APPENDIX 15
ATTACHMENT 1

City of Joondalup

Mullaloo Foreshore Reserve Management Plan

V1 – 09 November 2017

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Contents

Acknowledgements

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- City of Joondalup staff
- Mullaloo Beach Community Group Inc.

Abbreviations and Acronyms

Abbreviation	Description
AHD	Australian Height Datum
BAM Act	*Biosecurity and Agriculture Management Act 2007* (WA)
BoM	Bureau of Meteorology
the City	City of Joondalup
CoJ	City of Joondalup
Cwlth	Commonwealth
DAFWA	Department of Agriculture and Food WA
DBCA	Department of Biodiversity, Conservation and Attractions (previously Department of Parks and Wildlife)
DEC	Department of Environment and Conservation (now Department of Parks and Wildlife)
DER	Department of Environment Regulation (WA)
DEE	Department of the Environment and Energy (Cwlth)
DPaW	Department of Parks and Wildlife (WA)
DPIRD	Department of Primary Industries and Regional Development (previously Department of Agriculture and Food WA
DRF	Declared rare flora
DWER	Department of Water and Environmental Regulation (previously Department of Environment Regulation)
EDOWA	Environmental Defenders Office of WA (Inc)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)
GIS	Geographical information system
GPS	Global positioning system
ha	Hectare
IUCN	International Union for Conservation of Nature
km	Kilometre
km/h	Kilometres per hour
m	Metre
m^2	Square metres
MBCG	Mullaloo Beach Community Group Inc.
Natural Area	Natural Area Consulting Management Services
NIASA	Nursery Industry Accreditation Scheme Australia
PMST	Protected Matters Search Tool

Abbreviation	Description
NR Info	NR Info portal
WA	Western Australia
WALGA	Western Australian Local Government Association
WAH	Western Australian Herbarium
WONS	Weeds of National Significance

Executive Summary

Natural Area Consulting Management Services (Natural Area) was contracted by the City of Joondalup to prepare a Management Plan for the Mullaloo Foreshore Reserve. This Plan identifies management strategies that will assist the City with ongoing management of the site over the next five years, with a focus on maintaining both the environmental and recreational values of the area. This Management Plan is consistent with the overarching *Coastal Foreshore Natural Areas Management Plan* whilst providing site-specific recommendations for management of the Mullaloo Foreshore Reserve.

The site is located approximately 23 km north of the Perth Central Business District in the suburb of Mullaloo. The site extends for 1.5 km from Merrifield Place in the south to the footpath just north of the West View carpark on the boundary of Ocean Reef Foreshore Reserve in the north. It is bounded by Oceanside Promenade to the east and the Indian Ocean to the west. The Reserve is recognised for its regional environmental significance by the City and by its inclusion as a portion of Bush Forever Site 325.

The Mullaloo Coastal Foreshore Reserve is characterised by wide sandy beaches with low vegetated dunes that vary in width between 100 – 150 m. Infrastructure includes car parks, shaded and non-shaded seating and picnicking areas, barbeques, playgrounds, grassed and non-grassed recreational areas, the Mullaloo surf lifesaving club, a kiosk, and access ways to the beach.

The majority of the native vegetation at Mullaloo Foreshore Reserve is in Very Good condition (Natural Area Consulting Management Services, 2017) and is part of the regional ecological linkage chain that extends along the coast from Burns Beach in the north to North Beach in the south. A total of 80 flora species comprising one conifer, one moss, 19 monocotyledons and 59 dicotyledons were recorded during the 2016 spring flora survey; none were declared rare or priority listed species under the *Wildlife Conservation Act 1950* (WA) and/or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). A range of mammal (4), bird (23), reptile (9) and invertebrate (28) species were observed within the reserve during the fauna surveys undertaken by Natural Area in spring 2016 and autumn 2017, including the priority 4 listed Southern Brown Bandicoot (*Isoodon obesulus fusciventer*). The range and diversity of species recorded within the Reserve indicates a healthy ecological community.

A number of management actions are outlined within this Plan to address key environmental threats at Mullaloo Foreshore Reserve. Management actions are to be implemented over a five-year period and include the implementation of the City's Pathogen Management Plan, erosion control, weed control, revegetation, fire management, environmental education, and regular surveys for flora, fauna and fungi. Management actions will be implemented by the City of Joondalup in partnership with key stakeholders and community groups, where relevant.

1.0 Introduction

1.1 Background

The City of Joondalup (the City) is situated on the Swan Coastal Plain, approximately 30 km north of the Perth Central Business District. The City covers an area of 96.5 kilometres that encompasses a diverse range of natural areas including 17 kilometres of coastal foreshore, a chain of wetlands and a variety of bushland ecosystems (Figure 1). The City's southern boundary is approximately 16 kilometres from the Perth Central Business District, and is bounded by the City of Wanneroo to the east and north, the City of Stirling to the south, and the Indian Ocean to the west.

There are a number of regionally, nationally and internationally significant natural areas located within the City including Yellagonga Regional Park and a number of Bush Forever sites that contain species of high conservation value. Significant natural areas adjacent to the City include Marmion Marine Park and Neerabup National Park.

The City of Joondalup is committed to conserving and enhancing the City's natural assets to ensure the long-term protection of the environment for future generations.

1.2 Natural Area Management Plans

The City is developing Natural Areas Management Plans and associated Action Plans to provide strategic and operational management of the City's natural areas to protect native vegetation and ecosystems. Natural Areas Management Plans describe the potential environmental impacts and risks of activities and environmental threats in natural areas, and the associated management strategies that are implemented to minimise potential impacts.

Environmental threats have the potential to degrade natural areas and reduce biodiversity values. Environmental threats addressed in this Plan include weeds, plant disease, fire, non-native fauna species, human impacts, access and infrastructure.

1.3 Study Area

The study area for the Mullaloo Foreshore Reserve Management Plan is the Mullaloo Foreshore Reserve in the suburb of Mullaloo (Figure 2). The reserve is located approximately 23 km north-west of the Perth Central Business District, and covers an area of approximately 14.8 ha which includes native vegetation, carparks, tracks and part of the sandy beach. The site extends south from Ocean Reef Foreshore Reserve to Merrifield Place in the south, and is bounded by Oceanside Promenade and Merrifield Place to the east, and the Indian Ocean to the west. An additional portion south of the surf club adjacent to Merrifield Place was added to this Plan and surveyed during the autumn 2017 site assessments undertaken by Natural Area. This portion was not previously included in the 2016 flora, fauna and fungi survey.

1.3.1 Tenure

The Mullaloo Foreshore Reserve is Crown Land with management orders assigned to the City of Joondalup; it is reserved for Parks and Recreation under the Metropolitan Region Scheme (MRS)[1]. The site is zoned Parks and Recreation under the City of Joondalup District Planning Scheme No. 2[2].

1.3.2 Land Use

The main use of the Mullaloo Foreshore Reserve is for passive recreational purposes, including walking, dog exercise, photography, nature watching, and passing through the site to access the beach area and for swimming.

[1] Department of Planning, Lands and Heritage, (2017)
[2] City of Joondalup, (2016)

Figure 1: Location of Mullaloo Foreshore Reserve within the City of Joondalup

Client: City of Joondalup
Project: Mullaloo Foreshore Management Plan
Map Prepared by: S. Hynes
Date: 23/05/2017
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

Figure 2
Site Location
Mullaloo Foreshore, Mullaloo

0 N 100
Meters

1.4 Purpose

The purpose of the Mullaloo Foreshore Reserve Management Plan is to:

- provide information to assist the City of Joondalup in prioritising maintenance schedules
- guide the future development of the City's Conservation Capital Works Program
- increase opportunities for grant funding by having a detailed schedule of projects
- provide guidance to City employees, contractors and Friends Groups operating within the Mullaloo Foreshore Reserve.

1.5 Aims and Objectives

The aim of the Mullaloo Foreshore Reserve Management Plan is to provide a framework to protect and enhance biodiversity values whilst maintaining appropriate community access and awareness of the natural area.

The objectives of the Mullaloo Foreshore Reserve Management Plan are to:

- establish a baseline description of the environment to guide future environmental planning and recommended management actions
- outline key environmental threats and the impact they have on conservation and recreational values
- outline management actions to address key threats, including monitoring and reporting.

1.6 Strategic Context

In order to ensure the Mullaloo Foreshore Management Plan complements other management initiatives within the City, along with relevant legislation, policies, guidelines and documents were reviewed and are summarised in this Section.

1.6.1 Local Government

Strategic Community Plan

The City of Joondalup's *Strategic Community Plan 2012 – 2022* is the long-term strategic planning document, which outlines the commitment of the City to achieve its commitment to achieving the visions and aspirations of its community and stakeholders.

Environmental Plan

The City of Joondalup's *Environmental Plan 2014 – 2019* was developed to guide the City's strategic response to local environmental pressures.

Biodiversity Action Plan

The City of Joondalup *Biodiversity Action Plan 2009 – 2019* was prepared to provide direction for biodiversity management activities within the City, with retention and enhancement of biodiversity a key priority. Development of individual Natural Area Management Plans was included as a management action.

Figure 3: City of Joondalup Strategic Environmental Framework

***Local Biodiversity Program* (formerly *Perth Biodiversity Project*)**

The City of Joondalup was one of 32 local governments participating in the Western Australian Local Government Association's (WALGA's) Perth Biodiversity Project, which documented the local biodiversity within its boundaries. The aim of the program was to support local governments to effectively integrate biodiversity conservation into land use planning to protect and manage local natural areas.

As part of the Program, the City of Joondalup assessed all natural areas in 2004 and at later times using the ecological criteria of the Natural Area Initial Assessment, resulting in a priority ranking of natural areas. The Natural Area Initial Assessments include a desktop assessment and field survey and document information such as:

- vegetation complexes
- threatened or significant flora or ecological communities
- structural plant communities
- weed species
- vegetation condition assessment
- ecological criteria ranking
- a viability estimate
- fauna species observed.

While funding for the program ceased in 2014, the assessment template continues to provide a useful assessment tool.

Pest Plant Local Law 2012

The purpose of the *Pest Plant Local Law 2012* is to prescribe pest plants within the City of Joondalup that are likely to adversely affect the value of the property in the district or the health, comfort or convenience of the inhabitants of the district.

Pest plants are generally highly adaptable and will establish quickly after a disturbance event such as fire, or through unrestricted access. If pest plants are allowed to establish they have the potential to out-compete

the City's unique floral biodiversity. The *Pest Plant Local Law 2012* requires the owner or occupier of private land within the City of Joondalup district to destroy, eradicate or otherwise control scheduled pest plants on notice by the City. Currently one weed species is scheduled under the Local Law – Caltrop (*Tribulus terrestris*). Caltrop was not identified in the Mullaloo Foreshore Reserve.

1.6.2 State Government

Relevant Legislation, Policies and Documents

Aboriginal Heritage Act 1972

The Act makes provision for the preservation on behalf of the community of places and objects customarily used by or traditional to the original inhabitants of Australia or their descendants. The Mullaloo Foreshore Reserve is not listed on any State or Federal Aboriginal heritage inventory or register. However, there is an Aboriginal heritage site north of the Reserve boundary; this is Site 3673 Mullaloo Desert North.

Biosecurity and Agriculture Management Act 2007

The Act provides for the control of declared flora and fauna species (declared organisms) that are known to be a significant environmental threat and makes provision for the management, control and prevention of these declared plants and animals. The *One-leaf Cape Tulip (*Moraea flaccida*) was recorded within the Foreshore Reserve, which is listed as a category C3 declared pest under the *BAM Act 2007* (WA), which requires the species to be managed by the land owner to reduce the impact and spread.

Bushfires Act 1954

The Act makes provision for diminishing the dangers resulting from bush fires and for the prevention, control and extinguishment of bush fires.

Cat Act 2011

The Act makes provision for the control and management of cats, and promotes and encourages the responsible ownership of cats. Cats may be seized where they are found wandering in public areas, such as Mullaloo Foreshore Reserve, in accordance with the *Cat Act 2011* (WA).

Dog Act 1976

The Act makes provisions for the control of dogs in public and private spaces and promotes the responsible ownership of dogs. The Act requires dog owners to register their dogs and encompasses the ownership and keeping of dogs and the obligations and rights of dog owners. Local governments are responsible for administering, monitor compliance and enforcing the Act within their respective districts.

Tom Simpson Park within the Mullaloo Foreshore Reserve is designated as a place where dogs are not permitted and dogs must be on a lead at all times on the coastal dual path by Council resolution in accordance with the *Dog Act 1976* (WA).

Environmental Protection Act 1986

The Act provides authority to the Environmental Protection Authority (EPA) for the prevention, control and abatement of pollution and environmental harm, for the conservation, preservation, protection, enhancement and management of the environment in Western Australia.

Heritage of Western Australia Act 1990

The Act provides for and encourages the conservation of places that have significance to the cultural heritage in the State. The Mullaloo Foreshore Reserve is not listed on any State or Federal cultural heritage inventory or register.

State Planning Policy 2.6 – State Coastal Planning Policy 2013

The purpose of the policy is to provide guidance for decision making in the coastal zone throughout Western Australia, with objectives including:

- considering coastal processes during development
- identifying appropriate and sustainable land use
- providing for public use and access of coastal areas
- the development of coastal reserves to protect, conserve and enhance coastal biodiversity, ecosystem functioning, and indigenous and non-indigenous cultural significance.

State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Region

This policy aims to provide direction and an implementation framework that will ensure bushland protection and management issues in the Perth Metropolitan Region are appropriately addressed, and integrated with broader land use planning and decision-making.

State Planning Policy 3.7 – Planning in Bushfire Prone Areas

This policy aims to implement effective risk-based land use planning and development to protect life and reduce the impact of bushfire on property and infrastructure, by identifying bushfire prone areas to be addressed in regards to bushfire risk management within strategic planning documents, strategic planning proposals, and subdivision and development applications.

Government of Western Australia 'Bush Forever' Strategy 2000

The Strategy identifies regionally significant bushland in the Perth Metropolitan Region to be retained, managed and protected forever. The Mullaloo Foreshore Reserve forms part of Bush Forever Site 325, which extends from Burns Beach south to Hillarys.

DPaW Weed Prioritisation Process 2013

The Department of Parks and Wildlife, now the Department of Biodiversity, Conservation and Attractions, prepared the weed prioritisation process to assist with the on-ground management of weeds in a particular location, considering their ecological impact, rate of dispersal and population trend.

Wildlife Conservation Act 1950

The Act provides the statute relating to conservation and legal protection of flora and fauna. Four fauna species listed under the *Wildlife Conservation Act 1950* are considered to either use or possibly use Mullaloo Foreshore Reserve, these being:

- Australian Sealion (*Neophoca cinerea*) (mammal) – **Specially Protected Fauna**
- Black-striped Snake (*Neelaps calonotos*) (snake) – **Priority 3**
- Quenda (*Isoodon obesulus fusciventer*) (mammal) – **Priority 5**
- Graceful Sun Moth (*Synemon gratiosa*) (insect) – **Priority 4.**

Quenda tracks were observed during the November – December 2016 fauna survey undertaken by Natural Area[3].

1.6.3 Federal Government

Environment Protection and Biodiversity Conservation Act 1999

The Act provides for the protection of the environment and the conservation of biodiversity, and for related purposes. Nine *Environment Protection and Biodiversity Conservation* (*EPBC*) *Act 1999* listed species have been recorded as occurring or potentially occurring within Mullaloo Foreshore Reserve[1], these being:

- Australian Fairy Tern (*Sternula nereis nereis*) – **Vulnerable**
- Australian Lesser Noddy (*Anous tenuirostris melanops*) - **Vulnerable**
- Australian Painted Snipe (*Rostratula australis*) – **Endangered**
- Australian Sealion (*Neophoca cinerea*) – **Vulnerable**
- Bar-tailed Godwit (*Limosa lapponica baueri*) - **Vulnerable**
- Bar-tailed Godwit (*Limosa lapponica menzbieri*) - **Vulnerable**
- Carnaby's Cockatoo (*Calyptorhynchus latirostris*) – **Endangered**
- Chuditch (*Dasyurus geoffroii*) – **Vulnerable**
- Forest red-tailed Black Cockatoos (*Calyptorhynchus banksii naso*) - **Vulnerable.**

While none of the above were observed by Natural Area[1] during the November to December 2016 fauna surveys, the Carnaby's Cockatoo has been previously observed on site by the Mullaloo Beach Community Group (MBCG).

Australia's Biodiversity Conservation Strategy 2010-2030

The Strategy aims to protect biological diversity and maintain ecological processes and systems.

National Weeds Strategy 1997

The *National Weeds Strategy 1997* provides a strategic framework for managing weeds at a national level. As part of the implementation of the National Weeds Strategy, 32 Weeds of National Significance are identified as nationally agreed priority plant species for control and management based on the criteria of invasiveness and impact characteristics, potential and current area of spread and economic, environmental and social impacts. The Mullaloo Foreshore Reserve contains no known Weeds of National Significance.

Threatened Species Strategy 2015

The *Threatened Species Strategy 2015* outlines the Federal Government's approach to threatened flora and fauna species recovery through reversing population declines.

1.6.4 International Conventions or Listings

International Union for Conservation of Nature (ICUN) Red List of Threatened Species

The ICUN Red List of Threatened Species™ provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the ICUN Red List Categories and Criteria. The Carnaby's Cockatoo (*Calyptorhynchus latirostris*) is an ICUN Red List species that has been recorded within the Mullaloo area by the MBCG members.

[3] Natural Area Consulting Management Services, (2017)

2.0 Description of Physical Environment

2.1 Geology, Soils and Landforms

2.1.1 Soils of the Swan Coastal Plain

The Mullaloo Foreshore Reserve is situated within the City of Joondalup, which is located within the Swan Coastal Plain. The Swan Coastal Plain comprises two major divisions, namely Swan Coastal Plain 1 Dandaragan Plateau, and Swan Coastal Plain 2 – Perth Coastal Plain. The Mullaloo Foreshore Reserve is located within the Perth subregion, which is broadly characterised as including areas of Jarrah and Banksia woodlands on sandy soils in a series of sand dunes, along with wetland areas, often within the interdunal swales[4]. The majority of the soils of the Swan Coastal Plain were formed by material deposited by rivers and wind. A series of dune systems has been formed with the youngest dunes being the Quindalup Dunes nearest the coast, followed by the Spearwood Dunes and the oldest Bassendean Dunes are the farthest inland[5] (Figure 5).

The Mullaloo Foreshore Reserve is located on the youngest formation, the Quindalup Dune System, which are still being actively formed. The NR Info portal indicates one soil type occurs within the site boundary, namely the Quindalup Dunes soil with one soil phase[6]. This is the Quindalup South unstable sand Phase which is described as presently unstable calcareous sand.

The Reserve is a wide sandy beach associated with a wider vegetated zone that ranges from 100 to 150 m wide, and ranges in height from 1 – 10 m Australian Height Datum (AHD), with the highest points occurring on the large secondary dunes, west of the vegetated zone[7] (Figure 4).

Figure 4: Topography at Mullaloo Foreshore Reserve - wide beach and low vegetated dunes

[4] Mitchell, Williams and Desmond, (2002)
[5] Government of Western Australia (2000)
[6] Department of Agriculture and Food (WA) (2017b)
[7] Ibid.

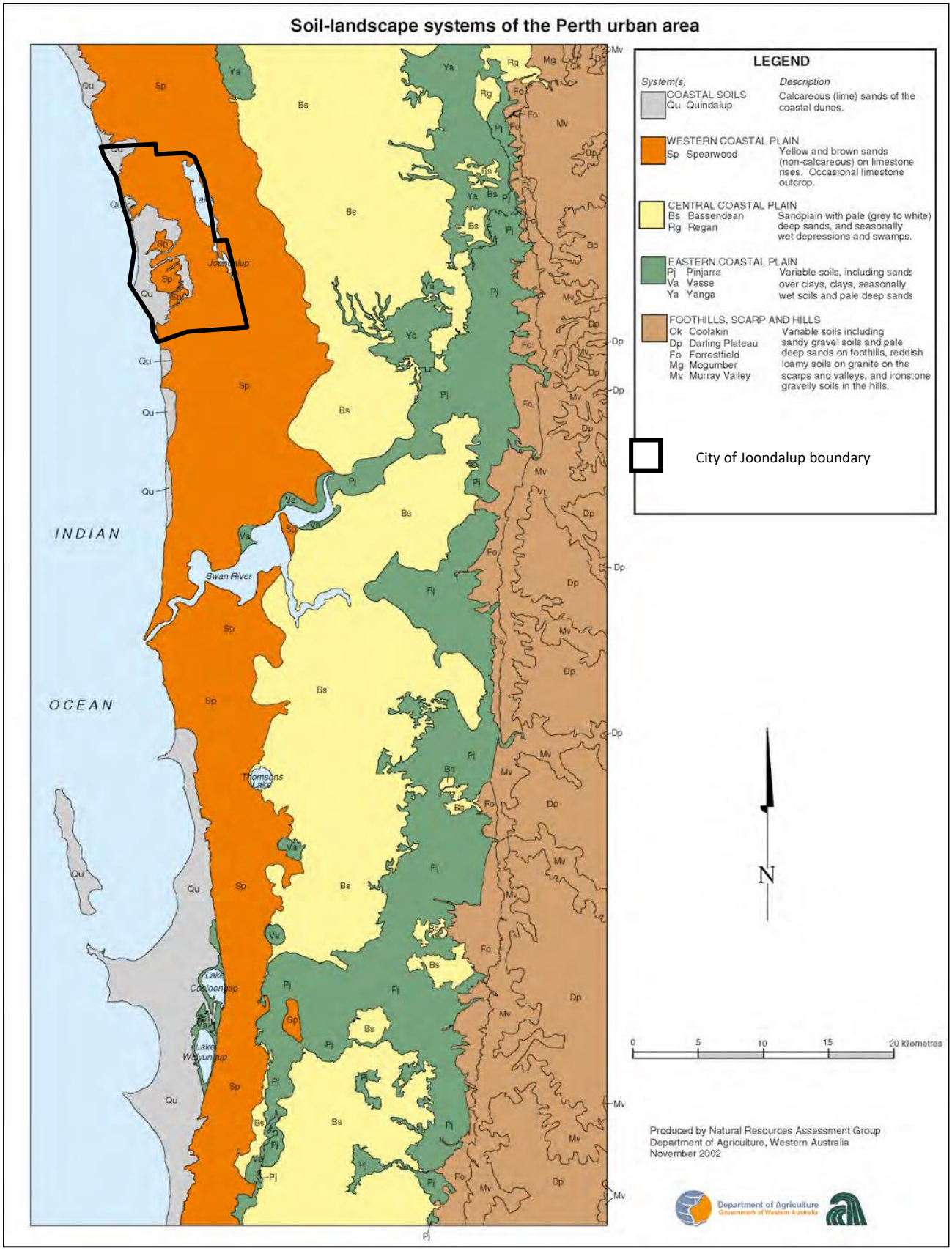


Figure 5: Soils of the Swan Coastal Plain (Department of Agriculture, 2002)

2.1.2 Acid Sulphate Soils

Acid sulphate soils are naturally occurring soils that contain iron sulphides, primarily in the form of pyrite materials, formed under water logged conditions in fresh and saline wetlands around Western Australia. If left and not exposed to the air, acid sulphate soils do not pose a significant risk to humans or the environment. Exposure to air causes the formation of sulphuric acid, which can lead to the heavy metals being released into the surrounding environment[8].

Acid sulphate soils are categorised as potential acid sulphate soils or actual acid sulphate soils. Potential acid sulphate soils have not been oxidised by exposure to air whilst actual acid sulphate soils have been disturbed or exposed to oxygen and become acidic.[9] The risk of acid sulphate soils is based on their likelihood of occurring within soil profiles and has been mapped by the then Department of Environment Conservation (DEC), now the Department of Water and Environmental Regulation (DWER), using available desktop information and limited ground-truthing within areas where intensive on-ground mapping and soil analysis work has been undertaken. Review of this mapping indicated that no potential acid sulphate soils are known or likely in the Mullaloo Foreshore Reserve on the basis of origin of the geological units present, depth to groundwater and partial 'ground truthing' or onsite investigation.

2.1.3 Erosion

The major function of vegetation within coastal dune systems is stabilising sand within dunes, with erosion occurring where vegetative cover is absent or reduced. Erosion is a naturally occurring process on the coast, particularly during winter months when rainfall and wind speed increase. Human factors can increase the rate and extent of erosion via activities such as people and pets walking on the dunes instead of keeping to nominated pathways, or the installation of infrastructure in dune areas. Over time, projected climate change impacts are expected to include[10]:

- stronger winds during storm events
- increased storm surge potential
- lower rainfall, potentially leading to water stress on plants and impacts to flora and fauna habitat
- sea level rise and associated coastal inundation.

Accordingly, erosion is likely to be an ongoing issue that will impact on rehabilitation and ongoing maintenance requirements. Climate change risks with the City of Joondalup are outlined in the *Climate Change Strategy 2014 – 2019*[11], as are proposed mitigation and adaptation strategies.

The Mullaloo Foreshore Reserve was observed to be in good condition during the 2016 and 2017 site assessments. The only erosion recorded occurring along the foredunes in the area south of the surf club (Figure 6), where a reduction in vegetation cover was noted and fences were being destabilised and buried, particularly on the high foredunes in the south west. This was exacerbated where informal pedestrian tracks lead down to the beach through the dunes. Erosion causing the western fence line to be buried is associated with the natural accretion of sand on Mullaloo Beach, with a loader and grader likely to be required to remove excess sand in front of the fence line on a regular basis. However, the machinery and equipment can

[8] Department of Environment Regulation (2016)
[9] Department of Environment and Conservation, n.d.
[10] City of Joondalup (2014b)
[11] City of Joondalup (2014)

sometimes get caught on the fence resulting in damage to the fence line with some of the chain link wire being detached from the posts.

Figure 6: Erosion at the end of a concrete path and on higher foredunes in the south-west of the Reserve

While the majority of the site is currently showing minimal signs of erosion, ongoing monitoring is recommended to prevent or mitigate any threatening processes that could result in future erosion. Considerations for management of erosion will include:

- areas affected
- causes
- natural, conservation and human values of the affected area
- priorities for action in terms of feasibility of success in the medium to longer term
- techniques used to restore or stabilise affected areas.

The City has undertaken a coastal hazard assessment[12], with the objective to update previous assessments and provide consistent assessment across the whole city. The City's Coastal Monitoring Program was established in 2015/16 to monitor shoreline movements over time. The Program aims to:

- provide valuable information that can be used to inform planning decisions in the coastal zone
- inform maintenance and asset replacement schedules of coastal infrastructure
- provide early warning of any increased vulnerability of assets
- guide the timing and need for coastal adaptation works
- identify the requirement for updates to hazard and vulnerability assessments
- improve the City's understanding of coastal processes and monitor actual shoreline erosion compared to modelled erosion.

The Coastal Monitoring Program includes: photo monitoring at identified sites (every six months), shoreline mapping from aerial photography (annually), beach profile surveys (biennially) and analysis and report (biennially).

[12] MP Rogers & Associates P/L, 2016

Erosion from both natural and human causes can largely be managed through sand stabilisation and access control. Revegetation and rehabilitation activities are often the most effective means of stabilising sand dune areas. These can include:

- applying appropriate revegetation techniques that will allow plants to become established and stabilise the soil
- erecting sand trap fencing that allows wind-borne sand to collect and create incipient dunes over time
- applying stabilising materials such as biodegradable jute or coir matting, brushing or mulch to exposed areas to provide a stable surface that will allow seedlings to become established and grow
- use of signage to provide information about erosion and the need to keep off the dunes
- establishing barriers to deter human (and their pets) access to vegetated areas, and allowing bare areas to regenerate.

2.1.4 Recommended Management Actions

Action	Detail
Holistic consideration of erosion	Erosion issues to be considered holistically, with the most appropriate management options determined on a case by case basis and recognising that all exposed sand does not need to be covered by vegetation, reflecting what would occur within a natural environment.
Brushing	Brushing materials will be of suitable species that do not contain seed pods or other materials that can propagate and result in the presence of weeds at the site.
Early consideration of erosion	Address erosion issues as early as possible to avoid larger areas to be rehabilitated later.
Wider context	Consider erosion in the wider context of climate change impacts that could occur over time.

2.2 Hydrology

2.2.1 Groundwater

The City of Joondalup is located on Perth's largest source of groundwater, the Gnangara Groundwater System, comprising four main aquifers: superficial (shallow, unconfined), Mirrabooka (deeper, semi confined), Leederville (deep, mostly confined) and the Yarragadee (deep, mostly confined). The Gnangara Mound extends across most of the superficial aquifer and refers to the water table creating a mound shape (Figure 7). Groundwater levels in the superficial aquifer have been declining over recent years due to pressure from extraction and the impacts of climate change.

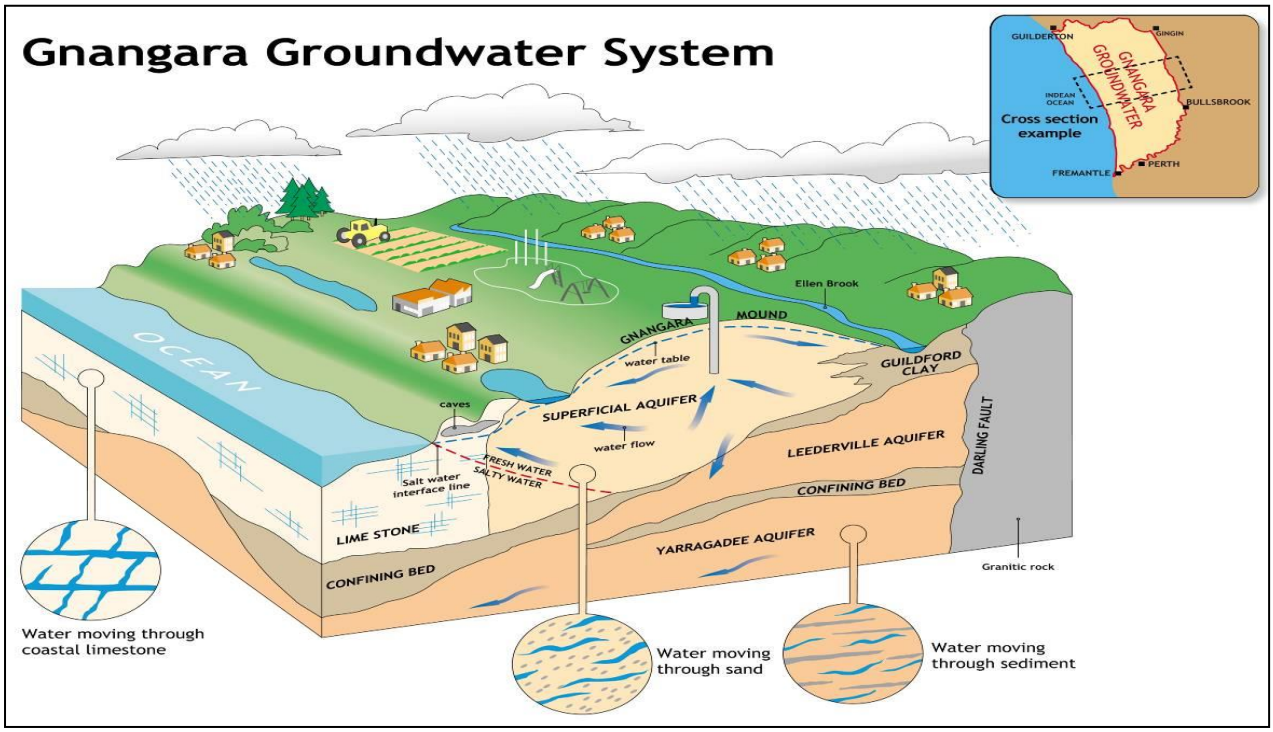


Figure 7: Gnangara Groundwater System[13]

2.2.2 Drainage

Mullaloo Foreshore Reserve has no natural or man-made water bodies present. Depth to groundwater in the site ranges from 0 m to 9 m below ground level[14], which is consistent with a site located on the coast, where groundwater enters into the ocean (Figure 8).

[13] Department of Water (n.d.)
[14] Department of Water (2017)

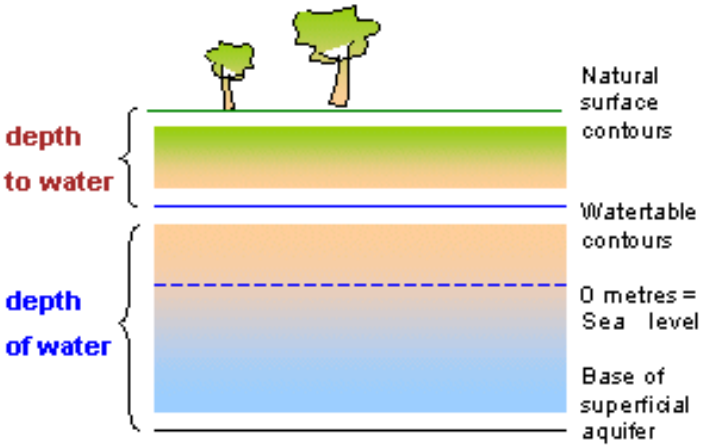


Figure 8: Groundwater Depth Explanation[15]

2.3 Climate

The City of Joondalup experiences a Mediterranean climate of hot dry summers with an average temperature of 30.9 °C during the day and mild wet winters with an average daytime temperature of 18.5 °C. The average annual rainfall from 1944 to 2017 was 766.1 mm, with approximately 80 percent of the annual rainfall occurring between the months of May and September (Figure 9)[16].

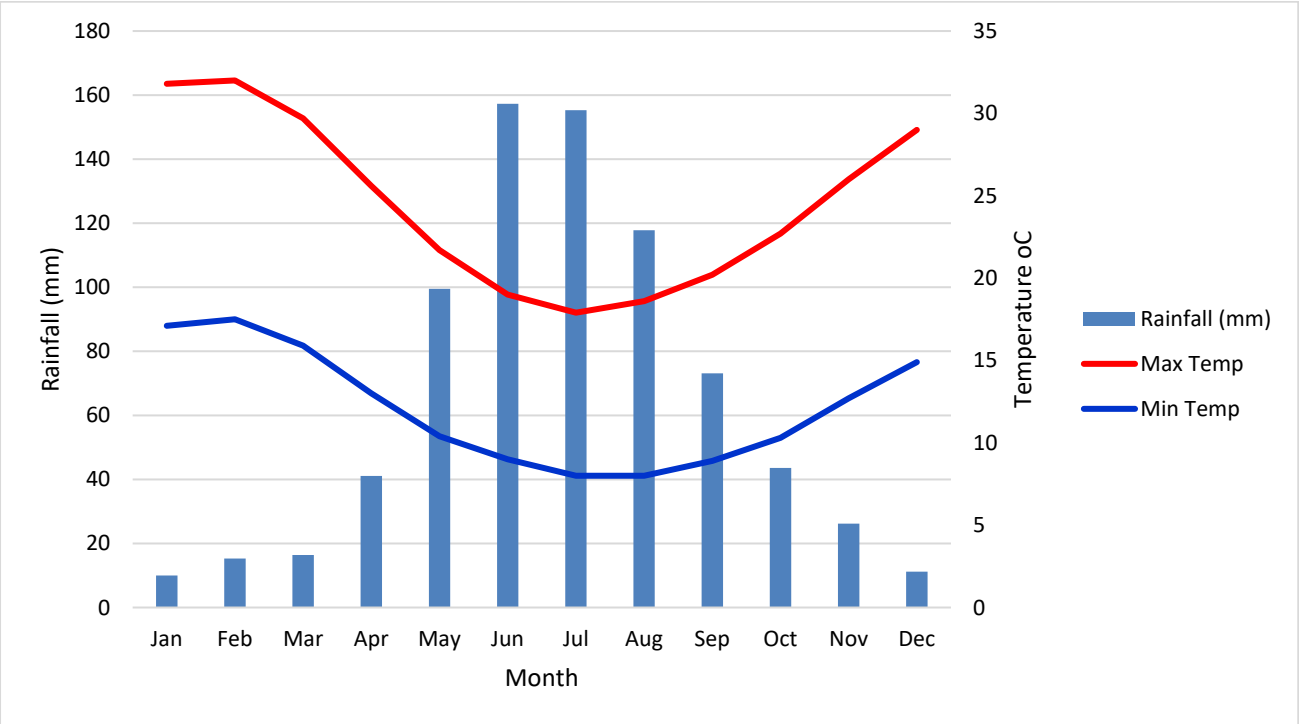


Figure 9: Climate data for Perth, Station ID 009021, (1994 – 2017)

[15] Department of Environment (2004)
[16] Bureau of Meteorology (2017)

2.3.1 Climate Change

The City of Joondalup is located in the south-west of Western Australia, and which is experiencing impacts associated with climate change such as rising temperatures, decreased rainfall and sea level rise. According to the Climate Commission, Western Australia's temperature has been increasing steadily since the 1950's, with an overall rise of approximately 0.8 ^{o}C[17].

The City has developed the draft Climate Change Strategy 2014 – 2019[18] to guide climate change activities, both in terms of mitigation and adaptation, in coming years. Strategies to be adopted include:

- reduce greenhouse gas emissions
- offset carbon emissions
- improve understanding of future climate scenarios
- identify risks and how they can be managed
- support the community to prepare and adapt to climate change.

2.4 Vegetation

Flora surveys were undertaken by Natural Area in September 2016 and additional areas in April 2017, with outcomes provided in this section.

2.4.1 Vegetation Complexes

Vegetation complexes are classified by the soil and landforms contained in medium to large areas along the Swan Coastal Plain. Regional scale mapping indicates that the Mullaloo Coastal Foreshore Reserve occurs within the 'Quindalup Complex on Quindalup Dunes' (Figure 10). The Quindalup Complex is a coastal dune complex consisting mainly of two alliances – the strand and foredune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata – Callitris preissii* and the closed scrub of *Acacia rostellifera*[19].

The pre-European extent remaining within the Swan Coastal Plain IBRA region for the Quindalup Complex is 55.38%[20]. The pre-European extent remaining within the City of Joondalup is 12.55%[21].

2.4.2 Floristic Community Types

Seven Floristic Community Types (FCTs) have either been sampled within or inferred to occur within Bush Forever Site 325 according to *Bush Forever Vol. 2*, with five likely to occur on site due to soil and landforms present[22]. These include:

- 29a Coastal shrublands on shallow sands (sampled within Bush forever Site 325)
- 29b *Acacia* shrublands on taller dunes (inferred)
- S11 Northern *Acacia rostellifera — Melaleuca acerosa* shrublands (inferred)
- S13 Northern *Olearia axillaris — Scaevola crassifolia* shrublands (inferred)

[17] Climate Commission, (2011)
[18] City of Joondalup, (2014b)
[19] Heddle *et al*. (1980)
[20] WALGA (2013)
[21] WALGA (2010)
[22] Government of Western Australia (2000)

- S14 *Spinifex longifolius* grasslands and low shrublands (inferred).

According to Natural Area (2017), one FCT had a 22% similarity to the Mullaloo quadrats recorded on site during 2016 site assessments, which was FCT 19 – Sedgelands in Holocene dune swales. This community is listed as threatened under the *Wildlife Conservation Act 1950* (WA) and as endangered under the *Environmental Protection and Biodiversity Conservation Act 1999* (Cwlth)[23]. The low similarity is not considered to be significant and a closer look at the common species found by Gibson *et al*. (1994) in this community type showed the only flora species consistent with the Mullaloo data were the weed species. Therefore, this community type is unlikely to be present.

[23] Natural Area Consulting Management Services (2017)

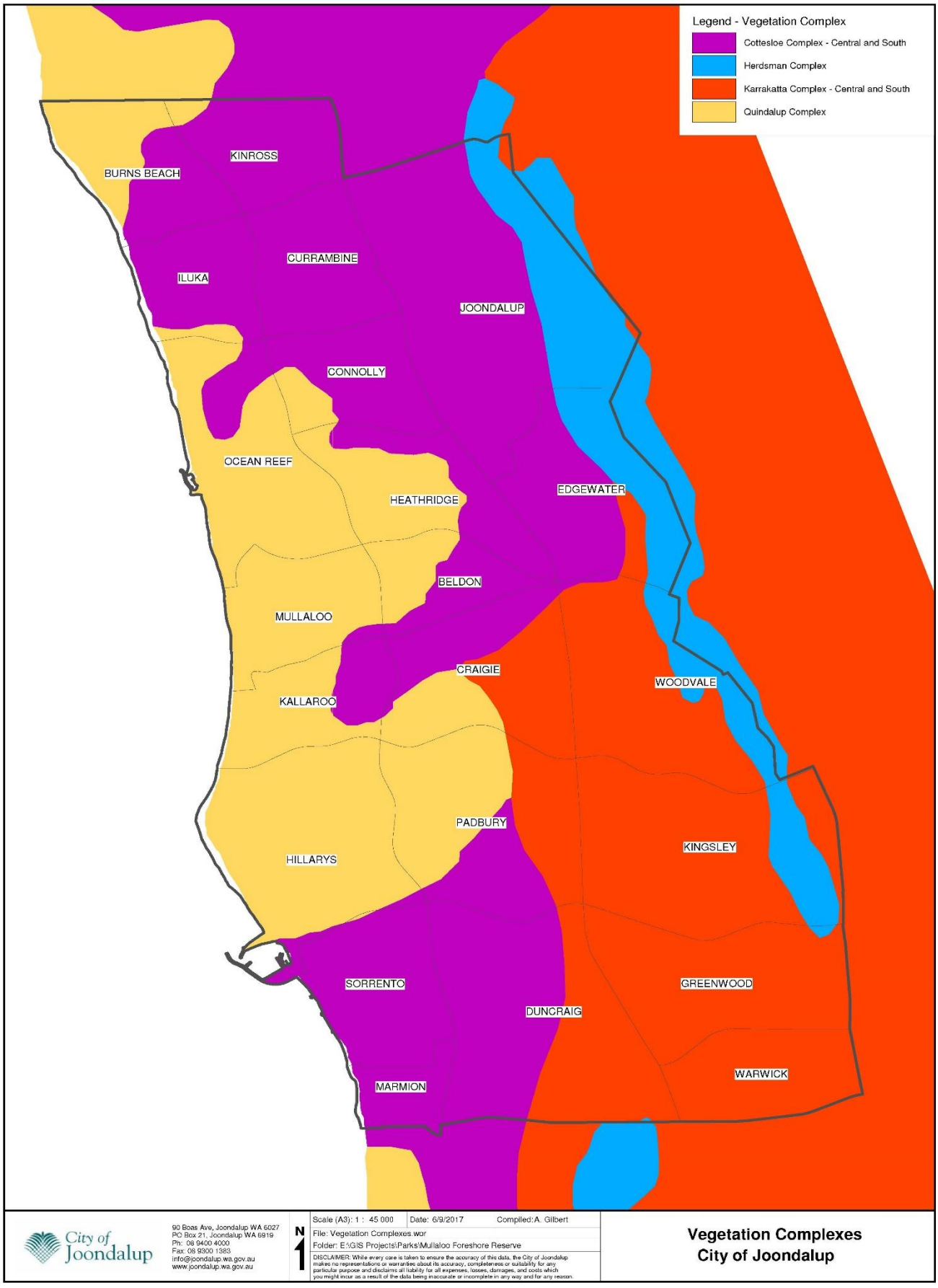


Figure 10: City of Joondalup Vegetation Complexes

2.4.3 Vegetation Communities

Three vegetation types were recorded during the 2016 spring flora survey undertaken by Natural Area, these have been described in Table 1 and illustrated in Figure 11. The dominant vegetation type on site is *Olearia axillaris* and *Scaevola crassifolia* Shrubland. No Threatened or Priority Ecological Communities were identified within the site. The structural classes used to describe vegetation type are provided in Appendix 1. The portion of the reserve south of the surf club adjacent Merrifield Place was surveyed during the 2017 site assessments and an additional vegetation type *Acacia cyclops* Shrubland was recorded (Table 1; Figure 11).

Table 1: Vegetation types within the Mullaloo Foreshore

Vegetation Type	Description	Photo
Acacia rostellifera Shrubland	*Acacia rostellifera* Shrubland over mixed shrubland*; Scaevola crassifolia, Rhagodia baccata and Spyridium globulosum* and a weedy grass understory; **Bromus diandrus*. This vegetation type occurs on the tertiary dunes at the eastern edge of the site.	
Acacia cyclops Tall Shrubland	*Acacia cyclops* Tall Shrubland over mixed shrubland of *Olearia axillaris*, *Rhagodia baccata* and *Scaevola crassifolia*, and an understory of *Lepidosperma gladiatum* and mixed herbs and grasses. This vegetation type occurs in the tertiary dunes south of the surf club, adjacent Merrifield Place.	
Spinifex hirsutus and **Thinopyrum distichum* Open Grassland	*Spinifex hirsutus* and **Thinopyrum distichum* Open Grassland with sparse patches of *Olearia axillaris.* This vegetation type occurs along the foredunes on the western edge of the site.	

Vegetation Type	Description	Photo
Olearia axillaris and *Scaevola crassifolia* Open Shrubland	*Olearia axillaris* and *Scaevola crassifolia* Open Shrubland over a grassy herb under storey; **Lagurus ovatus, Ficinia nodosa* and weedy herb; **Trachyandra divaricata*. This vegetation type occurs on the secondary dunes in between the other two vegetation types along the entire length of the site.	

*Denotes introduced species

Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 02/06/2017
Image Source: City of Joondalup, 2014
Datum: GDA94
Projection: MGA Zone 50

Figure 11:
Vegetation types
Mullaloo Foreshore, Mullaloo

0 N 100
Meters

2.4.4 Vegetation Condition

Vegetation condition assessments were undertaken by Natural Area in 2012, with improvements in vegetation condition noted during the on-ground site assessments in 2016, and additional areas south of the surf club in 2017. Vegetation condition assessments include observations regarding the numbers of native species, weed cover, species diversity, amount of understorey, health condition of populations and physical disturbance.

Vegetation condition ranged from Completely Degraded to Very Good within the Mullaloo Foreshore Reserve, with the majority of the site classified as Very Good; none was considered to be in Excellent or Pristine condition (Table 2; Figures 13, 14 and 15). The areas with reduced vegetation condition were primarily found in the foredunes and primary dunes closest to the beach. These areas had less vegetation cover and more weed species, with pockets of degraded areas where weed species were the dominant vegetation present (Figure 13). Patches of Degraded and Completely Degraded vegetation were recorded in previously cleared areas around the periphery of the vegetated dunes, in the foredunes and higher secondary dune and in the sump/drainage area (Figure 12). The secondary and tertiary dunes were mostly in Very Good condition with higher levels of vegetation cover and species diversity. Revegetation noted across the dunes in 2016 has improved vegetation condition and increased vegetation cover in previously open areas.

Table 2: Vegetation Condition at Mullaloo Foreshore Reserve

Vegetation Condition	Completed Degraded	Degraded	Good	Very Good	Excellent	Pristine	Total
Area (ha)	0.21	0.32	3.54	8.57	0	0	12.64
Area (%)	1.7	2.5	28	67.8	0	0	100

Legend	
Completely Degraded	
Degraded	
Good	
Very Good	
Site Boundary	

Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 02/06/2017
Image Source: City of Joondalup, 2014
Datum: GDA94
Projection: MGA Zone 50

Figure 12:
Vegetation condition
Mullaloo Foreshore, Mullaloo

0 N 100
Meters

3.0 Biodiversity Management

Mullaloo Foreshore Reserve supports a range of flora and fauna species, and provides an important ecological linkage to adjacent coastal reserves. The long term protection of biodiversity values within the reserve is critical to ensure the conservation of this habitat. The protection and enhancement of biodiversity within the reserve also benefits the community through the provision of ecological services, including:

- the production of oxygen and capture of carbon dioxide
- noise and air quality regulation
- cooling of urban environments
- supporting seed dispersal and pollination
- a number of recreational and cultural experiences[24].

Flora, fauna and fungi surveys are undertaken as part of the management plan review every five years within the Mullaloo Foreshore Reserve.

A number of environmental threats pose a risk to the biodiversity of the Mullaloo Foreshore Reserve. The key environmental threats include:

- weeds
- pathogens and disease
- non-native fauna species
- human impacts
- access and infrastructure
- fire.

Management strategies to mitigate the effects of key environmental threats have been established and are discussed in the following sections. There are other additional environmental threats that are out of the scope of this Plan and thus not addressed, such as climate change and groundwater decline.

3.1 Flora

The Mullaloo Foreshore Reserve is located in the Southwest Australian biodiversity hotspot, which is one of the world's 35 biodiversity hotspots. It extends from Shark Bay in the North to Israelite Bay in the south, with over 2,900 endemic plant species occurring within the region. Approximately 30% of the original vegetation extent of this area remains, with habitat loss primarily due to agricultural expansion[25].

Flora surveys enable collection of scientific data related to the occurrence and distribution of flora species and vegetation communities. Information obtained from flora surveys is used as a baseline to monitor the ecological health of flora populations and vegetation communities. Natural Area was engaged to undertake a desktop and field flora survey of the Mullaloo Foreshore Reserve in September 2016. A total of 80 plant species were recorded within the Reserve, including 37 native (46%) and 43 (54%) introduced species.[26]

[24] City of Joondalup (2014a)
[25] Conservation International (2017)
[26] Natural Area Consulting Management Services (2017)

3.1.1 Flora Survey Methodology

Desktop and on-ground flora survey methodology for the Mullaloo Foreshore Reserve was undertaken by Natural Area in September 2016 in accordance with *EPA Technical Guide – Flora and Vegetation Surveys for Environmental Impact Assessment* (December 2016). The survey methodology undertaken included Natural Area botanists setting up a series of quadrats in each vegetation type and documenting[27]:

- the landscape characteristics including soil type, soil colour, aspect, slope, and topography
- leaf litter depth
- percentage vegetative cover and percentage bare ground
- recording vegetation type and condition
- presence of native and non-native flora species present, including significant flora, along with habit, life form, percentage cover and height
- walking the site to record incidental sightings of species not present in quadrats.

3.1.2 Native Flora

Native flora is an important part of the Mullaloo Foreshore Reserve ecosystem, providing habitat and resources for fauna present. Reduction in flora species or vegetation cover can lead to a loss of fauna that depend on it for resources and shelter. A total of 37 native plant species, of which none were Threatened or Priority species, were recorded within the Reserve[28].

3.1.3 Weeds

Weeds can be native or introduced species that have colonised an area where they did not originally exist. An environmental weed generally reproduces quickly, and requires action to reduce its negative impact on economic, social and environmental values of the area. Weeds are commonly introduced and distributed within bushland areas through seed dispersal by water, wind, animals such as birds, fire, the dumping of garden waste, and human or vehicle movement in natural areas. Weeds can have major economic, environmental and social impacts in Australia and can:

- displace native plant species
- alter nutrient cycling and soil quality within ecosystems
- harbour pests and diseases
- increase fire fuel loads
- impact negatively on native flora and fauna and their habitats
- compete with native species for resources[29].

Over 28,000 known alien plant species have been introduced to Australia with approximately 10% now being established in the environment.[30] Garden plants are the main source of Australia's weeds, accounting for 66% of recognised weed species.[31]

[27] Natural Area Consulting Management Services (2017)
[28] Ibid.
[29] Department of the Environment (2015)
[30] Groves, Bowden and Lonsdale (2005)
[31] DSEWPC (2013)

A total of 43 weed species were recorded within the Mullaloo Foreshore Reserve by Natural Area during the September 2016 surveys. No weeds of national significance (WoNS) were recorded, although one category C3 declared pest, the One-leaf Cape Tulip (*Moraea flaccida*) listed on the WAOL under the *Biosecurity and Agriculture Management Act 2007* (WA) (BAM Act), was recorded within the Reserve. Three species are listed on the City of Joondalup's priority weed list, namely Geraldton Carnation Weed (*Euphorbia terracina*), Gazania (*Gazania linearis*) and Rose Pelargonium (*Pelargonium capitatum*).

3.1.4 Revegetation

The City of Joondalup encourages natural bushland regeneration through weed management and conservation fencing to allow the vegetation to re-establish itself and maintain species diversity and populations. Revegetation is undertaken on an as required basis in Degraded, Completely Degraded, or Good areas where further planting is considered to be beneficial using local provenance species.

Weed control and revegetation has occurred within the Mullaloo Foreshore Reserve, which has increased biodiversity and reduced weed abundance. Areas of Degraded (Figure 13) and Good vegetation condition that would benefit from planting along with a proposed planting list is provided in Appendix 7, including species that are not present or under-represented on site.

Figure 13: Area of Degraded vegetation condition suitable for revegetation activities

3.1.5 Current Management Approach

The City undertakes an integrated approach to weed management, including:

- prevention of weed introduction through hygiene measures
- regular monitoring and reporting of weed populations
- on ground weed control, including prioritisation of natural areas and priority weeds to target
- community education initiatives
- fire prevention measures
- hand weeding by bushland friends group volunteers and contractors.

Weed monitoring is conducted by the City every six months at the Mullaloo Foreshore Reserve to establish the extent and distribution of weeds species and to identify priority weeds.

In accordance with Annual Maintenance Schedules and Weekly Maintenance Schedules, on ground weed management occurs through weed spraying and hand weeding methods. In addition to this, contractors are engaged to spray weeds and hand weed. City of Joondalup personnel act in accordance with internal spraying procedures and conduct trials periodically to evaluate the most effective management methods. Resources, such as the DBCA FloraBase website or *Southern Weeds and their Control* (DAFWA Bulletin 4744), are also consulted in regard to weed control.

Environmental weeds are classified as priority by the City if they meet any of the following criteria:

- weed of national significance (WoNS)
- declared plant listed under the *Biodiversity and Agriculture Management Act 2007* (WA)
- high priority weed according to the Swan Regional Ranking
- pest plant under *Local Government Act 1995* (WA)
- major threat to vegetation
- major threat to the structure of vegetation communities
- contribute to a high fuel load, for example dry grasses.

A list of weeds and their priority rating according to the DBCA Swan Regional Ranking is provided in Appendix 5, with the recommended weed treatment methodology for high priority weed species detailed in Appendix 6.

The City of Joondalup *Weed Management Plan* has been adopted and provides an ongoing strategic approach to the management of natural areas and parks in order to reduce the incidence of weeds. A number of education initiatives are undertaken to raise the awareness of weeds with the community, these include:

- delivery of gardening workshops
- development and distribution of two weed brochures – *Environmental Weeds* and *Garden Escapees* (available in hard copy and on the City's website)
- weed education workshops for local Friends Groups.

3.1.6 Recommended Management Actions

To monitor, conserve and protect native flora in the Mullaloo Foreshore Reserve, the following management actions are proposed.

Action	Detail
Weed monitoring	Continue to undertake weed monitoring every six months.
Targeted weed control	Continue to undertake a targeted weed control program, as described in Appendix 6.
Ongoing weed control	Continue to undertake coordinated approach to regular weed control by implementing the Annual Maintenance Schedule.
Weed Management Plan	Implement the City of Joondalup Weed Management Plan when it is finalised to provide an ongoing strategic approach to the management of natural areas in order to reduce the incidence of weeds.
Restoration	Conduct restoration as outlined in the Revegetation Strategy in Appendix 7.

Action	Detail
Friends Group	Continue to support the activities of the MBCG.

3.2 Fungi

It is estimated that there are 10 times more species of fungi than plants in the world, equating to approximately 140,000 fungi and 14,000 plant species in Western Australia. The amount of species of fungi present in bushland can be an indicator of ecosystem health. Fungi are strongly interconnected with plants and animals as fungi are recyclers that break down litter and debris to provide nutrients for plants. Native plants such as eucalypts, wattles and orchids have beneficial partnerships with fungi. Fungi also provide food and/or habitat for fauna such as bandicoots and other fauna including invertebrates[32].

Fungi surveys are important to provide baseline information, and to highlight changes in fungi occurrence over time. Undertaking surveys also enables comparison of ecological data with other City of Joondalup natural areas. The most common time to see the fruiting bodies of fungi is after autumn and winter rains.

3.2.1 Fungi Field Survey

No fungi species were identified within the Mullaloo Foreshore Reserve during the September 2016 opportunistic field survey conducted by Natural Area[33]. This was most likely due to the timing of survey activities, which was not the optimum time to see fruiting bodies as it was too late in the year and the weather warm and dry. Fungi species likely to occur are expected to be similar to those observed within the Marmion Coastal Foreshore Reserve and other City of Joondalup bushland areas.

3.2.2 Current Management Approach

The City of Joondalup currently monitors fungi in the Reserve through surveying for incidental sightings of fungi species every 5 years as part of the flora, fauna and fungi survey.

3.2.3 Recommended Management Action

To monitor fungi health in the Mullaloo Foreshore Reserve, the following management action is proposed:

Action	Detail
Opportunistic fungi survey	Continue to undertake opportunistic fungi sightings during other site activities.

[32] Bougher (2009)
[33] Natural Area Consulting Management Services (2017)

3.3 Plant Diseases

Vegetation can be subject to diseases that result in plant health decline and potentially death in the longer term. Pathogens are the organisms such as fungi, bacteria and viruses that cause plant diseases; with many introduced into new areas through movement of infected plant material or soils, whilst some are naturally occurring in the soil. Some pathogens will result in rapid plant death while others will lead to the slow decline in plant health over time[34].

Phytophthora dieback is a water-borne fungus and the most common plant disease encountered on the Swan Coastal Plain, with the most common species encountered being *Phytophthora cinnamomi*. While *Phytophthora cinnamomi* is considered the most destructive, other varieties are being described which may have similar impacts, such as *Phytophthora multivora* which is known to attack a variety of species including *Eucalyptus gomphocephala*, *E. marginata* and *Agonis flexuosa* and a range of Banksia species[35]. The nature of the vegetation combined with the presence of limestone based soils within the foreshore reserve mean that *Phytophthora cinnamomi* is unlikely. However, *Phytophthora multivora* is known to be tolerant of alkaline conditions as it has been found in Tuart forests underlain by limestone soils south of Mandurah and as far as Cape Naturaliste, where it has been associated with individual spot deaths and areas of tree decline[36]. *Phytophthora multivora* has been recorded in urban areas of Perth, including inland dune systems and within the City's parks. If suspected within the foreshore reserve or other natural areas, it should be treated in the same manner as *Phytophthora cinnamomi*.

Armillaria luteobubalina has been previously identified within a number of the City's parks. *Armillaria* is a soil-borne fungus that causes root rot of a wide variety of plants including many species of native flora. The fungus is native to Australia and can cause major damage to natural ecosystems. *Armillaria luteobubalina* is commonly known as the 'Honey Fungus' due to the colour of the fruiting body seen above the ground during certain times of the year (Figure 14). Fruiting bodies (mushrooms) are not evident at all infected sites and their presence is usually a sign that the fungus is well established in that area[37].

Figure 14: *Armillaria luteobubalina*

[34] City of Joondalup (2012)
[35] Scott et al, (2009)
[36] Ibid.
[37] Smith and Smith, (2003)

At present, there is no reliable mechanism for the complete eradication of *Phytophthora* species and the control of *Armillaria luteobubalina* is both expensive and labour intensive.

3.3.1 Current Management Approach

The City of Joondalup has developed a *Pathogen Management Plan 2013-2016* to protect native vegetation and ecosystems by establishing the level of risk for areas to be infected by pathogens, prioritisation of areas and detail preventative and management actions to be implemented within the City, including guidelines for dieback-free purchasing of plant stock and materials and a hygiene procedure. The City has also developed *Pathogen and Weed Hygiene Guidelines*[38] and *Purchasing Guidelines for the Supply of Landscaping Materials*[39] to minimise the spread of pathogens.

Sampling undertaken by Arbor Carbon[40] in 2015 found *Phytophthora nicotianae* in one location at Tom Simpson Park.

3.3.2 Recommended Management Action

To prevent pathogen spread and protect biodiversity values at the Mullaloo Foreshore Reserve, the following management action is recommended:

Action	Detail
Pathogen Management	Implement recommendations from the Pathogen Management Plan that are applicable to the management of the Mullaloo Foreshore Reserve, particularly in sites affected by pathogens.
Pathogen Management	Implement *Pathogen and Weed Hygiene Guidelines* and *Purchasing of Landscaping Materials Guidelines* to prevent the introduction or spread of weeds or pathogens into the Mullaloo Foreshore Reserve

3.4 Fauna

Fauna surveys were undertaken by Natural Area in November to December 2016 to establish a baseline of species inhabiting the Reserve and document their occurrence, extent and minimum population numbers. Outcomes of the Natural Area fauna surveys are presented in this section.

3.4.1 Fauna Survey Methodology

Desktop and field fauna survey activities were undertaken by Natural Area in accordance with *EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*, along with the principles outlined in *EPA Position Statement No. 3: Terrestrial Biological Surveys as an element of Biodiversity Protection, and the Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*. The methodology undertaken by Natural Area for the November – December 2016 fauna surveys included:

- setting up a range of pitfall and funnel traps in a series of trap lines in each habitat type

[38] City of Joondalup, (2016)
[39] City of Joondalup, (2015)
[40] Arbor Carbon, 2015

- setting up Elliott and cage traps in other locations within the reserve
- checking traps within 3-hours of sunrise, recording species captured and releasing them back into the environment
- setting out a motion activated camera for 10 days to capture sightings of other animals that are unable to be trapped
- walking the site to record opportunistic sightings or indications of (calls, tracks, scats, dens) of vertebrate fauna
- recording incidental sightings or captures of invertebrates
- reporting outcomes[41].

3.4.2 Fauna Habitat

Four vegetation communities were identified by Natural Area on site during the September 2016 surveys, comprising low coastal shrubland, Spinifex Grasslands on foredunes and tall Acacia shrubland on low dunes throughout the majority of the study area. In terms of habitat type, these vegetation communities can be classed as Quindalup dune mixed shrublands on sandy soils.

This habitat type supports a range of coastal shrubland birds and terrestrial reptiles. No wetlands or open water bodies occur on site meaning there is no habitat for aquatic species. Amphibians may be able to travel to the site from nearby water sources in residential gardens or reserves. Large trees in the adjacent Tom Simpson Park and car parks provides nesting and roosting habitat for birds.

3.4.3 Native Fauna

Fauna and flora are interconnected in complex relationships with each other and with factors such as soil, water, climate and landscape. The decline of native fauna can cause the loss of plant species and changes to ecological communities; for example, the loss of pollinating fauna species can reduce or even cease plant reproduction. A total of 36 vertebrate fauna species were recorded on site, which consisted of 4 mammals, 23 birds and 9 reptiles[42]. A total of 28 native invertebrate species were also recorded.

Mammals

One native mammal species, the Quenda or Southern Brown Bandicoot (*Isoodon obesulus fusciventer*), was recorded at the northern end of the Reserve during 2016 surveys (Appendix 4), with all other mammals recorded were introduced species. The Quenda is a Priority 5 species listed under the *Wildlife Conservation Act 1950* (WA).

Birds

Twenty-three native bird species were recorded including 21 during the 2016 fauna survey activities within Mullaloo Foreshore (Tables 12 and 13), and all were common or moderately common to the area[43]. Two additional bird species were recorded during the 2017 site assessment undertaken by Natural Area (Appendix 4). Of the bird species observed, three are listed as locally significant for the Swan Coastal Plain, namely the Variegated Fairy-wren (*Malurus lamberti*), the White-winged Fairy-wren (*Malurus Leucopterus*)

[41] Natural Area Consulting Management Services, 2017
[42] Natural Area Consulting Management Services, 2017
[43] Ibid

and the White-breasted Robin (*Eopsaltria georgiana*) (Figure 15). These species are habitat specialists that prefer dense shrub vegetation and have a reduced distribution on the Swan Coastal Plain[44].

Variegated Fairy-wren (*Malurus lamberti*)

White-breasted Robin (*Eopsaltria georgiana*)

White-winged Fairy-wren (*Malurus Leucopterus*)

Figure 15: Locally significant bird species found at Mullaloo Foreshore Reserve

Reptiles

A total of nine native reptile species from four families were recorded during the 2016 fauna survey, of which one was a snake and eight were lizards (Figure 16; Appendix 4). None were listed as conservation significant and all were common to the Perth region. All reptiles captured were in good health, with both mature and juvenile animals captured indicating breeding populations[29].

Sandplain Worm-Lizard (*Aprasia repens*)

South-western Spiny-tailed Gecko (*Strophurus spinigerus*)

West-coast Laterite Ctenotus (*Ctenotus fallens*)

Figure 16: Examples of reptiles captured within Mullaloo Foreshore Reserve

Amphibians

No amphibians were recorded during the 2016 survey, and may be due to dry weather conditions at the time as well as the distance to open water bodies (Appendix 4).

[44] Government of Western Australia, 2000

Invertebrates

A total of 28 native invertebrate species from 23 families were recorded opportunistically by Natural Area during the 2016 fauna survey (Appendix 4). Examples of invertebrates observed are shown in Figure 17.

Wolf Spider (*Lycosa* sp.)

Centipede (*Scolopendra* sp.)

Cicada (Cicadidae)

Figure 17: Examples of invertebrate observed at Mullaloo Foreshore Reserve

3.4.3 Non-native Fauna

Non-native fauna impact native fauna and flora through predation, competition for food and shelter, spreading diseases and destroying habitat. These impacts can result in the diminishing or extinction of native species.[45] Non-native animals such as cats, foxes, rabbits, mice, birds, millipedes and bees inhabit the City's bushland, wetland and coastal areas. Introduced species recorded during the surveys included 3 mammals, 4 birds and 4 invertebrates.

Introduced Mammals

Three introduced mammal species were captured or signs of their presence was observed during the 2016 fauna surveys, including the *Domestic Dog (*Canis lupus familiaris*), *House Mouse (*Mus musculus*) and the *European Rabbit (*Oryctolagus cuniculus*). The house mouse was captured on site, the European Rabbit and the Domestic dog were observed and signs of both were recorded within the vegetated dunes. The European Rabbit is listed on the WA Organism List (WAOL) as a C3 declared pest under the BAM Act 2007 (WA), which requires management of this species by the land manager to reduce its impact and spread.

Domestic animals such as dogs (*Canis lupus*) can cause damage to the City's natural environment, particularly when exercised unleashed within natural areas. Dogs can harass native fauna, including large mammals such as kangaroos, often resulting in stress and harm to the animals. Dogs can also spread pathogens if they disturb the soil, particularly around trees which may contain soil-based diseases. Dog droppings, if not removed, contribute a significant amount of nutrients to the site, encouraging weed growth and potentially polluting groundwater. Some dog droppings contain harmful bacteria.

Dogs are not permitted in Tom Simpson Park and are required to be on a lead on the coastal dual use path. The City Rangers patrol Mullaloo Foreshore Reserve to ensure dogs are not in Tom Simpson Park, are kept on leads on the coastal dual path and their droppings are collected.

[45] DSEWPC (2012)

Domestic and feral cats (*Felis catus*) have the potential to cause significant environmental harm when allowed to roam within urban natural areas. Feral cats are attributed to be the major threat to mammalian fauna extinction in Australia. The Australian Wildlife Conservancy estimates 'feral cats kill at least 75 million native animals every night across Australia[46]. The Federal Government in 2015 endorsed the National Declaration of Feral Cats as Pests. In order to combat this threat to native fauna populations, the Australian Government has set an objective through the Threatened Species Strategy 2015, for 2 million cats to be culled across Australia by 2020.

The *Cat Act 2011* (WA) encourages responsible pet ownership by ensuring cats are registered, sterilised and microchipped. The Act also enables the City of Joondalup to seize cats if they are reported to be on private property without the consent of the owner/occupier, and commenced cat control activities in its foreshore reserves in 2017.

The City has a fox and rabbit control program and operates under the BAM Act to manage these non-native mammals at Mullaloo Foreshore Reserve.

Introduced Birds

Four introduced bird species were recorded during the 2016 survey within the site, namely the *Rock Dove (*Columba livia domestica*), *Spotted Turtle-Dove (*Streptopelia chinensis*), *Laughing Turtle-Dove (*Streptopelia senegalensis*) and the *Rainbow Lorikeet (*Trichoglossus haematodus*)[30] (Appendix 4). These species are common throughout the Perth metropolitan region[31]. Introduced birds have a negative impact on native species by increasing competition with native species for food and nesting resources.

Introduced Invertebrates

Four introduced invertebrates were recorded by Natural Area during the November to December 2016 survey including the *European Honey Bee (*Apis mellifera*), which was observed in several locations across the site, however no bee hives were recorded[47]. This species can negatively impact native bird species by increasing competition for nesting hollows and can pose a safety risk to people utilising the site. The Portuguese Millipede (*Ommatoiulus moreleti*), Rolling Slater (*Armadillidium vulgare*) and the Purple Woodlouse (*Porcellionoides* sp.) were also recorded throughout the site. The Portuguese Millipede is considered to be a pest at high population levels and is avoided by many predators[48]. This species is common within bushland and suburban areas across the Perth metropolitan region.

3.4.5 Ecological Corridors

Naturally connected landscapes and ecosystems are generally healthier than fragmented ones, supporting and protecting a greater diversity of species, providing pathways for species movement and can store carbon more effectively than degraded landscapes[49]. In urban areas, infrastructure can divide landscapes creating barriers for native fauna movement, which may make it necessary to provide wildlife crossings such as underpasses, tunnels, viaducts or overpasses to enable wildlife movement.

[46] Australian Wildlife Conservancy, (2012/2013)
[47] Natural Area Consulting Management and Services (2017)
[48] Department of Agriculture and Food (WA) (2017a)
[49] NWCPAG (2012)

The Mullaloo Foreshore Reserve is part of an ecological linkage coastal strip that extends from Burns Beach in the north to North Beach in the south and inland to Periwinkle Park, Korella Park Natural Area and Kallaroo Park Natural Area within the City of Joondalup (Figure 18).

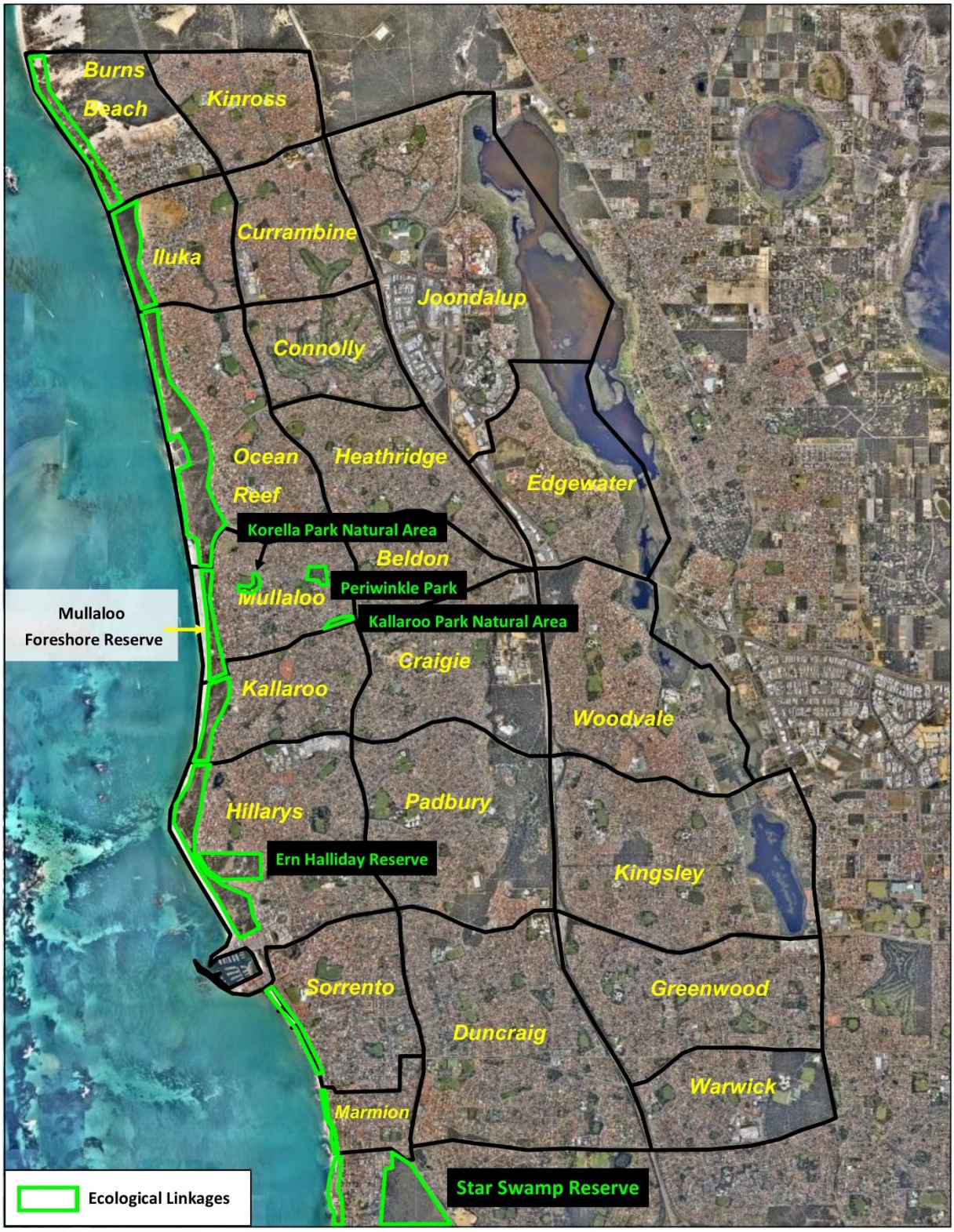
3.4.6 Current Management Approach

The City of Joondalup is implementing a number of management actions to monitor native fauna and address the environmental impacts of domestic and pest animals within the City's natural areas. Monitoring of native fauna occurs through fauna surveys. Control of non-native fauna is undertaken as required within bushland, wetland and coastal areas. Control methods employed include trapping, baiting and exclusion methods such as fencing.

The City's current management practices have greatly reduced the incidence of pest animal populations within the City, however continued and coordinated action is required to ensure that populations remain at controllable numbers and that the impacts on natural areas remain at a minimum. The City also promotes responsible pet ownership and encourages the community to ensure that domestic pets do not have a negative impact on the natural environment.

3.4.7 Recommended Management Actions

Action	Detail
Fauna	Carry out follow-up fauna surveys in spring and a targeted invertebrate survey after five years.
Feral animal control	Continue to monitor feral animal populations and implement regular fox and rabbit control to reduce pressures on native fauna and flora.
Dog control	Control dogs in accordance with the *Dog Act 1976* (WA) and City of Joondalup's policies and procedures in relation to removal on land managed by the City.
Cat control	The City commenced cat control in 2017 on foreshore reserves; to control cats in accordance with the *Cat Act 2011* (WA) and City of Joondalup's policies and procedures in relation to their trapping and removal on land managed by the City.



Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 18/05/2017
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

Figure: 18

Ecological linkages

Mullaloo Foreshore Reserve

0 N 2.0

kilometers

3.5 Social and Built Environment

3.5.1 History and Heritage

The Mullaloo Foreshore Reserve is not listed on any State or Federal Aboriginal or non-Aboriginal heritage inventory or register[50]. The foreshore area is part of the Marmion Marine Park, which is listed on the State Heritage Resister.

3.5.2 Social Value

The Reserve provides a number of recreational activities, including picnicking, walking, jogging and cycling along the pathways. Water based activities include swimming and surfing.

Key external stakeholders associated with the management of the Reserve include:

- Mullaloo Beach Community Group Inc.
- Joondalup Community Coastcare Forum
- Mullaloo Surf Life Saving Club
- Department of Fire and Emergency Services
- Department of Education
- Department of Planning, Lands and Heritage.

3.5.3 Access and Infrastructure

Access includes the dual use path, access to the beach and parking areas, while infrastructure includes parking, bins, bicycle racks, drink fountains, seating, and ablution blocks. Each are discussed, with their locations shown in Figures 25 and 26.

Parking

There are three carparks adjacent the Mullaloo Foreshore Reserve that allow access to the adjacent parks, the beach and the pedestrian pathways. One adjacent to West View boulevard at the northern end of the site, the other two at the southern end near Tom Simpson Park adjacent to Iluka Avenue and the Mullaloo Beach Hotel. Parking areas are also provided along Oceanside Promenade. Bike racks (Figure 19) are provided in three locations adjacent carparks and pedestrian pathways.

Figure 19: Bike racks available at Mullaloo Foreshore Reserve

[50] Department of Aboriginal Affairs (2016)

Fencing

Current fencing is installed around the perimeter of vegetated dune areas. Fencing consists of pine post with ringlock wire mesh and two high tensile string wires at the top, and PVC sleeves over pine posts and chainmesh fencing (Figure 20). The PVC sleeve and chainmesh fencing occurs along upgraded access ways to the beach and along the foredunes for the portion north of the surf club (Figure 20). Fencing along the dual use path adjacent Tom Simpson carpark is showing signs of wear, with damaged areas, sagging of the wire and rust.

a) b)

c) d)

Figure 20: Fencing: a) pine post and square ringlock and wire fencing, b) PVC sleeves over pine posts and chainmesh fencing, c) damaged fencing along the beach d) damaged fencing adjacent access way.

Access Points

Twelve formalised access ways provide pedestrian access to the beach (Figures 21, 25 and 26). They provide access from the recreational parkland areas, car parks and the dual-use path. Two beach access ways are constructed of concrete and one of bitumen, allowing access for those with disabilities; no stairways are present. All other access ways are sandy paths, with two adjacent Tom Simpson park having stairways at the eastern end. The western beach ends of the concrete and bitumen path infrastructure or paths adjacent higher dunes are vulnerable to erosion and pose an ongoing maintenance issue.

Vulnerable access ways were in a good state of repair at the time of the 2017 site assessment. Signs of erosion were recorded at the western end of the southern concrete path near Merrifield Place. Current beach access within the Mullaloo Foreshore Reserve is adequate.

Sandy access way to beach

Concrete access way to beach

Figure 21: Access points within Mullaloo Foreshore Reserve

Paths and Trails

A dual use path extends along the eastern boundary of the reserve before cutting through to the centre of the reserve adjacent to Atoll Court and continuing to the northern boundary. Twelve access footpaths lead off this pathway to the beach (Figure 28). All pathways were found to be in good condition during the 2017 site assessment.

Access and Inclusion

In a Survey of Disability, Ageing and Carers conducted in 2012, 31,400 people, or 18.73% of the population in the City of Joondalup[51] currently have a core activity limitation associated with communication, mobility or self-care, for which assistance is required. A further 5,800 or 3.4% of the population have a disability that restricts schooling or employment opportunities but does not limit their daily core activities.

The City of Joondalup has an *Access and Inclusion Plan 2015-2017*[52], outlining that 'the City is committed to including people with disability through the continuous improvement of access to its information, facilities and services'. The *Walkability Plan 2013-18*[53] includes a recommendation to 'maintain existing internal and external trails to meet trail useability and accessibility standards'.

There is adequate access for people with a disability to move along the dual use pathway, the bitumen access way just north of the surf club, two concrete access ways south of the surf club, and an observation platform, pathway and seating area south of the northern ablution block adjacent Tom Simpson Park. All other access points to the beach are sandy tracks with some in the southern section having stairs at the eastern end and do not allow access by those with disabilities.

Water Sensitive Urban Design

There is one drainage outlet within the Reserve that leads into the sump adjacent the Tom Simpson Park carpark (Figure 22); fencing was replaced at this this site in April/May 2017. The area around the sump and

[51] City of Joondalup, (2015)
[52] City of Joondalup, (2015)
[53] City of Joondalup, (2013)

drainage inlet has an increased risk of potential erosion, and weed and rubbish introduction via the stormwater drains. No erosion was noted around the sump during the 2017 site assessment undertaken by Natural Area. A high diversity and density of weeds was present within the sump and most likely introduced via the stormwater drainage system. It is recommended that the drain and sump be regularly inspected for erosion and other damage, and that maintenance activities include weed control and rubbish removal to reduce the potential for blockages.

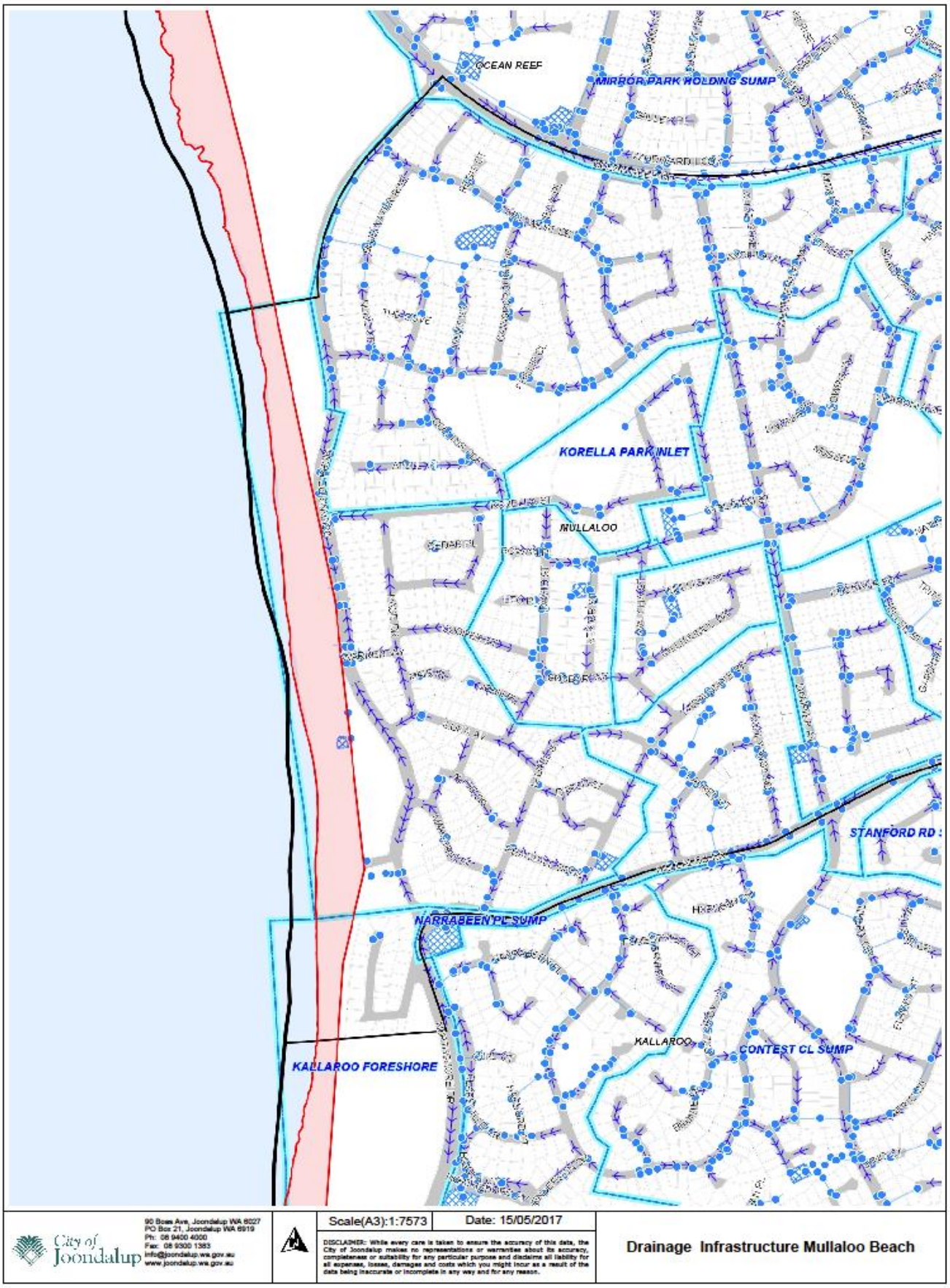


Figure 22: Drainage, Mullaloo Foreshore Reserve

Signage

Signage is used to convey a range of messages to users of the Mullaloo Foreshore Reserve. This includes those informing users of the flora and fauna present on site, safety precautions, conservation values, penalties that apply for vandalism and unauthorised access, locations of amenities available (wayfinding signage), permitted activities, and appropriate use of the dual use path (Figure 23). The majority of the signs were in good condition with a few showing signs of wear and minor graffiti.

Figure 23: Examples of signage within the Mullaloo Foreshore Reserve
(Source: City of Joondalup and Natural Area)

Toilets

Two ablution blocks are located adjacent the Tom Simpson carpark and the surf club at the southern end of the Mullaloo Foreshore Reserve.

Seating

There are a number of shade structures with picnic tables within Tom Simpson Park at the south of the Reserve, and two shaded seats are situated along the walk trail (Figures 24 and 25). Bench seats are provided at the southern end of the site near the surf club. All structures are currently in good repair but will require ongoing maintenance as they are situated in a salty environment and are subject to weathering.

Rubbish Bins

Rubbish bins are located along the dual use pathway at the entrance to most access ways, within the parkland areas near carparks and picnic areas where people congregate to enjoy the views or sit down and rest (Figures 24 and 25). Minimal rubbish was recorded during the 2016 and 2017 site assessments, with the majority being plastic bags, paper and cardboard on the periphery of vegetated areas adjacent to parklands and roads, which has most likely blown in by the wind.

3.5.4 Anti-social Behaviour

Anti-social behaviour includes inappropriate use and activities such as graffiti vandalism to property, construction of cubbies, destruction of natural and human assets, rubbish dumping, camping, and lighting of fires on the beach. Impacts of such activities included decreased aesthetics, damage to the vegetation through trampling and clearing, and increased maintenance costs to remove or repair damaged assets and infrastructure. There was little evidence of anti-social behaviour within the Mullaloo Foreshore Reserve during the 2016 and 2017 site assessment activities, with campfire construction being the most obvious (Figure 26).

3.5.5 Recommended Management Actions

To enhance the social and built environment in the Mullaloo Foreshore Reserve, the following management actions are proposed:

Action	Detail
Access	Implement recommendations outlined in the Walkability Plan as they relate to the Mullaloo Foreshore Reserve.
Fencing	Regularly review sand build up along the beach fence and arrange removal when required.
Water erosion from drainage	Monitor erosion and water pooling around the storm drains and restore when required.
Signage maintenance	Continue signage inspections in conjunction with other monitoring activities in accordance with the Annual Bushland Schedule and repair or replace damaged or vandalised signs as required.
Inappropriate signage	Remove any advertisement signage affixed to the fencing or other locations in the Reserve by business owners or individuals when observed.
Rubbish	Monitor rubbish around the reserve in accordance with the Annual Bushland Schedule, with removal occurring when observed.
Anti-social behaviour	Monitor evidence of anti-social behaviour, promptly: ▪ removing any cubbies, or dumped rubbish ▪ repairing vandalised assets and/or infrastructure ▪ restoring damage to bushland areas as soon as possible after discovery.

Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 13/06/2017
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

Figure 24:
Infrastructure & Amenities (map 1)
Mullaloo Foreshore, Mullaloo

0 N 50
Meters

Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 13/06/2017
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

Figure 25:
Infrastructure & Amenities (map 2)
Mullaloo Foreshore, Mullaloo

0 N 50
Meters

3.6 Fire Management

Fire is an important natural feature of the Western Australian landscape as it helps to shape the diversity of plant communities with many Australian native plants having adapted fire-reliant methods of reproduction. Human activities such as accidents and arson have resulted in an increased incidence of fire within many urban bushland reserves that threatens biodiversity, reduces the ability of native species to complete their lifecycle and can encourage the growth of fire promoting invasive weeds. A high intensity fire may damage infrastructure such as property, signage, fences and gates. Fire suppression methods may also compromise the environmental values of the Reserve, such as clearing native vegetation for firebreaks.

Bushfires are unplanned fires that can be caused by events such as lightning, planned burning operations, escape from industrial activities, damaged power transmission lines, discarded cigarette butts or deliberate arson. Bushfires can cause significant damage to people, property and the environment.[54] Management of the Mullaloo Foreshore Reserve is the responsibility of the City of Joondalup, which has a 'duty of care' to take all reasonable precautions to prevent any bushfire from spreading onto neighbouring property. The City of Joondalup does not currently have a prescribed burn management regime for the area. The Department of Fire and Emergency Services (DFES) work with the community and government to prevent, prepare for, respond to and recover from a diverse range of emergencies, including fire.[55] There are numerous water hydrants located around the Reserve, which are installed and maintained by the Water Corporation.

Objectives

The objectives of fire management within the Mullaloo Foreshore Reserve are to:

- protect life, property and environment in Mullaloo, and adjacent residential areas
- fulfil obligations under the *Bush Fires Act 1954* (WA)
- protect the ecological and amenity values
- protect landscape values (including flora and fauna) from uncontrolled fire and inappropriate suppression techniques
- reduce the frequency, impact and area of unplanned fires
- minimise the spread of disease and weeds during fire-fighting operations and when establishing emergency firebreaks, and during post-fire clean-up activities
- minimise impacts on air quality.

Fire Risk

The site has a low to moderate fire risk due to the coastal heath and shrubland vegetation present. Fine fire fuels present such as dry grass, leaves, twigs and loose bark increase the risk of fire ignition and spread within the Reserve. The highest risk for the site is from deliberately lit fires within the vegetated dune areas and discarded cigarette butts. The steep slopes on higher dunes in the portion south of the surf club pose a safety risk to fire respondents in the event of a fire, especially if there is low visibility due to smoke. Fire fuel load assessments are carried out every year to determine fire risk based on fuel load, assessments should be undertaken using methodology described in the Department of Fire and Emergency Services (DFES) *Visual Fuel Load Guide for the Swan Coastal Plain and Darling Scarp*[56].

[54] EDOWA (2011)
[55] DFES (2017a)
[56] DFES (2015)

Fire Prevention

The City of Joondalup implements a number of on ground measures to reduce the risk of fire, including undertaking:

- controlled access
- management of non-native flora (weed) species
- fuel load assessment and management
- maintenance and installation of fire access tracks (fire access ways and strategic firebreaks).

Fuel load assessments are conducted annually at Mullaloo Foreshore Reserve and the results used to inform fire management of the site. In 2016, the fire fuel load assessed by the City was moderate at 5.4 – 12.5 tonnes/ha.

Weed control and maintenance of fire access tracks are conducted in accordance with the City's Annual Bushland Schedule. The City of Joondalup is currently developing a *Draft Bushfire Risk Management Plan* outlining the City's strategy for assessing fire risk, prevention, response and recovery. The City has also developed *Post-Fire Weed Management Guidelines* to mitigate the impact of weeds within the post fire environment of the City's natural areas, and are implemented within the City's natural areas after a fire event.

Fire occurrences

A review of historical aerial imagery from Landgate indicates that no fires occurred within the Mullaloo Foreshore Reserve since 1953[57]; however, as there were up to 10 years or more in between photos prior to 1995 there is a possibility that fires may have occurred during these times. It is also probable that small fires will not show on aerial imagery. Two campfire remnants were recorded within the Mullaloo Foreshore Reserve during the 2016 and 2017 site assessments with one occurring in the vegetated dunes (Figure 26) and one on the beach, both were at the northern end of the site near the Westview carpark.

Fire incidence information provided by DFES[58] indicates that:

- a total of 27 fires occurred within Mullaloo along Oceanside Promenade and Mullaloo Drive between 01 January 2002 until 30 June 2017
- all were described as landscape fires
- 20 were considered suspicious or deliberate, two were associated with cigarettes, two a campfire/ bonfire or outdoor cooking (Figure 27), one was associated with children's misadventure, one was unreported and the last fire's cause was undetermined
- all burnt one hectare or less.

[57] Landgate (2017)
[58] DFES (2017b)

Figure 26: Remnants of a camp fire within the dunes at Mullaloo Foreshore Reserve

Fire Response

The closest fire station is the Duncraig Fire Station on Hepburn Avenue, Duncraig (approximately 5 km away) and they are responsible for suppressing fires within the Mullaloo Foreshore Reserve. The Western Australia Police are responsible for the evacuation of residents and visitors, if required.

3.6.1 Recommended Management Actions

To prevent fire occurrences and minimise the environmental impact of fire occurrences in Mullaloo Foreshore Reserve, the following management actions are proposed:

Action	Detail
Assess fire fuel load	Continue to annually assess and report fire fuel load using the DFES *Visual Fuel Load Guide for the Swan Coastal Plain and Darling Scarp* to inform fire prevention actions required.
Develop and implement Bushfire Risk Management Plan	Develop and implement a *Bushfire Risk Management Plan*, outlining the City's strategy for assessing fire risk, prevention, response and recovery.
Monitor fire occurrences	Continue to monitor fire occurrences through mapping and updating Geographic Information System (GIS) layers detailing fire incidents and frequency to inform fire prevention actions.
Post Fire Weed Management	After fires, implement the *Post Fire Weed Management Guidelines* to aid regrowth of native species by selecting appropriate chemicals, targeting weeds if safe to do so, and spraying grasses.
Maintain fire access tracks and footpaths	Regularly inspect and maintain fire access tracks and footpaths as required.

3.7 Education and Training

An important objective of this Plan is to ensure that the local community, visitors to the City's natural areas and those that manage the City's natural areas have the necessary awareness, knowledge, motivation and behaviour to assist in protecting the City's natural areas. Environmental objectives cannot be achieved through the actions of the City alone; the community can also affect the local environment in both positive and negative ways. Environmental outcomes require the support of an engaged community that is aware and participating in environmental activities.

The local community can protect and enhance Mullaloo Foreshore Reserve through the following actions:

- contact the City of Joondalup if they are interested in initiating or participating in an environmental volunteer group such as the MBCG to assist with bushland restoration and maintenance activities
- minimising access and disturbance to the site by staying on paths, not taking vehicles into natural areas, and not allowing dogs to run off-lead
- contain cats, particularly at night, and ensure they stay out of Mullaloo Foreshore Reserve.
- planting local, native species in gardens where possible
- avoid touching or feeding wildlife and picking wildflowers or native plants
- undertaking appropriate hygiene practices such as cleaning footwear when entering and leaving the site, removing any weed seeds attached to clothing and removing and disposing appropriately of dog excrement (may contain weed seed)
- not dumping garden rubbish or littering on site; litter could be collected from site when spotted, or people could organise or get involved with a Clean Up Australia Day event.

Schools are also an important avenue for raising awareness and interest in environmental issues and creating future community members that are aware of, appreciate and actively participate in local environmental management. Mullaloo Beach Primary School is located within close proximity to Mullaloo Foreshore Reserve which creates possible bushland learning opportunities for students.

Current Management Approach

The City implements an Annual Environmental Education Program to address key environmental issues and encourage greater environmental stewardship by the community. The Environmental Education Program includes a Think Green Biodiversity campaign, focussed on raising awareness of key environmental issues within the City and encouraging community participation in protecting the natural environment.

The City implements an Adopt a Coastline Program to give primary school students the opportunity to take part in an environmental program involving education, rehabilitation and conservation activities along the coastline including on-ground coastal activities such as weeding, planting and care of dune systems.

In order to educate the community about how they can protect natural areas, the City has developed a number of key brochures titled '*Being WEEDwise: Garden Escapees in the City of Joondalup*', '*Being WEEDwise: Environmental Weeds in the City of Joondalup*' and '*Protecting our Natural Areas and Parks*'.

The City of Joondalup Natural Areas Team currently conducts regular plant identification training, including weed management. New members in the Natural Areas team undertake training for the identification and management of pathogens.

The City's Friends Groups are instrumental in assisting to protect, preserve and enhance significant bushland areas within the City and may also benefit from training related to pathogen hygiene and weed management. The MBCG operate within Mullaloo Foreshore Reserve.

3.7.1 Recommended Education and Training Management Actions

Action	Detail
Environmental Education Program	Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as: ▪ pathogens ▪ weeds ▪ litter ▪ fire ▪ flora, fauna and fungi awareness ▪ prevention of hand feeding wildlife ▪ responsible pet ownership.
Adopt a Coastline Program	Continue implementing the Adopt a Coastline Program within Mullaloo.
Natural Areas Team Training	Conduct regular Natural Areas Team plant identification training, including weed management, to increase the effectiveness of weed control activities, as required.

4.0 Implementation Plan

4.1 Auditing and Inspection

Inspections of the Mullaloo Foreshore Reserve are conducted by the City of Joondalup as per the Annual Bushland Schedule.

4.2 Key Performance Indicators

A review of the Mullaloo Coastal Foreshore Management Plan will be undertaken annually through reporting against progress made in implementing recommended management actions.

Ongoing reporting against Council endorsed Natural Key Performance Indicators will also be undertaken to ascertain whether current management practices are leading to positive environmental outcomes. These indicators will be measured and reported on an annual, biennial and five yearly basis, as shown in Table 4.

Table 4: Natural Area Key Performance Indicators

Key Performance Indicator	Source	Reporting Period
Density of weeds per area – expressed as a percentage.	Data obtained from site investigations of transects positioned within natural areas.	Annual 2017/18- 2021/22
Waste present in natural areas – items per hectare	This data is collected on an annual basis from ten of the City's reserves.	Annual 2017/18- 2021/22
Percentage of natural areas protected within City reserves	Areas (hectares) included in the City's proposed Conservation Reserves within the District/Local Planning Scheme (previously Schedule 5 and City of Joondalup Bush Forever sites).	Annual 2017/18- 2021/22
Overall change in vegetation vigour (condition) per area – expressed as an increase or decrease in the Vegetation Condition Index (VCI)	Source- Data obtained from analysis of remote multi spectral imagery. The imagery is currently obtained every two years.	Biennial (every two years) 2017/2018 2019/2020 2021/2022
Canopy Cover – expressed as a percentage per natural area	Source- Data obtained from analysis of remote multi spectral imagery. The imagery is currently obtained every two years.	
Vegetation condition per area – expressed using the Keighery Scale* of vegetation condition, expressed as a percentage for each classification (pristine to degraded).	Data obtained through on site floristic survey undertaken to inform the review of the Management Plan, service provided by specialised consultants.	Five Yearly 2021/2022

4.3 Management Plan Review

The Mullaloo Foreshore Reserve Management Plan is to be reviewed every 5 years. The next review is due to occur in 2022/23, which will include a flora, fauna and fungi survey.

4.4 Recommended Management Actions

A summary of the recommended management actions is provided below.

Biodiversity Conservation Area	Recommended Management Action	Detail
Physical Environment	Holistic consideration of erosion	Erosion issues to be considered holistically, with the most appropriate management options being determined on a case by case basis and recognising that all exposed sand does not need to be covered by vegetation, reflecting what would occur within a natural environment.
Physical Environment	Brushing	Brushing materials will be of suitable species that do not contain seed pods or other materials that can propagate and result in the presence of weeds at the site.
Physical Environment	Early consideration of erosion	Address erosion issues as early as possible to avoid larger areas to be rehabilitated later.
Physical Environment	Wider context	Consider erosion in the wider context of climate change impacts that could occur over time.
Flora	Weed monitoring	Continue to undertake weed surveys every six months.
Flora	Targeted weed control	Continue to undertake a targeted weed control program, as described in Appendix 6.
Flora	Ongoing weed control	Continue to undertake coordinated approach to regular weed control by implementing the Annual Bushland Schedule.
Flora	Targeted Weed Control	Continue to prioritise the control of high and very high priority weeds within the Mullaloo Foreshore Reserve, determining the best method of control for these species.
Flora	Weed Management Plan	Implement the City of Joondalup Weed Management Plan to provide an ongoing strategic approach to the management of natural areas in order to reduce the incidence of weeds.
Flora	Restoration	Conduct revegetation as outlined in the Revegetation Strategy in Appendix 7.
Flora	Friends Group	Continue to support the activities of the MBCG.
Fungi	Opportunistic fungi survey	Continue to undertake opportunistic fungi sightings during other site activities.
Pathogens	Pathogen Management	Implement recommendations from the Pathogen Management Plan that are applicable to the management of the Mullaloo Foreshore Reserve, particularly in sites affected by pathogens.

Biodiversity Conservation Area	Recommended Management Action	Detail
Pathogens	Pathogen Management	Implement *Pathogen and Weed Hygiene Guidelines* and *Purchasing of Landscaping Materials Guidelines* to prevent the introduction or spread of weeds or pathogens into the Mullaloo Foreshore Reserve
Fauna	Fauna	Carry out follow-up fauna surveys in spring and a targeted invertebrate survey after five years.
Fauna	Feral animal control	Continue to monitor feral animal populations and implement regular fox and rabbit control to reduce pressures on native fauna and flora.
Fauna	Dog control	Dogs are controlled in accordance with the *Dog Act 1976* (WA) and City of Joondalup's policies and procedures in relation to removal on land managed by the City.
Fauna	Cat Control	The City commenced cat control in 2017 on foreshore reserves; to control cats in accordance with the *Cat Act 2011* (WA) and City of Joondalup's policies and procedures in relation to their trapping and removal on land managed by the City.
Social and Built Environment	Access	Implement recommendations outlined in the Walkability Plan as they relate to the Mullaloo Foreshore Reserve.
Social and Built Environment	Fencing	Regularly review sand build up along the beach fence and arrange removal when required.
Social and Built Environment	Water erosion from drainage	Erosion within the sump particularly around the inlet drain be monitored and restored when water erosion is found.
Social and Built Environment	Signage maintenance	Continue inspections in conjunction with other monitoring activities on a regular basis, and repair or replace damaged or vandalised signs as required.
Social and Built Environment	Inappropriate signage	Any advertisement signage affixed to the fencing or other locations in the Reserve by business owners or individuals be removed when observed.
Social and Built Environment	Rubbish	Monitoring of rubbish around the reserve continue, with removal occurring when observed.
Social and Built Environment	Anti-social behaviour	Monitor evidence of anti-social behaviour, promptly: ▪ removing any cubbies, or dumped rubbish ▪ repairing vandalised assets and/or infrastructure ▪ restoring damage to bushland areas as soon as possible after discovery.
Fire Management	Assess fire fuel load	Continue to annually assess and report fire fuel load using the DFES *Visual Fuel Load Guide for the Swan Coastal Plain and Darling Scarp* to inform fire prevention actions required.
Fire Management	Develop and implement Fire Management Plan	Develop and implement a Bushfire Risk Management Plan, outlining the City's strategy for assessing fire risk, prevention, response and recovery.

Biodiversity Conservation Area	Recommended Management Action	Detail
Fire Management	Monitor Fire occurrences	Continue to monitor fire occurrences through mapping and updating Geographic Information System (GIS) layers detailing fire incidents and frequency to inform fire prevention actions.
Fire Management	Post Fire Weed Management	After fires, implement the *Post Fire Weed Management Guidelines* to aid regrowth of native species by selecting appropriate chemicals, targeting weeds if safe to do so, and spraying grasses.
Fire Management	Maintain fire access tracks and footpaths	Regularly inspect and maintain fire access tracks and footpaths as required.
Education	Environmental Education Program	Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as: ▪ pathogens ▪ weeds ▪ fire ▪ flora and fauna awareness ▪ prevention of hand feeding wildlife ▪ responsible pet ownership.
Education	Adopt a Coastline Program	Continue implementing the Adopt a Coastline Program within Mullaloo.
Education	Natural Areas Team Training	Conduct regular Natural Areas Team plant identification training, including weed management, to increase the effectiveness of weed control activities.

5.0 References

Arbor Carbon. (2015). *Phase 2 Pathogen Sampling and Mapping Project – Final Report*. Unpublished report prepared for the City of Joondalup.

Australian Pesticides and Veterinary Medicines Authority. (2017). *Agriculture and Veterinary Permits Search*. Retrieved May 2017 from: http://apvma.gov.au/search.

Australian Wildlife Conservancy. (2012/2013). Stopping the Slaughter: Fighting Back Against Feral Cats, in Wildlife *Matters*, Summer 2012/2013, retrieved October 2017 from: http://www.australianwildlife.org/media/27964/AWC-Wildlife-Matters-Summer-2012-2013.pdf.

Biosecurity and Agricultural Management Act 2007 (WA)

Bougher, N. (2009). *Fungi of the Perth Region and Beyond: A Self-Managed Field Book*. Perth. Western Australia.

Brown, K., Brooks, B. (2002). *Bushland Weeds*. Greenwood, Western Australia: Environmental Weeds Action Network (Inc.).

Bureau of Meteorology. (2017). *Climate and Weather Statistics*. Retrieved April 2017 from: http://www.bom.gov.au/climate/data/.

Cat Act 2011 (WA)

City of Joondalup (CoJ). (2015). *Access and Inclusion Plan 2015 – 2017*. Retrieved October 2017 from http://www.joondalup.wa.gov.au/Files/2015-2017%20Access%20and%20Inclusion%20Plan.pdf.

City of Joondalup (CoJ). (2014a). *City of Joondalup Environment Plan 2014-2019*. Retrieved June 2016 from: http://www.joondalup.wa.gov.au/Files/8506%20Environment%20Plan%202014-2019%20Final%20WEB.pdf.

City of Joondalup (CoJ). (2014b). *Climate Change Strategy 2014 – 2019*. Retrieved May 2016 from: http://www.joondalup.wa.gov.au/Files/Climate%20Change%20Strategy%202014-2019.pdf.

City of Joondalup (CoJ). (2015). *City of Joondalup Purchasing Guidelines for the Supply of Landscaping Materials – COJ BMM Guideline 4.0: Purchasing Materials*. City of Joondalup, Western Australia.

City of Joondalup (CoJ). (2016a). Local Planning Scheme No. 2 – Updated to include AMD 84 GG 13/12/16. Retrieved October 2017 from: http://www.planning.wa.gov.au/LPS/DATA/Local%20Planning%20Schemes/Joondalup%20-%20City%20of%20(Scheme%202)/index.aspx.

City of Joondalup (CoJ). (2012). *Pathogen Management Plan*. Retrieved October 2017 from: http://www.joondalup.wa.gov.au/Files/7902%20COJ%20Pathogen%20Management%20Plan%202013-2016%20V4%20Single%20Column%20Web%20Version.pdf.

City of Joondalup (CoJ). (2013). *Walkability Plan 2013 – 2018*. Retrieved October 2017 from: http://www.joondalup.wa.gov.au/Files/8077%20Walkability%20Plan%201COLUMN%20V4.pdf.

City of Joondalup (CoJ). (2016b). *Weed Management Plan 2016*. Retrieved October 2017 from: http://www.joondalup.wa.gov.au/Libraries/City_Policies/9463_Weed_Management_Plan_v4_2.pdf.

Climate Commission. (2011). *The Critical Decade: Western Australian Climate Change Impacts*. Retrieved October 2017 from: https://www.climatecouncil.org.au/uploads/e0d4e50478b96d1a50c821b7b2c022a4.pdf.

Conservation International. (2017). *Hotspots*. Retrieved April 2017 from: http://www.conservation.org/How/Pages/Hotspots.aspx.

Department of Aboriginal Affairs. (2017). *Aboriginal Heritage Inquiry System*. Retrieved April 2017 from: http://maps.dia.wa.gov.au/AHIS2/.

Department of Agriculture and Food, (2017a), *Pest Insects – Portuguese millipedes* (currently under review), Retrieved April 2017 from: https://www.agric.wa.gov.au/pest-insects/portuguese-millipedes.

Department of Agriculture and Food WA. (2017b). *Natural Resource Information – Soils and Contours*. Retrieved April 2017 from: https://maps.agric.wa.gov.au/nrm-info/.

Department of Parks and Wildlife. (2012). *DPaW Weed Prioritisation Process – Swan Ranking Summary*. Retrieved October 2015 from: http://www.dpaw.wa.gov.au/search?searchword=swan%20weed%20ranking%20summary&searchphrase=al

Department of Environment Regulation. (2016). *Treatment and Management of Soil and Water in Acid Sulfate Soil Landscapes*. Department of the Environment, Western Australia.

Department of the Environment and Energy. (2016). *Threatened Species Strategy*. Retrieved May 2017 from: https://www.environment.gov.au/biodiversity/threatened/publications/threatened-species-strategy

Department of the Environment and Energy. (2017). *Weeds in Australia*. Retrieved May 2017 from: http://www.environment.gov.au/biodiversity/invasive/weeds/.

Department of Environment and Conservation. (undated). *What are Acid Sulphate Soils?* Retrieved June 2015 from: http://www.der.wa.gov.au/images/documents/your-environment/acid-sulfate-soils/fact_sheets/ass_fact_sheets1.pdf.

Department of Fire and Emergency Services (DFES). (2015). *Visual Fuel Load Guide for the Swan Coastal Plain and Darling Scarp*. Retrieved April 2017 from: https://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/VisualFuelLoadsPublications/Visual%20Fuel%20Load%20Guide%20Swan%20Coastal.pdf.

Department of Fire and Emergency Services (DFES). (2017a). *The Department of Fire and Emergency Services – Safety Information*. Retrieved April 2017 from: https://www.dfes.wa.gov.au/safetyinformation/Pages/default.aspx.

Department of Fire and Emergency Services (DFES). (2017b). *Fire Callouts – Foreshore; at Mullaloo*. Unpublished report provided to Natural Area Consulting Management Services.

Department of Parks and Wildlife. (2016). *Conservation Codes*. Retrieved May 2016 from: http://www.dpaw.wa.gov.au/images/documents/plants-animals/threatenedspecies/Listings /Conservation_code_definitions_18092013.pdf.

Department of Planning, Heritage and Lands. (2017). *Metropolitan Region Scheme*. Retrieved October 2017 from: https://www.planning.wa.gov.au/1222.aspx.

Department of Water (DOW). (undated). *Gnangara Groundwater System*. Retrieved May 2015 from: http://www.water.wa.gov.au/water-topics/groundwater/understanding-groundwater/gnangara-groundwater-system.

Department of Water. (2017). *Perth Groundwater Map*. Retrieved April 2017 from: https://maps.water.wa.gov.au/#/webmap/gwm.

Dog Act 1976 (WA)

Eco Logical Australia, (2016), *Whitfords Nodes Foreshore Flora, Fauna and Fungi Survey*, unpublished draft report prepared by Eco Logical Australia for the City of Joondalup.

Environmental Defender's Office WA (Inc.) (EDOWA). (2011). *Bush Fires Fact Sheet No. 35*. Perth, Western Australia.
Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)

Environmental Protection Authority (EPA) and Department of Environment and Conservation (DEC). 2010. *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment* (eds. B.M. Hyder, J. Dell and M.A. Cowan). Perth, Western Australia.

Environmental Protection Authority. (2004a). *Guidance for the Assessment of Environmental Factors. Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*. Environmental Protection Authority, Perth Western Australia.

Environmental Protection Authority. (2004b). *Guidance for the Assessment of Environmental Factors, Guidance Statement 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. Environmental Protection Authority, Perth Western Australia.

Environmental Protection Authority (EPA), (2015). *Perth and Peel @ 3.5 Million Environmental impacts, risks and remedies*. Interim strategic advice of the Environmental Protection Authority to the Minister for Environment under section 16 (e) of the *Environmental Protection Act 1986.*

Gibson N., Keighery B. J., Keighery G. J., Burbidge A. H. and Lyons M. N. (1994). *A Floristic survey of the southern Swan Coastal Plain.* Unpublished report for the Australian Heritage Commission, prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc.).

Government of Western Australia. (2000). *Bush Forever, Volume 2 – Directory of Bush Forever Sites*. Perth Western Australia: Department of Environmental Protection.

Groves R. H., Boden R. and Londsdale W.M. (2005) *Jumping the Garden Fence: Invasive Garden Plants in Australia and their Environmental and Agricultural Impacts*. CSIRO report prepared for WWF-Australia. Sydney, New South Wales.

Heddle, E.M., Loneragan, O.W. & Havel, J.J. (1980), *Vegetation Complexes of the Darling System, Western Australia*, In: *Atlas of Natural Resources, Darling System*, *Western Australia*, Department of Conservation and Environment, Perth, Western Australia.

Landgate. (2016). *Map Viewer*. Retrieved March 2016 from: https://www.landgate.wa.gov.au/bmvf/app/mapviewer/.

Mitchell, Williams and Desmond, (2002), *Swan Coastal Plain 2* (*SWA2 – Swan Coastal Plain Subregion*), available World Wide Web URL: http://www.dec.wa.gov.au/pdf/science/bio_audit/swan_coastal_plain02_p606-623.pdf, accessed October 2016.

M P Rogers and Associates P/L, (2016), *Joondalup Coastal Hazard Assessment*, unpublished report prepared by M P Rogers and Associates for the City of Joondalup. Retrieved October 2017 from http://www.joondalup.wa.gov.au/Files/Joondalup%20Coastal%20Hazard%20Assessment%202016.pdf.

National Wildlife Corridors Plan Advisory Group (NWCPAG), (2012), *National Wildlife Corridors Plan*, Canberra, Australia.

Natural Area Consulting. (2013). *Joondalup Coastal Foreshore, Natural Areas Management Plan*. Unpublished report prepared for the City of Joondalup.

Robinson, R., n.d. *Forest Fungi: Lifestyles of the little-known*. Department of Conservation and Land Management. Manjimup, Western Australia.

Scott, P., Burgess, T., Barber, P., Shearer, B., Stukely, M., Hardy, G., and Jung, T. (2009). '*Phytophthora multivora* sp. Nov., a New Species Recovered from Declining *Eucalyptus*, *Banksia*, *Agonis* and Other Plant Species'. in *Persoonia* 22, 2009:1 – 13.

Smith, I., and Smith, D., (2003), *Forest Fact Sheet – Armillaria Root Rot: A Disease of Native and Introduced Trees*, Forest Science Centre, Department of Sustainability and Environment, Victoria, available World Wide Web URL: http://www.dse.vic.gov.au/__data/assets/pdf_file/0013/102145/Armillaria_Root_Rot.pdf, accessed October 2013.

Western Australian Local Government Association (WALGA), (2010), *Native vegetation extent by vegetation complexes for each Local Government in Perth and Peel*, Retrieved June 2016 from: http://lbp.walga.asn.au/Publications.aspx.

Western Australian Local Government Association (WALGA), (2013), *Native vegetation on the Swan Coastal Plain*. Retrieved June 2016 from: http://pbp.walga.asn.au/Home.aspx.

Appendix 1: Bush Forever Vegetation Structural Classes

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

(Source: Government of Western Australia, 2000)

Appendix 2: Vegetation Condition Rating Scale

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

(Source: Government of Western Australia, 2000)

Appendix 3: Flora Species List for Mullaloo Foreshore

This flora list was compiled from Natural Areas flora survey in 2016 and site assessments in 2017.
Sorted by class then family
*Denotes introduced species

Family	Species Name	Common Name
	CLASS: Bryopsida (Moss)	
POTTIACEAE	*Didymodon torquatus*	Moss
	CLASS: Pinopsida (Pines and Conifers)	
CUPRESSACEAE	*Callitris preissii*	Rottnest Island Pine
	CLASS: Liliopsida (Monocotyledons)	
ASPARAGACEAE	*Acanthocarpus preissii*	
	Lomandra maritima	
ASPHODELACEAE	**Trachyandra divaricata*	Trachyandra
CYPERACEAE	*Ficinia nodosa*	Knotted Club Rush
	Isolepis cernua var. *setiformis*	
	Lepidosperma gladiatum	Coast Sword-sedge
HAEMODORACEAE	*Conostylis candicans* subsp. *calcicola*	
IRIDACEAE	**Moraea flaccida*	One-leaf Cape Tulip
	**Romulea rosea*	Guildford Grass
POACEAE	**Avena barbata*	
	**Bromus diandrus*	Great Brome
	**Ehrharta longiflora*	Annual Veldt Grass
	**Lagurus ovatus*	Hare's Tail Grass
	**Lolium rigidum*	Wimmera Ryegrass
	**Poa annua*	Winter Grass
	Spinifex hirsutus	Hairy Spinifex
	Spinifex longifolius	Beach Spinifex

Family	Species Name	Common Name
	**Thinopyrum distichum*	Sea Wheat
TYPHACEAE	**Typha orientalis*	Bulrush
	CLASS: Magnoliopsida (Dicotyledons)	
AIZOACEAE	*Carpobrotus virescens*	Coastal Pigface
	**Tetragonia decumbens*	Sea Spinach
ANACARDIACEAE	**Schinus terebinthifolius*	Japanese Pepper Tree
ASTERACEAE	**Arctotheca calendula*	Cape weed
	**Gazania linearis*	Gazania
	**Leontodon rhagadioloides*	Cretan Weed
	Leucophyta brownii	
	Olearia axillaris	Coastal Daisybush
	**Osteospermum ecklonis*	African Veldt Daisy
	**Sonchus asper*	Rough Sowthistle
	**Sonchus oleraceus*	Common Sowthistle
	**Urospermum picroides*	False Hawkbit
BRASSICACEAE	**Brassica tournefortii*	Mediterranean Turnip
	**Cakile maritima*	Sea Rocket
CASUARINACEAE	**Casuarina equisetifolia*	
CHENOPODIACEAE	*Atriplex cinerea*	Grey Saltbush
	Atriplex isatidea	Coast Saltbush
	Rhagodia baccata	Berry Saltbush
	Threlkeldia diffusa	Coast Bonefruit
CRASSULACEAE	**Crassula glomerata*	
DILLENIACEAE	*Hibbertia racemosa*	Stalked Guinea Flower

Family	Species Name	Common Name
EUPHORBIACEAE	**Euphorbia paralias*	Sea Spurge
EUPHORBIACEAE	**Euphorbia peplus*	Petty Spurge
	**Euphorbia terracina*	Geraldton Carnation Weed
	**Ricinus communis*	Castor Oil Plant
FABACEAE	*Acacia cochlearis*	Rigid Wattle
	Acacia cyclops	Coastal Wattle
	Acacia lasiocarpa var. *lasiocarpa*	Panjang
	Acacia rostellifera	Summer Scented Wattle
	Acacia saligna	Orange Wattle
	Acacia truncata	
	Hardenbergia comptoniana	Native Wisteria
	**Lupinus cosentinii*	Blue Lupin
	**Medicago polymorphus*	Burr Medic
	**Melilotus indicus*	
	**Trifolium campestre*	Hop Clover
GERANIACEAE	**Pelargonium capitatum*	Rose Pelargonium
GOODENIACEAE	*Scaevola crassifolia*	Thick-leaved Fan-flower
MALVACEAE	**Malva parviflora*	Marshmallow
	Thomasia triphylla (planted)	
MYRTACEAE	**Eucalyptus utilis*	
	Melaleuca cardiophylla (planted)	Tangling Melaleuca
	Melaleuca huegelii	Chenille Honeymyrtle
	Melaleuca lanceolata	Rottnest Teatree
	**Melaleuca nesophila*	Mindiyed
	Melaleuca systena	

Family	Species Name	Common Name
ONAGRACEAE	**Oenothera drummondii* subsp*. drummondii*	Beach Evening Primrose
OXALIDACEAE	**Oxalis pes-caprae*	Soursob
PAPAVERACEAE	**Fumaria capreolata*	Whiteflower Fumitory
PRIMULACEAE	**Lysimachia arvensis*	Pimpernel
PROTEACEAE	*Grevillea crithmifolia*	
	Grevillea thelemanniana	Spider Net Grevillea
RHAMNACEAE	*Spyridium globulosum*	Basket Bush
RUBIACEAE	**Gallium murale*	Small Goosegrass
SANTALACEAE	*Leptomeria preissiana*	
SCROPHULARIACEAE	**Dischisma arenarium*	
	Eremophila glabra	Tar Bush
	Myoporum insulare	Blueberry Tree
TROPAEOLACEAE	**Tropaeolum majus*	Garden Nasturtium

Appendix 4: Fauna List for Mullaloo Foreshore

A complete list of fauna species is provided below showing the results from the 2016 survey undertaken by Natural Area (NA 2016), and observations recorded by the Mullaloo Beach Community Group (MBCG), and opportunistic observations during site assessments by Natural Area (NA 2017).

Mammals					
Family	**Species Name**	**Common Name**	**MBCG**	**NA 2016**	**NA 2017**
Canidae	**Canis lupus familiaris*	Domestic Dog		X	
Canidae	*Vulpes vulpes	European Red Fox	X		
Leporidae	**Oryctolagus cuniculus*	European Rabbit	X	X	
Muridae	** Mus musculus*	House Mouse		X	
Peramelidae	*Isoodon obesulus fusciventer*	Southern Brown Bandicoot, Quenda	X	X	
Birds					
Family	**Species Name**	**Common Name**	**MBCG**	**NA 2016**	**NA 2017**
Accipitridae	*Elanus caeruleus axillaris*	Black-shouldered Kite	X	X	
Artamidae	*Cracticus tibicen*	Australia Magpie		X	
Cacatuidae	*Cacatua roseicapilla*	Galah	X	X	
Cacatuidae	*Cacatua sanguinea*	Little Corella		X	
Cacatuidae	*Calyptorhynchus latirostris* (T/En)	Carnaby's Cockatoo	X		
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike		X	
Columbidae	**Streptopelia chinensis*	Spotted Turtle-Dove		X	
Columbidae	**Streptopelia senegalensis*	Laughing Turtle-Dove		X	
Columbidae	*Columbia livia domestica*	Feral Pigeon, Rock Dove		X	

Birds					
Family	**Species Name**	**Common Name**	**MBCG**	**NA 2016**	**NA 2017**
Corvidae	*Corvus coronoides*	Australia Raven	X	X	
Falconidae	*Falco cenchroides*	Nankeen Kestrel	X	X	
Falconidae	*Falco longipennis*	Australian Hobby	X		
Hirundinidae	*Hirundo neoxena*	Welcome Swallow			X
Laridae	*Larus novaehollandiae*	Silver Gull	X	X	
Laridae	*Larus pacificus*	Pacific Gull	X		
Laridae	*Thalasseus bergii*	Crested Tern		X	
Maluridae	*Malurus lamberti*	Variegated Fairy-wren	X	X	
Maluridae	*Malurus leucopterus*	White-winged Fairy-wren	X		X
Meliphagidae	*Anthochaera carunculata*	Red wattlebird		X	
Meliphagidae	*Anthochaera lunulata*	Western Wattlebird		X	
Meliphagidae	*Lichenostomus virescens*	Singing Honeyeater		X	
Meliphagidae	*Lichmera indistincta*	Brown Honeyeater	X	X	
Meliphagidae	*Phylidonyris niger*	White-cheeked Honeyeater		X	
Meliphagidae	*Phylidonyris novaehollandiae*	New Holland Honeyeater	X	X	
Pelecanidae	*Pelecanus conspicillatus*	Australian Pelican	X		
Petroicidae	*Eopsaltria georgiana*	White-breasted Robin	X	X	
Psittacidae	**Trichoglossus haematodus*	Rainbow Lorikeet		X	
Rallidae	*Gallirallus philippensis*	Buff-banded Rail	X		
Rhipidura	*Rhipidura leucophrys*	Willie Wagtail	X	X	

Zosteropidae	*Zosterops lateralis*	Silvereye	X	X	
Reptiles					
Family	**Species Name**	**Common name**	**MBCG**	**NA 2016**	**NA 2017**
Elapidae	*Pseudonaja affinis*	Dugite		X	
Gekkonidae	*Strophurus spinigerus*	South-Western Spiny-tailed Gecko		X	
Pygopodidae	*Aprasia repens*	Sandplain Worm-Lizard		X	
Scincidae	*Ctenotus australis*	Western Limestone Ctenotus		X	
Scincidae	*Ctenotus fallens*	West Coast Ctenotus		X	
Scincidae	*Egernia kingii*	King's Skink		X	
Scincidae	*Hemiergis quadrilineata*	Two-toed Earless Skink		X	
Scincidae	*Lerista elegans*	Elegant Slider		X	
Scincidae	*Tiliqua rugosa rugosa*	Bobtail		X	
Invertebrates					
Family	**Species Name**	**Common Name**	**MBCG**	**NA 2016**	**NA 2017**
Acrididae		Grasshopper	X		
Anisolabididae		Earwig		X	
Apidae	*Apis mellifera**	European Honey Bee	X	X	
Araneae		Brown Spider		X	
Armadillidiidae	*Armadillidium vulgare**	Introduced Rolling Slater		X	
Armadillidiidae	*Porcellionoides* sp.	Introduced Purple Woodlouse		X	
Blattidae	*Cutilia nigra*	Bush Cockroach		X	
Buthidae	*Lychas marmoreus*	Marbled Scorpion		X	

Invertebrates					
Family	**Species Name**	**Common Name**	**MBCG**	**NA 2016**	**NA 2017**
Carabidae		Carab Beetle		X	
Chysomelidae		Leaf Beetle		X	
Cicadidae		Cicada		X	
Cossidae		Goat Moth, Wood Moth		X	
Curculionidae	*Catasarcus* sp.	Weevil	X	X	
Formicidae	*Camponotus minimus*	Ant	X	X	
Formicidae	*Camponotus terebrans*	Ant		X	
Grillidae		Field cricket		X	
Julidae	*Ommatioulus moreleti**	Portuguese Millipede	X	X	
Lepismatidae	*Ctenolepisma* sp.	Silverfish		X	
Lycosidae	*Lycosa sp.*	Wolf Spider		X	
Lymantiidae		Tussock Moth	X		
Mutillidae	*Ephutomorpha* sp.	Velvet Ant		X	
Nymphalidae	*Vanessa kershawi*	Australian Painted Lady	X		
Pentatomidea		Shield Bug		X	
Pyrgomorphidae		Grasshopper		X	
Pieridae	*Pieris rapae*	Cabbage Butterfly		X	
Pisauridae		Fishing Spider		X	
Pompilidae		Spider wasp		X	
Reduviidae		Assassin bug		X	

Invertebrates					
Family	**Species Name**	**Common Name**	**FOMF**	**NA 2016**	**NA 2017**
Scolopendridae	Scolopendra sp.	Pale Centipede	X	X	
Tabanidae		March Fly	X	X	
Tenebrionidae	*Pterohelaeus* sp.	Piedish beetle		X	

Appendix 5: Key Weed Species in Mullaloo Foreshore Reserve

Species Name	Common Name	Prioritisation	Photograph
Carpobrotus edulis	Hottentot Fig	High priority (DPaW Swan Environmental Weed List)	
Euphorbia paralias	Sea Spurge	Moderate priority (DPaW Swan Environmental Weed List)	
Euphorbia terracina	Geraldton Carnation Weed	Moderate priority (DPaW Swan Environmental Weed List)	
Gazania linearis	Gazania	Moderate priority (DPaW Swan Environmental Weed List)	

Species Name	Common Name	Prioritisation	Photograph
Moraea flaccida	One-leaf Cape Tulip	C3 Declared Pest	
Ricinus communis	Castor Oil Plant	Moderate priority (DPaW Swan Environmental Weed List)	
Schinus terebinthifolius	Japanese Pepper Tree	Moderate priority (DPaW Swan Environmental Weed List)	
Tetragonia decumbens	Sea Spinach	High priority (DPaW Swan Environmental Weed List)	

Significant Weeds Identified and their Potential Environmental Impact

Species	Common Name where applicable	DPaW Swan Region Environmental Weed List			Natural Area Recommended Control Priority
		Ecological Impact H: high M: medium L: low U: unknown	Rate of dispersal R: rapid M: moderate S: slow	General trend D: decreasing S: stable I: increasing U: unknown	
Agave americana	Century Plant	M	M	S	Moderate
Avena barbata	Wild Oat	H	R	I	Moderate
Bromus diandrus	Great Brome	H	R	I	High
Carpobrotus edulis	Hottentot Fig	H	S	U	High
Ehrharta longiflora	Annual Veldt Grass	H	R	S	High
Euphorbia terracina	Geraldton Carnation Weed	H	R	I	Very High
Gazania linearis	Gazania	H	R	I	Moderate
Moraea flaccida	One-leaf Cape Tulip	H	R	I	Very High
Oenothera drummondii	Primrose	L	M	I	Moderate
Pelargonium capitatum	Rose Pelargonium	H	R	I	High
Ricinus communis	Castor Oil Plant	M	R	I	Moderate
Schinus terebinthifolius	Japanese Pepper Tree	H	M	I	High
Tetragonia decumbens	Sea Spinach	H	R	I	High
Trachyandra divaricata	Trachyandra	M	R	I	Moderate

(Source: Department of Parks and Wildlife, 2015)

Appendix 6: Weed Management

Weed control is an ongoing management issue within Mullaloo Foreshore Reserve. It will contribute to the reduction of competition with natives for resources, and result in enhanced vegetation condition and fauna habitat. The City of Joondalup personnel and contractors currently undertake weed control and are involved in the manual removal of weeds across the Reserve. Weed control activities will be undertaken in accordance with the City's operational procedures and guidelines.

Weed management can be achieved through the use of manual, chemical, or biological treatment methods, with manual and chemical treatments being the most common to remove weeds from coastal and terrestrial bushland areas. Characteristics of particular target species determine what weed control method is used. The presence of native flora will need to be taken into account when determining the most appropriate weed control technique for an area, especially the location of significant flora. The table below describes the different type of weed treatments recommended for those species observed on site. Treatment rates were taken from the recommended rates from off label permit no. 13333 issued by the Australian Pesticides and Veterinary Medicines Authority (2012). It is recommended that herbicides such as metsulfuron and triasulfuron be used once a year at the recommended dose in the reserve to reduce residual effect in soils, which can lead to some species becoming resistant to their effects and associated death of non-target species. The recommended treatment and treatment times are shown in weed control methodology table (DPaW, FloraBase 2017; Brown and Brooks, 2002). Chemical weed control activities will be in accordance with the City's operational procedures and guidelines.

Weed treatment types

Treatment Number	Treatment Type	Targeted Species	Application Method and Comments
1	Glyphosate Spray	Annual and perennial grass and broadleaf weeds	Spot spray – non-selective
2	Selective grass herbicide (such as Quizalofop or Fusilade Forte)	Annual and perennial grasses	Spot spray, or overall spray in broad leaf host situations – selective grass spray
3	Metsulfuron	Annual broadleaf weeds and bulbs	Spot spray – semi selective
4	Glyphosate glove/Metsulfuron glove sponge wipe	One-leaf Cape Tulip	Wipe Leaves with sponge prior to or just on flowering
5	Triclopyr, Picloram, or Glyphosate	Woody weeds and trees	Cut and paint or basal bark (summer)
6	Manual removal /hand weeding	Carnation Weeds, Fleabane, Pigface, and similar	Gloves required due to caustic sap of Carnation Weed
7	Triasulfuron	Carnation Weeds, Brassicaceae weeds post emergence and other annual	Spot spray - selective

(Source: DPaW, FloraBase 2017; Brown and Brooks, 2002)

Weed Control Methodology

Species Name	Common Name	Treatment Number	Timing
Agave americana	Century Plant	5 or 6	Year round
Arctotheca calendula	Cape Weed	1 or 6	June – November
Avena barbata	Wild Oats	2	July – November
Brassica tournefortii	Mediterranean Turnip	1 or 7	May – September
Bromus diandrus	Brome Grass	2	June – September
Cakile maritima	Sea Rocket	1 or 6	June – November
Crassula glomerata		1 or 6	July – September
Dischisma arenaria		1 or 6	July – September
Ehrharta longiflora	Annual Veldt Grass	2	June – August (before flowering)
Euphorbia paralias	Sea Spurge	1 or 6	June – October
Euphorbia peplus	Petty Spurge	1 or 6	June – September
Euphorbia terracina	Geraldton Carnation Weed	1, 6 or 7	Manual: June – November Herbicide: August – September
Fumaria capreolata	Whiteflower Fumitory	3 or 6	July – September
Galium murale	Small Goosegrass	1 or 6	July – August
Gazania linearis	Gazania	1	June – October
Lagurus ovatus	Hare's Tail Grass	2 or 6	Manual: July – December Herbicide: June – August
Leontodon rhagadioloides	Cretan Weed	1 or 6	June – November
Lolium rigidum	Wimmera Ryegrass	1, 2 or 6	July – October
Lupinus cosentinii	Blue Lupin	3 or 6	June – September
Lysimachia arvensis	Blue Pimpernel	1	June – November
Malva parviflora	Marshmallow	1 or 6	Manual: April – September Herbicide: April – June (only effective in early growth stages)
Medicago polymorphus	Burr Medic	3	July – August
Melaleuca nesophila	Mindiyed	5 or 6	Year round
Melilotus indicus		3 or 6	July – November
Moraea flaccida	One-leaf Cape Tulip	4	July – August
Oenothera drummondii	Beach Primrose	1	July – September
Osteospermum ecklonis	African Veldt Daisy	1 or 6	June – November

Species Name	Common Name	Treatment Number	Timing
Oxalis pes-caprae	Soursob	3	June – July
Pelargonium capitatum	Rose Pelargonium	1	June – October
Poa annua	Winter Grass	2	June – October
Ricinus communis	Castor Oil Plant	5 or 6	September – December
Romulea rosea	Guildford Grass	3	July – August
Schinus terebinthifolius	Japanese Pepper Tree	5 or 6	December – February
Solanum nigrum	Black Berry Nightshade	1 or 6	June – November
Sonchus asper	Rough Sowthistle	1 or 6	Manual: June – October Herbicide: June – July
Sonchus oleraceus	Common Sowthistle	1 or 6	Manual: June – November Herbicide: June – September
Tetragonia decumbens	Sea Spinach	1	June – October
Thinopyrum distichum	Sea Wheat		June – September
Trachyandra divaricata	Trachyandra	1 or 4	June – August
Trifolium campestre	Hop Clover	1	June – August
Tropaeolum majus	Garden Nasturtium	1	June – September
Typha orientalis	Bulrush	1 and 6	December - February
Urospermum picroides	False Hawkbit	1 or 6	June – August

Implementation Schedule

A recommended implementation schedule is provided below outlining all the works set outlined in Appendix 5 and 6. The schedule is set up for rehabilitation works to commence in the spring of 2018 with completion of prescribed works in 2021.

Year 1 (2018)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Glyphosate Spray						■	■	■	■			
Selective Grass Spray						■	■					
Triclopyr or Picloram	■	■	■									■
Metsulfuron								■				
Triasulfuron								■	■			■
Hand Weeding			■			■			■			■
Revegetation all zones						■	■					
Informal monitoring	■	■	■	■	■	■	■	■	■	■	■	■

Year 2 (2019)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Glyphosate Spray												
Selective Grass Spray												
Triclopyr or Picloram												
Metsulfuron												
Triasulfuron												
Hand Weeding												
Revegetation all zones (Infill)												
Informal monitoring												

Year 3 (2020)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Glyphosate Spray												
Selective Grass Spray												
Triclopyr or Picloram												
Metsulfuron												
Triasulfuron												
Hand Weeding												
Revegetation all zones (Infill)												
Informal monitoring												

Year 4 (2021)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Glyphosate Spray												
Selective Grass Spray												
Triclopyr or Picloram												
Metsulfuron												
Triasulfuron												
Hand Weeding												
Revegetation all zones (Infill)												
Informal monitoring												

Appendix 7: Restoration and Regeneration

Restoration within the Mullaloo Foreshore Reserve will enhance biodiversity within the site and stabilise the dunes and reduce erosion. Restoration will focus on the vegetation condition areas assessed as Good. It is recommended that this revegetation program be carried out over a five-year period, from 2018 until 2022, and that planting occur from June to August each year.

Areas classified as having Good vegetation condition located on site are recommended to be prioritised for restoration to reduce potential impacts of erosion. Rehabilitation areas were focussed on areas with large areas of bare ground, particular the periphery of vegetated blocks and areas on hillslopes to reduce erosion and the introduction of weeds into vegetated areas. The largest area selected for revegetation was in the region south of the surf club. This area is not currently actively managed by the MBCG and has a higher proportion of weeds, open areas and erosion. These seven revegetation areas are shown in the figures below. Revegetation for the site has been split into seven areas and involves the installation of 5150 plants:

- Area 1 – 272 m^2 (250 plants)
- Area 2 – 364 m^2 (300 plants)
- Area 3 – 603 m^2 (500 plants)
- Area 4 – 254 m^2 (250 plants)
- Area 5 – 599 m^2 (450 plants)
- Area 6 – 1228 m^2 (1100 plants)
- Area 7 – 4606 m^2 (2300 plants).

Planting density of 1 plant/m^2 is recommended, taking into consideration existing native plants present planting numbers have been reduced for certain areas. Tubestock is recommended to be:

- sourced from a NIASA accredited nursery
- grown from local provenance seed
- hardened off and in good condition prior to planting.

Note that some species are difficult to grow and consideration will need to be given to the collection of suitable seed, with germination often taking more than one season. It is recommended that guarding and staking of new planting occurs to mitigate detrimental impacts of strong winds, salt spray and erosion due to the close proximity to the ocean. Indicative plant species numbers for the priority restoration areas are provided in the Table below, noting that the numbers will be lower than 1/m^2 is some areas to account for existing native vegetation.

Indicative Plant Numbers for Priority Restoration Areas

Species Name	Form	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7
Acacia lasiocarpa var. *lasiocarpa*	Small shrub	0	0	50	0	50	125	100
Acanthocarpus preissii	Small shrub	0	0	50	0	50	125	100
Carpobrotus virescens	Ground cover	10	10	50	10	30	100	80
Conostylis candicans subsp. *calcicola*	Herb	0	0	30	0	20	60	50
Ficinia nodosa	Sedge	15	15	50	15	50	100	50
Hardenbergia comptoniana	Climber	0	0	20	0	20	40	60
Hemiandra glabra	Ground cover	0	0	30	0	30	60	60
Lepidosperma gladiatum	Sedge	0	0	30	0	30	60	100
Lomandra maritima	Herb	0	0	20	0	0	40	20
Melaleuca huegelii	Shrub	0	0	0	0	0	20	0
Melaleuca systena	Small shrub	0	0	30	0	30	60	50
Myoporum insulare	Shrub	0	0	10	0	10	20	50
Olearia axillaris	Shrub	25	25	30	25	30	80	200
Rhagodia baccata subsp. *baccata*	Shrub	0	0	30	0	30	60	80
Scaevola crassifolia	Shrub	0	0	50	0	50	100	200
Spinifex hirsutus	Grass	100	125	0	100	0	0	500
Spinifex longifolius	Grass	100	125	0	100	0	0	500
Spyridium globulosum	Shrub	0	0	10	0	10	30	50
Threlkeldia diffusa	Ground cover	0	0	10	0	10	20	50
	Area totals	**250**	**300**	**500**	**250**	**450**	**1100**	**2300**

The Mullaloo Foreshore Reserve has undergone a substantial amount of restoration over the last ten years, and most of the planting required is infill planting throughout the site in areas of Good vegetation condition. Additional species recommendations are based upon underrepresented species within the site and the following reference sites within the City of Joondalup; the Marmion Coastal Foreshore Reserve, Iluka Coastal Foreshore, and the Ocean Reef Foreshore. Recommended additional species for revegetation are listed in the table below; these should be used in addition to existing planting lists.

Proposed Additional Revegetation Species List

Species Name	Common Name	Comments
Anthocercis littorea	Yellow Tailflower	Not recorded within the site but found within the Joondalup Coastal Foreshore
Clematis linearifolia	Slender Clematis	Not found on site, but is common in coastal areas of Perth and would be suitable within the secondary and tertiary dunes
Diplolaena dampieri	Southern Diplolaena	Not found in the area but is recorded within the Joondalup coast line, would be suitable to be planted in the tertiary dunes
Exocarpos sparteus	Broom Ballart	Not found within the site, but would be suitable to plant in the secondary and tertiary dunes
Leptomeria preissiana		Not found on site but suitable to be planted in the secondary and tertiary dunes
Leucophyta brownii		Found on site but in low abundance suitable for planting in the primary and secondary dunes
Lomandra maritima	Maritime Mat Rush	Found within the site, it is an important plant as it provides habitat for the Priority 4 Graceful Sun Moth (*Synemon gratiosa*), suitable to be planted near existing plants. Larger plants would be best as they have better survival success than tubestock for this species.
Myoporum insulare	Blueberry Tree	Some large shrubs within the site but in low abundance, suitable to plant in secondary and tertiary dunes
Senecio pinnatifolius	Variable Groundsel	Not found on the site but suitable to be planted throughout the site

Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 02/06/2017
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

Proposed revegetation areas

Mullaloo Foreshore Reserve (north)

0 N 50

Meters

Client: City of Joondalup
Project: Mullaloo Foreshore Reserve Management Plan
Map Prepared by: S. Hynes
Date: 02/06/2017
Image Source: City of Joondalup
Datum: GDA94
Projection: MGA Zone 50

Proposed revegetation areas

Mullaloo Foreshore Reserve (south)

0 N 50

Meters