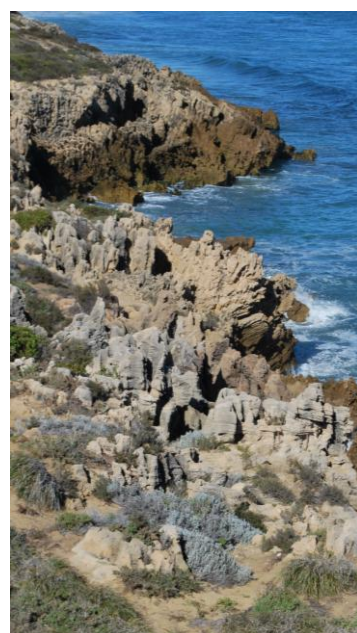


City of Joondalup

Marmion Coastal Foreshore Reserve Management Plan

January 2015



City of Joondalup

Marmion Coastal Foreshore Reserve Management Plan

January 2015

Report prepared for: City of Joondalup
Report prepared by: Natural Area Consulting
99C Lord St
Whiteman, WA 6068
consulting@naturalarea.com.au

Disclaimer

Natural Area Holdings Pty Ltd, trading as Natural Area Consulting (NAC) has prepared this report for the sole use of the Client and for the purposes as stated in the agreement between the Client and NAC under which this work was completed. This report may not be relied upon by any other party without the express written agreement of NAC.

NAC has exercised due and customary care in the preparation of this document and has not, unless specifically stated, independently verified information provided by others. No other warranty, expressed or implied, is made in relation to the contents of this report. Therefore, NAC assumes no liability for any loss resulting from errors, omission or misrepresentations made by others. This document has been made at the request of the Client. The use of this document by unauthorised third parties without written permission from NAC shall be at their own risk, and we accept no duty of care to any such third party.

Any recommendations, opinions or findings stated in this report are based on circumstances and facts as they existed at the time NAC performed the work. Any changes in such circumstances and facts upon which this document is based may adversely affect any recommendations, opinions or findings contained in this document.

No part of this document may be copied, duplicated or disclosed without the express written permission of the Client.

| Document Control | | | | |
|------------------|---|-----------------------------|---------------------------|--------------------|
| Document: | Marmion Coastal Foreshore Reserve Management Plan | | | |
| File: | City of Joondalup | | | |
| Version | Date | Prepared by | Reviewed by | Approved by |
| Draft 1 | July 2013 | Sharon Hynes Sue Brand | Sue Brand Luke Summers | Luke Summers |
| Draft 2 | October 2013 | Jacquie Milner Sue Brand | Sue Brand Luke Summers | Luke Summers |
| Draft 3 | September 2014 | Sue Brand | Sue Brand | Luke Summers |

Table of Contents

| | |
|---|-------------|
| Acknowledgements..... | vii |
| Abbreviations and Acronyms..... | viii |
| Executive Summary..... | ix |
| 1.0 Introduction | 1 |
| 1.1 Background..... | 1 |
| 1.2 Natural Area Management Plans | 1 |
| 1.3 Study Area | 1 |
| 1.4 Purpose..... | 4 |
| 1.5 Aims and Objectives | 4 |
| 1.6 Strategic Context | 4 |
| 1.6.1 Local Government | 4 |
| 1.6.2 State Government | 6 |
| 1.6.3 Federal Government..... | 7 |
| 1.6.4 International Conventions or Listings..... | 8 |
| 2.0 Description of the Physical Environment..... | 9 |
| 2.1 Geology, Soils and Landforms | 9 |
| 2.1.1 Soils of the Swan Coastal Plain | 9 |
| 2.1.2 Acid Sulphate Soils..... | 11 |
| 2.1.3 Erosion..... | 11 |
| 2.1.4 Recommended Management Actions | 13 |
| 2.2 Hydrology | 13 |
| 2.2.1 Groundwater | 13 |
| 2.2.2 Drainage..... | 14 |
| 2.3 Climate..... | 14 |
| 2.4 Vegetation | 15 |
| 2.4.1 Vegetation Complexes..... | 15 |
| 2.4.2 Floristic Community Types | 16 |
| 2.4.3 Vegetation Communities..... | 18 |
| 2.4.4 Vegetation Condition..... | 22 |
| 3.0 Biodiversity Conservation | 24 |
| 3.1 Flora..... | 24 |
| 3.1.1 Flora Survey Methodology | 24 |

| | | |
|------------|--|-----------|
| 3.1.2 | Native Flora | 25 |
| 3.1.3 | Weeds..... | 27 |
| 3.1.4 | Revegetation..... | 28 |
| 3.1.5 | Current Management Approach | 28 |
| 3.1.6 | Recommended Management Actions | 29 |
| 3.2 | Fungi | 30 |
| 3.2.1 | Fungi Field Survey..... | 30 |
| 3.2.2 | Current Management Approach | 30 |
| 3.2.3 | Recommended Management Action: | 30 |
| 3.3 | Plant Diseases..... | 32 |
| 3.3.1 | Current Management Approach | 33 |
| 3.3.2 | Recommended Management Action | 33 |
| 3.4 | Fauna | 34 |
| 3.4.1 | Fauna Survey Methodology..... | 34 |
| 3.4.2 | Native Fauna..... | 35 |
| 3.4.3 | Non-native Fauna | 41 |
| 3.4.4 | Fauna Habitat | 42 |
| 3.4.5 | Ecological Corridors..... | 42 |
| 3.4.6 | Current Management Approach | 42 |
| 3.4.7 | Recommended Management Actions..... | 43 |
| 3.5 | Social and Built Environment | 45 |
| 3.5.1 | History and Heritage..... | 45 |
| 3.5.2 | Social Value..... | 45 |
| 3.5.3 | Access and Infrastructure..... | 45 |
| 3.5.4 | Recommended Management Actions | 51 |
| 3.6 | Fire Management | 51 |
| 3.6.1 | Recommended Fire Management Actions..... | 52 |
| 3.7 | Education and Training..... | 53 |
| 3.7.1 | Recommended Education and Training Management Actions..... | 53 |
| 4.0 | Implementation Plan | 54 |
| 4.1 | Auditing and Inspections | 54 |
| 4.2 | Key Performance Indicators | 54 |
| 4.3 | Routine Reporting | 54 |
| 4.4 | Scientific Research and Monitoring..... | 54 |

| | | |
|--------------------|--|-----------|
| 4.5 | Management Plan Review..... | 54 |
| 4.6 | Management Actions | 54 |
| 5.0 | References..... | 57 |
| Appendix 1: | Bush Forever Vegetation Structural Classes | 60 |
| Appendix 2: | Vegetation Condition Rating Scale..... | 61 |
| Appendix 3: | Flora Species List..... | 62 |
| Appendix 4: | Key Weed Species in Marmion Coastal Foreshore Reserve | 66 |
| Appendix 5: | Weed Management | 72 |
| Appendix 6: | Restoration and Regeneration..... | 76 |
| | Restoration Zone 1 | 81 |
| | Restoration Zone 2 | 81 |
| | Restoration Zone 3 | 81 |
| | Restoration Zone 4 | 81 |

DRAFT

Acknowledgements

Natural Area Consulting wish to acknowledge and thank the following for assistance and input into the plan during its development:

- City of Joondalup staff
- Friends of Sorrento Beach.

DRAFT

Abbreviations and Acronyms

| Abbreviation | Description |
|----------------|--|
| AHD | Australian Height Datum |
| BoM | Bureau of Meteorology |
| the City | City of Joondalup |
| CoJ | City of Joondalup |
| Cwlth | Commonwealth |
| DAFWA | Department of Agriculture and Food Western Australia |
| DEC | Department of Environment and Conservation |
| DPaW | Department of Parks and Wildlife |
| DRF | Declared rare flora |
| DSEWPC | Department of Sustainability, Environment, Water, Population and Communities |
| EDOWA | Environmental Defenders Office of WA (Inc) |
| EPBC | Environmental Protection and Biodiversity Conservation |
| EWSWA | Environmental Weed Strategy for Western Australia |
| 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 ² | Square metres |
| MAAC | Marmion Aquatic and Angling Club |
| NAC | Natural Area Consulting |
| PMST | Protected matters search tool |
| SLIPs NRM | Shared land information portal – natural resource management |
| WA | Western Australia |
| WALGA | Western Australian Local Government Association |
| WA HERB | Western Australian Herbarium |

Executive Summary

Natural Area Consulting (NAC) was contracted by the City of Joondalup to prepare a Management Plan for the Marmion Coastal Foreshore Reserve. The plan identifies management strategies that will assist the City with ongoing management of the site for the next five years, while maintaining both the environmental and recreation values of the area. This Management Plan is consistent with the provisions of the *Joondalup Coastal Foreshore, Natural Areas Management Plan* whilst providing more site specific recommendations for management of the Marmion Foreshore Reserve. As recommended in the overarching plan, the Reserve is now a City of Joondalup conservation area.

Marmion Coastal Foreshore Reserve extends from Marine Terrace in the north to Beach Road at the City of Stirling boundary in the south. It can be considered in two sections namely Marmion Beach and Watermans Beach. The Marmion Beach portion is a narrow sandy beach associated with a vegetated zone that ranges from 30 to 50 m wide; it extends from Marine Terrace south to Bettles Street. Facilities include a small car park area in the vicinity of Gull Street, a toilet block and a ramp down to the beach. Marmion Foreshore Coastal Reserve covers an area of 4.3 hectares.

Watermans Beach extends from Bettles Street to the City of Stirling boundary at Beach Road. This area incorporates both rocky and sandy shorelines, with a rocky area occurring from the Marmion Aquatic and Angling Club to Troy Avenue where it becomes sandy once again. Vegetated areas are associated with high, narrow, steep dunes that range in width from 17 - 55 m.

The Foreshore Reserve represents a significant area of coastal heath vegetation with limestone occurring on both Quindalup and Spearwood dunes. The 2012 survey found a range of bird, reptile, invertebrate, fungi and flora species present in the Reserve. The range and diversity of the species indicates that the local ecological community is in a healthy state despite the relative small and narrow nature of the site and the surrounding urbanisation.

1.0 Introduction

1.1 Background

The City of Joondalup ('the City') is situated along the Swan Coastal Plain, 30 kilometres from the Perth Central Business District. The City covers an area of 96.5 kilometres which 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 located 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, Marmion Marine Park, and a number of Bush Forever sites which contain species of high conservation value.

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 and protect native vegetation and ecosystems.

Environmental threats have the potential to degrade natural areas and reduce biodiversity values.

Environmental threats addressed in this Plan include weeds, plant diseases, fire, non-native fauna species, human impacts and access and infrastructure.

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.

1.3 Study Area

The Study Area for the Marmion Coastal Foreshore Reserve Management Plan is Marmion Coastal Foreshore Reserve, Marmion (Figure 2). The reserve covers an area of approximately four hectares and is bounded by the Indian Ocean to the west, West Coast Drive to the east, Marine Terrace in the north and Beach Road to the south, which is also the City of Stirling boundary.

Marmion Coastal Foreshore Reserve is Crown Land managed by the City of Joondalup and is reserved for the purposes of Parks and Recreation under the Metropolitan Region Scheme. Nearby properties to the east are zoned as Low Density Residential. The main uses of the reserve are for passive recreational purposes such as walking, dog walking or cycling. Access to two small beach areas is available at the north and south ends.

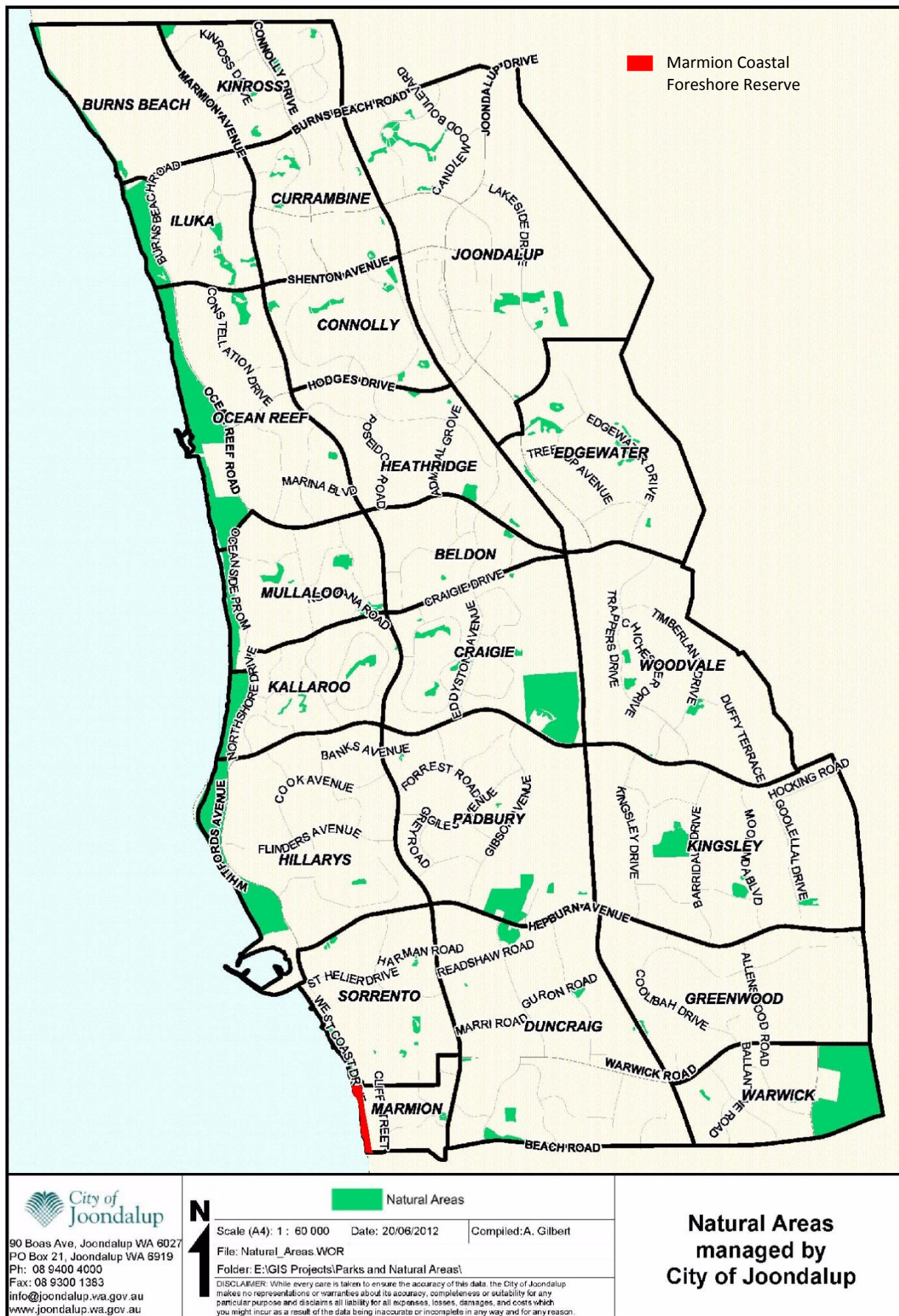


Figure 1: Location of Marmion Coastal Foreshore Reserve



Figure 2: Marmion Coastal Foreshore Reserve

1.4 Purpose

The purpose of the Marmion Coastal 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; and
- Provide guidance to City employees and contractors and Friends Groups operating within Marmion Coastal Foreshore Reserve.

1.5 Aims and Objectives

The aims of the Marmion Coastal 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 management strategies to minimise impact and protect conservation and recreation values.
- Outline management actions to address key threats including monitoring and reporting.

The objective of the Marmion Coastal Foreshore Reserve Management Plan is to provide mechanisms to protect and enhance biodiversity values of the natural area whilst maintaining appropriate community access and awareness of the natural area.

1.6 Strategic Context

To ensure the Marmion Coastal Foreshore Reserve Management Plan complements other management initiatives, relevant legislation, policies, guidelines and documents were reviewed and are briefly detailed below.

1.6.1 Local Government

Strategic Community Plan

The City of Joondalup *Strategic Community Plan 2012-2022* highlights the focus on preservation, conservation and accessibility of the City's natural assets and the importance of engaging with the community and regional stakeholders.

Environment Plan

The *City of Joondalup Environment Plan 2013-2018* provides strategic direction in the delivery of environmental initiatives within the City of Joondalup.

Biodiversity Action Plan

The *City of Joondalup Biodiversity Action Plan 2009 – 2019* provides direction for the City's biodiversity management activities and details the development of individual Natural Area Management Plans as an action. The City of Joondalup Strategic Environmental Framework is outlined in Figure 3.

Climate Change Strategy 2014-2019

The City of Joondalup's *Climate Change Strategy 2014-2019* sets the City's approach to mitigation and adaptation to climate change for a five year period.



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 that participated in the Western Australian Local Government Association's (WALGA's) Local Biodiversity Program. The aim of the Local Biodiversity 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 Local Biodiversity Program, the City of Joondalup assessed all natural areas from 2004 onwards using the ecological criteria of the Natural Area Initial Assessment, resulting in a priority ranking of natural areas. The City of Joondalup assesses major conservation, high priority and medium priority natural areas approximately every 5 – 7 years using this assessment tool.

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.

City of Joondalup District Planning Scheme No. 2 Schedule 5

Planning for land use occurs under the District Planning Scheme No. 2. Schedule 5 (Clause 5.3.1) of the District Planning Scheme lists *Places and Objects Having Significance for the Purpose of Protection of the Landscape or Environment*. The Marmion Foreshore Coastal Reserve is not listed under District Planning Scheme No.2. Schedule 5.

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 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 has not been identified in Marmion Coastal 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. Marmion Coastal Foreshore Reserve is not listed on any State or Federal Indigenous heritage inventory or register.

Biosecurity and Agricultural Management Act 2007

The Act gives provision to declare plants and animals that are known to be a significant environmental threat and provides for the management, control and prevention of these declared plants and animals for the protection of agriculture and related resources.

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.

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 which have significance to the cultural heritage in the State. Marmion Coastal Foreshore Reserve is not listed on any State or Federal cultural heritage inventory or register. However, Marmion Marine Park which is located adjacent to Marmion Coastal Foreshore Reserve, is listed on the State heritage register.

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 Marmion Coastal Foreshore Reserve, these being:

- Australian Lesser Noddy (*Anous tenuirostris* subsp. *melanops*) (bird) – **Threatened**
- Graceful Sun Moth (*Synemon gratiosa*) (Insect) – **Priority 4**
- Southern Giant Petrel (*Macronectes giganteus*) (bird) – **Threatened**
- Wedge-tailed Shearwater (*Puffinus pacificus*) (bird) – **Protected under international agreement**

WA Planning Commission “Bush Forever” Strategy 2000

The Strategy identifies regionally significant bushland in the Perth Metropolitan Region to be retained, managed and protected forever. Marmion Coastal Foreshore Reserve is not listed as a Bush Forever site but contains two flora species considered to be naturally occurring significant flora of the Perth Metropolitan Region, these being:

- *Lechenaultia linarioides*
- *Melaleuca lanceolata*

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

The *State Planning Policy 2.8 – Bushland Policy for the Perth Metropolitan Region* 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 2.6* requires local governments to have regard to the policy when preparing or amending local planning schemes.

Environmental Weed Strategy for Western Australia 1999

The Department of Parks and Wildlife (DPAW) developed an Environmental Weed Strategy for Western Australia (WA) (1999). The Strategy prioritises 1,350 weed species using the criteria of invasiveness, distribution and environmental impacts to rate weeds as high, moderate, mild or low priority. High ratings were issued to 34 weed species. Marmion Coastal Foreshore Reserve contains five high priority rated weeds in the Environmental Weed Strategy for WA.

1.6.3 Federal Government

Environment Protection and Biodiversity Act 1999

The Act provides for the protection of the environment and the conservation of biodiversity, and for related purposes. Fourteen *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* listed species have been recorded in or as potentially occurring within Marmion Coastal Foreshore Reserve:

- Australian Painted Snipe (*Rostratula australis*) - **Vulnerable**
- Carnaby's Black Cockatoo, (*Calyptorhynchus latirostris*) - **Endangered**
- Cattle Egret (*Ardea ibis*)
- Caspian Tern (*Sterna caspia*)

- Fairy Tern (Australian) (*Sternula nereis*) - **Vulnerable**
- Fork-tailed Swift (*Apus pacificus*)
- Gibson's Albatross (*Diomedea exulans gibsoni*) – **Vulnerable**
- Great Egret, White Egret (*Ardea alba*)
- Northern Giant Petrel (*Macronectes halli*) - **Vulnerable**
- Rainbow Bee-eater (*Merops ornatus*) - **Migratory**
- Shy Albatross, Tasmanian Shy Albatross (*Thalassarche cauta*) - **Vulnerable**
- Southern Giant Petrel (*Macronectes giganteus*) – **Endangered**
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

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 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. Marmion Coastal Foreshore Reserve contains no known Weeds of National Significance.

1.6.4 International Conventions or Listings

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

The IUCN Red List of Threatened Species™ provides taxonomic, conservation status and distribution information on plants and animals that have been globally evaluated using the IUCN Red List Categories and Criteria.

2.0 Description of the Physical Environment

2.1 Geology, Soils and Landforms

2.1.1 Soils of the Swan Coastal Plain

Marmion Coastal Foreshore Reserve is situated within the City of Joondalup, which is located within the Swan Coastal Plain. The Swan Coastal Plain is characterised by Tuart and heath on limestone soils, and Banksia-Jarrah-Marri woodland on sandy soils. The majority of the soils of the Swan Coastal Plain are 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 farthest from the coast (Figure 4).

Despite its coastal situation, Marmion Coastal Foreshore Reserve is primarily located within the Spearwood Dunes which have a core of sandy aeolianite with a capping of secondary limestone (Tamala Limestone, predominantly calcarenite) overlain by yellow brown siliceous sands with weak podzol development.¹² The Spearwood Dunes are believed to have formed around 40,000 years ago and comprise of red/brown, yellow and pale yellow/grey sands.³ The Spearwood Sand Phase is characterised by undulating dunes with rocky crests on aeolian sand over limestone. It also contains some of the Quindalup Dune formation, which are made of unconsolidated calcareous sands close to the coast and are still actively being formed.

Marmion Coastal Foreshore reserve contains two major soil types,⁴ these being the Quindalup Dunes S2 phase at the northern end that is dominated by white calcareous sand, and the Spearwood LS1 phase at the southern end of the area that comprises of limestone that is covered with light brown sand. The two different soil types are described in Table 1.

Table 1: Soil Types Marmion Coastal Foreshore Reserve

| Soil Type | Description |
|-----------|---|
| Sp_LS1 | Limestone-Light, yellowish brown sand, fine to coarse-grained, sub-angular to well rounded, quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin. Minor heavy minerals |
| Qu_S2 | Calcareous Sand - white, fine to medium-grained, sub-rounded quartz and shell debris, of eolian origin |

The Marmion Coastal Foreshore Reserve is a narrow sandy beach associated with a narrow but steep vegetated zone (Figure 5) that ranges from 20 to 50 m wide that extends from Marmion Terrace south to Bettles Street. The area ranges in height from 0 – 19m above sea level, with the northern end being steeper and narrower than the southern end.

¹ Department of Environment (2004b)

² McArthur and Bettenay, (1974)

³ Bolland (1998)

⁴ Dept of Agriculture and Food (2012)

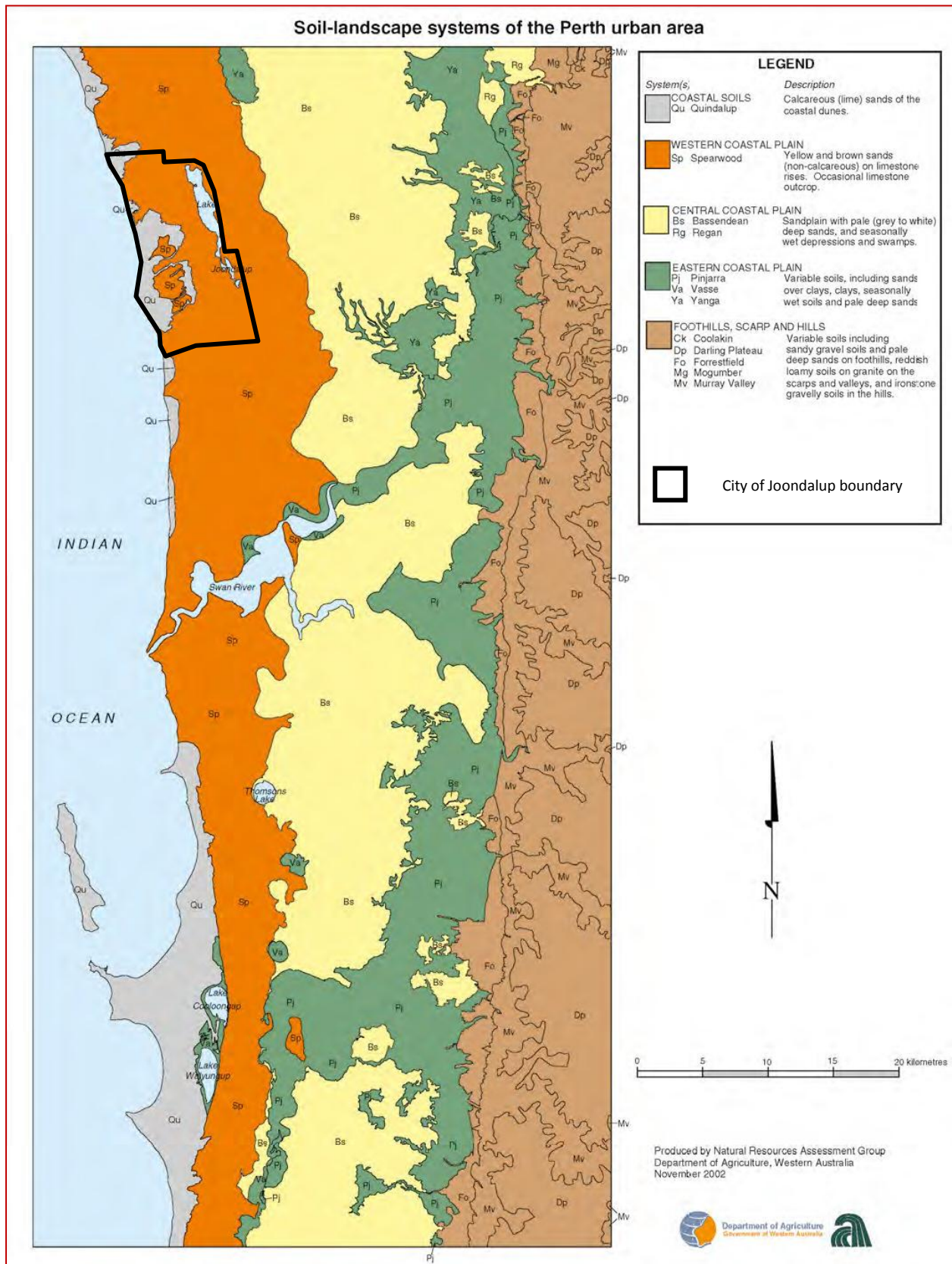


Figure 4: Soils of the Swan Coastal Plain (Department of Agriculture, 2002)



Figure 5 Topography at Marmion Foreshore Reserve (a: narrow sandy beach, b: steep dunes, c: rocky limestone coast)

2.1.2 Acid Sulphate Soils

Acid sulphate soils are naturally occurring soils and sediments that contain iron sulphides. They are predominantly found in low-lying coastal wetlands and tidal flats and are harmless when left undisturbed. Exposure to air causes the iron sulphides in acid sulphate soils to react with oxygen and water producing iron compounds and sulphuric acid, which can lead to heavy metals being released into the surrounding environment.⁵

Acid sulphate soils are categorised as potential acid sulphate soils (PASS) or actual acid sulphate soils (AASS). PASS have not been oxidised by exposure to air whilst AASS have been disturbed or exposed to oxygen and become acidic.⁶ The risk of acid sulphate soils is based on their likelihood of occurring within soil profiles and has been mapped by the DPAW using available desk-top (see page 25) information and limited ground-truthing within areas where intensive on-ground mapping and soil analysis work has been undertaken.

The mapping undertaken has found that acid sulphate soils are not known or expected to occur in the environment of Marmion Coastal 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

Sand within the coastal dune systems is generally held in place by vegetation, with erosion occurring where there is either no vegetation or the vegetative cover has been reduced, is non-existent or the area has been compromised by one or more threatening processes. Erosion of coastal dune systems is common, and will occur as a result of natural processes as well as human factors such as people and pets walking across dunes instead of keeping to nominated pathways. Expected climate change impacts are also likely to increase the potential for erosion with stronger winds during storm events and less rainfall potentially leading to water stress on flora and vegetation. Accordingly, the issue of erosion is likely to be an ongoing one, and will impact on rehabilitation and ongoing maintenance requirements. During the site assessment activities the Reserve was found to be in good condition with only one area observed exhibiting signs of erosion. This section of dune is situated between Lennard Street and Troy Avenue with a stormwater drain down the centre of the area (Figure 6).

⁵ Department of Environment (2004a)

⁶ Department of Environment and Conservation, n.d.



Figure 6: Signs of erosion in vicinity of drain line and presence of Japanese Pepper Trees

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

- area 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 .

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
- 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 |
|-----------------|---|
| Erosion Control | 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 |
| Erosion Control | Address erosion issues as early as possible to avoid larger areas to be rehabilitated later. |
| Erosion Control | 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 Gngangara Groundwater System, comprising four main aquifers: superficial (shallow, unconfined), Mirrabooka (deeper, semi-confined), Leederville (deep, mostly confined) and the Yarragadee (deep, mostly confined). The Gngangara 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.

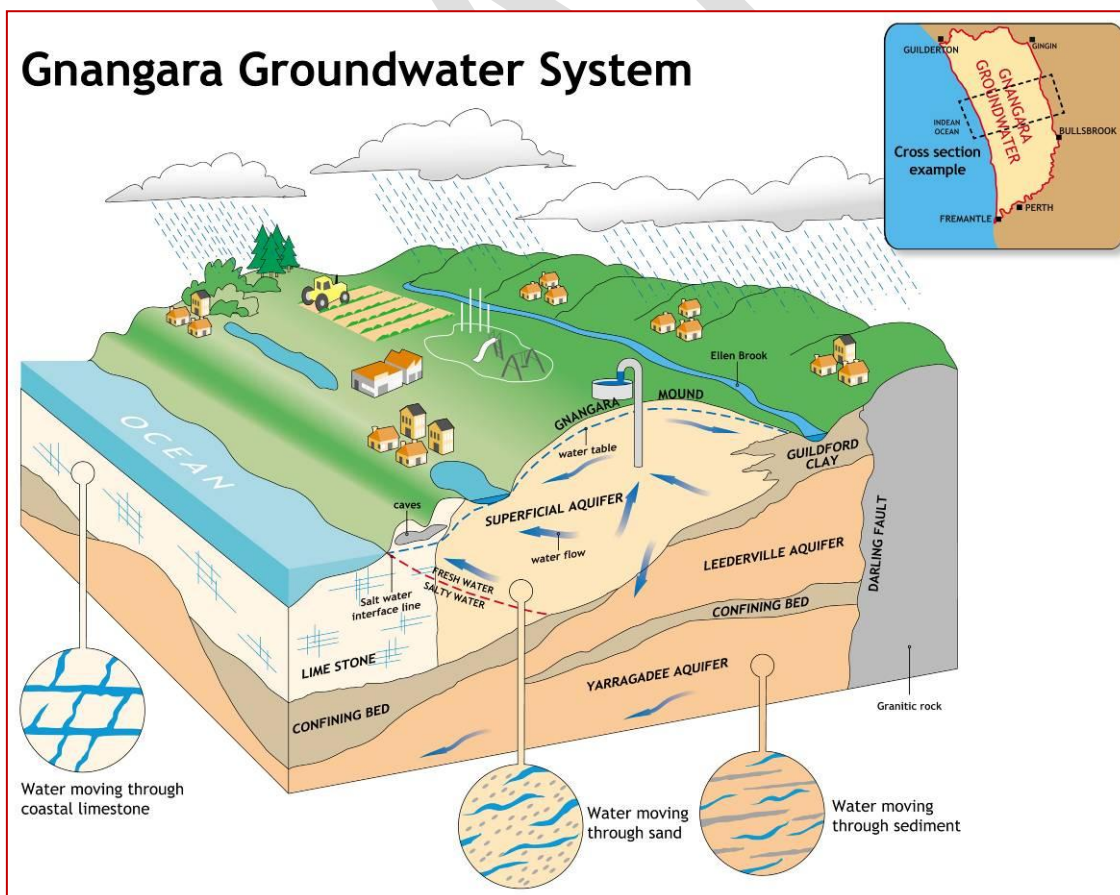


Figure 7: Gngangara Groundwater System⁷

⁷ Department of Water, n.d.

2.2.2 Drainage

Marmion Coastal Foreshore Reserve has no natural wetlands or natural drainage lines. There are four storm water drainage outlets. Depth to ground water in the reserve is between 0 - 14 metres AHD.⁸ This is consistent with a site located on the coast, where groundwater enters into the ocean (Figure 8).

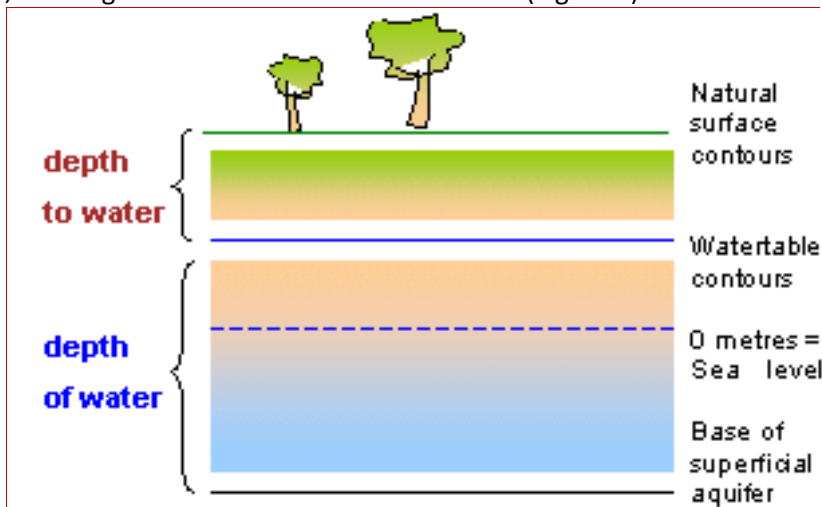


Figure 8: Groundwater Depth Explanation⁹

2.3 Climate

The City of Joondalup experiences a Mediterranean climate of hot dry summers with an average temperature of 31 degrees during the day and mild wet winters with an average day time temperature of 18 degrees. The average annual rainfall from 2002 to 2012 was 679mm. Approximately 80 percent of the annual rain falls between the months of May and September (Figure 9).

⁸ Department of Environment (2004a)

⁹ Department of Environment (2004a)

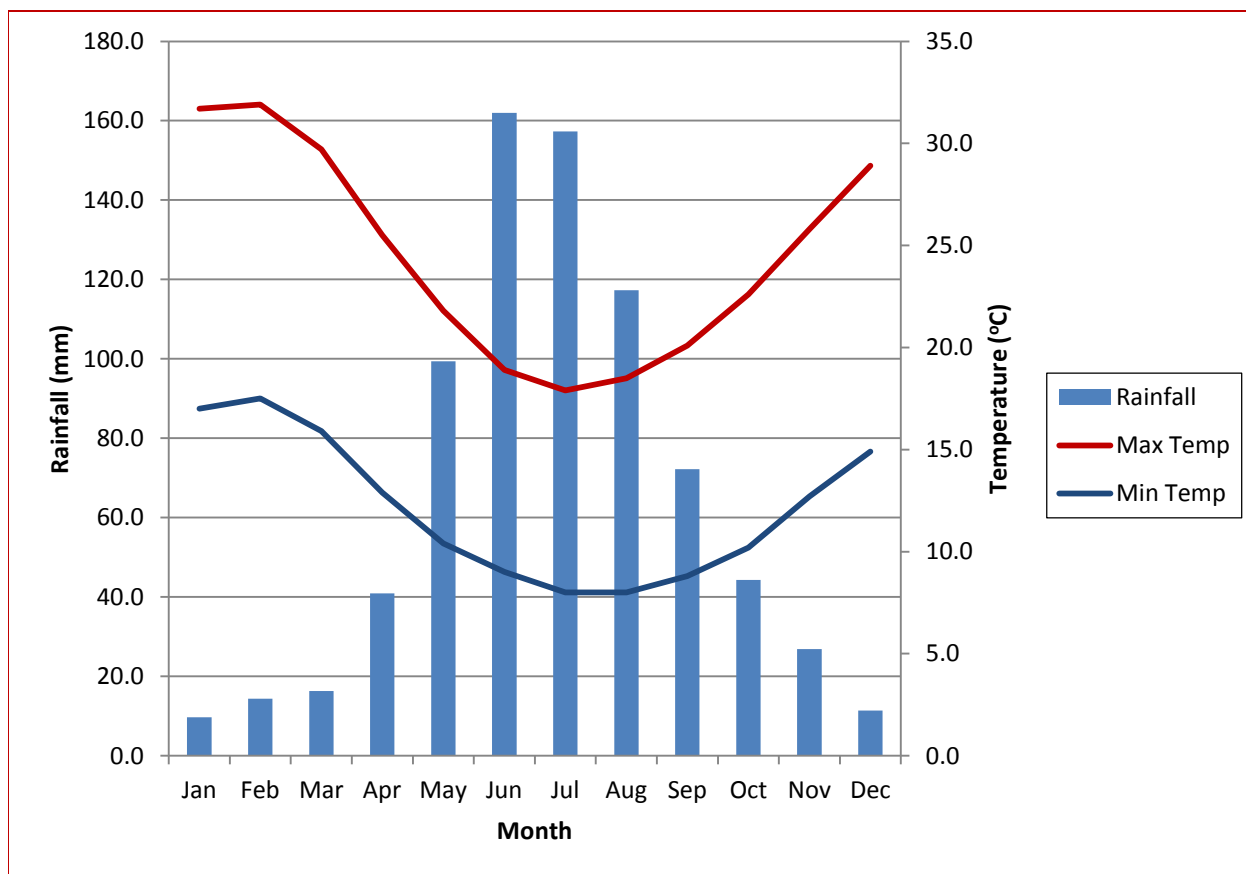


Figure 9: Climate data for Perth¹⁰

2.4 Vegetation

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 shows the study area is classified as having Cottesloe Complex – Central and South (Figure 10). This complex consists of a mosaic of Tuart woodland and an open forest of Tuart-Jarraah-Marri on the deeper sands, with heaths on limestone outcrops¹¹.

The State Government has established targets under Bush Forever which aim to protect at least 10% of each vegetation complex¹² in the Perth metropolitan region to achieve a comprehensive representation of all the ecological communities originally occurring in the region.¹³

The City of Joondalup portion of the pre-European extent of Cottesloe Complex – Central and South in Perth and Peel was 9% (3,966 ha). Approximately 35% (15,251 ha) of this vegetation complex currently remains in Perth and Peel, with the City of Joondalup proportion of the current extent being 2% (345 ha) and the level of retention is just under 9%.

¹⁰ Bureau of Meteorology (2012)

¹¹ Heddle *et al* (1980)

¹² Government of Western Australia (2000)

¹³ WALGA (2012)

2.4.2 Floristic Community Types

Floristic Community Types (FCTs) are generally groups of flora species that consistently occur together. Marmion Coastal Foreshore Reserve is inferred to have the following FCTs:

- FCT 29a – Coastal Shrublands on shallow sands
- FCT S14 – *Spinifex longifolius* grassland and low shrubs.

Whilst FCTs can be a useful way of describing groups of flora species, vegetation communities are more commonly used to define plant communities.

DRAFT

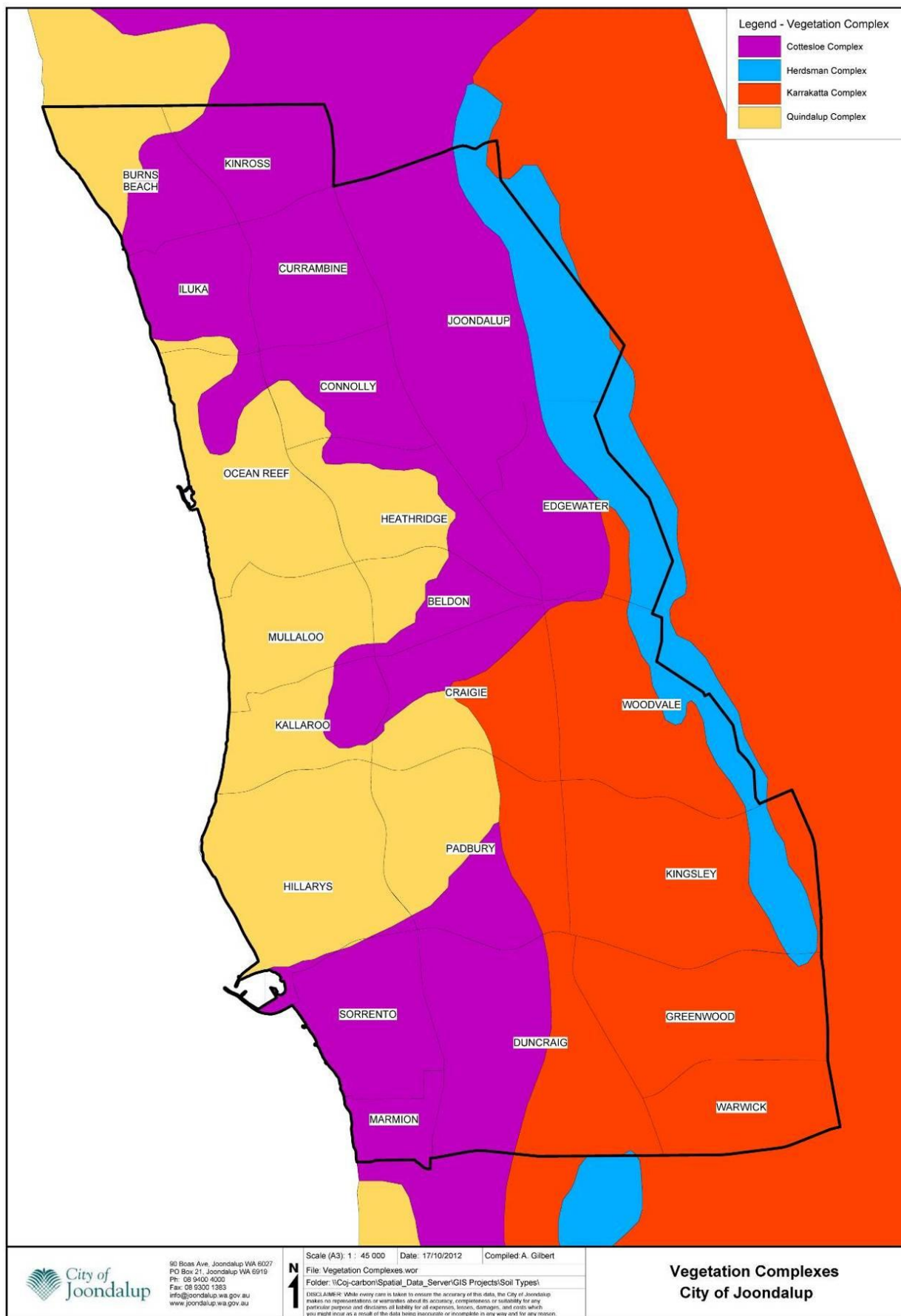


Figure 10: City of Joondalup Vegetation Complexes

2.4.3 Vegetation Communities



Four vegetation communities were identified in Marmion Coastal Foreshore Reserve, as described in Table 2 and Figure 11. Approximately 12.5% of the reserve was under rehabilitation at the time of assessment and was not able to be assigned to a particular community type¹⁴. Vegetation structural classes are provided in Appendix 1. No Threatened or Priority Ecological Communities were identified within Marmion Coastal Foreshore Reserve or in nearby bushland.



The majority of the site can be considered to be a Mixed Open Low Heath which was not dominated by any one species, but a range of common species was found at varying densities. Where the site was in good to very good condition the shrubs formed a thick cover over the ground to a height of 1.5 m. In disturbed areas the vegetative cover was lower and sparser, with bare sand commonly seen. Soil depth over the underlying limestone rock influences the height of the vegetation, with low shrubs and areas of *Sporobolus virginicus* (Marine Couch) found near the edge of the limestone cliffs where the soil is very shallow; further back from the cliffs towards the road the shrubs were higher and denser as a result of the deeper soils allowing better root establishment.

The other three vegetation types can be readily identified by their dominant species. The *Melaleuca huegelii* Open Heath exhibited prominent wind pruning on the Melaleuca foliage, which created a thick, dense foliage layer which discouraged other shrubs growing in between them. A damp microclimate was created underneath the canopy that encouraged a herbaceous layer where there was sufficient sunlight. The *Lepidosperma gladiatum* Sedgeland had few shrubs and the weed species recorded were primarily around the edges or in disturbed spots.

¹⁴ Natural Area Consulting (2013)

Table 2: Vegetation communities in Marmion Coastal Foreshore Reserve

| Vegetation Community | Description | Site Coverage | Photograph |
|------------------------------------|--|---------------|--|
| Mixed Open Low Heath | <p>Mixed Open Low Heath of <i>Scaevola crassifolia</i>, <i>Olearia axillaris</i>, <i>Rhagodia baccata</i>, <i>Spyridium globulosum</i>, <i>Grevillea crithmifolia</i>, <i>Myoporum insulare</i>, <i>Templetonia retusa</i> and <i>Acanthocarpus preissii</i>. An Open to Very Open Herbland of <i>Lomandra maritima</i> was found in areas of Good to Very Good condition with a Very Open Grassland of <i>Austrostipa flavescens</i>. The annual species <i>Daucus glochidiatus</i> and <i>Trachymene pilosa</i> were presenting as a Very Open Herbland at the time of the survey.</p> | 59.5% |  |
| <i>Banksia sessilis</i> Open Heath | <p>An Open Heath to Low Open Heath of <i>Banksia sessilis</i> var. <i>cygnorum</i> with scattered shrubs of <i>Olearia axillaris</i>, <i>Spyridium globulosum</i> and <i>Rhagodia baccata</i>. Some areas have an Open Sedgeland of <i>Lepidosperma gladiatum</i> scattered within them.</p> | 18.8% |  |

| Vegetation Community | Description | Site Coverage | Photograph |
|--|--|---------------|--|
| <p><i>Melaleuca huegelii</i> Open Heath</p> | <p>An Open Heath to Open Low Heath of <i>Melaleuca huegelii</i> with scattered shrubs of <i>Spyridium globulosum</i>, <i>Scaevola crassifolia</i>, <i>Rhagodia baccata</i> and <i>Threlkeldia diffusa</i>.</p> | <p>4.6%</p> |  |
| <p><i>Lepidosperma gladiatum</i> Sedgeland</p> | <p>Sedgeland dominated by <i>Lepidosperma gladiatum</i>, with scattered shrubs of <i>Olearia axillaris</i>, <i>Rhagodia baccata</i>, <i>Banksia sessilis</i> var. <i>cygnorum</i> and <i>Hardenbergia comptoniana</i>.</p> | <p>4.6%</p> |  |

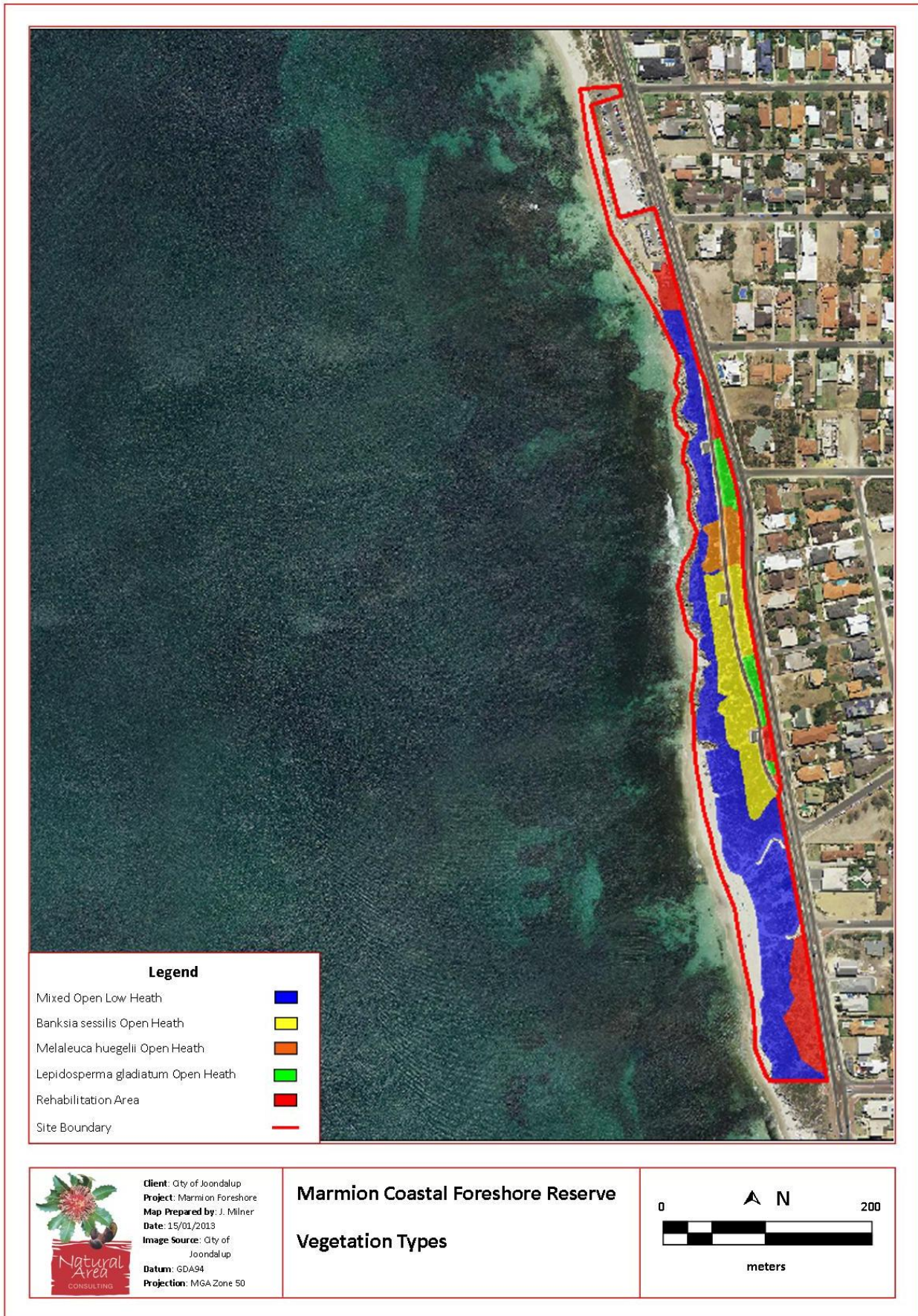


Figure 11: Vegetation types in the reserve

2.4.4 Vegetation Condition

Vegetation condition assessments include observations regarding the numbers of native species, weed cover, vegetation structure, species diversity, amount of understorey, health condition of most species' populations and physical disturbance. The Keighery Scale is a tool used to rate the condition of vegetation from pristine to completely degraded, as detailed in Appendix 2. The City of Joondalup conducted Natural Areas Initial Assessments in 2011 to assess the vegetation condition at the site. Natural Area Consulting conducted a follow-up vegetation condition assessment.

The vegetation condition at Marmion Coastal Foreshore Reserve ranges from Very Good to Completely Degraded. No significant areas were considered to be in excellent condition but the presence of three species of orchids indicates that the vegetation is in a healthy and stable state, despite the obvious presence of weeds. The best areas were towards the middle of the site where the rocky limestone cliffs were prevalent. There were significant areas (9% of the site) of ongoing rehabilitation that have been recently established that were not able to be assessed at the time of the survey. Vegetation condition in the reserve is shown in Table 3 and Figure 12.

Since 2009 there has been a reduction in the amount of vegetation rated as Excellent and Very Good with an increase in the amount of vegetation rated as Good. This can be attributed to the difference of opinion between assessors and more precise methods of measurement using GIS mapping and software in 2012.

The Friends of Sorrento (bush care group) have undertaken considerable planning and weed removal in the winters of 2013 and 2014 on both the Marmion and Sorrento Foreshore. These efforts have greatly improved the overall vegetation condition, and will not be reflected in condition ratings until the next vegetation condition survey is undertaken.

Table 3: Vegetation condition assessment using the Keighery Scale

| Year | Pristine | Excellent | Very Good | Good | Degraded | Completely Degraded | Under Rehabilitation |
|------|----------|-----------|-----------|------|----------|---------------------|----------------------|
| 2011 | 0 | 30% | 30% | 20% | 20% | 0% | |
| 2012 | 0 | 0 | 23% | 24% | 41% | 3% | 9% |

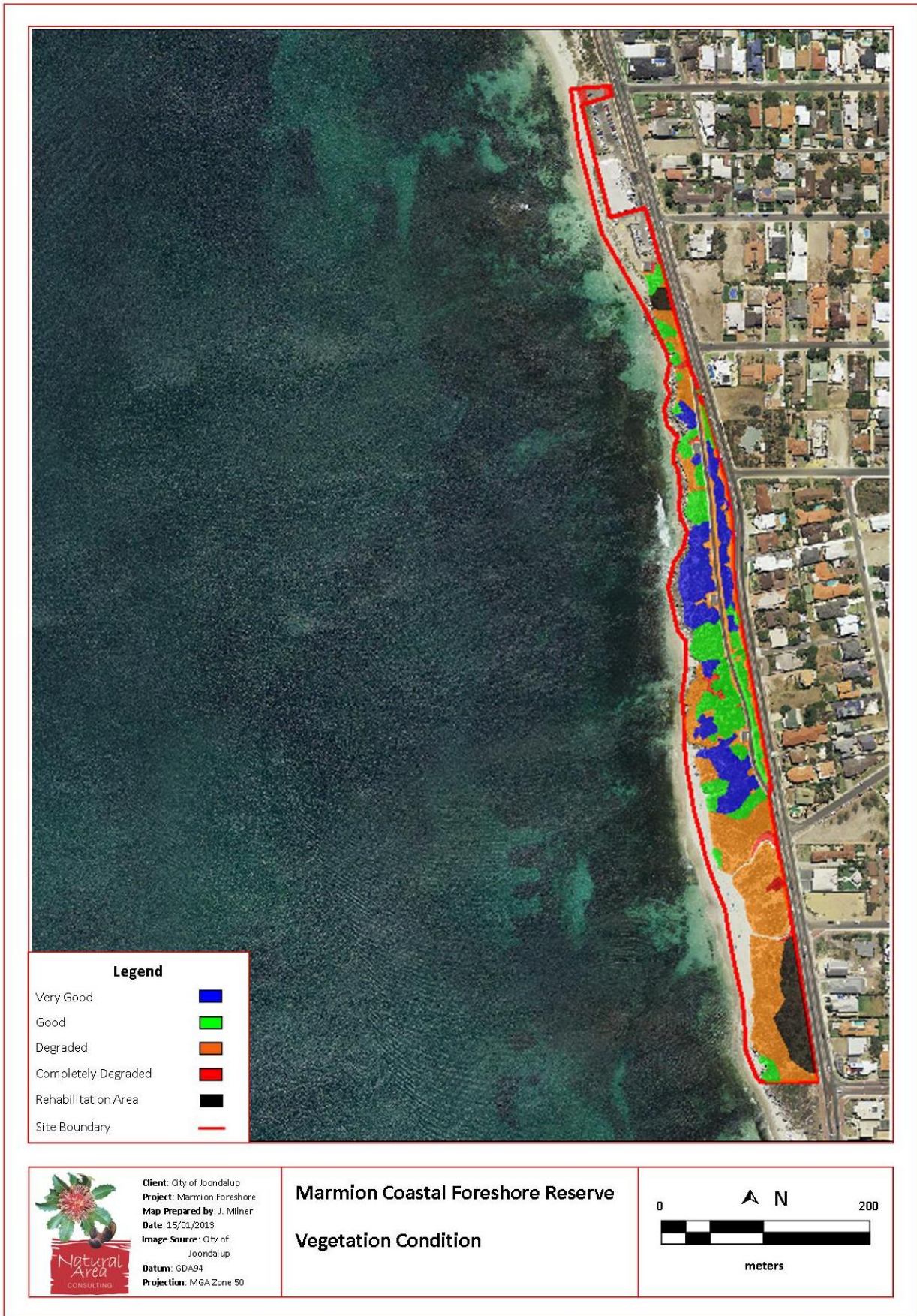


Figure 12: Vegetation condition

3.0 Biodiversity Conservation

Marmion Coastal Foreshore Reserve supports a variety of plant and animal species, including some species considered significant to the Perth metropolitan area. The long term protection of biodiversity values within the reserve is critical to ensure the conservation of this unique habitat. The protection and enhancement of biodiversity within the reserve also benefits the community through the provision of ecological services such as:

- 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 experiences¹⁵.

There are a number of environmental threats that pose a risk to the biodiversity of Marmion Coastal Foreshore Reserve. The key environmental threats include:

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

Management strategies to address the key environmental threats have been established and are discussed in the following sections.

3.1 Flora

Marmion Coastal Foreshore Reserve is located within the Southwest Australia biodiversity hotspot. Southwest Australia, from Shark Bay in the north to Israelite Bay in the south, is one of 34 biodiversity hotspots in the world with over 2,900 endemic plant species occurring in this region. Approximately 30% of the original vegetation extent of this area remains, with habitat loss being primarily due to agricultural expansion.¹⁶

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 Consulting was engaged to undertake a desktop and field flora survey of Marmion Coastal Foreshore Reserve in September 2012.

3.1.1 Flora Survey Methodology

Desktop Survey

A review was undertaken of all the available information provided by the City of Joondalup and any additional relevant information to provide a detailed background for Marmion Coastal Foreshore Reserve. A

¹⁵ City of Joondalup (2012b)

¹⁶ Conservation International (2013)

Natural Area Initial Assessment was undertaken by the City of Joondalup in 2011 and was reviewed as part of the desktop study. Natural Area Initial Assessments include documenting information such as:

- vegetation complexes
- threatened or significant flora or ecological communities
- structured plant communities
- weed species
- rating vegetation condition
- ecological criteria rankings
- a viability estimate.

External databases were also consulted, including:

- NatureMap, for local species previously recorded in the surrounding area
- DEC (now DPaW) threatened and priority flora databases
- DEC (now DPaW) threatened and ecological community database
- Protected Matters Search Tool provided by Department of Sustainability, Environment, Water, Population and Communities for significant fauna, flora, threatened and priority ecological communities at a Commonwealth level.

Field Survey

The design of the flora survey was aligned with methodology outlined in EPA *Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia*. The methodology undertaken in conducting the survey included the use of 10 m x 10 m quadrats and opportunistic sampling of species not recorded within the quadrats. A minimum of two quadrats were established per vegetation community.

3.1.2 Native Flora


Native flora is an important part of the Marmion Coastal Foreshore Reserve ecosystem. The loss of native plant species can lead to a loss of fauna that depend on flora for food and shelter. A total of 107 flora species were recorded on site, including 51 (48%) native species and 56 (52%) introduced species. A list of species identified is presented in Appendix 3, and has been used to compile the revegetation list for the area.

No Threatened or Priority flora was found during the survey. Several species of local significance were found and a brief discussion of their significance is presented in Table 4.

There were large areas of *Banksia sessilis* var. *cygnorum* present on the site, which are known to be a food source for Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*). There were no signs that there had been any recent activity there by cockatoos, which could be for seasonal reasons as it was flowering time during the survey and seeds were not presenting. An area of *Parietaria cardiostegia* was found growing in a sheltered microclimate under wind-pruned shrubs of *Melaleuca huegelii*. This is a native flora species that is preferred by native butterflies for breeding upon, but it can easily be mistaken for a weed. A small individual plant of *Hovea pungens* was located next to a sampling quadrat. This species is not usually considered to be a coastal plant which makes it a notable occurrence.

Table 4: Significant flora in Marmion Coastal Foreshore Reserve

| Name | Common Name | Significance | Photograph |
|---------------------------------|----------------------|--|--|
| <i>Lechenaultia linarioides</i> | Yellow Leschenaultia | Considered to be poorly reserved, Significant Flora of the Perth Metropolitan Region. |  |
| <i>Lomandra maritima</i> | | Known habitat plant for the Graceful Sun Moth. Many large, mature specimens occur in the reserve. |  |
| <i>Melaleuca lanceolata</i> | Rottnest Teatree | Natural populations on the mainland in the Perth area have been fragmented due to urban development. A single plant was located during the survey. |  <p><i>Melaleuca lanceolata</i> Photos: K. Richardson & K.R. Thiele</p> <p>Photo credit: K. Richardson & K.R. Thiele</p> |
| <i>Nitraria billardiarei</i> | Nitre bush | Uncommon in the Perth area. They tend to occur in small, isolated populations. Only one shrub was seen during the survey. |  |

| Name | Common Name | Significance | Photograph |
|-------------------------------|------------------|--|--|
| <i>Zygophyllum fruticosum</i> | Shrubby twinleaf | Common along the coast to the north of Perth and also found in scattered inland areas. There are isolated populations in the Perth area near the southern edge of its range. |  |

3.1.3 Weeds

Non-native flora or weeds can be exotic species or native species in ecosystems in which they previously did not exist. Weeds are commonly introduced and distributed within bushland areas through the dispersal of seed by water, wind, animals such as birds, fire, the dumping of garden refuse and human or vehicle movement in natural areas.

Weeds have major economic, environmental and social impacts in Australia and can:

- displace native plant species
- alter nutrient recycling and soil quality
- harbour pests and diseases
- create fuel loads for fires
- impact negatively on fauna and flora and their habitats
- compete with native species for space, water and nutrients¹⁷.

Over 28,000 known alien plant species have been introduced to Australia with approximately 10% now being established in the environment.¹⁸ Garden plants are the main source of Australia's weeds, accounting for 66% of recognised weed species.¹⁹

A total of 56 weed species have been recorded at Marmion Coastal Foreshore Reserve (Appendix 3). No Weeds of National Significance were recorded in the Reserve. Five weed species recorded in Marmion Coastal Foreshore Reserve were rated as having a high treatment priority in the Environmental Weed Strategy for WA (1999). Key weed species existing in Marmion Coastal Foreshore Reserve are shown in Appendix 4 and the location of One-leaf Cape Tulip (*Moraea flaccida*) are shown in Appendix 4.

¹⁷ DSEWPC (2013)

¹⁸ Groves, Boden and Lonsdale (2005)

¹⁹ DSEWPC (2013)

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 conducted on degraded or completely degraded areas using local provenance species, as required.

3.1.5 Current Management Approach

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

- prevention of introduction of weeds through weed 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.

Weed monitoring is conducted every two months at Marmion Coastal Foreshore Reserve to establish the extent and distribution of weed species and to identify priority weeds. Natural Areas Initial Assessments are conducted approximately every 5 years in the Reserve to assess site-specific ecological values, biodiversity significance and threatening processes at a level that is consistent with regional scientific standards. The outcomes from weed monitoring inform on ground weed management programs. The vegetation condition assessment (Figure 12) also informs weed management as the vegetation in the best condition can be prioritised for weed control.

In accordance with the City's Annual Bushland Schedule and Weekly Bushland 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 use a weed spraying procedure and conduct trials periodically to evaluate the most effective management methods. Resources, such as the DPaW's Florabase website or *Southern Weeds and their Control* (DAFWA Bulletin 4744), are also consulted in regards to weed control.

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

- weed of national significance
- declared plant
- high priority weed according to the Environmental Weed Strategy for WA
- pest plant under Local Government Act 1995
- major threat to vegetation
- major threat to the structure of vegetation communities
- contribute to a high fuel load, for example grasses.

A list of key weed species and their priority rating according to EWSWA²⁰ and the DEC²¹ is provided in Appendix 4, with the recommended weed treatment methodology for high priority weed species is detailed in Appendix 5.

²⁰ CALM, 1999

²¹ DEC, 2011

A City of Joondalup Weed Management Plan is being developed in 2014/15 to provide an ongoing strategic approach to the management of natural areas 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 Marmion Coastal Foreshore Reserve, the following management actions are proposed:

| Action | Detail |
|----------------------------------|--|
| Weed Survey | Undertake a follow up weed survey within the next 5 years to supplement the previous flora survey. |
| Weed Control | Undertake a targeted weed control program, as described in Appendix 5, to get major weeds under control in the Reserve. |
| Weed Control | Undertake coordinated approach to regular weed control by implementing Annual Bushland Schedule and Weekly Bushland Schedule. |
| Targeted control of Cape Tulip | Prioritise the control of Cape Tulip (<i>Moraea flaccida</i>) in Marmion Coastal Foreshore Reserve. |
| Weed Management Plan | Implement the <i>City of Joondalup Weed Management Plan</i> to provide an ongoing strategic approach to the management of natural areas in order to reduce the incidence of weeds. |
| Revegetation | Conduct revegetation as outlined in the Revegetation Strategy in Appendix 6. |
| Natural Areas Initial Assessment | Conduct five yearly follow up of Natural Areas Initial Assessment to monitor ecological health of site. |

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.²² 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.²³ 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 beetles.²⁴

Fungi surveys are important in providing 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.

3.2.1 Fungi Field Survey

During the flora and fauna survey components, Natural Area Consulting recorded all incidental sightings of fungi within Marmion Coastal Foreshore Reserve. Four fungi species were recorded from the study area (Table 5). Due to time limitations, the fungi survey was conducted in spring where the weather had been warming and beginning to dry the soil. The optimum time for fungi surveys is in autumn or winter after substantial rainfall.

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.

3.2.3 Recommended Management Action:

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





| Action | Detail |
|--------------|--|
| Fungi survey | Undertake a comprehensive fungi survey in autumn or winter after substantial rain, to supplement previous incidental fungi survey, within 5 years. |

²² Bougher, 2009

²³ Robinson, n.d.

²⁴ DEC, n.d.

Table 5: Fungi in Marmion Coastal Foreshore Reserve

| Name | Common Name | Photograph |
|-----------------------------|---------------------|--|
| <i>Colus pusillus</i> | Red fingers |  |
| <i>Phlebia subceracea</i> | Golden Splash Tooth |  |
| <i>Scleroderma sp.</i> | Earthball |  |
| <i>Volvariella speciosa</i> | Common Rosegill |  |

3.3 Plant Diseases

Organisms such as fungi, bacteria and viruses that cause plant diseases are known as pathogens. Whilst some pathogens are naturally occurring within soil populations, others have been introduced to the environment through the movement of plant materials and soils.²⁵ The symptoms produced by plants that are affected by pathogens vary depending upon the species of pathogen, host species, environment and climatic conditions. Some pathogens can cause rapid death of plants whilst others result in a slow, perennial decline in health.²⁶

Phytophthora dieback refers to the disease caused by the introduced plant pathogen *Phytophthora*. While there are numerous species of *Phytophthora*, the most aggressive species affecting native plants throughout South-western Australia is *Phytophthora cinnamomi*. Whilst *Phytophthora cinnamomi* is the most common species of *Phytophthora* dieback within Western Australia a second species of *Phytophthora*, *Phytophthora multivora* is common in urban areas of Perth, particularly along the inland dune systems, and has been identified within the City's parks areas. *Phytophthora multivora* is named due to its wide host range, including *Banksia* and Eucalypt species. *Phytophthora multivora* can cause rapid death of plants, or a slow, perennial decline in health of the crown and is commonly associated with individual spot deaths and areas of tree decline.²⁷

Armillaria luteobubalina has also been identified within a number of parks within the City of Joondalup. *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 'Honey Fungus' due to the colour of the fruiting body seen above the ground during certain times of the year (Figure 13). 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.²⁸



Figure 13: *Armillaria luteobubalina*

The City is undertaking pathogen mapping and sampling work at several reserves, however no pathogen mapping and sampling has yet been undertaken in Marmion Coastal Foreshore Reserve.

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.²⁹

²⁵ City of Joondalup, 2012c

²⁶ City of Joondalup, 2012c

²⁷ City of Joondalup, 2012c

²⁸ City of Joondalup, 2012c

²⁹ City of Joondalup, 2012c

3.3.1 Current Management Approach

The City of Joondalup has developed a Pathogen Management Plan to protect native vegetation and ecosystems by establishing: the level of risk for areas to be infected by pathogens, prioritisation of areas, detailed preventative and management actions to be implemented within the City, and guidelines for dieback-free purchasing and a hygiene procedure.

In order to reduce the risk of spreading pathogens between vegetated areas, City of Joondalup personnel currently spray vehicles, shoes and tools with methylated spirits and brush down before they enter and leave bushland reserves.

3.3.2 Recommended Management Action

To prevent pathogen spread and protect biodiversity values at Marmion Coastal Foreshore Reserve, the following management action is proposed:

| Action | Detail |
|---------------------|---|
| Pathogen Management | Implement recommendations from the Pathogen Management Plan that are applicable to the management of Marmion Coastal Foreshore Reserve. |

3.4 Fauna

Fauna surveys document the occurrence, distribution and population of fauna species. Information from fauna surveys is used as a baseline to monitor the health of fauna species.

3.4.1 Fauna Survey Methodology

The fauna survey design was aligned with *EPA Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia*, 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*.

Desktop Survey

As part of the fauna survey, NAC reviewed data provided by City of Joondalup to compile a complete data set which has been utilised in the development of this Plan. Database searches of NatureMap, the DPAW threatened fauna database and the Protected Matters Search Tool (Cwlth) were also undertaken for comparison.

Field Survey

Natural Area Consulting undertook a fauna survey of Marmion Coastal Foreshore Reserve in October 2012. The field survey for fauna was carried out in two components (Table 6).

Table 6: Fauna Survey Methodology

| Activity | Method |
|----------------------------|--|
| Opportunistic fauna survey | The presence of fauna within the reserve was assessed opportunistically while conducting field work. Fauna were also identified through the interpretation of diggings, scats and tracks. |
| Targeted fauna survey | In order to record the presence of terrestrial fauna, a trapping programme was undertaken over three days (9 – 11 October 2012). This involved the setting up of 13 baited Elliot traps and 6 pitfall trap lines. The trap lines consisted of: <ul style="list-style-type: none"> ▪ a line of plastic to divert fauna movement ▪ 1 large pitfall trap, ▪ 2 pipe traps, and ▪ 2 funnel traps (Figure 14). Traps were installed as per DPaW (then DEC) licence requirements and all were checked by 9am. |

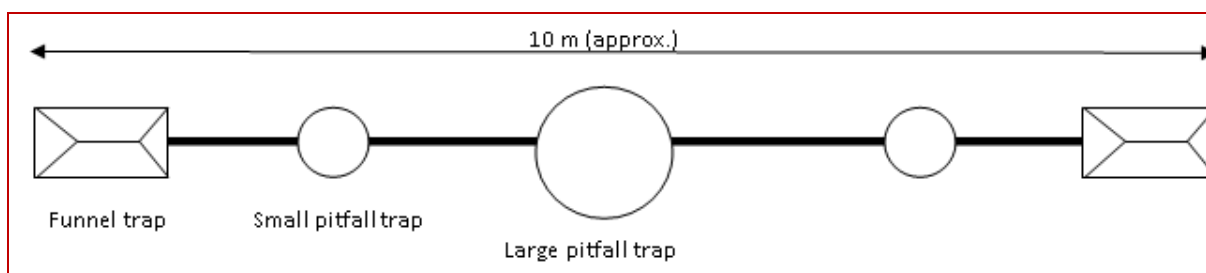


Figure 14: Trap Line Layout

3.4.2 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 loss of plant species and changes to ecological communities.³⁰

A total of 24 native species of vertebrate fauna were recorded of which 12 were birds and 12 were reptiles. A total of eight 8 introduced fauna species were recorded within the Reserve.

The only species of mammal found during the survey was the introduced European Rabbit (*Oryctolagus cuniculus*). While there was not a positive sighting of an individual there were clear signs of recent activity with fresh scats and burrow entrances observed.

Mammals

No native mammal species were located within the Reserve.

Reptiles

Twelve species of reptile were recorded during the 2012 fauna survey (Table 7). The diverse range of species found within the site and the presence of the Barking Gecko (*Underwoodisaurus milii*) which is an uncommon species on limestone, indicate that the populations present are in a good state of health.³¹

There is, however, some concern that the high sides of a recently constructed stairway access in the southern end of the site presents a barrier to reptile movement along the site and that further constructions of a similar nature could result in further fragmentation of the environment, placing them under further strain than they are already facing in a small reserve.




³⁰ DSEWPC (2012)

³¹ Natural Area Consulting (2013b)

Table 7: Reptiles and Amphibians

| Species | Common Name | Photograph |
|---------------------------------------|----------------------------|--|
| <i>Cryptoblepharus plagiocephalus</i> | Fence Skink |  |
| <i>Ctenotus australis</i> | Western Limestone Ctenotus |  |
| <i>Ctenotus fallens</i> | West Coast Ctenotus |  |
| <i>Cyclodomorphus celatus</i> | Slender Bluetongue |  |

| Species | Common Name | Photograph |
|--------------------------------|---------------------------------|--|
| <i>Lerista elegans</i> | West Coast Four-toed Lerista |  |
| <i>Lerista lineopunctulata</i> | West Coast Line Spotted Lerista |  |
| <i>Lialis burtonis</i> | Burton's Legless Lizard |  |
| <i>Morethia lineoocellata</i> | Western Pale-flecked Morethia | |
| <i>Morethia obscura</i> | Southern Pale-flecked Morethia |  |

| Species | Common Name | Photograph |
|-------------------------------|-------------------------------------|--|
| <i>Strophurus spinigerus</i> | Southern Western Spiny-tailed Gecko |  |
| <i>Tiliqua rugosa</i> | Bobtail Lizard |  |
| <i>Underwoodisaurus milii</i> | Barking Gecko |  |

Birds

Incidental sightings of birds were recorded during the 2012 fauna survey (Figure 15). Twelve bird species were identified, all of which were common to the area (Table 8).³² No additional species were seen during the 2013 site assessment.

³² Natural Area Consulting (2013b)

Table 8: Birds recorded during the fauna survey

| Species | Common Name |
|------------------------------------|-----------------------|
| <i>Corvus coronoides</i> | Australian Raven |
| <i>Gymnorhina tibicen</i> | Magpie |
| <i>Hirundo neoxena</i> | Welcome Swallow |
| <i>Larus novaehollandiae</i> | Silver Gull |
| <i>Larus pacificus</i> | Pacific Gull |
| <i>Lichenostomus virescens</i> | Singing Honeyeater |
| <i>Pandion haliaetus</i> | Osprey |
| <i>Phalacrocorax varius</i> | Pied Cormorant |
| <i>Streptopelia chinensis</i> * | Spotted Turtle Dove* |
| <i>Streptopelia senegalensis</i> * | Laughing Turtle Dove* |
| <i>Trichoglossus haematodus</i> * | Rainbow Lorikeet* |
| <i>Zosterops lateralis</i> | Silver Eye |

* Denotes introduced species



Osprey (*Pandion haliaetus*)

Figure 15: Osprey observed in Marmion Coastal Foreshore Reserve

Invertebrates

Invertebrates are animals without backbones such as insects, worms and molluscs. Invertebrates constitute more than 95% of all living animal species, with Australia having documented 100,000 species and an estimated 200,000 undescribed invertebrate species.³³ Some invertebrates are important indicators of ecosystem health, such as ants (seed dispersers), bees (pollinators) or spiders (top invertebrate predators).³⁴

³³ DEC (n.d.b.)





³⁴ V Framenau 2012, email, 9 July

There were nine species of invertebrates found within the Reserve during the 2012 incidental invertebrate fauna survey. These species are listed in Table 9.³⁵ No new species were recorded during the 2013 site assessment.

Table 9: Species of invertebrates found within the Reserve

| Species | Common Name | |
|-----------------------|----------------------|--|
| <i>Acrididae</i> | Grass Hopper Species |  |
| <i>Anisolabidae</i> | Earwig |  |
| <i>Blattodea</i> | Bush Cockroach |  |
| <i>Catasarcus sp.</i> | Weevil |  |
| <i>Lycosa sp.</i> | Wolf Spider |  |

³⁵ Natural Area Consulting, 2013b

| Species | Common Name | |
|-------------------------|-------------------|--|
| <i>Maratus sp.</i> | Peacock Jumper |  |
| <i>Pompilidae</i> | Spider Wasp |  |
| <i>Pterohelaeus sp.</i> | Pie Dish Beetle |  |
| Unknown | Beetle Larvae sp. |  |

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.³⁶ Non-native animals such as cats, foxes, rabbits, mice, birds, millipedes and bees inhabit the City’s bushland, wetland and coastal areas.

Introduced Mammals

Two species of non-native mammals have been observed in the Reserve. Fresh scats and burrow entrances of the introduced European Rabbit (*Oryctolagus cuniculus*) were seen during a fauna survey in 2012³⁷. During the 2013 site assessment, tracks from the Black Rat (*Rattus rattus*) were noted to the north of the Marmion Aquatic and Angling Club (Figure 16). Cats are also likely, and are to be controlled in accordance with the provisions of the *Cat Act 2011* (WA), and the City’s protocols relating to their control.

³⁶ DSEWPC (2012)

³⁷ Natural Area Consulting (2013b)



Figure 16: Black Rat tracks sighted north of the Marmion Angling and Aquatic Club

3.4.4 Fauna Habitat

Vegetation condition at Marmion Coastal Foreshore Reserve, in terms of fauna habitat, ranges from very good to degraded. Whilst the site provides habitat for reptiles and birds the inner metropolitan location of the Reserve and its small size limits the Reserve's use by fauna.

3.4.5 Ecological Corridors

Naturally connected landscapes and ecosystems are generally healthier, protect a diversity of species, provide pathways for species movement and can store carbon more effectively than degraded landscapes.³⁸ In urban areas where there is engineered infrastructure dividing the landscape, it may be necessary to provide wildlife crossings such as underpasses, tunnels, viaducts or overpasses to enable wildlife movement.

Marmion Coastal Foreshore Reserve is part of an ecological linkage thread along the coast from Burns Beach to Sorrento Beach in the north to North Beach and inland to Star Swamp in the City of Stirling to the south (Figure 17).

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 annually within bushland, wetland and coastal areas. Control methods employed include biological and chemical control, 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.

³⁸ NWCPAG (2012)

3.4.7 Recommended Management Actions

| Action | Detail |
|----------------------|---|
| Feral Animal Control | Implement regular fox and rabbit control to reduce pressures on native fauna and flora. |
| Cat control | Cats are to be controlled in accordance with the requirements of the <i>Cat Act 2011</i> (WA) and the City's protocols in relation to their trapping and removal on land managed by the City. |
| Fauna monitoring | Undertake further fauna surveys at appropriate time frames to review species presence and abundance. |

DRAFT

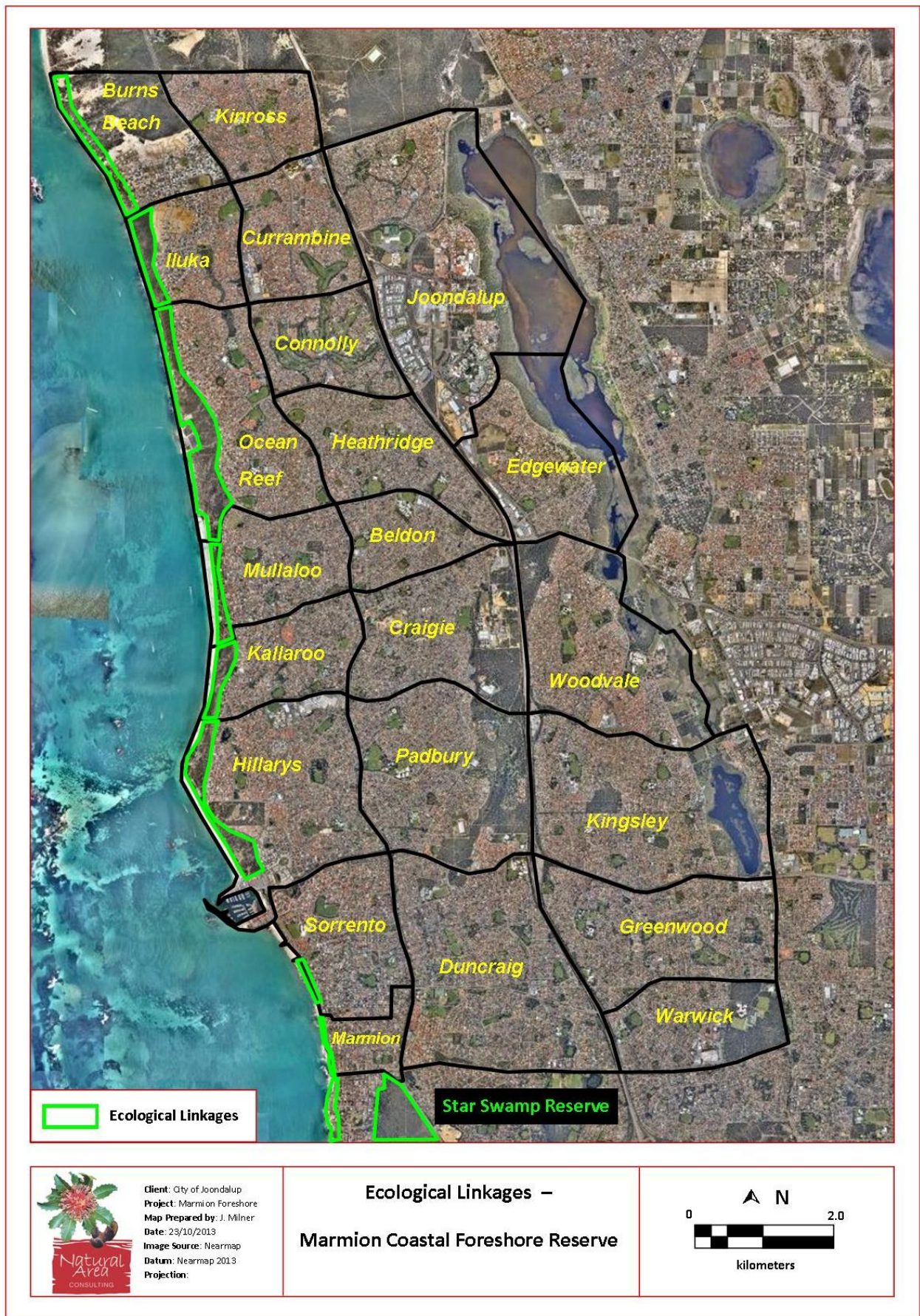


Figure 17: Ecological Linkages

3.5 Social and Built Environment

3.5.1 History and Heritage

Marmion Coastal Foreshore Reserve is not listed on any State or Federal Indigenous or non-Indigenous heritage inventory or register.³⁹ The foreshore area is part of the Marmion Marine Park, which is listed on the State heritage register.

3.5.2 Social Value

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

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

- Marmion Angling and Aquatic Club (MAAC)
- Friends of Sorrento Beach
- DFES (formerly Fire and Emergency Services Authority (FESA))

3.5.3 Access and Infrastructure

Parking

There is a small parking area for 20 cars adjacent to the MAAC (south side) at the north end of the Reserve, and the City has a current (2014) proposal to expand parking at this location. There is no parking adjacent to the Reserve along West Coast Drive within the City boundary.

Bike racks are provided next to the car park and at the top of the two sets of limestone stairs at the south end of the Reserve (Figure 22).

Fencing

Fencing exists along the western side of the dual use pathway, consisting of marine grade stainless steel wire strung between wooden Jarrah fence posts. In places retaining walls of limestone blocks also act as fencing to direct people along paths and stairways. This fencing restricts incidental access into the bushland areas on the west and east side of the dual use pathway while still allowing access to the beach areas of the Reserve.

Access Points

Two stairways are located near Troy Ave and Lennard Street that provide access to Watermans Beach. These stairways are paved until halfway down the dune, and then continue as sandy tracks. Erosion has occurred at the end of the paved sections of the access ways (Figure 18a), and has since been repaired. In 2013, the lower portion of the access way down to Marmion Beach located at the southern end of the car park had been washed away and replaced with a ramp (Figure 18b). The ramp incline is flexible in that it increases when sand is eroded from the area and can be decreased by manually removing the ramp from the sand when levels increase during accretion processes. Access to the beach is also available either end of the MAAC buildings. Beach access within the Marmion Coastal Foreshore Reserve is adequate.

³⁹ Department of Indigenous Affairs (2013)

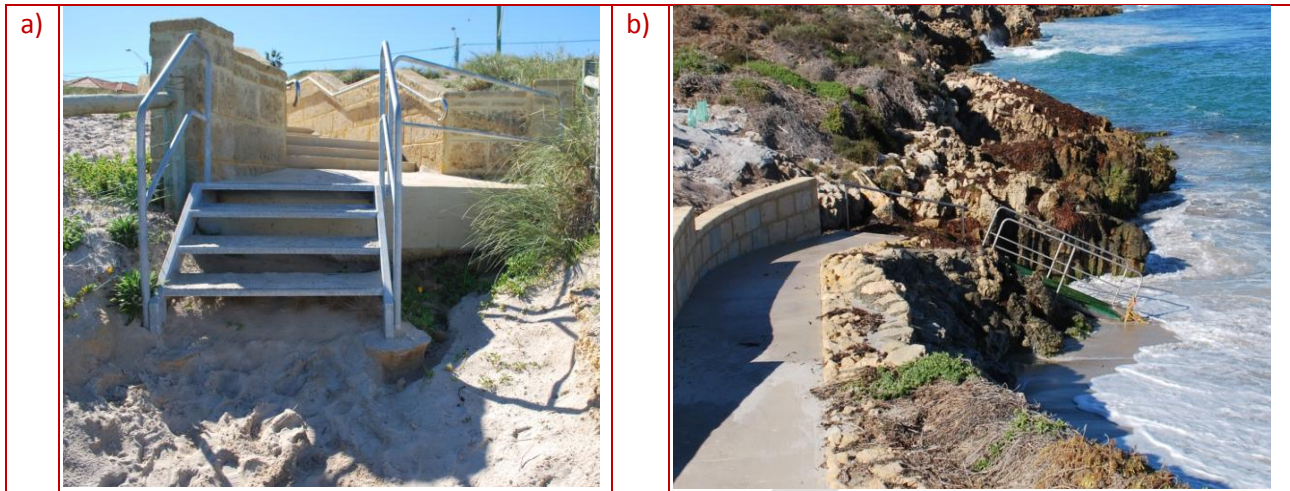


Figure 18: Beach access: a) erosion apparent at end of beach access stairs, b) adjustable ramp near MAAC

Paths and Trails

A dual use path follows West Coast Drive before veering west into the Foreshore Reserve around Bettles Street until Troy Avenue where it again follows the road. A limestone retaining wall has been constructed along the eastern portion of the dual use path to minimise the loss of soil material from the upper portion of the dune and the western side is fenced to prevent uncontrolled access to the lower dunes and the rocky coastline.

Access and Inclusion

Four million Australians (20%) reported having a disability in the Survey of Disability, Ageing and Carers conducted in 2009. The study considers disability to include any impairments, activity limitations and participation restrictions which impede everyday activities for a period of at least 6 months. In 15 years time the number of West Australians with a disability is expected to increase from 1 in 5 people (20%) to 1 in 4 people (25%).

The City of Joondalup has an *Access and Inclusion Plan 2012-2014*, outlining that 'the City is committed to ensuring that its activities and services are inclusive of all members, including people with disabilities and their families or carers, and people from culturally and linguistically diverse backgrounds'. There is adequate access for people with a disability to move along the concreted pathways and use the three observation platforms currently in place but there is no beach access.

Stormwater Drainage

There are five drainage outlets located within the Reserve that allow stormwater to drain to the ocean (Figure 19). Four are enclosed, but the southern most outlet drains across the surface of the dunes and has created a deep gully that is infested with weeds due to the loss of the coastal vegetation.



Figure 19: Drainage in Marmion Coastal Foreshore Reserve

Signage

Signage at the site informs park users about the Marmion Marine Park, dangerous cliffs, penalties that apply for vandalism and unauthorised access, amenities available and appropriate use of the dual use path (Figure 20). The majority of the signs were in good condition.



Figure 20: Examples of signage at Marmion: a) Educational sign about the history of site and the natural food sources, was in good state of repair, b) Warning sign noting dangers of the rocky limestone coast, c) Painted sign on dual use path informing cyclists of appropriate behaviours

Toilets

A toilet block is located at the north end of the Reserve next to the car park. The current building was constructed in November 2009, replacing a previous ablution block that was on the site.

Seating

The three observation platforms contain shade structures with seating and bike racks that provide the opportunity to relax and look out over the ocean. In a salty coastal environment, these and associated structures are subject to weathering and need ongoing maintenance. All structures showed signs of salt build up and will require continual maintenance (Figure 21).

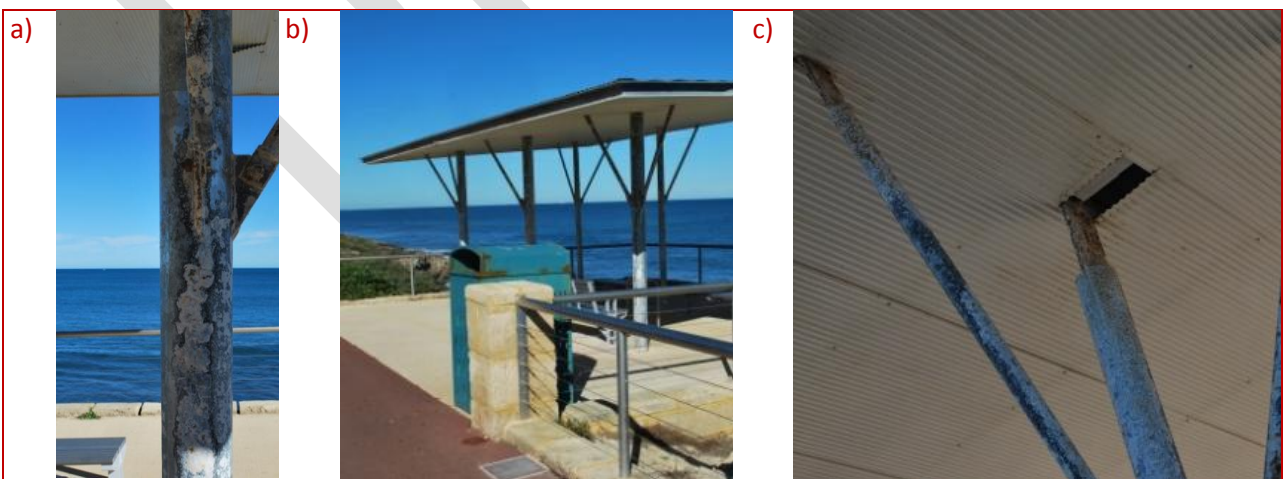


Figure 21: Infrastructure management: a) salt build up b) indications of salt impact c) effects of wind and salt and section of roof panel missing

Rubbish

Rubbish bins are generally installed in locations where people gather to socialise or undertake recreational activities. Rubbish bins are provided at the car park next to the MAAC, at the three observation platforms and at the top of the limestone stairs at the south end (Figure 22).

DRAFT

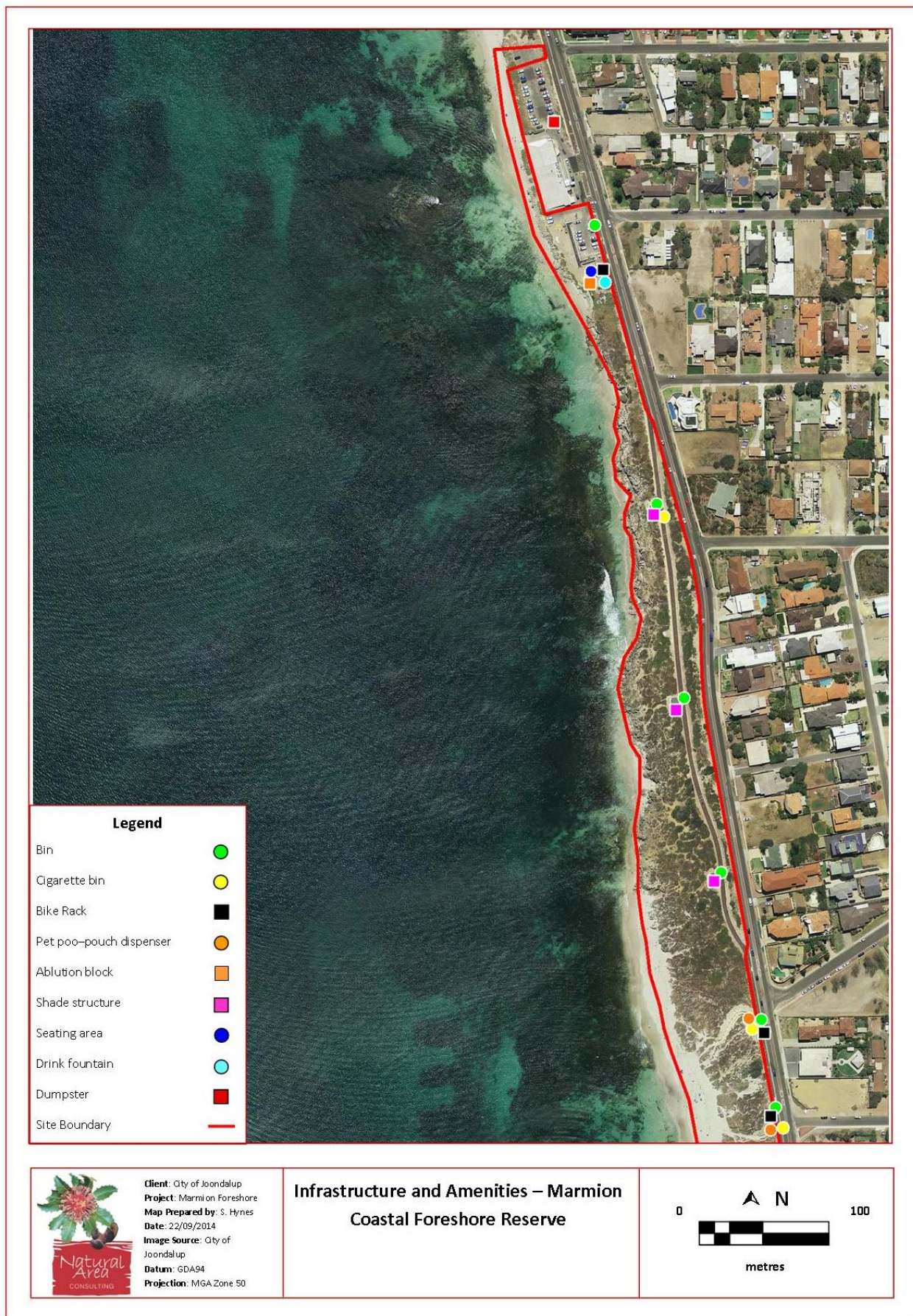


Figure 22: Infrastructure and amenities – Marmion Coastal Foreshore Reserve

3.5.4 Recommended Management Actions

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

| Action | Detail |
|---------|---|
| Signage | Inspections should occur in conjunction with other monitoring activities on a regular basis. |
| Signage | Damaged or vandalised signs be repaired or replaced in accordance with the City of Joondalup's procedures, policies and guidelines. |
| Signage | Any advertisement signage affixed to fencing or other locations in the Reserve by businesses or individuals be removed when observed. |

3.6 Fire Management

Fire is an important natural feature of the Western Australian landscape. Fire helps to shape the diversity of plant communities with many native plants having developed fire-related adaptations over time, for example fire expedites many species to flower or germinate. Human activity such as accidents and arson have resulted in increased incidences of fire within many urban bushland reserves, which can have a negative effect on biodiversity and encourage growth of highly flammable and invasive weeds.

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.⁴⁰ Management of Marmion 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. DFES work with the community and government to prevent, prepare for, respond to and recover from a diverse range of emergencies.⁴¹

Objectives

The objectives of fire management within Marmion Coastal Foreshore Reserve are to:

- protect life, property and environment in Marmion and adjacent residential areas
- fulfil obligations under the *Bushfires Act 1954* (WA)
- protect the ecological and amenity values of Marmion Coastal Foreshore Reserve
- 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 firebreaks
- minimise impacts on air quality.

Fire Risk

A fire fuel load assessment was conducted in the Reserve in 2014 which indicated that the site has a moderate fuel load of between one and 20 tonnes/ha. The fuel load assessment was undertaken using the methodology described in the FESA Visual Fuel Load Guide for the Scrub Vegetation of the Swan Coastal Plain.⁴² Fuel load assessments should be conducted annually for the Reserve.

⁴⁰ EDOWA (2011)

⁴¹ DFES (2013)

Fire Prevention

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

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

Weed control and maintenance of fire access tracks are conducted in accordance with the City's Annual Bushland Schedule and Weekly Bushland Schedules. The City of Joondalup will develop a Fire Management Plan in 2014/15, outlining the City's strategy for assessing fire risk, prevention, response and recovery. There are numerous water hydrants located around the Reserve which are installed and maintained by the Water Corporation.

Fire Occurrences

A review of the City's historical aerial imagery indicates that there have been no major fires within the Marmion Coastal Foreshore Reserve in the last 13 years.

Three small fires have been reported by DFES since 2002.

Fire Response

The closest branch of the DFES is located at the Duncraig Fire Station in Lilburne Park, Hepburn Avenue, Duncraig, and they are responsible for suppressing fires within Marmion Coastal Foreshore Reserve. The Western Australia Police are responsible for the evacuation of residents and visitors, if required.

3.6.1 Recommended Fire Management Actions

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

| Action | Detail |
|--|---|
| Assess fire fuel load | Annually assess and report fire fuel load using the FESA <i>Visual Fuel Load Guide for the Scrub Vegetation of the Swan Coastal Plain</i> to inform fire prevention actions required. |
| Develop and implement Fire Management Plan | Develop and implement a Fire Management Plan, outlining the City's strategy for assessing fire risk, prevention, response and recovery. |
| Monitor fire occurrences | Monitor fire occurrences through mapping and updating Geographic Information System (GIS) layers detailing fire incidents and frequency to inform fire prevention actions. |

⁴² FESA (2007)

| Action | Detail |
|--|--|
| Revise weed control after fire incidents | Revise weed control after fire incidents to aid regrowth by selecting appropriate chemicals, targeting weeds if safe to do so for new seedlings, and spraying grasses using backpacks. |

3.7 Education and Training

The City implements an Annual Environmental Education Program to address key environmental issues and encourage greater environmental stewardship by the community. The City of Joondalup actively encourages participation within its community to raise awareness of key environmental issues within the City. The City of Joondalup Natural Areas Team currently conducts regular plant identification training, including weed identification. New members in the Natural Areas team undertake training for the identification and management of pathogens. The City will continue to conduct the Adopt a Coastline program with local schools. This program encourages schools to become involved in coastal conservation activities.

3.7.1 Recommended Education and Training Management Actions

To increase community awareness and training opportunities regarding natural areas management, the following actions are proposed:

| Action | Detail |
|---------------------------------|--|
| Environmental Education Program | Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as: <ul style="list-style-type: none"> ▪ pathogens ▪ weeds ▪ fire ▪ flora and fauna awareness ▪ prevention of hand feeding wildlife ▪ Continue the Adopt a Coastline program with local schools |
| Natural Areas Team training | Conduct regular Natural Areas Team plant identification training, including weed identification, to increase the effectiveness of weed control activities. |

4.0 Implementation Plan

4.1 Auditing and Inspections

Inspections of Marmion Coastal Foreshore Reserve are conducted by the City of Joondalup once every 8 weeks.

4.2 Key Performance Indicators

Key Performance Indicators are not collected for Marmion Coastal Foreshore Reserve.

4.3 Routine Reporting

Assessing the management of Marmion Coastal Foreshore Reserve will be undertaken through annually reporting progress against the implementation plan.

4.4 Scientific Research and Monitoring

A Natural Areas Assessment is to be conducted on Marmion Coastal Foreshore Reserve every 5 years. The most recent assessment was conducted in 2011, with the next assessment due for completion in 2016.

4.5 Management Plan Review

The Marmion Coastal Foreshore Reserve Management Plan is to be reviewed every 5 years. The next review is due in 2018/19.

4.6 Management Actions

A summary of the recommended management actions is provided below.

| Biodiversity Conservation Area | Recommended Management Action | Detail |
|--------------------------------|-------------------------------|---|
| Physical Environment | Erosion Control | 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 | Erosion Control | Address erosion issues as early as possible to avoid larger areas to be rehabilitated later. |
| Physical Environment | Erosion Control | Consider erosion in the wider context of climate change impacts that could occur over time. |
| Flora | Weed Survey | Undertake a follow up weed survey within the next 5 years to supplement the previous flora survey. |
| Flora | Weed Control | Undertake a targeted weed control program, as described in Appendix 5, to get major weeds under control in the Reserve. |
| Flora | Weed Control | Undertake coordinated approach to regular weed control by implementing Annual Bushland Schedule and Weekly Bushland Schedule. |

| Biodiversity Conservation Area | Recommended Management Action | Detail |
|--------------------------------|--|---|
| Flora | Targeted control of Cape Tulip | Prioritise the control of Cape Tulip (<i>Moraea flaccida</i>) in Marmion Coastal Foreshore Reserve. |
| Flora | Weed Management Plan | Implement the <i>City of Joondalup Weed Management Plan</i> to provide an ongoing strategic approach to the management of natural areas in order to reduce the incidence of weeds. |
| Flora | Revegetation | Conduct revegetation as outlined in the Revegetation Strategy in Appendix 6. |
| Flora | Natural Areas Initial Assessment | Conduct five yearly follow up of Natural Areas Initial Assessment to monitor ecological health of site. |
| Fungi | Fungi survey | Undertake a comprehensive fungi survey in autumn or winter after substantial rain, to supplement previous incidental fungi survey, within 5 years. |
| Plant Disease | Pathogen Management | Implement recommendations from the Pathogen Management Plan that are applicable to the management of Marmion Coastal Foreshore Reserve. |
| Fauna | Feral Animal Control | Implement regular fox and rabbit control to reduce pressures on native fauna and flora. |
| Fauna | Cat Control | Cats are to be controlled in accordance with the requirements of the <i>Cat Act 2011</i> (WA) and the City's protocols in relation to their trapping and removal on land managed by the City. |
| Fauna | Fauna monitoring | Undertake further fauna surveys at appropriate time frames to review species presence and abundance. |
| Social and Built Environment | Signage | Inspections should occur in conjunction with other monitoring activities on a regular basis |
| Social and Built Environment | Signage | Damaged or vandalised signs be repaired or replaced in accordance with the City of Joondalup's procedures, policies and guidelines. |
| Social and Built Environment | Signage | Any advertisement signage affixed to fencing or other locations in the Reserve by businesses or individuals be removed when observed. |
| Fire Management | Assess fire fuel load | Annually assess and report fire fuel load using the <i>FESA Visual Fuel Load Guide for the Scrub Vegetation of the Swan Coastal Plain</i> to inform fire prevention actions required. |
| Fire Management | Develop and implement Fire Management Plan | Develop and implement a Fire Management Plan, outlining the City's strategy for assessing fire risk, prevention, response and recovery. |
| Fire Management | Monitor fire occurrences | Monitor fire occurrences through mapping and updating Geographic Information System (GIS) layers detailing fire incidents and frequency to inform fire prevention actions. |
| Flora | Revegetation | Conduct Flora Survey every five years. |

| Biodiversity Conservation Area | Recommended Management Action | Detail |
|--------------------------------|--|---|
| Fire Management | Revise weed control after fire incidents | Revise weed control after fire incidents to aid regrowth by selecting appropriate chemicals, targeting weeds if safe to do so for new seedlings, and spraying grasses using backpacks. |
| Education and Training | Environmental Education Program | Implement initiatives of a 'Think Green Biodiversity' campaign (part of the Environmental Education Program) targeting environmental issues such as: <ul style="list-style-type: none"> ▪ pathogens ▪ weeds ▪ fire ▪ flora and fauna awareness ▪ prevention of hand feeding wildlife ▪ Continue with Adopt a Coastline program with local schools |
| Education and Training | Natural Areas Team training | Conduct regular Natural Areas Team plant identification training, including weed identification, to increase the effectiveness of weed control activities. |

DRAFT

5.0 References

Agriculture and Related Resources Protection Act 1976 (WA)

Australian Pesticides and Veterinary Medicines Authority. (2012). *Agriculture and Veterinary Permits Search*. Retrieved from: <http://www.apvma.gov.au/permits/search.php>. Accessed May 2013.

Bolland, (1998), *Soils of the Swan Coastal Plain*, Bunbury, Western Australia.

Bougher, N., (2009), *Fungi of the Perth Region and Beyond: A Self-Managed Field Book*, Western Australian Naturalists Club (Inc.), Perth Western Australia, available World Wide Web URL: <http://fungiperth.org.au>, accessed August 2011.

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

Bureau of Meteorology. *Climate and Weather Statistics*. Retrieved from: <http://www.bom.gov.au/climate/data/>. Accessed June 2013.

Cat Act 2011 (WA)

City of Joondalup (CoJ), (2012b), *City of Joondalup Environment Plan 2007-2011*, Perth, Western Australia.

City of Joondalup (CoJ), (2012c), *Pathogen Management Plan*, Perth, Western Australia.

Conservation International (2013), *Southwest Australia*, available World Wide Web URL: http://www.conservation.org/where/priority_areas/hotspots/asia-pacific/Southwest-Australia/Pages/default.aspx, accessed 1 October 2013.

Department of Agriculture. (2007a). *Fox Baiting Farmnote 61/2003*. Retrieved from: http://www.agric.wa.gov.au/objtwr/imported_assets/content/pw/vp/ddf/fn061_2003.pdf. Accessed May 2013.

Department of Agriculture. (2007b). *Options for Rabbit Control 56/2001*. Retrieved from: http://www.agric.wa.gov.au/objtwr/imported_assets/content/pw/vp/rab/f08901.pdf. Accessed May 2013.

Department of Agriculture. (2008). *Rat and Mouse Control in and Around Buildings, Farmnote 114/2000*. Retrieved from: http://www.agric.wa.gov.au/objtwr/imported_assets/content/pw/vp/rod/f11400.pdf. Accessed May 2013.

Department of Agriculture and Food. (2012). *SLIPs NRM Portal*. Retrieved from: <http://spatial.agric.wa.gov.au/slip/framesetup.asp>. Accessed October 2012.

Department of Conservation and Land Management. (1999). *Environmental Weed Strategy for WA*. Retrieved from <http://www.dec.wa.gov.au/content/view/847/2282/>. Accessed July 2013.

Department of Environment. (2004a). *Perth Groundwater Atlas*, Second Edition. Perth, Western Australia: Department of Environment.

Department of Environment (DoE) (2004b), *Stormwater Management Manual for Western Australia*, Perth, Western Australia.

Department of Environment and Conservation. (2011). *Conservation Codes*. Retrieved from: <http://www.dec.wa.gov.au/content/view/852/2010/1/1/>. Accessed May 2013.

Department of Environment and Conservation. (2009). *DEC Swan Weed Assessment*. Retrieved from: <http://www.dec.wa.gov.au/content/view/6295/2358/1/1/>. Accessed July 2013.

Department of Environment and Conservation. (2013). FloraBase. Retrieved from: <http://florabase.dec.wa.gov.au/>. Accessed May 2013.

Department of Environment and Conservation (DEC), n.d., *Acid Sulfate Soils: Fact Sheet*, Perth, Western Australia.

Department of Fire and Emergency Services (DFES), (2013), *The Department of Fire and Emergency Services*, available World Wide Web URL: <http://www.dfes.wa.gov.au/pages/default.aspx>, accessed 26 February 2013.

Department of Indigenous Affairs. (2013). *Aboriginal Heritage Inquiry System*. Retrieved from: <http://www.dia.wa.gov.au/>. Accessed May 2013.

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)

Fire and Emergency Services Authority of Western Australia (FESA), (2007), *Visual Fuel Load Guide for the scrub vegetation of the Swan Coastal Plain*, Perth, Western Australia.

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

Hedde, 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.

MacArthur, W.M. and Bettenay, E. (1974), *The Development and Distribution of the Soils of the Swan Coastal Plain, Western Australia*, Soil Publication No. 16, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia, Melbourne

MP Rogers and Associates Pty Ltd. (2012). *Marmion – Sorrento Coastal Protection Study*. Unpublished report prepared for the City of Joondalup.

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

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

Natural Area Consulting. (2013b). Marmion Coastal Foreshore Reserve Flora Fauna and Fungi Survey. Unpublished report prepared for the City of Joondalup.

NatureMap, *Species Report*. Retrieved from: <http://naturemap.dec.wa.gov.au/default.aspx>. Accessed November 2012.

Nearmap. (2012). *Aerial Imagery*. Retrieved from: <http://www.nearmap.com>. Accessed September 2012.

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.

Stenhouse, R., (2004), 'Fragmentation and Internal Disturbance of Native Vegetation Reserves in the Perth Metropolitan Area, Western Australia', *Landscape and Urban Planning* 68, 389–401.

Western Australian Local Government Association (WALGA), n.d., *Perth Biodiversity Project*, available World Wide Web URL: <http://pbp.walga.asn.au/Home.aspx>, accessed 23 May 2013.

Wildlife Conservation Act 1950 (WA)

Appendix 1: Bush Forever Vegetation Structural Classes

| 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

Key to Symbols

| Symbol | Meaning |
|--------|---------------------------|
| * | Weed species |
| (S) | Significant flora species |
| Syn. | Synonymous with |

Key to flora abundance ratings

| Abbreviation | Abundance estimate (across the site) |
|--------------|--------------------------------------|
| Ab | Abundant |
| C | Common |
| Un | Uncommon |
| R | Rare |






| Family | Species | Common Name | Abundance |
|--|---|-----------------------|-----------|
| Class LILIOPSIDA (Monocotyledons) | | | |
| AGAVACEAE | * <i>Agave americanum</i> | Century Plant | Un |
| ALLIACEAE | * <i>Nothoscordum gracile</i> | | R |
| ASPARAGACEAE | <i>Acanthocarpus preissii</i> | | C |
| | <i>Lomandra maritima</i> | | C |
| | <i>Thysanotus patersonii</i> | Climbing Fringed Lily | C |
| ASPHODELACEAE | * <i>Trachyandra divaricata</i> | Trachyandra | C |
| CYPERACEAE | <i>Ficinia nodosa</i> | Knotted Club Rush | Un |
| | <i>Lepidosperma gladiatum</i> | Coastal Sword Sedge | C |
| HAEMODORACEAE | <i>Conostylis aculeata</i> subsp. <i>cygnorum</i> | | C |
| HEMEROCALLIDACEAE | <i>Corynotheca micrantha</i> | Sand Lily | Un |
| | <i>Tricoryne elatior</i> | Yellow Autumn Lily | Un |
| IRIDACEAE | * <i>Gladiolus caryophyllaceus</i> | Pink Gladiolus | Un |
| | * <i>Moraea flaccida</i> | Cape Tulip | Un |
| | * <i>Romulea rosea</i> | Guildford Grass | C |
| ORCHIDACEAE | <i>Caladenia latifolia</i> | Pink Fairy Orchid | R |
| | <i>Diuris magnifica</i> | Pansy Orchid | R |
| | <i>Microtis media</i> | | R |


| Family | Species | Common Name | Abundance |
|---|--|-----------------------|-----------|
| POACEAE | <i>Austrostipa flavescens</i> | | C |
| | * <i>Avena barbata</i> | Wild Oats | C |
| | * <i>Briza maxima</i> | Blowfly Grass | C |
| | * <i>Bromus diandrus</i> | Brome Grass | C |
| | * <i>Catapodium rigidum</i> | Rigid Fescue | Un |
| | * <i>Cynodon dactylon</i> | Couch | C |
| | * <i>Ehrharta calycina</i> | Perennial Veldt Grass | Un |
| | * <i>Ehrharta longiflora</i> | Annual Veldt Grass | C |
| | * <i>Lagurus ovatus</i> | Hare's Tail Grass | C |
| | * <i>Lolium rigidum</i> | Rye Grass | C |
| | * <i>Poa annua</i> | Winter Grass | C |
| | <i>Spinifex longifolius</i> | Beach Spinifex | C |
| | <i>Sporobolus virginicus</i> | Marine Couch | C |
| | * <i>Stenotaphrum secundatum</i> | Buffalo Grass | Un |
| | * <i>Vulpia bromoides</i> | Squirrel Tail Fescue | C |
| Class MAGNOLIOSPIDA (Dicotyledons) | | | |
| AIZOACEAE | * <i>Carpobrotus edulis</i> | Pigface | Un |
| | <i>Carpobrotus virescens</i> | Native Pigface | Un |
| | * <i>Mesembryanthemum crystallinum</i> | Ice Plant | Un |
| | * <i>Tetragonia decumbens</i> | Sea Spinach | C |
| ANACARDIACEAE | * <i>Schinus terebinthifolius</i> | Japanese Pepper Tree | Un |
| APIACEAE | <i>Daucus glochidiatus</i> | Native Carrot | Ab |
| ARALIACEAE | <i>Trachymene coerulea</i> | Blue Lace Flower | Un |
| | <i>Trachymene pilosa</i> | Native Parsnip | C |
| ASTERACEAE | * <i>Arctotheca calendula</i> | Capeweed | Un |
| | * <i>Dimorphotheca ecklonis</i> | Veldt Daisy | Un |
| | * <i>Gazania linearis</i> | Gazania | C |
| | * <i>Hypochaeris glabra</i> | Smooth Catsear | C |
| | * <i>Lactuca serriola</i> | Prickly Lettuce | Un |
| | <i>Leucophyta brownii</i> | | C |
| | * <i>Monoculus monstrosus</i> | Stinking Roger | C |
| | <i>Olearia axillaris</i> | Coastal Daisybush | Ab |
| | <i>Senecio pinnatifolius</i> | | C |
| | * <i>Sonchus asper</i> | Rough Sowthistle | C |
| | * <i>Sonchus oleraceus</i> | Sowthistle | C |
| * <i>Urospermum picroides</i> | False Hawkbit | Un | |






| Family | Species | Common Name | Abundance |
|-----------------------------|---|------------------------------|-----------|
| BRASSICACEAE | <i>*Brassica tournefortii</i> | | C |
| | <i>*Diplotaxis muralis</i> | | Un |
| | <i>*Lobularia maritima</i> | Alyssum | Un |
| | <i>*Matthiola sp.</i> | Stock | Un |
| | <i>*Raphanus raphanistrum</i> | Wild Radish | C |
| CARYOPHYLLACEAE | <i>*Cerastium glomeratum</i> | Mouse-eared Chickweed | C |
| | <i>*Silene gallica</i> | French Catchfly | Un |
| CHENOPODACEAE | <i>Atriplex isatidea</i> | | R |
| | <i>Rhagodia baccata</i> | Berry Saltbush | Ab |
| | <i>Threlkeldia diffusa</i> | Coast Bonefruit | C |
| CONVOLVULACEAE | <i>*Ipomoea cairica</i> | Mile-a-minute, Morning Glory | R |
| CRASSULACEAE | <i>Crassula colorata</i> var. <i>colorata</i> | Stonecrop | Ab |
| | <i>*Crassula glomerata</i> | | C |
| ERICACEAE | <i>Leucopogon parvifolius</i> | Coast Beard-heath | R |
| EUPHORBIACEAE | <i>*Euphorbia paralias</i> | Sea Spurge | Un |
| | <i>*Euphorbia peplus</i> | Petty Spurge | C |
| | <i>*Euphorbia terracina</i> | Geraldton Carnation Weed | C |
| FABACEAE | <i>Acacia cyclops</i> | | C |
| | <i>Acacia saligna</i> | | Un |
| | <i>Gastrolobium nervosum</i> | | Un |
| | <i>Hardenbergia comptoniana</i> | Native Wisteria | C |
| | <i>Hovea pungens</i> | Devil's Pins | R |
| | <i>Jacksonia calcicola</i> | | C |
| | <i>*Lupinus cosentinii</i> | Blue Lupin | Un |
| | <i>*Melilotus indicus</i> | Hexham Scent | Un |
| | <i>Templetonia retusa</i> | Cocky's Tongue | C |
| <i>*Trifolium campestre</i> | Hop Clover | C | |
| FRANKENIACEAE | <i>Frankenia pauciflora</i> | Seaheath | C |
| GERANIACEAE | <i>*Erodium botrys</i> | Long Storksbill | Un |
| | <i>*Pelargonium capitatum</i> | Rose Pelargonium | C |
| GOODENIACEAE | <i>Lechenaultia linarioides</i> | Yellow Leschenaultia | Un |
| | <i>Scaevola crassifolia</i> | Thick-leaved Fan-flower | Ab |




| Family | Species | Common Name | Abundance |
|-----------------|---|--|-----------|
| | <i>Scaevola thesioides</i> subsp. <i>thesioides</i> | | R |
| LAMIACEAE | <i>Hemiandra pungens</i> | Snakebush | C |
| MALVACEAE | * <i>Malva arborea</i> | Tree Mallow, syn. <i>M. Dendromorpha</i> | R |
| MYRTACEAE | * <i>Leptospermum laevigatum</i> | Victorian Teatree | C |
| | <i>Melaleuca huegelii</i> | Chenille Honeymyrtle | C |
| | <i>Melaleuca lanceolata</i> | Rottnest Island Teatree | R |
| NITRARIACEAE | <i>Nitraria billardierei</i> | Nitre Bush | R |
| ONAGRACEAE | * <i>Oenothera drummondii</i> | Beach Primrose | C |
| OXALIDACEAE | * <i>Oxalis pes-caprae</i> | Soursob | C |
| PAPAVERACEAE | * <i>Fumaria capreolata</i> | Whiteflower Fumitory | C |
| | * <i>Fumaria muralis</i> | Wall Fumitory | C |
| PORTULACEAE | <i>Calandrinia granulifera</i> | Pygmy Purslane | C |
| | <i>Calandrinia calyptata</i> | Strap Purslane | Ab |
| PRIMULACEAE | * <i>Lysimachia arvensis</i> var. <i>caerulea</i> | Blue Pimpernel | C |
| PROTEACEAE | <i>Banksia sessilis</i> var. <i>cygnorum</i> | Parrot Bush | C |
| | <i>Grevillea crithmifolia</i> | | Un |
| RHAMNACEAE | <i>Spyridium globulosum</i> | Basket Bush | Ab |
| SANTALACEAE | <i>Exocarpos sparteus</i> | Broom Ballart | R |
| SCOPHULARIACEAE | <i>Eremophila glabra</i> | Tar Bush | R |
| | <i>Myoporum insulare</i> | Blueberry Tree | Un |
| SOLANUM | * <i>Solanum nigrum</i> | Nightshade | Un |
| URTICACEAE | <i>Parietaria cardiostegia</i> | Native Pellitory | Un |
| ZYGOPHYLLACEAE | <i>Zygophyllum fruticosum</i> | Shrubby Twinleaf | Un |

Appendix 4: Key Weed Species in Marmion Coastal Foreshore Reserve

| Name | Common Name | Conservation Status | Photograph |
|------------------------------|-----------------|---|--|
| <i>Arctotheca calendula</i> | Capeweed | High priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Brassica tournefortii</i> | Wild turnip | High priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Cynodon dactylon</i> | Couch | High priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Ehrharta calycina</i> | Perennial Veldt | High priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Ehrharta Longiflora</i> | Annual Veldt | Low priority (DEC Environmental Weed Strategy for WA) |  |

| Name | Common Name | Conservation Status | Photograph |
|----------------------------------|---------------------------------|---|--|
| <i>Euphorbia terracina</i> | Geraldton Carnation Weed | High priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Fumaria capreolata</i> | Fumaria | Mild priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Gazania linearis</i> | Gazania | Mild priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Gladiolus caryophyllaceus</i> | Pink gladiolus | Moderate priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Ipomoea cairica</i> | Morning glory, Mile-a-minute | Mild priority (DEC Environmental Weed Strategy for WA) |  |

| Name | Common Name | Conservation Status | Photograph |
|--------------------------------|----------------------|---|--|
| <i>Moraea flaccida</i> | One-leaf Cape Tulip | <p>Declared Weed (DAFWA)</p> <p>High priority (DEC Environmental Weed Strategy for WA)</p> |  |
| <i>Oenothera drummondii</i> | Beach primrose | <p>Moderate priority (DEC Environmental Weed Strategy for WA)</p> |  |
| <i>Oxalis pes-caprae</i> | Soursob | <p>High priority (DEC Environmental Weed Strategy for WA)</p> |  |
| <i>Raphanus raphanistrum</i> | Wild radish | <p>Low priority (DEC Environmental Weed Strategy for WA)</p> |  |
| <i>Schinus terebinthifolia</i> | Japanese Pepper tree | <p>Moderate priority (DEC Environmental Weed Strategy for WA)</p> |  |

| Name | Common Name | Conservation Status | Photograph |
|-------------------------------|------------------|---|---|
| <i>Pelargonium capitatum</i> | Rose pelargonium | High priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Tetragonia decumbens</i> | Sea spinach | Moderate priority (DEC Environmental Weed Strategy for WA) |  |
| <i>Trachyandra divaricata</i> | Trachyandra | Mild priority (DEC Environmental Weed Strategy for WA) |  |



Cape Tulip density (*Moraea flaccida*) – Marmion Foreshore Reserve

Significant Weeds Identified and their Potential Environmental Impact

| Species | Common Name where applicable | ESWA Priority Rating | DEC Swan Region Environmental Weed List | | | 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 | |
| <i>Agave americana</i> | Agave | Low | M | M | S | Moderate |
| <i>Arctotheca calendula</i> | Cape Weed | Moderate | H | R | I | High |
| <i>Euphorbia terracina</i> | Geraldton Carnation Weed | High | H | R | I | High |
| <i>Fumaria capreolata</i> | Fumaria | Mild | H | R | I | High |
| <i>Fumaria muralis</i> | Wall Fumitory | Mild | H | R | I | High |
| <i>Gazania linearis</i> | Gazania | Mild | H | R | I | High |
| <i>Gladiolus caryophyllaceus</i> | Pink Gladiolus | Moderate | H | R | I | Moderate |
| <i>Ipomoea cairica</i> | Morning Glory | Mild | H | M | I | High |
| <i>Leptospermum laevigatum</i> | Victorian Tea Tree, Coast Tea Tree | High | H | R | I | High |
| <i>Malva arborea</i> | Tree Mallow | High | H | M | I | Moderate |
| <i>Mesembryanthemum crystallinum</i> | Ice Plant | Moderate | H | R | I | Moderate |
| <i>Moraea flaccida</i> | Cape Tulip | High | H | R | I | High |
| <i>Nothoscordum gracile</i> | | Low | L | R | U | Moderate |
| <i>Oenothera drummondii</i> | Primrose | Moderate | L | M | I | Moderate |
| <i>Oxalis pes-caprae</i> | Sour Sob | Unavailable | H | S | I | High |
| <i>Pelargonium capitatum</i> | Rose pelargonium | High | H | R | I | High |
| <i>Raphanus raphanistrum</i> | Wild Radish | Low | U | M | I | Moderate |
| <i>Schinus terebinthifolia</i> | Japanese Pepper tree | Moderate | H | M | I | High |
| <i>Tetragonia decumbens</i> | Sea Spinach | Moderate | H | R | I | High |
| <i>Trachyandra divaricata</i> | Dune Onion Weed | Mild | M | R | I | High |

(Source: Department of Conservation and Land Management, 1999; Department of Environment and Conservation, 2009)

Appendix 5: Weed Management

Weed control will be an ongoing management issue within the Marmion Coastal Foreshore Reserve in order to reduce the density of weed populations. Controlling weeds will contribute to reducing competition with native flora species for natural resources, enhancing the vegetation condition of the reserve, and providing good quality habitat for fauna species. Disturbed areas either side of the dual use pathway were noted as having a high density of weed species, and should be a main focus for weed control activities and monitoring. The One-leaf Cape Tulip (*Moraea flaccida*) was noted during the 2012 flora survey, and has the potential to spread due to the production of a large numbers of corms. It is listed as a Priority 1 Declared Plant under the *Agriculture and Related Resources Protection Act 1976 (WA)*, which means the introduction or movement of the plant within the State is prohibited.

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 number 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 (DEC, FloraBase 2013; Brown, 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 | Quizalofop | Annual and perennial grasses | Spot spray, or overall spray in broad leaf host situations – selective grass spray |
| 3 | Metsulfuron | bulbs | Spot spray - selective |
| 4 | Glyphosate glove/sponge wipe | One-leaf Cape Tulip | Wipe Leaves with sponge prior to or just on flowering |
| 5 | Triclopyr or Picloram | 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 | Brassicaceae weeds post emergence and other annual broad leaf and grass weeds pre emergence, carnation weeds | Spot spray - selective |

(Source: Australian Pesticides and Veterinary Medicines Authority, 2012)

Weed control methodology

| Species | Common Name | Treatment Number | Timing |
|--|---------------------------------|------------------|---|
| <i>Agave americanum</i> | Century Plant | 5 | November - January |
| <i>Arctotheca calendula</i> | Capeweed | 1 | June - December |
| <i>Avena barbata</i> | Wild Oats | 2 | July - November |
| <i>Brassica tournefortii</i> | Mustard | 1 or 7 | May - September |
| <i>Briza maxima</i> | Blowfly Grass | 2 | June - September |
| <i>Bromus diandrus</i> | Brome Grass | 2 | June - September |
| <i>Carpobrotus edulis</i> | Pigface | 1 or 6 | June - November |
| <i>Catapodium rigidum</i> | Rigid Fescue | 1 | June - October |
| <i>Cynodon dactylon</i> | Couch | 2 | November - February |
| <i>Ehrharta calycina</i> | Perennial Veldt | 2 | June - August (prior to flower formation) |
| <i>Ehrharta longiflora</i> | Annual Veldt | 2 | June - August (prior to flower formation) |
| <i>Euphorbia paralias</i> | Sea Spurge | 1 | June - October |
| <i>Euphorbia peplus</i> | Petty Spurge | 1 | June - October |
| <i>Euphorbia terracina</i> | Geraldton Carnation Weed | 1, 6 or 7 | Manual: June - November Herbicide: June - August |
| <i>Fumaria capreolata</i> | Whiteflower Fumitory | 3 | July - September |
| <i>Fumaria muralis</i> | Wall Fumitory | 3 | July - September |
| <i>Gazania linearis</i> | Gazania | 1 | June - October |
| <i>Gladiolus caryophyllaceus</i> | Pink Gladiolus | 1, 4 or 6 | July - September |
| <i>Hypochaeris glabra</i> | Smooth Catsear | 4 or 6 | May - October |
| <i>Ipomoea cairica</i> | Mile-a-Minute, Morning Glory | 1 (cut vines) | June - August |
| <i>Lactuca serriola</i> | Prickly Lettuce | 1 | September - November |
| <i>Lagurus ovatus</i> | Hare's Tail Grass | 1 or 2 | June - October |
| <i>Leptospermum laevigatum</i> | Victorian Teatree | 5 | July - October |
| <i>Lolium rigidum</i> | Rye Grass | 1,2 or 6 | July - October |
| <i>Lupinus cosentinii</i> | Blue Lupin | 3 or 6 | June - October |
| <i>Mesembryanthemum crystallinum</i> | Ice Plant | 1 or 6 | June - October |
| <i>Monoculus monstrosus</i> | Stinking Roger | 1 or 6 | July - October |
| <i>Moraea flaccida</i> | One-Leaf Cape Tulip | 3 | July - September |

| Species | Common Name | Treatment Number | Timing |
|---------------------------------|-----------------------|------------------|---|
| <i>Oenothera drummondii</i> | Beach Primrose | 1 | July - September |
| <i>Oxalis pes-caprae</i> | Soursob | 3 | July - September |
| <i>Pelargonium capitatum</i> | Rose Pelargonium | 1 | June - October |
| <i>Poa annua</i> | Winter Grass | 2 | Herbicide: June - November Manual: June - January |
| <i>Raphanus raphanistrum</i> | Wild Radish | 1 or 6 | Manual: June - January Herbicide: before flowering |
| <i>Romulea rosea</i> | Guilford Grass | 3 | July - September |
| <i>Schinus terebinthifolius</i> | Japanese Pepper Trees | 5 | December - March |
| <i>Solanum nigrum</i> | Nightshade | 1 or 5 | Manual: June - November Herbicide: July - December |
| <i>Sonchus asper</i> | Rough Sowthistle | 1 or 6 | Manual: June - November Herbicide: July - August |
| <i>Sonchus oleraceus</i> | Sowthistle | 1 | Manual June - November Herbicide: June - September |
| <i>Stenotaphrum secundum</i> | Buffalo Grass | 1 or 2 | November - May |
| <i>Tetragonia decumbens</i> | Sea Spinach | 1 | June - October |
| <i>Trachyandra divaricata</i> | Onion Weed | 1 | June - August |
| <i>Trifolium campestre</i> | Hop Clover | 1 | June - September |
| <i>Vulpia bromoides</i> | Squirrel Tail Fescue | 2 | July - September |

(Source: FloraBase, 2013; Brown & Brooks, 2002)

Implementation Schedule

A recommended implementation schedule is provided below outlining the works set out in Appendix 6. The schedule is set up for rehabilitation works to commence in the spring of 2014 with completion of prescribed works in 2017.

Year 1 (2014)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Glyphosate Spray | | | | | | | | | | | | |
| Quizalofop Spray | | | | | | | | | | | | |
| Triclopyr or picloram | | | | | | | | | | | | |
| Metsulfuron | | | | | | | | | | | | |
| Triasulfuron | | | | | | | | | | | | |
| Hand Weeding | | | | | | | | | | | | |
| Revegetation all zones | | | | | | | | | | | | |
| Informal monitoring | | | | | | | | | | | | |

Year 2 (2015)

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

Year 3 (2016)

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

Year 4 (2017)

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

Appendix 6: Restoration and Regeneration

Revegetation of the Marmion Coastal Foreshore Reserve will enhance the vegetation condition and biodiversity of the site as well as reduce erosion processes by stabilising dunes. Restoration will focus on the vegetation condition areas that were assessed as degraded. Four main zones are recommended for restoration, although other areas of vegetation should be maintained and enhanced where possible to do so. It is recommended that this revegetation program be carried out over a five year period from 2014 until 2018, and that planting occur from June – August each year.

Recommended densities of tubestock are 1 plant/m² for planting, taking into consideration native plants already present in each nominated zone. It is recommended that tubestock used in revegetation activities is sourced from a NIASA accredited nursery using local provenance seed. The use of plant guards and native fertiliser tablets at the time of plant installation will assist with maximising establishment and longer term survival.

Recommended plants for each restoration area are displayed in the tables below. Species numbers for each revegetation zone are indicative numbers according to the recommended densities, and will be subject to change as revegetation activities progress over time, native vegetation already established within each of the zones, stock availability and plant survival.

Recommended plant species for restoration

| Species | Form | Revegetation Areas | | | |
|--|--------------|--------------------|--------|--------|--------|
| | | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
| <i>Acacia cyclops</i> | Tree | | X | X | X |
| <i>Acanthocarpus preissii</i> | Shrub | X | X | X | X |
| <i>Atriplex isatidea</i> | Shrub | | X | X | |
| <i>Austrostipa flavescens</i> | Grass | | X | X | X |
| <i>Banksia sessilis</i> | Shrub | X | X | X | X |
| <i>Carpobrotus virescens</i> | Ground cover | | X | X | X |
| <i>Conostylis aculeata subsp. cygnorum</i> | Herb | X | X | X | X |
| <i>Eremophila glabra</i> | Shrub | | X | X | X |
| <i>Ficinia nodosa</i> | Sedge | X | X | X | X |
| <i>Grevillea crithmifolia</i> | Shrub | X | X | X | X |
| <i>Hardenbergia comptoniana</i> | Climber | X | X | X | X |
| <i>Hemiandra pungens</i> | Ground cover | X | X | X | X |
| <i>Lechenaultia linarioides</i> | Shrub | X | X | X | X |
| <i>Lepidosperma gladiatum</i> | Sedge | X | X | X | X |
| <i>Lomandra maritima</i> | Herb | X | X | X | |
| <i>Leucophyta brownii</i> | Shrub | X | X | X | X |
| <i>Melaleuca huegelii</i> | Tree | X | X | X | X |
| <i>Myoporum insulare</i> | Shrub | X | X | X | X |
| <i>Olearia axillaris</i> | Shrub | X | X | X | X |
| <i>Rhagodia baccata</i> | Shrub | X | X | X | X |

| Species | Form | Revegetation Areas | | | |
|------------------------------|-------|--------------------|--------|--------|--------|
| | | Zone 1 | Zone 2 | Zone 3 | Zone 4 |
| <i>Scaevola crassifolia</i> | Shrub | X | X | X | X |
| <i>Spinifex longifolius</i> | Grass | | X | X | |
| <i>Sporobolus virginicus</i> | Grass | X | | | X |
| <i>Spyridium globulosum</i> | Shrub | X | X | X | X |
| <i>Templetonia retusa</i> | Shrub | X | X | X | X |
| <i>Threlkeldia diffusa</i> | Herb | X | X | X | X |

Restoration species for Zone 1

| Species | Form | Plant Numbers |
|---|--------------|---------------|
| <i>Acanthocarpus preissii</i> | Shrub | 40 |
| <i>Banksia sessilis</i> var. <i>cygnorum</i> | Shrub | 68 |
| <i>Conostylis aculeata</i> subsp. <i>cygnorum</i> | Herb | 40 |
| <i>Ficinia nodosa</i> | Sedge | 20 |
| <i>Frankenia pauciflora</i> | Shrub | 40 |
| <i>Grevillea crithmifolia</i> | Shrub | 40 |
| <i>Hardenbergia comptoniana</i> | Climber | 40 |
| <i>Hemiandra pungens</i> | Ground cover | 40 |
| <i>Lechenaultia linarioides</i> | Shrub | 20 |
| <i>Lepidosperma gladiatum</i> | Sedge | 60 |
| <i>Leucophyta brownii</i> | Shrub | 50 |
| <i>Lomandra maritima</i> | Herb | 20 |
| <i>Melaleuca huegelii</i> | Tree | 60 |
| <i>Myoporum insulare</i> | Shrub | 30 |
| <i>Olearia axillaris</i> | Shrub | 40 |
| <i>Rhagodia baccata</i> | Shrub | 40 |
| <i>Scaevola crassifolia</i> | Shrub | 40 |
| <i>Sporobolus virginicus</i> | Grass | 30 |
| <i>Spyridium globulosum</i> | Shrub | 40 |
| <i>Templetonia retusa</i> | Shrub | 60 |
| <i>Threlkeldia diffusa</i> | Herb | 40 |
| Total | | 858 |

Restoration species for Zone 2

| Species | Form | Plant Numbers |
|---|--------------|---------------|
| <i>Acacia cyclops</i> | Tree | 20 |
| <i>Acanthocarpus preissii</i> | Shrub | 80 |
| <i>Atriplex isatidea</i> | Shrub | 62 |
| <i>Austrostipa flavescens</i> | Grass | 80 |
| <i>Banksia sessilis</i> var. <i>cygnorum</i> | Shrub | 120 |
| <i>Carpobrotus virescens</i> | Ground cover | 60 |
| <i>Conostylis aculeata</i> subsp. <i>cygnorum</i> | Herb | 100 |

| Species | Form | Plant Numbers |
|---------------------------------|--------------|---------------|
| <i>Eremophila glabra</i> | Shrub | 90 |
| <i>Ficinia nodosa</i> | Sedge | 60 |
| <i>Frankenia pauciflora</i> | Shrub | 80 |
| <i>Grevillea crithmifolia</i> | Shrub | 100 |
| <i>Hardenbergia comptoniana</i> | Climber | 80 |
| <i>Hemiandra pungens</i> | Ground cover | 100 |
| <i>Lechenaultia linarioides</i> | Shrub | 80 |
| <i>Lepidosperma gladiatum</i> | Sedge | 140 |
| <i>Leucophyta brownii</i> | Shrub | 120 |
| <i>Lomandra maritima</i> | Herb | 50 |
| <i>Melaleuca huegelii</i> | Tree | 100 |
| <i>Myoporum insulare</i> | Shrub | 120 |
| <i>Olearia axillaris</i> | Shrub | 140 |
| <i>Rhagodia baccata</i> | Shrub | 150 |
| <i>Scaevola crassifolia</i> | Shrub | 120 |
| <i>Spinifex longifolius</i> | Grass | 150 |
| <i>Spyridium globulosum</i> | Shrub | 120 |
| <i>Templetonia retusa</i> | Shrub | 150 |
| <i>Threlkeldia diffusa</i> | Herb | 100 |
| | Total | 2572 |

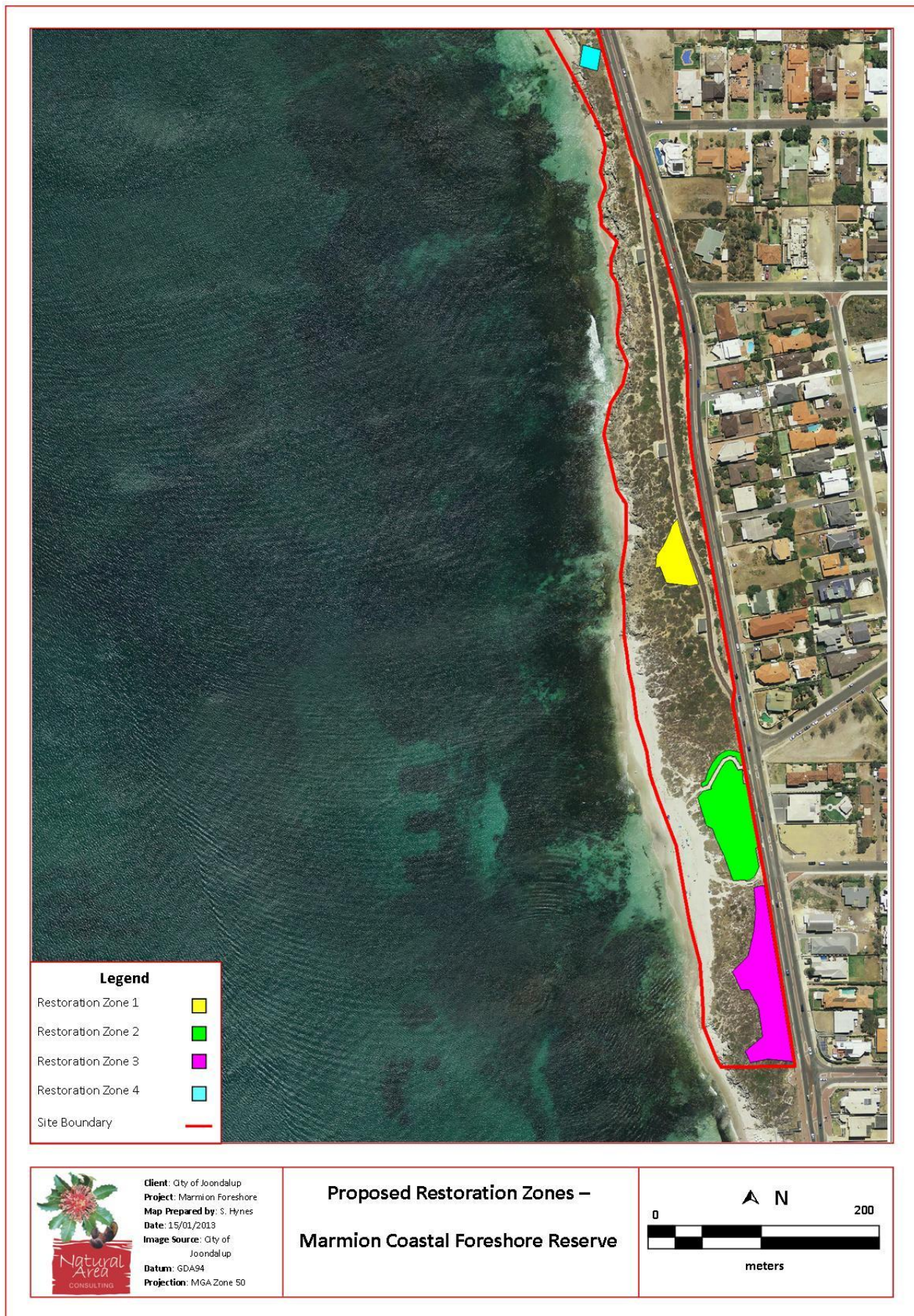
Restoration species for Zone 3

| Species | Form | Plant Numbers |
|---|--------------|---------------|
| <i>Acacia cyclops</i> | Tree | 10 |
| <i>Acanthocarpus preissii</i> | Shrub | 100 |
| <i>Atriplex isatidea</i> | Shrub | 80 |
| <i>Austrostipa flavescens</i> | Grass | 83 |
| <i>Banksia sessilis</i> var. <i>cygnorum</i> | Shrub | 120 |
| <i>Carpobrotus virescens</i> | Ground cover | 100 |
| <i>Conostylis aculeata</i> subsp. <i>cygnorum</i> | Herb | 140 |
| <i>Eremophila glabra</i> | Shrub | 80 |
| <i>Ficinia nodosa</i> | Sedge | 80 |
| <i>Frankenia pauciflora</i> | Shrub | 80 |
| <i>Grevillea crithmifolia</i> | Shrub | 100 |
| <i>Hardenbergia comptoniana</i> | Climber | 80 |
| <i>Hemiandra pungens</i> | Ground cover | 80 |
| <i>Lechenaultia linarioides</i> | Shrub | 100 |
| <i>Lepidosperma gladiatum</i> | Sedge | 140 |
| <i>Leucophyta brownii</i> | Shrub | 100 |
| <i>Lomandra maritima</i> | Herb | 40 |
| <i>Melaleuca huegelii</i> | Tree | 110 |
| <i>Myoporum insulare</i> | Shrub | 130 |

| Species | Form | Plant Numbers |
|-----------------------------|-------|---------------|
| <i>Olearia axillaris</i> | Shrub | 120 |
| <i>Rhagodia baccata</i> | Shrub | 120 |
| <i>Scaevola crassifolia</i> | Shrub | 100 |
| <i>Spinifex longifolius</i> | Grass | 100 |
| <i>Spyridium globulosum</i> | Shrub | 120 |
| <i>Templetonia retusa</i> | Shrub | 120 |
| <i>Threlkeldia diffusa</i> | Herb | 50 |
| Total | | 2583 |

Restoration species for Zone 4

| Species | Form | Plant Numbers |
|---|--------------|---------------|
| <i>Acacia cyclops</i> | Tree | 20 |
| <i>Acanthocarpus preissii</i> | Shrub | 40 |
| <i>Austrostipa flavescens</i> | Grass | 20 |
| <i>Banksia sessilis</i> var. <i>cygnorum</i> | Shrub | 40 |
| <i>Carpobrotus virescens</i> | Ground cover | 40 |
| <i>Conostylis aculeata</i> subsp. <i>cygnorum</i> | Herb | 20 |
| <i>Eremophila glabra</i> | Shrub | 20 |
| <i>Ficinia nodosa</i> | Sedge | 40 |
| <i>Frankenia pauciflora</i> | Shrub | 40 |
| <i>Grevillea crithmifolia</i> | Shrub | 40 |
| <i>Hardenbergia comptoniana</i> | Climber | 20 |
| <i>Hemiandra pungens</i> | Ground cover | 20 |
| <i>Lechenaultia linarioides</i> | Shrub | 40 |
| <i>Lepidosperma gladiatum</i> | Sedge | 40 |
| <i>Leucophyta brownii</i> | Shrub | 20 |
| <i>Melaleuca huegelii</i> | Tree | 40 |
| <i>Melaleuca lanceolata</i> | Tree | 20 |
| <i>Myoporum insulare</i> | Shrub | 20 |
| <i>Olearia axillaris</i> | Shrub | 60 |
| <i>Rhagodia baccata</i> | Shrub | 40 |
| <i>Scaevola crassifolia</i> | Shrub | 40 |
| <i>Sporobolus virginicus</i> | Grass | 40 |
| <i>Spyridium globulosum</i> | Shrub | 40 |
| <i>Templetonia retusa</i> | Shrub | 60 |
| <i>Threlkeldia diffusa</i> | Herb | 40 |
| <i>Atriplex isatidea</i> | Shrub | 20 |
| Total | | 880 |



Proposed restoration zones – Marmion Coastal Foreshore Reserve

Restoration Zone 1

This zone occurs in between the southern two shaded seating areas on the western side of the dual use path, and is approximately 860 m² in size. Weed control has occurred at this site to remove Victorian Tea Trees (*Leptospermum laevigatum*) which has left it with little vegetation cover, replanting will restore vegetation cover to the area and stabilise the soil.

Restoration Zone 2

This zone is located in between the two beach access ways at the southern end of the reserve, with a smaller section to the right of the northern access way and is approximately 2,600 m² in size. A storm water drain runs down the centre of the area from the dual use pathway down to the beach and includes an area of increased weed density, particularly the Japanese Pepper Tree (*Schinus terebinthifolius*) (Figure 6). Weed control will be required prior to revegetation to maximise the survival of plantings.

Restoration Zone 3

This zone is located at the southern end of the site adjacent to the City of Stirling boundary and is approximately 2,600 m² in size. Weed control has already been undertaken here. Restoration would benefit the area by restabilising the dune and reducing the impact of erosion.

Restoration Zone 4

This zone occurs on the steep dune to the south of the ablution block and is approximately 215 m² in size. Restoration at this site would aid revegetation of the steep dunes and reduce the risk of erosion.