City of Melville

City of Melville

Central Reserves Strategic Management Plan 2017-2022

July 2017

Executive Summary

The Central Reserves are located in the suburb of Ardross, Booragoon, Mount Pleasant and Willagee in the centre of the City of Melville. The seven reserves (Carawatha Bushland; Al Richardson and Reg Seal Reserves; Connelly, Hatfield, Harry Stickland and Len Shearer Parks) include 6.44 hectares of bushland that has been has been moderately isolated from other terrestrial bushland remnants for approximately 40 years.

These reserves were rated low in terms of their overall value in the NAAMP. Of the four ratings, all parks/reserves were rated in the second lowest tier, except Harry Stickland Park which was rated in the second highest tier, and Carawatha Bushland which was not managed as a bushland reserve in 2013 and therefore not rated.

Of the 15 assets targeted for monitoring and management, the 4 assets of regional, state and/or national significance were:

- 1 ecological community
    - Bassendean Vegetation Complex – Central and South
- 3 bird species
    - *Calyptorhynchus banksii*, Forest Red-Tailed Black-Cockatoo
    - *Calyptorhynchus latirostris,* Carnaby's Black-Cockatoo
    - *Smicrornis brevirostris,* Weebill

The vegetation is regionally significant, with less than 30% of the Bassendean Central and South vegetation complex remaining uncleared.

The 125 native plant species recorded onsite represent approximately 30% of the species recorded in the City of Melville:

- of the plants of regional, state or national significance:
    - 1 shrub (*Jacksonia sericea*), which would be of regional significance if naturally occurring rather than planted in the Central Reserves;
- another five tree / shrub species are at very high risk of local extinction:
    - *Banksia grandis* (4 plants)
    - *Banksia ilicifolia* (1 plant)
    - *Eremaea pauciflora* (2 plants)
    - *Hakea prostrata* (1 plant)
    - *Persoonia saccata* (5 plants)

The 26 native animal species (2 bat, 5 reptile and 19 bird species) recorded onsite represent 10% of species recorded in the City of Melville, but the inventory for the Central Reserves is not comprehensive. Of these:

- 2 birds (*Calyptorhynchus banksii*, Forest Red-Tailed Black-Cockatoo and *Calyptorhynchus latirostris,* Carnaby's Black-Cockatoo) that are threatened migratory birds of national significance that would utilise the Central Reserves seasonally for feeding, and as a linkage between larger remnants, but not for breeding.

Of the 44 threats considered for targeted monitoring and management, the 10 very high impact threats directly affecting the reserves were:

- 5 weeds
    - *Schinus terebinthifolius,* Brazilian Pepper,
    - *Eucalyptus* species, very large tree weeds,
    - *Ehrharta calycina*, perennial clumping grasses
    - *Asparagus asparagoides, Bridal Creeper*
    - *Lachenalia reflexa, Soldiers*
- 1 plant pathogen
    - *Phytophthora cinnamomi*, Dieback
- 2 feral animals
    - Foxes
    - Cats
- 2 weather events
    - High Temperatures
    - Low Rainfall

A discussion is provided on changes in assets and threats between 2012 and 2017, but a comprehensive audit of key performance indicators, and many leading and lagging indicators was not possible as quantitative data collection was not previously standardised by the City of Melville for bushland management. Between 2012 and 2017:

- 18 threats were prevented;
- 9 threats were unchanged or decreased;
- 15 threats could not be assessed for changes;
- 18 assets were maintained; and
- 3 assets could not be assessed for changes.

Applying the principles established in the City of Melville's *Natural Areas Asset Management Plan*, this strategic reserve plan establishes 38 objectives for threats in order to meet the 24 goals for assets for the period 2017-2022. These are to be implemented through operational reserve plans, guidelines and procedures, and the outcomes and effectiveness of management reviewed using quantitative data.

The major priorities for management should be:

- Maintaining the populations of plants in low abundance;
- Maintaining bushland with very high native plant cover at 36%; and
- Enhancing revegetation sites.

Recommended Reference

The recommended reference for this document is:

Waters, A (2017) *Central Reserves Strategic Management Plan 2017-2022,* Woodgis Environmental Assessment and Management for the City of Melville, Perth.

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Acronyms and Definitions

ANZECC	Australian and New Zealand Environment and Conservation Council
DBH	Diameter at Breast Height
DEC	(WA) Department of Environment and Conservation
DEP	(WA) Department of Environmental Protection
DPaW	(WA) Department of Parks and Wildlife
EPBC Act	Environment Protection and Biodiversity Conservation Act
FCT	Floristic Community Type
ha	hectares
Melville	City (rather than suburb) unless specifically stated otherwise
NAAMP	Natural Areas Asset Management Plan
PEC	Priority Ecological Community (as defined and listed by DPaW)
WAPC	Western Australian Planning Commission

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1 Introduction

1.1 Background

In accordance with the City of Melville's *Natural Areas Asset Management Plan* (NAAMP) framework, the Strategic Reserve Plan forms part of the integrated set of documents shown in Figure 1.

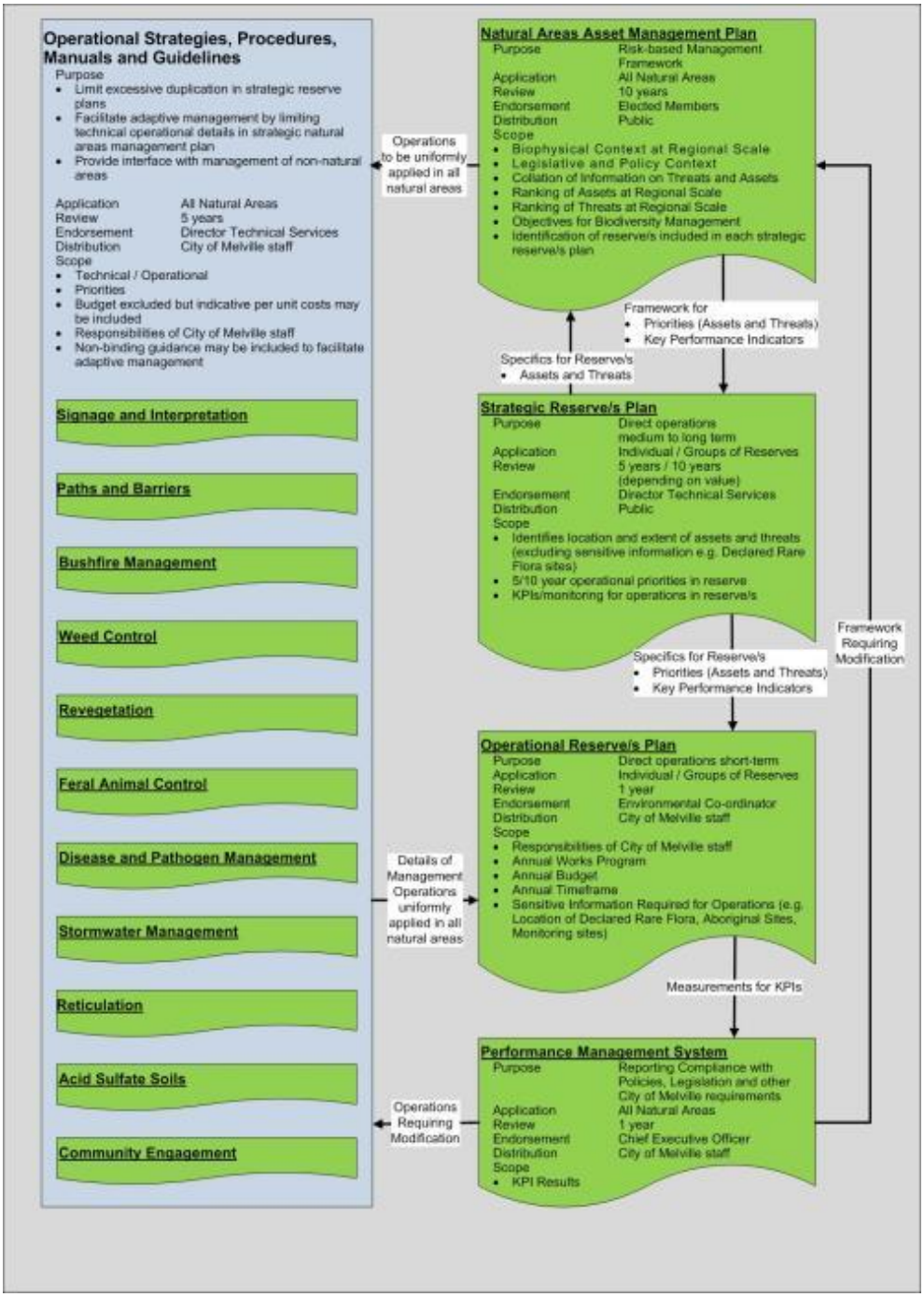

Figure 1 Context of Strategic Reserve Plans in relation to other documents

The Strategic Reserve Plan is structured with the major headings of assets and threats in accordance with the NAAMP framework, whereby assets are maintained or enhanced by the management of threats (using the strategies and guidelines) as summarised in Figure 2.

Priorities for Protection from Threats								Threats impacting on assets and therefore subject to Management	Techniques for Management of Threats									
BIODIVERSITY ASSETS								THREATS	STRATEGIES AND GUIDELINES									
Bush Forever Reserves	Ecological Community Sites	Wetland Sites	Heritage Sites	Community Interest Sites	Reference Sites	Native Flora Species	Native Fauna Species		Sign, Path and Barrier Guidelines	Bushfire Strategy	Weed Control Strategy & Guidelines	Revegetation Strategy & Guidelines	Feral Animal Strategy and Guidelines	Diseases and Pathogen Guidelines	Stormwater Management Strategy	Reticulation Guidelines	Acid Sulfate Soils Guidelines	Community Engagement
X	X		X	X	X	X		Physical Disturbance	X	X	X	X	X	X	X	X	X	X
X	X		X	X		X	X	Fire		X	X	X				X		X
X	X	X	X	X		X	X	Weeds		X	X	X				X		X
X	X					X	X	Habitat Loss				X	X					X
X	X					X	X	Feral Animals				X	X					X
X	X	X	X	X	X	X	X	Diseases & Pathogens	X					X				X
X	X	X	X		X	X	X	Stormwater							X			X
						X		Reticulation								X		
X	X	X	X			X	X	Acid Sulfate Soils									X	
X	X	X	X			X		Climate Change			X	X						

Figure 2 Documents used to Maintain/Enhance Assets by Managing Threats

Red = Strategy intended to Prevent, Eliminate, Contain or Manage impacts from threat
Orange = Strategy or Guideline to Manage secondary impacts from threats

Guidelines and procedures were to largely pre-empt strategic reserve plans, to ensure efficiency and consistency in benchmarking and monitoring expected outcomes. The City of Melville has begun to develop the guidelines and procedures required but they do not yet fully apply the framework for ranking/prioritising assets and threats, nor document all management and monitoring techniques.

Historically management plans have focused on developing flora and fauna inventories to identify reserves of greatest significance within the City of Melville. Under the NAAMP framework, the focus is moving to risk assessment and prioritisation of management objectives within reserves, and it is envisaged that future plans will focus to a greater degree on reviewing the outcomes and effectiveness of management strategies and guidelines.

The NAAMP provides a framework for:

- consistently prioritising assets and threats;
- a format for plans; and
- community involvement in managing specific reserves:
  - the community can assist during the preparation of strategic reserve plans in:
    - the identification and benchmarking of assets and threats; and
    - quantifying objectives for threats and goals for assets (e.g. specific number of very high value plants of a species to be established onsite).
  - the community can assist during the life of strategic plans in:
    - the identification and delineation of additional assets (including revegetation sites) and threats;
    - the monitoring of assets and threats; and
    - on-grounds works in the context of specific and measurable goals.

1.2 Objectives

Under the framework of the NAAMP, the objectives of this and all City of Melville Strategic Reserve Plan/s are to:

- document:
  - the extent and/or abundance and condition of assets;
  - the present and potential level and extent of impacts of threats;
  - any changes evident in the assets and threats over time;
  - reserve-specific risk-based management priorities;
  - management strategies relevant to the specific reserve; and
- discuss:
  - reserve specific application of strategies and make reserve specific recommendations regarding the implementation of strategies.

1.3 Scope

The scope of this plan is the 6.44 ha of bushland in the 16.46 ha of reserves listed in Table 1.

Table 1 Reserve Extents

Reserve Name	Reserves / Lots	Parkland Extent	Bushland Extent
Al Richardson Reserve	R 30699	0.40 ha	0.60 ha
Carawatha Bushland	Lot 300	-	0.59 ha
Connelly Park	R 38051	-	0.54 ha
Harry Stickland	R 36511 and Lot 361	-	0.91 ha
Hatfield Park	R 36011	-	1.20 ha
Len Shearer Park	R 26742, R 34009, R 38573 and R 41250	9.36 ha	2.30 ha
Reg Seal Reserve	R 25734	0.26 ha	0.30 ha

These reserves are located in the suburbs of Ardross, Booragoon, Mount Pleasant and Willagee in the centre of the City of Melville, as shown in Figure 3.

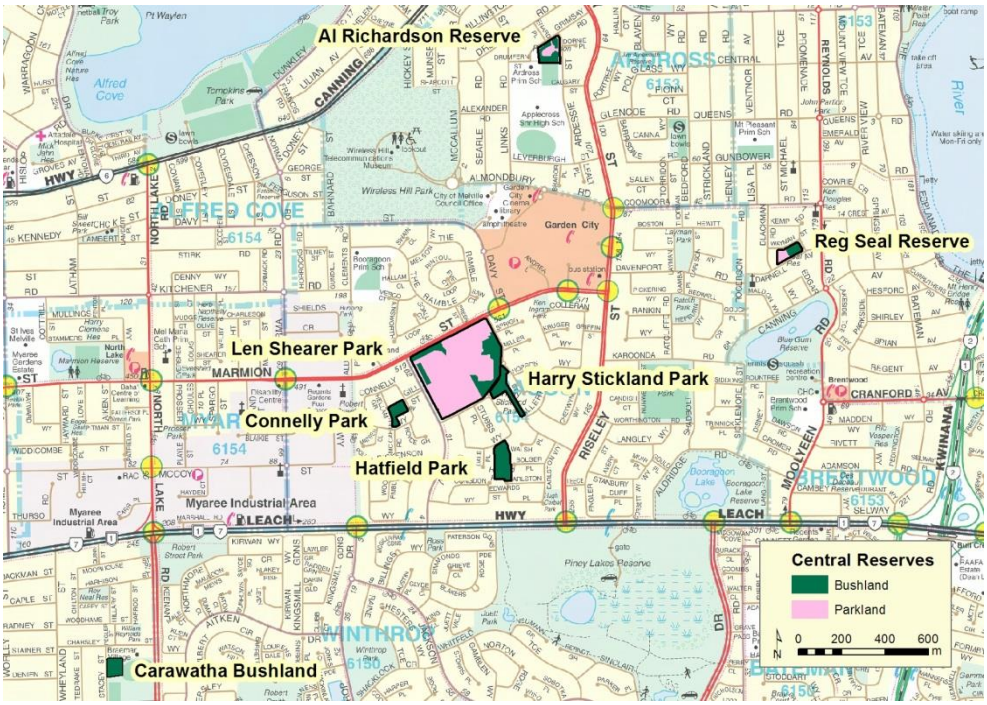

Figure 3 Location of Reserves included in Plan

These reserves were rated low in terms of their overall value in the NAAMP. Of the four ratings, all parks/reserves were rated in the second lowest tier, except Harry Stickland Park which was rated in the second highest tier, and Carawatha Bushland which was not managed as a bushland reserve in 2013 and therefore not rated.

2 Assets

2.1 Overview

The City of Melville has committed to a strategic goal to 'contribute to the maintenance and enhancement of biodiversity for the preservation of our natural flora and fauna'.

The NAAMP documents the regional context for climate, soils, landforms, flora and fauna; and establishes a framework by which biodiversity is:

- defined as assets at three scales:
  - **Reserves** (usually defined by cadastral boundaries);
  - **Sites** (management units such as a vegetation type that may encompass either a part or the entirety of a reserve); or
  - **Species** (a group of organisms capable of interbreeding freely with each other but not with members of other species).
- prioritised for either maintenance and enhancement (or confirmation if its status onsite is uncertain, or monitoring if a reserve is not critical habitat) in terms of:
  - **Values** (assessed with reference to local regional, state, national and international significance) as shown in Figure 4.

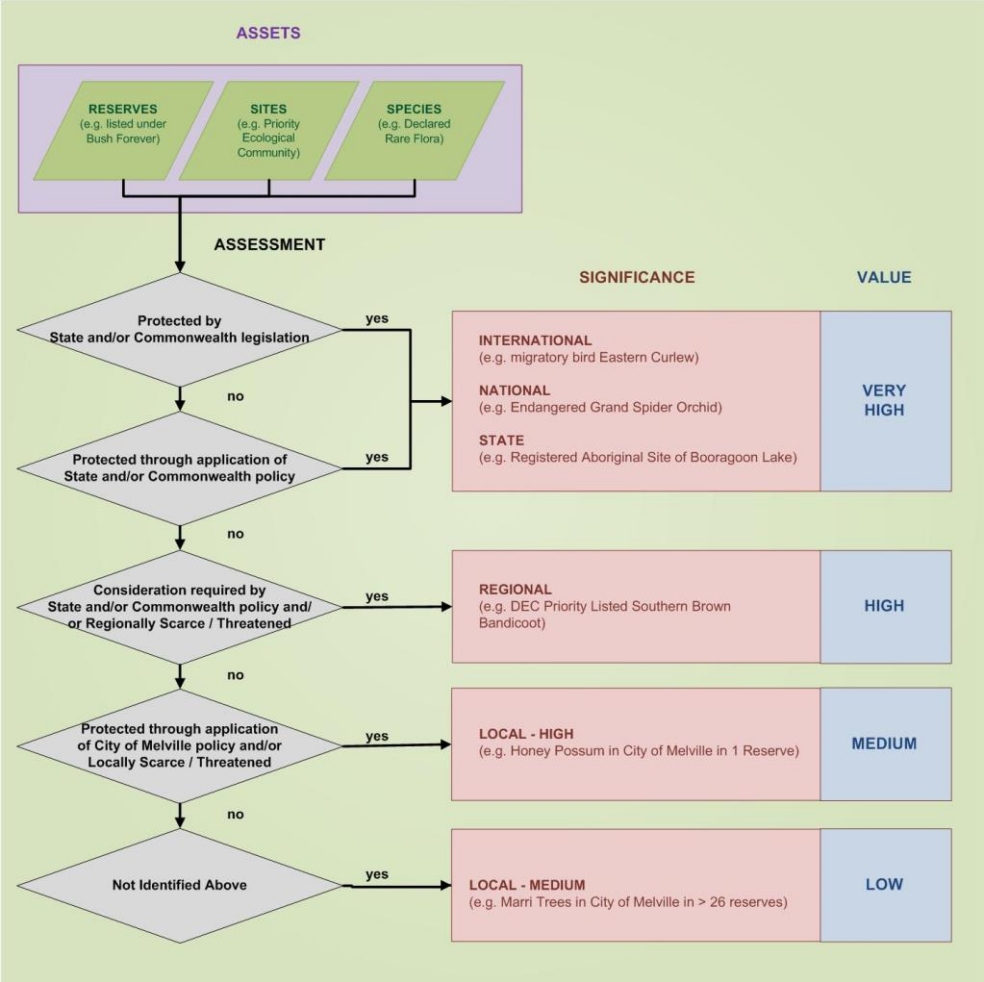

Figure 4 Assessment of Assets in Natural Areas

The values of assets are reviewed periodically as they will occasionally change (e.g. the significance of an occurrence of a species may be downgraded if it is recorded in more reserves over time with additional targeted surveys). A change in the value of an asset is applicable to that asset in all natural areas in the City of Melville, including in reserves with current endorsed strategic reserve management plans.

To provide foci for management and monitoring, a strategic risk assessment was undertaken in the 2013 NAAMP (Waters A. , 2013) to identify assets with elevated susceptibility to threats.

Assets are used as indices where they are significant and/or vulnerable to loss or degradation without targeted action. Vulnerable assets were determined on the basis of the characteristics summarised in Table 2.

Table 2 Groups of Assets generally most susceptible to Threats

Threats	Assets		
	Sites	Fauna Species	Flora Species
Physical Disturbance	All sites	Ground dwelling and/or burrowing reptiles	All shrubs, and herbaceous species
Fire	All sites	All ground dwelling species (non-burrowing, non-climbing and non-flying species)	Trees and shrubs that are killed by fire and regenerate only from seed stored on the plant
Weeds	All sites	Ground dwelling and/or burrowing reptiles	All shrubs, and herbaceous species
Habitat Loss	Ecological Community listed as Threatened or Priority by DPaW Present in few reserves	Listed as Threatened or Priority by DPaW Present in few reserves or few individuals in a reserve Cannot persist in urban or 'small' bushland areas Hollow dependent species	Listed as Threatened or Priority by DPaW Present in few reserves or few individuals in a reserve
Feral Animals Cats and foxes Rabbits Bees	- Revegetation sites -	All species - Hollow dependent species	- - All herbaceous species
Diseases & Pathogens	All sites	No species	Wide range of species
Stormwater	All wetlands	All wetland dependent species	All wetland dependent species
Reticulation	All sites	Reptiles that are either ground dwelling and/or burrowing	All shrubs, and herbaceous species
Acid Sulfate Soils		All wetland dependent species	All wetland dependent species
Climate Change	All wetlands	All wetland dependent species	Long-lived shallow rooted and associated with saturated soils

2.2 Reserve Assets

2.2.1 Bush Forever

Bush Forever Sites are properties listed as containing regionally significant bushland by the Government of Western Australia (2000). Bush Forever is not subject to ongoing revision and therefore the Bush Forever status of reserves is expected to remain unchanged for the foreseeable future. However under the NAAMP, Bush Forever status is considered in terms of:

- prioritising management resources between reserves, and
- managing sites and species within reserves to ensure reserves continue to meet the Bush Forever criteria for which they were listed.

None of the Central Reserves were listed by the Government of Western Australia (2000) as Bush Forever Sites using the following criteria:

- **Representation of ecological communities**
  Areas that as a suite represent the range of ecological communities and the places in which these communities merge
- **Diversity**
  Areas with a high diversity of flora and/or fauna species or communities in close association
- **Rarity**
  Areas containing rare or threatened communities or species, or species of restricted distribution
- **Maintaining ecological processes or natural systems**
  Maintenance of ecological processes or natural systems at a regional or national scale
- **Scientific or evolutionary importance**
  Areas containing evidence of evolutionary processes either as fossilised material or as relict species and areas containing unusual or important geomorphological or geological sites; Areas of recognised scientific and educational interest as reference sites or as examples of the important environmental processes at work
- **General criteria for the protection of wetland, steamline and estuarine fringing vegetation and coastal vegetation**
  Conservation category wetlands areas including fringing vegetation and associated upland vegetation. Coastal vegetation within the accepted coastal management zone
- **Criteria not relevant to determination of regional significance, but which may be applied when evaluating areas having similar values**
  Attributes which taken alone do not establish regional significance, but which can add to the value of bushland and enhance it contribution to Bush Forever

2.2.2 Ecological Linkages

Ecological linkages can increase the effective size of flora populations, and increase available habitat for individual animals, and help maintain genetic diversity for animals and plants by providing connections between groups of animals and plants in isolated bushland remnants.

The management of linkages is outside the scope of Strategic Reserve Plans and is dealt with through processes such as:

- land use planning processes;
- the *City of Melville's Green Plan* (Alan Tingay and Associates, 1998);
- the *City of Melville Streetscape Strategy;* and
- the *City of Melville Public Open Space Strategy.*

Under the NAAMP, linkages are considered in terms of:

- prioritising management resources between reserves, and
- determining whether species can persist onsite in the long term.

None of the Central Reserves were included in

- Regional Linkages in Bush Forever (Government of Western Australia, 2000); or
- Perth Biodiversity Plan Regional Linkages; or
- Regional Greenways (Alan Tingay and Associates, 1998).

The bushland of the Central Reserves has been moderately isolated from other terrestrial bushland remnants for approximately 40 years. Aerial photography between 1965 and 1995 is shown in Figure 5 to Figure 8.

Figure 5 Remnant Vegetation in 1965

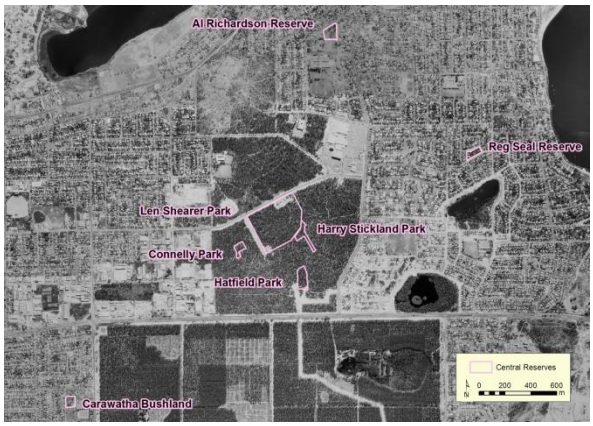

Figure 6 Remnant Vegetation in 1974

Figure 7 Remnant Vegetation in 1979

Figure 8 Remnant Vegetation in 1981

Historic clearing between 1953 and 2014 is shown in Figure 9.

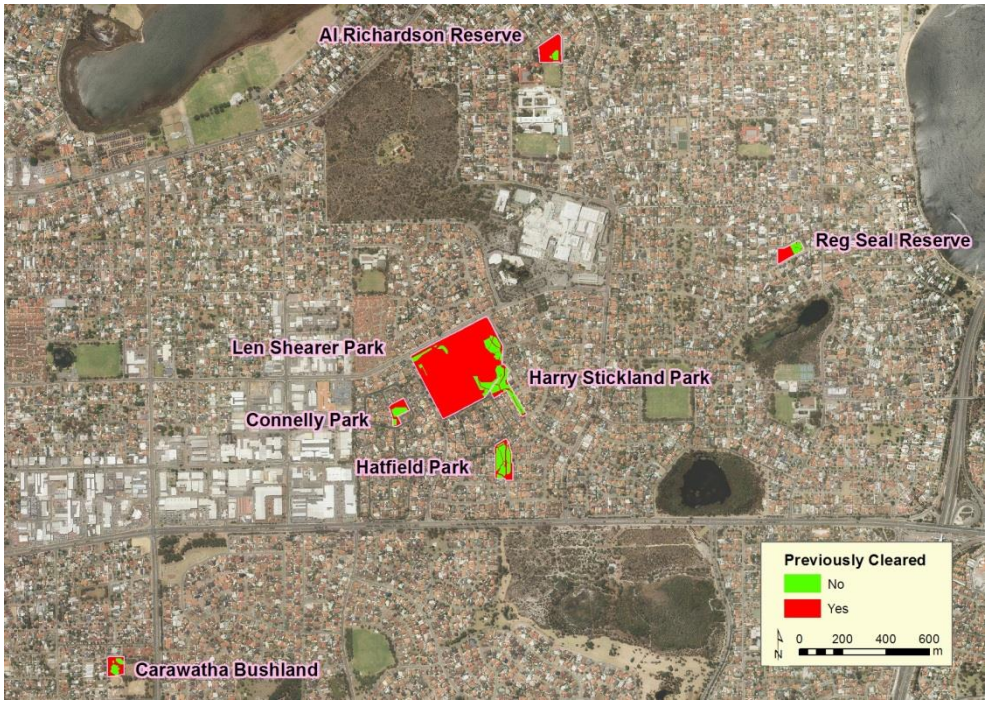

Figure 9 Location of Physical Disturbances

There is approximately 8% native vegetation in the circle extending 2 km out from the centre of Central Reserves as shown, using Department of Agriculture vegetation boundaries, as shown in Figure 10.

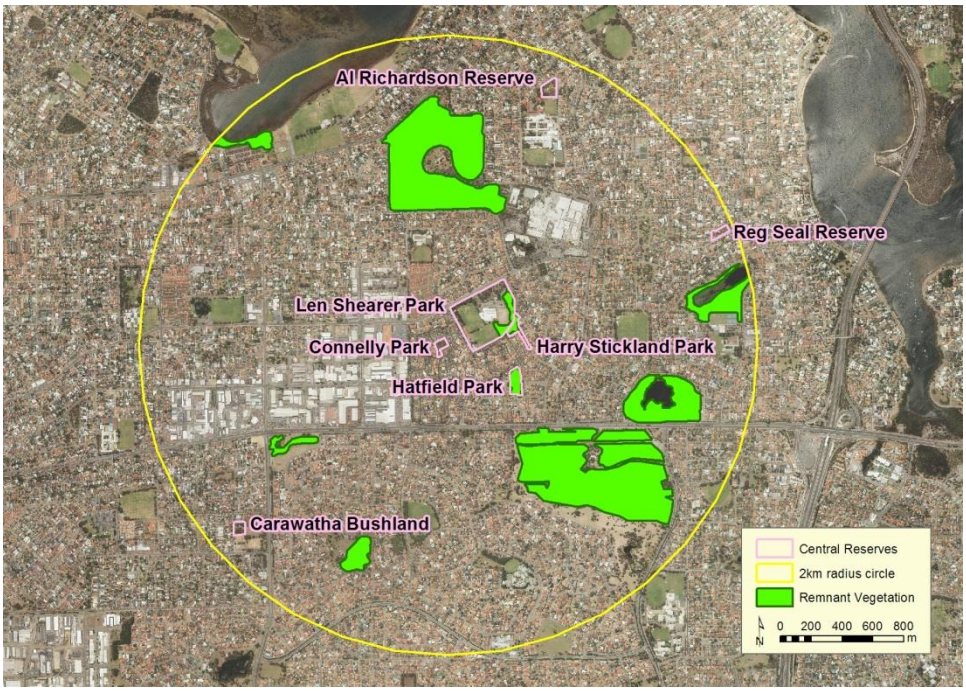

Figure 10 Remnant Vegetation with 2 km of Central Reserves

The total native cover in this area has implications for the long term persistence and management of some flora and fauna species onsite (see Section 2.4 and Section 4).

2.3 Site Assets

2.3.1 Ecological Communities

The one vegetation association, on which management will be based in the Central Reserves, is detailed in *Flora and Vegetation Surveys City of Melville Central Reserves (Carawatha Bushland; Al Richardson and Reg Seal Reserves; Connelly, Hatfield, Harry Stickland and Len Shearer Parks)* (Waters A. , 2017) and shown in Figure 11.

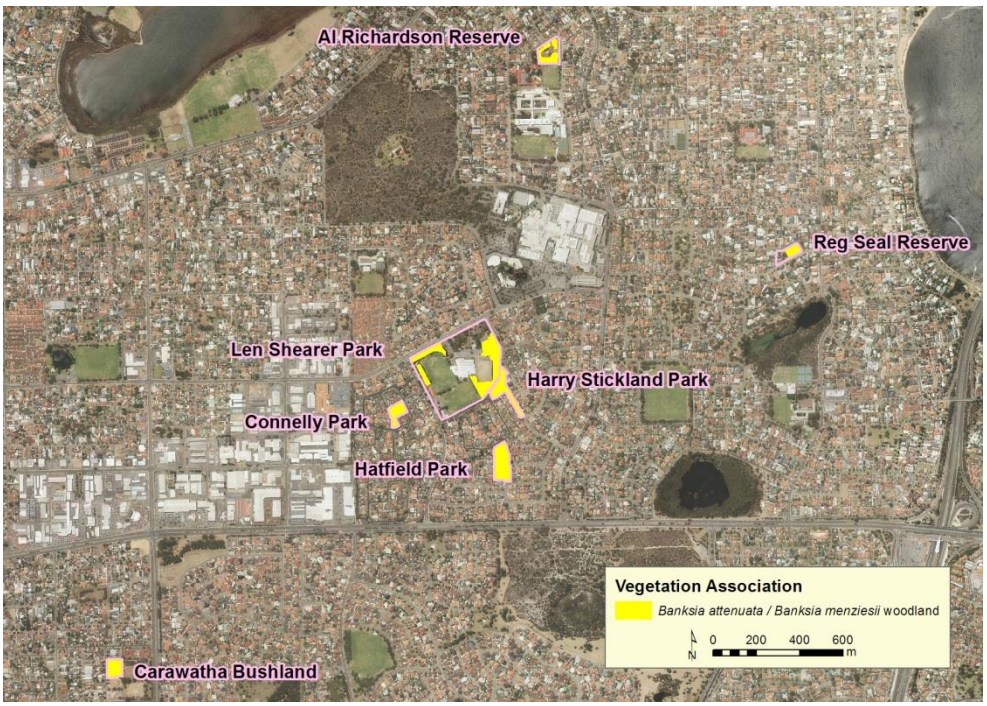

Figure 11 Vegetation Associations

The flora recorded in each reserve is documented in Appendix 2. The extents of each vegetation association are listed in Table 3.

Table 3 Extents of Vegetation Associations

Associations	Dominant / Typical / Indicative species	Reserve Name	Extent	Total
Banksia attenuata / Banksia menziesii woodland	*Allocasuarina fraseriana* *Banksia attenuata* *Banksia menziesii* *Corymbia calophylla* *Eucalyptus marginata*	Al Richardson Reserve	0.60 ha	6.44 ha
		Carawatha Bushland	0.59 ha	
		Connelly Park	0.54 ha	
		Harry Stickland	0.91 ha	
		Hatfield Park	1.20 ha	
		Len Shearer Park	2.30 ha	
		Reg Seal Reserve	0.30 ha	

Assets are prioritised on the basis of their highest level of significance when they are assessed against multiple datasets. The significance of vegetation can be assessed in terms of several classifications:

- **Vegetation Complexes** are a regional classification for the Swan Coastal Plain, Darling Scarp and Darling Plateau mapped by Heddle *et al.* (1980) on the basis of combinations of plants communities, soils and landforms. Plant communities may occur in more than one soil-landform combination but the relative proportions of plant communities vary between these (Government of Western Australia, 2000).
- **Floristic Community Types** (FCTs) are a regional classification for the Swan Coastal Plain and Darling Scarp defined in terms of groups of co-occurring plants by Gibson *et al*. (1995) and the DEP (1996). Whilst FCTs are distributed in more of a mosaic than vegetation complexes, the classifications are equivalent in dividing the region into a roughly equal number of classes. There are some associations between FCTs and vegetation complexes (i.e. some FCTs tend to occur in particular complexes), but there is **no** hierarchical relationship between them. No FCTs were inferred for the Central Reserves because there were no detailed reference sites or species inventories to compare species presence/absence between vegetation associations.
- **Vegetation Types** are a local classification in the City of Melville mapped by Ecoscape (2006) in terms of dominant overstorey species. The general descriptions of vegetation types were applied to avoid issues with minor discrepancies in interpretation of boundaries.

It does not appear the vegetation meets the criteria of a Matter of National Environmental Significance (MNES) under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) where occurrences are either: entirely in 'Pristine' condition; 'Excellent' condition for patches greater than 0.5 ha; or 'Very Good' condition for patches over 1 ha; or 'Good' condition for patches over 2 ha.

The ecological communities for which objectives apply in the Central Reserves are listed in Table 4.

Table 4 Ecological Community Sites

Vegetation Association	Vegetation Complex	Floristic Community Types	Vegetation Types
Banksia attenuata / Banksia menziesii woodland	Bassendean - Central and South **High Significance** Vegetation Complex with 10-30% uncleared	Not Determined	Banksia and Allocasuarina species on upland areas / Eucalyptus and Banksia species on upland areas **Low Significance** Multiple occurrences in Melville

The areas of high native plant cover (<25% non-woody weeds, <25% bare ground and >15 m from very large live weed trees) in 2016 is shown in Figure 12.

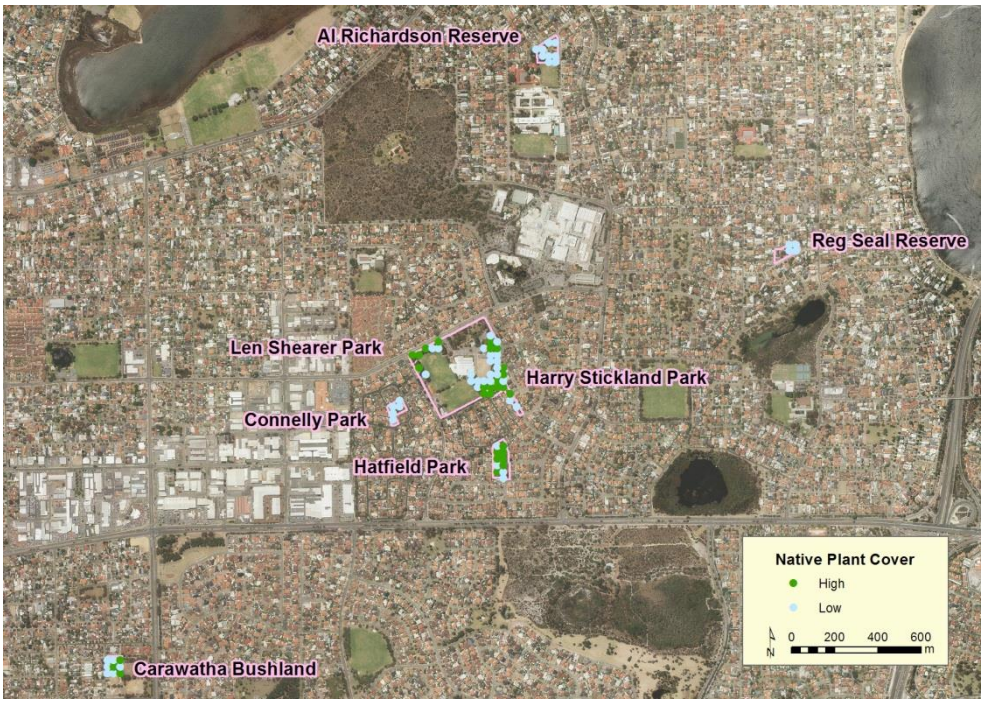

Figure 12 Areas of High Native Plant Cover 2016

The ecological community indices are listed in Table 5.

Table 5 Ecological Community Indices

Values	Ecological Community Sites	High Native Plant Cover 2012	High Native Plant Cover 2016	Assets 2012-2017
High Vegetation Complex with 10-30% uncleared	Bassendean – Central and South Vegetation Complex • *Banksia attenuata/Banksia menziesii* woodland • *Melaleuca thymoides* Shrubland • *Melaleuca preissiana* woodland	No Data	36%	Not Assessable

2.3.2 Fauna Habitat

Very large trees are important habitat sites for a number of resident and migratory birds and bats onsite:

- many birds rely on tree hollows (Birdlife Australia, 2013);
- roost sites (in tree hollows and under flaking/rough bark) are a critical habitat requirement for bats (Hosken, 1996); and
- The size of trees is one of the critical factors in determining the likelihood of hollow formation in trees (Gibbons & Lindenmayer, 2002).

The locations of the very large dead trees and live native trees (trunk diameter at breast height greater than 50 cm) are shown in Figure 13.

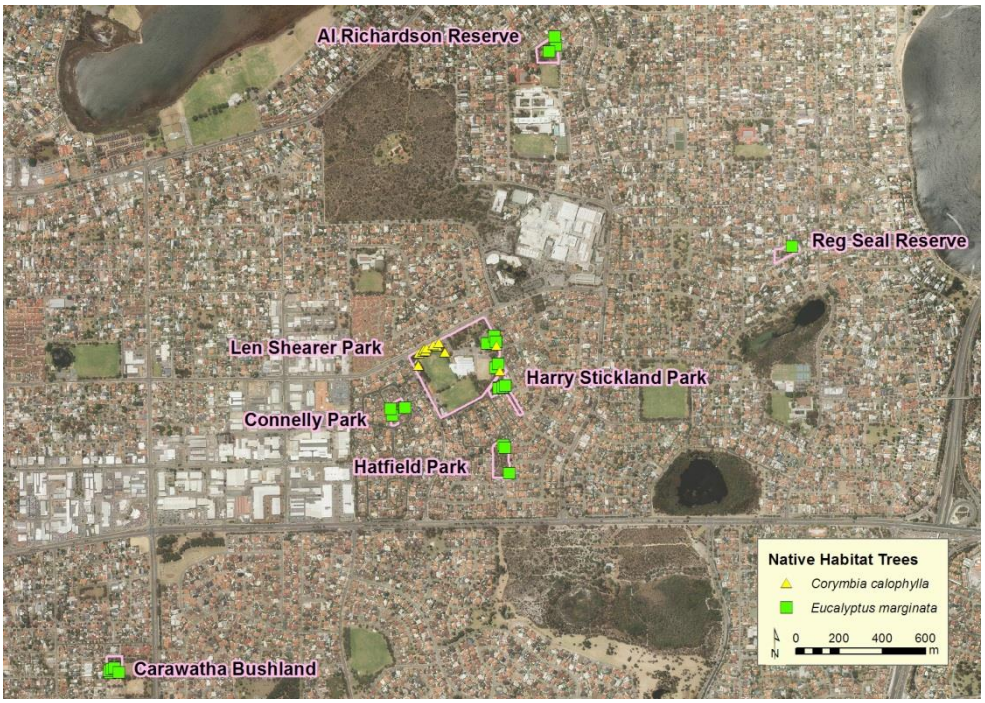

Figure 13: Distribution of Native Habitat Trees in 2016

The numbers of very large trees by species are listed in Table 6. There were no dead very large weed trees.

Table 6 Numbers of Very Large Native Trees by Species

Species	Al Richardson	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Reg Seal	Total
Native Habitat Trees	**2**	**5**	**4**	**25**	**3**	**1**	**40**
Corymbia calophylla				13			13
Eucalyptus marginata	2	5	4	12	3	1	27
Dead Habitat Trees	**1**	**0**	**0**	**0**	**0**	**0**	**1**
Corymbia calophylla	1						1
Total	**3**	**5**	**4**	**25**	**3**	**1**	**41**

The density of very large trees in bushland areas in the Central Reserves is compared to other reserves in Table 7.

Table 7 Numbers of Very Large Trees per Hectare in Melville Reserves

Species	Central Reserves (2 reserves)	South-Eastern (infested) Reserves (8 reserves)#	Eastern Reserves (3 reserves)	Bullcreek Reserves (7 reserves)	North-West Reserves (3 reserves)	Estuarine Reserves+ (4 reserves)	Heathcote Reserve (1 reserve)	Wireless Reserve (1 reserve)	Piney Lakes Reserve (1 reserve)	Quenda (1 reserve)	Central (modified) (2 reserves)	Central (2 reserves)
Live Native	2	8	6	12	17	18	4	3	1	2	5	6
Dead	<1	1	<1	0	2	3	0	<1	0	0	0	<1
Total	**2**	**9**	**6**	**13**	**19**	**21**	**4**	**3**	**1**	**2**	**5**	**6**

#updated to include Dudley Hartree Park

The density of habitat trees in the Central Reserves was very low number, which is the case of a number of natural areas in the City of Melville.

The fauna habitat for which objectives apply are listed in Table 8, which reflects that the number of very large trees was not previously benchmarked for the Central Reserves, and that there was no evidence of significant changes 2012-2017.

Table 8 Fauna Habitat Sites Indices

Values	Habitat Sites	Trees / Hectare 2012	Trees / Hectare 2016	Assets 2012-2017
Medium Very Large Trees	Live Native Tree	No Data	2	Maintained (assumed unchanged)
	Dead Tree		0	

2.3.3 Wetlands

Wetlands are defined in Schedule 5 of the *Environmental Protection Act 1986* as areas 'of seasonally, intermittently or permanently waterlogged or inundated land, whether natural or otherwise, and includes a lake, swamp, marsh, spring, dampland, tidal flat or estuary'.

The Central Reserves contain no wetland sites identified in the DPaW's *Geomorphic Wetlands Swan Coastal Plain* dataset, based on the mapping of Hill *et al.* (1996).

There are no wetland indices for the Central Reserves as there:

- are no open waterbodies in which to measure water levels; and
- is no ongoing groundwater data available for the vicinity for assessing changes in the depth to the watertable.

2.3.4 Heritage

There are no heritage indices for the Central Reserves as there were no heritage sites listed on:

- The National Heritage List;
- WA Aboriginal Sites Register;
- the WA Heritage Register; or
- the City of Melville's Municipal Heritage Inventory.

2.3.5 Community Interest

Revegetation sites can be a focus for community interest as these are visible manifestations of natural area management, and the public is often directly involved in their proposal or implementation. There are extensive plantings in a number of the reserves, and there are bird and bat boxes. Community interest sites are listed in Table 9 and shown in Figure 14.

Table 9 Community Interest Sites 2016

Species	Al Richardson	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Reg Seal	Total
Local Native Plantings	0.25 ha	0.38 ha	-	0.38 ha	1.03 ha	0.22 ha	**2.25 ha**
Bird Boxes	1	-	-	-	-	-	**1**
Bat Boxes	3	-	-	-	-	-	**3**

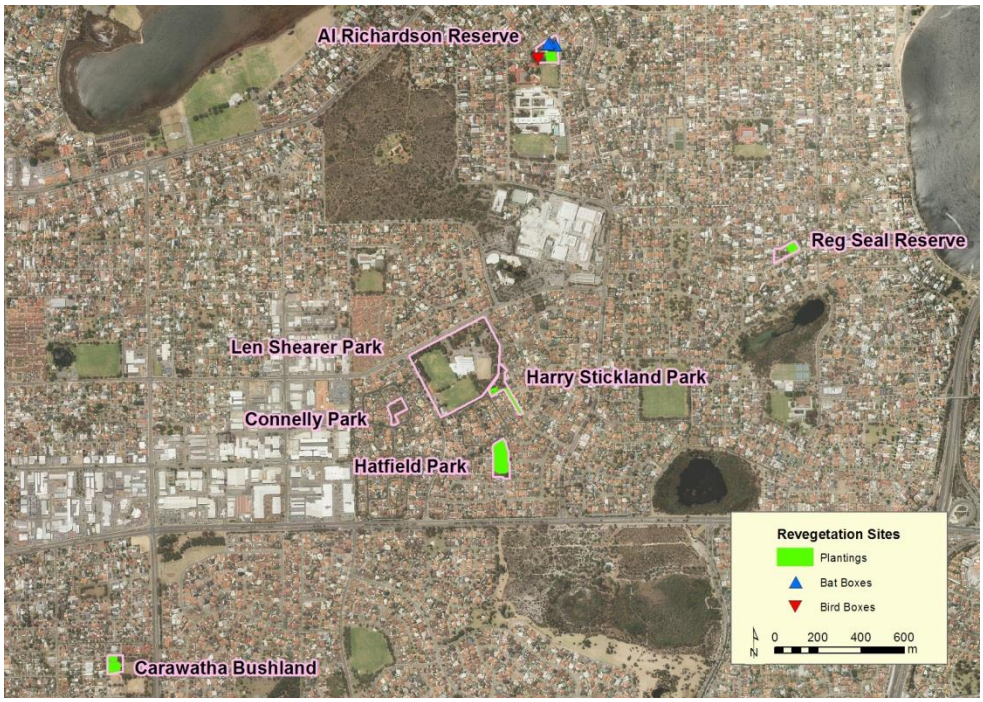

Figure 14 Community Interest Sites

Revegetation sites (plantings) are areas in which plantings have been undertaken and are currently being intensively managed and had not been assessed against the completion criteria, at which point they stop being treated as revegetation sites. No plantings in Figure 14 have been assessed against criteria in Table 10.

Table 10 Revegetation Objectives

Revegetation Category	Objectives
Establishment of individual plants or artificial hollows	• Plants > 5 years old • Hollows used by target species • A minimum number of plants or artificial hollows
Rehabilitation Reinstating self-sustaining and functional ecosystems based on local species, but not aspiring to fully replace all of the original components of an ecosystem.	• Plants > 5 years old • Gaps between native plants < 1 m x 1 m • Weed cover < 25% and bare ground <25% in any 100 m^2 area (in which a rectangle with a minimum side of 2 m can fit) • A number of shrubs/trees (the number varying between sites) • Diversity criteria generally not set
Restoration of vegetation Reinstating the composition, structure, function and dynamics of pre-existing indigenous ecosystems	• Diversity and density measurements benchmarked against reference site

The community interest sites for which objectives apply are listed in Table 11.

Table 11 Community Interest Site Indices

Values	Community Interest Sites	Completion Criteria Met 2007-2012	Completion Criteria Met 2012-2017	Assets 2012-2017
Medium Revegetation Sites	Local Native Plantings	No data	No data	Change Not Assessable
	Bird and Bat Boxes			

Generally, additional planting areas are explicitly defined in operational plans, rather than strategic reserve plans which indicate broad priorities (within and between ecological communities, and between species) and document the effectiveness of revegetation (changes in weed and native plant cover, and bare ground). This framework facilitates the identification and delineation of additional revegetation sites with community input during the life of the strategic plans, prioritising sites using:

- the values of assets (with a focus on ecological communities and native species);
- objectives relating to the extent of ecological communities to be enhanced; and
- threats identified in the strategic plans.

2.3.6 Reference

Reference sites provide opportunities for long-term monitoring and research. There are no reference indices for the Central Reserves as no reference sites have been established.

2.4 Species

2.4.1 Native Flora

The Central Reserves support 125 native plants, approximately 30% of the flora species recorded in the natural area reserves in the City of Melville. The flora diversity in the individual reserves (combining contiguous Len Shearer and Harry Stickland Parks) varied between 39 and 83 native plant species

In 2016 the flora inventory (Table 48 in Appendix 1) was increased by an average of 49 species in each reserve, after which it is estimated to include more than 80% of species present.

Plants in the Central Reserves are to be managed as meta-populations (disjunct but nearby stands functioning as a single population due to occasional interbreeding through dispersal of seed or pollen) not as a series of independent populations:

- nearby populations (within scales of 5-20 km) can contribute to each other's vigour through interbreeding, for some species (Young, Broadhurst, Byrne, Coastes, & Yates, 2005);
- consolidation of meta-populations in individual reserves should contribute to the overall viability of the species across all the reserves; and
- a plant species is to be managed as a single asset across all the reserves, with presence of subpopulations in each reserve monitored.

The indices for plants are listed in Table 12.

Table 12 Plant Indices

Values	Plants	Status 2012	Status 2016	Assets 2012-2017
Low Present in many Melville reserves, but in low abundance or decline	*Adenanthos cygnorum*	Assumed Present	17 plants	10 species Maintained
	Banksia attenuata		200 plants	
	Banksia grandis		4 plants	
	Banksia ilicifolia		1 plants	
	Banksia menziesii		176 plants	
	Eremaea pauciflora		2 plants	
	Hakea prostrata		1 plants	
	Macrozamia riedlei		12 plants	
	Persoonia saccata		5 plants	
	Regelia ciliata / inops		>1 plants	

Jacksonia sericea is a target species and is a significant native species in nearby Wireless Hill Park, but is not an index as all have been planted in low numbers in Harry Stickland / Len Shearer Park.

Xylomelum occidentale, Woody Pear, is a target species but not an index as all four plants appear to be planted in Len Shearer Park in previously cleared areas.

Agonis flexuosa is a target species that is significant in the Estuarine Reserves, but is considered a weed in the Central Reserves as per Table 15.

Dodonaea hackettiana is a target species, but is considered a weed in the Central Reserves as per Table 15. It has been only recorded as plantings in the City of Melville to date.

Plants at High Risk of Local Extinction

Banksia trees (Table 13 below, Figure 21 in Appendix 3):

- *Banksia grandis,* Bull Banksia:
  - is susceptible to dieback;
  - is at significant risk of local extinction in Kings Park due to its low abundance, where there was an average of 2.11 plants/ha over 267 hectare of bushland, or approximately 560 plants (Crosti, Dixon, Ladd, & Yates, 2007);
  - has a slow natural replacement rate given that it doesn't start setting seed until it is 10 years old (George, 1996); and
  - generally deposits seed within 15 metres of the parent plant (Powell, Leaf and Branch - Trees and Tall Shrubs of Perth, 2009).
- *Banksia ilicifolia,* Holly-leaved Banksia:
  - is susceptible to dieback; and
  - is at significant risk of local extinction in Kings Park due to extremely low abundance (Crosti, Dixon, Ladd, & Yates, 2007); and
  - survival rates of *Banksia ilicifolia* seedlings from populations of less than 20 plants is half that of seedlings from populations of more than 100 plants (Heliyanto, He, Lambers, Veneklaas, & Krauss, 2009)

The Central Reserves support a small proportion of Banksia trees in the City of Melville reserves as shown in Table 13.

Table 13 Number of Banksia Trees in City of Melville Reserves

Species	Central Reserves (2 reserves)	South-Eastern (infested) Reserves (8 reserves)#	Eastern Reserves (3 reserves)	Bullcreek Reserves (7 reserves)	North-West Reserves (3 reserves)	Estuarine Reserves+ (4 reserves)	Heathcote Reserve (1 reserve)	Wireless Reserve (1 reserve)	Piney Lakes Reserve (1 reserve)	Quenda (1 reserve)	Central (modified) (2 reserves)	Central (2 reserves)	Total (35 reserves)
Banksia attenuata	16	578	28	22	>26*	98	7	2218	110	10	65	207	**3385**
Banksia grandis	5	6	0	5	13	1	0	7	24	3	0	4	**68**
Banksia ilicifolia	6	138	16	22	1	0	0	4	0	0	0	1	**188**
Banksia littoralis	0	23	0	0	0	4^	0	0	91	140	0	0	**258**
Banksia menziesii	48	694	152	78	>74*	177	40	1529	202	20	46	180	**3240**
Banksia prionotes	0	0	52^	0	0	168	0	0	0	0	0	0	**220**
Total	**75**	**1439**	**248**	**127**	**114**	**448**	**47**	**3758**	**427**	**173**	**118**	**392**	**7359**

All trees counted except where * indicates only trees with trunk >30 cm diameter counted
^assumed planted

Eremaea pauciflora (Figure 24 in Appendix 3):

- is widespread in south-west Western Australia (Barrett & Pin Tay, 2005)
- occurs on deep sandy soils and sand over laterite (Young, et al., 2005)
- takes 4 years to start flowering (producing seed) after germination (Muir, 1987)
- is long-lived (>40 years) (Young, et al., 2005)
- is insect pollinated (Young, et al., 2005)
- disperses seed by gravity (Young, et al., 2005)
- is deep-rooted, relying on soil moisture at 2-6 metres deep during summer (Groom, Froend, Mattiske, & Koch, 2000)

Hakea prostrata, Harsh Hakea (Figure 24 in Appendix 3):

- is susceptible to *Phytophthora cinnamomi*, dieback (Groves, Hardy, & McComb, nd_1)
- is widespread in south-west Western Australia (Powell, 2009)
- is most abundant on coastal limestone but only absent from infertile Bassendean sands and some wetlands (Powell, 2009)
- resprouts and reseeds readily, and one of the most resilient native species in the Perth region (Powell, 2009)

Persoonia saccata (Figure 24 in Appendix 3):

- is susceptible to *Phytophthora cinnamomi*, dieback (Groves, Hardy, & McComb, nd_1)
- was recorded across approximately 40% of the City of Melville in 1978 (Bridgewater & Wheeler, 1980);
- resprouts vigorously after fire (Baird, 1977);
- flowers after fire regardless of season, but only in December if unburnt (Baird, 1977);
- can be mistaken for *Conospermum stoechadis* when not in flower (Barrett & Pin Tay, 2005); and
- is difficult to propagate from seed (Maher, 2009);

Plants at Moderate Risk of Local Extinction

Banksia trees (Figure 21 in Appendix 3):

- *Banksia attenuata,* Slender Banksia and *Banksia menziesii,* Firewood Banksia:
  - are both susceptible to *Phytophthora cinnamomi*, dieback (Groves, Hardy, & McComb, nd_1)
  - have both declined in Kings Park over a 60 year period due to post dispersal seed predation and seasonal deaths (Crosti, Dixon, Ladd, & Yates, 2007); and
  - are both in lower densities in long isolated small urban bushland remnants (within 30 km of the Perth CBD on Bassendean or Spearwood soils), with high fire frequencies and declining water tables possibly amongst the contributing factors (Ramalho, 2012).

Adenanthos cygnorum, Woollybush:

- is susceptible to *Phytophthora cinnamomi*, dieback (Groves, Hardy, & McComb, nd_1)
- is well-represented in City of Melville bushland reserves
- is almost entirely restricted in the Perth area to the grey Bassendean sands on the eastern side of the Swan Coastal Plain (Powell, 2009)
- grows from Kalbarri in the north to Kulin in the Wheatbelt (Powell, 2009)
- seedlings readily establish (Powell, 2009)

Macrozamia fraseri, Sandplain Zamia:

- is susceptible to *Phytophthora cinnamomi*, dieback (Groves, Hardy, & McComb, nd_1)
- is well-represented in City of Melville bushland reserves
- occurs between Mandurah and Jurien Bay (Barrett & Pin Tay, 2005)
- previously confused in Kings Park with *Macrozamia riedlei,* which is a Darling Range species (Barrett & Pin Tay, 2005)

Plants at Low Abundance but Low Risk of Local Extinction

Nuytsia floribunda, Christmas Tree:

- is resistant to *Phytophthora cinnamomi*, dieback (Groves, Hardy, & McComb, nd_2)
- consists of twelve trees in Central Reserves
- is well-represented in City of Melville bushland reserves
- is common on the Swan Coastal Plain, and ranges from Kalbarri to Israelite Bay in south-west Western Australia (Powell, 2009)
- is more common in low-lying areas (Powell, 2009), and in some vegetation types occurs in very low densities, and it is uncommon in Kings Park (Barrett & Pin Tay, 2005)
- is well-represented in City of Melville bushland reserves
- can be difficult to establish, is rarely cultivated, and can take up to 20 years to progress from a low shrub into a tree (Powell, Leaf and Branch - Trees and Tall Shrubs of Perth, 2009)
- However, even in low numbers *Nuytsia floribunda* may be important as it:
    - appears to support more insects than the banksias, with its flowers a very rich source of pollen and nectar (Powell, Leaf and Branch - Trees and Tall Shrubs of Perth, 2009); and
    - forms an extensive network of underground semi-parasitic roots (from which it can re-sprout) extending up to 100 m (Cunningham, 1998)

Regelia ciliata / Regelia inops

- *Regelia inops* is well-represented in City of Melville bushland reserves
- *Regelia ciliata* is not well-represented in City of Melville bushland reserves
- only one individual plant was located in Hatfield Park, but it was not counted in previously surveyed Central reserves - the locations of all plants need to be recorded with GPS to determine if it is in very low abundance
- all plants need to be examined during flowering to determine species (Barrett & Pin Tay, 2005), although *Regelia inops* occurs on Bassendean and Karrakatta soils in contrast to *Regelia ciliata* which is typical of the east side of the Swan Coastal Plain and tends to be absent from these soils (Powell & Emberson, 1996)
- *Regelia inops* was recorded in/around Booragoon in 1978 (Bridgewater & Wheeler, 1980)
- *Regelia inops* was recorded in Wireless Hill Park in the *Green Plan for the City of Melville* (Alan Tingay and Associates, 1999)

Plants Extinct or Not Confirmed Onsite

No plants were confirmed extinct in 2016. The focus of the 2016 flora survey was increasing the flora inventory to more than 80% of species onsite. In 2016 the flora inventory was increased by an average of 49 species in each reserve.

Native Species to be Managed as Weeds

A number of species native to Western Australia have been planted, some of which do not naturally occur onsite. Detailed planting records were not available and a comprehensive audit of plantings was not conducted, but it is noted that introducing different forms of species, as well as non-local species, can also result in negative impacts in terms of hybridization and competition, especially for significant isolated populations of native species targeted for monitoring and management.

Some Australian species can be readily identified as not naturally occurring in the Swan Coastal Plain (e.g. *Acacia iteaphylla, Acacia podalyriifolia, Callistemon viminalis, Casuarina cunninghamiana, Corymbia citriodora, Eucalyptus conferruminata, Corymbia maculata, Eucalyptus grandis, Eucalyptus platypus, Hibbertia scandens* and *Melaleuca armillaris).*

The species that naturally occurs on the Swan Coastal Plain, but could possibly be introduced as plantings into the Central Reserves is listed in Table 14. The reserves in which it occurs is documented in Table 49 in Appendix 2.

Table 14 Native Coastal Plain Plants possibly introduced to Reserves

Species	Comments
Conostylis candicans	**Should be neither planted nor treated as a weed until further investigations are completed** • Typical of coastal Quindalup soils but can be present on Bassendean soils (Powell & Emberson, 1996)

The species listed in Table 15, which naturally occur on the Swan Coastal Plain, are considered weeds in the Central Reserves.

Table 15 Native Coastal Plain Plants that should be treated as weeds

Species	Generally absent from Bassendean dune soils [1]	Generally absent from Karrakatta soils[1]	Comments
Agonis flexuosa	✓	✓	• Was not recorded in/around Booragoon in 1978 (Bridgewater & Wheeler, 1980) • Does not usually occur on Karrakatta or Bassendean soils (Powell & Emberson, 1996) • In the Perth Region has a natural distribution restricted to calcareous dunes (Dixon, 2011). • Naturally occurred along the Swan Estuary downstream from Freshwater Bay (Powell, 2009) with Blackwall Reach possibly being one of the most easterly occurrences (Government of Western Australia, 2000). • Has the ability to completely alter the structure of communities it invades, and it is currently being removed from Kings Park (Keighery G. , 2013).
Callitris preissii	✓	✓	• At one time this plant was fairly common around the Swan River (Main & Serventy, 1957). • A weed in tuart woodland in Kings Park, but native to river escarpment in Kings Park (Keighery G. , 2013). • The main population remaining on the Swan River is now at Peppermint Grove (Powell, 2009). • Does not usually occur on Karrakatta or Bassendean soils (Powell & Emberson, 1996) • It has germinated from mulch in other Melville reserves
Calothamnus quadrifidus	✓		• Can occur on Karrakatta soils (Powell & Emberson, 1996) • Associated with limestone in Kings Park and Bold Park (Barrett & Pin Tay, 2005) • *Calothamnus* species have the capacity to completely alter the structure of communities that they invade and there is significant risk of hybridization between local and introduced forms of this species (Keighery G. , 2013).
Dodonaea hackettiana			• Occurs on Quindalup, Cottesloe, Karrakatta, Bassendean and Herdsman soils (Powell & Emberson, 1996) • Only previously recorded onsite in City of Melville in Attadale Reserve but only plantings present • *Dodonaea viscosa* previously recorded in Blackwall reach Reserve by Keighery and Keighery (1991) but this may be a misidentification as this not one of the species of Dodonaea recorded in the Perth region by Barrett & Pin Tay (2005) or Marchant, Wheeler, Rye, Bennett, Lander, & Macfarlane (1987) and recorded as in the Darling Plateau but not the Swan Coastal Plain by Powell and Emberson (1996) • *Dodonaea viscosa* and *Dodonaea hackettiana* superficially similar, being differentiated on the basis of whether the branchlets are hairy.
Grevillea crithmifolia	✓		• Coastal species growing on limestone from Perth to just south of Mandurah (Rippey & Rowland, 2004) • Occurs on Quindalup, Cottesloe and Karrakatta soils (Powell & Emberson, 1996) • Associated with sand over limestone in Kings Park and Bold Park (Barrett & Pin Tay, 2005)
Grevillea preissii	✓	✓	• Was not recorded in/around Booragoon in 1978 (Bridgewater & Wheeler, 1980) • Does not usually occur on Karrakatta or Bassendean soils (Powell & Emberson, 1996) • Occurs on coastal dunes from Jurien Bay to Bunbury, with Kings Park one of its most inland locations (Dixon, 2011) • Associated with limestone outcropping in Kings Park and Bold Park (Barrett & Pin Tay, 2005)
Grevillea vestita			• Was recorded in/around Booragoon in 1978 (Bridgewater & Wheeler, 1980) • Naturally occurring in nearby Wireless Hill Park • One plant only in Central Reserves
Ricinocarpos undulatus			• 5 individuals planted in Connelly Park • Occurs on sandy soils of the Swan Coastal Plain (Marchant, et al., 1987) and is scattered in Kings Park (Barrett & Pin Tay, 2005) • Was not recorded in any of the 17 reserves for which flora inventories were documented in the *Green Plan for the City of Melville* (Alan Tingay and Associates, 1999) • Previously confused with *Ricinocarpus glaucus* in Kings Park (Barrett & Pin Tay, 2005) • Occurs from Dongara to Fremantle (Barrett & Pin Tay, 2005)

1. Source: Growing Locals (Powell & Emberson, 1996)

2.4.2 Native Fauna

The native fauna recorded in 2017 in the Central Reserves is listed in Table 51 in Appendix 2. The 26 native animal species (2 bat, 5 reptile and 19 bird species) recorded to date onsite represent approximately 10% of species recorded in the City of Melville, although the inventory for the Central Reserves is not comprehensive.

Mammals

Two native mammals were confirmed in the Central Reserves in 2016 (Bamford, Shepherd, Browne-Cooper, & Chuk, 2017), both were bats, as listed Table 51 in Appendix 2.

The persistence onsite of suitable feeding and breeding habitat, rather than individual bats, is the focus of management of the bat listed in Table 16.

Table 16 Mammal Species to be Monitored

Species Values	Mammals	Status	Last Confirmed
Medium Bushland dependent species (recorded in less than 3 Melville reserves	*Austronomus australis* White-striped Bat	Migratory – Breeding Onsite	2017
Low Bushland dependent species recorded in more than 2 Melville reserves	*Chalinolobus gouldii* Gould's Wattled Bat	Resident – Large Home Range Breeding Onsite	

Austronomus australis, the White-striped Bat, would utilise the reserves during breeding season. This bat migrates north, by up to 1200 km in winter (Bullen & McKenzie, 2005), and breeds over summer (Churchill, 2008) when it would be in Perth. The White-striped Bat is a fast-flying species that predominantly forages insects (such as moths, beetles and grasshoppers) in open areas 50 metres or more above the ground, well above canopy height (Churchill, 2008). Their diet also includes large numbers of ants and non-flying beetles, presumably caught on the ground (Churchill, 2008). They occupy a variety of vegetation types and so may not be entirely dependent upon very large trees (Bullen & McKenzie, 2005) but they launch by dropping about 4 metres to gain speed before circling up to higher airspace (Churchill, 2008).

The *Chalinolobus gouldii,* Gould's Wattled Bat, population present is expected to be partially dependent upon the Central Reserve as it has a large home range and can regularly forage 5 to 10 km from roosts (Churchill, 2008). They feed on insects caught whilst flying between 1 and 20 metres off the ground (Strahan, 1998), along gaps in vegetation and just below tree canopies (Churchill, 2008). Gould's Wattled Bats have a strong preference for roosting in large live trees (although they will also utilise dead trees and buildings where preferred habitat is not available) (Webala, 2010). At least four of the bat boxes in the City of Melville were utilised by Gould's Wattled Bats between 2011 to 2013 (Natsync Environmental, 2014).

The most important habitat requirement for all bat species is very large trees, as indicated in Table 17.

Table 17 Mammal Habitat Considerations for Revegetation

Mammals	Habitat Requirements	Diet
Austronomus australis White-striped Bat	Very large trees (for roosting hollows) Nearby open areas Perches more that 4 m above ground from which to launch	Invertebrates
Chalinolobus gouldii Gould's Wattled Bat	Very large trees (for roosting hollows) Vegetation 1 – 20 m high (for foraging)	Invertebrates

Reptiles and Amphibians

Each reserve is a separate management and monitoring unit for reptiles and amphibians. Each reserve is likely to support independent resident populations without the potential for unassisted re-colonisation if extinction occurs in an individual reserve. Urban areas are likely to be effective barriers to movement of reptiles between reserves. Most reptile species are sedentary and of low mobility, suggesting that they may have limited capacity to move between patches of habitat isolated by clearing or land-use (Wilson & Valentine, 2009).

The 5 native reptiles confirmed in the Central Reserves in 2016 (Bamford, Shepherd, Browne-Cooper, & Chuk, 2017) are listed in Table 51 in Appendix 2. Four of the five reptiles recorded are skinks (with one gecko species also confirmed). Skinks are relatively persistent in urban bushland as they are the only reptiles whose diversity is not correlated with the size of remnants on the Swan Coastal Plain (How & Dell, 2000).

The one reptile indicator species is listed in Table 18.

Table 18 Reptile Indices

Values	Reptiles	Status 2012	Reserves Confirmed Present in 2017	Assets 2012-2017
Low Bushland dependent species and recorded in >2 Melville Reserves	*Tiliqua rugosa rugosa* Bobtail	Assumed Present	Reg Seal Reserve Carawatha Bushland	2 populations Maintained

Whilst ground dwelling species (non-burrowing, non-climbing and non-flying species) are generally considered indicator species, species that can survive in urban environments and gardens are not (e.g. *Christinus marmoratus,* Marbled Gecko).

The critical habitats for indicator reptiles to be considered during revegetation are summarised in Table 19.

Table 19 Reptile Habitat Considerations for Revegetation

Reptile	Habitat Description	Diet
Tiliqua rugosa rugosa Bobtail	Home range 2-2.7 ha Variety of vegetation types (including gardens) Shelters beneath dead vegetation and in burrows	Invertebrates, Slugs, Snails, Carrion Flowers and Fruit (including some weeds),

Birds

The Central Reserves are a single management and monitoring unit for birds. In urban environments areas of low overall habitat cover, the degree of connectivity may influence species richness to a greater extent than small differences in patch size, and species persistence may depend upon the occurrence of several populations and dispersal between them (Wilson & Valentine, 2009). The Central Reserves are small and moderately isolated, with approximately 11% bushland cover in a circle with a 2 km radius. The threshold core habitat requirement for the most sensitive bird species on the Swan Coastal Plain is 60% total vegetation cover within a circle with a 2 km radius (Brown, Davis, Sonneman, & Kinloch, 2009).

The 8 native bushland birds confirmed in the Central Reserves in 2016 (Bamford, Shepherd, Browne-Cooper, & Chuk, 2017) are listed in Table 51 in Appendix 2.

The 5 indicator species listed in Table 20. Native birds that are resident and/or breed in the City of Melville and require tree hollows, but are not indicator species if they have colonised Perth and compete with more vulnerable species (e.g. *Cacatua roseicapilla*, Galah).

Table 20 Bird Indices

Values	Birds	Status 2012	Reserves Confirmed Present in 2017	Assets 2012-2017
High Habitat specialist with reduced populations on Swan Coastal Plain	*Smicrornis brevirostris* Weebill	Assumed Present	Al Richardson Connelly Hatfield	5 species Maintained
Low Bushland dependent species recorded in more than 2 Melville reserves	Hirundo nigricans Tree Martin		Shearer / Stickland	
	Pardalotus striatus Striated Pardalote		Connelly	
	Phylidonyris novaehollandiae New Holland Honeyeater		Connelly Hatfield Shearer / Stickland Carawatha	
	Purpureicephalus spurius Red-capped Parrot		Al Richardson	

Other bushland dependent birds, that are either migratory or have large home ranges are listed in Table 21.

Table 21 Other Bird Species to be Monitored

Species Values	Birds	Status	Last Confirmed
Very High Matter of National Environmental Significance under EPBC Act 1999 (threatened)	*Calyptorhynchus banksii* Forest Red-Tailed Black-Cockatoo	Regular non-breeding migrant	2017
	Calyptorhynchus latirostris Carnaby's Black-Cockatoo		

Calyptorhynchus latirostris, Carnaby's Black-Cockatoo, and *Calyptorhynchus banksii*, Red-tailed Black-Cockatoo are threatened migratory birds that would utilise the Central Reserves seasonally for feeding, and as a linkage between larger remnants:

- Neither species breeds in the vicinity;
- Sites such as these are likely to provide part of an invaluable network of habitat remnants providing food resources for Carnaby's Black-Cockatoo on the Swan Coastal Plain, especially given the potential for removal of pines at Gnangara (Gole, 2003). It may also be important for the survival of the Cockatoos that reserves are not only retained, but also that native vegetation is maintained in good condition (Gole, 2003).
- Non-breeding feeding habitat is particularly important within 6 km of roost sites (DEC, 2012) and there are confirmed roost sites at Wireless Hill (Ardross) and Shirley Strickland Oval (Ardross), and potential roost sites nearby including Point Walter (Bicton), and Groves Park (Attadale) (Burnham, Barrett, Blythman, & Scott, 2010);
- These birds are granivores, so the dominant overstorey in the Central Reserves of Eucalypts, Banksia and Sheoaks represents a significant food source; and
- Movement corridors with breaks of less than 4 km between other foraging, breeding and roosting sites are important to allow the birds to move between these areas. (Department of Sustainability, Environment, Water, Population and Communities, 2013).

The critical habitats for birds to be considered in revegetation are summarised in Table 22.

Table 22 Bird Habitat Considerations for Revegetation

Bird	Breeds Onsite	Habitat			Diet			
		Trees Only	Hollows	Bushland	Seed/Plants	Invertebrates	Nectar	Vertebrates
Calyptorhynchus banksii, Red-tailed Black-Cockatoo	N		X	X	X			
Calyptorhynchus latirostris, Carnaby's Black-Cockatoo	N		X	X	X			
Smicrornis brevirostris, Weebill	Y	X				X		
Purpureicephalus spurius, Red-capped Parrot	Y		X	X		X		
Hirundo nigricans, Tree Martin	Y		X	X		X		
Pardalotus striatus, Striated Pardalote	Y	X	X			X		
Phylidonyris novaehollandiae, New Holland Honeyeater	Y			X			X	

Calyptorhynchus latirostris, Carnaby's Black-Cockatoo, and *Calyptorhynchus banksii*, Red-tailed Black-Cockatoo are generally not listed as requiring hollows in City of Melville reserves as neither migratory bird species breeds in the City. However there is an unconfirmed roosting site for *Calyptorhynchus latirostris*, Carnaby's Black-Cockatoo, in Wireless Hill Park (Kabat, Scott, Kabat, & Barrett, 2012) and both species can utilise tree hollows for roosting.

Invertebrates

There have been no systematic surveys for invertebrates in bushland in the City of Melville, and no records exist for invertebrates in the Central Reserves.

3 Threats

3.1 Overview

The NAAMP identified the ten most significant threats to natural areas in the City of Melville and details the impacts they can have. These threats (with the exception of stormwater and reticulation, which are specific to small bushland remnants in an urban environment) align with the major biodiversity threatening processes identified in the comprehensive technical review *'Biodiversity values and threatening processes of the Gnangara groundwater system - Report for the Gnangara Sustainability Strategy and the Department of Environment and Conservation'* (Wilson & Valentine, 2009).

The significance of threats can be assessed in a similar manner to that used for assets as indicated in Figure 15.

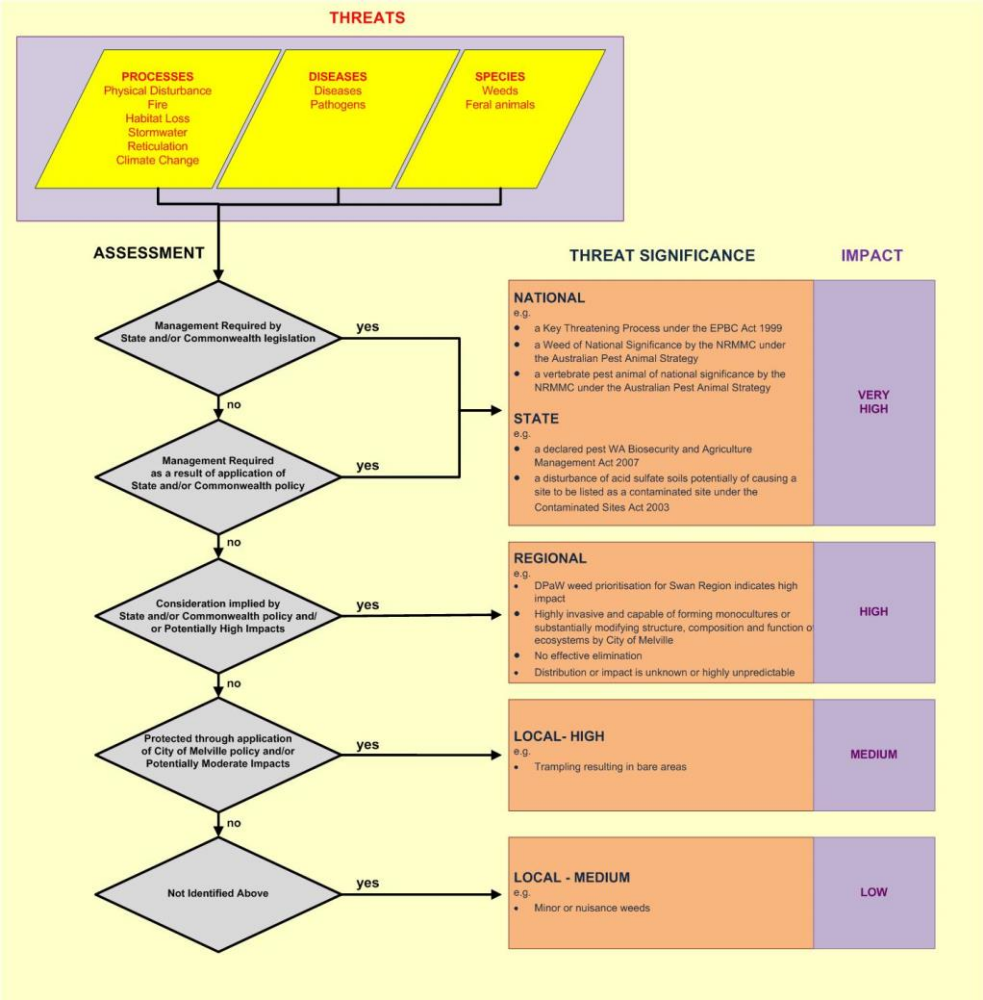

Figure 15 Assessment of Threats in Natural Areas

3.2 Physical Disturbance

There is no data for physical disturbance available, but there was little evidence of any disturbance onsite in 2016 so an assumption that it was minimal for 2012-2017 is reflected in Table 23.

Table 23 Physical Disturbance Indices

Impacts	Physical Disturbance	Disturbances 2007-2012	Disturbances 2012-2017	Threats 2012-2017
High Potential to substantially change ecosystem structure, composition or function	Clearing for utilities	No Data	No Data	1 Threat Not Assessable
Medium Potential to moderately change ecosystem structure, composition or function	Trampling		Carawatha hotspot for BMX tracks Connelly contains informal track	7 Threats Not Assessable
	Rubbish Dumping		Reg Seal some dumping	
	Sediment/Erosion Tree Poisoning Illegal Clearing Firewood Collection		No Data	
Medium Potentially costly remediation	Vandalism			

3.3 Fire

An individual fire may not necessarily be a threat to the biodiversity, as the flora and fauna of the region has evolved in the context of, adapted to, and in part depends upon, fire. However modified fire regimes (characterised in terms of intensity, frequency, season and scale), especially in the context of external factors such as habitat fragmentation and climate change can lead to the decline and/or local extinction of species.

The two fire scenarios that were identified in the NAAMP as potential triggers for local extinctions of vulnerable species were:

- Large Fires (a fire burning more than one third of a reserve); and
- Repeat Fires (fires burning the same portions of a reserve within eight years).

Table 24 reflects that there was no evidence of large or repeat fires from 2012-2017.

Table 24 Fire Indices

Impacts	Fires	Extent of Fires 2007-2012	Extent of Fires 2012-2017	Threats 2012-2017
High Potential for local extinctions of ground dwelling species	Large fires	No data	0 ha	2 Threats Prevented
High Potential for local extinctions of trees and shrubs that regenerate only from seed stored on the plant	Repeated fires		0 ha	

3.4 Weeds

The 77 weed species recorded in the Central Reserves are listed in Appendix 1. Most weeds were rated as High (Table 25) as a result of 39 species/genera being shrubs or trees.

Table 25 Number of Weed Species in Each Impact Category

Impact	Al Richardson	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Reg Seal	Total
Very High	2	3	3	4	2	2	5
High	22	12	14	29	19	7	49
Medium				3	1		4
Low	3	4	4	16	8	2	19
Total	**27**	**19**	**21**	**52**	**30**	**11**	**77**

Methods for surveying weeds were not standardised by the City of Melville until the review of the *Natural Areas Asset Management Plan* (Waters A. , 2013). The extents of weeds in 2016 (based on presence at 78 reference points in a grid with 30 metre spacing - with each point representing approximately 13% of the total of the bushland) are listed in Table 26, with distributions mapped in Appendix 4. Weed distributions were not previously mapped in the Central Reserves, and weed inventories were not comprehensive. The following assumptions were made in terms of trends 2012-2017:

- weeds were prevented if not observed in 2016;
- weeds were contained if restricted to small areas in 2016; and
- weeds were not assessable if widespread in 2016.

Table 26 Weed Indices

Impact	Weeds	Al Richardson	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Reg Seal	Total	Threats 2012-2017
Very High	Arum Lily Asparagus Fern Blackberry Golden Dodder Lantana Madeira Vine Narrowleaf Cottonbush One Leaf Cape Tulip Paterson's Curse Tamarisk Willows	0%	0%	0%	0%	0%	0%	0%	11 weeds Prevented
	Soldiers	0%	0%	0%	0%	9%	0%	1%	4 weeds Contained
	Brazilian Pepper	0%	0%	0%	3%	0%	0%	1%	
	Bridal Creeper	0%	11%	0%	3%	0%	25%	4%	
	Very Large Trees	0%	11%	0%	20%	0%	0%	12%	
	Perennial Clumping Grass	89%	56%	100%	70%	91%	75%	76%	1 weed Not Assessable
High	Annual Clumping Grass Giant Grasses	0%	0%	0%	0%	0%	0%	0%	2 weeds Prevented
	Perennial Running Grass	11%	0%	40%	0%	0%	0%	4%	1 weed Contained
	Clumping Geophytes	22%	67%	60%	38%	55%	50%	44%	2 weeds Not Assessable
	Shrubs and Trees	67%	44%	40%	45%	18%	0%	41%	
Medium	Perennial Weeds	11%	56%	40%	43%	27%	75%	40%	1 weed Not Assessable
Low	Annual Weeds	67%	100%	100%	95%	91%	100%	92%	1 weed Not Assessable

The shrub or tree weeds were very abundant, as indicated in Table 27.

Table 27 Number of Plants in 2016 of Selected Weeds

Impact	Weeds	Al Richardson	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Reg Seal	Total
Very High	*Asparagus asparagoides*		1		3		2	**6**
	Lachenalia reflexa					1		**1**
	Schinus terebinthifolius				1			**1**
	Very Large Live Weed Trees		3		16	2		**21**
High	Shrub and Tree Weeds	55	20	87	217	83	9	**471**
	Total	**55**	**24**	**87**	**237**	**86**	**11**	**500**

As a general rule, a site-based approach should be applied to prioritising woody weeds for removal with a focus on shrub and tree weeds in the vicinity of key assets, as well as removing shrub and tree weed species in low numbers.

3.5 Habitat Loss

Habitat loss can be managed and monitored:

- between reserves (which is outside of the scope of this plan), and
- within reserves (in terms of the extent, quality or continuity of bushland areas).

The distribution of weed cover is shown in Figure 16.

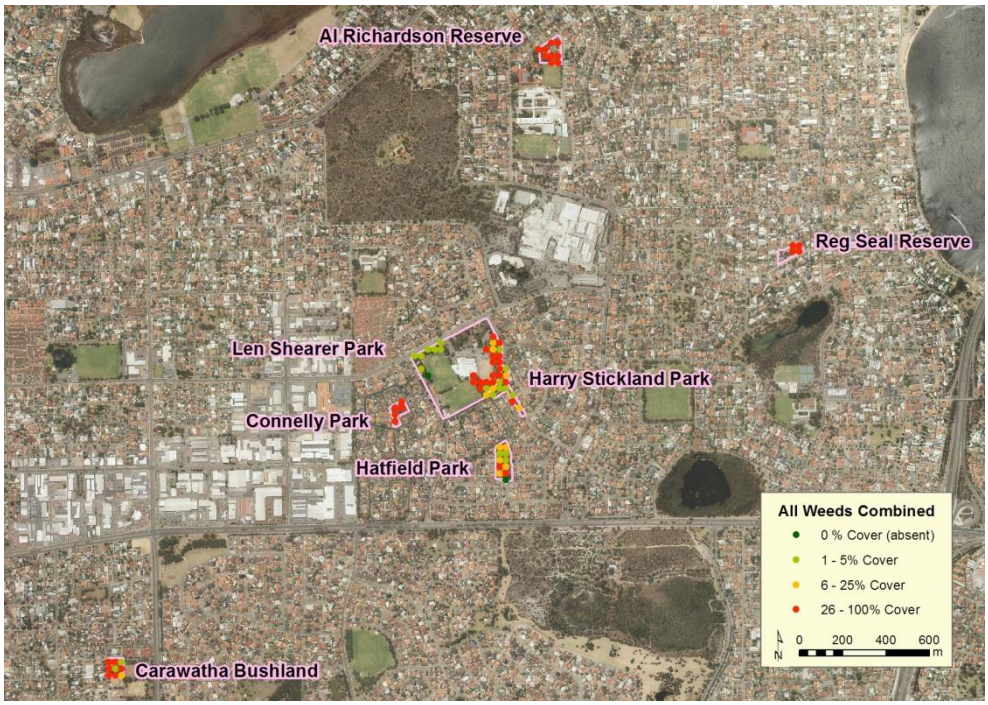

Figure 16: Cover of All Weeds Combined

The extent of bushland in each category of weed is indicated in Table 28.

Table 28 Cover of All Weeds Combined

Category	Al Richardson	Carawatha	Connelly	Harry Stickland	Hatfield	Len Shearer	Reg Seal	Total
0%	0%	0%	0%	0%	9%	13%	0%	3%
1-5%	0%	22%	0%	25%	27%	88%	0%	26%
6-25%	0%	11%	0%	19%	45%	0%	0%	15%
26-100%	100%	67%	100%	56%	18%	0%	100%	56%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The distribution of bare cover is shown in Figure 17.

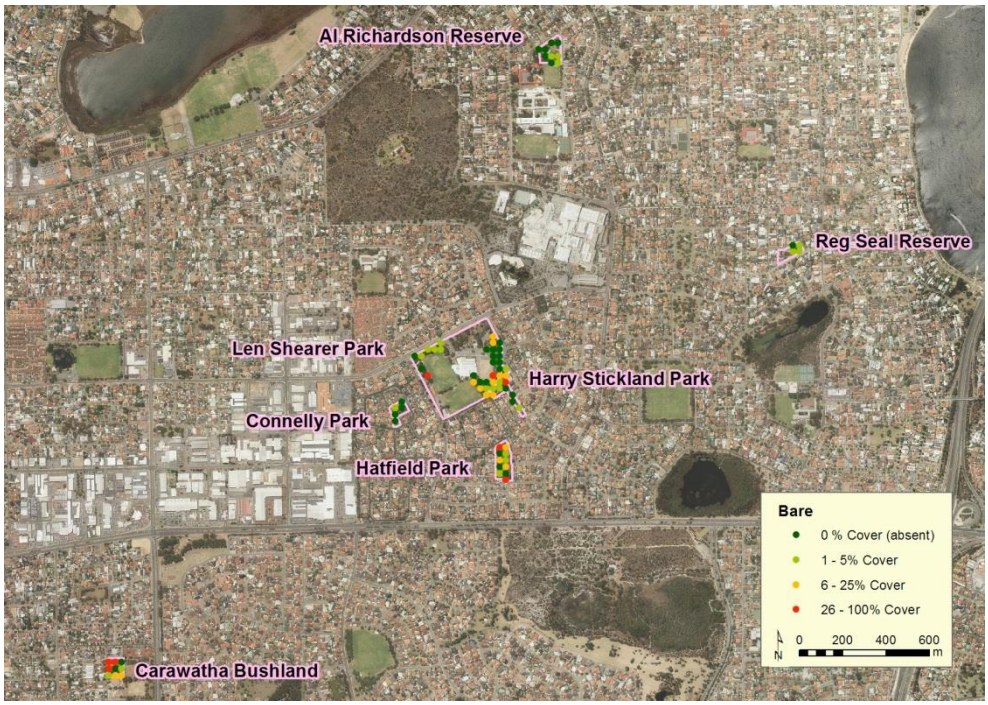

Figure 17: Bare Ground

The extent of bushland in each category of bare ground indicated in Table 29.

Table 29 Bare Ground Cover

Category	Al Richardson	Carawatha	Connelly	Harry Stickland	Hatfield	Len Shearer	Reg Seal	Total
0%	67%	22%	80%	47%	27%	25%	25%	42%
1-5%	33%	22%	20%	19%	27%	63%	75%	29%
6-25%	0%	22%	0%	28%	27%	0%	0%	18%
26-100%	0%	33%	0%	6%	18%	13%	0%	10%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

The habitat loss indices are listed in Table 30.

Table 30 Habitat Loss Indices

Impact	Habitat Loss	% of Reserve 2012	% of Reserve 2016	Threats 2012-2017
Medium Process of moderate ecosystem function modification • Reduced natural regeneration • Increased fire or erosion risk	Weed Cover > 25%	No Data	56%	Change Not Assessable
Low Process of low ecosystem function modification • Reduced natural regeneration • Increased fire or erosion risk	Bare Ground > 25%		10%	

3.6 Feral Animals

Documenting feral animal occurrences was not previously standardised by the City of Melville, but as indicated in Table 31 some data has been captured and some assumptions can be made.

Table 31 Feral Animal Records

Feral Animal		Status 2012	Status 2017
Mammals	*Oryctolagus cuniculus,* Rabbits	Assumed Present	Confirmed Absent Eliminated in Carawatha 2015/2016
	Vulpes vulpes, Foxes		Assumed Present
	Mus musculus, House Mice		
	Rattus norvegicus, Brown Rat		
	Felis catus, Feral Cats		Confirmed Present
	Rattus rattus, Black Rat		
Birds	*Dacelo novaeguineae,* Laughing Kookaburra		
	Streptopelia chinensis, Spotted Dove		
	Streptopelia senegalensis, Laughing Dove		
	Trichoglossus haematodus, Rainbow Lorikeet		
Insects	*Apis mellifera,* Feral Honeybee		

Oryctolagus cuniculus, rabbits, were absent in 2017 (Bamford, Shepherd, Browne-Cooper, & Chuk, 2017). Rabbits have relatively well-defined and small home ranges in the order of 0.2-2 ha (DEPI, 2013). Most dispersal of rabbits is over relatively short distances (DEPI, 2013) and the Central Reserves are not contiguous with other bushland.

Vulpes vulpes, foxes, are assumed present although there was no evidence (scats, dens etc) in 2017. Due to their small sizes the Central Reserves could not sustain foxes, although the reserves could potentially form part of the home range, which in urban areas can be in the order of 30 hectares (Lapidge, Braysher, & Sarre, 2013).

Felis catus, cats, are assumed present. Domestic cats in suburban Canberra catch an average of 10 prey animals per year (with 6% of cats catching five times this) (Grayson & Calver, 2004); and male feral cats may occupy a home range of 10 square kilometres, or larger if food is scarce (DEWHA , 2008).

Mus musculus, House Mice, *Rattus rattus,* Black Rats and *Rattus norvegicus,* Brown Rats are assumed to be present, although their numbers may be low. House Mice are common in urban bushland remnants in Perth, and were caught at every one of twenty two remnants sampled by the Western Australian Museum (How, Harvey, Dell, & Waldock, 1996). In the same survey, Black Rats were caught infrequently and Brown Rats were not captured. House Mice become more abundant in native habitats after fire to take advantage of the significant post-fire seed fall (Clarke, et al., 2000).

The indices for feral animals are only for those species for which some control is practical and effective. The indices are listed in Table 32, with an occurrence defined as specific sightings of dens, warrens, hives or animals (and as control of feral animals is to be initiated within 10 working days from date of observation – the resighting of a den, warren, hive or animal is recorded as an additional occurrence at 10 working day intervals until the elimination of the occurrence).

Table 32 Feral Animal Indices

Impact	Feral Animal	Occurrences 2007-2012	Occurrences 2012-2017	Threat 2012-2017
Very High Key Threatening Process under the EPBC Act 1999	*Oryctolagus cuniculus*, Rabbit	Present	Present 2014 Absent 2017	Eliminated
	Vulpes vulpes, Fox	No Data – Assumed Present	Assumed Present	Change Not Assessable
	Felis catus, Feral Cat			
High Competition with native birds for hollows and food (impact level variable)	*Apis mellifera,* Honeybee		Confirmed	Assumed Contained

3.7 Diseases and Pathogens

Phytophthora cinnamomi, Dieback, is a microscopic water mould that weakens or kills the plants by reducing or stopping the movement of water and nutrients within the plant (Dieback Working Group, 2000), and 'is one of the major threats to the biodiversity of Western Australia's ecosystems' (DEC, 2010).

Two areas within the Central Reserves were assessed as infested with *Phytophthora cinnamomi*, Dieback, by Dieback Treatment Services (2013) (2016) as shown in Figure 18.

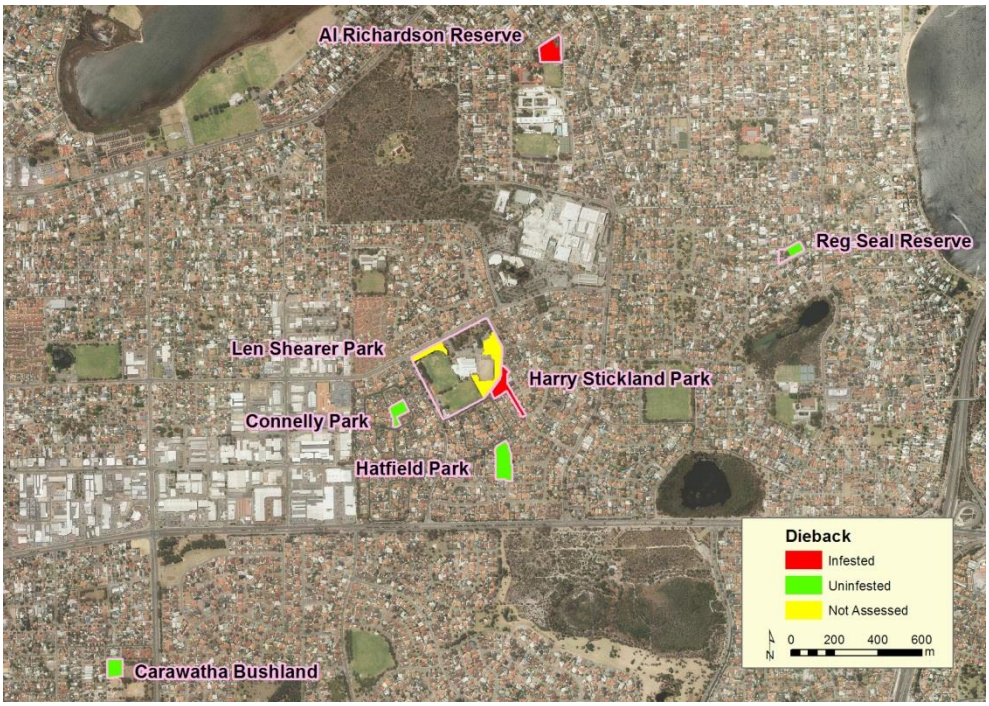

Figure 18 Interpretation of Extent of Dieback Infestation in 2016

Armillaria luteobubalina, Honey Fungus, is an indigenous parasitic mushroom that is widespread in south west Western Australia that causes decay in roots and stems that can result in the death of the host plant (Shearer, 1994). Whilst no targeted surveys have been undertaken it is assumed to be absent from the Central Reserves:

- no occurrences of *Armillaria luteobubalina* have been documented in the City;
- there were also no opportunistic observations of patches of dead susceptible plants, or the parasitic mushroom itself; and
- it occurs most frequently in coastal dunes, and forests east of the Darling Scarp, and rarely occurs in the acidic sands of the Bassendean Dune system (Shearer, 1994).

The diseases and pathogens for which objectives apply are listed in Table 33.

Table 33 Disease and Pathogen Indices

Impact	Diseases and Pathogens	Extent 2012	Extent 2016	Threats 2012-2017
Very High Key Threatening Process under the EPBC Act 1999	*Phytophthora cinnamomi* Dieback	No Data	28%	Not Assessable
Medium Native species capable of moderate modification of structure and composition of flora by killing multiple species	*Armillaria luteobubalina* Honey Fungus		Assumed Absent	Assumed Prevented

3.8 Stormwater

There are no stormwater discharge points into the reserves.

There are no water quality indices for which objectives apply in the Central Reserves as these only apply in bushland where the stormwater is discharged into an open waterbody. Any erosion/sedimentation associated with the stormwater outlets is monitored as a physical disturbance and would be discussed in Section 3.2 if applicable.

3.9 Reticulation

There is reticulated lawn adjacent to bushland in Al Richardson Reserve, Carawatha Bushland, Len Shearer Park and Reg Seal Reserve but there have been no ongoing instances of additional water being applied to the bushland. The indices for reticulation are listed in Table 34, with an occurrence defined as specific sightings of excessive drift or leaking (and this is to be rectified within 5 working days from date of observation – the resighting of overspray or leakage is recorded as an additional occurrence at 5 working day intervals until the elimination of the occurrence).

Table 34 Reticulation Indices

Impact	Water Sources	Occurrences 2007-2012	Occurrences 2012-2017	Threat 2012-2017
Low Alteration of Surface Water Flows	Overspray / leakages from reticulation	No Data	No Data	Assumed Contained

3.10 Acid Sulfate Soils

Acid Sulfate Soil reactions can potentially occur where:

- excavations are dug below the minimum level of the watertable; and/or
- groundwater extraction results in oxidation of soils previously permanently saturated by lowering the minimum level of the watertable.

An occurrence of an acid sulfate soils threat is recorded when these activities are undertaken and the risks associated with acid sulphate soil reactions are not managed at the time.

There are no records of excavations in the Central Reserves.

There is no evidence of any acid sulphate soil reactions previously occurring in the Central Reserves. No excavations or groundwater extraction has occurred in the Central Reserves since 2007, as reflected in Table 35.

Table 35 Acid Sulfate Soil Indices

Impact	Potential Initiation of ASS Reactions	Occurrences 2007-2012	Occurrences 2012-2017	Threat 2012-2017
Very High An occurrence of could result in the reserve being listed as a contaminated site under the Contaminated Sites Act 2003	Excavations below the minimum level of the watertable	No Data	0	Assumed Prevented
	Groundwater extraction resulting in lowering of minimum level watertable		No Data	

3.11 Climate Change

The regional climate is becoming hotter and drier (McHugh & Bourke, 2008):

- the annual rainfall in south-west WA has declined by about 10% since the mid-1970s (Hope & Foster, 2005); and
- the mean annual temperatures across Western Australia have increased since 1910 by approximately 0.8ºC, with the strongest trend observed since the 1950s (Indian Ocean Climate Initiative, 2009).

The average monthly maximum temperatures and rainfall for nearby Perth Airport in the last 6 years are shown in Table 36 and Table 37.

Table 36 Average Monthly Maximum Temperatures 2012-2017

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2011	33.7	34.9	32.8	27.9	23.6	19.7	18.4	20.2	20.5	24.4	26.1	30.6	26.1
2012	33.4	31.3	31.6	26.4	23.0	19.3	19.2	20.0	21.4	24.9	26.1	31.4	25.7
2013	32.3	34.6	28.4	28.7	21.7	19.9	18.7	20.3	20.1	24.1	29.5	31.1	25.8
2014	32.9	33.7	30.8	26.9	21.3	19.6	18.4	21.5	22.1	24.9	26.4	29.7	25.7
2015	33.8	33.1	29.9	25.7	21.4	21.0	18.7	19.4	22.8	27.0	29.0	30.1	26.0
2016	32.4	32.8	30.0	25.0	20.8	18.5	17.7	17.5	18.5	22.0	28.3	29.3	24.4
1944-2016 Mean	31.8	32.0	29.7	25.6	21.8	19.0	17.9	18.6	20.2	22.7	26.0	29.0	24.5

Table 37 Monthly Rainfall 2012-2017

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2011	43.2	0.4	0	26.2	58.6	143.2	164.6	127.8	102.4	63.4	38.6	67.4	835.8
2012	27.4	19	0	53.2	39.8	134.4	30.6	117.8	103.8	13.8	84.8	24.8	649.4
2013	8.2	1	60.2	7.8	112.2	23	119.2	160.6	172.4	32.4	6.2	1	704.2
2014	0.4	0.0	4.4	18.6	125.2	92.2	139.2	109.6	70.2	34.2	26.6	0.2	620.8
2015	0.4	28.4	22.0	56.0	68.8	100.2	98.8	102.8	46.8	19.2	17.4	17.4	578.2
2016	23.4	0.8	21.4	61.6	106.0	86.4	129.4	131.6	61.8	37.8	5.6	8.6	674.4
1944-2016 Mean	10.0	15.3	16.4	40.5	98.8	157.3	155.3	117.8	73.1	43.6	26.2	11.2	766.1

The six year period 2012-2017 included one year of dry weather and five years of hot weather, with the weather being more extreme than the preceding 6 years, as indicated in Table 38.

Table 38 Climate Indices

Impact	Extreme Weather Events	Number of Years (2006-2011)	Number of Years (2012-2016)	Threat 2012-2017
Very High Key Threatening Process under the EPBC Act 1999	Total Annual rainfall 'very much below average' (lowest 10% of records)	2	1	Not Assessable as time period too short
	Annual mean maximum temperatures 'very much above average' (highest 10% of records)	1	5	

No objectives apply to containing or preventing climate change as as the threat can only be addressed indirectly through management of impacts to assets.

4 Management

4.1 Review of Management 2012-2017

4.1.1 Key Performance Indicators

Key performance indicators measure the degree to which operational reserve plans are implemented. These indicate whether systems are being applied and whether resources are adequate.

On-ground works undertaken included weed control, plantings and feral animal control, although most were not fully documented. There was no previous management plan for the Central Reserves, so no audit was undertaken of these works.

Infrastructure in 2016 is summarised in Table 39, with the location of tracks and fences shown in Figure 19 and the location of lights, seats and signs shown in Figure 20.

Table 39 Infrastructure Extents / Numbers

Infrastructure	Extent / Number 2016
Lights	12
Seats	2
Signs	7
Open Tracks	2075 m
Fences	760 m

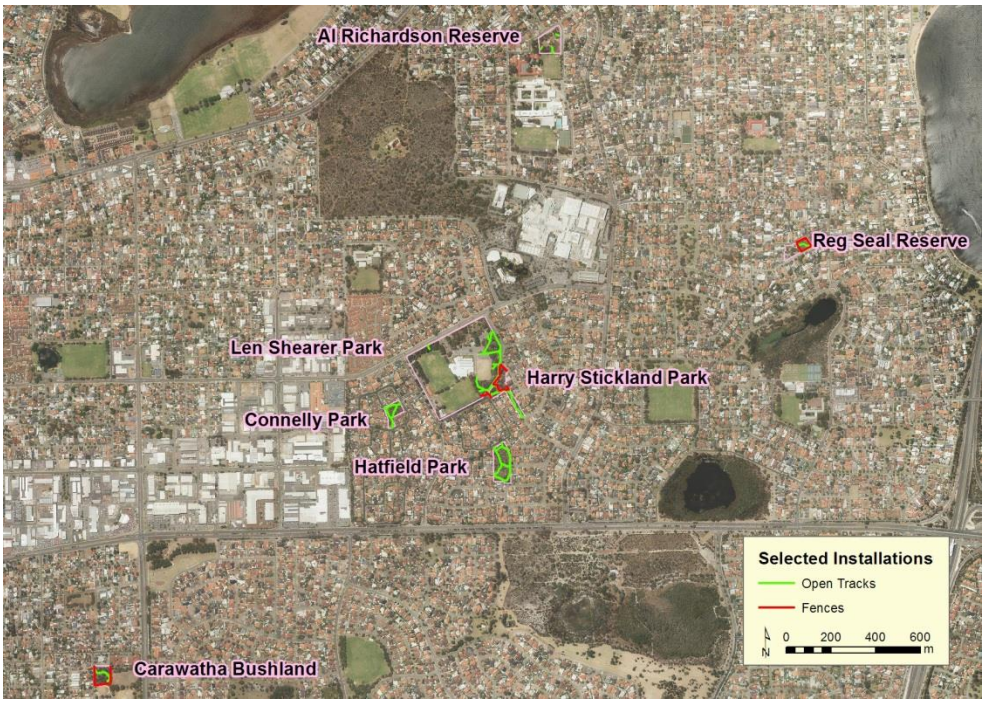

Figure 19 Track and Fence Locations 2016

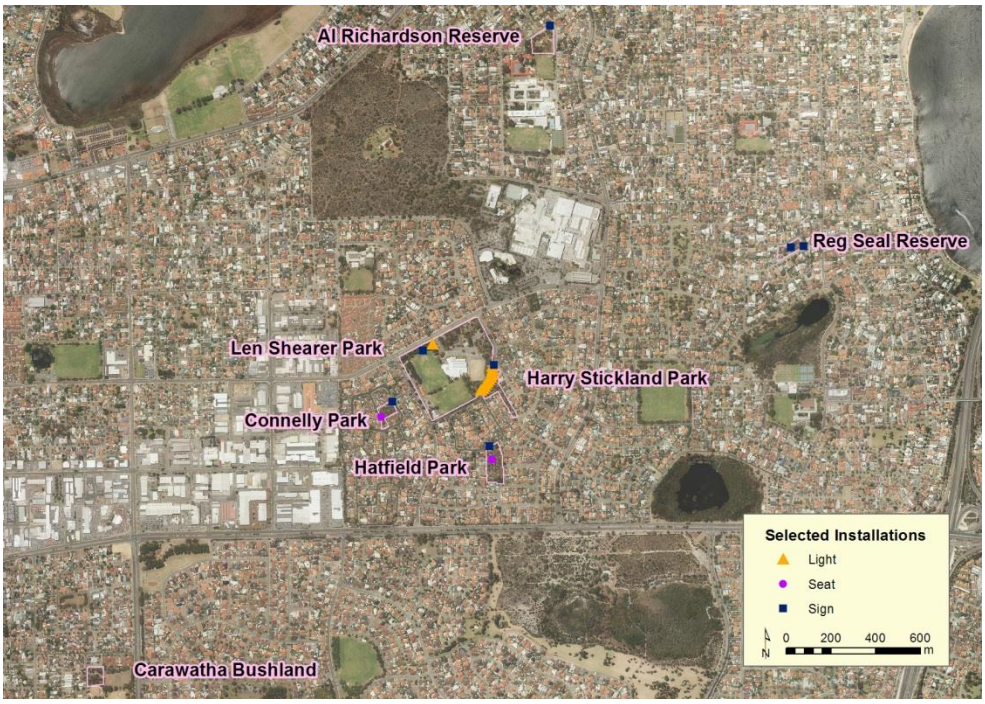

Figure 20 Light, Seat and Sign Locations 2016

4.1.2 Leading Indicators

Leading indicators (trends in threats) indicate for the life of a reserve management plan:

- whether guidelines and procedures are being effective in meeting objectives of preventing, eliminating, containing and managing impacts from threats; and
- provide a feedback mechanism as to whether guidelines and procedures need to be modified.

Trends in threats are categorised in Table 40, with many trends not assessable because the previous management plans preceded the standardisation of quantitative data collection.

Table 40 Leading Indicators

Impacts	Prevented (absent or avoided)	Eliminated (no longer present)	Contained (decrease or no change)	Not Contained (increase)	Not Assessable	Total Threat Indices
Very High	11 Weeds 2 Acid Sulfate	1 Feral	4 Weeds 1 Climate	1 Climate	1 Weed 2 Ferals 1 Pathogen	**24**
High	2 weeds 2 Fires (large & repeat)		1 Weed 1 Disturbance 1 Feral		2 Weeds	**9**
Medium	1 Pathogen				1 Weed 1 Habitat Loss 5 Disturbances	**8**
Low			Reticulation		1 Weed Bare Ground	**3**
Total Threat Indices	**18**	**1**	**9**	**1**	**15**	**44**

4.1.3 Lagging Indicators

Lagging indicators (trends in assets) indicate whether strategic goals of maintaining and enhancing assets are being met.

Trends in assets are categorised in Table 41, with many trends not assessable because no previous management plan existed and there was no standardised quantitative data collection. Trends apply only for the life of a reserve management plan and therefore trends were not assessable for assets that have been lost and it was unclear whether they were still present at the time of the last reserve management plan in 2007.

Table 41 Lagging Indicators

Values	Enhanced	Maintained	Not Maintained	Not Assessable	Total Assets
Very High					**0**
High		1 Bird Population		1 Ecological Community Site	**2**
Medium		Live Native Habitat Trees		Local Native Plantings Bird and Bat Boxes	**3**
Low		10 Flora Species 2 Reptile Populations 4 Bird Populations			**16**
Total Assets	**0**	**18**	**0**	**3**	**21**

4.2 Management Objectives 2017-2022

4.2.1 Key Performance Indicators

Under the NAAMP, key performance indicators are measures of the degree of implementation of operational reserve plans. Operational reserve plans are internal City of Melville documents that include work schedules for individual reserves based on guidelines and strategies (that establish default management practices).

The City of Melville is developing and implementing guidelines and strategies. A comprehensive review of these documents is beyond the scope of this reserve management plan but:

- most need further clarification to facilitate the auditing of their implementation; and
- aspects of the guidelines should be specifically reviewed where recommendations for their application below are not directly associated with specifications in the guidelines.

There are no unusual characteristics of the Central Reserves that require variations to standard management embedded in any guidelines or strategies, except:

1. The following target species need not necessarily be maintained in the Central Reserves as the entire populations have been planted:
   - *Agonis flexuosa*
   - *Jacksonia sericea*
   - *Xylomelum occidentale*
2. The following plants to be managed as weeds in Central Reserves, although they may be treated as native in other City of Melville Reserves:
   - *Agonis flexuosa*
   - *Callitris preissii*
   - *Calothamnus quadrifidus*
   - *Dodonaea hackettiana*
   - *Grevillea crithmifolia*
   - *Grevillea preissii*
   - *Grevillea vestita*
   - *Ricinocarpos undulatus*

4.2.2 Leading Indicators

Leading indicators are associated with changes in the density / abundance / extent / occurrences of threats. The levels of acceptable changes are determined in the framework established in the NAAMP as summarised in Table 42 and applied in Table 43 and Table 44.

Table 42 Tiered Objectives for Threats and Associated Leading Indicators

Objective	Leading Indicator	Applicable When
Prevent	• Prevent introduction to or occurrence of	• Threat absent from reserve • Unplanned Introduction Possible
Eliminate	• Reduce rate of density / abundance / extent (Eventual complete removal, but in short term may only be reduction of numbers or prevention of seed set onsite)	• Large discrepancy between current and potential impact • Potential impact high • Elimination feasible
Contain	• Stop, restrict, or reduce rate of spread or frequency of occurrence	• Moderate discrepancy between current and potential impact • Potential but not current impact high • Elimination not feasible
Manage	• Limit negative impacts on assets	• Small discrepancy between current and potential impact • Threat "naturalised" or near maximum extent • No information on density/abundance/extent
None	• Not Applicable	• Threat absent from reserve • Only Planned Introduction Possible

Table 43 Objectives for Weed Species in the Central Reserves

Objective	Impact	Weed Species / Group	2016 Extent	Comments
Prevent	Very High	Arum Lily Asparagus Fern Blackberry Golden Dodder Lantana Madeira Vine Narrowleaf Cottonbush One Leaf Cape Tulip Paterson's Curse Tamarisk Willows	0%	Not Present Onsite
	High	Annual Clumping Grass Giant Grasses		
Eliminate	Very High	Brazilian Pepper	1%	Eliminate 1 tree
		Bridal Creeper	4%	Eliminate 6 occurrences
		Soldiers	1%	Eliminate 1 occurrence
Contain	Very High	Perennial Clumping Grasses	76%	Elimination not feasible in short to medium term Prevent extent / density from increasing
		Very Large Trees	12%	
	High	Clumping Geophytes	44%	
		Trees and Shrubs	41%	
		Perennial Running Grass	4%	
Manage	Medium	All other perennial weeds	40%	Focus in terms of asset protection – revegetation sites
	Low	All other annual weeds	92%	

Table 44 Objectives for all other Threats in the Central Reserves

Objective	Impact	Threat	Comments
Prevent	Very High	Acid Sulfate Soil	Monitoring required as groundwater extraction proposed
		Ferals (Foxes)	Absent - occasional incursion may occur and remove/eliminate with 10 working days of observations, before they permanently establish
		Ferals (Rabbits)	
	High	Fires (large)	Prevent fires that burn more than one third of bushland, in consultation with Department of Fire and Emergency Services
	High	Ferals (Bees)	Absent – remove/eliminate with 10 working days of observations, before they permanently establish
	Medium	Diseases and Pathogens (Honey Fungus)	Assumed absent - never recorded in the City of Melville Apply appropriate hygiene standards for onground works to prevent introduction
Contain	Very High	Ferals (Cats)	Trap onsite within 10 working days of sightings Also manage indirectly through revegetation - increase vegetation cover to aid small vertebrates evade predation Vegetation characteristics may be more important to persistence of some native species than cat restrictions around urban bushland (Lilith, Calver, & Garkaklis, 2010)
		Habitat Loss	Limit fragmentation of bushland (e.g. by paths) within reserves
	High	Fire (repeat)	Limit fires burning same portion of bushland, in consultation with Department of Fire and Emergency Services
	Medium	Physical Disturbance	Public access adequately limited through provision of paths and use of soft barriers (such as plantings) and hard barriers (such as fences) Conversion of informal trail into sealed path is recommended in Connelly Park
Manage	Very High	Diseases and Pathogens (Dieback)	Manage impacts directly through Phosphite applications and maintaining unfavourable conditions of closed tree canopy and deep leaf litter to reduce soil temperatures.
		Climate Change	Global-scale threat - cannot prevent, eliminate or contain by reserve scale actions. Manage through: • revegetation if mass plant deaths occur or are likely. • prioritisation of removal of high water use weeds (especially trees and shrubs) • maintenance of soil moisture through maintenance of canopy and thick leaf litter • limit other factors that could interact cumulatively with climate change to result in permanent change (e.g. repeat fires)
	High	Ferals (Birds)	Regional-scale threat - cannot prevent, eliminate or contain by reserve scale actions. Install only bird and bat boxes that limit use by ferals
	Low	Ferals (Mice)	Likely ongoing presence due to adjacent urban areas - cannot prevent, eliminate or contain Manage indirectly through revegetation to offset seed predation
		Reticulation	Manage through maintenance and operation of reticulation to avoid drift or leaks into bushland

4.2.3 Lagging Indicators

Lagging indicators are associated with changes in the density / abundance / extent / occurrences of assets. The levels of acceptable change are determined in the framework established in the NAAMP as summarised in Table 45 and applied in Table 46 and Table 47.

Table 45 Tiered Goals for Assets and Associated Lagging Indicators

Goal	Lagging Indicator	Applicable When
Enhance	Increase in either • extent • density • numbers or • occurrences	Asset can be enhanced and • occurs in only one reserve and/or • at risk of local extinction and/or • minimal cost (e.g. incorporated in revegetation program) and/or • reduces operational costs (e.g. reduces requirements for on-going for threat management)
Maintain	No decrease in either • extent • density • numbers or • occurrences	Asset can be maintained and • the asset occurs in a number of reserves and/or • not a risk of local extinction and/or • occurs in only one reserve but insufficient knowledge/resources to enhance
Confirm	Decrease in: • number of assets for which their presence is uncertain	Asset significant and • historic but no recent records in reserve and/or • potential to be in reserve based on habitat and/or proximity of other records
Monitor	No indices for management effectiveness	Assets that cannot be maintained by actions within City of Melville boundaries or for which no quantifiable indices exist and: • for which reserves are not critical component of habitat (e.g. highly mobile/wide roaming and/or infrequent/irregular visitors to the City of Melville) • there is a risk of local extinction from processes that cannot be mitigated by the City of Melville (e.g. climate change, some pathogens)

Table 46 Goals for Species

Goal	Priority	Asset	Comments
Enhance	**Low**	*Banksia grandis*	Increase the population from 4 to 10 plants • Susceptible to dieback, and may require Phosphite treatments to be retained onsite.
		Banksia ilicifolia	Increase the population from 1 to 10 plants • Susceptible to dieback, and may require Phosphite treatments to be retained onsite.
		Eremaea pauciflora	Increase the population from 2 to 10 plants
		Hakea prostrata	Increase the population from 1 to 10 plants • Susceptible to dieback, and may require Phosphite treatments to be retained onsite.
		Persoonia saccata	Increase the population from 5 to 10 plants • Susceptible to dieback, and may require Phosphite treatments to be retained onsite. • Species is problematic to propagate
High	**High**	*Smicrornis brevirostris*	Resident bird that does not require tree hollows for breeding onsite. Expected to persist onsite if standard threat management procedures and guidelines are effective and implemented.
Maintain	**Low**	*Banksia attenuata*	>175 plants each • Trees susceptible to dieback, and likely requires Phosphite treatments to be retained onsite.
		Banksia menziesii	
		Adenanthos cygnorum	17 plants • Susceptible to dieback, and may require Phosphite treatments to be retained onsite.
		Macrozamia riedlei	12 plants • Susceptible to dieback, and may require Phosphite treatments to be retained onsite.
		Tiliqua rugosa rugosa	Reptile expected to persist onsite if standard threat management procedures and guidelines are effective and implemented.
		Hirundo nigricans	Resident bird that requires tree hollows for breeding onsite. Expected to persist onsite if standard threat management procedures and guidelines are effective and implemented.
		Pardalotus striatus	
		Purpureicephalus spurius	
		Phylidonyris novaehollandiae	Resident birds not requiring tree hollows for breeding. Expected to persist onsite if standard threat management procedures and guidelines are effective and implemented.
Monitor	**High**	*Calyptorhynchus banksii*	Migratory bird species: maintain habitats only in form of existing overstorey trees onsite.
		Calyptorhynchus latirostris	
	Medium	*Austronomus australis*	Migratory bat species breeding onsite: maintain habitat in form of very large trees
	Low	*Chalinolobus gouldii*	Bat with large home range: maintain habitat in form of very large trees
Confirm	**Low**	*Regelia ciliata / inops*	All plants to be examined (and locations recorded) during flowering to determine which species present and number of plants: • *Regelia inops* likely native and in low abundance • *Regelia ciliata* likely planted

Table 47 Goals for Sites

Goal	Priority	Asset	Comments
Enhance	**Medium**	Revegetation Sites – existing plantings	Revegetate 10% (0.22 ha) to the standard of 'Rehabilitation' in NAAMP
Maintain	**High**	Bassendean – Central and South Vegetation Complex	Maintain bushland with very high native plant cover at 36%
	Medium	Habitat Sites - very large live native trees	Assets that are expected to persist onsite if standard threat management procedures and guidelines are effective and implemented.
		Bird and Bat Boxes	Maintain 1 bird box in Al Richardson Reserve Maintain 3 bat boxes in Al Richardson Reserve

References

Alan Tingay and Associates. (1998). *A Strategic Plan for Perth's Greenways - Final Report.* Perth: prepared for Environment Australia, Ministry for Planning, CALM, WAMA, DEP, WRC, Main Roads WA, Swan Catchment Centre, Conservation Council, Greening WA and Australian Trust for Conservation Volunteers.

Alan Tingay and Associates. (1999). *Green Plan for the City of Melville.* Perth: City of Melville.

Baird, A. (1977). Regeneration after fire in King's Park, Perth, Western Australia. *Journal of the Royal Society of Western Australia, 60*(1), 1-22.

Bamford, M., Shepherd, B., Browne-Cooper, R., & Chuk, K. (2017). *City of Melville Reserves Fauna Assessment.* Perth: unpublished report by Bamford Consulting Ecologists for City of Melville.

Barrett, R., & Pin Tay, E. (2005). *Perth Plants.* Perth: Botanic Gardens and Parks Authority.

Birdlife Australia. (2013). *Nest Boxes for Native Birds - Information Sheet.* Carlton, Victoria: Birdlife Australia.

Bridgewater, P., & Wheeler, J. (1980). *Atlas of the distribution of certain plant species in the City of Melville, Western Australia.* Perth: Murdoch University.

Brown, P., Davis, R., Sonneman, T., & Kinloch, J. (2009). *Ecological Linkages proposed for the Gnangara Groundwater System.* Perth: Department of Environment and Conservation.

Bullen, R., & McKenzie, N. (2005). Seasonal range variation of Tadarida australis (Chiroptera : Molossidae) in Western Australia: the impact of enthalpy. *Australian Journal of Zoology, 53*, 145–156.

Burnham, Q., Barrett, G., Blythman, M., & Scott, R. (2010). *Carnaby's Cockatoo (Calyptorhynchus latirostris) identification of nocturnal roost sites and the 2010 Great Cocky Count.* Perth: WA Department of Environment and Conservation.

Churchill, S. (2008). *Australian Bats (2nd ed.).* Sydney: Allen and Unwin.

Clarke, G., Grosse, S., Matthews, M., Catling, P., Baker, B., Hewitt, C., . . . Saddlier, S. (2000). *Environmental Pest Species in Australia, Australia: State of the Environment, Second Technical Paper Series (Biodiversity).* Canberra: Department of the Environment and Heritage.

Crosti, R., Dixon, K., Ladd, P., & Yates, C. (2007). Changes in structure and species dominance in vegetation over 60 years in an urban bushland remnant. *Pacific Conservation Biology, 13*, 158-170.

Cunningham, I. (1998). *The Trees that were Nature's Gift.* Perth: Format Finishing.

DEC. (2010). *Phytophthora dieback - About Phytophthora dieback*. (Department of Environment and Conservation) Retrieved June 08, 2010, from http://www.dec.wa.gov.au/content/view/5729/2305/

DEC. (2012). *Carnaby's Cockatoo (Calyptorhynchus latirostris) Recovery Plan.* Perth, Western Australia: Department of Environment and Conservation.

DEP. (1996). *System 6 and Part System 1 Update Programme* . Perth: Department of Environmental Protection.

Department of Sustainability, Environment, Water, Population and Communities. (2013, June 13). *Calyptorhynchus latirostris — Carnaby's Black-Cockatoo, Short-billed Black-Cockatoo: SPRAT Profile*. Retrieved from EPBC - Biodiversity - Species Profile and

Threats Database: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59523

DEPI. (2013, September 18). *European Rabbit*. Retrieved from Department of Environment and Primary Industries, Victoria: http://www.dpi.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-animals/a-z-of-pest-animals/european-rabbit

DEWHA . (2008). *Background document for the threat abatement plan for predation by feral cats.* Canberra: Department of the Environment, Water, Heritage and the Arts (DEWHA).

Dieback Treatment Services. (2013). *Phytophthora dieback mapping of Reserves throughout the City of Melville.* Perth: unpublished report for the City of Melville.

Dieback Treatment Services. (2016). *Phytophthora Dieback Mapping and Treatment of Reserves throughout the City of Melville.* Perth: unpublished report for the City of Melville.

Dieback Working Group. (2000). *Managing Phytophthora Dieback - Guidelines For Local Government.* Perth: Dieback Working Group.

Dixon, K. (2011). *Coastal Plants - A Guide to the Identification and Restoration of Plants of the Perth Region.* Collingwood, Victoria: CSIRO Publishing.

Ecoscape. (2006). *Weed Mapping and Vegetation Community Assessment.* Melville: unpublihsed report for the City of Melville.

George, A. (1996). *The Banksia Book - 3rd edition.* Sydney: Kangaroo Press Pty Ltd.

Gibbons, P., & Lindenmayer, D. (2002). *Tree Hollows and Wildlife Conservation in Australia.* Collingwood, Victoria: CSIRO Publishing.

Gibson, N., Keighery, B., Keighery, G., Burbridge, A., & Lyons, M. (1995). *A Floristic Survey of the Southern Swan Coastal Plain.* Perth: Unpublished report for the Australian Heritage Commission.

Gole, C. (2003). *Bird surveys in selected Perth metropolitan reserves.* Perth: Birds Australia.

Government of Western Australia. (2000). *Bush Forever. Volume 2: Directory of Bush Forever Sites.* Perth: Western Australian Planning Commission.

Grayson, J., & Calver, M. (2004). Regulation of domestic cat ownership to protect urban wildlife: a justification based on the precautionary principle. In D. Lunney, & S. Burgin, *Urban Wildlife: more than meets the eye* (pp. 169-178). Sydney: Royal Zoological Society of New South Wales.

Groom, P., Froend, R., Mattiske, E., & Koch, B. (2000). Myrtaceous shrub species respond to long-term decreasing groundwater levels on the Gnangara Groundwater Mound, northern Swan Coastal Plain. *Journal of the Royal Society of WA*, 75-82.

Groves, E., Hardy, G., & McComb, J. (nd_1). *Western Australian natives susceptible to Phytophthora cinnamomi.* Perth: Dieback Working Group.

Groves, E., Hardy, G., & McComb, J. (nd_2). *Western Australian natives resistant to Phytophthora cinnamomi.* Perth: Murdoch University.

Heddle, E., Loneragan, O., & Havel, J. (1980). *Vegetation complexes of the Darling system, Western Australia. In: Atlas of natural resources: Darling system, Western Australia.* Perth: Department of Conservation and Environment.

Heliyanto, B., He, T., Lambers, H., Veneklaas, E., & Krauss, S. (2009). Population Size Effects on Progeny Performance in Banksia ilicifolia. *Journal of Biosciences, 16*(2), 43-48.

Hill, A., Semeniuk, C., Semeniuk, V., & Del Marco, A. (1996). *Wetlands of the Swan Coastal Plain Volume 2B: Wetland Mapping, Classification and Evaluation, Wetland Atlas.* Perth: Water and Rivers Commission and Department of Environmental Protection.

Hope, P., & Foster, I. (2005). How our rainfall has changed - The south-west, Climate Note 5/05. Perth: Indian Ocean Initiative, Government of Western Australia.

Hosken, D. (1996, September). Roost selection by the lesser long-eared bat, Nyctophilus geoffroyi, and the greater long-eared bat, N. major (Chiroptera: Vespertilionidae) in Banksia woodlands. . *Journal of the Royal society of Western Australia, 79*(3), 211-216.

How, R., & Dell, J. (2000). The Zoogeographic Significance of Urban Bushland Remnants to Reptiles in the Perth Region, Western Australia. *Pacific Conservation Biology, 1*, 132-140.

How, R., Harvey, M., Dell, J., & Waldock, J. (1996). *Ground Fauna of Urban Bushland Remnants in Perth.* Perth: Western Australian Museum.

Indian Ocean Climate Initiative. (2009). *How WA's Climate Has Changed.* Perth: Government of Western Australia, Bureau of Meterology, CSIRO.

Kabat, A., Scott, R., Kabat, T., & Barrett, G. (2012). *2011 Great Cocky Count: Population estimates and identification of roost sites for the Carnaby's Cockatoo (Calyptorhynchus latirostris).* Perth: Report prepared by BirdLife Australia for the WA Department of Environment and Conservation.

Keighery, G. (2013). Weedy native plants in Western Australia: an annotated checklist. *Conservation Science Western Australia, 8*(3), 259-275.

Keighery, G., & Keighery, B. (1991). *Floristics of Reserves and Bushland Areas of the Perth Region (System 6) Parts II-IV.* Perth: Wildflower Society of Western Australia.

Lapidge, K., Braysher, M., & Sarre, S. (2013, September 19). *feral.org.au*. Retrieved from Fox FAQs: http://www.feral.org.au/pest-species/faq/fox-faqs/

Lilith, M., Calver, M., & Garkaklis, M. (2010). Do cat restrictions lead to increased species diversity or abundance of small and medium-sized mammals in remnant urban bushland? *Pacific Conservation Biology, 16*, 162-172.

Maher, K. (2009). *Restoration of Banksia woodland after the removal of pines at Gnangara.* Perth: Department of Environment and Conservation.

Main, A., & Serventy, D. (1957). King's Park as an Indigenous Park - A Natural History Appraisal. *The Western Australian Naturalist*, 25-53.

Marchant, N., Wheeler, J., Rye, B., Bennett, E., Lander, N., & Macfarlane, T. (1987). *Flora of the Perth Region, Part One.* Perth: Western Australian Herbarium / Department of Agriculture.

McHugh, S., & Bourke, S. (2008). *Management Area Review of Shallow Groundwater Systems on Gnangara and Jandakot mounds.* Perth: Department of Water.

Muir, B. (1987). Time between germination and first flowering. *Kingia*, 75-83.

Natsync Environmental. (2014). *Pt Walter, Pt Heathcote and Bull Creek Bat Report.* Perth: unpublished report for Bamford Consulting Ecologists.

Powell, R. (2009). *Leaf and Branch - Trees and Tall Shrubs of Perth.* Perth: DEC.

Powell, R., & Emberson, J. (1996). *Growing Locals.* Perth: Western Australian Naturalists' Club.

Ramalho, C. (2012). *Effects of urbanisation on remnant woodlands - PhD Thesis.* Perth: The University of Western Australia.

Rippey, E., & Rowland, B. (2004). *Coastal Plants - Perth and the South-West Region.* Perth: University of Western Australia Press.

Shearer, B. (1994). The major plant pathogens occurring in native ecosystems of south-western Australia. *Journal of the Royal Society of Western Australia,, 77*(4), 113-122.

Strahan, R. (1998). *The Mammals of Australia.* Melbourne: New Holland Publishers.

Waters, A. (2013). *Natural Areas Asset Management Plan.* report by Woodgis Environmental Assessment and Management for the City of Melville, Western Australia.

Waters, A. (2017). *Flora and Vegetation Surveys City of Melville Central Reserves (Carawatha Bushland; Al Richardson and Reg Seal Reserves; Connelly, Hatfield, Harry Stickland and Len Shearer Parks).* Perth: unpublished report by Woodgis Environmental Assessment and Management.

Webala, P. (2010). *Bat community structure and habitat use across logging regimes in jarrah eucalypt forests of south-western Australia - PhD Thesis.* Perth: Murdoch University.

Wilson, B., & Valentine, L. (. (2009). *Biodiversity values and threatening processes of the Gnangara groundwater system - Report for the Gnangara Sustainability Strategy and the Department of Environment and Conservation.* Perth: Gnangara Sustainability Strategy Taskforce - Department of Water.

Young, A., Broadhurst, L., Byrne, M., Coastes, D., & Yates, C. (2005). *Genetic and Ecological Viability of Plant Populations in Remnant Vegetation.* Canberra: Land and Water Australia.

Young, A., Broadhurst, L., Coates, D., Byrne, M., Yates, C., & Elliott, C. (2005). *Land and Water project number CPI 10 : Genetic and ecological viability of plant populations in remnant vegetation.* Canberra: CSIRO.

Appendix 1 Flora Inventory

Table 48 Native Flora Inventory

Family	Species	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Al Richardson	Reg Seal
ANARTHRIACEAE	*Lyginia barbata*					1	
	Lyginia imberbis	1		1	1		
APIACEAE	*Platysace compressa*						1
ASPARAGACEAE	*Laxmannia ramosa subsp. ramosa*				1		
	Laxmannia squarrosa		1	1	1	1	
	Lomandra caespitosa	1		1			1
	Lomandra hermaphrodita		1	1			
	Lomandra maritima				1		
	Lomandra preissii		1	1	1		1
	Sowerbaea laxiflora			1			
	Thysanotus manglesianus		1	1			
	Thysanotus multiflorus						1
ASTERACEAE	*Senecio pinnatifolius*			1	1		
CASUARINACEAE	*Allocasuarina fraseriana*	1		1	1	1	1
	Allocasuarina humilis	1	1	1	1	1	1
COLCHICACEAE	*Burchardia congesta*		1	1	1	1	1
CYPERACEAE	*Lepidosperma leptostachyum*				1		
	Lepidosperma scabrum		1	1			
	Lepidosperma sp.	1	1	1	1		1
	Mesomelaena pseudostygia	1	1	1	1	1	1
	Schoenus clandestinus			1			
	Tetraria octandra		1	1			
DASYPOGONACEAE	*Calectasia narragara*			1	1		1
	Dasypogon bromeliifolius	1	1	1	1	1	1
DILLENIACEAE	*Hibbertia huegelii*		1	1	1	1	
	Hibbertia hypericoides	1	1	1	1	1	1
	Hibbertia racemosa			1	1	1	
DROSERACEAE	*Drosera glanduligera*						1
	Drosera menziesii						1
	Drosera pallida			1	1		
	Drosera porrecta						1
ERICACEAE	*Astroloma pallidum*				1		1
	Conostephium pendulum	1	1	1	1	1	1
	Leucopogon australis						1
	Leucopogon conostephioides		1	1	1		
	Leucopogon propinquus			1	1	1	
FABACEAE	*Acacia applanata*				1		
	Acacia cochlearis			1	1	1	
	Acacia cyclops					1	
	Acacia huegelii				1		
	Acacia pulchella	1	1		1	1	1

Family	Species	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Al Richardson	Reg Seal
	Acacia saligna	1	1	1	1	1	A
	Acacia stenoptera					1	1
	Acacia stenoptera	1	1	1	1	1	
	Acacia willdenowiana		1	1		1	
	Bossiaea eriocarpa	1	1	1	1	1	1
	Daviesia decurrens		1				
	Daviesia divaricata	1			1		
	Daviesia nudiflora	1	1	1	1	1	1
	Daviesia physodes	1	1	1			
	Daviesia triflora	1	1	1	1		1
	Gastrolobium capitatum		1	1	1		
	Gompholobium capitatum				1		
	Gompholobium tomentosum	1	1	1	1		1
	Hardenbergia comptoniana	1	1	1	1	1	1
	Hovea pungens				1		A
	Hovea trisperma		1	1		1	A
	Isotropis cuneifolia subsp. cuneifolia				1		A
	Jacksonia furcellata	1	1	1	1	1	1
	Jacksonia sternbergiana	1		1	1	1	1
	Kennedia prostrata	1	1	1	1	1	A
	Templetonia retusa					1	
GOODENIACEAE	*Dampiera linearis*		1		1	1	1
	Lechenaultia floribunda				1	1	
	Scaevola canescens		1	1	1	1	1
	Scaevola repens	1		1	1	1	1
HAEMODORACEAE	*Anigozanthos humilis subsp. humilis*				1		A
	Anigozanthos manglesii		1	1	1	1	A
	Conostylis aculeata	1	1	1	1	1	1
	Conostylis setigera	1		1	1	1	
	Haemodorum species	1					
	Phlebocarya ciliata	1		1		1	
HEMEROCALLIDACEAE	*Corynotheca micrantha*				1		
	Dianella revoluta	1		1	1	1	1
	Tricoryne elatior			1			A
IRIDACEAE	*Patersonia occidentalis*		1				1
JUNCACEAE	*Juncus pallidus*				1		
LAMIACEAE	*Hemiandra pungens*	1				1	1
LORANTHACEAE	*Nuytsia floribunda*		1			1	
MYRTACEAE	*Calytrix flavescens*				1		
	Corymbia calophylla			1	1	1	A
	Eremaea pauciflora			1		1	1
	Eucalyptus marginata subsp. marginata	1	1	1	1	1	1
	Hypocalymma angustifolium		1	1		1	1

Family	Species	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Al Richardson	Reg Seal
	Hypocalymma robustum	1	1	1	1	1	1
	Kunzea glabrescens			1			
	Melaleuca nesophila		1			1	
	Regelia ciliata/inops			1	1		1
ORCHIDACEAE	*Caladenia flava*		1				
	Diuris longifolia				1		
	Microtis media			1			
	Pterostylis sanguinea			1			
	Pterostylis species		1	1			
	Pterostylis vittata		1		1		
PHYLLANTHACEAE	*Phyllanthus calycinus*			1			
PITTOSPORACEAE	*Billardiera fusiformis*		1	1		1	
POACEAE	*Amphipogon turbinatus*			1			
PROTEACEAE	*Adenanthos cygnorum subsp. cygnorum*		1	1	1	1	
	Banksia attenuata	1	1	1	1	1	1
	Banksia grandis		1	1			1
	Banksia ilicifolia					1	
	Banksia lindleyana			1		1	1
	Banksia littoralis						
	Banksia menziesii	1	1	1	1	1	1
	Banksia sessilis var. cygnorum			1		1	
	Hakea lissocarpha					1	
	Hakea prostrata	1	1	1	1	1	1
	Persoonia saccata		1	1	1	1	1
	Petrophile linearis	1		1	1	1	1
	Petrophile macrostachya			1	1	1	
	Petrophile serruriae			1			
	Stirlingia latifolia	1	1	1	1	1	1
	Synaphea spinulosa			1			
RESTIONACEAE	*Desmocladus fasciculatus*		1	1			1
	Desmocladus flexuosus	1	1	1	1		
	Hypolaena exsulca	1	1	1	1	1	
RUBIACEAE	*Opercularia vaginata*		1				
RUTACEAE	*Philotheca spicata*			1			
THYMELAEACEAE	*Pimelea imbricata*						1
	Pimelea rosea			1			
	Pimelea sulphurea			1	1		
VIOLACEAE	*Hybanthus calycinus*		1	1	1		
XANTHORRHOEACEAE	*Xanthorrhoea brunonis*						1
	Xanthorrhoea preissii	1	1	1	1	1	1
ZAMIACEAE	*Macrozamia fraseri*		1	1	1	1	1
Total	**126**	**39**	**58**	**83**	**73**	**60**	**53**

A= Anecdotal evidence from community sighting

Table 49 Dubious Species Inventory

Family	Species	Carawatha	Connelly	Harry Stickland / Len Shearer	Hatfield	Al Richardson	Reg Seal
HAEMODORACEAE	*Conostylis candicans*	1				1	

Table 50 Weed Inventory

Impact	Weed Group / Species	FAMILY	Species	Common Name	Carawatha	Connelly	Stickland / Len Shearer	Hatfield	Al Richardson	Reg Seal
Very High	Arum Lily	ARACEAE	*Zantedeschia aethiopica*	Arum Lily		1				
	Brazilian Pepper	ANACARDIACEAE	*Schinus terebinthifolius*	Brazilian Pepper			1		1	
	Bridal Creeper	ASPARAGACEAE	*Asparagus asparagoides*	Bridal Creeper	1		1			1
	Perennial Clumping Grass	POACEAE	*Ehrharta calycina*	Perennial Veld Grass	1	1	1	1	1	1
	Soldiers	ASPARAGACEAE	*Lachenalia reflexa*	Soldiers	1	1	1	1		
High	Annual Clumping Grasses	POACEAE	*Avena barbata*	Bearded Oat				1		
			Ehrharta longiflora	Annual Veldt Grass	1		1			
			Vulpia myuros	Rat's Tail Fescue				1		
	Clumping Geophytes	IRIDACEAE	*Freesia alba x leichtlinii*	Freesia			1		1	1
			Gladiolus caryophyllaceus	Wild Gladiolus	1	1	1	1	1	
			Romulea rosea	Guildford Grass	1				1	1
			Watsonia meriana var. bulbillifera	Bungle Lily			1			
		OXALIDACEAE	*Oxalis corniculata*	Yellow Wood Sorre			1			
			Oxalis pes-caprae	Soursob	1	1	1	1	1	1
	Perennial Running Grasses	POACEAE	*Cynodon dactylon*	Couch					1	
	Shrubs and Trees	APOCYNACEAE	*Nerium oleander*	Oleander			1			
		BIGNONIACEAE	*Jacaranda mimosifolia*	Jacaranda	1					
		CASUARINACEAE	*Allocasuarina species*	Sheoak			1	1		
		CUPRESSACEAE	*Callitris preissii*	Rottnest Island Pine			1	1	1	1
			Hesperocyparis lusitanica	Mexican White Cedar			1			
		EUPHORBIACEAE	*Ricinocarpos undulatus*	Wedding Bush		1				
			Ricinus communis	Castor Oil Plant					1	
		FABACEAE	*Acacia iteaphylla*	Flinders Range Wattle	1	1	1	1	1	
			Acacia longifolia	Sydney Golden Wattle	1	1	1	1		
			Acacia podalyriifolia	Queensland Silver Wattle					1	
		MALVACEAE	*Brachychiton populneus*	Kurrajong	1		1		1	
		MYRTACEAE	*Agonis flexuosa*	Peppermint	1		1	1	1	1
			Callistemon species	Bottlebrush		1	1	1		
			Calothamnus quadrifidus	One-sided Bottlebrush			1	1	1	
			Chamelaucium uncinatum	Geraldton Wax	1	1	1	1	1	1
			Corymbia citriodora	Lemon Scented Gum				1		
			Darwinia species	Darwinia			1			
			Eucalyptus cladocalyx	Sugar Gum	1			1		
			Eucalyptus forrestiana	Fuchsia Gum			1			
			Eucalyptus globulus	Blue Gum			1			
			Eucalyptus leucoxylon	SA Blue Gum					1	
			Eucalyptus species	Gum Trees	1	1	1	1	1	1
			Kunzea baxteri						1	
			Leptospermum laevigatum	Victorian Tea Tree		1	1			
			Melaleuca quinquenervia	Broad-leaved Paperbark			1			
			Melaleuca species			1	1		1	

Impact	Weed Group / Species	FAMILY	Species	Common Name	Carawatha	Connelly	Stickland / Len Shearer	Hatfield	Al Richardson	Reg Seal
		OLEACEAE	*Olea europaea*	Olive		1		1	1	
		PINACEAE	*Pinus species*	Pine			1			
		PROTEACEAE	*Grevillea crithmifolia*						1	
			Grevillea preissii				1	1		
			Grevillea 'Robyn Gordon'			1		1		
			Grevillea species				1			
			Grevillea vestita				1			1
			Hakea laurina	Pincushion Hakea			1	1	1	
			Hakea species	Hakea					1	
		ROSACEAE	*Pyracantha species*	Firethorn			1			
		RUTACEAE	*Coleonema pulchellum*	Diosma		1				
		SAPINDACEAE	*Dodonaea hackettiana*	Hackett's Hopbush					1	
		PROTEACEAE	*Banksia media*			1				
Medium	Other Perennial Weeds	APOCYNACEAE	*Vinca major*	Blue Periwinkle				1		
		ASTERACEAE	*Gazania linearis*	Gazania			1			
		GERANIACEAE	*Pelargonium capitatum*	Rose Pelargonium			1			
		ORCHIDACEAE	*Disa bracteata*	African Weed Orchid			1			
Low	Annual Weeds	ASTERACEAE	*Arctotheca calendula*	Cape Weed				1		
			Hypochaeris species	Flatweed	1	1	1	1	1	
			Lactuca serriola	Prickly Lettuce			1			
			Monoculus monstrosus	Stinking Roger			1			
			Osteospermum ecklonis	African Daisy		1	1	1		
			Symphyotrichum squamatum	Bushy Starwort			1	1		
			Ursinia anthemoides	Ursinia			1	1		
		BRASSICACEAE	*Brassica tournefortii*	Mediterranean Turnip			1			
		EUPHORBIACEAE	*Euphorbia peplus*	Petty Spurge			1			
		EUPHORBIACEAE	*Euphorbia terracina*	Geraldton Carnation Weed	1		1			
		FABACEAE	*Lupinus ?angustifolius*	Narrowleaf Lupin	1					
			Lupinus cosentinii	Sandplain Lupin			1	1		
		OROBANCHACEAE	*Orobanche minor*	Lesser Broomrape			1			1
		PAPAVERACEAE	*Fumaria capreolata*	Whiteflower Fumitory		1	1	1	1	1
		POACEAE	*Briza maxima*	Blowfly Grass			1		1	
			Poa annua	Winter Grass			1			
		PRIMULACEAE	*Lysimachia arvensis*	Pimpernel	1					
		SOLANACEAE	*Solanum nigrum*	Blackberry Nightshade			1	1		
		TROPAEOLACEAE	*Tropaeolum majus*	Garden Nasturtium		1	1			

Appendix 2 Fauna Inventory

"Risk" categories
(species of particular sensitivity in urban areas):
X = listed as "at risk" by City of Melville
# = additionally identified by BCE
"-" = removed by BCE

Status categories:
CS 1 = listed under legislation
CS2 = listed as Priority by DPaW.

Population categories:
R = Resident
Mb. = Regular breeding migrant
Mnb = Regular non-breeding migrant
Vis = Visitor
Vag = Vagrant
? = Prefix indicating potential to occur but not confirmed- listed for management purposes

Occurrence categories:
2016 = confirmed in 2016

Locally extinct species excluded from list

Table 51 Native Fauna Inventory

Family		Species	At risk category	Conservation Status	Status in Melville	Connelly Park	Hatfield Park	Len Shearer and Harry Stickland parks	Reg Seal Reserve	Al Richardson Reserve	Carawatha Bushland
Mammals	**Phalangeridae** (possums)	Brush-tailed Possum *Trichosurus vulpecula*	X		R	?Vag	?Vag	?Vag	?Vag	?Vag	?Vag
	Mollosidae (mastiff bats)	White-striped Bat *Austronomus australis*			Mb	Mb	Mb	?Mb	?Mb	2016 Vis	Mb
	Vespertilionidae (vesper bats)	Gould's Wattled Bat *Chalinolobus gouldii*	X		R	R	R	?R	?R	2016 R	R
		Chocolate Wattled Bat *Chalinolobus morio*	X		R	R	R	?R	?R	R	R
		Southern Forest Bat *Vespedalus regulus*	X		R	Vis	Vis	?Vis	?Vis	Vis	Vis
		Lesser Long-eared Bat *Nyctophilus geoffroyi*	X		R	Vis	Vis	?Vis	?Vis	Vis	Vis
Reptiles and Amphibians	**Myobatrachidae** (ground frogs)	Moaning Frog *Heleioporus eyrei*			R	Vis	Vis	?Vis	?Vis	Vis	Vis
		Pobblebonk *Limnodynastes dorsalis*			R	Vis	Vis	?Vis	?Vis	Vis	Vis
	Hylidae (tree frogs)	Slender Tree-Frog *Litoria adelaidensis*			R	-	-	-	?R	-	-
		Motorbike Frog *Litoria moorei*			R	Vis	Vis	?Vis	?R	Vis	Vis
	Gekkonidae (geckoes)	Southern Spiny-tailed Gecko *Strophurus spinigerus*	#		R	R	R	?R	?R	R	R
		Marbled Gecko *Christinus marmoratus*	X		R	2016 R	2016 R	**2016 R**	?R	2016 R	2016 R
	Pygopodidae (legless lizards)	Sand-Plain Worm-lizard *Aprasia repens*	X		R	R	R	?R	?R	R	R
	Scincidae (skink lizards)	Fence Skink *Cryptoblepharus buchananii*			R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
		West Coast Ctenotus *Ctenotus fallens*	#		R	R	R	?R	?R	R	R
		Two-toed Earless Skink *Hemiergis quadrilineata*			R	2016 R	2016 R	?R	2016 R	2016 R	R
		West Coast Four-toed Lerista *Lerista elegans*			R	R	R	?R	?R	R	R
		Perth Lined Lerista *Lerista lineata*	X	CS2	R	R	R	?R	?R	R	R
		Worm Lerista *Lerista praepedita*			R	R	R	?R	?R	R	R
		Dwarf Skink *Menetia greyii*			R	R	R	**2016 R**	2016 R	R	2016 R
		West Coast Morethia *Morethia lineoocellata*			R	R	R	?R	?R	R	R
		Dusky Morethia *Morethia obscura*			R	R	R	?R	?R	R	R
		Bobtail Skink *Tiliqua rugosa*	#		R	R	R	?R	2016 R	R	2016 R
Birds	**Columbidae** (pigeons and doves)	Crested Pigeon *Ocyphaps lophotes*			R	-	-	?Vag	-	Vag	-
	Podargidae (frogmouths)	Tawny Frogmouth *Podargus strigoides*	#		R	Vag	Vag	?Vis	?Vag	Vag	Vag
	Ardeidae (herons and egrets)	Straw-necked Ibis *Threskiornis spinicollis*			Vis	-	-	?Vis	-	Vis	Vis
		Australian White Ibis *Threskiornis molucca*			Vis	-	-	?Vis	-	Vis	Vis
	Accipitridae (kites, hawks and eagles)	Eastern-Osprey *Pandion cristatus*		CS1	R	-	-	-	-	-	2016 Vag
		Brown Goshawk *Accipiter fasciatus*			R	-	-	?Vis	-	-	Vis
		Collared Sparrowhawk *Accipiter cirrhocephalus*			R	Vis	Vis	?R	?Vis	Vis	Vis
	Falconidae (falcons)	Nankeen Kestrel *Falco cenchroides*			R	-	-	?Vis	-	-	-
		Australian Hobby *Falco longipennis*			R	Vag	Vag	?Vag	?Vag	Vag	Vag
		Peregrine Falcon *Falco peregrines*		CS1	R	Vag	Vag	?Vag	?Vag	Vag	Vag
	Cacatuidae (cockatoos)	Forest Red-tailed Black-Cockatoo *Calyptorhynchus banksii naso*	X	CS1	R	2016 Vis	2016 Vis	?Vis	?Vis	2016 Vis	2016 Vis
		Carnaby's Black-Cockatoo *Calyptorhynchus latirostris*	X	CS1	M ?b	Vis	Vis	**2016 Vis**	?Vis	Vis	2016 Vis
		Galah *Cacatua roseicapilla*	X		R	Vis	Vis	**2016 Vis**	?Vis	2016 Vis	Vis
		Little Corella *Cacatua sanguinea*	X		Vis	-	-	?Vis	-	Vis	-
	Psittacidae (lorikeets and parrots)	Australian Ringneck *Barnardius zonarius*	X		R	Vis	Vis	?R	?Vis	R	R
		Red-capped Parrot *Purpureicephalus spurious*	X		R	R	R	?R	?R	2016 R	R
	Strigidae (hawk-owls)	Southern Boobook Owl *Ninox novaeseelandiae*	#		R	Vis	Vis	?Vis	?Vag	Vag	Vag
	Tytonidae (barn owls)	Barn Owl *Tyto javanica*			Vis	Vag	Vag	?Vag	?Vag	Vag	Vag
	Apodidae (swifts)	Fork-tailed Swift *Apus pacificus*	X		Vis	Vis	Vis	?Vis	?Vis	Vis	Vis

Family		Species	At risk category	Conservation Status	Status in Melville	Connelly Park	Hatfield Park	Len Shearer and Harry Stickland parks	Reg Seal Reserve	Al Richardson Reserve	Carawatha Bushland
Birds	**Halcyonidae** (forest kingfishers)	Sacred Kingfisher *Todiramphus sanctus*	X		Mb	Vis	Vis	?Vis	?Vis	Vis	Vis
	Meropidae (bee-eaters)	Rainbow Bee-eater *Merops ornatus*	X	CS1	Mb	Vis	Vis	?Mb	?Vis	Vis	Vis
	Acanthizidae (thornbills and allies)	Weebill *Smicrornis brevirostris*	X		R	2016 R	2016 R	?E	-	2016 R	E
		Western Gerygone *Gerygone fusca*			R	Vis	Vis	?R	?Vis	Vis	R
	Pardalotidae (pardalotes)	Spotted Pardalote *Pardalotus punctatus*			Vis	Vis	Vis	?Vis	?Vis	Vis	Vis
		Striated Pardalote *Pardalotus striatus*	X		R	2016 R	R	?R	?R	R	R
	Meliphagidae (honeyeaters)	Singing Honeyeater *Lichenostomus virescens*			R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
		Western Wattlebird *Anthochaera lunullata*	X		R	Vis	Vis	?R	?Vis	-	Vis
		Red Wattlebird *Anthochaera carunculata*			R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
		Tawny-crowned Honeyeater *Glyciphila melanops*	#		Vis	Vag	Vag	?Vag	?Vag	Vag	Vag
		Brown Honeyeater *Lichmera indistinct*			R	2016 R	2016 R	**2016 R**	?R	R	R
		New Holland Honeyeater *Phylidonyris novaehollandiae*	X		R	2016 R	2016 R	**2016 R**	?R	R	2016 R
		White-cheeked Honeyeater *Phylidonyris nigra*			R	Vis	Vis	?Vis	?Vis	Vis	Vis
	Campephagidae (cuckoo-shrikes)	Black-faced Cuckoo-shrike *Coracina novaehollandiae*			R	R	R	?R	2016 R	Vis	R
		White-winged Triller *Lalage sueurii*			Mb	Vag	Vag	?Vag	?Vag	Vag	Vag
	Pachycephalidae (whistlers)	Rufous Whistler *Pachycephala rufiventris*	#		R	Vag	Vag	?Vag	?Vag	Vag	Vag
	Artamidae (woodswallows)	Grey Butcherbird *Cracticus torquatus*			R	Vis	Vis	**2016 Vis**	2016 R	2016 R	Vis
		Pied Butcherbird *Cracticus nigrogularis*			Vag	Vag	Vag	?Vag	?Vag	Vag	Vag
		Australian Magpie *Gymnorhina tibicen*			R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
	Rhipiduridae (fantails, willie wagtail)	Grey Fantail *Rhipidura fuliginosa*	#		R	Vis	Vis	?Vis	?Vis	Vis	Vis
		Willie Wagtail *Rhipidura leucophrys*			R	R	2016 R	**2016 R**	?R	2016 R	2016 R
	Corvidae (ravens and crows)	Australian Raven *Corvus coronoides*			R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
	Monarchidae (flycatchers)	Magpie-lark *Grallina cyanoleuca*			R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
	Megaluridae (songlarks)	Rufous Songlark *Cincloramphus mathewsi*	#		Mb	Vag	Vag	V?ag	?Vag	Vag	Vag
	Timaliidae (white-eyes)	Silvereye *Zosterops lateralis*			R	R	2016 R	**2016 R**	?R	Vis	R
	Hirundinidae (swallows)	White-backed Swallow *Cheramoeca leucosternus*			Mb	M	M	?M	?M	M	M
		Welcome Swallow *Hirundo neoxena*			R	Vis	Vis	?Vis	?Vis	Vis	Vis
		Tree Martin *Hirundo nigricans*	X		R	Vis	Vis	**2016 Vis**	?Vis	Vis	Vis
	Nectariniidae (flower-peckers)	Mistletoebird *Dicaeum hirundinaceum*			R	Vis	Vis	?Vis	?Vis	Vis	Vis
	Motacillidae (pipits and true wagtails)	Australasian (Richard's) Pipit *Anthus novaeseelandiae*			R	-	-	?Vis	-	Vis	Vis
Invertebrates	**Castniidae** (moths)	Graceful Sunmoth *Synemon gratiosa*	#	CS2	R	-	-	?R	?R	-	R
	Colletidae (bees)	Native bee *Leioproctus douglasiellus*	#	CS1	R	R	R	?R	?R	-	R
		Native bee *Neopasiphae simplicior*	#	CS1	R	R	R	?R	?R	-	R
		Native bee *Leioproctus contraries*	#	CS2	R	R	R	?R	?R	-	R

Table 52 Feral Animal Inventory

Family		Species	Status in Melville	Connelly Park	Hatfield Park	Len Shearer and Harry Stickland parks	Reg Seal Reserve	Al Richardson Reserve	Carawatha Bushland
Mammals	**Muridae** (rats and mice)	House Mouse *Mus musculus*	R	R	R	?R	?R	R	R
		Brown Rat *Rattus norvegicus*	R	R	R	?R	?R	R	R
		Black Rat *Rattus rattus*	R	R	R	?R	2016 R	R	R
	Leporidae (rabbits and hares)	Rabbit *Oryctolagus cuniculus*	R	-	-	?Vis	**-**	**-**	-
	Canidae (foxes and dogs)	European Red Fox *Vulpes vulpes*	R	R	R	?R	?R	R	R
	Felidae (cats)	Feral Cat *Felis catus*	R	R	R	**2016 R**	?R	R	R
Birds	**Columbidae** (pigeons and doves)	Rock Dove *Columba livia*	R	Vis	Vis	?Vis	?Vis	Vis	Vis
		Spotted Dove *Streptopelia chinensis*	R	2016 R	2016 R	?R	?R	R	R
		Laughing Dove *Streptopelia senegalensis*	R	2016 R	2016 R	**2016 R**	?R	R	2016 R
	Cacatuidae (cockatoos)	Eastern Long-billed Corella *Cacatua tenuirostris*	Vis	-	-	?Vis	-	Vis	-
	Psittacidae (lorikeets and parrots)	Rainbow Lorikeet *Trichoglossus moluccanus*	R	2016 R	2016 R	**2016 R**	2016 R	2016 R	2016 R
	Halcyonidae (forest kingfishers)	Laughing Kookaburra *Dacelo novaeguineae*	R	Vis	Vis	?R	?Vis	Vis	2016 R

Invertebrates	**Colletidae** (bees)	Honey Bee *Apis mellifera*	R	Vis	Vis	2016 R	?Vis	Vis	Vis

Appendix 3 Native Plant Distributions

Target Species

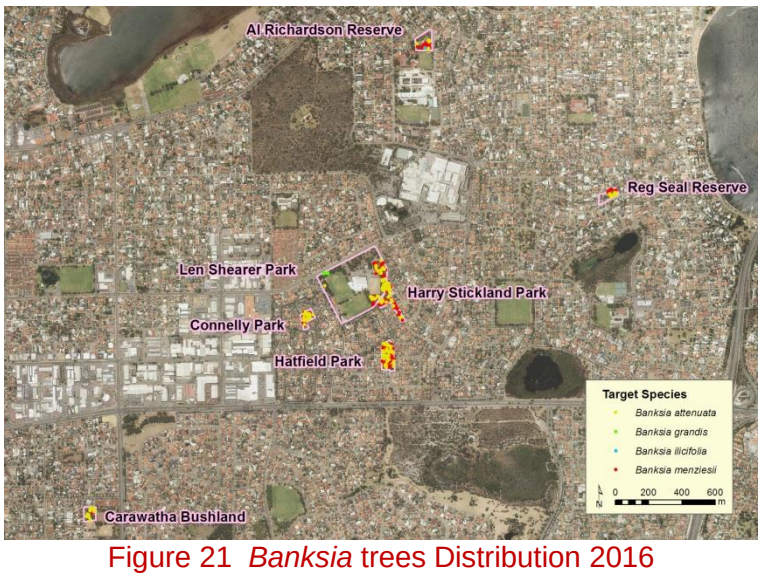

Figure 21 *Banksia* trees Distribution 2016

Figure 22 *Jacksonia sericea* Distribution 2016

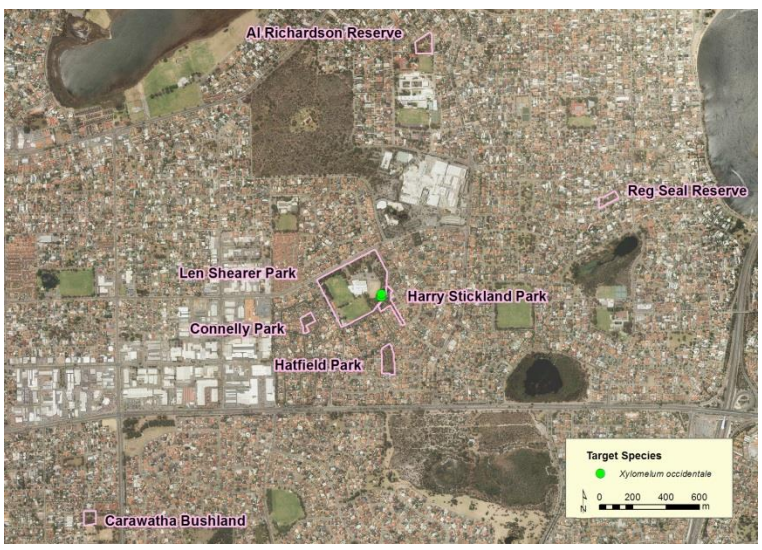

Figure 23 *Xylomelum occidentale* Distribution 2016

Other Species

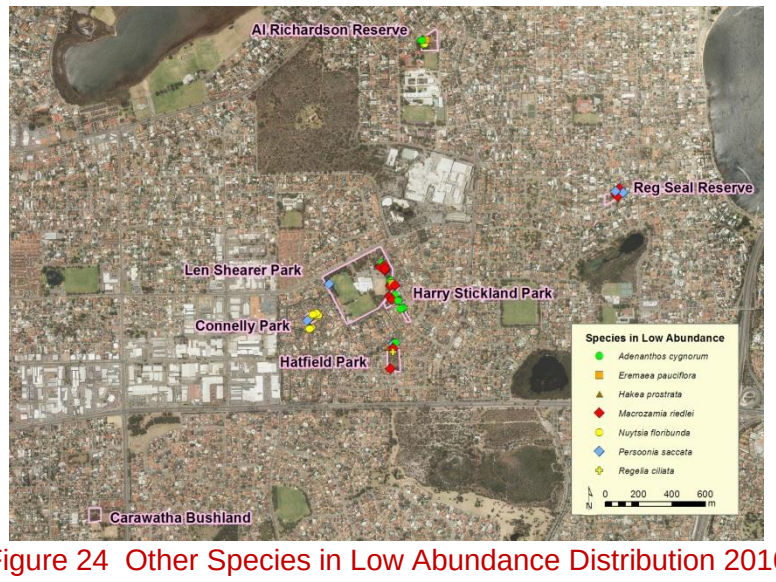

Figure 24 Other Species in Low Abundance Distribution 2016

Appendix 4 Weed Distributions

Figure 25 Very High Impact Weeds (excluding grasses)

Figure 26 High Impact Weeds (shrubs and trees)

Figure 27 High Impact Weeds (geophytes)

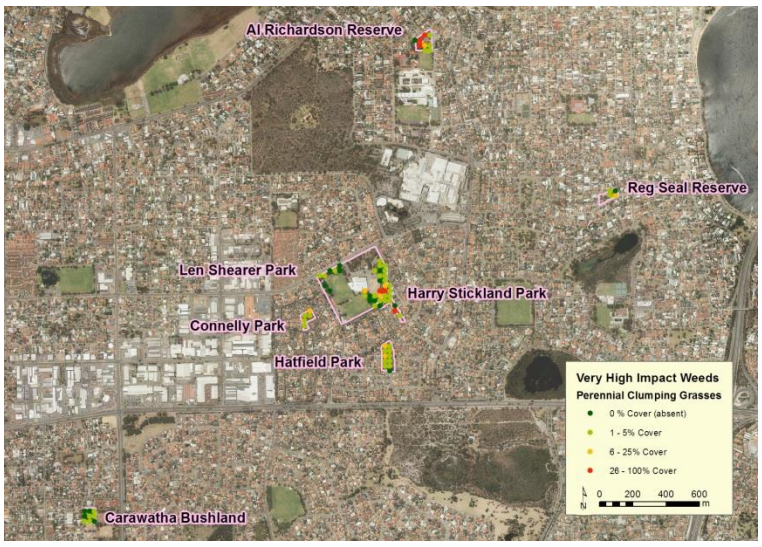

Figure 28 Very High Impact Perennial Clumping Grasses

Figure 29 High Impact Annual Clumping Grasses

Figure 30 High Impact Perennial Running Grasses

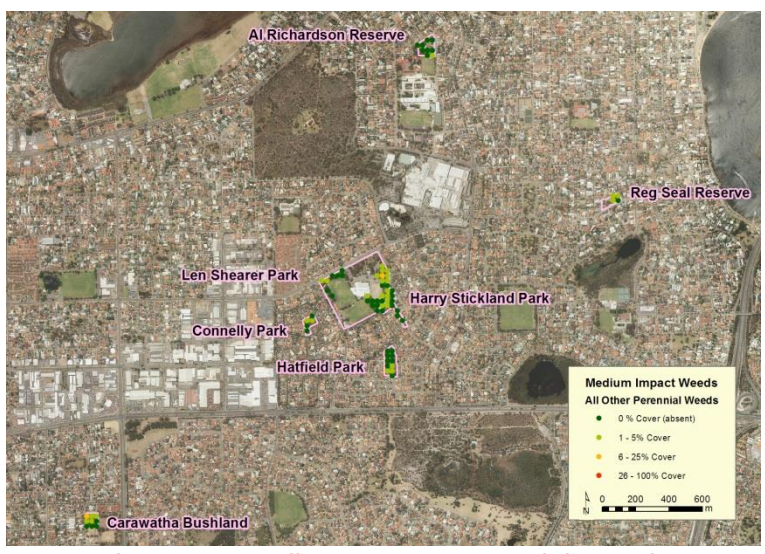

Figure 31 Medium Impact Perennial Weeds

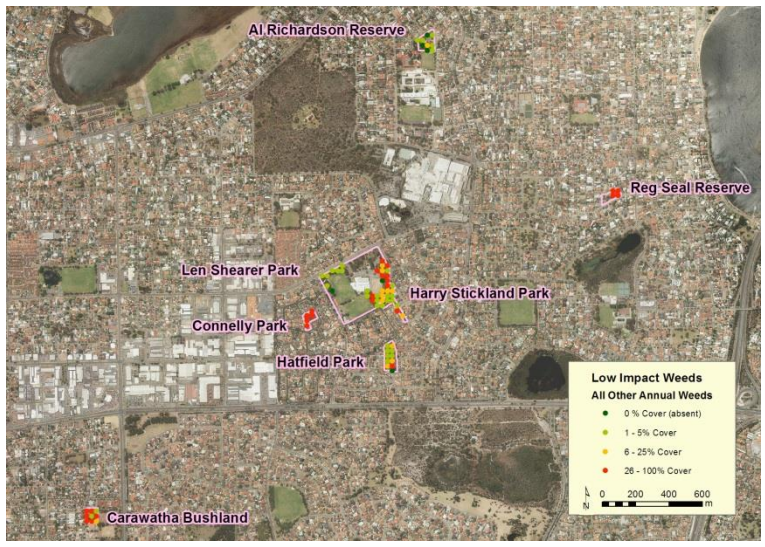

Figure 32 Low Impact Annual Weeds