



**CITY OF COCKBURN  
NATURAL AREA  
MANAGEMENT STRATEGY  
2012 –2022**

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## SUMMARY

The purpose of this Natural Area Management Strategy is to outline the approach used to manage the Cities vested natural areas and to build and enhance Council's capacity to effectively manage our natural areas for the conservation of biodiversity. The ultimate goal is for all of the Cities natural areas to have a vegetation condition rating of good or better based on the Keighery 1994 definition of vegetation condition.

Presently the City of Cockburn has management responsibility for more than 82 separate bushland reserves, many of which contain wetlands. The total area contained within reserves is approximately 1091 hectares. Most of the larger reserves containing vegetation are under active management. The smaller reserves generally contain small pockets of poor quality bushland and current resources are not adequate to actively manage these smaller pockets. It is expected that more public open space which, in line with Councils Bushland Conservation policy, increasingly contains good quality bushland will be handed to Council in future years.

Total Area of Reserves Containing Bushland	1091
Total Area of Bushland in Conservation Reserves	904
Area of Bushland in Actively managed Conservation Reserves	896
% Bushland in Actively Managed Conservation Reserves	91
% Bushland in Non Actively Managed Conservation Reserves	9
Number of Actively Managed Reserves	48
Number of Non Actively Managed	34

To maintain the quality of our natural areas it will be necessary to undertake frequent and effective maintenance and monitoring. A reduction in bushland condition would be deleterious to native fauna and flora, suburban amenity, impact on carbon sequestration and not be aligned with community expectations.

It is important that our natural areas are prioritised for management and allocated appropriate resources. A prioritisation system has been developed to evaluate the 'importance' of our natural areas to ensure that resources are expended in a cost effective manner.

Bushland condition assessments are undertaken annually in natural areas. This allows areas to be prioritised into three management categories; High, Medium and Low Priority reserves.



Little Rush Lake

The following table shows the categories of bushland condition and the number of hectares within each category for all reserves actively managed by the City as at July 2012.

**Table 1. Vegetation Condition**

<b>Bushland Vegetation Condition</b>	<b>Hectares</b>	<b>Percentage of Bushland</b>
Pristine	0	0
Excellent	59	7
Very Good	317	35
Good	225	25
Degraded	113	13
Completely Degraded	182	20
<b>Total</b>	<b>896</b>	<b>100</b>

It is envisaged that future management strategies will enhance the overall condition of the existing bushland with the ultimate long term goal of upgrading the overall condition of Councils natural areas to a minimum vegetation condition rating of good or better based on the Keighery 1994 definition of vegetation condition. Vegetating ratings are further explained in Section 4.

The main threats to our natural areas are considered to be environmental weeds, feral animals, illegal access, illegal rubbish dumping, increased fire frequency, disease such as dieback, untreated storm water and climate change.

A series of management actions have been identified for each of these issues and future funding requirements have been noted.

The main components of future funding requirements include increasing operating expenditure; increasing staff resources; projection of extra funding required for effective management, management of additional natural areas as the City continues to develop and increased level of maintenance in line with community expectations.

Implementation of this strategy will provide long-term benefits to the City through the following areas:

- Economic benefits: The cost of managing existing issues will continue to grow if left unchecked and therefore, it is more cost-effective to implement actions in the short and medium rather than long term.
- Increased public amenity: Through enhancement of bushland condition and provision of access points and trails.
- Meet public expectations for bushland management: Through more intensive maintenance regimes.
- Conservation of biodiversity by the protection and enhancement of natural areas.
- Maintain genetic diversity: Through the creation of bushland corridors and enhancement of habitat.
- Offset greenhouse gas emissions: Revegetating degraded areas captures and stores carbon.
- Retain the uniqueness of the City of Cockburn: By retaining, conserving and enhancing our unique natural areas.
- Reducing bushfire risk: By reducing the amount of weeds and thus the fuel loads.

- The management approach outlined in this strategy will enhance the overall condition of the existing bushland with the ultimate long term goal of upgrading the overall condition of Councils natural areas to a minimum rating of good.

#### **SUMMARY OF KEY ACTIONS**

- 1.** Prioritise reserves based on the following aspects: Vegetation condition, size, shape, perimeter to area ratio, connectivity, visibility and community involvement. (KA1)
- 2.** Re-assess reserve prioritisation every 8 years. (KA2)
- 3.** Map the priority weeds and the vegetation condition in all bushland reserves every 4 years. (KA3)
- 4.** Develop and implement a Weed Control Strategy. (KA4)
- 5.** Review and update the Priority Weed Control List every 5 years. (KA5)
- 6.** Prepare and implement a works programme to manage priority weeds in bushland reserves. (KA6)
- 7.** Develop revegetation programs following weed control programs where required. (KA7)
- 8.** Assist and encourage volunteers such as community “friends of” groups, Conservation Volunteers Australia and educational institutions to participate in bushland management activities within bushland areas managed by the City. (KA8)
- 9.** Provide support and assistance to community volunteer groups that undertake bushland management activities within bushland areas managed by the City. (KA9)
- 10.** Offer incentives, training, and information to landowners to encourage management of natural areas on private property. (KA10)
- 11.** Work with internal staff, contractors and the community to ensure that construction activities minimise the spread of weeds. (KA11)
- 12.** Encourage, support and where practical, be involved in weed control trials with agencies and educational institutions. (KA12)
- 13.** Adopt the principles of the Bradley Method of Bush Regeneration wherever possible when planning and implementing weed control work. (KA13)
- 14.** Instigate feral animal control programs in areas where feral animals are known to exist. (KA14)
- 15.** Assess the viability of installing rabbit proof fencing around high priority reserves. (KA15)

## **SUMMARY OF KEY ACTIONS CON'T**

- 16.** Construct appropriate fences around conservation reserves to prevent and control unauthorised access. (KA16)
- 17.** Undertake fence repairs within 2 working days of notification of damage. (KA17)
- 18.** Work with other local governments and government agencies with the aim of developing and implementing a regional feral animal control program. (KA18)
- 19.** Erect signage at entry points to reserves that provides information on the impact and safety issues associated with illegal access. (KA19)
- 20.** Remove rubbish from conservation reserves as early as practical. (KA20)
- 21.** Develop a community education program that includes a component about the impacts of illegal dumping. (KA21)
- 22.** Ensure there are adequate firebreaks that comply with the Bush Fires Act around the perimeter of all conservation reserves and fire access trails strategically located through larger reserves. (KA22)
- 23.** Utilise herbicides where practical rather than grading to keep firebreaks free from vegetation and loose sand. (KA23)
- 24.** Ensure verges adjoining reserves are free from weeds. (KA24)
- 25.** Prepare Bush Fire Response Plans for all conservation reserves and review every three (3) years. (KA25)
- 26.** Assess the suitability and appropriateness of prescribed burning to reduce high fuel loads in reserves. (KA26)
- 27.** Liaise with government agencies such as FESA and DEC in relation to best practice fire risk reduction and suppression. (KA27)
- 28.** Staff and contractors to practice good dieback hygiene procedures when working in reserves identified as containing dieback. (KA28)
- 29.** Undertake dieback assessment and mapping in reserves containing and suspected of containing dieback. Re-assess reserves every three years. (KA29)
- 30.** Instigate dieback control methods where practical such as phosphite treatment, limestone on firebreaks and revegetation using dieback tolerant endemic species. (KA30)
- 31.** Ensure fire response plans show dieback infected areas. (KA31)
- 32.** Support the Dieback Working Group in their endeavours. (KA32)



## SUMMARY OF KEY ACTIONS CON'T

33. Ensure best practise Water Sensitive Urban design is practised in new subdivisions (KA33)
34. Retrofit best practise Water Sensitive Urban Design measures into areas where water quality is being adversely affected by outdated practises (KA34)
35. Undertake regular water quality monitoring of wetland areas. (KA35)
36. Increase the resilience of natural areas by addressing the threats posed by weeds, feral animals, illegal access, illegal rubbish dumping, increased fire frequency, disease such as dieback, storm water drainage and climate change. (KA36)
37. Continue to keep informed about the latest research developments in terms of climate change scenarios and best practice bushland adaptation techniques. (KA37)
38. Be prepared to alter management practices to adapt to a changing climate. (KA38)
39. Implement a best management practice for natural area regeneration and rehabilitation that includes detailed pre-work site assessment, identifies clear aims and outcomes, recommendations for regeneration techniques. (KA39)
40. Prepare planting plans for planting sites prior to undertaking revegetation works. (KA40)
41. Develop and implement a program of regeneration/restoration works across natural areas that is informed by:
  - the priorities for managing threatened species and habitat;
  - the extent of priority weed species which are targeted for control;
  - statutory requirements for fire management; and
  - the human resources available (staff and volunteers) (KA41)
42. Ensure the provision of adequate resources for the ongoing maintenance of natural areas. (KA42)
43. When selecting areas to revegetate within reserves select those sites that offer the best opportunities to enhance ecological connectivity (KA 43).
44. Support the Department of Main Roads in their endeavours to maintain and enhance natural vegetation within existing road reserves (KA 44).
45. Seek to ensure that, should the proposed Roe Highway extension proceed, native vegetation is retained and revegetation undertaken so that it maintains some function as an ecological linkage (KA 45).
46. Retain and enhance the current east west ecological linkage functions of Beeliar Drive, Armadale Road, Russell Road, Gibbs Road, Rowley Road and Wattleup Road. (KA46).
47. Ensure that the commitments to establish suitable ecological linkages within the Latitude 32 development are honoured (KA47).

## SUMMARY OF KEY ACTIONS CON'T

- 48.** Examine the potential to enhance sections of the rail reserves for enhanced ecological function and biodiversity conservation (KA48).
- 49.** Commence discussions with West Rail to gain support for rail reserves to be vegetated to enhance their value as ecological corridors/linkages (KA49).
- 50.** Liaise and encourage Western Power to retain and maintain native vegetation within the identified power line easements (KA50)
- 51.** Ensure future landscaping of the BP Refinery Oil Pipeline is undertaken in a manner that enhances the pipelines ability to function as an ecological linkage (KA51).
- 52.** Continue to support tertiary studies that investigate potential locations, designs and the effectiveness of ecological corridors (KA52).
- 53.** Continue to encourage developers to consider ecological linkages when formulating structure plans (KA53).
- 54.** Support the objectives of the Cities Bushland Conservation Policy (KA54).
- 55.** Where roads are being constructed, upgraded or widened through natural areas ensure that consideration is given to the construction of wildlife crossings. Continue to support initiatives to promote the use of local endemic native plants in residential gardens and verges (KA55).



Coogee Beach Seed Collection

## INTRODUCTION

This strategy outlines the actions and processes necessary to manage the natural areas vested with the City of Cockburn. It sets out the process for prioritising reserves and identifies management requirements that are deemed necessary to maintain and enhance the condition of our natural areas for the protection and conservation of biodiversity.

### WHAT IS A NATURAL AREA AND WHY ARE THEY IMPORTANT?

Natural Area is a term used to describe an area that contains native species or communities in a relatively natural state and hence contains biodiversity. Natural areas can be areas of native vegetation, vegetated or open water bodies (lakes, swamps, wetlands) or waterways (rivers, streams, creeks), springs, rock outcrops, bare ground (sand or mud), caves, coastal dunes or cliffs. Natural areas exclude parkland cleared areas, isolated trees in cleared settings, ovals and turf areas. (Perth Biodiversity Project adapted from Environmental Protection Authority 2003a)

Reserves which contain natural areas are important for many reasons. They provide for the retention and protection of biodiversity; they provide a sense of place and create a 'green' living environment for local residents; they provide many recreational opportunities such as bushwalking, bird watching and also provide a valuable educational resource for schools, technical colleges and universities.

It is also important that we retain our natural areas to ensure the long term survival of our range of diverse ecological communities. Research suggests that at least 30% of a regions ecological community may need to be retained to maintain species diversity. This is referred to as the 30% threshold. The Commonwealth Government has recognised the need to retain 30% of each vegetation community and has set objectives and targets to achieve this outcome (see National Objectives and Targets for Biodiversity Conservation 2001-2005).

Within Cockburn there are six different vegetation complexes. As the table below indicates a number of these are currently below the 30% threshold, these being the Cottesloe Complex – Central and South and the Karrakatta Complex-Central and South. It is important that representatives of these complexes are retained to ensure their long term survival.

**Table 2. Remnant Vegetation Extent by Vegetation Complexes within the City of Cockburn**

Vegetation Complex	Pre-European extent (ha)	2010 Remnant vegetation extent (ha)	% of Pre-European Extent
Bassendean Central and South	6850	2217.37	32.37%
Cottesloe Complex-Central And South	4839	1035.17	21.39%
Herdsman Complex	1235	514.56	41.67%
Karrakatta Complex-Central And South	1390	171.01	12.30%
Quindalup Complex	138	87.44	63.48%
Southern River Complex	313	112.85	36.07%
<b>TOTAL</b>	<b>14765</b>	<b>4138.40</b>	<b>28.02%</b>

Source: Perth Biodiversity Project Planning Tool 2011

Research is also indicating that there is an enormous range of potential health and wellbeing benefits from contact with nature, including crime reduction, fostering psychological wellbeing, reducing stress, boosting immunity, enhancing productivity, promoting healing in psychiatric and other patients, reducing blood pressure, heart rate, and cholesterol and fostering spiritual development (Deakin University 2002)

### CITY OF COCKBURN NATURAL AREAS

There are 1093 hectares of reserves that are currently the responsibility of the City. The quality of this bushland ranges from degraded through to excellent and it is contained within 82 reserves. Of these 82 reserves, 48 are actively managed. These reserves are scattered throughout the City and consist of coastal, wetland and upland areas. Sizes range from small reserves surrounded by parkland of approximately 3500 square metres to larger reserves of 256 hectares. Of the 82 reserves, 13 are included in Bush Forever. Bush Forever is a State Government initiative that aims to protect regionally significant bushland.

Most of the larger reserves containing vegetation are under active management. The smaller reserves generally contain small pockets of poor quality bushland and current resources are not adequate to actively manage these smaller pockets. The City will also become responsible for management of additional areas as a result of Public Open Space allocations from new subdivisions.

**Table 3. Reserve Summary**

Total Area of Reserves Containing Bushland	1091
Total Area of Bushland in Conservation Reserves	904
Area of Bushland in Actively managed Conservation Reserves	896
% Bushland in Actively Managed Conservation Reserves	91
% Bushland in Non Actively Managed Conservation Reserves	9
Number of Actively Managed Reserves	48
Number of Non Actively Managed	34

Viable management strategies will enhance the overall condition of the existing bushland with the ultimate long term goal of upgrading the overall condition of Councils natural areas to a minimum vegetation condition rating of good or better based on the Keighery 1994 definition of vegetation condition. The definition of a vegetation rating of good is explained in Section 4.

Each reserve is mapped for bushland condition every four years. Comparisons with previous mapping will allow Council to monitor its performance in terms of maintenance and progress toward enhancement of our natural areas.

Bushland Condition Maps are placed on Councils Geographical Information System (Intramaps) for ease of reference.

### VALUES

Cockburn's Biodiversity is part of the South West Botanical Province of Western Australia, which is now recognised as one of the world's top 25 biodiversity hot spots (Myers et al 2000). It has been recognised as globally significant not only because of the huge diversity of plants, animals and habitat types that are highly endemic but because of the loss of these areas due to clearing and urban development (PBP 2004).

As well as many of the reserves being classified as Bush Forever many of the reserves are also contained within three Regional Parks, Beeliar, Jandakot and Woodman Point Regional Parks.

Within the City are some important wetlands including Thomsons Lake which is a listed Ramsar Wetland. Ramsar is an intergovernmental treaty dedicated to the conservation and 'wise use' of



wetlands. Some of the other wetlands within the Beeliar Regional Park are also listed in the Directory of Important Wetlands in Australia.

The City also has some important coastal vegetation. The coastal region also consists of numerous limestone outcrops and significant features such as the Henderson Cliffs.

## FLORA

There are a variety of flora species, vegetation complexes and vegetation assemblages existing within Cockburn's natural areas. Many of the species are classified as DEC Declared Rare and Priority Flora or *EPBC Act* Listed Flora and Threatened Ecological Communities.

The City has developed a species list for each of the reserves which are continually being updated as additional species are discovered. A herbarium has also been established and is being continually updated.

The management strategies identified in this plan will assist to conserve and protect the flora that remains. The enhancement of the natural areas will hopefully allow some species to be re-introduced into areas where they have become scarce.

A number of brochures have been developed to promote the use of local plants in gardens and the City also offers a plant subsidy scheme to encourage residents to purchase local species. By using local species in their gardens local residents are able to conserve water while contributing habitat and food sources for local fauna.

A list of flora of the Perth region can be found on the Department of Environment and Conservation website: <http://www.dec.wa.gov.au>



Kangaroo Paws are a good source of food for native birds



## FAUNA

The combination of dryland and wetland areas has resulted in a variety of habitat types for local fauna within the City of Cockburn. There is an assortment of reptiles, frogs, birds and mammals present within each reserve.

The wetlands within Cockburn range from fresh to quite saline. These wetlands offer good seasonal habitats for amphibians such as frogs and turtles.

A variety of birdlife can be found inhabiting the various vegetation assemblages both around wetlands on the coast and in upland areas.

Quendas are in evidence throughout the municipality where it inhabits dense vegetation in many of the reserves.

Old trees provide nesting hollows for many species of birds and mammals such as possums. Nesting hollows are usually only found in very old mature trees, however artificial sites have been created by the installation of nesting boxes in trees which are not yet mature enough to have developed nesting hollows. The installation of nesting boxes provides additional habitat and encourages breeding for local species.

Reptiles inhabit both wetland and dryland areas with many examples of lizards and snakes being quite common.

Fauna surveys have been undertaken in a number of reserves including Denis De Young, Yangebup Lake, Little Rush Lake and Bibra Lake. Less intensive surveys have also been undertaken as part of a fauna corridor study in Manning Lake, Market Garden Swamp and Banksia Woodland Reserve.

The use of motion sensitive cameras also revealed interesting information.

The surveys reveal that a variety of native species are still in evident within our natural areas. Further information in relation to these surveys can be obtained from Councils Environmental Service Unit.

Some fauna species found in the natural areas are considered significant or rare under the *Western Australian Wildlife Conservation Act 1950* or EPBC Act Conservation Codes. Others are listed by the DEC Priority Fauna Codes.

Further details in relation to the fauna in the Perth region can be found on the Department of Environment and Conservation website: <http://www.dec.wa.gov.au>



Slender Tree Frogs breed in many wetlands

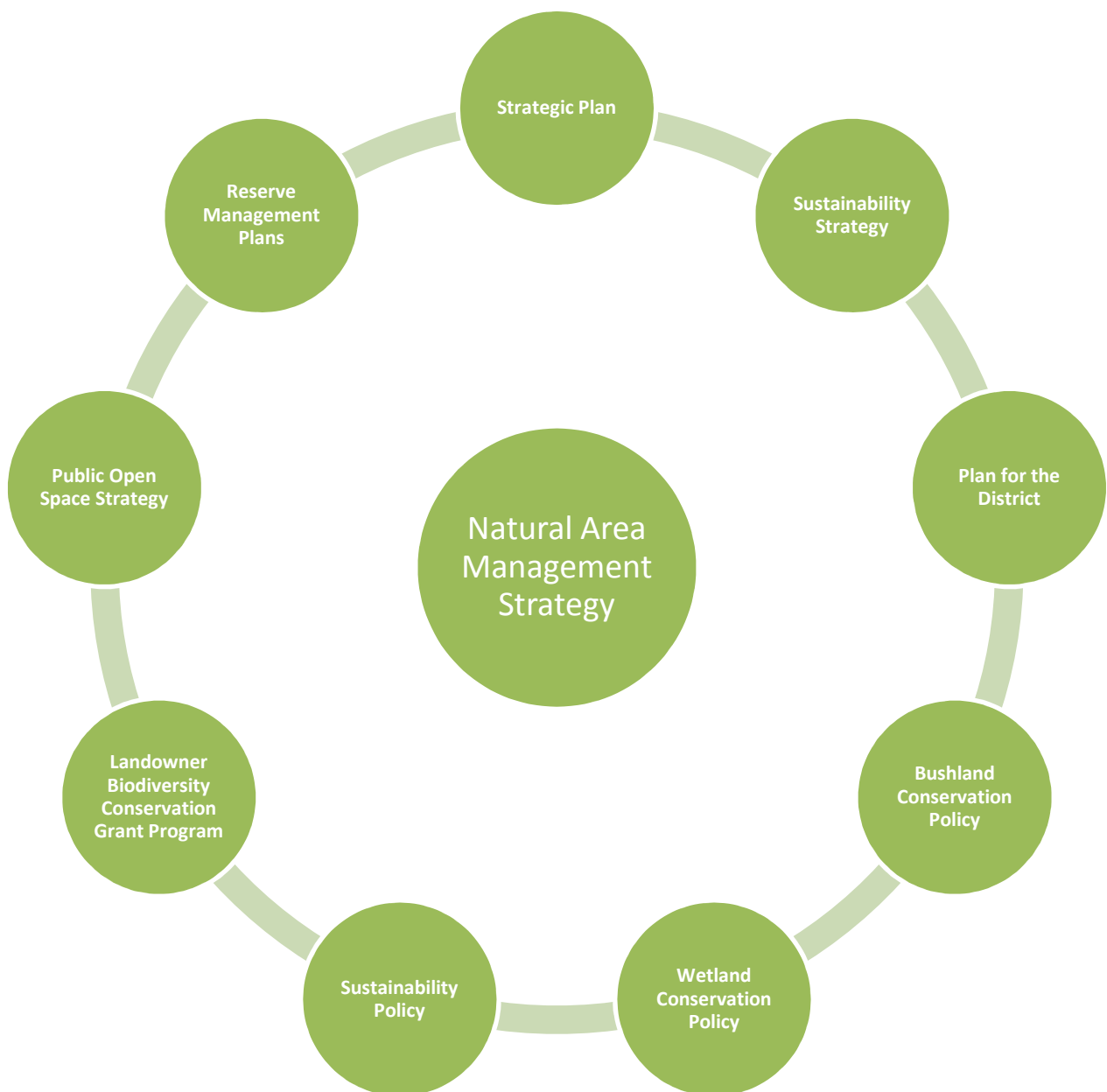
## RELATIONSHIP TO OTHER STRATEGIES AND DOCUMENTS

The Australian Government is committed to the internationally agreed Convention on Biological Diversity that established three main goals:

- Conservation of biological diversity
- Sustainable use of its components
- Fair and equitable sharing of the benefits from the use of genetic resources.

The Australian Government *Environment Protection and Biodiversity Conservation Act (2000)* was established to protect the environment, particularly on matters of national environmental significance. The Act promotes the conservation of biodiversity by providing strong protection for threatened species and ecological communities.

A number of existing Council documents and strategies make clear the importance that the City of Cockburn places on our natural areas.



## **CITY OF COCKBURN STRATEGIC PLAN 2006 - 2016**

The strategic plan has been developed to provide an outline of Council's Strategic directions and priorities, and to guide Council's activities over the ten years from 2006 to 2016.

The Strategic Plan lists 'Strategic Actions' required across all sectors within the organisation. Within the Environmental Management sector, the Strategic Plan has listed the following action;

- Develop an Environmental Management Strategy that is integrated with the City's existing management programs, which provides for long-term resource conservation. *It will include a Five-Year works program for the existing Revegetation Program*
- Expand the City's State of the Environment Report to track and report on the effectiveness of the Environmental Management Strategy

One of the goals identified in the Strategic Plan is to:

Preserve and remediate ecosystems for future generations –  
To have diligently preserved the various ecosystems of the City and to make real progress in the remediation of those parts of Cockburn have been previously damaged environmentally.

The Natural Area Management Strategy will assist the City to achieve this goal.

*Note: This Natural Area Management Strategy replaces the Environmental Management Strategy. The State of Environment Report has been replaced by the State of Sustainability Report*

## **CITY OF COCKBURN SUSTAINABILITY STRATEGY 2012-2016**

The City of Cockburn's sustainability strategy places the principles of sustainability at the forefront of our decision-making processes across the entire Council.

The City has adopted the following definition of 'Sustainability' as defined in the Policy:  
*"Meeting the needs of current and future generations through integration of environmental protection, social advancement, and economic prosperity."*

Principles of the Sustainability Strategy that relate directly to natural area management are:

- Conservation management of bushland and wetland areas
- Wildlife corridor enhancement
- Protection of coastal & marine systems

The Natural Area Management Strategy will provide a method by which the above principles can be met.

## **PLAN FOR THE DISTRICT 2010-20**

One of the 7 key drivers that are identified to shape the City over this 10 year time period are the natural surroundings in which the City co-exists, including air, water, land, flora, and fauna.

The Natural Area Management Strategy will help to ensure that the natural surroundings within the City are retained for the benefit of future generations.

### **BUSHLAND CONSERVATION POLICY (SPD1)**

The purpose of this policy is to provide Council with a clear position and a range of strategies for ensuring that the conservation, protection and management of local bushland within the District are optimised.

### **WETLAND CONSERVATION POLICY (SPD5)**

The purpose of this policy is to provide Council with a clear position and range of strategies for the protection of wetlands within the district.

### **SUSTAINABILITY POLICY (SC37)**

One of the objectives of this policy is to conserve the quality, extent and uniqueness of the natural environment that exists within the district.

### **LANDOWNER BIODIVERSITY CONSERVATION GRANT PROGRAM (AEW5)**

The objective of this policy is to provide financial support to local landowners for the purpose of assisting with the conservation and enhancement of natural bushland and wetland areas on privately owned land.

### **PUBLIC OPEN SPACE STRATEGY/GREENING PLAN**

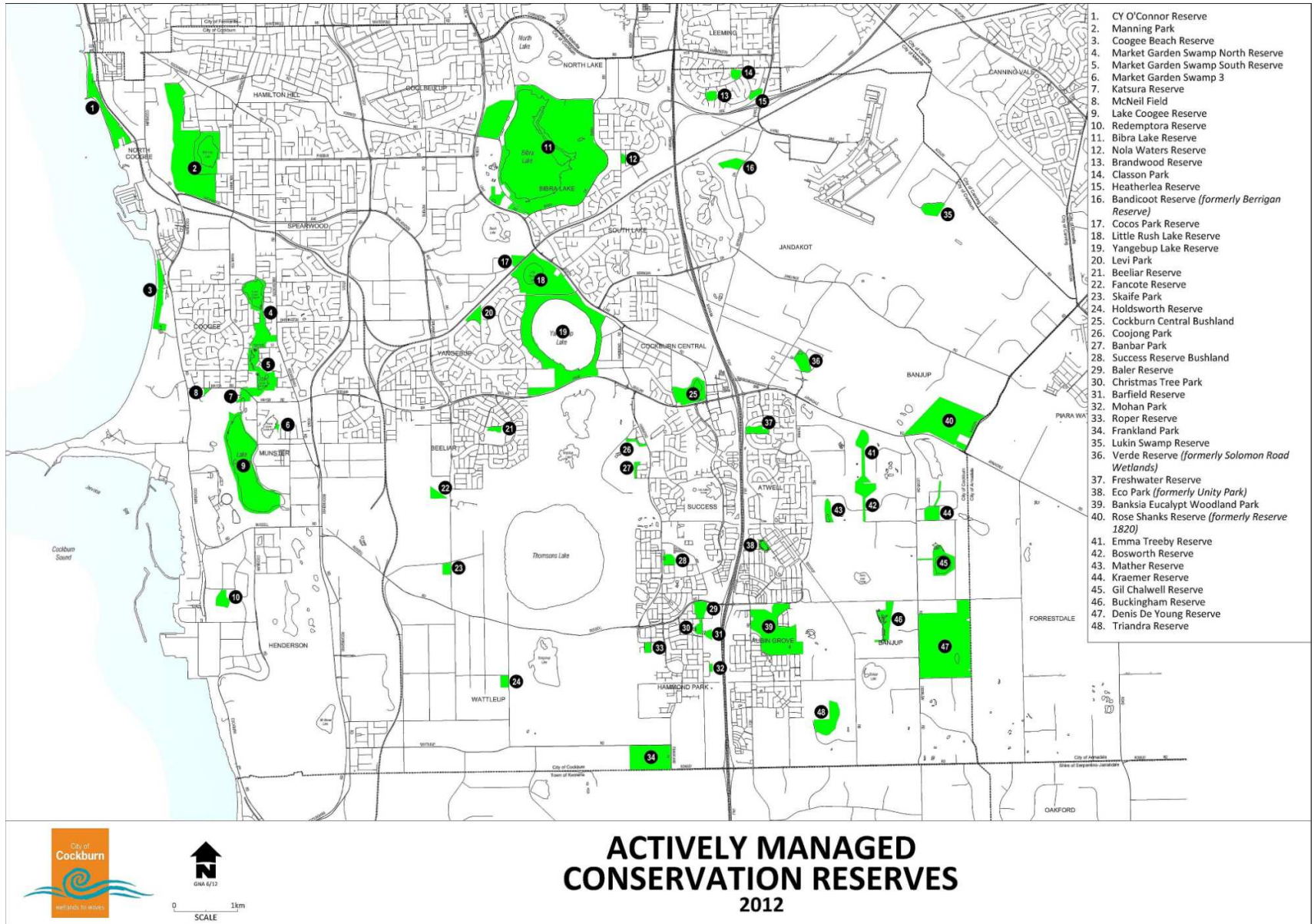
One of the actions identified within the now obsolete Greening Plan was to develop a Natural Area Management Strategy (NAMS) which will provide the main mechanism whereby biodiversity is managed within City of Cockburn reserves. The intent is to also prepare a Public Open Space Strategy to complement the NAMS. These two new strategies will be more focused on their individual areas and will replace the Greening Plan while still achieving the objective of the Greening Plan which was to:

*develop a long-term strategic plan for the maintenance and enhancement of remnant vegetation within the City of Cockburn, the revegetation of previously cleared areas, road reserves, public land and the enhancement of ecological, landscape and streetscape values and community amenity.*

### **RESERVE MANAGEMENT PLANS**

This strategy provides an overarching framework for natural areas but individual reserve management plans are necessary to provide a more detailed approach to management in areas where there are unique factors specific to that particular reserve.

A number of reserve management plans have been prepared for individual reserves. These include Market Garden Swamp, Coogee Beach, Bibra Lake, Denis De Young Reserve, Freshwater Reserve, Yangebup and Little Rush Lakes, Lake Coogee and Banksia Eucalypt Woodland. A combined management plan for the small eastern reserves was in the process of being finalised at the time of writing this document. Other plans will be developed while others are due to be updated.





## **PRIORITISING RESERVES**

### **PRIORITISATION OF BUSHLAND RESERVES FOR MANAGEMENT**

*Management Objective: To identify reserves that are considered to be of higher value to ensure that finances and resources are allocated in a manner that will provide the best outcomes for both the community and the natural area.*

It is important that we prioritise bushland reserves for management. Financial and resource constraints mean that it is not currently possible to manage and improve the condition of all natural areas within the City. Given these constraints there needs to be a focus on the reserves that will give the best return on expenditure. Prioritisation ensures that finances and resources are allocated in a manner that will provide the best outcomes for both the community and the natural area.

Some of the natural areas may not be viable to manage. It may not be practical or make economical sense to allocate funds to these areas. If a determination is made that a reserve is not viable it will most likely be turned into parkland or passive open space. The process of prioritisation will determine the viability of these reserves. An example of an area of bushland that would not be viable to manage would be a small section of bushland of less than 200 square metres surrounded by parkland. The funds required to maintain the integrity of such a small area would be considerable yet the value that this small area would provide to fauna and surrounding residents would be minimal and funds should be directed to other more viable areas.

A number of factors are taken into consideration when prioritising natural areas. The factors that have been used to prioritise the natural areas within the City of Cockburn have been taken from the Perth Biodiversity Project Local Government Biodiversity Planning Guidelines 2004 and they are as follows:

- Vegetation condition
- Reserve size
- Shape
- Perimeter to area ratio
- Connectivity
- Visibility/Community Involvement

Social values such as visibility and community involvement have also been considered when assessing each reserve. Prominent reserves are valued more highly by the community and have higher community participation rates. This generally means that there are higher expectations in relation to management therefore maintenance costs are generally higher than less prominent reserves. Greater community involvement also provides benefits as applications for funding from alternative sources such as grants are more likely to be successful.

### **VEGETATION CONDITION**

Vegetation condition is a measure of an areas similarity to what it would have looked like prior to the effects of disturbance from European settlement in Australia (Keighery 1994).

Various condition scales have been developed. The condition scale used to assess the vegetation condition of the natural areas in Cockburn is the *Keighery 94* method.

A description of the Keighery vegetation condition ratings are outlined below:

#### **Pristine**

- Vegetation structure intact.
- *0% weed cover*

#### **Excellent**

- disturbance affecting individual species and weeds are non aggressive species.
- *1 - 5% weed cover*

#### **Very Good**

- Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
- *6 – 25% weed cover*

#### **Good**

- Vegetation structure significantly altered by obvious signs of multiple disturbances.
- Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
- *26 – 50% weed cover*

#### **Degraded**

- Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
- *51 – 75% weed cover*

#### **Completely Degraded**

- The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as „parkland cleared“ with the flora comprising weed or crop species with isolated native trees or shrubs.
- *76 – 100% weed cover*

*Note: Only the bushland within each reserve is given a condition rating. Areas such as parkland, playgrounds etc are excluded and are considered as areas for other purposes. These areas are not included when calculating the area of bushland. Firebreaks and trails however are included in the rating assessment and are ranked as completely degraded. The reasoning behind this is that the firebreaks or trails, if not maintained, would revert to bushland.*

The various factors assessed using the condition scales are:

- plant community structure and composition
- disturbance factors such as logging, grazing, partial clearing, inappropriate fire regime, soil disturbance, predation by feral animals, impacts from surrounding land uses
- weed invasion
- vegetation health such as disease pests, threatening processes such a salinisation, lowering of water table, climate change, fragmentation.

Vegetation condition mapping has been undertaken in vegetated areas of the City's natural areas using the Perth Biodiversity Project Natural Area Assessment (NAIA) templates a copy of which can be downloaded from the Perth Biodiversity Project Website.

[http://www.walqa.asn.au/about/policy/pbp/tools/na\\_templates](http://www.walqa.asn.au/about/policy/pbp/tools/na_templates)

All reserves had been mapped for vegetation condition by April 2011. The second round of mapping commenced in Spring 2011.

Table 1 gives a breakdown of the March 2012 vegetation condition ratings of our natural areas. The table only includes areas of bushland and does not include areas that are considered parkland and unlikely to be revegetated in the future.

**Table 4. Condition Ratings (*Keighery 94*) by Hectare and Percentage**

Bushland Vegetation Condition	Hectares	Percentage of Bushland
Pristine	0	0
Excellent	59	7
Very Good	317	35
Good	225	25
Degraded	113	13
Completely Degraded	182	20
<b>Total</b>	<b>896</b>	<b>100</b>

Each reserve will be re-mapped for vegetation condition every four years. Comparisons with previous mapping will allow Council to monitor its performance in terms of maintenance and progress toward enhancement of these natural areas.

A full round of vegetation condition mapping was completed in April 2011 and this mapping will be used as the baseline to assess progress.

Bushland Condition Maps are stored on Councils Geographical Information System (Intramaps) for ease of reference.

#### SIZE

Size is an important factor when determining the long term viability of a natural area: the bigger the area the greater its capacity to retain its biodiversity, maintain ecological function and resist disturbance factors and threatening processes. However the minimum size for a given area to be viable varies

greatly between different ecological communities and depends on the presence of threats and how well these can be controlled.

Minimum size also depends on what you want the area to be viable for, as different species have different requirements. Remnants as small as 4 ha are important for retaining intact examples of reptile diversity and areas of 1 ha can retain viable populations of many reptiles species if fire frequency and feral animal predation are controlled (How & Dell 2000).

The guiding principle when planning or prioritising natural areas is that management costs are much lower for larger and more viable areas. Patches of remnant vegetation at the small end of the scale usually require intensive management and can be costly to maintain. Community expectations can be high for these areas as they are often considered the local patch and voluntary community support for management may be available.

Consideration of these factors can give an indication of the viability of a natural area. Viability is a measure of how well an ecological community can sustain and support the organisms that occur naturally within that community in the long-term (PBP 2004).



Manning Lake with riparian vegetation

## SHAPE

Shape influences the level of impact that threats may have on the edges of a natural area. These edge effects can be observed extending into natural areas. The degree that edge effects extend into natural areas varies greatly between ecological communities and depends on the types of threats and how well they can be controlled. Threats acting at the edges include weed invasion, grazing and trampling, increased sun and wind exposure, pollutants, drift or runoff, air pollution, noise, artificial light at night,



rubbish accumulation and dumping, exposure to feral animals and pests and diseases from surrounding land uses.

In the metropolitan area of the Swan Coastal Plain edge effects are typically observed to extend up to at least 25 metres into natural areas ( Karen Clarke, pers. comm. July 2003 Perth Biodiversity Project)

Compact areas such as circles, squares, and squat rectangles have the greatest viability, as their core areas are the largest possible for the given size. Long, thin shapes have the lowest viability as most of the area is impacted by edge effects.

Research has indicated that native vegetation that acts as a link between larger viable natural areas needs to be at least 25 – 50 metres wide for use by many bird species (Barret 2000: Fruedenberger 1999). Also birds are more likely to use patches of native vegetation if these patches are within 500-1000 metres of viable natural areas (Freudenberger 1999). Therefore long thin areas at least 50M wide located within 500-1000 metres of viable natural areas may have important ecological linkage value despite the low viability of the poorly shaped areas itself.

Circle, square or squat rectangle	Highest viability
Oval, squat oblong or symmetrical triangle	High viability
Irregular shape with few indentations	Medium viability
Irregular shape with many indentations	Medium to low viability
Long shape with large proportion of area greater than 50m wide	Lower viability
Long thin shape with large proportion of area less than 50m wide	Very low viability

#### **PERIMETER TO AREA RATIO**

Perimeter to area ratio is determined by size and shape and therefore can be a useful indicator of viability. Divide the length of the perimeter by the area. The higher the score the lower the viability because the greater the perimeter the more likely the site is to be impacted by outside influences. This is more commonly known as edge effects.

As most impacts on natural areas occur around their edges and as a general rule, because circular remnants have less edge relative to their area than long and narrow areas, the protected area within the natural area is greater for circles (Hawkesbury Nepean Catchment Trust 2000).

#### **CONNECTIVITY**

The viability of any natural area depends on its proximity to other natural areas and the quality of the ecological linkage between them. These two factors influence the movement of individual living organisms and the flow of genetic material between natural areas. In turn this determines the long term survival of species, their genetic variation, their ability to adapt to changes in the environment and the maintenance of ecosystem processes. The viability of a given natural area will increase:

- the closer it is to other protected natural areas
- the greater the number of protected natural areas within close proximity
- the better the condition of the surrounding natural areas



The better the condition and structural complexity of surrounding natural areas, the more effective they will be as ecological links to larger natural areas and as habitat.

Chapter 8 further discusses the importance of ecological connectivity.

### **VISIBILITY/COMMUNITY INVOLVEMENT**

Social values such as visibility and community involvement have also been considered when assessing each reserve. Prominent reserves are valued more highly by the community and have higher community participation rates. This generally means that there are higher expectations in relation to management therefore maintenance costs are generally higher than less prominent reserves. Greater community involvement also provides benefits as applications for funding from alternative sources such as grants are more likely to be successful.

When prioritising the reserves consideration has been given to proximity to residential areas, public perception and amenity and whether or not the reserves that have active community groups that is involved in assisting to maintain the reserve.

### **MANAGEMENT CATEGORIES**

The 82 natural areas managed by the City have been prioritised using the 6 criteria detailed above. Each of the criteria was given a rating out of 5 and totalled.

The reserves were then prioritised into three management categories; High, Medium and Low.

**Table 5. Management Categories**

Score	Priority Rating	Hectares
<b>1 to 10</b>	Low	7.42
<b>11 to 20</b>	Med	169.51
<b>Above 20</b>	High	719.41

High Priority bushland reserves have the highest ecological viability and/or community involvement. Resources should be directed to the management of these reserves before being directed to Medium or Low Priority areas.

Medium Priority bushland reserves have a lower ecological viability and/or community involvement than the high priority reserves. Resources should be directed to the management of these reserves to maintain their current condition priority before being directed to Low Priority areas.

Low Priority bushland reserves have the lowest ecological viability and have little or no community involvement. Generally, minimal resources should be directed towards Low Priority reserves until such times as the other priority reserves are in good or better condition.

*Bushfire protection measures are not based on the management categories. Bushfire protection measures such as firebreaks are required by law. All natural reserves managed by the City have a trafficable firebreak a minimum of three (3) metres wide or an approved alternative installed and maintained annually.*

**Table 6. Management category explanations**

Management Category	Comments
High Priority	Very high viability, Bush Forever Site, Low community involvement
	High viability, Bush Forever Site High community involvement,
	High viability rating, Bush Forever Site, Low community involvement
Medium Priority	Medium viability, Med-Low community involvement
	Low Viability, Med-High Community involvement
	Medium viability, Low community involvement
	Low viability, High community involvement, Bush Forever Site, part of Regional Park
	Low viability, Very high community involvement
Low Priority	Medium viability, Low community involvement
	Medium viability, Low-med community involvement
	Low viability, medium to low community involvement



*Scaevola crassifolia* (Thick Leaved Fan Flower)

**Table 7. Actively Managed Reserve Priority Classification**

	<b>Reserve Name</b>	<b>Priority</b>	<b>Area of Bushland (hec)</b>
1	C.Y. O'Connor Reserve	Med	15.85
2	Manning Park	High	55.90
3	Coogee Beach Reserve	High	9.86
4	Market Garden Swamp North Reserve	High	20.90
5	Market Garden Swamp South Reserve	High	18.61
6	Market Garden Swamp 3	Med	8.25
7	Katsura Reserve	Low	0.35
8	McNeil Field	Med	0.45
9	Lake Coogee Reserve	High	63.81
10	Redemptora Reserve	Med	3.94
11	Bibra Lake Reserve	High	228.27
12	Nola Waters Reserve	Med	0.79
13	Brandwood Reserve	Med	3.20
14	Classon Park	Med	2.78
15	Heatherlea Reserve	Med	1.69
16	Bandicoot Reserve ( <i>formerly Berrigan Reserve</i> )	High	4.19
17	Cocos Park Reserve	High	2.04
18	Little Rush Lake Reserve	High	36.03
19	Yangebup Lake Reserve	High	133.34
20	Levi Park	Low	1.31
21	Beeliar Reserve	Med	4.54
22	Fancote Reserve	Low	2.25
23	Skaife Reserve	Low	1.80
24	Holdsworth Reserve	Med	1.58
25	Cockburn Central Bushland	Med	19.70
26	Coojong Park	Low	1.06
27	Banbar Park	Low	0.22
28	Success Reserve Bushland	High	2.77
29	Baler Reserve	Med	3.66
30	Christmas Tree Reserve	Med	2.86
31	Barfield Reserve	Med	0.92
32	Mohan Park	Low	0.43
33	Roper Reserve	High	1.36
34	Frankland Park	High	24.23
35	Lukin Swamp Reserve	Med	5.20
36	Verde Reserve ( <i>formerly Solomon Road Wetland</i> )	Med	5.70
37	Freshwater Reserve	Med	4.38
38	Eco Park ( <i>formerly Unity Park</i> )	Med	1.01

39	Banksia Eucalypt Woodland Park	High	40.00
40	Rose Shanks Reserve ( <i>formerly Reserve 1820</i> )	Med	32.80
41	Emma Treeby Reserve	Med	7.00
42	Bosworth Reserve	Med	6.53
43	Mather Reserve	Med	3.05
44	Kraemer Reserve	Med	4.44
45	Gil Chalwell Reserve	Med	11.07
46	Buckingham Reserve	High	7.32
47	Dennis De Young Reserve	High	78.20
48	Triandra Reserve	Med	10.70
<b>Total</b>			<b>896.34</b>

Currently there are three Bushland Maintenance Teams undertaking on ground works in the conservation reserves. Each team is assigned a selection of reserves and a set number of hours to undertake on ground works. This system ensures that all actively managed reserves have at least some maintenance undertaken and are regularly inspected. Higher priority reserves are allocated the most hours.

A breakdown of the Bushland Maintenance Team Reserve allocations as at July 2012 can be found in Appendix B.

### **Actions**

1. Prioritise reserves based on the following aspects: Vegetation condition, size, shape, perimeter to area ratio, connectivity, visibility and community involvement. (KA1)
2. Re-assess reserve prioritisation every 8 years. (KA2)



## THREATS AND THEIR MANAGEMENT

Management of reserves requires the identification of the major threats to the health or biodiversity of each of the reserves. The main threats to Cockburn reserves are considered to be **environmental weeds** particularly perennial veldt grass; **feral animals, uncontrolled and illegal vehicle access, illegal rubbish dumping, fire, disease, stormwater drainage and climate change.**

### ENVIRONMENTAL WEEDS

*Objective: To control and manage environmental weeds within Council Managed Natural Areas.*

The Environmental Weed Strategy for Western Australia defines environmental weeds as “plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade” (CALM, 1999).

According to the Department of Environment and Heritage, “weeds are among the most serious threats to Australia’s natural environment and primary production. They displace native species; contribute significantly to land degradation...”

Environmental weeds can also increase the frequency and intensity of fire in bushland areas, which in turn results in more weeds becoming established. This is often called the fire-weed cycle and ultimately leads to a loss of biodiversity and an increase in the fire hazard of a bushland area.

Many of the natural areas within the City of Cockburn are being severely impacted by weeds. A number of reserves have heavy infestations of weeds, which degrades the quality and affects the overall viability of the area.

The City has developed a Weed Management Strategy, a copy of which can be found in Appendix A. One of the recommendations of this strategy is to undertake weed mapping throughout all of our natural areas. The first round of weed mapping for all of the City’s natural areas was completed in April 2010. Weed mapping allows us to identify the types of weeds that are within a given reserve and this in turn allows us to prioritise the type of weed that should be targeted and the type of control that will need to be undertaken.

As part of the Weed Control Strategy a Priority Weed list was developed. Priority weeds were those weeds considered to be highly invasive and that pose the most serious threat to native vegetation. Weeds are listed in order of threat thus indicating the order in which weeds should be targeted for control. The Priority Weed List is reviewed every 5 years to ensure that priorities are still relevant.

Weed mapping, along with vegetation condition mapping, allows us to measure the effectiveness of our weed control program for individual reserves and our overall management performance. The City undertakes weed mapping within each reserve every 4 years. This is used to monitor the effectiveness of our weed control program. It also allows programs to be modified should they be deemed ineffective. This type of quantification provides a good indicator of the current status of our natural areas and enables management goals and targets to be set.

Initial observations from the weed mapping indicate that Perennial Veldt Grass (PVG) is having the greatest impact on our natural areas. It is well established in many reserves and is considered the most widely spread and abundant environmental weed. PVG is also considered a major fire hazard. There are other factors to be considered however when targeting PVG for control. Without a concerted revegetation program in degraded areas other significant environmental weeds such as Geraldton Carnation weed, Gladiolus spp and Wild Oats may replace the grass and many of these are more difficult to control and also negatively impact the natural area.

## The Cost of Controlling Environmental Weeds

The cost of controlling weeds is substantial. Based on 2011 tender rates the costs to control perennial veldt grass is approximately \$543/ha and for other broadleaf and bulbous weeds the cost is approximately \$471/ha.

There is a high recurrent cost to weed control and it requires a long-term commitment to be effective.

It is estimated that for weed control to be effective in our natural areas approximately **\$1,245,051** would need to be allocated per annum.

This figure has been arrived at using the following assumptions:

- Only bushland of Medium or High Priority would be treated for weeds (889 Hectares)
- Given that 376 hectares of bushland is in Pristine, Excellent & Very good condition and requires little weed control it can be discounted. (889 Hectares – 376 Hectares = 513 Hectares)
- Four general weed control events would take place each year.
- One grass weed control event would take place each year.

513 hectares x \$471 (general weed control) X 4	= \$966,492
513 hectares X \$543 (grass weed control)	= \$278,559
<b>Total weed control costs</b>	<b>\$1,245,051</b>

## Environmental Weeds Funding Shortfall

Current 2012/13 funding for weed control equates to **\$746,377** which is made up of the following allocations:

Herbicide	\$12,000
Contract Grass Weed Control	\$81,100
Contract General Weed Control	\$86,200
Firebreak Weed Control	\$23,000
Hand Weed Control	\$90,600
50% Bush Maintenance Labours hours	\$453,477
<b>Total</b>	<b>\$746,377</b>
<b>Shortfall</b>	<b>\$498,674</b>

The current shortfall in funding (\$498,674) highlights the importance of prioritising bushland reserves for management purposes and reinforces the need to secure external funding from grants and highlights the importance of volunteer labour programs.

It is not currently possible to effectively manage all environmental weeds in all reserves. Limited resources for weed management are a major constraint, and therefore, it is critical that funds are strategically directed towards significant environmental weeds in priority bushland reserves.

The current approach is to control high priority weeds and then focus efforts on medium and lower priority weeds.

Further details relating to funding can be found in Section 8 Operational Funding Requirements.

Where practical the Bradley Method of Bush Regeneration is practised. The Principles of the Bradley Method can be found in Appendix C.

## Actions

1. Map the priority weeds and the vegetation condition in all bushland reserves every 4 years to assist with developing weed management plans and to monitor progress. (KA3)
2. Develop and implement a Weed Control Strategy. (KA4)
3. Review and update the Priority Weed Control List every 5 years. (KA5)
4. Prepare and implement a works programme to manage priority weeds in bushland reserves. (KA6)
5. Develop revegetation programs following weed control programs where required. (KA7)
6. Assist and encourage volunteers such as community “friends of” groups, Conservation Volunteers Australia and educational institutions to participate in bushland management activities within bushland areas managed by the City. (KA8)
7. Provide support and assistance to community volunteer groups that undertake bushland management activities within bushland areas managed by the City. (KA9)
8. Offer incentives, training, and information to landowners to encourage management of natural areas on private property. (KA10)
9. Work with internal staff, contractors and the community to ensure that construction activities minimise the spread of weeds. (KA11)
10. Encourage, support and where practical, be involved in weed control trials with agencies and educational institutions. (KA12)
11. Adopt the principles of the Bradley Method of Bush Regeneration wherever possible when planning and implementing weed control work. (KA13)

## FERAL ANIMALS

Management *Objective: To control and where possible eradicate feral animals within Council managed natural areas.*

A feral animal can be defined as an introduced or domestic animal now living in the wild. Those that are considered to cause the greatest impact within Cockburn’s natural areas are rabbits, foxes, cats, bees and a number of birds such as the eastern rosella that are not endemic to the state.

Feral animals compete with our native species for food, breeding sites, prey on our native animals and destroy native vegetation particularly new germinates.

The control of feral animals is an ongoing problem. Many reserves are fragmented and surrounded by residential, commercial and industrial areas. Many domesticated and feral animals move from these areas into local reserves to hunt.

The City tackles the problem using an integrated pest control program. The program includes fencing, baiting, trapping, virus release, fumigation, nest removal and hive destruction. Specialist contractors are engaged to undertake the program. Before contractors undertake any form of animal control site risk assessments are conducted and a license is obtained from the Department of Environment and Conservation if required.

The City does not undertake any feral animal control on private property but rural landowners may apply through the Landowner Biodiversity Conservation Grant Program for funding.

The City does not condone cruelty to any animals and all animals are trapped and, if required, destroyed humanely.

No feral animal control programs are undertaken where there is risk to pets, people or native wildlife.

Cats are caught in standard box traps that are set at dusk and removed or closed at dawn. This prevents ravens and other fauna being captured. Feral cats are euthanized and domestic cats are returned to their owners if they can be identified, otherwise they are taken to a refuge. Cat Control legislation is soon to be implemented and it is expected that this will help to reduce the number of cats entering reserves.

Most of the high priority reserves such as Bibra Lake, Yangebup Lake, Denis De Young, Little Rush Lake, Coogee Beach, Manning Lake and Redemptora Reserve have annual programs. Control programs in other reserves are initiated as required.

Local residents are encouraged to be responsible pet owners and undertake their own feral animal control in rural areas.

A number of reserves have been fenced with rabbit proof fencing. As at July 2012 two reserves have had rabbit proof fencing installed. They are: Cocos Reserve and Denis De Young Reserve. An intensive program of rabbit control is planned for these reserves. Inspections and comparisons of vegetation condition will be used to determine if the rabbit proof fencing has been successful in reducing the impact of rabbits within these reserves.



The fox and rabbit are introduced species



The installation of rabbit proof fencing needs to be carefully considered. Fire is a major concern as the fencing can prevent escape. To compensate concrete pipes have been buried in some reserves to provide refuge for fauna in the event of fire. Fencing can reduce migration to and from areas and thus can impact on genetic diversity. It can also impact on the makeup of resident populations by preventing the dispersal of offspring.

Nesting boxes for birds and bats are installed in trees within reserves to compensate for the hollows that have been taken over by pest species including bees.

A typical program of feral animal control would be structured as per the Table 7 below.

**Table 8. Typical Feral Animal Control Program**

Reserve	Treatment type Spring	Treatment Type Spring/Summer	Treatment Type Summer
Manning Lake	CV, FW, FT, CT	FT, CT	PB, FT, CT
Denis De Young	MV, FW, FT, CT	FT, CT	PB, FT, CT
Coogee Beach	CV, FW, FT, CT	FT, CT	PB, FT, CT
Bibra Lake	MV, FW, FT, CT	FT, CT	PB, FT, CT
Yangebup Lake	CV, FW, FT, CT	FT, CT	PB, FT, CT
CV- Calici Virus, MV- Mixamotosis, FW - Fumigation of Warrens, FT - Fox Trapping, CT - Feral Cat Trapping, PB - Pindone Baiting			

#### Feral Animal Control Funding Shortfall

Funding allocated to feral animal control in 2012/13 equates to \$39,350. This allocation will be used to carry out control in a number of high priority reserves with the total area being 691 hectares. This equates to \$57 per hectare for feral animal control. Based on \$57 per hectare the costs undertake feral animal control in all reserves would be closer to \$51,072 based on 896 hectares of actively managed land. The current funding shortfall is \$11,722. Note that this cost is included within the overall cost to maintain 1 hectare of bushland as outlined in Section 9, Operational Funding Requirements.

To overcome the present short fall, feral animal control is only undertaken in the higher priority reserves where feral animals have been identified as having a major impact.

#### **Actions**

1. Instigate feral animal control programs in areas where feral animals are known to exist. (KA14)
2. Assess the viability of installing rabbit proof fencing around high priority reserves. (KA15)
3. Work with other local governments and government agencies with the aim of developing and implementing a regional feral animal control program. (KA18)

## ILLEGAL ACCESS

*Management Objective: To minimise the impacts to natural areas caused by unauthorised and uncontrolled access by off road vehicles*

Bushland reserves are a valuable community asset and controlled public use is encouraged. However unauthorised access by off road vehicles and motor bikes is a major contributor to environmental degradation within bushland reserves. Apart from vegetation destruction other issues associated with unauthorised vehicles includes risks to other users, erosion and illegal dumping of rubbish and green waste. Anecdotal evidence suggests that reserves with uncontrolled access are also more prone to arson attacks and graffiti.

The majority of the Cities bushland reserves have fencing to prevent illegal access. Reserves surrounded by passive parkland are generally not fenced as this detracts from the amenity of the area.

A number of different types of fences, gates and entry points are used to control access. The type of fence installed depends on the location and the objective of the fence. Consideration is also given to access for authorised vehicles, wheel chairs, prams and gophers and as well as access for fire fighting purposes. Where practical, chicanes are installed at pedestrian access points to restrict motorbike access while gates are installed to allow authorised vehicle access.

Although most of the reserves are fenced illegal access still occurs. Fences are cut and motorbikes access reserves via pedestrian access points. Fence repairs are carried out within 2 working days of notification.

### Illegal Access Funding Shortfall.

All reserves that have been identified as requiring fences have had fences installed. Resources to maintain fences are currently seen as adequate.

### **Actions**

1. Construct appropriate fences around conservation reserves to prevent and control unauthorised access. (KA16)
2. Undertake fence repairs within 2 working days of notification of damage. (KA17)
3. Erect signage at entry points to reserves that provides information on the impact and safety issues associated with illegal access. (KA19)

## ILLEGAL RUBBISH DUMPING

*Management Objective: To prevent illegal rubbish dumping in natural areas.*

Illegal dumping refers to the dumping of rubbish and garden waste in public areas. The environmental impacts of illegal dumping are significant. Dumped rubbish and garden waste can introduce weeds, leach contaminants, encourage vermin, reduce aesthetic value and amenity as well as increase bushfire risk. Water quality within wetlands can also be affected.

Illegal dumping can also pose serious health risks. Areas used for illegal dumping may be accessible to people, especially children, who are vulnerable to the physical and chemical hazards posed by waste.

Most reserves are fenced which helps to prevent illegal dumping. Where dumping still occurs the current strategy is to clean up any rubbish as soon as practical and dispose of it appropriately. The cost of removal is generally born by the reserve maintenance budget. Rubbish removal costs impact on the funding available for other maintenance and enhancement activities. Where possible the perpetrators are identified and fines are imposed.

In areas where illegal dumping occurs regularly Environmental Services have adopted a strategy of community education and involvement. Community groups are also encouraged to be involved in cleanup programs such as Keep Australia Beautiful.

### Illegal Rubbish Dumping Funding Shortfall

Currently rubbish found within reserves is removed within adequate time frames. The employment of a full time Environmental and Waste Education Officer in 2010/11 to development and implement waste education programs will assist in reducing the amount of waste being dumped and raise awareness of the issues associated with dumping.

The current funding deemed adequate.

### **Actions**

1. Construct appropriate fences around conservation reserves to prevent and control unauthorised access. (KA16)
2. Remove rubbish from conservation reserves as early as practical. (KA20)
3. Develop a community education program that includes a component about the impacts of illegal dumping. (KA21)

## **FIRE MANAGEMENT**

*Management Objective: To protect the biodiversity values of the City of Cockburn bushland reserves and limit the risk to people and property by reducing the frequency and intensity of unplanned fires.*

Unplanned fires are a major cause of degradation of bushland areas. Many fires are deliberately lit.

Frequent fires lead to the degradation of bushland by creating an environment ideally suited to weed establishment, particularly grass weeds like perennial veldt grass. The lack of canopy cover and the additional nutrients post-fire are ideal conditions for weed growth.

Frequent fires also impact on plant diversity by destroying slower growing species before they can produce seed. This can lead to the loss of species and changes to vegetation communities.

The control of environmental weeds, particularly perennial veldt grass, is an effective way to reduce the fuel load within bushland areas. Reducing the fuel load minimises the likelihood of fire and reduces the intensity should a fire occur.

Prescribed burning can also be an effective management tool. Undertaking slow burns every 8 to 10 years in cooler months can reduce the fuel load within natural areas.

Firebreaks are important aspect for fire management in bushland reserves. All reserves greater than 2 hectares are required, by law, to have a 3m wide firebreak around the perimeter. In larger reserves additional strategic firebreaks are also considered. When funding is available limestone is also placed on firebreaks. This reduces maintenance costs, gives surety to access and helps to reduce the spread of disease such as dieback.

Controlling illegal vehicle access into reserves can also reduce the incidence of unplanned fires within natural areas.

Weed control is undertaken on verges directly abutting reserves to reduce the fuel load and the likelihood of road side firebreaks spreading into reserves.

Fire response plans are prepared for all reserves. Plans use current aerial photos to show designated firebreaks, past fire sites, access points, vegetation types, water points and constraints within the reserve. Plans are updated every four years. Fire response plans are issued to the Fire and Emergency Services Authority.

### Fire Management Funding Shortfall

Weeds are seen as the major contributor to fire risk within reserves. A full scale weed control program would assist considerably in reducing this risk. It can be argued that the fire management funding shortfall is the same as the environmental weed control funding shortfall. This is currently estimated at \$498,764.



## Actions

1. Prepare and implement a works programme to manage priority weeds in bushland reserves. (KA6)
2. Ensure there are adequate firebreaks that comply with the Bush Fires Act around the perimeter of all conservation reserves and fire access trails strategically located through larger reserves. (KA22)
3. Utilise herbicides or install limestone where practical rather than grading firebreaks. (KA23)
4. Construct appropriate fences around conservation reserves to prevent to control access. (KA16)
5. Ensure verges adjoining reserves are free from weeds. (KA24)
6. Prepare Bush Fire Response Plans for all conservation reserves and review every three (3) years. (KA25)
7. Assess the suitability and appropriateness of prescribed burning to reduce high fuel loads in reserves. (KA26)
8. Liaise with government agencies such as FESA and DEC in relation to best practice fire risk reduction and suppression. (KA27)



Frequent fires can impact on species diversity

## DISEASES EFFECTING BUSHLAND

*Management Objective: To reduce the impact of plant disease on natural areas.*

There are a number of diseases that have the potential to impact on the quality of bushland. These include Dieback and Armillaria root rot. The main disease affecting our bushland areas is Dieback, *Phytophthora cinnamomi*.

Dieback can have catastrophic consequences for the biota of ecosystems. It causes a decline in biodiversity and irreversible damage to plant communities. This reduces habitat and food supplies for native fauna. Once established in an area it can never be eradicated.

Dieback has been identified as occurring in a number of the bushland reserves. The reserves impacted include Denis De Young, Little Rush Lake, Yangebup Lake, Holdsworth, Berrigan, Bosworth and Gil Chalwell.

Dieback hygiene procedures are employed in all reserves. Staff and contractors are expected to follow the correct hygiene procedures when undertaking works within Council reserves. A copy of the Dieback Hygiene procedures can be found in Appendix D.

Where dieback is suspected, a dieback survey is initiated. Phytophthora dieback surveys are undertaken by speciality contractors. Consultants undertaking the surveys discount other factors that could have caused the plant death, such as fire, insects, flood, drought, nutrient deficiencies or toxicities and other plant disease before making a determination.

If dieback is positively identified as occurring in a reserve the area is then mapped for future reference. Dieback areas are highlighted on Fire Response Plans. Reserves are re-mapped and follow up treatments occur every three years.

The treatment for dieback is undertaken using a product called Phosphite. Treatment can include spraying the affected area or stem injecting susceptible plants with a phosphite solution. A combination of both treatments can also be employed.

Where large areas have been infected aerial treatment using a helicopter can be undertaken. This method has been used at Denis De Young Reserve

Where resources permit, limestone is placed on firebreaks in reserves containing dieback. Limestone makes an ideal material for use in construction of the firebreaks as its high pH is very suppressive of Phytophthora Dieback.

Where possible plants resistant to dieback are used when undertaking revegetation in dieback infected areas.

Further information and details on how to manage dieback can be found at the Dieback Working Group Website. [www.dwg.org.au](http://www.dwg.org.au)

### Diseases Effecting Bushland Funding Shortfall

Currently it is estimated that it approximately 67 hectares of bushland is infected by dieback. The current costs to re-interpret/map and treat infected bushland is \$1,000 per hectare. This is based on manual treatment. Treatment using a helicopter is considerably cheaper however there are currently no operators within the Perth metropolitan area that can undertake aerial treatment.

Current funding to control dieback is considered adequate.

## Actions

1. Construct appropriate fences around conservation reserves to prevent and control unauthorised access. (KA16)
2. Ensure staff and contractors practice good dieback hygiene procedures when working in reserves. (KA28)
3. Undertake dieback assessment and mapping in reserves containing and suspected of containing dieback. Re-assess reserves every three years. (KA29)
4. Instigate dieback control methods where practical such as phosphite treatment, limestone on firebreaks and revegetation using dieback tolerant endemic species. (KA30)
5. Ensure fire response plans show dieback infected areas. (KA31)
6. Support the Dieback Working Group in their endeavours. (KA32)



Aerial spraying to control *Typha orientalis* weed at Bibra Lake



## STORMWATER DRAINAGE

*Management Objective: To enhance wetland water quality and reduce erosion within conservation areas.*

The City of Cockburn has numerous wetlands, many of which are within the Beeliar Regional Park. Some of the reserves in the east of the also contain wetlands. These include Bosworth, Emma Treeby, Mather and Denis de Young Reserve.

In the not too distant past wetlands were filled to make way for development or development was allowed to occur very close to wetlands. In the latter case stormwater and effluent was generally discharged directly into wetlands and as a result many wetlands suffered from water quality issues associated with excess nutrients, hydrocarbon and heavy metal contamination.

Today wetlands are valued to a greater degree and planning controls exist to prevent the discharge of stormwater directly into wetlands. Guidelines for Water Sensitive Urban Design have been developed by the Department of Water which have been developed to enhance water quality and help to protect wetlands.

In the event that stormwater is to be discharged near wetlands it is generally discharged into infiltration basins or vegetated swales, sometimes called nutrient stripping basins. These swales and basins retain water for short periods and allow larger particles to settle and nutrients to be filtered or utilised by vegetation. The water within these basins is filtered as it percolates through the soil entering the groundwater which then recharges the wetlands.

Within Cockburn basins and swales are generally required to be designed to contain 1 in 5 year storm event. In events greater than a 1 in 5 stormwater then flows out of the basin directly into the wetland buffer and ultimately into the wetland. The theory behind this is that most of the contaminants have already been washed into the infiltration basins in the early downpour and the quality of the water flowing into the wetland is reasonably good. Erosion control measures are included in the basin design to prevent erosion in the event of an overflow in bigger storm events.

Gross pollutant traps are also required to be installed adjacent to wetland areas to capture larger material such as leaves and litter before it enters swales and basins.

Poor water quality can also lead to problems associated with nuisance midge and mosquitoes. Seasonal midge swarms in the vicinity of lakes and wetlands adversely affects the quality of life of nearby residents. The City receives numerous complaints from residents that live close wetlands. Larger wetlands are generally treated with pesticide when midge numbers become excessive.

This has developed an integrated midge control strategy. Further details of this strategy can be found on Councils website at: <http://www.cockburn.wa.gov.au/>



Living Stream flowing into Yangebup Lake

## Stormwater Drainage Funding Shortfall.

All new developments adjacent to wetland areas are required to utilise water sensitive urban design principles to reduce impacts on water quality. A number of wetlands still receive direct discharge of stormwater. The water quality within Yangebup Lake is of major concern however the water body is not managed by the City and the drainage infrastructure is operated by the Water Corporation. The City is currently negotiating with stakeholders to develop procedures to improve the water quality of this wetland. Stormwater discharge into other wetlands is considered minor and not considered a major threat. Best practise management techniques will be installed as these systems require upgrading.

The current funding and procedures that are in place are considered adequate to maintain wetland water quality.

### **Actions**

1. Ensure best practise Water Sensitive Urban Design is practised in new subdivisions (KA33)
2. Retrofit best practise Water Sensitive Urban Design measures into areas where water quality is being adversely affected by outdated practises (KA34)
3. Undertake regular water quality monitoring of wetland areas. (KA35)

## **CLIMATE CHANGE**

*Management Objective: To build the resilience of natural areas to allow them to adapt naturally to climate change.*

The recently released draft of Australia's Biodiversity Conservation Strategy indicates that we need to ensure that our natural environments are able to retain their biodiversity values and critical ecological functions in the face of growing pressure, including that from climate change. Parks and reserves play a key role in buffering natural systems against climate change. Maintaining reserves and developing ecological linkages is the most effective and immediate strategy to build resilience in a changing climate. Maintaining a comprehensive, adequate and representative reserve system is the best way to secure the habitats of vulnerable species (DEWHA 2009).

Reduced rainfall, increased storm intensity, sea level rise and temperature change all have the potential to impact on natural areas. Perhaps the most challenging aspect of climate change in terms of natural area management is reduced rainfall. Reduced rainfall has the potential to dramatically alter vegetation communities. Increasingly wetlands are retaining less water for shorter periods. If rainfall continues to decrease plants that depend on periodic inundation may suffer water stress which may impact on species diversity. Lower rainfall could eventually lead to a change in vegetation communities. Upland vegetation will progressively move into areas that were once the domain of wetland species. Although there is no certainty that rainfall will continue to reduce in the longer term the current trend indicates that this will be the case.

Vegetation, ecological communities and natural areas in general are very resilient. If allowed to take their own course there will be a natural succession with plants that survive in dryer areas replacing wetland dependent species. The Cities management approach to natural areas in the face of climate change is to allow nature to take the lead, that is: allow natural succession. In order to allow this to occur we need to make the system as resilient as possible to maintain ecological function. This involves



reducing the other threats that our natural areas face so that ecosystems can focus their energies on adapting to climate change.

The establishment and enhancement of ecological corridors also promotes resilience by allowing species migration to and from natural areas.

### Climate Change Funding Shortfall.

The management approach to natural areas in the face of climate change is to allow nature to take the lead, that is: allow natural succession. This implies reducing the other threats that our natural areas face so that ecosystems can focus their energies on adapting to climate change. The funding shortfall therefore is a combined total of the overall funding shortfall which is detailed in Section 8. Operational Funding Requirements.

### **Actions**

1. Increase the resilience of natural areas by addressing the threats posed by weeds, feral animals, illegal access, illegal rubbish dumping, increased fire frequency, disease such as dieback, storm water drainage and climate change. (KA36)
2. Continue to keep informed about the latest research developments in terms of climate change scenarios and best practice bushland adaptation techniques. (KA37)
3. Be prepared to alter management practices to adapt to a changing climate. (KA38)



Manning Lake

## REHABILITATION, REGENERATION & REVEGETATION

*Management Objective: To enhance and rehabilitate degraded natural areas.*

The City manages a number of reserves that have been impacted by past land use practises and their condition ranges from degraded to excellent. Enhancing the condition of these degraded areas has a number of benefits that make the exercise worthwhile. Enhancing bushland improves the habitat values of an area, reduces the longer-term management inputs and increases other values such as amenity and recreational use. It can also assist in reducing the risk of fire by reducing the prevalence of weeds.

Given the variation in condition within the reserves the City uses a number of approaches to enhance the condition of the reserves. These approaches are:

- Rehabilitation: defined as the restoration of a natural area that has been temporarily and grossly disturbed and no natural components are present. (Local Govt Biodiversity Planning Guidelines, Corbyn unpublished 2003 and Kaesehagen unpublished 2001).
- Regeneration: defined as the restoration of natural ecosystems through the natural cyclic process of renewal and self maintenance of species and their populations. The aim of those undertaking regeneration is to restore conditions so that the natural regeneration capacity of the ecosystem is able to continue (Kaesahagan unpub 2001).

The major differences between methods of regeneration are the means of weed removal, the means of germinating existing native plant propagules and whether or not revegetation will be undertaken.

Revegetation: defined as the planting or direct seeding of native species in areas that have been cleared or highly modified (Commonwealth of Australia 2001).

Where practical the City generally utilises the basic principles of the Bradley method of regeneration. However this may be used in conjunction with revegetation of the larger areas where weeds have been controlled or removed generally by chemical means. The Principles of the Bradley Method of Bush Regeneration can be found in Appendix C.

Generally a combination of techniques is used to enhance natural areas. Techniques may include direct removal of weeds, selectively timed application of herbicides, release of organisms harmful to weeds and targeted weed control in areas that have recently been impacted by unplanned bushfire. In the future another approach that is being considered and assessed is the deliberate use of fire to kill weeds, destroy their seeds and stimulate native plant growth. Based on past experience the use of fire may be a very effective way to control invasive weeds such as Geraldton Carnation.

The use of top soil from other locations where clearing has taken place is also a viable and proven process for regeneration. This method has been used at Denis De Young and Solomon Reserves where top soil from other clearing works has been spread. The use of top soil for regeneration only occurs where vegetation community is the source of top soil. Top soil is only used if it is free from disease such as dieback.

Bushland enhancement is a slow process which requires the ongoing commitment of resources. An intensive weed control program can produce great changes in a short space of time. However, follow-up work is always required over a number of years to prevent reinfestation. Thus regeneration programs need to be planned with a view to long term commitment to maintenance and input of resources.

Only local native species are used when undertaking rehabilitation and revegetation. Where possible local plants are grown from seed sourced locally.

The Council has an effective natural area management program, with a strong emphasis on coordinated actions that assist natural bushland regeneration. Three full time bush maintenance teams are currently employed to undertake on ground works. Casual staff, external contractors and volunteers are also utilised. However, despite the major contribution by volunteers, the volume of work that is required from year to year presently exceeds the current resources of Council staff and volunteers alike.

The main emphasis in developing a long-term approach to management objectives for natural area enhancement is to integrate all regeneration and restoration works with weed control with consideration given to fire management planning. Detailed site assessments are undertaken by staff experienced in natural area management prior regeneration and restoration works. Planting plans are prepared for each planting site prior to works commencing.



Planting using local native species at Bibra Lake

## Actions

1. Implement a best management practice for natural area regeneration and rehabilitation that includes detailed pre-work site assessment, identifies clear aims and outcomes, recommendations for regeneration techniques. (KA39)
2. Prepare planting plans for planting sites prior to undertaking revegetation works. (KA40)
3. Develop and implement a program of regeneration/restoration works across natural areas that is informed by:
  - the priorities for managing threatened species and habitat;
  - the extent of priority weed species which are targeted for control;
  - statutory requirements for fire management; and
  - the human resources available (staff and volunteers) (KA41)
4. Ensure the provision of adequate resources for the ongoing maintenance of natural areas. (KA42)



## WETLAND MANAGEMENT

*Management Objective: To enhance and rehabilitate natural wetland areas while increasing their resilience to withstand impacts associated with climate change.*

Many of the reserves managed for conservation also contain wetlands. Wetland dependent vegetation is managed in a similar manner to dry land vegetation. The procedures used for revegetation are also similar.

The Cities management approach to wetland natural areas in the face of climate change is to allow nature to take the lead, that is: allow natural succession. In order to allow this to happen we need to make the system as resilient as possible to maintain ecosystem function. This implies reducing the other threats that our wetlands face so that ecosystems can focus their energies on adapting to climate change. Rehabilitation strategies will also reflect changes to vegetation communities.

As part of the Integrated Midge Control Program wetland water quality is monitored in many of the larger wetland systems where there have been water quality issues in the past. In smaller wetland areas water quality are addressed on an as needs basis.

Measures used to address poor water quality include revegetation of riparian vegetation, removal of weeds such as *Typha orientalis* and replacement with native species, installation of gross pollutant traps and nutrient stripping basins and converting drains into living streams.

### Actions

1. Develop and implement a Weed Control Strategy (KA4).
2. Retrofit best practise Water Sensitive Urban Design measures into areas where water quality is being adversely affected by outdated practises (KA34)
3. Undertake regular wetland Water Quality Monitoring in wetland areas (KA35)
4. Increase the resilience of natural areas by addressing the threats posed by weeds, feral animals, illegal access, illegal rubbish dumping, increased fire frequency, disease such as dieback, storm water drainage and climate change. (KA36)



Recent planting at Bibra Lake

## ECOLOGICAL CORRIDORS AND LINKAGES.

*Management Objective: To maintain genetic diversity and genetic viability across natural areas.*

The modification, loss and fragmentation of the City's natural bushland and wetlands have resulted in a number of small isolated pockets of bushland that are increasingly at risk of decline. The species that reside in these areas are at risk because there is limited potential for these species to maintain their genetic diversity and hence their resilience because of their isolation.

With changing weather patterns due to climate change these isolated pockets are at further risk because smaller populations with their limited diversity will have difficulty adapting to changing environmental conditions and increased competition from weeds.

One way that we can assist to halt the decline of these isolated areas is to develop a network of ecological corridors and linkages that will help to connect isolated areas and thus promote the movement and the exchange of genetic material between these remnants.

Ecological corridors are contiguous natural areas or revegetated areas that directly connect larger areas allowing movement over time of organisms between these larger areas. While ecological linkages are non-contiguous natural areas they connect larger natural areas by forming stepping stones that allow the movement, over time, of organisms between the larger areas (Perth Biodiversity Project 2004).

For the sake of simplicity both corridors and linkages will be referred to as linkages within this document.

WALGA's Perth Biodiversity Project has identified a network of possible future ecological linkages across the metropolitan area. Figure 1 shows the proposed locations of these linkages within Cockburn as well as the existing natural areas managed by the City.

**Figure 1. Regional Ecological Linkages**





## **NORTH/SOUTH LINKAGES.**

The existing north to south linkages within Cockburn can be considered to be quite good. The linkages are generally through areas contained within regional parks. The Beeliar Regional Park runs north to south along the western edge as well as through the centre of the City and is made up of a number of wetland and bushland areas managed by private landowners, the Department of Environment and Conservation and the City. Except for roads, the park is almost contiguous from north to south with only two areas, one, between Manning Reserve and Market Garden Swamp and the other between Lake Coogee and Brownman Swamp, having distances of slightly more than 400 metres separating them.

The Baldivis Tramway Trail also abuts portions of the Beeliar Regional Park namely Kogalup and Thomsons Lakes and Harry Waring Marsupial Reserve. The trail also extends into and through Kwinana and Rockingham to Baldivis. Although quite thin it has been identified as an ecological linkage and was identified in the Strategic Plan for Perth Greenways as Greenways link 78. It has also been identified as major north south greenway in the Beeliar Regional Park Management Plan.

The north south linkage in the east of the City is also quite good as it incorporates large tracks of the Jandakot Regional Park as well as private lands within the rural zone, many of which still retain natural vegetation.

Stock Road and the Kwinana Freeway each retain some form of vegetation within their boundaries. Although dissected in many places these road corridors offer good ecological linkage function as they each traverse the municipality from north to south.

The function of the identified regional park and road reserves as ecological linkages is further enhanced because in many instances they intersect or run parallel to each other and are adjacent to rural areas in a number of places.

### **Actions**

1. When selecting areas to revegetate within reserves select those sites that offer the best opportunities to enhance ecological connectivity (KA 43).
2. Support the Department of Main Roads in their endeavours to maintain and enhance natural vegetation within existing road reserves (KA 44).

## **EAST/WEST LINKAGES.**

Currently there is limited connectivity between natural areas in the east with those in the west of the municipality and there is limited scope to develop east west contiguous corridors due to development that has occurred. Currently the best opportunities are offered by road reserves and railway corridors.

## EAST/WEST ROAD LINKAGES

A number of road reserves within the City have been identified as offering good potential to be utilised as east west ecological linkages. They are:

Roe Highway and Roe Extension Road Reserves

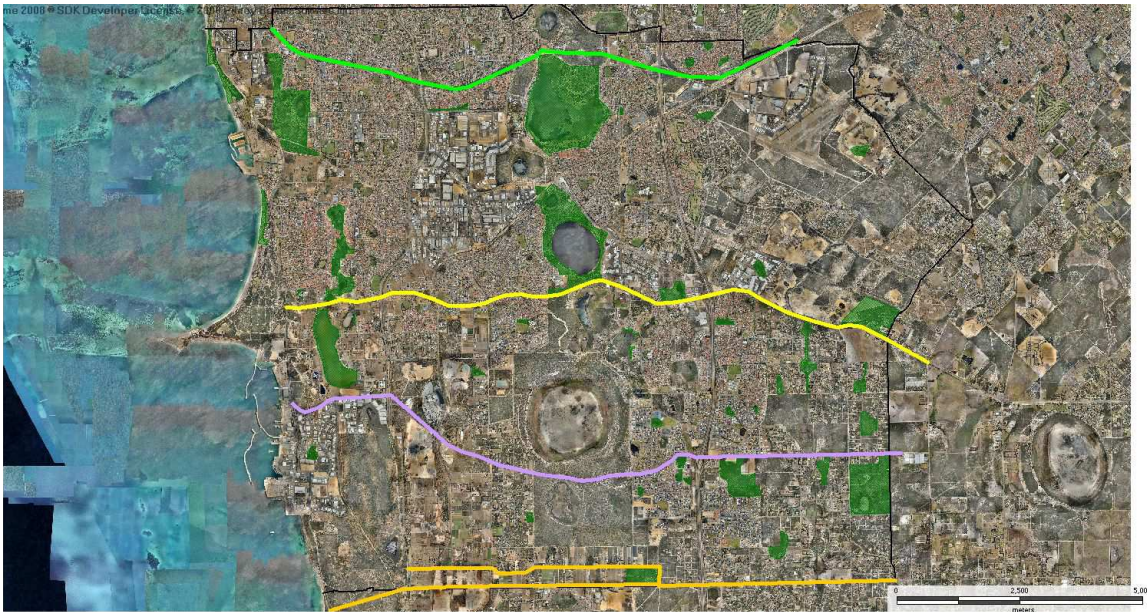
Beeliar Drive/Armadale Roads

Russell /Gibbs Roads

Rowley Road

The location of each is shown in Figure 2 below and are shown from top to bottom in the order they are written.

**Figure 2. East West Road Linkages.**



*Roe Highway and Roe Highway Extension* – The existing highway and the proposed extension currently traverses the City from east to west. The built portion of Roe Highway has vegetated areas adjacent to the road and although these areas are bi-sected by other roads the remnant vegetation still provides a good ecological linkage.

Most of the remaining unconstructed road reserve is vegetated to some extent through to North Lake Road. Although roads currently exist within the road reserve and it is also bisected by other roads the remnant vegetation is adequate to function as a linkage.

Moving west from North Lake Road along the proposed road alignment there is little native vegetation remaining which will limit its ecological function but the area offers good potential and could be revegetated over time.

There is currently a proposal to construct the Roe Highway Extension from where it terminates at the Kwinana Freeway through to North Lake Road. Should the project go ahead the proponent, Main Roads, has given commitments to retain vegetation along the alignment and to install fauna underpasses. Construction will reduce its current linkage value but some value will remain.

The Roe Highway may be extended in the future further west to link with Cockburn Road. Should this occur, it is expected that existing vegetation would be retained where possible and revegetation works would be undertaken to provide a good ecological linkage.

Due to the uncertainty of the proposed Roe Highway Extensions the City is reluctant to expend funds to strengthen the existing linkages. At the time of writing this strategy the City was opposed to the extension of the Roe Highway for a number of reasons, one of which is because construction will adversely impact on the ecological linkage currently provided by the road reserve.

*Beeliar Drive/ Armadale Road* – These two roads meet at Cockburn Central and together traverse the centre of the municipality from east to west. The road reserves are generally large and, although sparsely vegetated at present, there is scope to revegetate existing median strips and adjacent verges to enhance their linkage potential. Each road passes through a section of regional park and there are also a number of other reserves and parks directly adjacent to or in close proximity at various points along their paths. Armadale Road also passes through the rural area in the resource zone in the east of the municipality.

There are long term plans to widen Armadale Road and extend Beeliar Drive (which would see it dissect additional sections of the Beeliar Regional Park at Lake Coogee). If these works are to proceed the City should seek to ensure that measures are undertaken to enhance the ecological linkage values of each of these roads.

*Russell/ Gibbs Roads* – These two roads join at the Kwinana Freeway and together traverse the City from east to west in the central southern half of the municipality. Gibbs Road passes predominantly through rural areas in the resource zone and is adjacent to a number of large and small conservation reserves, two of which are within the Jandakot Regional Park (Denis De Young Reserve and Banksia Eucalypt Woodland Reserve). Russell Road also dissects two large conservation reserves within the Beeliar Regional Park (Thompson Lake and Harry Waring Marsupial Reserve). Revegetating the median strips and verges of these roads would enhance their value as ecological linkages.

*Rowley Road* – This road is the dividing border between the City of Cockburn and Town of Kwinana. The road currently traverses rural areas in the resource zone. These rural areas are important ecological linkages in their own right and complement the road reserve.

Rowley Road does not presently exist west of the Kwinana Freeway. After crossing the freeway it turns north and connects into Wattleup Road. Wattleup Road then heads west through rural areas and vacant cleared land to Stock Road. On the opposite side of Stock Road is Brownman Swamp, which is part of the Beeliar Regional Park. The existing rural and vacant land offers the ecological connectivity across the city in this southern zone. However, areas on each side of the freeway are soon to be developed, as are areas within Latitude 32 commercial precinct. This development will ultimately fragment the existing connectivity. To help maintain this connectivity the verges and future median strips of both Rowley and Wattleup Roads should be vegetated using native species.

There are plans to extend Rowley Road west to connect with the coast. This is being considered as one of the options to optimise access to the Fremantle Outer Harbour. At present the proposed alignment is predominantly made up of privately owned rural lots. Should the extension of Rowley Road proceed the City should ensure it is constructed and landscaped in a manner that allows it to act as an ecological linkage.

*Latitude 32* – There exists great opportunity to connect the western portion of the Beeliar Regional Park (Brownman Swamp and Mount Brown) with the eastern portion of the Park (Thomsons Lake & Harry Waring Marsupial Reserve) via Landcorps yet to be developed, Latitude 32 industrial area. Latitude 32 is located in the south western region of Cockburn and northern western parts of Kwinana.

No land has been set aside purely for the establishment of linkages, which is a shame, but links have been identified along road reserves and easements. The following has been extracted from the Latitude 32 Structure Plan - Creating the Structure Plan document.

#### *Latitude 32 East-west links*

*Rowley Road: will link the east and west Beeliam Regional Park wetland chains. This corridor will provide a sufficient width and vegetative cover to allow the movement of mammals and reptiles, in addition to birds, along the corridor.*

*Russell Road - will form part of the future upgraded road reserve, connecting the east and west Beeliam Regional Park wetland chains across the northern section of Latitude 32.*

*Western Power transmission line easement – Although it cannot be developed vegetation can exist subject to height restrictions. Depth restrictions also apply to plant roots where the easement intersects the Dampier to Bunbury Natural Gas Pipeline (DBNGP) easement.*

*Corridors in and around the Henderson Resource Recovery site buffers will provide localised revegetated buffers surrounding the Resource Recovery site.*

#### *Latitude 32 North-south links*

*A north-south ecological linkage between Anketell Road (Kwinana) and Long Swamp to Russell Road, utilising the new north-south district distributor road reserve and land adjacent to the DBNGP corridor.*

#### *Latitude 32 Additional wetland linkages*

*The 2007 Biodiversity Strategy identified a wide corridor from Long Swamp to Anketell Road, Kwinana with a spur linking the corridor to the Hendy Road Swamp East, Kwinana. A proposed 50m wide vegetated corridor between the two wetland areas is included in the District Structure Plan.*

*A well vegetated road reserve along the southern section of Dalison Avenue will provide a corridor that will link Banganup Lake bushland to the north south ecological linkage down to Long Swamp. Additional linkages between wetlands may exist along Alcoa's buffers the Western Power easement, Bush Forever Site 267, Wattleup Lake, Wattleup/Pearce Road Swamp and Bush Forever Site 392*

#### **Actions**

1. Seek to ensure that, should the proposed Roe Highway extension proceed, native vegetation is retained and revegetation undertaken so that it maintains some function as an ecological linkage (KA45).
2. Retain and enhance the current east west ecological linkage functions of Beeliam Drive, Armadale Road, Russell Road, Gibbs Road, Rowley Road and Wattleup Road. (KA46).
3. Ensure that the commitments to establish suitable ecological linkages within the Latitude 32 development are honoured (KA47).



## RAIL LINKAGES

The City is dissected from east to west and from north to south by an interconnected rail line. See Figure 3. The railway corridor represents an important potential ecological linkage across areas that have been cleared of native vegetation including residential and industrial areas. At some locations the rail corridors are adjacent to remnant vegetation including the bushland contained within Jandakot Airport and sections of the Beelihar Regional Park.

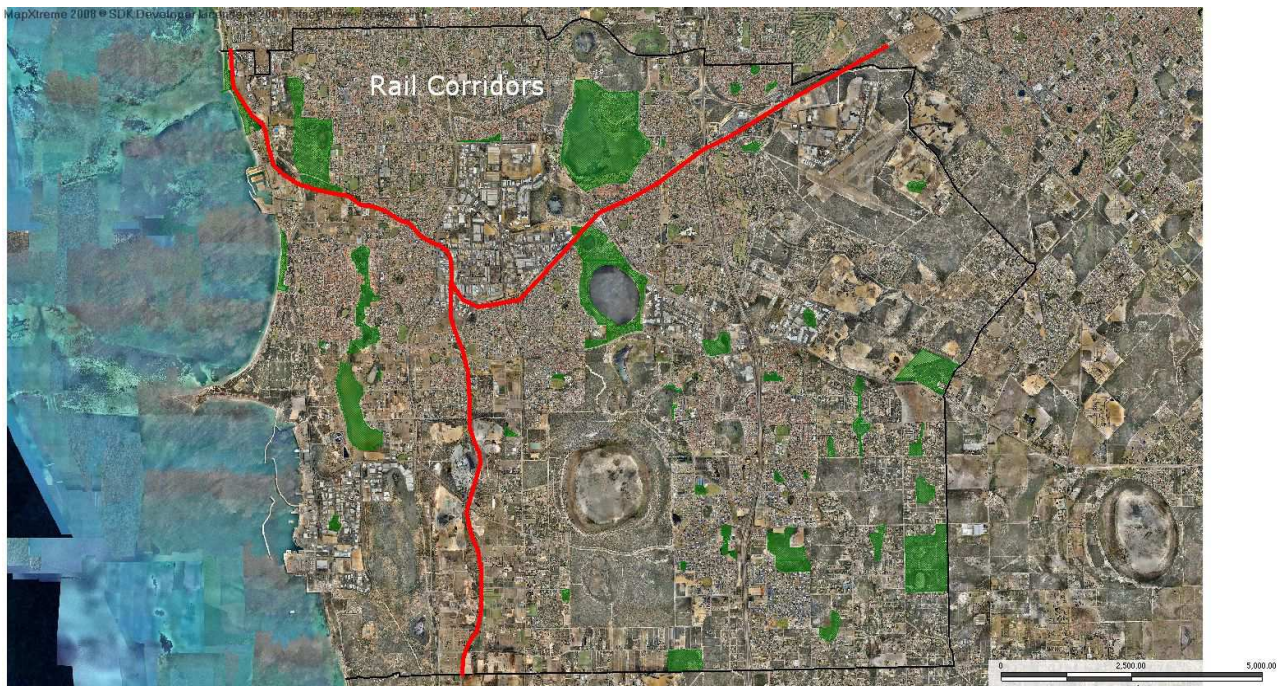
Rail reserves make a major contribution to ecological connectivity and in some landscapes provide key habitat for many species (VEAC 2011). The City of Cockburn rail reserves also have potential biodiversity value as a source of plant and animal species. The revegetation of some or all of the rail reserves within the City has the potential to link both large and isolated bushland areas throughout the municipality.

The City has funded a University 3<sup>rd</sup> Year project which identified rail corridors as highly valued ecological corridors.

### Actions

1. Examine the potential to enhance sections of the rail reserves for enhanced ecological function and biodiversity conservation (KA48).
2. Commence discussions with West Rail to gain support for rail reserves to be vegetated to enhance their value as ecological corridors/linkages (KA49).

**Figure 3. Rail Corridors within Cockburn**





## WESTERN POWER TRANSMISSION LINES

There are a number of Western Power transmission line easements that cross the City. Transmission lines cannot be developed under but offer an excellent opportunity as ecological linkages. Many of these easements also pass through reserves, rural areas and traverse other land already identified as possible ecological linkages such as rail corridors. Of the transmission line easements that cross the City two have been identified as possible ecological linkages and may already be functioning as linkages to a limited extent as many are lined with vegetation.

Figure 4 shows the transmission line easements that have been identified as possible ecological linkages.

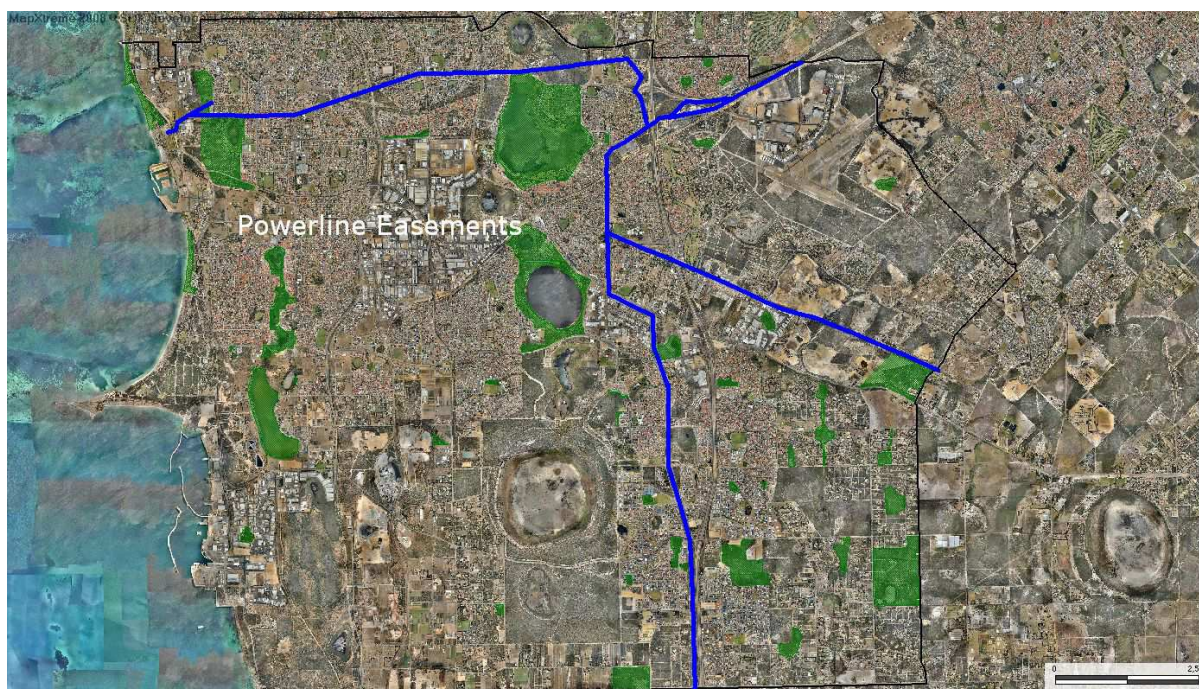
There are restrictions on what can be done within transmission easements. Vegetation can exist but is subject to height restrictions. Depth restrictions also apply to plant roots where the easement intersects the Dampier to Bunbury Natural Gas Pipeline (DBNGP) easement.

Based on past experience Western Power seem quite receptive to easements being vegetated (with restrictions) but generally the proviso is that the land is then maintained by the local authority and Western Power retain the right of entry to undertake works which may include the removal of vegetation. Even with these restrictions these easements are still considered ideal ecological linkages.

### Actions

1. Liaise and encourage Western Power to retain and maintain native vegetation within the identified power line easements (KA50).

**Figure 4. Powerline Easements within Cockburn**





## BP REFINERY OIL PIPE LINE

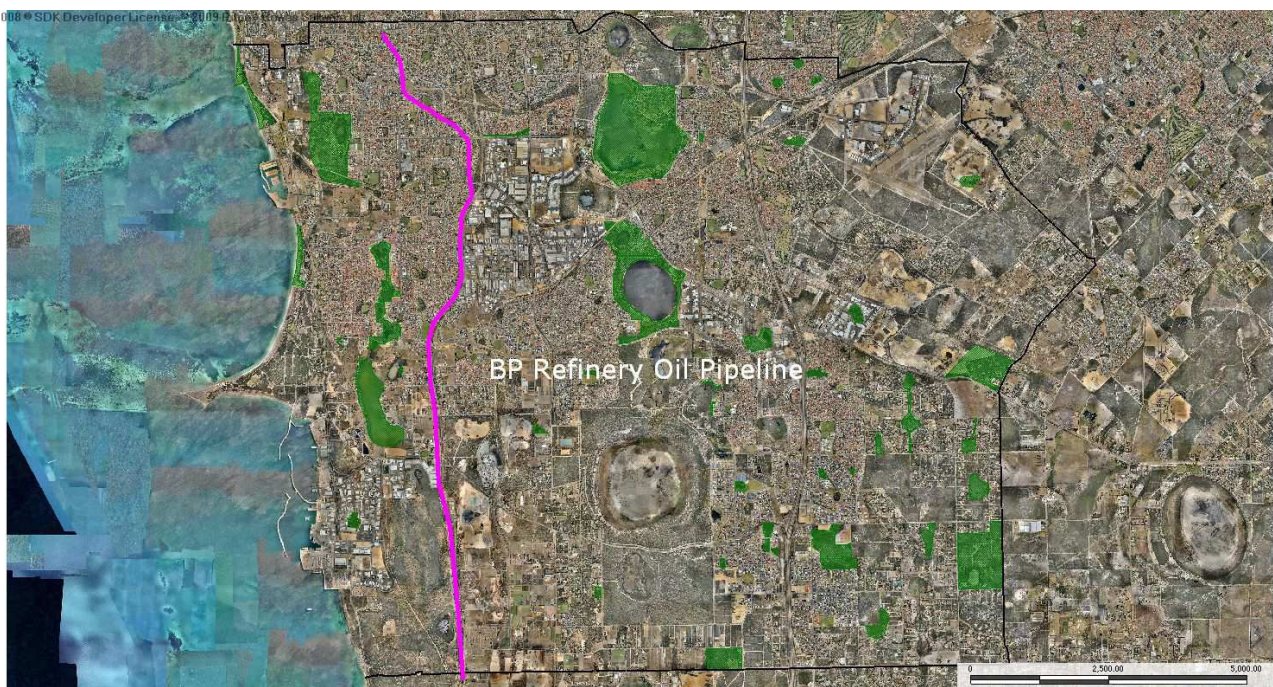
This pipe line has an easement the runs from Carrington Street in the north through residential and industrial areas of Hamilton Hill and Spearwood eventually connecting in to Stock Road near the intersection of Spearwood Avenue. The easement is only 20 metres wide and although not adjacent to any conservation areas, it does link to other road reserves, public open space and vacant lots in many areas and offers a good opportunity to create linkages to other identified linkages such as the Roe Highway road reservation and Stock Road. See Figure 5.

The City has undertaken landscaping works in some areas. However there is a limit to the type of infrastructure and landscaping that can be installed within the pipe line easement. The opportunity to plant large trees is limited but the planting of smaller shrubs and vegetation is permitted. Future landscaping could be undertaken in a manner that gives consideration to the establishment of a functioning ecological linkage.

### Actions

1. Ensure future landscaping of the BP Refinery Oil Pipeline is undertaken in a manner that enhances the pipelines ability to function as an ecological linkage (KA51).

**Figure 5. BP Refinery Oil Pipeline**



Apart from residential development adjacent to the Kwinana Freeway much of the eastern region of Cockburn is zoned resource and is predominantly comprised of private rural landholdings of approximately 2 hectares. The resource zoning is to assist in providing protection for the Jandakot Ground Water Mound. The mound is a shallow sand aquifer, formed by sediments deposited over the last 2 million years, with a saturated thickness of up to 40m. The aquifer is an important water resource for Perth.

Large amounts of easily accessible fresh groundwater occur in the Jandakot Mound. As the groundwater table is often close to the surface, the aquifer supports extensive wetland systems and groundwater dependent vegetation. The resource zoning affords the mound some protection as it limits the activities that can be undertaken on these lots. Many of the lots still retain native vegetation and the retention of native vegetation is encouraged. Retention of vegetation not only helps to protect the water mound but it also offers other ecological benefits including connectivity.

Within Cockburn but away from the mound there are other smaller rural and rural living zones. Generally these areas are considered transition areas and act as buffers between industry and higher density urban areas.

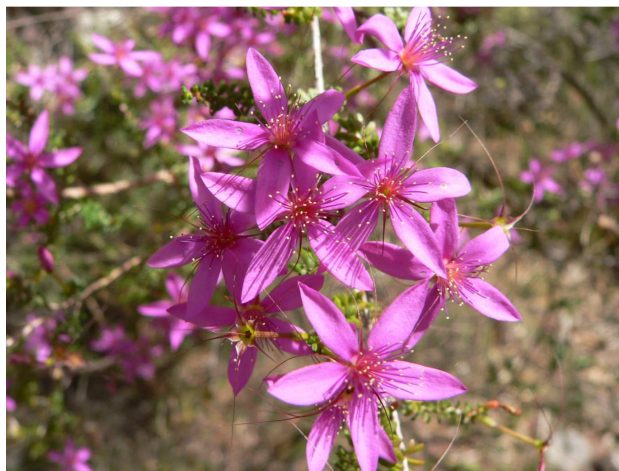
Both vegetated and pasture lots in the rural, rural living and the resource zones provide ecological connectivity between conservation reserves and other remnant vegetation. Private lots that still retain native vegetation will offer better ecological benefits than cleared lots.

The City has recognised the need to retain vegetation in the rural areas and has developed the Landowner Biodiversity Conservation Grant Program. This program is intended to give financial and natural resource management training and support to Cockburn landowners living in the rural, rural living and resource zones who wish to conserve and enhance the natural bushland and wetland areas on their property.

A total allocation of \$40,000 is made available each year. The maximum grant provided to any one landowner is \$3,000. The City encourages adjoining landowners to apply as this helps to enhance and maintain existing linkages and develop new ones.

### Actions

1. Offer incentives, training, and information to landowners and residents to encourage management of natural areas on private property and use of local species (KA10).



*Calytrix fraseri* (Pink Summer Calytrix)

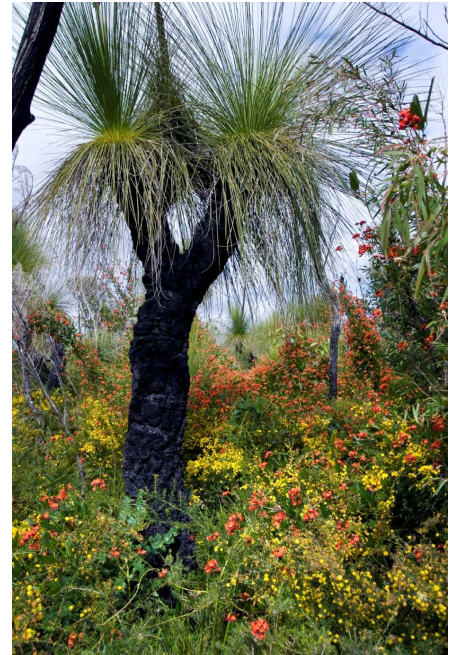


## RESIDENTIAL LINKAGES

Residential areas within the urban environment offer some potential as ecological linkages. Gardens and verges that are vegetated with local species will attract native fauna, help maintain genetic diversity within plant populations and provide a series of ecological stepping stones across the City, particularly for birds and insects. Gardens also offer habitat for some mammal and reptile species such as possums and lizards.

Gardens and verges are particularly valuable as linkages where they are close to remnant native vegetation such as that in conservation reserves, road reserves and easements.

The City recognises the important role local gardens can play in maintaining biodiversity and has developed a number of initiatives to encourage local residents to plant local species within their gardens and verges.



*Xanthorrhoea pressii* (Grass Tree)

Initiatives include:

- A Residential Plant Subsidy Scheme. The scheme provides residents with the opportunity to purchase discounted local native plants for their gardens.
- Local Plant Guide Brochures which list species endemic to areas within the City. The brochure also lists nurseries that sell local plant species.
- Verge Policy. This policy supports residential landowners who may wish to replace their lawn with plants.
- Development of a local and native plant species list for industrial lots. This list has been designed to promote the use of local native species and other non invasive species for landscaping in industrial areas. The list has been refined and only includes those plants that are practical in a landscape setting and are easily sourced.

The City supports and contributes to studies that investigate the potential for urban gardens to contribute to ecological connectivity. These studies and others like them will contribute valuable information relating to the establishment and practicalities of linkages in urban settings. Two such projects being supported at present are both being undertaken by Murdoch University Honours students:

- Reconnecting the City with Nature.
- Identification of Important Frog Habitat Requirements and Connectivity in Natural and Constructed Urban Systems.

### Actions

1. Offer incentives, training, and information to landowners and residents to encourage management of natural areas on private property and use of local species (KA10).

## OTHER INITIATIVES

Although a number of existing and potential ecological linkages have already been identified the City is aware that there may be other opportunities that have been overlooked. With this in mind the City has teamed with Curtin University and has undertaken a study to determine suitable species that can be tagged to monitor fauna movements across the City. Species identified include a number of bird species, bandicoots and lizards.

The next stage of the study is to tag these animals to try to get an idea of their movements and factors that will assist them to utilise and move through identified corridors. Funding has been allocated to this study.

### Actions

1. Continue to support tertiary studies that investigate potential locations, designs and the effectiveness of ecological corridors (KA52).



Western Glossy Swamp Egernia

## FUTURE DEVELOPMENT

Where practical the City encourages developers to consider ecological linkages when submitting local structure plans. It is important that linkages are considered early in the planning process. A number of good outcomes have been achieved through early considerations.

A good example is in the suburb of Beeliar. Development in this area has considered linkages and the suburb has a number of public open spaces that retain native vegetation and provide almost contiguous linkages to the Beeliar Regional Park in the east and to vegetated road reserves and rural zones in the west.

### Actions

1. Continue to encourage developers to consider ecological linkages when formulating structure plans (KA53).
2. Support the objectives of the City's Bushland Conservation Policy (KA54)



## WILDLIFE CROSSINGS

Wildlife crossings are structures that allow animals to cross constructed barriers safely. Wildlife crossings can vary in design and can be large to cater for animals such as kangaroos or they can be small to cater for smaller creatures such as frogs. Examples may include underpass tunnels, culverts and overpasses including structures such as rope bridges. Wildlife crossings provide connections or reconnections between habitats that have been fragmented. Generally some form of fence or guiding rail is required to guide animals to the underpasses

The City has installed a number of fauna underpasses under roads to provide connectivity to areas that would otherwise be separated. Examples include North Lake Road where two underpasses have been installed to connect Bibra Lake and South Lake. Other examples exist on Osprey Drive and Beeliam Drive in Yangebup.

### Actions

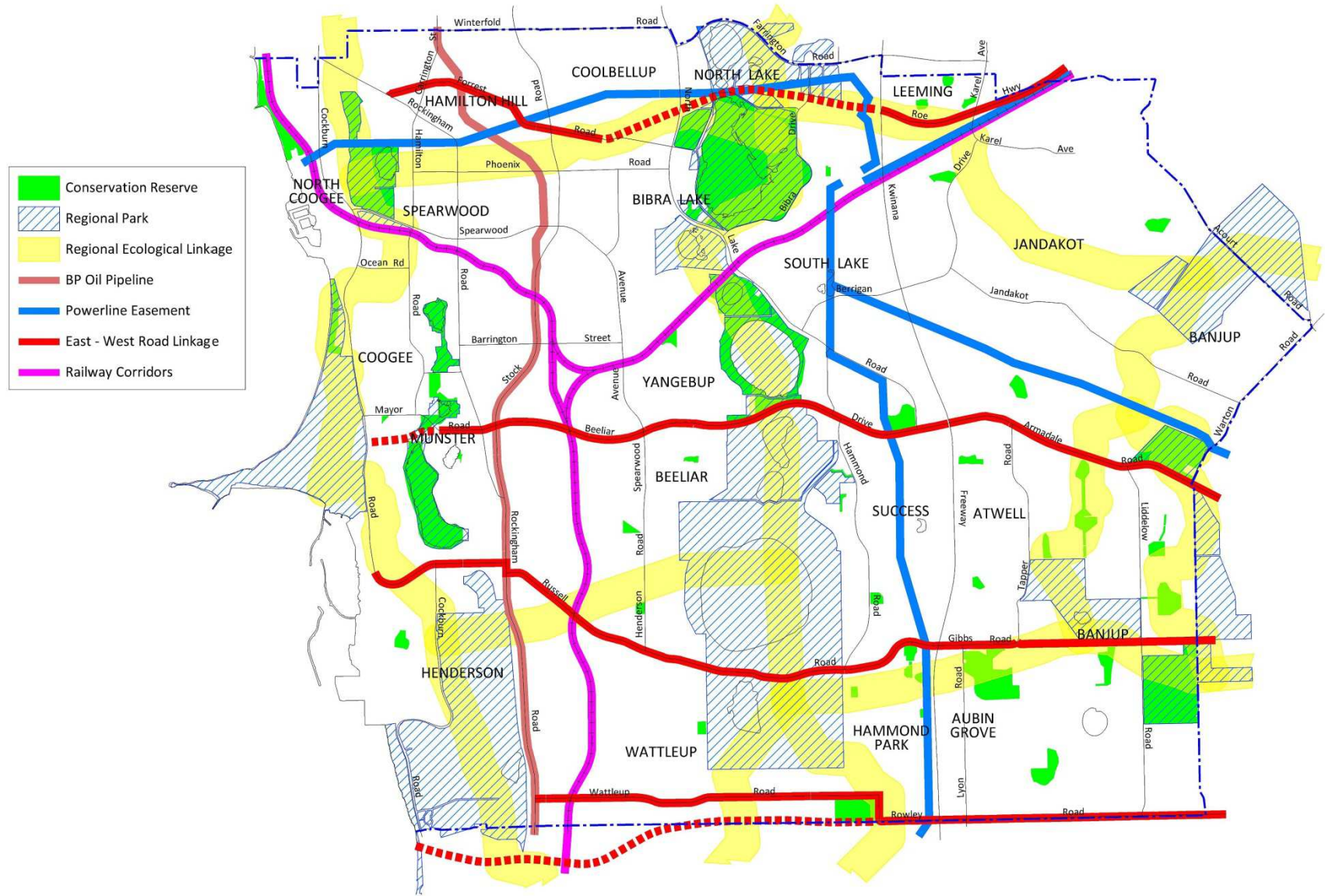
1. Where roads are being constructed, upgraded or widened through natural areas ensure that consideration is given to the construction of wildlife crossings. Continue to support initiatives to promote the use of local endemic native plants in residential gardens and verges (KA55).

Note: As with any revegetation that is to occur, revegetation within an ecological corridor would utilise local native species that are determined to be appropriate for the site giving consideration to restrictions particularly within power line and gas pipeline easements.



Black Tailed Monitor and Bobtail

Figure 6 on the following page depicts all of the proposed ecological linkages and their relationships with existing conservation areas.



**Figure 6 - Proposed Ecological Linkages**

## SUMMARY OF KEY STRATEGIC ACTIONS

The following table summarises the key strategic actions that will be undertaken to maintain and enhance the natural areas within Cockburn and the positions within the organisation that are responsible for implementing those actions.

**Table 9. Key Strategic Actions and Responsible Officers**

	Actions	Timeframe	Budget	Responsible Officer/s
KA1	<b>Prioritise reserves based on the following aspects: Vegetation condition, size, shape, perimeter to area ratio, connectivity, visibility and community involvement.</b>	Every 8 Years	Existing Operational Budget	Natural Resource Officer
KA2	<b>Re-assess reserve prioritisation every 8 years.</b>	Every 8 Years	Existing Operational Budget	Natural Resource Officer
KA3	<b>Map the priority weeds and the vegetation condition in all bushland reserves every 4 years.</b>	Every 4 Years	Existing Operational Budget	Natural Resource Officer
KA4	<b>Develop and implement a Weed Control Strategy.</b>	Completed. Reviewed every 4 years	Existing Operational Budget	Environmental Supervisor and Natural Resource Officer, Environmental Officer and Bushland Maintenance Officers
KA5	<b>Review and update the Priority Weed Control List every 5 years.</b>	Every 4 Years	Existing Operational Budget	Environmental Supervisor, Natural Resource Officer
KA6	<b>Prepare and implement a works programme to manage priority weeds in bushland reserves.</b>	Annually	Existing Operational Budget	Environmental Supervisor, Natural Resource Officer and Bushland Maintenance Officers
KA7	<b>Develop revegetation programs following weed control programs where required.</b>	Annually	Existing Operational Budget	Environmental Supervisor and Natural Resource Officer
KA8	<b>Assist and encourage volunteers such as community “friends of” groups, Conservation Volunteers Australia and educational institutions to participate bushland management activities within bushland areas managed by the City.</b>	Ongoing	Existing Operational Budget	Environmental Staff



<b>KA9</b>	<b>Provide support and assistance to community volunteer groups that undertake bushland management activities within bushland areas managed by the City.</b>	Ongoing	Existing Operational Budget	Environmental Staff
<b>KA10</b>	<b>Offer incentives, training and information to landowners to encourage management of natural areas on private property.</b>	Ongoing	Existing Operational Budget	Environment and Waste Education Officer, Environmental Officer and Natural Resource Officer
<b>KA11</b>	<b>Work with internal staff, contractors and the community to ensure that construction activities minimise the spread of weeds.</b>	Ongoing	Existing Operational Budget	Environmental Staff
<b>KA12</b>	<b>Encourage, support and where practical, be involved in weed control trials with agencies and educational institutions.</b>	Ongoing	Annual budget request as required	Environmental Staff
<b>KA13</b>	<b>Adopt the principles of the Bradley Method of Bush Regeneration wherever possible when planning and implementing weed control work.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor, Natural Resource Officer and Bushland Maintenance Officers
<b>KA14</b>	<b>Instigate feral animal control programs in areas where feral animals are known to exist.</b>	Seasonal	Existing Operational Budget	Environmental Officer
<b>KA15</b>	<b>Asses the viability of installing rabbit proof fencing around high priority reserves.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor, Environmental Officer and Natural Resource Officer
<b>KA16</b>	<b>Construct appropriate fences around conservation reserves to prevent and control unauthorised access.</b>	Ongoing	Annual budget request as required	Environmental Supervisor, Environmental Officer and Natural Resource Officer
<b>KA17</b>	<b>Undertake fence repairs within 2 working days of notification of damage.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor and Bushland Maintenance Officers
<b>KA18</b>	<b>Work with other local governments and government agencies with the aim of developing and implementing a regional feral animal control program.</b>	Ongoing	Annual budget request as required	Environmental Officer

<b>KA19</b>	<b>Erect signage at entry points to reserves that provides information on the impact and safety issues associated with illegal access.</b>	Ongoing	Annual budget request as required	Environment and Waste Education Officer and Environmental Officer
<b>KA20</b>	<b>Remove rubbish from conservation reserves as early as practical.</b>	Ongoing		Environmental Supervisor and Bushland Maintenance Officers
<b>KA21</b>	<b>Develop a community education program that includes a component about the impacts of illegal dumping.</b>	Ongoing	Existing Operational Budget	Environmental and Waste Education Officer
<b>KA22</b>	<b>Ensure there are adequate firebreaks that comply with the Bush Fires Act around the perimeter of all conservation reserves and fire access trails strategically located through larger reserves.</b>	Annually in October	Existing Operational Budget	Environmental Supervisor, Environmental Officer and Bushland Maintenance Officers
<b>KA23</b>	<b>Utilise herbicides or install limestone where practical rather than grading firebreaks.</b>	Ongoing	Existing Operational Budget (Annual budget request for limestone)	Environmental Supervisor, Environmental Officer and Bushland Maintenance Officers
<b>KA24</b>	<b>Ensure verges adjoining reserves are free from weeds.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor and Bushland Maintenance Officers
<b>KA25</b>	<b>Prepare Bush Fire Response Plans for all conservation reserves and review every three (3) years.</b>	October	Existing Operational Budget	Environmental Officer
<b>KA26</b>	<b>Assess the suitability and appropriateness of prescribed burning to reduce high fuel loads in reserves.</b>	Annually	Annual budget request as required	Environmental Staff in conjunction with FESA
<b>KA27</b>	<b>Liaise with government agencies such as FESA and DEC in relation to best practice fire risk reduction and suppression.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor and Environmental Officer and Natural Resource Officer
<b>KA28</b>	<b>Ensure staff and contractors practice good dieback hygiene procedures when working in reserves.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor, Environmental Officer Natural Resource Officer and BMO's



<b>KA29</b>	<b>Undertake dieback assessment and mapping in reserves containing and suspected of containing dieback. Re-assess reserves every three years.</b>	Ongoing	Existing Operational Budget	Environmental Officer
<b>KA30</b>	<b>Instigate dieback control methods where practical such as phosphite treatment, limestone on firebreaks and revegetation using dieback tolerant endemic species.</b>	Ongoing	Annual budget request as required	Environmental Officer, Natural Resource Officer, Environmental Supervisor
<b>KA31</b>	<b>Ensure fire response plans show dieback infected areas.</b>	Annually in October	Existing Operational Budget	Environmental Officer
<b>KA32</b>	<b>Support the Dieback Working Group in their endeavours.</b>	Ongoing	Existing Operational Budget	Environmental Officer
<b>KA33</b>	<b>Ensure best practise Water Sensitive Urban design is practised in new subdivisions.</b>	Ongoing	Existing Operational Budget	Environmental Staff (in conjunction with City Engineers and Planners)
<b>KA34</b>	<b>Retrofit best practise Water Sensitive Urban Design measures into areas where water quality is being adversely affected by outdated practises.</b>	Ongoing	Annual budget request as required	Environmental Staff (in conjunction with City Engineers and Planners)
<b>KA35</b>	<b>Undertake regular water quality monitoring of wetland areas.</b>	Ongoing	Existing Operational Budget	Environmental Officer
<b>KA36</b>	<b>Increase the resilience of natural areas by addressing the threats posed by weeds, feral animals, illegal access, illegal rubbish dumping, increased fire frequency, disease such as dieback, storm water drainage and climate change.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor, Natural Resource Officer and Bushland Maintenance Officers
<b>KA37</b>	<b>Continue to keep informed about the latest research developments in terms of climate change scenarios and best practice bushland adaptation techniques.</b>	Ongoing	Existing Operational Budget	Environmental Education Officer, Natural Resource Officer, Environmental Supervisor
<b>KA38</b>	<b>Be prepared to alter management practices to adapt to a changing climate.</b>	Ongoing	Existing Operational Budget	Environmental Supervisor and Natural Resource Officer and Bushland Maintenance Officers
<b>KA39</b>	<b>Implement a best management practice for natural area regeneration</b>	Ongoing	Existing Operational	Environmental Supervisor and

	and rehabilitation that includes detailed pre-work site assessment, identifies clear aims and outcomes, recommendations for regeneration techniques.		Budget	Natural Resource Officer
KA40	Prepare planting plans for planting sites prior to undertaking revegetation works.	Ongoing	Existing Operational Budget	Natural Resource Officer and Environmental Officer
KA41	Develop and implement a program of regeneration/restoration works across natural areas that is informed by: <ul style="list-style-type: none"> <li>the priorities for managing threatened species and habitat;</li> <li>the extent of priority weed species which are targeted for control;</li> <li>statutory requirements for fire management; and</li> <li>the human resources available (staff and volunteers)</li> </ul>	Ongoing	Existing Operational Budget	Environmental Supervisor, Environmental Officer and Natural Resource Officer
KA42	Ensure the provision of adequate resources for the ongoing maintenance of natural areas.	Ongoing	Existing Operational Budget	Environmental Manager
KA43	When selecting areas to revegetate within reserves select those sites that offer the best opportunities to enhance ecological connectivity.	Ongoing	Existing Operational Budget	Environmental Supervisor, Natural Resource Officer and Bushland Maintenance Officers
KA44	Support the Department of Main Roads in their endeavours to maintain and enhance natural vegetation within existing road reserves.	Ongoing	Existing Operational Budget	Environmental Manager
KA45	Seek to ensure that, should the proposed Roe Highway extension proceed, native vegetation is retained and revegetation undertaken so that it maintains some function as an ecological linkage.	Ongoing	N/A	Environmental Manager
KA46	Retain and enhance the current east west ecological linkage functions of Beeliar Drive, Armadale Road, Russell Road, Gibbs Road, Rowley Road and Wattleup Road. (SA46).	Ongoing	Existing Operational Budget	Parks and Environment

<b>KA47</b>	<b>Ensure that the commitments to establish suitable ecological linkages within the Latitude 32 development are honoured.</b>	Ongoing	N/A	Environmental Manager
<b>KA48</b>	<b>Examine the potential to enhance sections of the rail reserves for enhanced ecological function and biodiversity conservation.</b>	Ongoing	Existing Operational Budget	Environmental Manager
<b>KA49</b>	<b>Commence discussions with West Rail to gain support for rail reserves to be vegetated to enhance their value as ecological corridors/linkages.</b>	July 2012	N/A	Environmental Manager
<b>KA50</b>	<b>Liaise and encourage Western Power to retain and maintain native vegetation within the identified power line easements.</b>	Ongoing	N/A	Strategic Planning & Parks and Environment
<b>KA51</b>	<b>Ensure future landscaping of the BP Refinery Oil Pipeline is undertaken in a manner that enhances the pipelines ability to function as an ecological linkage.</b>	Ongoing	Parks and Environment CW Budget	Parks and Environment
<b>KA52</b>	<b>Continue to support tertiary studies that investigate potential locations, designs and the effectiveness of ecological corridors.</b>	Ongoing		Environmental Manager
<b>KA53</b>	<b>Continue to encourage developers to consider ecological linkages when formulating structure plans.</b>	Ongoing	N/A	Environmental Staff
<b>KA54</b>	<b>Support the objectives of the Cities Bushland Conservation Policy.</b>	Ongoing	N/A	
<b>KA55</b>	<b>Where roads are being constructed, upgraded or widened through natural areas ensure that consideration is given to the construction of wildlife crossings. Continue to support initiatives to promote the use of local endemic native plants in residential gardens and verges.</b>	Ongoing	N/A	Environmental Services and Engineering Construction

## OPERATIONAL FUNDING REQUIREMENTS

### OPERATIONAL COSTS

The costs to maintain and enhance bushland will vary depending on condition and the vegetation type. Degraded areas cost more to rehabilitate and maintain than areas in good or better condition.

A full break down of the costs to maintain and enhance some common vegetation types is provided in Appendix E. The costs have been calculated in conjunction with Councils Environmental Supervisor and experienced field staff.

To estimate the costs to maintain and enhance the bushland within Cockburn we will assume that all vegetation in the City of Cockburn is in good condition and that the vegetation type is Jarrah/Banksia Woodland. Based on this assumption, the estimated cost to maintain and enhance good quality Jarrah/Banksia Woodland is approximately \$3,310 per hectare per year based on current labour costs. Labour costs being the main component of maintenance.

**Table 10. Costs to maintain and enhance 1 hectare of Jarrah Banksia Woodland in Good Condition.**

Action	Cost (\$)
Staff Weed Control (20 hrs @ \$92 per hour)	1,840
Grass Weed Control (Contractor - 2011 tender rates)	543
Chemical Costs Broad Leaf	33
Chemical costs Bulbous	38
Chemical Costs Woody	1
Vegetation Condition Mapping (3 years)	15
Weed Mapping (3 Years)	15
Dieback Mapping (3 Years)	33
Rubbish Collection	585
Fence Repair	150
Feral Animal Control	57
<b>Total</b>	<b>3,310</b>

Based on this average cost estimate and, if it is assumed that all bushland managed by the City is in good condition, it would cost Council \$2,965,760 per annum to maintain and enhance the 896 hectares of bushland presently managed by the City.

Given that all of the bushland within the City is not in good condition what would be the true costs of maintaining and enhancing the bushland? To obtain an indication of the true costs a model was developed which uses the most up to date vegetation condition mapping to estimate the costs to raise the condition of selected bushland to a desired level over a five (5) year period.

The costs predicted by the model to increase the vegetation condition rating of all reserves from their current rating to a level of very good over a five (5) year period is a staggering **\$38M**.

(It is noted that 5 year old revegetation will never equate to natural vegetation that has never been disturbed. It is acknowledged that it takes up to twenty years before revegetation can be considered natural bushland. For the purposes of this exercise we will consider that revegetation with high species diversity, density and minimal weeds will be considered good.



Based on past experience it has been estimated by environmental staff that it costs approximately \$145,200 over a five (5) year period to revegetate and maintain a completely degraded area using tubestock. Table 11 gives a breakdown of the costs associated with revegetation.

**Table 11. Tubestock Revegetation Establishment and Maintenance Costs per Hectare for Completely Degraded Vegetation**

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Weed control - grass	\$500	\$600	\$500	\$300	\$300
Weed control - broad-leaved/bulbous	\$1,000	\$1,100	\$500	\$300	\$300
Woody weed removal	\$2,000	\$2,200	\$1,000	\$500	\$200
Revegetation tubestock (plant costs)	\$20,000	\$6,000	\$1,000	--	--
Revegetation - greenstock planting	\$27,500	\$15,000	\$3,000	--	--
Greenstock maintenance + watering	\$39,000	\$19,500	\$3,900	--	--
<b>Total</b>	<b>\$90,000</b>	<b>\$44,400</b>	<b>\$8,900</b>	<b>\$1,100</b>	<b>\$800</b>



Revegetation Bibra Lake 2010

## CURRENT OPERATIONAL FUNDING 2012/13

In the 2012/13 Financial Year \$1,327,756 has been allocated toward bushland maintenance. This equates to \$1,482 per managed hectare (896 hectares). This is considerably short of the estimate of \$3,310 required to maintain and enhance bushland condition.

A further \$362,406 has been allocated in 2012/13 for revegetation. This funding is slightly higher than funding in previous years. This is because additional funds have been allocated to undertake revegetation works as recommended in the recently prepared Bibra Lake Management Plan. This funding allocation will be used to revegetate and undertake infill planting in approximately 2.5 hectares of degraded bushland. Infill planting is undertaken at previously revegetated sites where adequate plant densities have not been achieved.

Funding is also allocated for revegetation as a consequence of road construction clearing offsets but, as this funding is not constant and only occurs on a project basis, it has not been included.

**Table 12. Current 2012/13 Operational Maintenance and Revegetation Cost breakdowns**

Operational	\$	Revegetation	\$
Herbicide	12,000	Plants & Sedges	115,900
Mulch	12,100	Fertiliser	4,129
Limestone for tracks	0	Tree Stakes	13,265
Habitat boxes	1,200	Tree Guards	12,832
Contract Rubbish removal	16,000	Contract Planting	147,880
Contract Fence & Gate Repairs	44,900	Watering Greenstock	26,700
Contract Grass Weed Control	81,100	Greenstock Maintenance	41,700
Contract General Weed Control	86,200		
Firebreak Weed Control	23,000		
Contract Hand Weeding	90,600		
Pruning	47,100		
Dieback Control	0		
Contract Reserve Patrols	9,600		
Path Maintenance	3,000		
Feral Animal Control	39,350		
On Ground Staff Labour Costs 95%	861,606	On Ground Staff Labour Costs 5%	45,348
<b>Total</b>	<b>1,327,756</b>		<b>362,406</b>



There are a further 195 hectares of natural area that is not currently actively managed and thus have no funding allocation. Without funding the condition of these reserves will continue to deteriorate.

Existing funding allocation gives management priority to reserves that are considered to have a medium or high priority rating. The aim is to focus management on the higher priority reserves to enhance condition while attempting to maintain the current condition of reserves with a lower rating.

Developers generally have management responsibility for the management of natural areas within subdivisions for a period of two years. After this time these areas are passed to Council to maintain. Each year additional funds are required to manage these reserves. Each year funding is also sought to allow one or two of reserves that are not presently managed to become actively managed reserves.

In 2012/2013 the following reserves were included on the actively managed reserve list.

Success Bushland	-	2.74	hectares
Coojong Reserve	-	1.0	hectares
Baler Reserve	-	4.0	hectares
Lukin Swamp	-	5.20	hectares
Mohan Park	-	0.43	hectares
North Coogee Foreshore (incorporated into C. Y. O'Connor)	-	1.03	hectares
Levi Reserve	-	1.31	hectares
Skaife Park	-	2.00	hectares

In total 13.68 hectares of bushland was added to the actively managed reserves in 2012/13.

#### **CURRENT STAFFING 2012/13**

Currently there is 9.5 full time equivalent (FTE) staff involved in natural area management for the City.

**Table 13. Current Environmental Service Unit Staffing Levels**

<b>Position</b>	<b>FTE allocation to Natural Area Management</b>
Environment Manager	0.5
Environmental Natural Resource Officer	1
Environment and Waste Education Officer	0
Environmental Supervisor	1
Environmental Officer	1
Bushland Maintenance Officers	6
Sustainability Officer	0
Climate Change Officer	0
<b>Total</b>	<b>9.5</b>

Bushland Maintenance Officers (BMO's) are responsible for the majority of the on ground maintenance work. With 82 reserves comprising over 1091 hectares of bushland and wetlands, the three existing bushland maintenance teams are only able to actively manage a small portion of these reserves. Currently teams are allocated a specific number of hours in each reserve. This hour's allocation varies depending on a number of factors such as reserve priority, size and condition.

Contractors can also be engaged to undertake some of the larger tasks such as grass weed control while casual and hire staff and volunteers may be engaged to undertake extra tasks such as hand weeding, rubbish removal and spreading mulch.

Given the lack of available staff hours, contractors have also been engaged to maintain a number of the smaller reserves. The reserves maintained by contractors are: Cocos, Holdsworth, Freshwater Reserves, Lukin Swamp, Skaife, Mohan, Levi Reserves and Katsura Gardens. These contracts are cost effective and the reserves are well maintained and their condition appears to be improving. BMO's are allocated hours to inspect the reserves to ensure they are being maintained appropriately. Consideration will be given to other reserves being maintained by contractors in the future should staff hours be limited.

Because the current funding is insufficient to maintain and enhance the condition of all of the actively managed reserves the overall condition of many of these reserves will continue to deteriorate in the long term unless funding is increased.

The other staff involved in natural area management indicated in Table 14, are primarily concerned with administration and organization.

### Future Staffing Requirements

Given that the BMO's are responsible for the majority of the on ground maintenance work they are the prime focus for future staffing needs.

The current maintenance budget is \$1,327,756 which includes wages for three fulltime bushland maintenance teams, materials and contractor payments.

Based on the current labour charge of \$92 per hour, it costs \$302,680 to employ an additional bushland maintenance team made up of two officers. This cost includes overheads.

Recently consideration has been given to the structure of the teams and it has been determined that teams of three would be the most effective and cost efficient.

Reasoning:

- Individual teams still function when a staff member is sick or on leave.
- A third member allows extra on ground capacity in each team.
- Less expenditure on vehicle and equipment costs.

The estimated cost to employ an additional three BMO's, at the current charge out rate of \$92, is \$454,020 p.a. However, through economies of scale, the actual charge out rate reduces to \$75 when three additional staff are employed. This is because overhead charges reduce. In true terms, it costs less to employ each additional team.

The cost to employ an additional three BMO's at \$75 per hour is \$370,125. If a further three officers are to be employed the rates again reduce to \$64 per hour with a total cost of \$315,840. If a further three officers are employed the rate and cost reduces to \$55 and \$271,425 respectively.

To maintain and enhance bushland condition in an effective manner it will be necessary to employ additional staff. The 10 year funding recommendation shown in Table 14 includes the employment of an additional 9 bushland maintenance officers by 2020/21, making a total of 15 on ground staff. The teams would be employed in 2014/15, 2017/18 and 2021/22.

The current Plan for the District 2010-2020 identifies the requirement for two additional Bushland Maintenance Offices in 2016/17 & 2019/20.



Five teams will still not be adequate to maintain and enhance our natural areas and more teams would be required in the long term. It is suggested that if we were to adequately maintain and enhance our bushland areas to achieve a final vegetation condition of good for all natural areas, staff numbers would need to reach similar levels as those of the Parks Department which currently employs approximately 51 on ground staff.

#### **FUTURE OPERATIONAL FUNDING RECOMMENDATIONS**

Based on the estimated costs (\$3,310 pa) to maintain and enhance one hectare of bushland, the current maintenance budget (\$1,327,756) allocated to Environmental Services for natural area management is not sufficient to maintain and enhance all of the actively managed reserves.

To allow all of the actively managed reserves to be maintained and enhanced maintenance funding would need to be increased to \$2,965,760. This equates to an increase of more than \$1,638,004 per annum.

A further \$645,450 would need to be allocated to commence management of those reserves that are not currently managed (195 hectares). This equates to a total increase in funding per year of \$2,283,454.

It is acknowledged that it will be difficult to find this amount of funding immediately. With this in mind three different funding options have been proposed which will ensure that the City makes progress toward the goal of having all natural areas achieve a vegetation condition rating of good or better.

Three funding options are proposed.

Note:

- The funding options do not take into account cost increases due to inflation or the consumer price index. The figures are at current rates and future funding will need to consider any increases.
- The funding options do not include funds that may be directed toward rehabilitation as offsets for clearing associated with works such as road construction. .
- Each funding option assumes that once development of the southern suburbs green field sites are complete no additional areas of bushland will be passed to the City for management. The development of these areas and other areas is expected to yield a maximum of 10 hectares for management.

#### **Funding Option1.**

Funding option 1 addresses the shortfall in funding over a 30 year timeframe by;

- employing additional bushland maintenance crews in 2013/14, 2016/17 and 2020/21 and then an additional team every 4 years until 2042/43;
- commencing active management of an additional 10 hectares per year and;
- allocating resources to revegetate at least 2.5 hectares per year (excluding offsets).

This funding option will ensure that the per hectare funding allocation continues to increase toward the target of \$3,310 per hectare, additional areas of bushland steadily become actively managed and degraded bushland areas within the City are revegetated.

Using the option 1 funding scenario the target value of \$3,310 per hectare will be achieved within 30 years and all bushland within the City will receive maintenance funding within the same period.

A 10 year funding program for Option 1 is shown in Table 14.

### Funding Option 2

Funding Option 2 addresses the funding shortfall over a slightly longer timeframe of 35 years by:

- employing additional bushland maintenance crews as proposed in the Plan for the District 2010-2020 in 2016/17 and 2020/21 and then employment of an additional team every 4 years until 2044/45;
- commencing active management of an additional 10 hectares per year and;
- allocating resources to revegetate at least 2.5 hectares per year (excluding offsets).

This option extends the time frame for achieving the target funding allocation of \$3,310 per hectare from 30 years to 35 years while still ensuring that additional areas of bushland steadily become actively managed and degraded bushland areas are revegetated.

A ten year funding program for Option 2 is shown in Table 15.

### Funding Option 3

Funding Option 3 addresses the funding shortfall over the longest timeframe of 40 years by:

- Delaying the employment of additional bushland maintenance crews until 2019/20 and then every 4 years and then employment of an additional team every 4 years until 2048/49;
- commencing active management of an additional 10 hectares per year and;
- allocating resources to revegetate at least 2.5 hectares per year (excluding offsets).

This option extends the time frame for achieving the target funding allocation of \$3,310 per hectare from 30 years as proposed in option 1 to 40 years while still ensuring that additional areas of bushland steadily become actively managed and degraded bushland areas are revegetated.

A ten year funding program for Option 3 is shown in Table 16.

**Table 14. Funding Option 1 for Bushland Maintenance and Enhancement**

Future Management Costs - Funding Option 1.											
Year	Hectares Actively Managed (Hec)	Additional area actively managed each year from non managed areas (Hec)	Expected areas to be handed to Council for management	Total Area to be managed this year	Additional Area to be Revegetated per year (Hec)	Annual Maintenance Allocation Required includes revegetated areas greater than 5 years old. (\$)	Revegetation Funding Allocation Required (\$)	Maintenance Costs per hectare (\$)	Additional 3 person Bushland Maintenance Team	Bushland Maintenance Team Cost	Total Funding required (\$)
2012/13	896	-			8	1,327,756	382,460	1,482			1,710,216
2013/14	904	10	2	916	2.5	1,357,393	363,000	1,502			1,720,393
2014/15	916	10	2	928	2.5	1,727,518	363,000	1,886	3	370,125	2,090,518
2015/16	928	10	2	940	2.5	1,727,518	363,000	1,862			2,090,518
2016/17	940	10	2	952	2.5	1,727,518	363,000	1,838			2,090,518
2017/18	952	10	2	964	2.5	2,043,358	363,000	2,146	3	315,840	2,406,358
2018/19	964	10	0	974	2.5	2,043,358	363,000	2,120			2,406,358
2019/20	974	10	0	984	2.5	2,043,358	363,000	2,098			2,406,358
2020/21	984	10	0	994	2.5	2,043,358	363,000	2,077			2,406,358
2021/22	994	10	0	1004	2.5	2,314,783	363,000	2,329	3	271,425	2,677,783
2022/23	1004	10	0	1014	2.5	2,314,783	363,000	2,306			2,677,783

**Table 15. Funding Option 2 for Bushland Maintenance and Enhancement**

Future Management Costs - Funding Option 2.											
Year	Hectares Actively Managed (Hec)	Additional area actively managed each year from non managed areas (Hec)	Expected areas to be handed to Council for management	Total Area to be managed this year	Additional Area to be Revegetated per year (Hec)	Annual Maintenance Allocation Required includes revegetated areas greater than 5 years old. (\$)	Revegetation Funding Allocation Required (\$)	Maintenance Costs per hectare (\$)	Additional 3 person Bushland Maintenance Team	Bushland Maintenance Team Cost	Total Funding required (\$)
2012/13	896	-			8	1,327,756	382,460	1,482			1,710,216
2013/14	904	10	2	916	2.5	1,357,393	363,000	1,502			1,720,393
2014/15	916	10	2	928	2.5	1,357,393	363,000	1,482			1,720,393
2015/16	928	10	2	940	2.5	1,357,393	363,000	1,463			1,720,393
2016/17	940	10	2	952	2.5	1,673,233	363,000	1,838	3	370,125	2,090,518
2017/18	952	10	2	964	2.5	1,673,233	363,000	1,815			2,090,518
2018/19	964	10	0	974	2.5	1,673,233	363,000	1,792			2,090,518
2019/20	974	10	0	984	2.5	1,944,658	363,000	2,098	3	315,840	2,406,358
2020/21	984	10	0	994	2.5	1,944,658	363,000	2,077			2,406,358
2021/22	994	10	0	1004	2.5	1,944,658	363,000	2,056			2,406,318
2022/23	1004	10	0	1014	2.5	2,216,083	363,000	2,035			2,406,318



**Table 16. Funding Option 3 for Bushland Maintenance and Enhancement**

Future Management Costs - Funding Option 3.											
Year	Hectares Actively Managed (Hec)	Additional area actively managed each year from non managed areas (Hec)	Expected areas to be handed to Council for management	Total Area to be managed this year	Additional Area to be Revegetated per year (Hec)	Annual Maintenance Allocation Required includes revegetated areas greater than 5 years old. (\$)	Revegetation Funding Allocation Required (\$)	Maintenance Costs per hectare (\$)	Additional 3 person Bushland Maintenance Team	Bushland Maintenance Team Cost	Total Funding required (\$)
2012/13	896	-			8	1,327,756	382,460	1,482			1,710,216
2013/14	904	10	2	916	2.5	1,357,393	363,000	1,502			1,720,393
2014/15	916	10	2	928	2.5	1,357,393	363,000	1,482			1,720,393
2015/16	928	10	2	940	2.5	1,357,393	363,000	1,463			1,720,393
2016/17	940	10	2	952	2.5	1,357,393	363,000	1,444			1,720,393
2017/18	952	10	2	964	2.5	1,357,393	363,000	1,426			1,720,393
2018/19	964	10	0	974	2.5	1,357,393	363,000	1,408			1,720,393
2019/20	974	10	0	984	2.5	1,727,518	363,000	1,774	3	370,125	2,090,518
2020/21	984	10	0	994	2.5	1,727,518	363,000	1,756			2,090,518
2021/22	994	10	0	1004	2.5	1,727,518	363,000	1,738			2,090,518
2022/23	1004	10	0	1014	2.5	1,727,518	363,000	1,721			2,090,518

## **SOURCES OF FUNDING**

It is anticipated that funding for maintenance, enhancement and revegetation for the Cities natural areas will come from a variety of sources. While the majority of the funding will need to come from Municipal Funds, contributions are also expected by way of grants from State and Federal government funding programs. There may also be scope for sponsorship and funding from developers as consideration for offset programs.

There are also options for the City to be involved in government employment programs such as Green Jobs Corps and Repay WA, a Department of Corrective Services initiative. These government employment and training initiatives are designed to give people within our community better long term employment prospects by giving them access to training and experience. The costs to local government are minimal being mainly associated with the purchase of equipment, while the benefits to both the participants and local government authority can be substantial.

In future year's consideration could be given to a small Environment Levy that could be applied to ratepayers for bushland maintenance and enhancement as has been established in other local government areas such as the Sunshine Coast Council.

## **MONITORING AND EVALUATION**

Monitoring and evaluation of the Natural Area Management Strategy's implementation and progress will be the key to its success. This strategy is supported by a long term vision which encourages long-term planning, investment and evaluation over time. The strategy has a 10 year time frame and a full review of all actions and progress will be undertaken at year five.

Field staff, the Environmental Supervisor and Environmental Officers generally visit all of the natural areas on a regular bases. Being familiar with the reserves staff are generally able to identify areas of concern and undertake measures to address these concerns.

Long term evaluation of maintenance and enhancement activities is generally undertaken using the four yearly rotating weed and vegetation condition mapping. This mapping gives a clear indication as to whether the condition of a particular reserve is deteriorating or being enhanced and provides an historical record of management progress.

Direct comparisons between the mapping from year to year clearly show where weeds have increased or where vegetation condition has changed. The vegetation condition mapping allows the various condition ratings to be shown as a percentage. Entering revised percentages into our historical spreadsheet provides an easy method of assessing our maintenance and enhancement activities across the entire municipality.

When assessing vegetation condition consideration is also be given to other factors that might be impacting vegetation such as reduced rain fall, longer heat waves and disease.

### **KEY PERFORMANCE INDICATORS (KPI's)**

Key Performance Indicators can be useful to measure the effectiveness of key actions. Key performance indicators that are currently measured are shown below.

#### **1. Percentage increase (hectares) in good quality vegetation**

Vegetation condition surveys will be undertaken in each reserve every 4 years and compared against previous surveys to assess overall condition. Due to the number of reserves, one quarter of reserves

will be surveyed each year. Percentages will be updated once the results of the surveys are available. This is generally in February each year.

Should no increase be recorded over a two year period then a review will be undertaken of the Natural Area Management Strategy to determine if a change to management practises is warranted.

It should be noted that climatic conditions may also have a detrimental effect on vegetation condition and will need to be considered when assessing vegetation condition.

2. Reduction in the number of high priority weeds within reserves.

Reserves will be mapped for weeds every four years and the number of high priority weeds within each reserve will be assessed against previous mapping.

Should there be no decrease in high priority weeds within a reserve then the weed control methods being implemented within the reserve will be reviewed to determine their effectiveness.

3. Reduction in the number of reports of feral animals and a reduction in the noted presence of feral animals within reserves.

A feral animal register is maintained and reported sightings noted. During routine visits staff will assess the amount of damage being inflicted on reserves due to the presence of feral animals. Should no decrease in feral animals be noted or recorded the feral animal control program will be reviewed to determine its effectiveness.

4. Number of reserves needing appropriate fencing

A list of reserves still requiring fences is maintained. Funding for individual reserve fencing is requested annually through the budgeting process.

5. Decrease in the amounts of rubbish being removed from reserves

Rubbish removal costs are allocated against each reserve. Reductions in costs will track progress.

Should the amounts of rubbish being removed from reserves increase then rubbish reduction initiatives will be reviewed.

6. Ensure best practice fire management is practised in all reserves.

Environmental Services maintains firebreaks to appropriate standards and has developed and regularly reviews fire response plans for all reserves under management. A register is kept of the fires occurring in each reserve. Records are kept by FESA. Fire scars are mapped and recorded in Councils geographical information system (Intramaps) and noted on Fire Response Plans. Inspections of fire breaks are carried out each year and fire response plans reviewed every 4 years.

7. Number of reserves containing dieback.

A register of the reserves containing dieback and the area affected is maintained. Mapping is undertaken every 3 years. No increase in area indicates that dieback control methods are working.

Should areas affected by dieback increase then dieback management and control methods will be re-assessed and reviewed.

8. Annual increase in funding per hectares (above the CPI) for reserve management.

An increase in the funding allocated per hectares represents an increase in resources which equates to an enhancement in bushland condition. Funding per hectare will be assessed each financial year.

Annual funding is the single most influential factor that will determine whether our vision, mission and goals are achieved. A selection of KPI's will be reported in the annual State of Sustainability Report each year.

## **5 YEAR PLAN**

A 5 year plan has been developed which can be considered to be a summary of this Natural Area Management Strategy.

A copy of the 5 year plan can be found in Appendix F.

## **NATURAL AREA MANAGEMENT STRATEGY REVIEW**

This plan will be reviewed every five years by Environmental Services. The next review would be due in 2017.



Lake Coogee



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## GLOSSARY

**Biodiversity** - the degree of variation of life forms within a given ecosystem, biome or an entire planet.

**Ecological function**- means the natural processes, products or services that living and non-living environments provide or perform within or between species, ecosystems and landscapes. These may include biological, physical and socio-economic interactions.

**Ecological linkage** – a series of contiguous or non contiguous patches of vegetation which by virtue of their proximity to one another allow flora and fauna to use them as stepping stones of habitat to move across the landscape.

**Flora** - the plant life occurring in a particular region, generally the naturally occurring or indigenous plant life

**Fauna** - all of the animal life of any particular region.

**Herbarium** – a systematically arranged collection of dried plants

**Sustainable** - how biological systems remain diverse and productive over time



*City of Cockburn*

*Weed Management Strategy*

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## SUMMARY OF RECOMENDATIONS

- Recommendation 1 :** Revise and update the Priority Weed list every 5 years.
- Recommendation 2 :** Review/re-map Natural Area Condition every 4 years.
- Recommendation 3 :** Review/re-map Weed Mapping every 4 years
- Recommendation 4 :** Focus primary weeding efforts in high priority areas
- Recommendation 5 :** Prioritise grass weed control where there is a threat to adjacent areas of high conservation value.
- Recommendation 6 :** ONLY control grass weeds if the bushland has the ability to naturally regenerate and out-compete the weeds OR in conjunction with revegetation.
- Recommendation 7 :** Prioritise weed control within recently burnt areas, particularly during the first year after fire.
- Recommendation 8 :** Do not attempt direct seeding without at least one year, and preferably two years, of prior weed control.
- Recommendation 9 :** Commence weed control in proposed revegetation sites two years prior to planting.
- Recommendation 10 :** Control feral pests to reduce the spread of weeds
- Recommendation 11 :** Undertake a community education campaign to inform residents of the harm caused by weed invasion

## 1 EXECUTIVE SUMMARY

Environmental weed invasion has been identified as one of the major threats to biodiversity conservation across Western Australia and on a national scale. Competition from weeds is a major factor affecting biodiversity and ecological communities. In 1999 the State Government developed the Environmental Weed Strategy for Western Australia to give direction in management of environmental weeds. In addition a National Weeds Strategy has also been developed.

One of the most significant environmental challenges facing Western Australia is minimising the impact from environmental weeds. In the relatively short history of Western Australia since European settlement, some 1155 exotic plant species have established as weeds in our diverse and generally fragile ecosystems (Dept of Agriculture 2001).

In response to this acknowledged threat the City of Cockburn has devised its own environmental weed management strategy to help guide management programs and assist in allocation of resources to protect natural areas vested within the City.

In developing this management strategy standard methodologies for ranking weed species was used to determine weeds that fell into high, medium or low priority categories for control. The level of weed control that can be achieved in each reserve is limited and based on resource allocation. Reserves which are ranked highly in terms of conservation values will receive greater focus in regards to weed control.

Strategic Objectives:

To provide a strategic direction for the management of weeds in the City of Cockburn;

To develop a list of weed species and rank them according to their level of invasiveness, distribution and environmental impact; and

To determine and apply best practice integrated methodology for control of these species.

A list of 35 high priority weeds for the City of Cockburn has been developed and monitoring of weed invasion, distribution and control outcomes is achieved through regular mapping of these priority weeds within City of Cockburn reserves.

## 2 INTRODUCTION

Environmental weeds are considered one of the most serious threats to biodiversity and natural ecosystems (CALM 1999). They adversely affect the regeneration of indigenous flora and thus survival of its associated fauna. Weeds can affect both ecosystem function and structure through:

Displacement of native species

Prevention of recruitment of native species

Reduction in species diversity

Competition for resources

Alteration of fire regimes

Alteration of nutrient cycling

Acceleration of soil erosion rates

Alteration of soil pH

Alteration of hydrological cycles

Acceleration of local, regional and global extinction rates

The City's Weed Management Strategy is based on the following principles:

- Weed control is an essential component of sustainable natural resource management but is much more than simply the elimination of weeds. The underlying objective is always the protection and restoration of naturally diverse ecosystems (Brown et al 2002).
- Prevention, early detection and early intervention are the most cost-effective means of weed management.
- Effective weed control requires a long-term commitment.
- Effective weed management requires a coordinated approach.

A simple and effective priority setting and planning process is needed to best utilise available weed management resources and to ensure the long-term implementation of the weed strategy.

Environmental weeds and management of them have been identified at three levels:

Local;

State; and

National

The Australian Government has established a list of Weeds of National Significance (WONS), which may include plants of concern in natural areas, waterways or agricultural land. Several weeds found in Western Australia are among recent additions to the Weeds of National Significance (WONS) list. Species are selected based on their ranking for invasiveness, potential to spread, and impact on socioeconomic and environmental assets (Commonwealth of Australia 2007).

'Declared Plants', as defined under the Agriculture and Related Resources Act 1976, are high priority weeds that are or may become a problem to agriculture or the environment and are

formally 'declared'. When a plant becomes declared, specific control strategies are required. Declared Plants (DP) when found on property, either privately owned or on crown land, must be controlled by landowners or managers.

The Local Government Act allows a local authority to declare plants as "pest plants". Declaration requires the control of that weed species on all lands within the local authority boundary. When this legislation is applied there is no requirement for consistency between adjacent local authorities, which may result in uncoordinated and less effective control.

In addition to other drivers, climate change may alter the potential range of some weeds. In Australia, the generally warming climate could allow tropical weed species to extend further south, temperate species to retreat to the south, and summer growing species to become more prevalent in the southern regions. This is a prevailing issue that will need consideration into the future. Additional resources may be required to identify and react to perceived threats.

## 2.1 WHAT IS A WEED?

There are a number of different definitions of weeds:

Bradley (1988) defines a weed as 'a plant out of place'

Dixon & Keighery, in Scheltema & Harris Ed. (1995), define weeds as 'plants growing where they are not wanted'

The National Weeds Strategy defines a weed as "a plant that has, or has the potential to have, a detrimental effect on economic, social or conservation values" (ARMCANZ, ANZECC and Forestry Ministers, 1997).

According to the Environmental Weed Strategy for Western Australia (1999) environmental weeds are plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.

Some native species can also become environmental weeds and require management. It is therefore perhaps useful to define weeds for the purpose of this document as comprising ALL non-indigenous plants PLUS any indigenous plant that has increased its distribution as a result of disturbance and is threatening the integrity of the local ecosystem.

Weed management in bushland is an important component of the City's overall program of managing its reserves. The primary objective is: *To control and manage weeds in all conservation reserves within the City of Cockburn in order to protect biodiversity, the natural ecosystems and, where possible, to restore them to a natural state.*





Bridal Creeper (*Asparagus asparagoides*) a WONS found in the City of Cockburn

### 3 Weed ranking

To set priorities for weed control, it is necessary to firstly rank weeds with regard to their impact or potential impact on natural areas.

#### 3.1 WEED RANKING METHODOLOGY

Weed-ranking methodologies are used to determine level of threat of a weed species.

The Environmental Weed Strategy for WA (EWSWA) ranks weeds according to:

**Invasiveness:** ability to invade bushland in good to excellent condition, or ability to invade waterways. (Score as yes or no).

**Distribution:** wide current or potential distribution including consideration of a known history of widespread distribution elsewhere in the world. (Score as yes or no).

**Environmental Impacts:** ability to change the structure, composition and function of an ecosystem. In particular an ability to form a monoculture in a vegetation community. (Score as yes or no).

The ranking of each weed was determined using the following scoring system:

**High** - a weed species would have to score yes for all three criteria. Rating a weed species as high would indicate prioritizing this weed for control i.e. prioritizing funding for it.

**Moderate** - a weed species would have to score yes for two of the above criteria. Rating a weed species as moderate would indicate that control should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).

**Mild** - a weed species scoring one of the criteria. A mild rating would indicate monitoring of the weed and control where appropriate.

Low - a weed species would score none of the criteria. A low ranking would mean that this species would require a low level of monitoring.

The City of Cockburn Weed Strategy uses rankings based primarily on the Environmental Weed Strategy for WA as a basis for determining the priority ranking of weed species.

Table 1: Target weed species that were found in selected COC reserves based on mapping 2012(Ecoscape)

<b>WEED SPECIES</b>	<b>EWSWA RATING</b>
<b><i>ASPARAGUS ASPARAGOIDES (BRIDAL CREEPER)</i></b>	HIGH
<b><i>LUPINUS COSENTINII (SANDPLAIN LUPIN)</i></b>	HIGH
<b><i>TYPHA ORIENTALIS (TYPHA)</i></b>	HIGH
<b><i>ZANTEDESCHIA AETHIOPICA (ARUM LILY)</i></b>	HIGH
<b><i>ACACIA LONGIFOLIA (SYDNEY GOLDEN WATTLE)</i></b>	MODERATE
<b><i>CARPOBROTUS EDULIS (PIGFACE)</i></b>	MODERATE
<b><i>CYNODON DACTYLON (COUCH)</i></b>	MODERATE
<b><i>FICUS CARICA (EDIBLE FIG)</i></b>	MODERATE
<b><i>PENNISETUM CLANDESTINUM (KIKUYU)</i></b>	MODERATE
<b><i>TRACHYANDRA DIVARICATA (DUNE ONION WEED)</i></b>	MODERATE
<b><i>ASPHODELUS FISTULOSUS (ONION WEED)</i></b>	MILD
<b><i>FUMARIA CAPREOLATA (FUMARIA)</i></b>	MILD
<b><i>PENNISETUM SETACEUM (FOUNTAIN GRASS)</i></b>	MILD
<b><i>MELALEUCA NESOPHILA (MINDIYED)</i></b>	LOW
<b><i>RICINUS COMMUNIS (CASTOR OIL PLANT)</i></b>	LOW
<b><i>FOENICULUM VULGARE (FENNEL)</i></b>	UNRATED

### 3.2 CITY OF COCKBURN PRIORITY WEED LIST

The City has developed its own priority weed list based on the state and national strategic documents and using local knowledge and information. The City of Cockburn Priority Weed List can be found in Appendix 1. Priority ranking of a weed species can change with time as weeds become more established and widespread, adapt to different growing conditions, or are brought under control.

These rankings give a current indication of the seriousness of the threat posed by each weed species within the City of Cockburn. In addition the City must be aware of other state or national weed species which may impact on the priority ranking within the City.

**Recommendation 1 :** Revise and update the City of Cockburn Priority Weed List every 5 years.

#### **4. RESERVE RANKING**

The City has limited resources to manage natural areas. It is therefore necessary for reserves to be prioritized according to the criteria outlined below, to ensure that resources are being used effectively in areas where the most benefit can be gained.

Each reserve has been ranked based on the following criteria:

- Vegetation condition
- Reserve size
- Reserve shape
- Perimeter to area ratio
- Connectivity
- Rarity
- Regional and local representation
- Education, community or passive recreation

Social values such as education and community involvement have also been considered when assessing each reserve. Generally reserves with higher visibility have a higher community involvement. A greater community involvement means that a reserve is valued by the community and that expectations in relation to funding and management are higher. It can be argued that the greater the community involvement the better the outcomes as funding from alternative sources such as grants are more likely to be forthcoming.

A viability estimate (VE score) is determined for each reserve and this in turn determines its ranking.

#### **4.1 RESERVE RANKING CRITERIA**

##### Vegetation Condition

All reserves within Cockburn have been mapped for vegetation condition and vegetation complexes.

Excellent/good condition bushland areas are more resilient to weed invasion and thus are more ecologically sustainable. Reserves with a majority of their bushland in excellent condition are rated higher than those with a lesser condition. Reserves have been prioritised into *three* management categories; High, Medium and Low.

Prioritising weed control helps facilitate the self-regenerating process inherent in such bushland and reduces the need for long-term (and ongoing) follow-up weed control work.

Bushland condition is unlikely to change *significantly* in the short term but the weed control program should be reviewed regularly.

**Recommendation 2 :** Re-map vegetation condition every 4 years.

#### Reserve Size

Large reserves have greater integrity through intact vegetation and resistance to weed invasion, so hence are more ecologically sustainable. Larger reserves are rated higher than smaller reserves.

#### Shape and Perimeter to Area Ratio

The size and shape of a piece of bushland is critical to its health - the smaller the area, the greater the proportion of the bushland that is exposed to degradation and the invasion of weeds. Edge effects increase as remnant size decreases and generally, narrow linear remnants experience higher edge effects due to a higher edge-to-area ratio. A low ratio has a 'high' ranking and a high ratio has a 'low' ranking.

In addition to the perimeter of the reserve, all paths, tracks, firebreaks, etc, act as 'edges'.

#### Connectivity

The viability of any natural area depends on its proximity to other natural areas and the quality of the linkage between them. These two factors influence the movement of individual living organisms and the flow of genetic material between natural areas. In turn this determines the long term survival of species, their genetic variation, their ability to adapt to changes in the environment and the maintenance of ecosystem processes. Hence reserves which form part of an ecological linkage or form contiguous links with other natural areas will be ranked higher.

#### Rarity

This represents whether a reserve has been identified as containing either a Threatened Ecological Community (TEC) and /or a species of plant or animal that are listed as declared rare or threatened under either state legislation or under the EPBC (Environmental Protection and Biodiversity Conservation) Act 1999. This category also indicates if the reserve contains vegetation that may be significant in supporting a listed fauna species.

#### Regional and local representation

In addition to a ranking based on local parameters, many City of Cockburn reserves are part of the regional conservation estate and as such require a higher level of priority. The following factors are taken into consideration:

- Local and regional significance of vegetation types and the remaining pre-European extent of those specific vegetation complexes
- Whether it is a regional park

- Whether it is a Bush Forever site
- Whether it is an EPP or Conservation Category Wetland
- Reserves are ranked higher based on meeting any of these criteria.

#### Education, community and passive recreation

Social values such as visibility, access and community involvement have also been considered when assessing each reserve. Greater community involvement can result in better conservation outcomes as funding from alternative sources such as grants are more likely to be forthcoming and volunteers, in the form of groups such as friends of groups, are willing to contribute labor hours to reserve management.

## **5. WEED MAPPING**

Maps that clearly show where weeds occur in bushland are excellent management tools. In conjunction with bushland condition maps, they provide the information needed for strategic weed management. They assist with determining appropriate use of limited resources and provide information on the spread of weeds over time plus the effectiveness of control programs. Not all weeds require mapping – only those that have a serious impact on bushland such as high or medium ranked species. Weed maps are produced at regular intervals based on the high priority weed list developed by the City.

Mapping of weed species varies depending on the nature of the weeds being mapped. The mapping techniques used consist of:

- Point Mapping - scattered individuals in a small area or clumps of bulbous weeds
- Density (polygon) Mapping – scattered individuals in a large area mapped at densities of:

<5%, 6-30%, 31-60 and >60%.

Maps produced will be loaded onto the City's Geographical Information System (GIS) and shall provide a record of priority weeds and their distribution throughout selected high value conservation reserves. This mapping is undertaken annually with each reserve having a four year rotation.

**Recommendation 3 :** Review/re-map weed mapping every 4 years



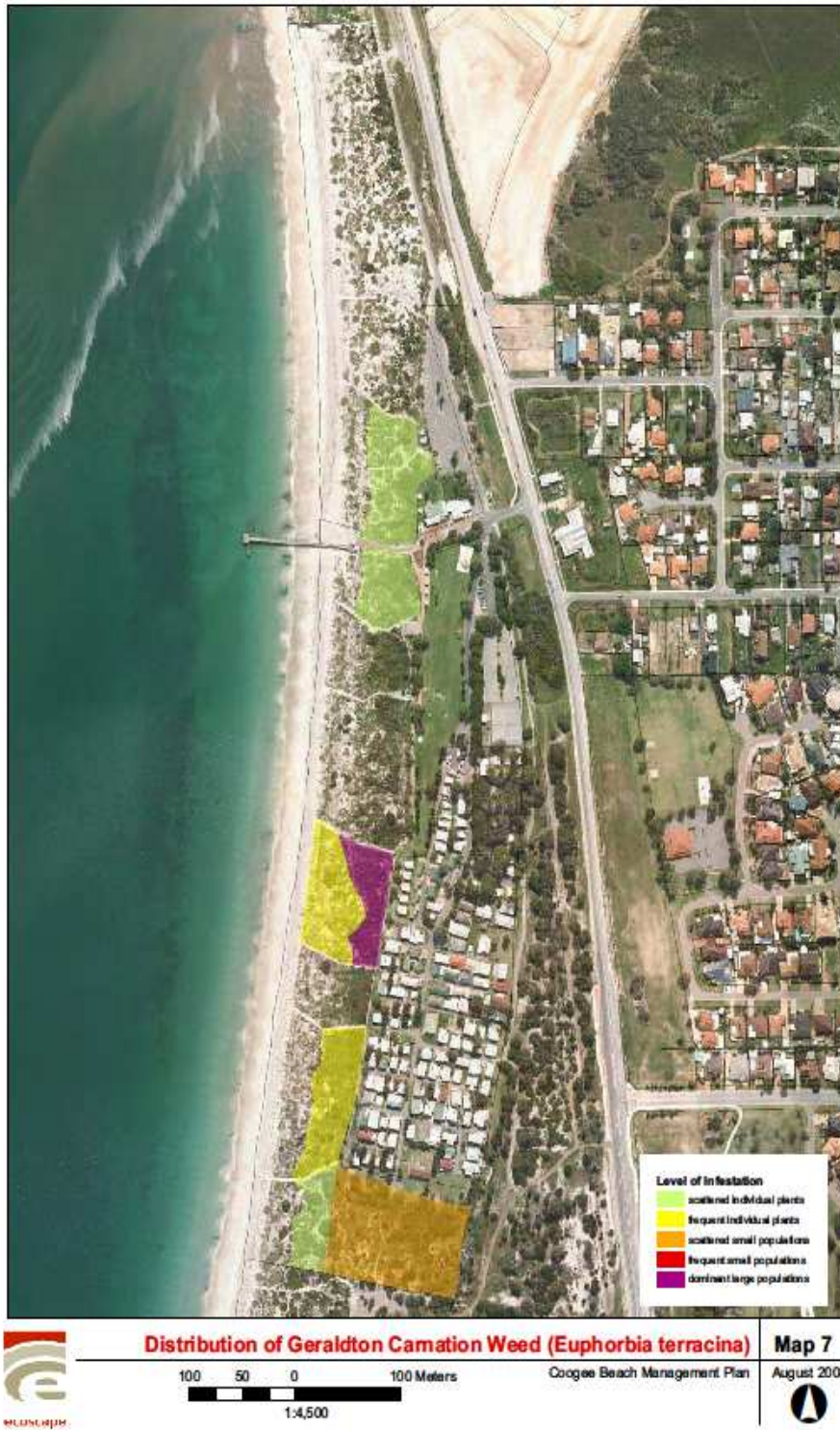


Figure 1 Distribution of Geraldton Carnation Weed (*Euphorbia terracina*) at Coogee beach

## 6 PRIORITISATION OF WEED CONTROL

To achieve the best outcomes in weed management an integrated approach is desirable. Integrated weed management is the combination of social, economic and technical approaches that lead to successful outcomes at all scales (CALM 1999). Integrated weed management involves the planned use of all control options available. Approaches to environmental weed management include:

Weed led control-strategy to prevent introduction, establishment, survival and dispersal of an emerging environmental weed.

Site led control-focus on identifying areas that require weed control to maintain their ecological values.

Human resources led control- will identify weeds and particular circumstances best suited to volunteer control and those managed by professionals.

Threatened species and communities led control-this approach places the protection of threatened species and threatened communities as the highest priority.

Cause led control-approach focuses on controlling, reducing or eliminating disturbance factors that increase ecosystem vulnerability.

All approaches will consider the national, state and local strategies and priorities.

To achieve the best use of resources and to enable them to be allocated to the overall program in a structured manner, it is imperative to prioritise weed control.

Prioritisation takes into consideration:

- Weed ranking - determination of both major weeds and lesser weeds
- The condition of the reserve, its urban or rural context and biological values.
- Fire hazard: the risk of high fuel loads, for example, Veldt Grass in degraded areas or weedy perimeters that are prone to arson.
- Aesthetic values: particularly along urban edges to encourage and engender an attitude of care.
- Revegetation sites: control of weeds prior to planting and reduction of competition during the establishment stage.

In general, high-priority weeds in areas of good quality bushland are those to be controlled first. However thought should be given to medium priority weeds that may occur in small populations in a reserve and without too much effort or expense can easily be controlled. Balancing the reserve size, reserve condition, weed flora, and the budget is crucial to the process of effectively determining weed control priorities.



Paterson's Curse (WONS) found in the City of Cockburn

### **6.1 WITHIN RESERVE PRIORITIZATION-SITE LED CONTROL**

Site led control focuses on identifying areas that require weed control to maintain their ecological values (CALM 1999). The condition of bushland within each reserve can vary from excellent to completely degraded. The perimeters of bushland are generally in poorer condition than the rest of a reserve due to edge effects, e.g. fire breaks, other land uses. Based on the Bradley principles of bush regeneration (Bradley, 1998), it is important to work from good condition bush first to consolidate the resilience of these areas. Once these core areas have been addressed, the Bradley method recommends moving onto bushland in poorer condition.

This method is practiced whereby primary weeding efforts are focused on good bushland first.

**Recommendation 4 :** Focus primary weeding efforts in areas of good bushland.

### **6.2 FIRE HAZARD**

Fire is an important issue in bushland management. Grass weeds contribute to increased fire risk in bushland areas and thus in order to minimize this risk, it is important to control these weeds. Grass weeds are generally prevalent on disturbed edges. While it is important to prioritize weed control efforts in good condition bushland it is also important to also diminish the fire risk. Unfortunately, if only grass weeds are controlled, it is highly likely that more aggressive and difficult-to-control weeds will invade and thus result in more costly long-term control. Fire also stimulates germination of native seeds which may be difficult to distinguish from weed germinant, as such care must be taken to ensure off target damage is reduced.

**Recommendation 5 :** Prioritise grass weed control where there is a threat to adjacent areas of high conservation value.

**Recommendation 6 :** Only control grass weeds if the bushland has the ability to naturally regenerate and out-compete the weeds or in conjunction with revegetation.

Fire episodes encourage the proliferation of weeds, often at the expense of native plants. However, during the succeeding one- to two-year period, access to the site is likely to be relatively easy with consequent easier targeting of weeds.

**Recommendation 7 :** Prioritise weed control within recently burnt areas, particularly during the first year after fire.

### **6.3 AESTHETIC VALUES**

The public interface with bushland is generally at the edges. If a bushland looks weed infested and untidy, and therefore appears uncared for, it promotes a negative public attitude. In order to engender a more positive, caring attitude to bushland reserves it is important to manage the edges, particularly for weeds.

### **6.4 REVEGETATION SITES**

Due to the large soil weed seed banks in degraded areas of bushland, the success of any revegetation program through either direct seeding or tubestock installation is directly related to the effectiveness of associated weed control. Without several years of weed control prior to revegetation taking place, the results are likely to be poor due to competition.

**Recommendation 8 :** Do not attempt revegetation without at least one year, and preferably two years weed control.

**Recommendation 9 :** Commence weed control in proposed revegetation sites two years prior to tubestock planting.

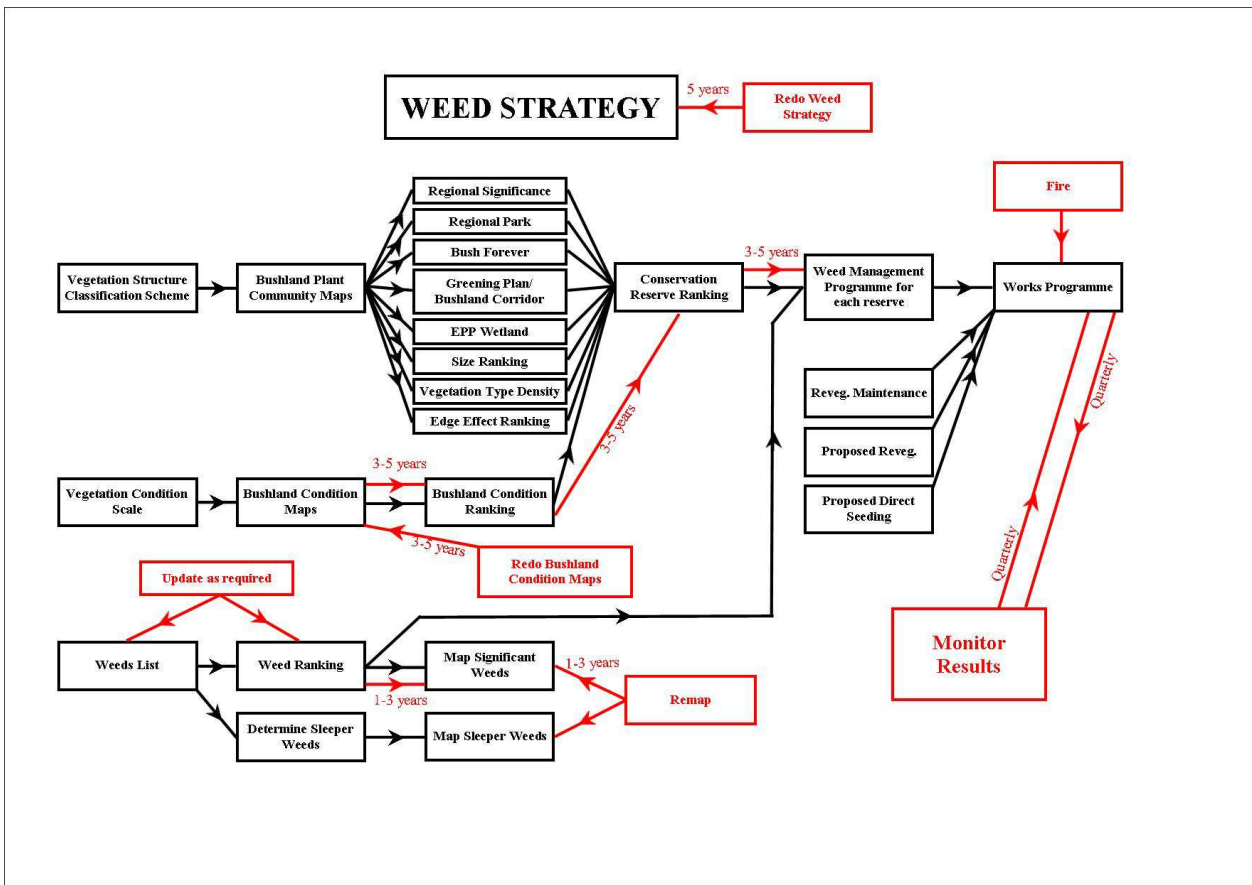


Table 2 Weed Organizational Strategy Flowchart

## 7. WEED CONTROL METHODS

Direct methods such as biological control, manual control, use of herbicides or indirect methods through effective land and water management can be used to control weeds. In several cases a combination of both direct and indirect methods are required for effective control. The selection of the best and most effective method depends largely on the biology of the weed species, for example, woody weeds may respond differently to bulbous weeds for a particular approach. As such it is vital that correct identification of the weed and its growth form is established prior to treatment. Controlling degrading influences that increase ecosystem vulnerability to weed invasion is in of itself a very effective method of reducing weed impact.

### 7.1 IDENTIFYING WEED SPECIES

It is important that before removal of weeds occurs, species are positively identified first. Some native species look very similar to introduced plants. In addition some native plants may become weeds and adequate care to minimize any off target damage to surrounding vegetation is required.

### 7.2 MECHANICAL/MANUAL WEEDING METHODOLOGIES

Manual and mechanical techniques such as pulling, cutting, stripping, ring barking, and stem injection may be useful to control some woody weeds, particularly if the population is relatively small.



Seedlings and small shrubs can be carefully pulled by hand, ensuring removal of the taproot. Seedlings can be distinguished by the presence of a long taproot while suckers have a hockey stick shaped end, where they have broken off the parent root.

Saplings and mature trees should not be removed using this method. The disturbance of soil structure and damage to native vegetation is counter-productive and may lead to invasion by other weeds. In addition, such disturbance of suckering species may stimulate growth from root fragments left in the soil.



Photo courtesy Bluemountains Bushcare

### 7.2.1 Felling and ring barking

These two techniques are suitable for trees and shrubs that do not re-sprout. The methods are labour intensive and may not be suitable for large infestations. Ring barking can be time consuming and the felling approach requires removal of branches from the site. However, on small infestations both techniques provide a simple, target specific, control option.

Ring barking involves cutting away a strip of bark, usually at least 20 mm wide, all the way around the trunk. The strip must be cut deep enough to completely sever the phloem and vascular cambium and stop the flow of plant food between the growing points of the tree. To be successful the cut MUST be around the complete circumference of the tree. (Felling the tree at the base has effectively the same result, cutting the flow of food between roots and crown.) The strip removed must be wide enough to prevent 'bridging'. A simple method is to use a chain saw to cut a continuous ring perhaps twice around the trunk. A SINGLE WIDTH cut in most species is NOT wide enough to prevent bridging.

Seedlings can be quickly slashed at ground level if not growing closely among native vegetation.

Non-sprouting shrubs, saplings and mature trees can be cut off at, or very near, ground level below any branches or dormant buds. Many non-sprouting plants have epicormal buds higher up the trunk so it is important to cut off the trunk as close to the ground as possible.

Keep in mind that surrounding vegetation can be damaged when trees and large shrubs are felled, and as branches are carried out.

### 7.2.2 Cut and paint

Cut and paint is a target-specific method, suitable for any small trees and shrubs that re-sprout. Successful control requires careful application - it is essential to apply the herbicide such a

Glyphosate IMMEDIATELY to cut stumps. If delayed, the tree seals the wounded stump, preventing absorption of the herbicide. Large trees and shrubs may need to be cut down sequentially to avoid injury to workers and damage to the surrounding bush (or left standing and treated by stem injection.) Cut down the plant until one metre of trunk remains above the ground. With herbicide ready, cut the remaining trunk off close to ground level (+100mm); apply herbicide immediately to the stump.

Shrubs and small trees can be treated by felling the plant close to ground level (+100mm) and immediately painting the exposed stump with a systemic herbicide. The entire surface of small stems can be painted using a paintbrush or sponge applicator. On larger stems, focus on the outer ring of wood containing the phloem, xylem and vascular cambium.

### 7.2.3 Stem Injection

One of the easiest ways to kill trees and large shrubs is to drill holes into the trunk and inject herbicide.

8-10mm diameter holes should be drilled around the circumference of the tree or shrub at a spacing of no greater than 100mm, at an angle of between 45<sup>0</sup> and 60<sup>0</sup> down into the sapwood, to a depth of 40-50mm. Immediately fill the hole with undiluted herbicide. The more herbicide that is injected, the greater the chance of success. If the plant is actively transpiring, it may be possible to refill the hole(s) with herbicide several times within a half-hour period. Multi-stemmed shrubs or trees will usually require at least one hole per stem. Some plants (e.g. *Acacia longifolia*) do not seem to be able to translocate the herbicide sideways and sometimes only half the plant dies. With such plants, the problem can be overcome by DECREASING the spacing between holes to 50-75mm.

### 7.2.4 Weed Disposal

There is some debate as to the merit of removing or not removing weeds from site. Decomposition of weeds adds to the nutrient load in soils that are naturally nutrient-poor thus assisting the growth of weeds to the detriment of native plants. However in wetlands, where there are naturally higher levels of nutrients, it may be more productive to leave in situ.

ALWAYS remove weeds with seeds e.g. Victorian Tea tree, Inkweed, Castor Oil.

Remove all other weeds if practicable.

Do NOT pile weeds in heaps

Piling weeds into neat, easy-to-carry heaps makes sense in a conventional garden, but it is bad practice in the bush. Heaps of soft weeds rot down into a nutrient-rich mess that is quite the wrong environment for natives, and there is a very good chance that some weeds will re-root and flourish.

Woody weeds in piles are tedious to untangle when, as they often do, some of their seedlings grow up through the heaps.

So, disperse what you uproot. The soft weeds will quickly dry out and the woody ones will not get in your way during follow-up.

Some weeds can be mulched but this should not be done where it is likely that seeds will remain viable and germinate.

When working in areas infested with Caltrop (*Tribulus terrestris*) during the summer months, check and clean all tyres of seeds before leaving the site, or before moving to another portion of the site. NB. Do not forget to roll the vehicle forwards a few inches to check the underneath portion of the tyres.

### 7.3 HERBICIDES

A number of important principles affect the performance of herbicide on weeds and on the surrounding environment.

The type of herbicide used is also important. Try to identify the most appropriate herbicide for a specific task. The Department of Agriculture and Food and other local authorities can be a good source of information. There are also a number of books that also provide advice. These include Bushland weeds (Brown et al) and Western Weeds (Hussey et al).

Make sure you apply the correct rate of herbicide. Regularly calibrate the spray equipment, and check the output of the nozzles particularly after using abrasive chemicals. Nozzles wear out, and should be replaced regularly if their output is more than 5 per cent above or below the correct output. It is also important to check at regular intervals that each nozzle is distributing spray evenly.

Spray as evenly as possible at all times. This is particularly important when spot spraying.

Spray in light wind conditions if possible. This ensures that as much herbicide as possible reaches the target plants, and minimises the danger of drift on to non-target vegetation.

Spray weeds at the correct size or stage of growth

Spray weeds when they are actively growing. This will ensure maximum uptake and translocation of the herbicide. Weeds should not be sprayed when they are under stress, either through lack of water (drought), too much water (water logging), and disease, insect or mechanical damage.

Avoid spraying when it's raining or likely to rain. Herbicide may be washed off the leaves before it can be absorbed. A 'rule of thumb' is that at least 30 minutes is required after spraying for the herbicide to be absorbed.

Do not apply a higher volume than necessary. Contact herbicides need to thoroughly wet the weed, to the point of run-off. Translocated herbicides such as Glyphosate, Metsulfuron Methyl, and Fluazifop do not need such thorough coverage. Desirable coverage for translocated herbicides is between 50% and 80% of leaf area.

Do not use more surfactant (wetting agent) than is recommended, otherwise too much spray mix may run off from the leaf surface. Moreover, it may cause the spray to form large amounts of foam in the spray tank, leading to difficulties in application.

Do not apply at a higher pressure than you need to obtain good coverage of the plant. High pressure may generate excessive numbers of small droplets in the spray, which increases the danger of mist drifting on to non-target plants, and increases the hazard to the operator.

The City in 2009 trialled an innovative approach to *Typha orientalis* control using an aerial herbicide application. This process appeared very successful but requires resourcing and planning, including follow up treatment.



#### 7.4 WEED INTRODUCTION AND DIEBACK CONTROL

Weeds may be introduced into a natural area through the movement of soil. All construction material must be inspected before bringing on to site, particularly limestone, for weed seed and only acquire from accredited clean sources. Black Flag (*Ferraria crispa*), Geraldton Carnation Weed (*Euphorbia terracina*) have been introduced to various bushland sites around Perth in construction materials.

Avoid bringing soil or mulch from elsewhere into bushland. This can be the greatest potential source, not only of weed seeds, but also pathogens such as *Phytophthora cinnamomi* (Dieback).

Always practice correct Dieback hygiene procedures when working in bushland.

#### 7.5 FAUNA AND WEEDS

Some weeds can provide habitat or an opportunistic food source for native animals. A list of the known fauna in a bushland can help determine this at a particular site. Removal of such weeds should be staged in conjunction with a complimentary revegetation program.

Examples of weeds being used by native fauna include Bandicoots using Kikuyu, *Pennisetum clandestinum*, at Little Rush Lake and water birds using *Typha orientalis*, at Bibra Lake (CALM 2001).

### 7.5.1 Weed Spread by Fauna

Weeds may continue to be introduced into a natural area even though control is occurring through fauna. Weeds as discussed previously do provide some habitat and foraging value for a variety of fauna species. Birds and other animals will continue to reintroduce seed of plants with fleshy fruits from surrounding areas, such as Olive, Fig, Japanese Pepper and Bridal creeper. Rabbits also can encourage the spread of weeds through eating seed of non-native plants and dispersing them through their scats.

**Recommendation 10 :** Control feral pests to reduce the spread of weeds

## **8 THE ROLE OF COMMUNITY IN WEED CONTROL**

Part of the solution to managing weeds in Western Australia is raising public awareness of the causes and appropriate responses to the problem.

Often people are not aware of the impact that weeds have on the natural environment and primary production or that they may be contributing to the problem through their own actions, for example, dumping weed-infested garden refuse in bushland or by distributing weed seeds by vehicles, animals and produce.

Community involvement can greatly contribute to the successful management of weeds in natural areas (CALM 2001). A growing number of community members are contributing to awareness and control of weeds through on ground action such as being part of a "Friends of" group or providing resources such as grants which can be otherwise limited. The City of Cockburn is developing a weed brochure to help inform community members about significant weeds within the City and to provide information on how to control them. In addition the City works with volunteer and "Friends of" groups to implement weed management strategies.



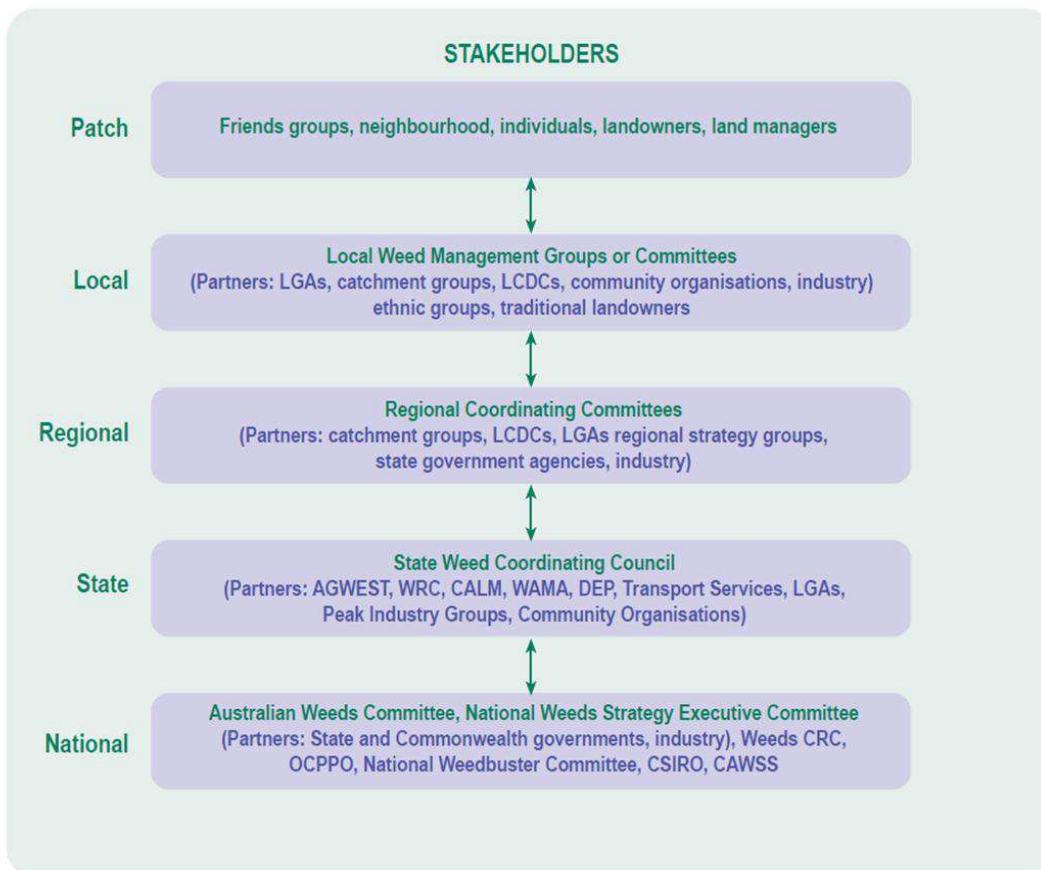


Table 3. Stakeholder flowchart (Dept Agriculture 2001)

**Recommendation 11 :** Undertake a community education campaign to inform residents of the harm caused by weed invasion

Community groups do require training or supervision when undertaking methods of weed control to ensure safe work practices are adhered to and no off target damage is incurred. Largely herbicide use by community volunteers should be limited and professional expertise in addition to community involvement is often required.

## **9 MONITORING**

Monitoring of the success of weed control will be achieved through regular weed mapping within the City's reserves (e.g. every 4-5 years). Where weeds are shown to have increased their distribution assessment and revision of current control methods will occur.

Where new populations or individuals of weeds ranked as high or medium priority have been recorded steps will be taken to ensure outbreaks are eliminated as soon as possible.

Monitoring quadrats will be established within specific locations where outbreaks of particularly invasive species have occurred to ensure that these populations are controlled effectively. In addition visual observations undertaken opportunistically can also inform management responses.

As part of the vegetation mapping that occurs regularly the loss of condition within a bushland will be closely linked to weed invasion and as such threatening process which may reduce the integrity and condition of vegetation within reserves will be assessed and mitigated where possible.

Photo monitoring of reserves also occurs on a regular basis (annually).

### **9.1 REVEGETATION SITES**

It is important to maintain ongoing weed control in revegetation sites post planting.

As soil has been disturbed from the planting process and there is good moisture available large amounts of weed germination tends to accompany planting. Where tree guards have been used maintenance of tree guards including hand weeding within the guard will require additional resources.

7 – 10 days after the first spray, check for effectiveness of initial work. Re-spray if necessary. The effect of the herbicide should start to appear within a few days so revisiting a site after 7 days means that previously sprayed weeds are quite obvious and it becomes easier to target those missed previously.

During winter and spring, inspect sites every 3-5 weeks for ongoing germinants. Spray if necessary. Control of weed germinants is easiest when plants are small, however, spraying too soon is inefficient as weed seeds may continue to germinate after spraying. However, it is imperative that spraying occurs before seed set.

During summer and autumn, inspect every 4-8 weeks for summer germinating weeds.

### **9.2 WOODY WEEDS**

Inspection of most woody weed sites is best done during flowering when it's easier to recognise plants. It also allows sufficient time to effect removal before seed set.

For Broad-leaved Paperbark (*Melaleuca quinquinerva*), Mindiyed (*Melaleuca nesophila*), Sydney Golden Wattle (*Acacia longifolia*) and Victorian Teatree (*Leptospermum laevigatum*), inspect all mapped locations biennially, and record observations on a weed map. For Sydney Golden Wattle, continue for ten years after the last seed set.

Inspect mapped locations of Edible Fig and Japanese/Brazilian Pepper within one year of removal to identify and treat suckers.

Inspect mapped locations of Castor Oil Plant twice during the year; once in Aug/Sep and once in Jan/Feb to ensure prevention of seed set. Continue site inspections for four years after the last seed set.

### **9.3 VELDT GRASS**

Timing for Veldt Grass spraying is crucial; too early, and ongoing rains will result in late germination and these plants will flower and set seed. Too late and, whilst seed set is prevented, dormant buds in the crown are not killed. Consider undertaking two controls during the season. The first the first germinates are developing seed heads and the second 4- 6 weeks later.

In April compile plans for veldt grass spraying that include:

Blanket spray of previous areas that have been blanket sprayed once. (2<sup>nd</sup> year of a 2-year blanket spraying program)

Spot spray of previous areas that have been blanket sprayed twice. (To pick up individual plants germinating from the soil seed bank)

Spraying of new areas based on mapping of current occurrences of veldt grass.

Undertake checks from late June to mid August to identify 'boot' stage. Then request spraying to commence.

Inspect spraying within 24 hrs to ensure complete cover. Request additional spraying if areas have been missed.

Inspect one to two weeks after spraying to ensure kill has been achieved. Request follow-up spraying if areas have been missed. However sometimes this can be a pointless exercise as seeds have already developed.

Assess areas for a second spray in late August.

## 9 GLOSSARY

**Boot Stage:** Growth stage when a grass inflorescence is enclosed by the sheath of the uppermost leaf.

**Declared Plant:** (DP) means a plant 'declared' by the Agriculture Protection Board under the Agriculture and Related Resources Protection Act 1976. If a plant is declared, all landholders are obliged to control that plant on their properties. Declarations specify a category, or categories, for each plant according to the control strategies or objectives that the Agriculture Protection Board believes are appropriate in a particular place. E.g. *Salvinia*, *Salvinia molesta* and Water Hyacinth, *Eichhornia crassipes* are both declared plants, category P2, which requires the landowner to complete eradicate infestations. One Leaf Cape Tulip (*Moraea flaccida*) is declared category P1, which requires the landholder to prevent infestation spreading beyond existing boundaries of infestation.

**Edge Effect:** When an edge is created to any natural ecosystem, and the area outside the boundary is a disturbed or unnatural system, the natural ecosystem is seriously affected for some distance in from the edge. In the case of a forest where the adjacent land has been cut, creating an openland/forest boundary, sunlight and wind penetrate to a much greater extent, drying out the interior of the forest close to the edge and encouraging rampant growth of opportunistic weedy species at the edge.

**Endemic:** Native to and restricted to a particular geographical region e.g. Mindiyed, *Melaleuca nesophila*, is endemic to the south coast of WA near Bremer Bay.

**Indigenous:** Originating and living or occurring naturally in an area or environment, not exotic; not imported. E.g. Broad-leaved Paperbark, *Melaleuca quinquenervia*, is indigenous to eastern Australia.

**Pest Plant:** (PP) means a plant declared to be a pest plant, in relation to a district, prescribed by local laws made by a local government in that district. Caltrop, *Tribulus terrestris*, is a prescribed Pest Plant in the City of Cockburn.

**Seed set:** the formation of mature fruits with viable seeds. To produce seeds after flowering.

**Sleeper Weeds:** 'Sleeper weeds' are plants that are just waiting to go feral. They possibly have not yet invaded the environment but have the potential to do so. Plants that have had a limited distribution for years may suddenly become environmental weeds. This can be caused by: changing climatic conditions; presence of a pollinator; presence of a vector (spreader); changes in horticultural or agricultural practices. E.g. Bridal Creeper – became feral recently after having been cultivated in the Wheatbelt for years, and Freesia – recently recognised as a serious weed after years of apparently limited distribution.

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## APPENDIX 1: PRIORITY WEEDS WITHIN THE CITY OF COCKBURN

Scientific Name	Common Name
<i>Acacia longifolia</i>	Sydney Golden Wattle
<i>Asparagus asparagoides (DP, WONS)</i>	Bridal Creeper
<i>Asphodelus fistulosus</i>	Onion Weed
<i>Chasmanthe floribunda</i>	African Cornflag
<i>Cortaderia selloana</i>	Pampas Grass
<i>Cynodon dactylon</i>	Couch grass
<i>Echium plantagineum (DP)</i>	Paterson's Curse
<i>Ehrharta calycina</i>	Perennial Veldt Grass
<i>Ehrharta villosa</i>	Pyp Grass
<i>Eragrostis curvula</i>	African Lovegrass
<i>Euphorbia paralias</i>	Sea Spurge
<i>Euphorbia terracina</i>	Geraldton Carnation
<i>Ferraria crispa</i>	Black Flag
<i>Freesia hybrid</i>	Freesia
<i>Fumaria bastardii</i>	
<i>Fumaria capreolata</i>	Climbing Fumitory
<i>Fumaria muralis</i>	Wall Fumitory
<i>Hyparrhenia hirta</i>	Tambookie Grass
<i>Juncus acutus</i>	Spiny Rush
<i>Lachenalia reflexa</i>	Yellow Soldiers
<i>Leptospermum laevigatum</i>	Victorian Tea Tree
<i>Moraea flaccida (DP)</i>	One-Leaf Cape Tulip
<i>Oxalis pes-caprae</i>	Soursob
<i>Pelargonium capitatum</i>	Rose Pelargonium
<i>Pennisetum clandestinum</i>	Kikuyu
<i>Pennisetum setaceum</i>	Fountain Grass
<i>Rubus discolor (DP, WONS)</i>	Blackberry
<i>Stenotaphrum secundatum</i>	Buffalo
<i>Tetragonia decumbens</i>	Sea Spinach
<i>Thinopyrum distichum</i>	Sea Wheat
<i>Trachyandra divaricata</i>	Dune Onion Weed
<i>Tribulus terrestris</i>	Caltrop
<i>Typha orientalis</i>	Typha, Bulrush
<i>Watsonia bulbifera</i>	Watsonia
<i>Zantedeschia aethiopica (DP)</i>	Arum Lily

### Medium Priority

<i>Scientific Name</i>	Common Name
<i>Arundo donax</i>	False Bamboo
<i>Brassica tournefortii</i>	Mediterranean Turnip
<i>Carpobrotus edulis</i>	Pigface
<i>Cirsium vulgare</i>	Spear Thistle
<i>Cyperus spp</i>	Nutgrass/ Dense Flat Sedge/ Umbrella Sedge
<i>Ehrharta longiflora</i>	Annual Veldt Grass
<i>Ehrharta villosa</i>	Pyp Grass
<i>Ficus carica</i>	Edible Fig
<i>Foeniculum vulgare</i>	Fennel
<i>Gazania linearis</i>	Gazania
<i>Gomphocarpus fruticosus (DP)</i>	Narrow Leaf Cotton Bush
<i>Lupinus cosentinii</i>	Sandplain Lupin
<i>Nicotiana glauca</i>	Tree Tobacco
<i>Olea europea</i>	Olive
<i>Opuntia stricta (DP)</i>	Prickly Pear
<i>Phytolacca octandra</i>	Inkweed
<i>Raphanus raphanistrum</i>	Wild Radish
<i>Ricinus communis</i>	Castor Oil
<i>Schinus terebinthifolia</i>	Japanese/Brazilian Pepper
<i>Solanum linnaeanum</i>	Apple of Sodom
<i>Symphotrichum subulatum</i>	Bushy Starwort
<i>Tagasaste</i>	

### Low Priority

<i>Scientific Name</i>	Common Name
<i>Agave americana</i>	Agave or Century plant
<i>Conyza bonariensis</i>	Flaxleaf Fleabane
<i>Dittrichia graveolens</i>	Stinkwort
<i>Malva parviflora</i>	Marshmallow
<i>Melaleuca nesophila</i>	Mindiyed
<i>Melaleuca quinquenervia</i>	Broad-leaved paperbark
<i>Narcissus tazetta</i>	Jonquil (Narcissus)
<i>Pteridium esculentum</i>	Bracken

## APPENDIX 2: WEED RANKING WITHIN CITY OF COCKBURN

Weeds species	Common Name	Weed Ranking			Comments
		Dixon/ Keighery 1995	Ecoscape 1998	Proposed new	
<i>Acacia longifolia</i>	Sydney Golden Wattle	Minor	Mod	High	Has 8 to 10-year seed viability, can produce a monoculture after fire
<i>Asparagus asparagoides</i>	Bridal Creeper	Major	High	High	
<i>Cortaderia selloana</i>	Pampas Grass	Major	High	High	
<i>Cynodon dactylon</i>	Couch grass	Major	Mod	High	
<i>Ehrharta calycina</i>	Perennial Veldt Grass	Major	High	High	
<i>Eragrostis curvula</i>	African Lovegrass	Major	High	High	
<i>Euphorbia terracina</i>	Geraldton Carnation	Major	High	High	A serious weed but control is difficult and very labour intensive
<i>Freesia hybrid</i>	Freesia	Major	High	High	
<i>Hyparrhenia hirta</i>	Tambooke Grass	Major		High	Currently has limited distribution. Worth attempting to eradicate before it spreads more
<i>Juncus acutus</i>	Spiny Rush	Nuisance		High	Totally replaces <i>Baumea juncea</i> and <i>Juncus kraussii</i> sedgelands
<i>Leptospermum laevigatum</i>	Victorian Tea Tree	Major	High	High	
<i>Melaleuca nesophila</i>	Mindiyed			High	Forms dense thickets after fire
<i>Moraea flaccida</i>	One-Leaf Cape Tulip	Major	High	High	Declared Plant' category P1. A serious weed but control is very labour intensive
<i>Opuntia stricta</i>	Prickly Pear			High	Not a serious weed in CoC but difficult to control once established
<i>Pelargonium capitatum</i>	Rose Pelargonium	Major	High	High	A serious weed but control is very labour intensive
<i>Pennisetum clandestinum</i>	Kikuyu	Major	Mod	High	
<i>Pteridium esculentum</i>	Bracken		Mod	High	Limited distribution but is slowly spreading. Allelopathic affect kills' many natives.
<i>Rubus discolor</i>	Blackberry	Major		High	eradicated?
<i>Stenotaphrum secundatum</i>	Buffalo	Major	Mild	High	
<i>Tetragonia decumbens</i>	Sea Spinach	Minor	Mod	High	Totally smothers natives
<i>Tribulus terrestris</i>	Caltrop			High	"Pest Plant" - occurs on disturbed edges
<i>Typha orientalis</i>	Typha, Bulrush	Major	High	High	
<i>Watsonia spp</i>	Watsonia	Major		High	
<i>Zantedeschia aethiopica</i>	Arum Lily	Major	High	High	
<i>Arundo donax</i>	False Bamboo	Nuisance	Low	Med	Suckers, and can produce dense thickets in damp areas
<i>Brassica tournefortii</i>	Mediterranean Turnip	Minor	High	Med	A serious weed but mostly of disturbed sites. Suggest control along path edges
<i>Carpobrotus edulis</i>	Pigface	Nuisance	Mod	Med	
<i>Chasmanthe floribunda</i>	African Cornflag	Minor	Mod	Med	
<i>Cirsium vulgare</i>	Spear Thistle	Minor	Mod	Med	
<i>Cyperus spp</i>	Nutgrass/ Dense Flat Sedge/ Umbrella	Nuisance	Mod	Med	Difficult to control.
<i>Ehrharta longiflora</i>	Annual Veldt Grass	Minor	Mod	Med	
<i>Ehrharta villosa</i>	Pyp Grass	Minor	Mod	Med	Currently only at CY O'Connor Reserve
<i>Ferraria crispa</i>	Black Flag	Nuisance	Mod	Med	Difficult to control. Currently has limited distribution. Worth attempting to eradicate before it spreads more
<i>Ficus carica</i>	Eddible Fig	Major	Mod	Med	
<i>Foeniculum vulgare</i>	Fennel	Nuisance	Mod	Med	
<i>Gomphocarpus fruticosus</i>	Narrow Leaf Cotton Bush	Minor	Mod	Med	
<i>Lupinus cosentinii</i>	Sandplain Lupin	Major	Mild	Med	A serious weed of disturbed sites
<i>Olea europea</i>	Olive	Minor	Mod	Med	
<i>Pennisetum setaceum</i>	Fountain Grass	Minor	Mild	Med	
<i>Phytolacca octandra</i>	Inkweed	Minor	Mild	Med	
<i>Raphanus raphanistrum</i>	Wild Radish	Minor	Mild	Med	A serious weed but mostly of disturbed sites. Suggest control along path edges
<i>Ricinus communis</i>	Castor Oil	Minor	Low	Med	Long seed viability
<i>Schinus terebinthifolius</i>	Japanese/Brazilian Pepper	Minor	Mod	Med	Forms dense growth that shades out natives
<i>Solanum linnaeanum</i>	Apple of Sodom	Minor	Mod	Med	"Declared Plant"
<i>Symphytrichum subulatum</i>	Bushy Starwort	Minor	Mod	Med	
<i>Agave americana</i>	Agave or Century plant	Minor	Low	Low	
<i>Conyza bonariensis</i>	Flaxleaf Fleabane	Minor	Low	Low	
<i>Dittrichia graveolens</i>	Stinkwort	Minor	Mild	Low	
<i>Echium plantagineum</i>	Paterson's Curse	Minor		Low	Declared Plant' category P1. Currently has limited distribution. Worth attempting to eradicate before it spreads more
<i>Malva parviflora</i>	Marshmallow	Minor	Low	Low	
<i>Melaleuca quinquenervia</i>	Broad-leaved paperbark			Low	
<i>Narcissus tazetta</i>	Jonquil (Narcissus)		Low	Low	
<i>Nicotiana glauca</i>	Tree Tobacco	Minor	Mild	Low	

## APPENDIX 3: INAUGURAL LIST OF WEEDS OF NATIONAL SIGNIFICANCE

### Appendix 3. Inaugural List of Weeds of National Significance

Common Name	Scientific Name
alligator weed	<i>Alternanthera philoxeroides</i>
athel pine	<i>Tamarix aphylla</i>
bilou bush / boneset	<i>Chrysanthemoides monilifera</i>
blackberry	<i>Rubus fruticosus</i> agg.
cabomba	<i>Cabomba caroliniana</i>
Chilean needle grass	<i>Nassella neesiana</i>
quise	<i>Ulex europaeus</i>
hymenachne	<i>Hymenachne amplexicaulis</i>
lantana	<i>Lantana camara</i>
mesquite	<i>Prosopis</i> spp.
mimosa	<i>Mimosa pigra</i>
Parkinsonia	<i>Parkinsonia aculeata</i>
parthenium weed	<i>Parthenium hysterophorus</i>
pond apple	<i>Annona glabra</i>
prickly acacia	<i>Acacia mitchellii</i> spp. <i>indica</i>
rubber vine	<i>Cryptosporia grandiflora</i>
sahiana	<i>Sahiana molesta</i>
sterile fuscuck	<i>Nassella triflorata</i>
Willows except weeping willows, pussy willow and sterile pussy willow	<i>Salix</i> spp. except <i>S. babylonica</i> , <i>S. x capulindron</i> and <i>S. x reichardii</i>

### Additional List of Weeds of National Significance – April 2012

Common Name	Scientific Name
African boxhorn	<i>Lycium ferocissimum</i>
Sagittaria	<i>Sagittaria platyphylla</i>
Asparagus weeds	<i>Asparagus setosus</i> , <i>A. africanus</i> , <i>A. asparagoides</i> Western Cape form, <i>A. declinatus</i> , <i>A. plumosus</i> and <i>A. scandens</i> . Includes original <i>Vitis Asparagus asparagoides</i> Excludes <i>A. officinalis</i> and <i>A. Racemosis</i>
Beltache bush	<i>Jatropha gossypifolia</i>
Brooms	
Scotch	<i>Cytisus scoparius</i>
Montpellier	<i>Genista monspesulana</i>
Flax leaf	<i>Genista linifolia</i>
Cat's claw creeper	<i>Maccladyna unguis-cati</i>
Fireweed	<i>Senecio madagascariensis</i>
Gamba grass	<i>Andropogon gayanus</i>
Madera vine	<i>Anredera cordifolia</i>
Opuntia cacti	<i>Opuntia</i> spp. (excludes <i>O. ficus-indica</i> ), <i>Cylindropuntia</i> spp., <i>Austrocylindropuntia</i> spp.
Silverleaf nightshade	<i>Solanum elaeagnifolium</i>
Water hyacinth	<i>Eichhornia crassipes</i>

## APPENDIX B – BUSHLAND MAINTENANCE TEAM ALLOCATION

Bushland Maintenance Team Reserve Allocations July 2012										
Team A	Team B	Team C	Responsible Crew	Reserve / Park	Visits Per Annum	Hours Per Visit	BMO Actual Hours Per Annum	Total Hours per Annum	Casual hrs	Midge hrs
520			Team A	Coogee Beach Reserve south jetty	26	20	520	523	3	
	314		Team B	Coogee Beach Reserve north jetty	26	12	314	317	3	
		530	Team C	CYO Connor Reserve	26	20.5	530	535	5	
28			Team A	Freshwater Reserve	12	2.25	28	28		
		56	Team C	Banksia Eucalypt Woodland Park (North)	12	4.75	56	56		
	28		Team B	Cocos Park Reserve	12	2.25	28	28		
		28	Team C	Holdsworth Reserve	12	2.25	28	28		
416			Team A	Lake Coogee Reserve	12	34.75	416	480	4	60
46			Team A	Mc Neil Field.	12	3.75	46	46		
	266		Team B	Redemptora Reserve	12	22.25	266	266		
		444	Team C	Manning Park	26	13	338	368	6	24
70			Team A	Market Garden Swamp #3	12	5.75	70	70		
	732		Team B	Market Garden Swamp North	26	28.25	732	788	4	52
		578	Team C	Market Garden Swamp South	26	22.25	578	634	4	52
1192			Team A	Yangebup Lake Reserve	52	23	1192	1384	6	186
	522		Team B	Bibra Lake Reserve	52	10	522	672	6	144
	662		Team B	Little Rush Lake Reserve	26	25.5	662	692	6	24
		610	Team C	Bibra Lake Reserve	52	11.75	610	610		
60			Team A	Nola Waters Reserve	6	10	60	60		
	26		Team B	Fancote Reserve	4	6.5	26	26		
		40	Team C	Roper Reserve	6	6.75	40	40		
158			Team A	Triandra Reserve	8	19.75	158	158		
	78		Team B	Gil Chalwell Reserve	6	13	78	78		
		118	Team C	Christmas Tree Park	6	19.75	118	130		12
58			Team A	Cockburn Central Bushland	4	14.5	58	70		12
	46		Team B	Mather Reserve	6	7.75	46	46		
		118	Team C	Verdi Reserve (Solomon)	12	9.75	118	118		
270			Team A	Kraemer Reserve	12	22.5	270	270		
	202		Team B	Buckingham Reserve	6	33.75	202	202		
		112	Team C	Bosworth Reserve	6	18.75	112	112		
128			Team A	Banksia Eucalypt Woodland Park (South)	6	21.25	128	128		
	54		Team B	Bandicoot Reserve	6	9	54	54		
		340	Team C	Denis De Young Reserve	26	13	340	344	4	
52			Team A	Beeliar Reserve	4	13	52	52		
	176		Team B	Eco Park	8	22	176	176		
		54	Team C	Barfield Reserve	6	9	54	54		
130			Team A	Emma Treeby Reserve	6	21.75	130	130		
	70		Team B	Frankland Park	4	17.5	70	70		
		104	Team C	Rose Shanks Reserve (formely 1820)	6	17.25	104	104		
58			Team A	Banbar Park	12	4.75	58	58		
	26		Team B	Heatherlea Reserve	4	6.5	26	26		
		12	Team C	Parkes St Basin	4	0	0	0		
40			Team A	Success Reserve Bushland	6	6.75	40	40		
	36		Team B	Brandwood Reserve	6	6	36	36		
		42	Team C	Classon Park	6	7	42	42		
38			Team A	Baler Reserve	12		38	38		
		52	Team C	Coojong Park	12		52	52		
26				Levi Park			26	26		
		26	Team C	Lukin Swamp Reserve			26	26		
	26		Team B	Mohan Park			26	26		
	26		Team B	Katsura Reserve			26	26		
		26	Team C	Skaife Park			26	26		



## APPENDIX C – PRINCIPLES OF THE BRADLEY METHOD OF BUSH GENERATION

### PRINCIPLES OF THE BRADLEY METHOD OF BUSH REGENERATION

The Bradley method of Bush regeneration as described in Bradley (Bradley 1997) works on three general principles, which are:

- work outwards from good bush areas towards areas of weed;
- make minimal disturbance to the environment; and
- let native plant regeneration dictate rate of weed removal.

Other important points highlighted in Bradley (1997) include:

- don't start on large weed infestations unless you are sure you will get back to do the follow-up work (removing parent plants may create light and space for hundreds of new weeds);
- many plants require 3 years or more of control; and
- aim for control, not eradication and tipping the balance in favour of the local native plants.

#### Prevention

Early detection and early intervention are the most cost-effective means of weed management).

#### Long-term Commitment

Effective weed management requires a long-term commitment from managers of private and public lands

#### Coordinated Approach

Effective weeds management requires a coordinated approach involving all relevant stakeholders

#### Priority Setting and Planning

A simple and effective priority setting and planning process is required to best utilise available weeds management resources

#### Local Provenance

Local provenance plant material only (sourced from within local area of each site) will be used in revegetation projects.

## APPENDIX D - DIEBACK HYGIENE PROCEDURES

### DIEBACK HYGIENE PROCEDURES

#### Cleaning Vehicles

Vehicles and equipment which are used in infested sites are to be washed before entering another site unless the site to which it is going to be moved is also known to be infested.

When entering a Dieback free site, make sure the vehicle is washed and/or disinfected on entry.

When exiting a Dieback infested site make sure the vehicle is cleaned down before departing. If you have to move between infected and uninfected sites, once again cleaning is needed between each area.

Try to remove the soil using a brush or stick. Pay attention to the tyres and mudflaps.

Removing all mud and soil from vehicles is sufficient to reduce the spread.

Spray with Methylated Spirits or bleach (1 part bleach to 10 parts water) to sterilise tyres and underneath of vehicle.

#### Cleaning Footwear

Remove mud and soil with brush or stick.

Dispose of it in a site already infested or one that contains no remnant vegetation (do not allow soil material into the bushland).

Use Methylated (Metho) Spirits or bleach (1 part bleach to 10 parts water) for sterilising footwear and hand tools. Place into spray bottle and allow for it to soak into soil on footwear.

You can also use bleach. 1 part bleach to 10 parts water, soak for a few minutes and then rinse.

Vehicles are to carry a spray bottle with Methylated Spirits or bleach mixture, rubbish bags and a small brush when entering these areas.

## APPENDIX E - BUSHLAND MAINTENANCE COSTS

### ESTIMATED BUSHLAND MAINTENANCE COSTS

Banksia/Jarrah Woodland									
	Very Good			Good			Degraded		
	Hours		Total cost	Hours		Total cost	Hours		Total cost
Staff weed control	6.5	BMO x2	1196.00	10	BMO x2	1840.00	15	BMO x2	2760.00
Grass weed control (contractor)		Grass WC	543.00		Grass WC	543.00		Grass WC	543.00
Chemical costs Broad leaf Glyphosate		2% Gly	33.00		2% Gly	33.00		2% Gly	33.00
Chemical Costs Bulbous Glyphos Mets Pulse		Bulbous	38.00		Bulbous	38.00		Bulbous	38.00
Chemical Costs Woody cut paint 100% Glyphosate		Woody	1.00		Woody	1.00		Woody	1.00
Vegetation Condition Mapping		Veg Map	15.00		Veg Map	15.00		Veg Map	15.00
Weed Mapping		Weed Map	15.00		Weed Map	15.00		Weed Map	15.00
Dieback Mapping		Die Map	33.00		Die Map	33.00		Die Map	33.00
Rubbish collection		Rubb	585.00		Rubb	585.00		Rubb	585.00
Fence Repair		Fence	150.00		Fence	150.00		Fence	150.00
Feral Animal Control		Feral	57.00		Feral	57.00		Feral	57.00
	6.5		2666.00	10		3310.00	15		4230.00
Melaleuca Wetland									
	Very Good			Good			Degraded		
	Hours	Chem	Total cost	Hours	Chem	Total cost	Hours	Chem	Total cost
Staff weed control	10	BMO x2	1840.00	15	BMO x2	2760.00	18	BMO x2	3312.00
Grass weed control (contractor)		Grass W.C	543.00		Grass W.C	543.00		Grass W.C	543.00
Chemical costs Broad leaf Glyphosate		2% Gly	33.00		2% Gly	33.00		2% Gly	33.00
Chemical Costs Bulbous Glyphos Mets Pulse		Bulbous	38.00		Bulbous	38.00		Bulbous	38.00
Chemical Costs Woody cut paint 100% Glyphosate		Woody	1.00		Woody	1.00		Woody	1.00
Vegetation Condition Mapping		Veg Map	15.00		Veg Map	15.00		Veg Map	15.00
Weed Mapping		Weed Map	15.00		Weed Map	15.00		Weed Map	15.00
Dieback Mapping		Die Map	33.00		Die Map	33.00		Die Map	33.00
Rubbish collection		Rubb	585.00		Rubb	585.00		Rubb	585.00
Fence Repair		Fence	150.00		Fence	150.00		Fence	150.00
Feral Control		Fera	57.00		Feral	57.00		Feral	57.00
	10		3310.00	15		4230.00	18		4782.00
Coastal Heathland									
	Very Good			Good			Degraded		
	Hours	Chem	Total cost	Hours	Chem	Total cost	Hours	Chem	Total cost
Staff weed control	7		1288.00	11		2024.00	20		3680.00
Grass weed control (contractor)		Grass W.C	543.00		Grass W.C	543.00		Grass W.C	543.00
Chemical costs Broad leaf Glyphosate		2% Gly	33.00		2% Gly	33.00		2% Gly	33.00
Chemical Costs Bulbous Glyphos Mets Pulse		Bulbous	38.00		Bulbous	38.00		Bulbous	38.00
Chemical Costs Woody cut paint 100% Glyphosate		Woody	1.00		Woody	1.00		Woody	1.00
Vegetation Condition Mapping		Veg Map	15.00		Veg Map	15.00		Veg Map	15.00
Weed Mapping		Weed Map	15.00		Weed Map	15.00		Weed Map	15.00
Dieback Mapping		Die Map	33.00		Die Map	33.00		Die Map	33.00
Rubbish collection		Rubb	585.00		Rubb	585.00		Rubb	585.00
Fence Repair		Fence	150.00		Fence	150.00		Fence	150.00
Feral Control		Feral	57.00		Feral	57.00		Feral	57.00
	7		2758.00	11		3494.00	20		5150.00

## APPENDIX F – FIVE YEAR NATURAL AREA MANAGEMENT PLAN

### 5 Year Plan Natural Area Management 2012-2017 ENVIRONMENTAL SERVICES

#### A. Statement of Vision and Goals

##### 1. Vision

**To protect and upgrade the valuable and significant natural environment**

*Source: City of Cockburn Strategic Plan 2006 – 2016 pp 2*

##### 2. Our Mission

Our *Mission* is to make the City of Cockburn the most attractive place to live, work and visit in the Perth Metropolitan Area.

*Source: City of Cockburn Strategic Plan 2006 – 2016 pp 2*

##### 3. Goals

- Eradication of all High Priority Weeds
- 2.5 hectares of degraded bushland rehabilitated each year
- Eradication of feral animals within all reserves
- All reserves fenced to prevent unauthorised vehicle access.
- No rubbish being dumped in reserves
- No illegally lit fires in reserves
- Dieback mapped and contained within existing areas.
- All reserves able to naturally adapt to climate change

*Source: City of Cockburn Natural Area Management Plan 2010*

##### 4. External Factors

Environmental Weeds  
Feral Animals  
Illegal Access  
Illegal Rubbish Dumping  
Fire  
Plant Disease  
Inappropriate drainage  
Climate Change

## 5. Program Priorities

In order to bring that vision to reality, accomplish those goals, and respond to the external factors identified, the following are our specific program priorities:

- Prioritise reserves to ensure that finances and resources are allocated in a manner that will provide the best outcomes for both the community and the natural area.
- Development, implementation and regular review of a Weed Control Strategy
- Development, implementation and regular review of a revegetation programs for degraded reserves.
- Rehabilitation of 2.5 hectares of degraded bushland every year.
- Instigation of a feral animal control program
- Construction of appropriate fences around all conservation reserves to prevent illegal access.
- Erection of signage at entry points to reserves that provides information on the impact and safety issues associated with illegal access.
- Implementation of a community education campaign that informs residents of the impacts of illegal dumping.
- Establishment and maintenance of complying firebreaks around all reserves.
- All reserves have a current Bush Fire Response Plans
- All reserves containing dieback to be mapped.
- Implementation of dieback control methods
- Provision of adequate resources increase the resilience and to enable continued enhancement of reserves.

## B. Key Performance Indicators

The methods described below will be used to measure progress toward the achievement of goals.

### 1. **Percentage increase (hectares) in very good quality vegetation**

Vegetation condition surveys will be undertaken in each reserve every 4 years and compared against previous surveys to assess overall condition. Due to the number of reserves one quarter of reserves will be surveyed every year. Percentages will be updated every year once the results of the surveys are available. This is generally in December each year.

Should no increase be recorded over a two year period then a review will be undertaken of the Natural Area Management Strategy to determine if a change to management practises is warranted.

### 2. **Reduction in the number of high priority weeds within reserves.**

Reserves will be mapped for weeds every four years and the number of high priority weeds within each reserve will be assessed against previous mapping.

Should no decrease in high priority weeds within a reserve be recorded then the weed control methods being implemented within the reserve will be reviewed to determine their effectiveness.

### 3. **Reduction in the number of reports of feral animals and a reduction in the noted presence of feral animals within reserves.**

A feral animal register is maintained and reported sightings noted. Staff will assess the amount of damage being inflicted on reserves due to the presence of feral animals during routine visits.



Should no decrease in feral animals be recorded the feral animal control program will be reviewed to determine its effectiveness.

#### **4. Number of reserves needing appropriate fencing**

A list of reserves still requiring fences is maintained. Funding for individual reserve fencing is requested annually through the budgeting process.

#### **5. Decrease in the amounts of rubbish being removed from reserves**

Rubbish removal costs are allocated against each reserve. Reductions in costs will track progress.

Should the amounts of rubbish being removed from reserves increase then the adequacy of the education campaign will be assessed and reviewed.

#### **6. Reduction in illegally lit fires within reserves.**

A register is kept of the fires occurring in each reserve. Records are kept by FESA. Fire scars are mapped using a GPS and recorded on Fire Response plans. Comparisons will be made each year.

Should the incidence of fires increase then an education campaign addressing the impacts of fire will be implemented in local schools.

#### **7. Number of reserves containing dieback.**

A register of the reserves containing dieback and the area of dieback is maintained. Mapping is undertaken every 4 years. No increase in area indicates that dieback control methods are working.

Should areas affected by dieback increase then dieback management and control methods will be assessed and reviewed.

#### **8. Annual increase in funding per hectares (above the CPI) for reserve management.**

An increase in funding allocated per hectares represents an increase in resources which equates to an enhancement in bushland condition. Funding per hectares will be reported each financial year.

Annual funding is the single most influential factor that will determine whether our vision, mission and goals are achieved.

The 2012/13 funding allocation for maintenance only equates to \$1,482 per hectare which is well short of the \$3,310 required to maintain and enhance our natural areas and reach the objective of having all of our natural area achieve a vegetation condition rating of good or better.

Current funding will permit 2.5 hectares to be revegetated and only allow for the current reserve condition to be maintained.

Alternative sources of funding such as grants and sponsorship will be sought to bolster current funding allocations.