treecreeper		
Coracina novaehollandiae	Blackfaced Cuckoo Shrike		
Corvus coronoides	Australian Raven		
Cracticus torquatus	Butcher Bird		
Cuculus pallidus	Palid Cuckoo		
Cygnus stratus	Black Swan		
Dacelo gigas	Laughing Kookaburra		
Egretta alba	Great Egret		
Falco cenchroides	Nankeen Kestrel		
Falco longipennis	Little Falcon		
Fulica atra	Coot		
Gallinula tenebrosa	Dusky Moorhen		
Gallinula ventralis	Black Tailed Native Hen		
Grallina cyanoleuca	Australian Magpie Lark		
Gymnorhina tibicen	Australian Magpie		
Halycon sancta	Sacred Kingfisher		
Himantopus himantopus	Pied Stilt		
Hirundo neoxena	Welcome Swallow		
Lichmera indistincta	Brown Honeyeater		
Meliphaga virescens	Singing Honeyeater		
Merops ornatus	Rainbow Bee Eater	Migratory	P4
Pachycephala pecforalis	Golden Whistler		
Pelecanus conspicilatus	Australian Pelican		
Phalacrocorax melanosleucos	Little Pied Cormorant		
Phalacrocorax sulcirostris	Little Black Cormorant		
Platalea flavipea	Yellow-billed Spoonbill		
Podiceps cristatus	Great Crested Grebe		
Podiceps poliocephalus	Hoary-headed Grebe		
Policeps novaehollandiae	Australian Little Grebe		
Porphyrio porhio	Swamp Hen		
Rallus philippensis	Buff Banded Rail		
Rhipidura fuliginosa	Grey Fantail		
Rhipidura leucophrys	Willie Wagtail		
Tadorn tadornoides	Mountain Duck		
Threskiornis molucca	White Ibis		
Zosterops lateralis	Silver Eye		

Scientific name	Common Name	EPBC	DEC
MAMMAL			
Dasyurus geoffroii	Chuditch	Vulnerable	Vulnerable
AMPHIBIAN			
Chelodina oblonga	Long Necked Tortoise		
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		
ATHRPOPOD			
Synemon gratiosa	Graceful Sun Moth	Endangered	

Table A4.4: Introduced, Pest and Overabundant Bird Species of Carine ROS

Scientific Name	Common Names
Cacatua pastinator	Corella
Columba livia	Domestic Pigeon
Corvus coronoides	Australian Raven
Streptopelia chinensis	Spotted Turtle Dove
Streptopelia senegalensis	Laughing Turtle Dove
Trichoglossus haematodus	Rainbow Lorikeet

Methodology of Prioritising Weeds

Rating Systems

The priority ratings of each weed species were determined after examining:

- the ratings under the *Environmental Weed Strategy of Western Australia* (EWSWA) by the Department of Conservation and Land Management (CALM 1999)
- the ratings under the *Environmental Weed Census and Prioritisation* (EWCP) by the Swan Natural Resource Management (Swan NRM 2008)
- the ratings under Dixon and Keighery (1995) *Recommended methods to control specific weed species*
- whether it was listed under the DAFWA (1976) *Agricultural and Related Resources Protection Act* (ARRPA)
- whether it was listed as a *Weed of National Significance* (WONS) (Weed Australia 2008)
- its local significance to the natural areas.

The role of EWSWA is to highlight which weed species pose significant environmental risk in Western Australia. The EWSWA rating provides a basis for determining which weeds are most critical to control. The three characteristics used for determining the EWSWA rating are:

- *invasiveness* – ability to invade bushland in good to excellent condition
- *distribution* – wide current or potential distribution including consideration of known history of wide distribution elsewhere in the world
- *environment impacts* – ability to change the structure, composition and function of ecosystems, in particular to form a monoculture in a vegetation community.

EWSWA weed species were rated accordingly:

- *High* – have all three of the characteristics
- *Moderate* – have two of the characteristics
- *Mild* – have one of the characteristics
- *Low* – not deemed to have any of the characteristics.

However, EWSWA is a general guide for prioritising weeds across the State. The Swan Natural Resource Management (2008) *Environmental Weed Census and Prioritisation* (EWCP) rates weeds species as a threat in Perth bushland conditions. A total of eight ratings are used, according to the risk each species poses to environmental assets in the region, based on invasiveness, ecological impact, current and potential distribution, and thus priority for management. In order of descending, priority, they are:

- Very High
- High
- Further Assessment Required (FAR)/ High
- Moderate/ High
- Moderate
- Low/ Moderate
- Low
- Further Assessment required (FAR)

Dixon and Keighery (1995) developed a rating system for 145 weed species. The rating system classified each species according to the threat they pose to bushland in the Perth Metropolitan region. The three classifications used were:

- *Priority 1* – major weeds, which are the most serious weeds within their ecosystem, often affecting many reserves or habitats in ways likely to permanently degrade them -
- *Priority 2* – nuisance weeds, which are generally found only in a few locations or ecosystems, usually in disturbed areas
- *Priority 3* – minor weeds, which have little known effect and occur in smaller numbers or are less competitive than *Priority 2* weeds.

The type of control for ARRPA declared weed species are listed below:

- *P1* – Prohibits movement of plants or their seeds within the State. This prohibits the movement of contaminated machinery and produce including livestock and feed.
- *P2* – Eradicate infestation to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
- *P3* – Control infestation in such a way that prevents the spread of seed or plant parts within and form the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants.
- *P4* – Prevent the spread of infestation from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set on all plants.

WONS was jointly declared by the Minister for Forestry and Conservation, the Minister for Agriculture, Fisheries and Forestry and the Minister for The Environment in 1999 as part of the *National Weeds Strategy*. The four characteristics used for determining where the species was of national significance were:

- invasiveness
- impacts
- potential for spread
- socioeconomic and environmental values.

Ranking Priority Weeds

The above sources were used to rank the recorded weed species in order of priority for control. Both the EWCP (Swan Natural Resource Management 2008) and EWSWA (CALM 1999) ratings were used because it allowed most weeds identified in the Reserve to be assigned a rating and thereby ranked. If only one source had been used, some of the weed species would have not been assigned a rating score.

The use of two rating systems does result in some conflict when assigning a ranking for a weed species. To overcome this issue, a matrix scoring system was developed to enable the ranking of the weed species. The matrix scoring system is summarised in **Table A5.1.** For the purposes of this study, the system gave a slight bias to the EWCP system, as this system was more relevant for the Reserve.

In addition, as weed species listed under either ARRPA or WONS are required by legislation to be controlled, any of these listed weed species recorded were automatically given a rating of 6.

Table A5.1: Matrix scoring system for rating weed priority

RATING SYSTEM		EWSWA				
		Unrated	Low	Mild	Moderate	High
Perth NRM	Unrated	1	1	3	4	5
	FAR	1	1	3	4	5
	Low	2	2	3	4	5
	L/M	2	3	4	4	5
	M	3	4	4	4	5
	M/H	4	4	4	5	6
	FAR/H	5	5	5	5	6
	H	5	5	5	6	6
	VH	6	6	6	6	6

If any weed species not assigned a rating by these any of the previous sources, the Dixon and Keighery (1995) rating system would then be used:

- Priority 1 = Rating 6
- Priority 2 = Rating 4
- Priority 3 = Rating 2

If any weed species were not given a rating be any of the previous systems, they would receive a default rating of 1.

The calculated ratings were then adjusted according to whether the species were more or less of a threat or dominant in the local native areas. Species with low ratings that were posing a greater threat or were already highly dominant had the rating raised. In contrast, species with high ratings but were not considered to be a local threat had their rating lowered accordingly.

The priority of each weed species was then classified by the final rating:

- Species given a rating of 5 or 6 were *High Priority Weeds*.
- Species with a final rating of 3 or 4 were *Moderate Priority Weeds*.
- Species with a rating of 1 or 2 were *Low Priority Weeds.*

Optimal Control Times

The optimal control times of the year for most of the weed species were determined from consulting:

- Moore and Wheeler (2008) *Southern Weeds and their control*
- Brown and Brooks (2002) *Bushland Weeds*
- Dixon and Keighery (1995) *Recommended methods to control specific weed species.*

For weed species where control times were not given in the above sources, the DEC (2009a) *Swan Weeds Database* was then consulted to identify the active growing and flowering periods. The optimal months were then estimated to target weed species when they were actively growing (therefore more likely to absorb any chemicals) but before they flowered (to prevent seed set).

The optimal times of the year were then determined be selecting which few months were ideal to target all fo the target High Priority weed species. These months were then compared to the optimal times of the moderate and low priority weed species. An additional control time was then presented if the optimal control times of any of the Moderate and Low Priority weed species did not correspond with the selected times to control the High Priority weed species.

Results

State and National Significance

The following weed species were given priority scores of 6 (High Priority) as they were listed by WONS and/or ARRPA:

- Lantana (*Lantana camara*) is federally listed by Weeds Australia as a Weed of National Significance (WONS) and state listed by the Department of Agriculture as P1.
- Tamarisk (*Tamarix aphylla*) is state by the Department of Agriculture as P1.
- Arum Lily (*Zantedeschia aethiopica*) is rated by the Department of Agriculture as P1 and P4.

Local Significance

Arctotheca calendula (Cape Weed) and *Ficus carica* (Edible Fig) *Hypochaeris glabra* and *Hypochaeris radicata* (Flatweeds) had calculated ratings of 6, while *Lupinus cosentinii* (Western Blue Lupin) and *Oxalis pes-caprae* (Soursob) had calculated ratings of 5, indicating that these species were high priority to control. However, these species were not deemed to be major threats to the reserve, so their final ratings were downgraded to 4, making these species a Moderate Priority.

Optimal Control Times

Targeting all of the High Priority weed species will require a minimum of two site visits – June and October. These months are also ideal for targeting all of the Moderate and Low Priority weed species except *Oxalis pes-caprae* (Soursob), whose optimal times lie within these two periods (July to September). However, control of this Moderate Priority species may still be attempted in these months. An additional visit in August may be necessary if the June and October control efforts are not effective.

Table A5.2: Prioritisation and optimal control times of weeds observed at Carine ROS Reserve

WEED SPECIES		PRIORITISATION									OPTIMAL CONTROL TIME											
Scientific Name	Common Names	EWSWA	Swan NRM	WONS	ARRPA	Dixon & Keighery	Calculated Rating	Local significance	Final Rating	PRIORITY	J	F	M	A	M	J	J	A	S	O	N	D
Avena fatua/ barbata	Wild Oat	Moderate	Very High			1	6															
Bromus diandrus	Great Brome	High	Very High			3	6															
Cynodon dactylon	Couch	Moderate	Very High			1	6															
Euphorbia terracina	Geraldton Carnation Weed	High	Very High			1	6															
Lagurus ovatus	Hares Tail Grass	High	High			2	6															
Lantana camara	Lantana	Moderate	Moderate	*	P1	3	6															
Paspalum dilatatum	Paspalum	Moderate	High			2	6															
Paspalum distichum	Water Couch	Moderate	High			2	6		6													
Pennisetum clandestinum	Kikuyu	Moderate	High			1	6			High												
Phyla nodiflora	Carpet Weed	Moderate	High			3	6															
Stenotaphrum secundatum	Buffalo Grass	Moderate	High			1	6															
Tamarix aphylla	Tamarisk	Moderate	High		P1		6															
Typha orientalis	Bullrush	High	Very High			1	6															
Zantedeschia aethiopica	Arum Lily	High	Very High		P1, P4	1	6															
Acetosella vulgaris	Sorrel	High	FAR				5															
Carpobrotus edulis	Pigface	Moderate	Moderate/ High			2	5		5													
Pelargonium capitatum	Rose Pelargonium	High	Moderate/ High			1	5															
Arctotheca calendula	Cape Weed	Moderate	High			3	6	No														
Briza maxima	Blowfly Grass	Moderate	FAR			2	4															
Chenopodium macrospermum		Low	Moderate			1	4															
Cirsium vulgare	Spear Thistle	Moderate	Low			3	4															
Ehrharta longiflora	Annual Veldgrass	Moderate	FAR			3	4															
Ficus carica	Edible Fig	Moderate	High			1	6	No														
Fumaria capreolata	Whiteflower Fumitory	Mild	Moderate/ High			2	4															
Hypochaeris glabra	Flat Weed	Moderate	High			3	6	No														
Hypochaeris radicata	Flat Weed	Moderate	High				6	No	4													
Lupinus cosentinii	Western Blue Lupin	High	Unrated			1	5	No														
Lythrum hyssopifolia	Lesser Loosestrife	Moderate	Moderate			3	4															
Melilotus indicus	King Island Melilot	Moderate	Unrated			3	4															
Orobanche minor	Lesser Broomrape	Moderate	FAR			3	4															
Oxalis pes-caprae	Soursob	Mild	High			2	5	No		Moderate												
Solanum nigrum	Black Nightshade	Moderate	Moderate			2	4															
Solanum linnaeanum		Moderate	Unrated				4															
Sonchus asper	Prickly Sowthistle	Moderate	FAR				4															
Sonchus oleraceus	Common Sowthistle	Moderate	FAR			3	4															
Aster subulatus	Bushy Starwort	Moderate	Unrated			3	4															
Foeniculum vulgare	Fennel	Unrated	Moderate			2	3															
Juncus articulatus		Mild	Unrated				3															
Medicago polymorpha	Burr Medic	Mild	FAR			3	3															
Phytolacca octandra	Ink Weed, Red Ink Plant	Mild	FAR			3	3		3													
Raphanus raphanistrum	Wild Radish	Mild	FAR			3	3															
Rumex crispus	Curled Dock	Mild	FAR			3	3															
Asparagus officinalis	Asparagus	Low	Low				2															
Bromus catharticus	Prairie Grass	Low	FAR			3	2															
Chenopodium album	White Goosefoot	Low	Low			3	2															
Chenopodium ambrosioides	Mexican Tea	Low	Low			3	2															
Conyza bonariensis	Flaxleaf Fleabane	Low	Low			3	2		2													
Digitaria sanguinalis	Summer Grass	Low	Low				2															
Malva parviflora	Small Flowered Marsh	Low	Low			3	2															
Melilotus albus		Low	Low				2															
Oenothera sp.		Unrated	Low				2			Low												
Citrullus lanatus	Wild Melon	Low	Unrated			3	1															
Fumaria officinalis		Unrated	Unrated				1															
Gladiolus sp.		Unrated	Unrated				1															
Mentha suaveolens		Low	Unrated				1		1													
Persicaria sp.	Barbgrass/ Knotweed	Unrated	Unrated				1															
Ricinus communis	Castor Oil Plant	Low	Unrated			3	1															
Trifolium sp.		Low	Unrated				1															
Vitis vinifera		Unrated	Unrated				1															

Optimal time to target weed species

The following pages provide descriptions and a variety of control methods the weed and aggressive native species recorded in the Carine ROS Reserve.

Weed management recommendations are based on information from:

4. Brown and Brooks (2002) *Bushland Weeds*
5. Dixon and Keighery (1995) *Recommended methods to control specific weed species*
6. Moore and Wheeler (2008) *Southern Weeds and their control.*

Herbicide recommendations have superscripted numbers assigned to them to indicate which of these sources above provided the information on herbicide type and dosage.

The quantities of herbicides suggested for spot spraying rate have been calculated for a 10L backpack with 25mL of wetting agent. It should be noted that surfactants should not be used near and wetlands or waterways. It is recommended that selective herbicides be implemented where practical to limit their impact on adjacent native plants.

Information on each of the recommended herbicide brands are summarised on **Table A6.2**.

It should be noted that manual control should always be considered first before using herbicides.

Control Methods

Manual Removal

When manually removing weeds, the process of removal should follow the Bradley (1971) *Bush Regeneration* method. The aim the Bradley Method is the systematic removal of weeds to allow native plants to re-establish themselves when and where they choose. This method does not involve replanting – simply the gradual removal of weeds so that no large openings are made. This makes the Bradley method ideal for many situations, such as where native plants are able to colonise the site by seeds or vegetative means, areas sensitive to erosion and areas likely to be over-used.

Underlying Principals

1. Always work from areas with native plants towards weed-infested areas.

This makes good ecological sense. If you are relying on natural regeneration then choose areas that will contain the maximum number of existing native plants and native plant seeds, and minimal weed seeds and vegetative reproductive organs of weeds.

2. Make minimal disturbance.

Application of this principal depends on the native species to regenerate. Many plant communities (both weeds and native) need disturbed and sunlit soil for successful regeneration. However, by following the 1st principle above, any weed regeneration should be minimised. Any soil that is disturbed should be returned in its original layers, thus ensuring that any native seed stored in the soil will still be on top. This principle also applies to the application of natural plant mulch in the work area – where a gap is left as a result of weeding, it is recommended that mulch from surrounding areas be added to the gap. This helps to minimise weed regeneration.

3. Let native plant regeneration dictate the rate of weed removal.

The ability to follow this principle may depend on the amount of time and money committed to a particular project. If few weeds and many native plants regenerate, or if the ground remains weed free, little time will need to be spent re-weeding a site, allowing time to be spent on other sites. If masses of weeds regenerate then a lot of time will be required re-weeding so that regenerating native plants can flourish.

Developing Work Plans

1. Prevent deterioration of good areas.

Start by removing weeds scattered through otherwise clean bush. Practically no follow up work will be needed, but it should be checked once or twice a year.

2. Improve the next best area.

Once you are confident you have prevented deterioration of better condition bush, you can start work on thicker patches of weed. Choose a place you can visit easily and often, where thick native growth is pushing up against weeds, preferably no worse than one weed species to every two native plant species. Start with a strip approximately 12 feet wide and no longer than can be managed with monthly weeding days. If the area to be cleared of weeds runs up a slope which may erode, clear a number of smaller patches instead.

3. Hold the advantage gained.

Resist the temptation to push deeper into the weeds before regenerating natives have stabilised each cleared area. The natives do not need to be very tall, but they usually need to form an almost complete ground cover. Weeds will always nearly keep germinating until this is achieved. These newly regenerated areas are most vulnerable to weed reinvasion and so must be re-weeded as required. If weeding occurs adjacent to the regenerating area prior to sufficient new cover light from adjacent cleared patches can affect the regeneration of natives.

4. Cautiously move into the really bad areas.

When new growth coming up consists almost entirely of native plants with only a few weeds among them, it is safe to move deeper into the weeds. Keep working along the regeneration boundary, making new clearings smaller as the weeds get more dense.

Weeding Techniques

1. Disturb the soil as little as possible.

All tools used for weeding programmes should be small, such as a broad boning knife, trowels, secateurs, pliers (for pulling roots), loppers, hatchet and small saws. This recommendation is based on the belief that using small tools will cause minimum soil disturbance and minimal damage to the roots and shoots of nearby native plants.

2. Sweep back the mulch surface.

Any weeding will disturb the ground litter and soil will be exposed. Repair the damage as you go, by pushing back as much mulch as possible. It is often helpful to sweep aside mulch prior to removing large plants, so that it can easily be redistributed when you have finished removing the plant.

3. Mulch with the weeds themselves.

Weeds removed can be used to add to existing mulch. In dry areas leaving the weed with its roots exposed will be sufficient to kill it. In moist areas, hanging the weeds on nearby native vegetation will allow them to dry out and die. Some items are unsuitable for mulch, and these are removed from the site. Such items include bulbs and tubers, plants that root at every node and free-seeders with ripe seed.

4. Watch where you put your feet.

Be careful how you move through the bush. A small weeding party moving through thick bush single file can open up a track. Efforts should be made to not walk on the same paths all the time, and to watch where you walk to ensure you are not trampling native vegetation.

Herbicides

Usage

It is necessary that the application of herbicides be in accordance to labelling requirements or the manufacturers Materials Safety Data Sheet (MSDS) and must be undertaken by personnel trained in the use of herbicide chemicals. The application of any herbicide for purposes not specified on the labelling requires an Off-Label Permit from the National Registration Authority in Canberra.

The application of herbicides must also be in accordance with water catchment restrictions. Chemical based weed control strategies in particular must recognise potential adverse impacts on water resources such as lakes, wetlands, streams, rivers and dams. Clearly, significant control measures must be implemented in Public Drinking Water Sources Areas for the water we consume. The Department of Water's (DOW 2000) *Statewide Policy No.2 Pesticides in Public Drinking Water Sources Areas* will provide further advice on this matter.

Timing is crucial in having an effective impact on weeds. Generally, weed populations should be targeted when actively growing (ie usually in spring) to allow maximum uptake of the chemical, but before flowering, to prevent seed spread. In certain cases, this time window can sometimes be reduced to target weed species without harming native species (eg Many annual grass weed species flower before native grasses) (Hussey & Wallace 2003). However, it should be noted that the timing for the targeting of specific weeds presented in this report is an estimate only, as it can vary according to time of year of fire and the impact of fire on native vegetation and the soil seed bank.

It should also be noted that the herbicide treatments are a suggestion only and many were adapted from large scale agriculture rates. The types and rates of herbicides should be verified by a qualified weed scientist before any such methods are used on the wetland site.

Surfactants should not be used with the herbicide treatments near or in the wetlands. Many common herbicides such as Roundup® contain NPE surfactants which are known to affect the development of amphibian species such as frogs, which can lead to a decline or even loss of such fauna species (Mann 2000). Herbicides not containing NPE surfactants, such as Bioactive®, are strongly recommended.

Techniques

There are several recommended techniques in applying herbicides to weed species. These methods vary as to which is the most effective in treating certain weed species, depending on:

- form of weed (eg herb, shrub or tree)
- the size and distribution of weed populations in the area
- effectiveness in targeting the weeds without harming adjacent native plants.

Stem Injection

An easy method to kill large trees and shrubs is to drill a hole into the trunk at a 45 degree angle and to immediately fill the hole with herbicide. The hole must be deep enough to penetrate the sapwood to ensure the herbicide is absorbed and circulated within the plant. If the plant has multiple stems, then all stems will need to be treated ((Dixon & Keighery 1995).

Cut Stump

Some species may be controlled by cutting down to ground level and treating the stump with straight herbicide. Typical species suitable for such treatment are trees, shrubs and vines ((Dixon & Keighery 1995).

Wicker Wiping

Herbaceous weed species may be treated with herbicide by wicker wiping. This involves sponge or rope soaked in a concentrated herbicide solution which is wiped against the leaves of the plant ((Dixon & Keighery 1995). Wiping is often more effective in targeting weed plants and not harming adjacent native plants, however this process may be more labour intensive. Weeds most ideal for this treatment are small populations of small shrubs and broadleaf herbs.

Spot Spraying

Spot spraying involves fine spraying a weak solution of herbicide over the foliage of the weeds. Certain tree species may also be treated by spot spraying the bade of the trunks with herbicides diluted in diesel. Care must be taken to avoid spraying adjacent native plants. Use of selective herbicides may reduce impact of herbicides on native flora ((Dixon & Keighery 1995).

Table A6.1: Control Methods of identified weed species in Carine ROS

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Acetosa vulgaris	Sorrel	Annual	Difficult to control especially by digging because of its spreading tubers. Seeds can remain viable for up to 20 years. The weed species was formally named *Rumex vesicarius*. Native to Northern Africa, Middle East and India.	Manual removal is generally not recommended as the plants have extensive rhizomatous root systems. Attempts often lead to greater infestations. Mowing and grazing is ineffective. (1)	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 100 mL glyphosate (450ml/L) when plants have reached early bud stage(2) • 50ml glyphosate (450ml/L) in winter is reasonably effective but rarely achieves control (3) • 0.02g metsulfuron methyl (600g/ kg) (1 & 3) • In small areas, use 0.05g Oust® for residual control of seedlings and rhizomes (3) • 0.05g Ally® or Brushoff® (3)
Arctotheca calendula	Cape Weed	Annual	A common weed of pastures, crops and roadsides, but also quite common in disturbed bushland. Native of South Africa.	Manually remove small populations before flowering.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 2.5 g Lontrel®750 + 25 mL wetting agent applied in early growth stages will provide good control and is safe on many native species (1 & 2) • 10 mL glyphosate (450ml/L) is also fairly selective in bushland and roadside situations if applied when young or at the budding stage (2)
Asparagus officinalis	Asparagus	Perennial	Not sighted in the reserve in recent years (Woods per comm.). Possible this species is no longer present.	Manually remove small populations.		• No suggestions, try 100 mL glyphosate (450ml/L).
Avena barbata/ fatua	Bearded Oat	Annual	Occurs mainly in highly disturbed areas. Easy to control.	Manually remove individuals before seeding.		• 5 mL quizalofop (100g/L) **or** 8 mL Fusilade®Forte **or** 1 mL Verdict®520, plus 100 mL spray oil applied in winter before flowering will provide control with little effect on broad-leaved species (1 & 2) • 100 mL of glyphosate (450ml/L) in non-selective situations (2).
Briza maxima	Blowfly Grass	Annual	Widespread and common weeds of wasteland, granite rocks, wetlands and woodlands throughout South-western Australia. Easy to control.	Manually remove individuals before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 10 mL quizalofop (100g/L) + wetting agent at 3 – 5 leaf stage (1) • 10 mL glyphosate (450ml/L) in late winter to early spring before flowering (2) • 200 g Propon® + 25 mL wetting agent applied as above will provide some residual action (2) • 4 g Achieve® plus 10 mL Supercharge® oil will provide highly selective control and is applied between the 2 leaf and tillering stage of the grass in winter (2)
Bromus catharticus	Prairie Grass	Annual	Competes with natives. Fire hazard.	Manually remove individuals.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• In bushland situations, fairly selective control can be achieved with 0.1 g Eclipse® or 0.5 g Logan® plus 100 mL of spray oil. 10 mL Brodal® is often added to this mix to provide short term residual control of seedlings (2). • 100 mL glyphosate (450ml/L) prior to flowering (1 & 2)
Bromus diandrus	Brome Grass	Annual	Typically does not usually invade bushland.	Manually remove individuals.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• In bushland situations, fairly selective control can be achieved with 0.1 g Eclipse® or 0.5 g Logan® plus 100 mL of spray oil. 10 mL Brodal® is often added to this mix to provide short term residual control of seedlings (2). • 100 mL glyphosate prior to flowering (1 & 2)

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Carpobrotus edulis	Pigface	Perennial	Usually in bare or disturbed areas. Competes with native plants. Very difficult to control with herbicides.	Pull up and destroy (2). Roll up large mats removing all roots (shallow-rooted) and stem fragments. Follow with removal of any germinated plants (1) .		
Chenopodium album	White Goosefoot	Annual	Common around Perth in summer in irrigated row crops and wasteland. A very common weed of horticulture. Requires bare ground for establishment and persistence.	Highly susceptible to mowing before flowering. Manually remove individuals after elongation and before seeding in summer (2).		• In bushland areas, use 80mL 2, 4-DB (400g/L) or 0.5 Broadstrike® plus 50ml Uptake in early summer on young actively growing plants. A repeated application may be required in areas where summer rains induce late germinations (3).
Chenopodium ambrosioides	Mexican Tea	Perennial	Occurs in disturbed sites. Competes/ smothers native plants.	Manually remove small populations (use gloves)		• 100 mL glyphosate (450ml/L) at flowering time (1 &2). • 0.7 metsulfuron before flowering (1).
Chenopodium macrospermum		Annual	Occurs around the edges and in lake beds as they dry up in summer. Replaces native species.	Manually remove individuals after elongation and before seeding in summer.		• 100 mL glyphosate (450ml/L) at flowering time (1 &2).
Cirsium vulgare	Spear Thistle	Annual	Seedlings establish on open bare ground, can be displaced with native vegetation.	Mowing is not very effective because the plant tends to regrow from the rootstock. Manual removal is effective in small areas but unpleasant due to spiny nature of plant.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water can provide reasonable control. (1)	• 50mL glyphosate (450ml/L) provides effective control of seedlings and adult plants or 6mL Lontrel when plants are rosette or early flowering (1). • 4g Lontrel® 750 provides reasonably selective control in bushland (3).
Citrullus lanatus	Wild Melon	Annual		Hand pull small infestations and isolated plants. Remove melons from site and destroy.		• 20mL 2,4-D amine (500g/L) when actively growing (2).
Conyza bonariensis	Flaxleaf Fleabane	Annual	Common weed of roadsides and disturbed bushland in Perth. Produces large numbers of seed therefore difficult to control. In poor seasons can flower when only a few cm high.	Manually remove small populations before they spread. Hand pulling after stem elongation is effective on loose soils, but on heavier soils a weed fork is required to prevent the plant breaking and regrowing from the base.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 4 g Lontrel®750 plus 25 mL wetting agent can be used for fairly selective control in bushland (2) • Isolated patches can be sprayed with 50 mL Tordon®75-D for control of plants and residual control of seedlings (2)
Cynodon dactylon	Couch	Perennial	Mainly in highly disturbed areas. It is widely planted as a lawn grass and it invades wetlands and river edges in southern Western Australia. Competes with native species. It is native to the Kimberley and the tropics worldwide.	Shade out with black plastic during spring and autumn.		• 100 mL glyphosate (450ml/L) + 25 mL Pulse when the grass is actively growing provides the best control. Repeat every 8 weeks or when regrowth reaches about 5 cm tall (1 & 2). • Selective control can usually be achieved by spraying 16 mL Verdict®520 **or** 80 mL quizalofop (100g/L) **or** 125 mL Fusilade®Forte, plus 100 mL spray oil (2
Digitaria sanguinalis	Summer Grass	Annual	A very common garden weed in southern Western Australia	Manually remove individuals before seeding.		• 100 mL glyphosate (450ml/L) in spring (1)
Ehrharta longifolia	Annual Veldt Grass	Annual	Easy to control	Remove small populations by hand.		• 20 mL quizalofop (100g/L), **or** 32 mL Fusilade®Forte, **or** 4 mL Verdict®520, plus 100 mL spray oil before flowering stem emerges provides good control with little damage to broad-leaf species (1 & 2) • In non-selective situations 40 mL glyphosate applied up to flowering provides good control (2)

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Euphorbia terracina	Geraldton Carnation Weed	Perennial	It is a widespread weed of offshore islands, coastal dunes and sandy soils, Produces a very toxic and irritating milky sap when cut.	Manually remove individuals and small populations before seeding. Ensure to wear gloves to prevent expose to toxic sap.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	Spray large infestations spray with: • 0.07 g metsulfuron + 100 mL glyphosate (450ml/L) before flowering (1)
Ficus carica	Editable Fig	Perennial	Usually in disturbed areas. Replaces native Melaleuca species.	Remove seedlings and small populations	• Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2) • Cut trees to ground level and treat stumps with straight glyphosate (450ml/L) • Inject trunks of trees with 50 to 100% glyphosate (450ml/L) in summer.	• Spray regrowth with 100 mL glyphosate (450ml/L) (1)
Foeniculum vulgare	Fennel	Perennial	Common on road verges, wasteland and in disturbed calcareous wetlands. Can be difficult to eradicate. Seeds germinate throughout the year. Parent plants do not flower until the 2nd year.	• Manually remove seedlings before seeding. • If crown is cut below ground level plants rarely regrow(2).	• Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2) • Cut to ground and treat stumps with straight Roundup® (2)	• Spot spray with 150 mL glyphosate(450ml/L) or 0.7g metsulfuron on older plants just before flowering. Follow up on seedlings (1)
Fumaria capreolata	White Fumitory	Annual	Occurs mainly in highly disturbed areas. Large colonies suppress native flora.	Small populations can be pulled by hand, best when the plants are large but before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 0.1g metsulfuron (1) • 50 - 75 mL glyphosate (450ml/L) (1 & 3)
Fumaria officinalis	Fumitory		Large colonies suppress native flora. Mainly in highly disturbed areas. Spreads by suckering.	Small populations can be manually removed, best when the plants are large but before seeding	Suggest trying to wicker wipe with 1: 2 glyphosate (450ml/L) to water.	• No recommendations, suggest trying same methods as *F. capreolata* (above)
Gladiolus sp.	Gladiolus	Biennial	Dies back each summer to an underground corm. Gladiolus is often highly invasive although does not appear to displace native plants.	Manually remove flower heads of individuals to prevent seeding. Physical removal of entire plants is not recommended as it often results in spread of cormels.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water just on flowering when corm is exhausted.	As exact species is unknown, suggest trying common methods applicable for various *Gladiolus* species. • 100ml glyphosate (450ml/L) + 0.13g metsulfuron methyl(1) • repeat in the next season to target any seedlings emerging from cormels (3)
Hypochaeris glabra	Flat Weed	Annual	Common weeds of lawns, horticultural areas, roadsides and bushland throughout the south-west. Native to Europe, competes with native herbs especially in richer soils and disturbed areas.	Use a weed fork to extract the taproot if hand pulling before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 4 g Lontrel®750 + 25 mL wetting agent (1) • For small infestations 50 mL Tordon®75-D will control growing plants and leave a soil residual to control seedlings for 12 months (2) • 100 mL glyphosate (3)
Hypochaeris radicata	Flat Weed	Annual	Common weeds of lawns, horticultural areas, roadsides and bushland throughout the south-west. Native to Europe, competes with native herbs especially in richer soils and disturbed areas.	Use a weed fork to extract the taproot if hand pulling before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 4 g Lontrel®750 + 25 mL wetting agent (1) • For small infestations 50 mL Tordon®75-D will control growing plants and leave a soil residual to control seedlings for 12 months (2) • 100 mL glyphosate (450ml/L) (3)
Juncus articulatus		Perennial	A weed of disturbed wetlands.	No recommendations, suggest same treatment as for *Juncus acutus*. Difficult to dig out. Slash in winter treat regrowth in summer	No recommendations, suggest trying wicker wiping with 1: 2 glyphosate (450ml/L) to water.	• No recommendations, suggest trying 100 mL glyphosate (450ml/L)

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Lagurus ovatus	Hares Tail Grass	Annual	Competes with native plants. A common weed of sandy soils, especially near the coast.	Manually remove individuals. Prevent seed set for 2-3 years by mowing or cultivation.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 16 mL Fusilade®Forte + 100 mL spray oil applied before flowering will provide reasonable control in sensitive areas where there are seedling native or broadleaved plants. Rate can be reduced to 8 mL in winter when the grass has 2 – 8 leaves (1 & 2) • Alternatively, 5 mL glyphosate plus (450ml/L) applied in winter when the grass is in the vegetative stage will provide reasonably selective control in bushland (2) • Use higher rates for higher levels of control in non-selective situations (2)
Lantana camara	Lantana	Perennial	Prolific seeder. Releases chemicals in soil that inhibit germination of native seeds. A serious bushland weed in eastern Australia.	Small plants may be hand pulled. Larger plants are more difficult as the crown may fragment and root and stem pieces often regrow or are missed.	Cut to ground level and treat stump with neat glyphosate or 1:60 triclopyr to diesel (3).	• Foliar spray regrowth and small plants under 2 m tall with 150 mL glyphosate (450ml/L) when actively growing(1)
Lupinus cosentinii	Western Blue Lupin Sandplain Lupin	Annual	Mainly in highly disturbed areas. Competes with native plants. Nitrogen fixing legume.	Manually remove small populations before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• Small areas can be treated with 20 mL Tordon®75-D in early winter leaving a soil residual which will control lupin and other broadleaf seedlings for about a year (2). • In bushland, 4 g Lontrel®750 **or** 1g Logran® are relatively selective (1 & 2). • 0.1 g metsulfuron can also be used but is less selective (1 & 2). • Glyphosate is relatively ineffective (2)
Lythrum hyssopifolia	Lesser Loosestrife	Annual	It grows on disturbed, winter-wet soils. It may be native to eastern Australia.	Manually remove small populations before seeding.	No recommendations, suggest trying wicker wiping with 1: 2 glyphosate (450ml/L) to water.	• No specific recommendations, try spraying with 100mL glyphosate (450ml/L) .
Malva parviflora	Small Flowered Mallow	Annual	Occurs mainly in highly disturbed sites. Competes with herbs and small shrubs.	Manually remove small populations	Cut plant to ground and treat stump with straight glyphosate (450ml/L) .	• No specific information, suggest 100-150mL glyphosate (450ml/L) in early growth stages and when actively growing (3).
Medicago polymorpha	Burr Medic	Annual	A common weed of gardens, pastures and roadsides. So common it may not be practical to control it.	Manually remove individuals from site and destroy.		• For small infestations and grass dominant areas an annual application of 10 mL Tordon®75-D in early winter gives excellent control of existing plants and has residual activity to control later seedlings (2) • In bushland, 4 g Lontrel®750 + 25 mL wetting agent **or** 1 g Logran® + 25 mL wetting agent applied in early winter provides reasonably selective control (2) • 0.1 g metsulfuron + wetting agent (1&2)
Melilotus alba	Meliot	Perennial	Has been found on roadsides and wasteland from Carnarvon to Esperance.	Manually remove small populations.	No recommendations, suggest trying wicker wiping with 1: 2 glyphosate (450ml/L) to water.	• No specific information, try spraying with 50-75 mL glyphosate (450ml/L).
Melilotus indicus	King Island Meliot	Perennial	Has been known to be difficult to control in areas purely because of the large numbers present.	Manually remove small populations.	No recommendations, suggest trying wicker wiping with 1: 2 glyphosate (450ml/L) to water.	• No specific information, try spraying with 50-75 mL glyphosate (450ml/L) .

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Mentha suaveolens	Mint	Perennial	occasional garden escapes in wet habitats between Perth and Albany.	Manual remove individual plants, ensuring to collect all stem fragments, as they may resprout.		• No specific information, try spraying with 100 mL glyphosate (450ml/L) .
Oenothera sp.	Evening Primrose	Perennial	Occurs mainly in highly disturbed areas. May only be able to control in sheltered areas or away from dunes where erosion from wind is unlikely.	Manually remove individuals.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	As exact species is unknown, suggest trying common methods applicable for various *Oenothera* species. • Control in seedling stage, older plants relatively tolerant of herbicide (1 & 2) • 0.4 g chlorsulfuron plus 100 mL spray oil (1) • 1 g Logran® plus 100 mL spray oil (2) • 4L/ha 2,4-DB (400g/L) (2)
Orobanche minor	Lesser Broomrape	Annual	This is a parasite totally dependent on its host. Effects on natives unknown. Best to pull out. Do not using translocated herbicides such as Roundup® as this may kill the host.	Manually remove only		
Oxalis pes-caprae	Soursob	Perennial	A major weed of crops, pastures, orchards, gardens, roadsides, wasteland and disturbed native vegetation throughout the south-west. Competes with and smothers native plants forming large colonies. Toxic.	Manual removal very difficult as it requires all the soil surrounding the roots to also be removed to prevent spread of bulbils.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• 0.1 g metsulfuron or 0.2 g chlorsulfuron plus 25 mL wetting agent (2) • 100 mL glyphosate (450ml/L) (1 & 2)
Paspalum dilatatum	Paspalum	Perennial	A fodder grass, it is found in disturbed clay pans (and in natural ones, where it is a serious weed), swamps, lawns, verges and pastures from Kalbarri to Albany and also at the Ord River.	Cut out small populations – ensure rhizome removal.	Cut near ground level and wide with 1:10 glyphosate (450ml/L) to water.	• Spray adult plants with 100 mL quizalofop (100g/L) + wetting agent. Rate can be reduced to 10 mL when spraying seedlings (1) • 100 mL glyphosate (450ml/L) (2 & 3)
Paspalum distichum	Water Couch	Perennial	Weed of wetter disturbed sites. Competes with plants, particularly in disturbed areas	Cut out small populations – ensure rhizome removal.	Cut near ground level and wide with 1:10 glyphosate (450ml/L) to water.	• Spray with 100mL glyphosate (450ml/L) 2-3 times over growing season (1).
Pelargonium capitatum	Rose Pelargonium	Perennial	A garden plant which has become a weed in disturbed areas, particularly on sandy soils near the coast. Smothers small native plants. Colonises natural bare sandy areas, therefore destroys natural habitat of burrowing snakes etc. Native to South Africa.	Carefully pull plants of small populations in autumn/winter when soil is damp. Ensure to remove entire plant as plant will reshoot if stem is broken at or below ground level.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2) Repeat applications may be necessary.	• Suggest 0.5 g Ally® or Brushoff® or 100 mL glyphosate (450ml/L) (2) • 20ml 2,4-D amine (500g/L) provides reasonably selective control. Repeat applications may be necessary.
Pennisetum clandestinum	Kikuyu Grass	Perennial	Occurs mainly in highly disturbed areas. Naturalised in swamps and wetlands in the wetter south-west. Readily escapes from parklands into bushlands. Smothers native plants.	Rake and remove as much of the kikuyu thatch as possible. Cover the remaining kikuyu in June/July with black plastic held down with rocks or pegs. In summer remove the black plastic, control any live kikuyu runners and seed or plant with native species.	Not recommended.	• 100 mL glyphosate (450ml/L) when the grass is actively growing provides the best control. Repeat every 8 weeks or when regrowth reaches about 5 cm tall (1 & 2). • Selective control can usually be achieved by spraying 16 mL Verdict®520 **or** 80 mL quizalofop (100g/L) **or** 125 mL Fusilade®Forte, plus 100 mL spray oil (2).

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Persicaria sp.	Knotweed	Annual	It is possible that some non-native Persicaria species occur in the reserve. A detail survey is required to locate any identity such species.	Manual removal is usually difficult because plants tend to grow in heavy soil and break off at the base and regrow. Use a weed fork to extract the taproot if removing manually.	In bushland areas, wipe actively growing plants with a mixture of 1 L glyphosate (450g/L) plus 2 L water.	As exact species is unknown, suggest trying common methods applicable for various *Persicaria and Polygonum* species. • For small areas, 0.2 g metsulfuron (600g/kg) plus 100 mL Tordon®75-0 to actively growing plants before flowering (3). • For larger areas, 10 mL Spinnaker® will provide reasonably selective control of small actively growing plants and control seedlings for about a year (3). • 0.2 g metsulfuron(600g/kg) also provides good control (3).
Phyla nodiflora	Carpet Weed	Perennial	Often planted as a lawn, and has been recorded as naturalised in wetlands throughout Western Australia.	Try cutting out small populations with a knife.		No information on control given. Suggest using 100ml glyphosate (450ml/L).
Phytolacca octandra	Ink Weed	Perennial	Weed of disturbed areas, including creek lines, roadsides, poorly-managed paddocks and waste land where it is readily spread by birds. It contains a number of toxic compounds.	Best to grub out small populations, cut root at least 5cm below ground level.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• Single plants may be sprayed with diesel (3). • Small populations may be treated with 100ml Tordon® 75-D. This will control existing plants and has residual activity for control of seedlings (3). • Large populations may be controlled with 1g metsulfuron methyl (600g/kg). half of these rates will control seedlings (3).
Raphanus raphanistrum	Wild Radish	Annual	Weed of roadside and disturbed areas, does not usually invade bushland.	Manually remove small populations before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• In bushland situations, fairly selective control can be achieved with 0.1 g Eclipse® or 0.5 g Logran® plus 100 mL of spray oil. 10 mL Brodal® is often added to this mix to provide short term residual control of seedlings (2). • 100 mL glyphosate (450ml/L) prior to flowering (1 & 2)
Ricinus communis	Castor Oil Plant	Perennial	Common in disturbed sites, it is scattered on road and rail verges, wasteland, rubbish tips, rivers, creeks and wetlands.	Manually remove seedlings.	Cut plant to ground and treat stump with straight glyphosate (450ml/L) . Basal bark – triclopyr or Garlon® (spring-summer)	• 125 mL glyphosate (450ml/L) for large populations of seedlings (3)
Rumex crispus	Curled Dock	Annual	A weed of creek lines, pasture and disturbed woodland.	Remove individual plants by cutting their roots at least 20 cm below ground level.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water. (2)	• On small infestations 0.5 g chlorsulfuron plus 100 mL Tordon®75-D in winter will control existing plants and seedlings for about a year (2) • 100 mL glyphosate in early bud stage (1)
Solanum linnaeanum	Apple of Sodom	Perennial	The stems, branches, leaves and calyces are all spiny. It is a common weed of wasteland and grazed woodlands and creek lines on the Swan Coastal Plain.	Manually remove seedlings, ensuring to wear gloves.		• Spray with 120ml amitrole (250g/L) until bush is thoroughly wet.
Solanum nigrum	Black Nightshade	Annual/ Perennial	Common weed of horticulture, gardens, pasture and waste land it is readily spread by birds into bushland. Shade reduces seed production.	Manually remove small populations before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water.	• On large infestations, 20 mL Starane®, applied when the weed is actively growing in summer will provide reasonable selective control (2) • 20 mL 2,4-D amine (500g/L) can also be used for the control of young plants in early summer and at these rates cause little damage to most established native species (2)

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Sonchus asper	Prickly Sowthistle	Annual	A common weed of pasture and waste land, but also invades bushland particularly in damp areas.	Manually remove isolated plants or graze the area to prevent seed set for several years.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water.	• 10 mL Lontrel®300 + 25 mL wetting agent applied at rosette stage (1) • 50-75 mL glyphosate (2 & 3) • 80 mL 2,4-DB (400g/L)+ 25 mL wetting agent will provide reasonable selective control in bushland (2)
Sonchus oleraceus	Common Sowthistle	Annual	A common weed of pasture and waste land, but also invades bushland particularly in damp areas.	Manually remove individuals before seeding.	Wicker wipe with 1: 2 glyphosate (450ml/L) to water.	• 10 mL Lontrel®300 + 25 mL wetting agent applied at rosette stage (1) • 50-75 mL glyphosate (450ml/L) (2 & 3) • 80 mL 2,4-DB (400g/L)+ 25 mL wetting agent will provide reasonable selective control in bushland (2)
Stenotaphrum secundatum	Buffalo Grass	Perennial	Planted as a lawn grass, it is a weed of riverine edges, swamps and road verges. Because of its dense growth habit, it can smother herbaceous species.	Rake the grass out of the rushes and roll back out of the rushes with a small amount of digging. Remove as much of the buffalo grass thatch as possible. Cover the remaining buffalo grass in June/July with black plastic held down with rocks.		• 100 mL glyphosate (450ml/L) when the grass is actively growing provides the best control. Repeat every 8 weeks or when regrowth reaches about 5 cm tall (1 & 2). • Selective control can usually be achieved by spraying 16 mL Verdict®520 **or** 80 mL quizalofop (100g/L) **or** 125 mL Fusilade®Forte, plus 100 mL spray oil (2).
Symphyotrichum squamatum	Bushy Starwort	Annual/ Biennial	Usually in disturbed areas. Difficult to control as it produces so much seed. Often seen growing in lawns, where it still manages to seed.			• No suggestions, try 100 mL glyphosate (450ml/L) .
Tamarisk aphylla	Tamarisk	Perennial	Commonly planted as a shade tree in arid areas. It can spread from the plantings when broken branches take root and if the trees are fertile, masses of seedlings are also produced	Hand pull seedlings. If removing established trees using loaders, tractors, excavators etc, ensure the entire crown and tap root to at least 1m is removed	Inject into root crown – neat glyphosate Cut and paint – 30% triclopyr (ie Garlon®) or Access® 17 mL/L in diesel	• Basal bark - Access® 17 mL/L in diesel applied to the lower 30 cm of trucks can be used to individual trees • Spray regrowth and seedlings once 1 m tall with 100 mL Garlon®
Trifolium sp.	Clover	Annual	Mainly in highly disturbed areas. Clovers are usually so abundant it is often only practical to control them in lightly infested areas.	Manually remove small populations		As exact species is unknown, suggest trying common methods applicable for various *Trifolium* and *Medicago* species. • For small infestations and grass dominant areas an annual application of 10 mL Tordon®75-D in early winter gives excellent control of existing plants and has residual activity to control later seedlings (2) • In bushland, 4 g Lontrel®750 + 25 mL wetting agent **or** 1 g Logran® + 25 mL wetting agent applied in early winter provides reasonably selective control (2) • 0.1 g metsulfuron + wetting agent (1&2)

WEED SPECIES				CONTROL RECOMMENDATIONS		
Scientific Name	**Common Names**	**Life form**	**Comments**	**Manual Control**	**Wicker Wipe/ Cut Stump**	**Spot Spray @10L water + 25mL surfactant** (1) (2) (3)
Typha orientalis	Bullrush	Perennial	*Typha orientalis* is native to eastern Australia while native Typha (*T. domingensis*) is native to Western Australia. Both species are aggressive colonisers of disturbed wetlands and compete with other native plants. The species can be difficult to correctly identify, especially as it is known to hybridise. Fire hazard.	Difficult to dig out even small populations and reinfestation can be rapid. Ensure all the rhizomatous root is removed. Remove flowers, seed source. Cut stems below water level in summer or just prior to recharge of wetland, plants then rot. Repeated cuttings in growing season (summer) will kill plants. Remove cut material.	Hard to get at to wipe, but try wiping with a high rate of Roundup Biactive® (eg 1 to 10 water). Slash plants first and wipe new growth when leaves approximately 1m high(3).	100-30mL Roundup Bioactive® after the male flowers have opened and before the female flowers have expanded. (1 & 3) Better results when not stood in water, wait if possible for water level to recede.
Vitis vinifera	Grape Vine	Perennial	Garden escape plant. Tends to occur near creeks, river banks and lake margins.	Remove small seedlings	Cut to ground level and treat with straight glyphosate (450ml/L)	No specific information available relating to herbicide control, suggest spot spraying regrowth with 100 mL glyphosate (450ml/L).
Zantedeschia aethiopica	Arum Lily	Perennial	A common and widespread serious weed, particularly of damp areas but also invading drier sites. The berries are spread by birds.	Mechanical removal is only effective if all the root fragments are removed.		• 0.3g metsulfuron or chlorsulfuron, higher concentrations in a one litre hand held sprayer applying a single squirt to leaves avoids off target damage (1) • 1 g chlorsulfuron plus 10 mL 2,4-D amine (500g/L)(2) • 1 g metsulfuron (2) • glyphosate is relatively ineffective (2).

Table A6.2: Summary of Herbicide information

Herbicide Brand	Type	Active ingredients
4Famers® Chlorsulfuron 750	B	75% chlorsulfuron w/w
4Farmers® 2,4-D amine	I	50% 2,4-D amine w/w
Access®	I	50% 2,4-D amine w/w
Achieve®	A	40% tralkoxydim w/w
Agriliance®	I	50% 2,4-D amine w/w
Agroxone®	I	50% 2,4-D amine w/w
Ally®	B	60% metsulfuron w/w
Amitrole®	F	50% 2,4-D amine w/w
Broadstrike®	B	80% flumetsulam w/w
Brodal®	F	50% diflufenican w/w
Brushoff®	B	60% metsulfuron methyl w/w
Eclipse®	B	10% metosulam w/v
Fusilade® Forte	A	12.8% fluazifop-P w/v
Garlon®	I	71.7% triclopyr butoxyethyl ester, 20% diethyl gycol monoethyl ester w/v
Glean®	B	75% chlorsulfuron w/w
Logran®	B	75% triasulfuron w/v
Lontrel®	I	59.1% clopyralid w/w
Oust®	B	56.25% sulfometuron methyl, 15% metsulfuron methyl w/v
Propon®	J	74% 2,2 DPA w/w
Roundup Bioactive®	M	36% glyphosate w/v
Roundup®	M	36% glyphosate w/v
Spinnaker®	B	24% imazethapyr w/v
Starane®	I	30.3% fluroxypyr methylheptyl ester w/v
Supercharge®	G	24% carfentrazone-ethyl w/v
Targa®	A	10.3% quizalofop-p-ethyl w/v
Titan® Metsulfuron 600	B	60% metsulfuron methyl w/v
Tordon® 75D	I	47.2% 2,4-D TIPA, 7.5% picloram TIPA w/v
Triclopyr® 600	I	60% triclopyr w/v
Verdict® 520	A	48% haloxyfop r-methyl ester, 43.4% diethylene glycol monoethyl ether w/v

Appendix Seven: Plates

Plate 1: Fauna tunnel linking southern end of Carine ROS under Reid Hwy

Plate 2: Visual clutter of signs at Carine ROS

Plate 3: Vandalised sign in Carine ROS

Plate 4: Bench seat without shade facing screen of shrubs

Appendix Eight: Public Comments

Carine ROS Environmental Management Plan

Table A8.1: Responses to Public Comments on Carine ROS Management Plan

	Comment	Response	Where Amended
1	**Heather and David Rowe**		
1.01	The drain at the corner of Beach and Duffy Roads has allowed silt to build up and form a dam from the parkland to the island on the little Carine Lake. Vegetation and small trees have taken root and there is now easy access to the island, increasing the possibility of vandalism, arson attacks and disturbance to wildlife on the island. This needs urgent attention (before rain) to remove the sandbar and vegetation and to allow the water to flow freely around the island. This would also reduce the incidence of algae and stagnant water in the lake.	Issue has been included in report. A recommendation has been made to remove the sandbar to prevent access and protect wildlife.	Section 6.3.3 pg 47 Section 6.3.4 pg 50 Section 6.3.5 pg 51
1.02	The outlet stream which used to run between the two lakes has not had any water in it for several years and it is badly degraded. The beautiful willow trees which were in this area were removed and replaced with native shrubs which have since died and the area is now an eyesore covered in weeds. We note in the Master plan that there is a proposal to improve this area, plus the bridge and we request that this is given high priority.	The report already recommends to improve the drainage and to be revegetated and converted as part of the Conservation Zone. Text shall be added to recommend that this particular area be revegetated.	Section 6.5.4 pg 60
1.03	Bull rushes have completely overtaken the large lake and there is very little open water left for the water birds to inhabit. This is also a very high fire hazard and the bull rushes should be replaced with native sedges and reeds as soon as possible, or the park will lose the native fauna from this area.	Already discussed and recommended in Section 6.6.4. This point has been reiterated in Section 6.10.4 (Fire Prevention).	Section 6.10.4 pg 75

1.04	White corellas seem to have taken over residence of the R.O.S. and are now in plague proportions. They are in huge flocks and decimate the trees and lawns in the park and the neighbouring gardens and are becoming a nuisance. This must have affected the native species of birds and we have noticed a drop in the native wattle birds, willie wagtails and pardolotes which usually can be seen in the bushland areas of the park, nor have we seen any 28 parrots for some time. We would appreciate some action if at all possible.	Mentioned in Section 4.3.1 (Native Fauna: Overabundant Fauna). Text has been added on how this species is non-local and a pest and how the City is currently within with DEC to control Corella population numbers	Section 4.3.1 pg 29
1.05	We have concerns that at least one tree in the parkland opposite 86 Monyash Road has dieback and we attach a photo for your records.	The Tree has been referred to the relevant area of the City for their attention.	None
1.06	Number 9.3 of the Master plan states that the public has been informed of the threat of dieback and that residents have been instructed how to minimise the risk. We have lived in Monyash Road, bordering the R.O.S. for nearly 26 Years and have received no such instruction. We have also not noticed any special measures shown by your gardeners when entering or leaving the park to prevent the spread of diseases such as dieback.	The "General Public" paragraph under 6.9.4 has been expanded to discuss how the public may minimise the risk and on how City works are minimising the risk.	Section 6.9.4 pg 73
1.07	We have not received any fire prevention education as stated in 6.10.4 of the management plan.	The wording in the report recommends that it should be done, it does not state that it has been done. Fire prevention/ preparation education is part of the plan being approved and should happen.	None

1.08	We have noted your intention to install a boardwalk across the large Carine Lake to observe the water and the birds. We feel that this would not be necessary and a waste of Ratepayers money as there is never any water in this lake. If a boardwalk was installed it would be a short cut to the skate park and would encourage vandalism and possible arson attacks on the rampant bullrushes in the lake. There would also be no area left for birds to escape from human intervention.	Construction of the boardwalk is up to the City to decide upon.	None
1.09	We would request high priority be given to the installation of toilet facilities near the children's playground and barbeque area off Okely Road. The nearest toilets are on the corner of Beach and Okely Roads, which are a very long walk from the playgrounds. Consequently, we have observed many parents taking their little children into the bushland near the big Lake, which is un-hygienic and an inconvenience to others using the park.	Toilets near playgrounds are not generally recommended due to an increase in undesirable behaviours and safety to children. The report has been amended to state that the City should decide whether or not to include toilets near the playgrounds, taking into account that the recommendations of the 2003 Master Plan has a contrary view.	Section 6.11.3 pg 83 Section 6.11.4 pg 87
1.10	We would urgently request that more trees are planted in all areas of the R.O.S., especially north of the pumping station off Okely Road. This was badly burnt several years ago and the melaleuca trees have not recovered. We recommend that this area is replanted with similar native trees to improve the appearance of this degraded and scruffy area.	A small list of suggested areas to be revegetated has been added, including the area north of the pumping station.	Section 6.5.4 pg 60

1.11	We live opposite the car park for the disabled riding centre and we are regularly disturbed by hoons doing burn outs in the centre of the car park, especially late at night. We have previously requested that this car park is closed at night but this request has been denied, so we wonder if it would be possible to erect traffic islands in the centre of the car park to deter this anti social behaviour?	Report now includes a recommendation that some infrastructure could be installed to deter antisocial behaviour, such as gates or traffic islands. It will be up to the City to determine what measures/ infrastructure should be put in place to deter this antisocial behaviour	Section 6.11.3 pg 60
1.12	We feel that the dog control in the R.O.S. has lapsed and there are quite a large proportion of owners not "picking up" after their animals, and dogs are allowed to run into the lakes and disturb the water birds. We realise that this is difficult to police but the presence of park rangers would alleviate the problem.	The City endeavours to undertake frequent patrols in the area	None
2	**Phyllis Robertson**		
2.01	Page x 6.1 - "promote local" etc	Already corrected	None
2.02	Page xi - East side of lake need not be reticulated	Presumption that the area mentioned is the east side of Little Carine Swamp, which is currently part of the Recreation Hydrozone (Moderate priority to be irrigated, Map 5). This area has been suggested to downgraded to a Parkland Hydrozone (Lowest Priority).	Section 6.3.4 pg 49
2.03	Page xi - Understorey in the transition zone needs revegetation, not landscaping	Wording of report emphasises that landscaping shall only occur in parklands, and that revegetation shall only occur in conservation areas.	None
2.04	Page xi - North dampland needs management – many weeds last season eg Scotch Thistles (*Cirsium vulgare*)	Area is part of the annual weed programme, as discussed in the Weed Strategy	None

2.05	Page xi - Island in lake needs revegetating with local native species – remove Callistemons etc	The island has been added to list of suggested areas to be revegetated (see point 1.10)	Section 6.5.4 pg 60
2.06	Page xi - More wetland species eg. Rushes on the eastern side of Little Carine lake	The island has been added to list of suggested areas to be revegetated (see point 1.10)	Section 6.5.4 pg 60
2.07	Page xi 8.9 - Surely a Riding School responsibility	Already corrected	none
2.08	Page xi 9.1 - Hygiene needs policing	City cannot police hygiene, only provide facilities to minimise hygiene problems. This issue is now discussed in the report.	Section 6.9.4 pg 72
2.09	Page xi 10.9 - Prevent fires in the first instance should be a priority	Comment does not relate to Section. Fire Prevention and preparation management has been already been recommended.	None
2.10	Page xi 11.4- Extra lighting can disrupt normal wildlife behaviour.	Text has been added to: • discuss that extra lighting may disturb wildlife behaviour • recommend that lighting installation should consider how to minimise this impact (eg less lights, less powerful lights, face away from vegetated areas into parklands)	Section 6.11.4 pg 87
2.11	Page xi 11.6 - It could be better to keep walking and cycling separate for safety reasons	Already discussed in report (Section 6.11.4)	None
2.12	Page xi 11.8 - Although this appears to be a good idea, in the final analysis it will probably will disrupt and disturb the wildlife diversity	Comment is noted. The report has been amended to state that the City will endeavour to ensure no disturbance will result the wetland ecology.	Section 6.11.4 pg 84
2.13	Page xi 11.10 - Care needs to be taken to ensure only local provenance and plant communities is used.	Already stated in report.	None

2.14	Page xii 11.14 - Surely a high priority to keep signs clean to reduce vandalism	City has currently chosen a moderate priority rating.	None
2.15	Page xii 11.18 - As above	City has currently chosen a moderate priority rating.	None
2.16	Page xii 11.19 BBQ facilities – leads to increased litter and possible vandalism – possibly low?	City has currently chosen a moderate priority rating.	None
2.17	Page xii 11.22 - Positioning is important	Refers to disabled toilets. The report has been amended to state that the City should consider where to position the toilet in the reserve.	Section 6.11.4 pg 87
2.18	Page xii 12.3 - Need to consider the ecological impact before implementing – could be environmentally adverse. See comment on page 2 of document.	"the multiple uses of the Reserve risks impacting on its long term sustainability and value" is underlined on page 2. Text has been added to discuss that the City should consider the impact of enabling schools and local community accessing the site as part of education excursions. (eg - Such excursions should be conducted in a manner that does not impact on and degrade the environmental values)	Section 6.12.4 pg 90
2.19	Page 3 – "Aims and Objectives" should be paramount with all management decisions and the public should be made aware of these	The listed Aim and Objectives have be integral in all management decisions throughout the report.	None
2.20	Page 7 – "A key focus is to protect the more common natural areas rather than the rare and threatened" needs always to be kept in mind with all management decisions.	The protection of common natural areas have be integral in all management decisions throughout the report.	None
2.21	Page 10 3.3.2 - "Water can be directed out to the ocean through an underground pipe from Big Carine Swamp". Is this necessary in a drying climate, or should an alternative management strategy be sought in these differing circumstances?	Text has been included to mention that this pipe already exists and is for the remote case of flooding from heavy local rains.	Section 3.3.2 pg 11

2.22	Page 11 – "Total nitrogen…" etc Could this have resulted from the sewerage spill? Could this have been prevented?	Text has been added to mention that the Water Corporation needs to install sewerage tanks to prevent further spills into the wetlands. Installation of sewerage tanks shall be added as a high priority recommendation.	Section 3.3.2 pg 12 Section 3.3.2 pg 42 Section 3.3.3 pg 49 Section 3.3.4 pg 50 Section 6.3.5 pg 51
2.23	Page 12 – "The extraction of groundwater…" etc. doesn't appear to be very logical – in fact the sentence appears to be contradictory.	The sentence has been rewritten to explain better the difference between the bore/ground water and metropolitan aquifer.	Section 3.3.3 pg 13
2.24	Page 14 table 6 – "Fence to limit…" etc. How would this impact on the swamp tortoise egg laying migrations?	Text has been added to explain that this table is a summary of standard CCW management recommendations from WAPC, and are not mandatory requirements. .	Section 3.4.2 pg 15
2.25	Page 14 - "Fire control to maintain…" etc. Is this a proven technology on the Swan Coastal Plain, or is it a failed technology? I think the latter.	Text has been added to explain that this table is a summary of standard CCW management recommendations from WAPC, and are not mandatory requirements. .	Section 3.4.2 pg 15
2.26	Page 18 Table 9 – There is no Flooded Gums at Star Swamp.	Table 9 refers to vegetation complexes, which include typical vegetation within each complex. One of the typical vegetations listed is "Flooded Gum – Melaleuca woodlands fringing lakes", which is just a general description. Star Swamp may not have Flooded Gum, but it does have Melaleucas fringing the wetlands. Text has been added to the report to explain this.	Section 4.1.2 pg 20
2.27	Page 22 4.2.2 Weeds – Some Persicaria have been on and off the weed list quite regularly, this list might need updating by an experienced botanist.	Already discussed and recommended in Section 6.4.	None

2.28	Page 25 Reptiles – Possible should be "feral/ domestic cat" as many domestic cats frequent the reserve and predate a variety of wildlife.	Have already amended sentence from feral to domestic cat.	None
2.29	Page 27 – Chuditch and Graceful Sunmoths have not been sighted on this reserve recently.	It was stated on page 29 that it is very unlikely that the Chuditch is in the Reserve. Also, it requires a proper site assessment in the right time of year and weather conditions to determine whether the Graceful Sun Moth is in the Reserve (which was recommended).	None
2.30	Page 31 – "Domestic pigeons…" etc. Possibly should add "and spread feather mite disease"	Already added.	None
2.31	Page 33 4.4.3 – All contractors who need to access the reserve should also know of disease risks and prevention measures, including the lawn mowing teams.	This item has been added to the report.	Section 6.9.4 pg 73
2.32	Page 35 5.0 – it is my understanding that all wetland areas require Section 18 assessment these days.	Only sites that have registered heritage sites require Section 18s, regardless of whether it is a wetland.	None
2.33	Page 45 6.2.1 – Does this include Potential Acid Sulphate Soils? (PASS)	Already added	None
2.34	Page 45 6.2.2 – Should Bushland and Restored Bushland be included?	As shown on Map 3, AASS and PASS may only occur in wetland zones.	None
2.35	Page 45 6.2.4 Site Works – after "ASS" insert "PASS"	Already added	None

2.36	Page 45 Big Carine Swamp – are the following dot points compatible with conservation aims?	Installing boardwalks, bird viewing platforms and hides and arts/ sculptures may not be assisting in conservation, but if done correctly (ie as in this section, not disturb any sites with ASS), it should not impact on conservation and can enhance recreation and education. Also, the public can be educated and encouraged to have more ownership and responsibility of the Reserve.	None
2.37	Page 45 Typo "Prove" = "provide"?	Already corrected	None
2.38	Page 45 Small Carine Swamp – is the first dot point compatible with the conservation aims?	Same as 2.36	None
2.39	Page 46 6.2.5 – Should this include "Potential Acid Sulphate Soils"?	Already added	None
2.40	Page 47 6.3.2 – Should this include "natural and reconstructed bushland"?	Report states that only the irrigated areas in the Transition and Bushland zones are included, as the areas may be irrigated as part of the revegetation process.	None
2.41	Page 48 Identify Ecozones – Should "in their plant communities" be added after (Map 10)?	Already added	None
2.42	Page 50 6.4.3 Priority Weed Species = "The location" etc see comment on page 22. 4.2.2	Already discussed and recommended in Section 6.4.	None
2.43	Page 51 Weed Control Methods – "As such…" etc should be policy	Text has been added to discuss City's practices when using herbicides in both terms of public health and environmental health.	Section 6.4.4 pg 55
2.44	Page 51 Monitoring Weeds – typo – "of" could be "after"	Word has been changed to "or"	None

2.45	Page 51 6.4.4 Weed Surveys – Caltrop (*Tribulus terrestris*) is a summer weed usually January, after rain, until March or maybe even latter	Caltrop has not been listed any information provided. A weed survey has already been recommended to update the weed flora inventory, which the control strategy (including optimal time of year) shall be adjusted accordingly	None
2.46	Page 56 Ecozones – Need to follow natural plant communities rather than landscaping when considering each of the management zones, especially where the lawn are removed.	Already discussed in 2.03 above	None
2.47	Page 57 – 6.5.4 Strategy – as above for Ecozones	Already discussed in 2.03 above	None
2.48	Page 58 Infill Planting – Map 10 "Appendix Three" should be "One" I think.	Already corrected	None
2.49	Page 61 Wetlands – "Bulrush" has two different spellings.	Already corrected	None
2.50	Page 63 6.7.3 Significant Fauna – Chuditch and Graceful Sunmoth have not been sighted recently on this reserve.	Already discussed in 2.29 above	None
2.51	Page 64 Public Actions (last part of 6.7.3 previous page) Under point 2 another dot point could be added. "Contributes to aggressive behaviour"	Dot point has been added	Section 6.7.3 pg 66
2.52	Page 65 6.7.5 Recommendations – add "7.5 Educate the public as to how to live with magpies. High – City of Stirling"	Dot point and recommendation has been added	Section 6.7.4 pg 67 Section 6.7.5 pg 67
2.53	Page 75 Post fire recovery – the dot point "too damaged" to "damaged" typo	Already corrected	None
2.54	Page 80 Infrastructure – "four issue in" "issues" typo	Already corrected	None
2.55	Page 81 6.11.4 Parking – last sentence is incomplete.	Already corrected	None
2.56	Page 82 – Recommend at the top of the page does not appear to support "ecological sustainability"	Already discussed in 2.36 above	None

2.57	Page 82 2nd paragraph – there may be an opportunity to create a series of boardwalks, but in view of "aims and Objectives" on page 3, I do not believe that such actions are supportive of "ecological sustainability"	Already discussed in 2.36 above	None
2.58	Page 82 Signage – The first paragraph is what we'd hope to happen, but it seldom does.	Paragraph has been reworded to state that the City envisages that the signs may help encourage public interest, not that it will encourage public interest.	Section 6.11.4 pg 84
2.59	Page 83 – First series of dot points, as it concludes could provide opportunities for vandalism, but managed well, could contribute to the "Aims and Objectives" on page 3	Comment noted	None
2.60	Page 83 – Infrastructure 2nd paragraph last sentence – "Any new" etc" will require, may not "require". The last paragraph on this page appears to be theoretical and not evidence based.	Paragraph has been removed.	Section 6.11.4
2.61	Page 84 First paragraph – great in theory, but not in practice and is far from evidence based.	Comment noted	None
2.62	Page 84 6.11.5 – 11.2 High, 11.6 Low often better separate, 11.8 Low, 11.14 High – to prevent/ discourage further vandalism, 11.18 High, 11.19 Low	City has currently decided final priority ratings on recommendation table in Section 6.11.5.	None
2.63	Page 86 4th paragraph – "bird hatches" is this a correct word or should it be "bird hides"?	Entire page has already been rewritten and "bird hatches" has been changed to "bird watching facilities"	None
2.64	Page 86 5th paragraph – "educational nodes…" etc theoretically a good idea, but not evidence based and in practice, often an expensive failure.	Comment noted	None

2.65	Pages 110, 111, 112, 113 – List could have some modifications as recorded.	Comment relates to minor typos/ corrections. Species names have been corrected, species cannot be changed without being given information from City that can verify its presence (eg will not add *Baumea preissii*)	Appendix 4
2.66	Page 123 Herbicides Usage third paragraph 2nd line – Typo – "target" = "targeted"	Already corrected.	None
2.67	Page 135 Plate 4 - Sometimes bird watchers like seating positioned like this, but in the shade.	Text has been added to mention that bird watchers may like seating facing the vegetation.	Section 5.3.4 pg 39