City of Joondalup

Coastal Foreshore Management Plan 2014 - 2024

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City of Joondalup

Coastal Foreshore Management Plan 2014 - 2024

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Acronyms

Acronym / Abbreviation	Definition
AHD	Australia Height Datum
the City	City of Joondalup
CALM	Department of Conservation and Land Management
Cwlth	Commonwealth
DAF	Department of Agriculture and Food
DEC	Department of Environment and Conservation
DEFL	DPaW's Threatened (Declared Rare) Flora Database
DPaW	Department of Parks and Wildlife (previously DEC)
DP List	DPaW's Declared Rare and Priority Flora List
DRF	Declared rare flora
DSEWPaC	Department of Sustainability, Environment, Water Population and Communities
EWSWA	Environmental Weed Strategy of Western Australia
EPBC	Environment Protection and Biodiversity Conservation
FCT	Floristic Community Type
g	gram
GIS	Geographic Information System
GPS	Global Positioning System
IBRA	Interim Biogeographical Regionalisation of Australia
km	Kilometres
kmh	Kilometres per hour
L	Litre
mm	Millimetres
MNES	Matters of national environmental significance
NAC	Natural Area Consulting
NPNCA	National Parks and Nature Conservation Authority
NRM	Natural resource management
PMST	Protected Matters Search Tool
PUBF	Perth Urban Bushland Fungi
SCP	Swan Coastal Plain
SLIPs	Shared Land Information Platforms
URL	Uniform Resource Locator
WA	Western Australia
WA Herb	Western Australian Herbarium

Executive Summary

The need for Natural Area Management Plans has been highlighted in the City of Joondalup Biodiversity Action Plan 2009-2019 and the *Coastal Foreshore Management Plan 2014 – 2024* has been designed to complement that document. The *Coastal Foreshore Management Plan 2014 – 2024* is intended to be an overarching management plan for the City of Joondalup coastal foreshore reserve ('coastal foreshore reserve') to broadly guide management in the longer term, with the expectation that local management plans will be developed for discrete portions in the future. It is considered that the local management plans will allow vegetation condition maps to be compared with the maps contained within the Coastal Foreshore Management Plan 2014-2024. It is recognised that any management activities undertaken within the coastal foreshore reserve will be prioritised in accordance with management aims and City resources.

The coastal foreshore reserve within the City of Joondalup represents a significant area of coastal heath vegetation on limestone and both Quindalup and Spearwood dunes. Portions, such as Iluka and the Ocean Reef Marina sites are reasonably intact and somewhat unique due to the amount of vegetation that has been reserved, along with the presence of a diverse array of flora. Accordingly, a number of locations have been recommended for continued or inclusion as conservation areas. The vegetation condition assessment indicated that 0.2% of the foreshore reserve was in excellent condition, 33.8% in very good condition, 48.2% in good condition, 13.3% in a degraded condition and 4.5% in a completely degraded condition.

The City faces a number of management issues associated with the coastal foreshore reserve and each have been discussed. Where appropriate, an indication of best practice management has also been provided. Key management issues revolve around human use and retention of natural values in the longer term. It is recommended that priorities for implementation focus on designated conservation areas (e.g.: Iluka, Mullaloo, Ocean Reef), then areas that are heavily used for recreation and other purposes (e.g.: Burns Beach, Pinnaroo Point), then other areas. Threatening processes, management strategies and recommendations are provided in Section 5, with suggested priorities provided in Section 6.

The work of 'Friends of' groups within the coastal foreshore reserve is important, and their contribution is acknowledged. Like the City, their aim is to improve the environmental and ecological values of the foreshore, thus the work they undertake supplements that of the City. It is also needs to be acknowledged that the 'Friends' groups work in areas that are very degraded or in poor condition due to ongoing impacts and which might not be immediately targeted by the City for various reasons including conservation ratings or resource priorities, as well as areas in good condition.

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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 the Yellagonga Regional Park, the Marmion Marine Park, the Neerabup National 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 to provide strategic ongoing 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 the *Coastal Foreshore Management Plan 2014 – 2024* 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 *Coastal Foreshore Management Plan 2014 – 2024* is the 17 km of coastal foreshore reserve that extends from Burns Beach in the north, south to the boundary of the City of Stirling at Beach Road, Watermans Bay (Figure 1). The foreshore extends inwards from the coast through a series of vegetated dunes, generally to the first road running parallel to the coast. It varies in width between the coast and the major road(s) running parallel to the coast. The reserve area is approximately 206.5 ha. It includes the following sections of coast:

- Burns Beach foreshore
- Iluka foreshore
- Ocean Reef foreshore
- Mullaloo foreshore

- Whitfords Nodes Kallaroo
- Whitfords Nodes Hillarys
- Sorrento foreshore
- Marmion foreshore.

The coastal foreshore reserve is vested with and managed by the City of Joondalup. The coastal foreshore reserve is an important regional resource and receives many visitors accessing various locations on a daily basis. The coastal foreshore reserve areas are under pressure from urban activities, particularly recreational and other users, and will continue to do so as population within the City increases. Thus, in order to manage these pressures and maintain their environmental and other values, it is necessary to review current conditions at the site, management practices, and suggest how they can be managed in the longer term.

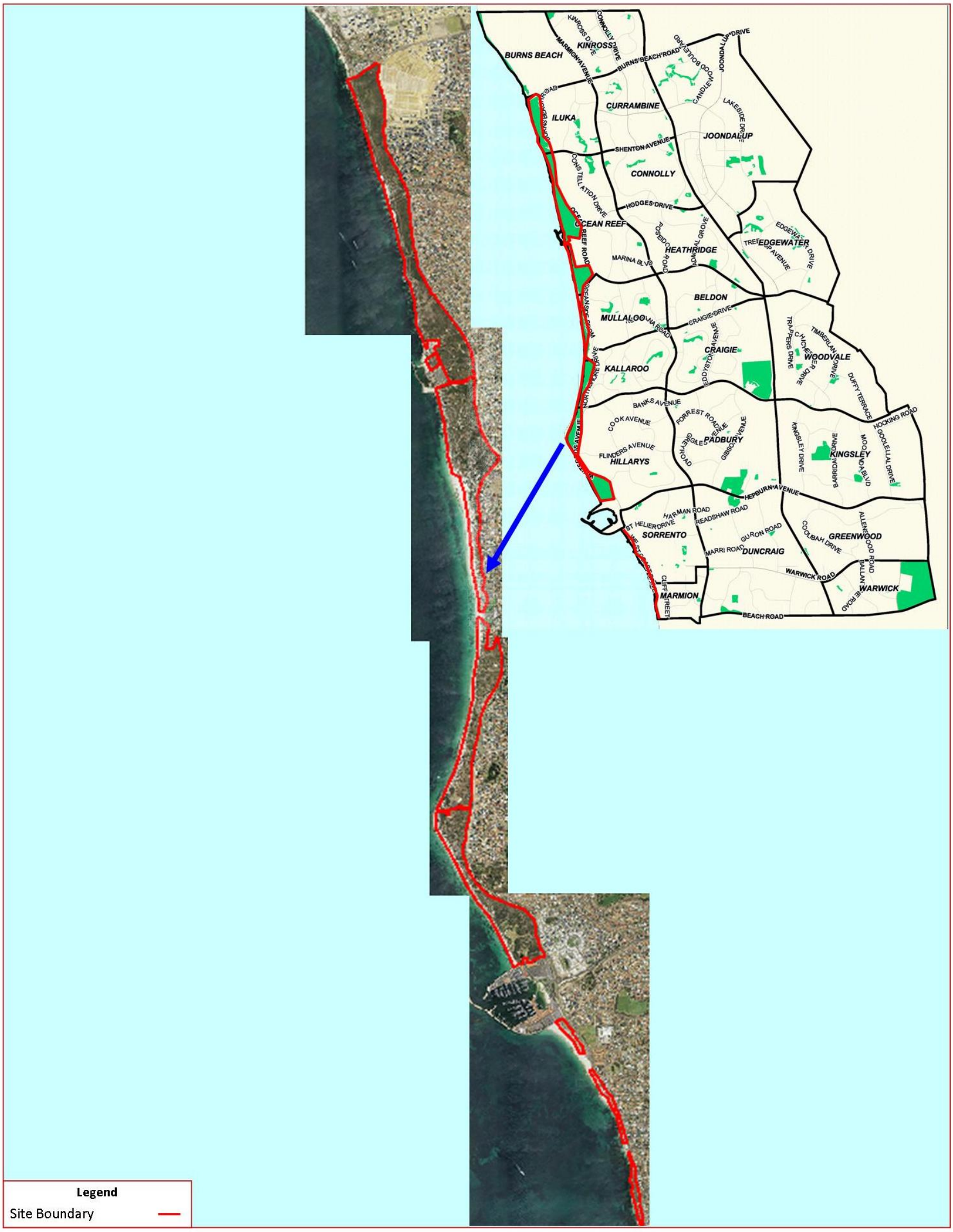
1.4 Purpose

The purpose of the *Coastal Foreshore Management Plan 2014 - 2024* is to:

- provide information to assist the City of Joondalup in prioritising maintenance schedules by outlining the current physical and management context of the coastal foreshore reserve within the City of Joondalup
- guide the future development of the City's Capital Works Program
- identify areas within the coastal foreshore reserve that are considered to have the highest conservation values, giving consideration to natural features including landform, flora and fauna, along with cultural values
- outline management issues apparent at various locations of the coastal foreshore reserve and suggest management strategies to manage those in the short to medium term
- identify current best practice management practices that can be implemented by the City
- increase opportunities for grant funding by having a detailed schedule of projects
- provide guidance to City employees, contractors and Friends groups operating within the coastal foreshore reserve.

The plan is designed to provide overarching management direction for the coastal foreshore reserve, with individual management plans to be developed for discrete sections in the future.

Figure 1: Site location and boundary, Coastal Foreshore Reserve



Client: City of Joondalup
Project: Foreshore Management Plan
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Site Location and Boundary

N
0 2000
Metres

1.5 Aims and Objectives

The aims of the *Coastal Foreshore Management Plan 2014 – 2024* 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 *Coastal Foreshore Management Plan 2014 – 2024* 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 *Coastal Foreshore Management Plan 2014 – 2024* 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 Draft Environment Plan* 2014–2019 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 2.

Figure 2: City of Joondalup Strategic Environmental Framework

Local Biodiversity Program (formerly Perth Biodiversity Project)

The City of Joondalup is one of 32 local governments participating in the Western Australian Local Government Association's (WALGA's) Local Biodiversity Program. The aim of the Local Biodiversity Program is 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 template, 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 p*laces and objects having significance for the purpose of protection of the landscape or environment*. No places within the coastal foreshore reserve are listed under Schedule 5 (Clause 5.3.1) of District Planning Scheme No. 2.

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.

Five registered Aboriginal heritage sites are located within the coastal foreshore reserve[1]. These are discussed further in Section 5.6.1.

Agriculture and Related Resources Protection Act 1976

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.

One declared plant, the One-leaf Cape Tulip (*Moraea flaccida*), has been recorded in the coastal foreshore reserve[2]. The One-leaf Cape Tulip and other weeds are discussed further in Section 5.1.2.

Bush Fires 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.

[1] Department of Indigenous Affairs, 2011
[2] Department of Agriculture and Food, 2013

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. There are no listings for any location within the coastal foreshore reserve on any State or Federal cultural heritage inventory or register.

Wildlife Conservation Act 1950

The Act provides the statute relating to conservation and legal protection of flora and fauna. Six fauna species listed under the *Wildlife Conservation Act 1950* are considered to either use or possibly use the coastal foreshore reserves these being[3]:

- Black-striped Snake (Neelaps calonotos) (reptile) – (Priority 3)
- Carnaby's Cockatoo (Calyptorhynchus latirostris) (bird) – (Threatened)
- Carpet Python (Morelia spilota subsp. imbricata) (reptile) – (Specially protected fauna)
- Peregrine Falcon (Falco peregrinus) (bird)- (Specially protected fauna)
- Shield-backed Trapdoor Spider (*Idiosoma nigrum*) (invertebrate) – (Threatened)

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.

Portions of the coastal foreshore reserve are listed as Bush Forever site 325 (coastal strip from Burns Beach to Hillarys). Significant flora species include[4]:

- Acacia xanthina
- Allocasuarina lehmanniana
- Alyogyne huegelii var. glabrescens
- Callitris preissii
- Eucalyptus foecunda
- Hibbertia spicata subsp. leptotheca
- Kennedia coccinea
- Melaleuca cardiophylla
- Marianthus paralius (Threatened)
- Plantago exilis.

[3] Department of Parks and Wildlife 2013b
[4] Government of Western Australia, 2000

These are discussed further in Section 5.1.1.

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.

Environmental Weed Strategy for Western Australia 1999

The Department of Conservation and Land Management (CALM) 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.

The coastal foreshore reserve contains eight weeds rated in the Environmental Weed Strategy for WA as 'high priority'[5]. These are discussed further in Section 5.1.2.

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.

Five *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* listed species have been recorded in or as having the potential to occur within the coastal foreshore reserve[6,7]:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) – Endangered
- Fork-tailed Swift (*Apus pacificus*) – Migratory
- Osprey (*Pandion haliaetus*) – Migratory
- Rainbow Bee-eater (*Merops ornatus*) - Migratory
- White-bellied Sea Eagle (*Haliaeetus leucogaster*) – Migratory.

These are discussed further in Section 5.4.1.

Australia's Biodiversity Conservation Strategy 2010-2030

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

[5] Department of Conservation and Land Management, 1999
[6] Western Wildlife, 2008
[7] DSEWPaC, 2011

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 (WONS) are identified as nationally agreed priority plant species for control and management based on the criteria of invasiveness and impact characteristics, potential and current area of spread and economic, environmental and social impacts. The 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. One endangered IUCN Red List species has been recorded for the coastal foreshore reserve, namely the Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*).

1.6.5 Consultation

During preparation of the *Coastal Foreshore Management Plan 2014 - 2024*, consultation occurred with representatives from the following organisations:

- City of Joondalup
- Joondalup Community Coast Care Forum
- Mullaloo Beach Community Group
- Friends of North Ocean Reef and Iluka Foreshore.

1.6.6 Land Tenure and Vesting

The City of Joondalup is responsible for the active management for the majority of the coastal foreshore reserve, which is reserved as Foreshore Coastal Reserve – Parks and Recreation. Exclusions are:

- Marmion Marine Park areas that interface with foreshore reserve
- Water Corporation land where the outlets from the Beenyup Waste Water Treatment Plant are located near the Ocean Reef Marina, and
- Hillarys Boat Harbour, which is owned by the State Government and managed by the Department of Transport.

2.0 Description of the Environment

Ecosystems are made up of a series of living and non-living components that strongly influence the communities that will exist at a particular location. The Swan Coastal Plain is a series of sand dunes that have built up over time, with the current coastline largely being characterised by the Quindalup Dune System. This system comprises a series of dune landforms of varying heights, with the youngest immediately adjacent to the coast and the oldest further inland adjacent to the Spearwood Dune System.

The width of the coastal foreshore reserve varies along its length according to prevailing conditions. Accordingly, ecosystems existing within the coastal foreshore reserve exhibit vegetation and fauna communities that have a close association with the soils, their location within the dune system and the prevailing conditions experienced.

2.1 Regional Context

The City of Joondalup is located in the northern portion of the Perth sub-region of the Swan Coastal Plain bioregion as described in the Interim Biogeographical Regionalisation of Australia (IBRA). The Swan Coastal Plain is a low coastal plain primarily characterised by a series of dunal formations extending to the Darling Scarp. According to Mitchell, Williams and Desmond[8], the Perth sub-region is characterised as having:

- colluvial and aeolian sands
- alluvial river flats
- coastal limestone
- Jarrah-Banksia woodlands on marine dunes.

2.2 Physical Environment

2.2.1 Geology, Soils and Landform

Soils of the Swan Coastal Plain

The coastal foreshore reserve is situated within the City of Joondalup, which is located on the Swan Coastal Plain. 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 3)

The geology of the coastal foreshore reserve is dominated by the Quindalup Dune System, the youngest of the aeolian dune systems associated with the Swan Coastal Plain. It is characterised by unconsolidated white calcareous sands that form a series of parabolic and nested parabolic dunes and relict cuspate beach-ridge plains (e.g.: Whitfords, Burns Beach)[9]. To the east of the Quindalup Dune System lie the older Spearwood dunes, a series of three dune lines that are characterised by deep yellow sands and calcarenite deposits made up of

[8] Mitchell, Williams and Desmond, 2002
[9] Gozzard, 2007

broken fossil shell and quartz sand collectively known as Tamala Limestone. Gozzard[11] describes the dunes as 'large-scale, convex, asymmetric, topographically irregular ridges that reach heights of 95 m in places.'

The foredunes closest to the coast range in height from low foredunes to an average of 5 – 10 m. Higher dunes some 10 – 20 m occur in areas where the foreshore reserve is wider, such as at Ocean Reef and Mullaloo.[10]

In addition to the sandy dunes, the region includes a series of cemented coastal dunes made up of shallow marine and beach calcarenite deposits, with examples being the Marmion Angling and Aquatic Club area and south of Ocean Reef Marina[11]. Offshore reefs are also Tamala Limestone, and act to reduce the energy of waves reaching the shoreline.

Two major soil types are found in the coastal foreshore reserves, namely soils associated with the Quindalup and the Spearwood dune systems. The Quindalup soils are generally loose, white calcareous sands with little organic matter present. They are associated with parabolic dunes of varying age, undulating landscapes within the dune system, and little soil profile development[12].

Soils associated with the Spearwood dunes are yellow and often incorporate areas where Tamala limestone occurs at the surface. The Spearwood dunes system is described by McArthur and Bartle[12] as being:

> ...low hilly to undulating terrain with a core of sandy limestone, capped by secondary calcite, overlain by siliceous sand, karst depressions with lakes, swamps and hydromorphic soils on the floors.

Differing soil types are highlighted in Table 1. The potential for acid sulphate soils within the foreshore is considered to be very low to low[14].

Table 1: Soil Types, Joondalup Foreshore Reserve

Soil Type	Description
Qu	Presently unstable sand
Q1	Oldest Quindalup phase. Dunes or remnants with low relief; soils have organic staining to about 30 cm, overlying pale brown sand, and within definite cementation below one metre.
Q2	Second Quindalup phase. A complex pattern of dunes with moderate relief; soils have organic staining to about 20 cm, passing into pale brown sand; some cementation below one metre.
Q3	Third Quindalup phase. Steep irregular dunes with high relief; soils consist of loose sand with little surface organic staining and incipient cementation at depth.

[10] WA Atlas, 2012
[11] Gozzard, 2007
[12] McArthur and Bartle, 1980

Soil Type	Description
Q4	Youngest Quindalup phase. Steep irregular dunes of loose pale brown sand with no soil profile development.
Qp	Undulating landscapes with deep calcareous sands overlying limestone; soils have dark grey-brown sand to about 50 cm and then pale brown sand; remnants of hummocks are often present.
Qs	Undulating landscapes with shallow calcareous sand over limestone and much rock outcrop.
Sp	Spearwood sand. Gently sloping to steep irregular banks of depressions; brown sandy surface over bright yellow-brown sand with limestone often within one metre; much limestone outcrop.
Kls	Bare limestone and shallow brown sandy soils over limestone
Ky	Karrakatta yellow sand (yellow phase). Grey-brown sandy surface passing into bright yellow sand and often with limestone within two metres

(Source: McArthur and Bartle, 1980)

Acid Sulphate Soils

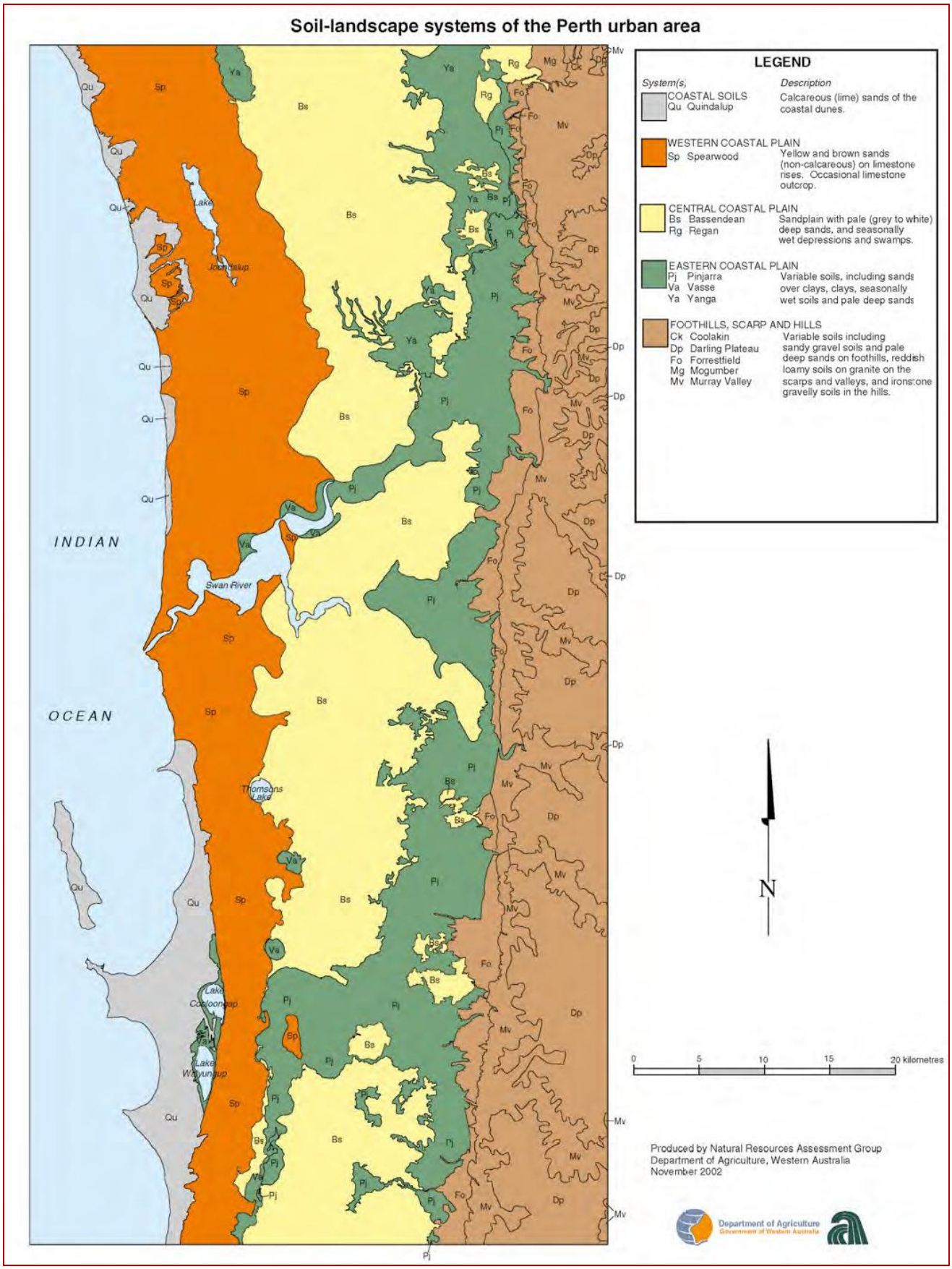
Acid sulphate soils are naturally occurring soils and sediments that contain iron sulphides. They are predominantly found in low-lying coastal wetlands and tidal flats and are harmless when left undisturbed. Exposure to air causes the iron sulphides in acid sulphate soils to react with oxygen and water producing iron compounds and sulphuric acid, which can lead to heavy metals being released into the surrounding environment[13].

Acid sulphate soils are categorised as 'potential acid sulphate soils' (PASS) or 'actual acid sulphate soils' (ASS). Potential acid sulphate soils have not been oxidised by exposure to air whilst actual acid sulphate soils have been disturbed or exposed to oxygen and become acidic[14].

The risk of acid sulphate soils is based on their likelihood within soil profiles and has been mapped by the then Department of Environment and Conservation using available desktop information and limited ground-truthing within areas where intensive on-ground mapping and soil analysis work has been undertaken. This process e mapping has found that acid sulphate soils are not known or expected to occur within the coastal foreshore reserve on the basis of origin of the geological units present, depth to groundwater and partial 'ground truthing' or onsite investigation.

[13] Department of Environment, 2004
[14] Department of Environment and Conservation, undated

Figure 3: Soils of the Swan Coastal Plain (Department of Agriculture, 2002)



2.2.2 Hydrology

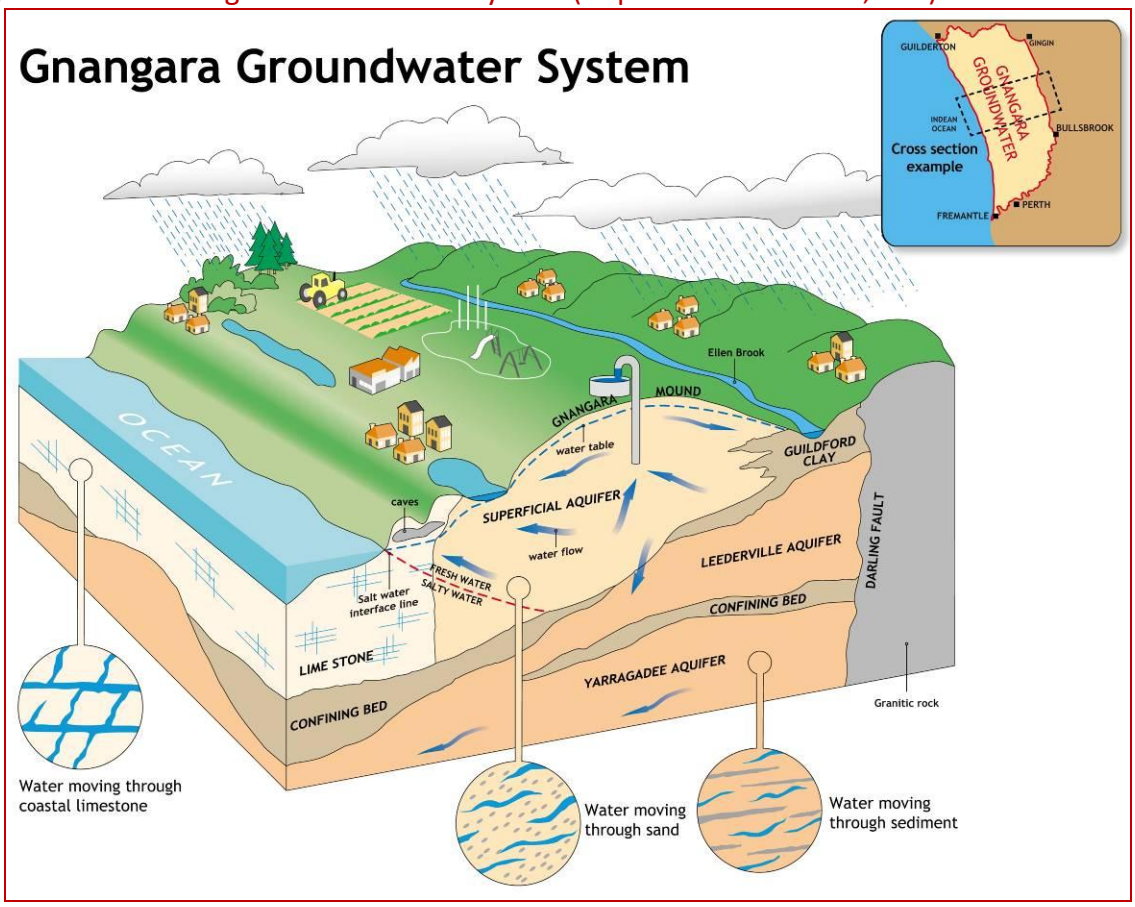
Groundwater

The City of Joondalup is located over Perth's largest groundwater source, the Gnangara groundwater system (Gnangara Mound). This system comprises four main aquifers:

- superficial (shallow, unconfined)
- Mirrabooka (deeper, semi-confined)
- Leederville (deep, mostly confined)
- the Yarragadee (deep, mostly confined).

The Gnangara Mound extends across most of the superficial aquifer and refers to the watertable creating a mound shape (Figure 4). Groundwater levels in the superficial aquifer have been declining over recent years due to pressure from extraction and the impacts of climate change.[15]

Figure 4: Gnangara Groundwater System (Department of Water, n.d.)



[15] Department of Water, undated

Stormwater Drainage

As development within the City of Joondalup has continued, the amount of stormwater that needs to be redirected from urban, built up areas has increased. Traditionally, drains have carried the stormwater to outlet pipes on the beach or in the dunes. As environmental awareness has increased, a number of impacts are known to be associated with this practice, including:

- carrying of pollutants such as nutrients, heavy metals and microbiological species to beach areas where they can come into contact with people when swimming, and thus impacting on the recreational amenity in the vicinity of discharge sites
- creating areas of erosion during larger rainfall and storm events at the outlet location
- creating wetter areas in dunes that, depending on the frequency and intensity of rainfall events, can impact on vegetation at the site.

As a result, the City has a policy of not allowing new drainage outlets in coastal and bushland areas[16].

Considerations for management include:

- treating stormwater before discharge onto beach areas
- reducing the potential for erosion at outlet locations
- consider the continued appropriateness of discharging stormwater into dunes.

Management Strategies

Management strategies associated with stormwater drainage include the assessing of drain locations and what impacts may be occurring as a result of their presence. Where impacts are occurring, those drains should be upgraded to prevent further impacts. This could include the fitting of gross pollutant traps in the short term, and in the longer term undertaking a capital works program to ensure stormwater is treated before discharge. Investigations into the feasibility of reusing treated water for irrigation or aquifer recharge could also be investigated.

Recommendations:

It is recommended that:

- current stormwater drain locations within the coastal foreshore reserve be evaluated with a view to assessing the current level of impact
- the possibility of treating stormwater prior to discharge be assessed, and whether or not there are alternatives to ocean discharge, such as through the installation of gross pollutant traps
- where impacts are known to occur, implementing an appropriate works program with the aim of preventing further degradation.

[16] City of Joondalup, 2012

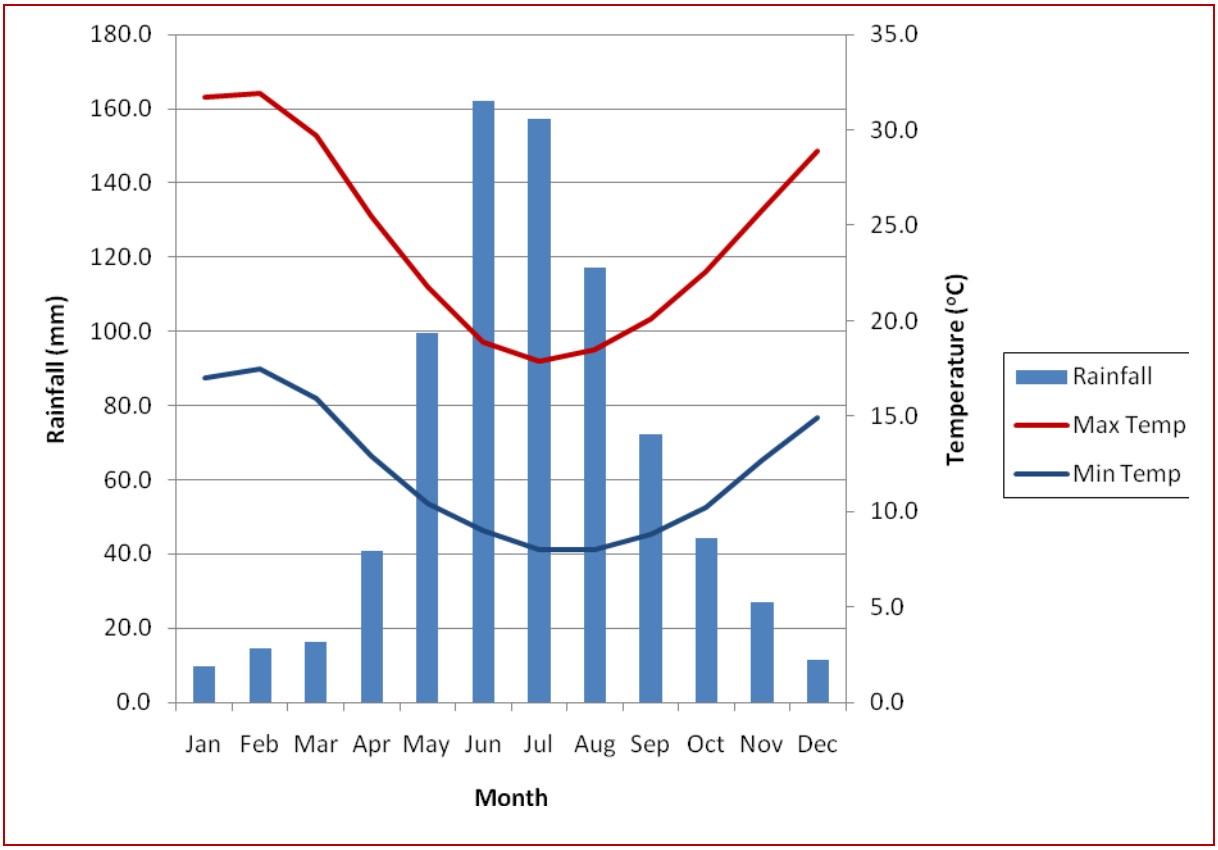
Best Practice Management

Best practice management for stormwater includes treating before discharge and looking at alternative uses rather than discharge. The latter is important in the context of a drying climate with decreased rainfall, as well as improving water efficiency and the Better Urban Water Management Framework[17].

2.2.3 Climate

The City of Joondalup experiences a Mediterranean climate with dry, hot summers with an average daytime temperature of 31 °C and cool, wet winters with an average daytime temperature of 18 °C. The average rainfall between 2002 and 2012 was 679 mm, with approximately 80% falling between May and September each year (Figure 5).[18]

Figure 5: Average Rainfall and Temperature – Perth Airport[19]



[17] WAPC and DPI, 2008
[18] Bureau of Meteorology, 2013
[19] Bureau of Meteorology, 2013

2.2.4 Vegetation

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 comprising areas of Quindalup Complex and Cottesloe Complex – Central and South (Figure 6). The Cottesloe Complex Central – South complex comprises a mosaic of Tuart Woodland and an open forest of Tuart-Jarrah-Marri on the deeper sands, with heaths on limestone outcrops[20]. The Quindalup Complex comprises two dunal vegetation alliances, the beach (strand) and foredune alliance and the mobile and stable dune alliance. Vegetation within these alliances can include low closed forests of *Melaleuca lanceolata* and *Callitris preissii* and an *Acacia rostellifera* scrub[21].

The State Government has established targets under Bush Forever[21] which aims to protect at least 10% of each vegetation complex in the Perth metropolitan region to achieve a comprehensive representation of all the ecological communities originally occurring in the region[22]. 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, with the City of Joondalup proportion being 2% (345 ha). For the Quindalup Complex, the City of Joondalup portion of the pre-European extent was 2436 ha, or approximately 25% of the Complex. Of this, approximately 306 ha remain within the City, or 3% of the overall pre-European extent of this vegetation complex.

Vegetation Community Types

Floristic Community Types (FCTs) are generally groups of flora species that consistently occur together. A large portion of the coastal foreshore reserve is recognised as Bush Forever site 325 – Coastal Strip from Burns Beach to Hillarys[22]. This site is recognised as incorporating vegetation complexes and floristic community types (FCT) associated with the Spearwood and Quindalup dunes, and are summarised in Table 2. Inferred floristic community types that were not sampled at the time of the Bush Forever listing are highlighted with an asterisk (*). Whilst FCTs can be a useful way of describing groups of flora species, vegetation communities are more commonly used to define plant communities.

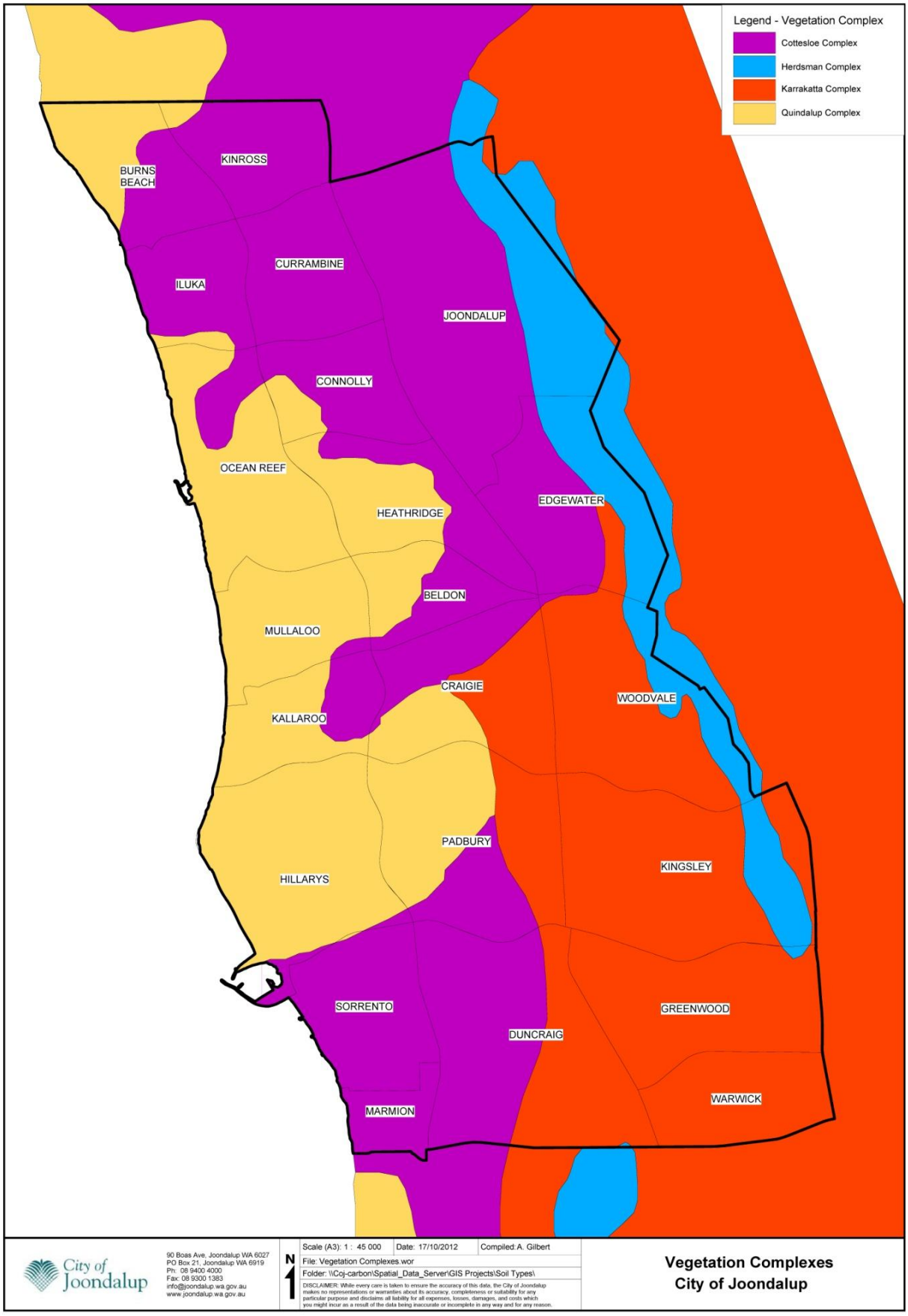
[20] Heddle *et al*, 1980
[21] Government of Western Australia, 2000
[22] WALGA, 2010

Table 2: Coastal Vegetation Complexes and Floristic Community Types

Bush Forever ID	Vegetation Complex	Floristic Community Type	
325	Spearwood dunes – Cottesloe Complex – central and south Quindalup complex	*16	Highly saline seasonal wetlands (*Frankenia pauciflora* low shrubland on Tamala limestone cliffs)
		27	Species-poor mallees and shrublands on limestone
		29a	Coastal shrublands on shallow sands
		*29b	*Acacia* shrublands on taller dunes
		*S11	Northern *Acacia rostellifera – Melaleuca acerosa* shrublands
		*S13	Northern *Olearia axillaris – Scaevola crassifolia* shrublands
		*S14	*Spinifex longifolius* grasslands and low shrublands

(Source: Government of Western Australia, 2000)

Figure 6: Vegetation Complexes, City of Joondalup



Vegetation Communities

Vegetation communities have been described in the original plan prepared by Ecoscape[23] and in Bush Forever[24] and have not changed significantly since then (Table 3).

Table 3: Vegetation Communities

Location	Description	Species	Photograph
Spearwood dune uplands on Tamala Limestone	Closed to open heath	*Melaleuca cardiophylla, M. huegelii, Scaevola crassifolia, Spyridium globulosum, Banksia sessilis, Templetonia retusa*	
Limestone cliffs	Low shrubland	*Frankenia pauciflora*	
Older Quindalup dunes and plains	Low heath to shrubland	*Melaleuca systena, Acacia rostellifera, Acacia xanthina and Olearia axillaris*	
Quindalup dunes close to the coast	Spinifex grassland	*Spinifex longifolius, Spinifex hirsutus, Cakile maritima*, Tetragonia decumbens**	

* denotes introduced species

[23] Ecoscape, 2002
[24] Government of Western Australia, 2000

Vegetation Condition

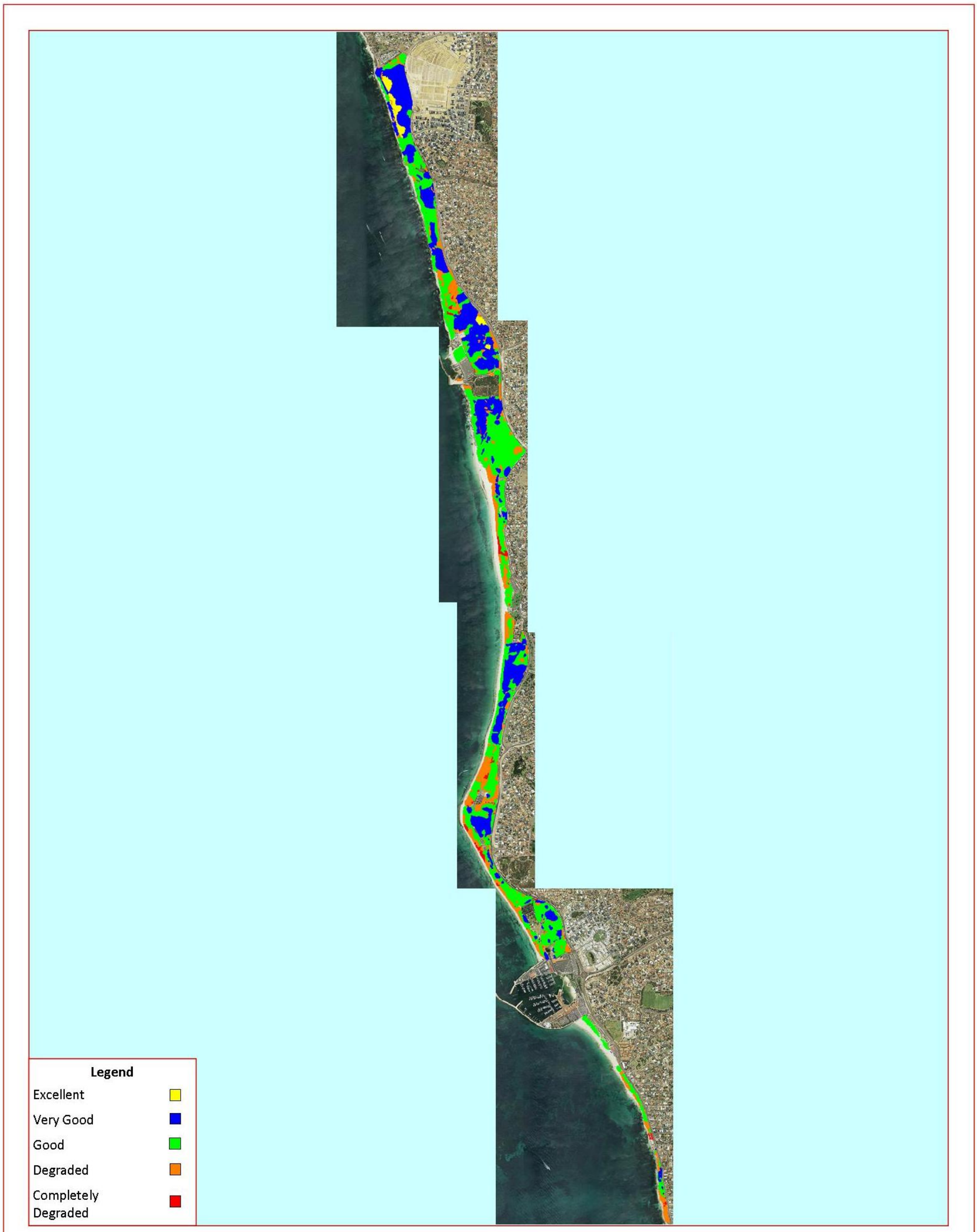
Vegetation condition was assessed by Syrinx Environmental Pty Ltd in 2010, and ranges from completely degraded to excellent using the rating system attributed to Keighery in the Bush Forever Volume 2 - Directory of Bush Forever Sites[25] and provided in Appendix 1. It needs to be recognised that assessment of vegetation condition relates to structure and impacts to the various vegetative layers of the communities being assessed. Accordingly, on occasion, there will be areas that are considered to be in good or better condition where weeds are present, or areas of bare sand. While a vegetation condition assessment was not required as part of the assessment activities, observations were noted during site assessment activities and used to supplement the Syrinx data[26]. Broad outcomes are provided in Table 4, Figure 7, with detailed maps for differing sectors provided in Appendix 2.

Table 4: Vegetation condition assessment using the Keighery Scale

Year	Pristine	Excellent	Very Good	Good	Degraded	Completely Degraded
2012	0	0.2%	33.8%	48.2%	13.3%	4.5%

[25] Government of Western Australia, 2000
[26] Syrinx, 2010

Figure 7: Vegetation Condition, Coastal Foreshore Reserve



2.2.5 Wind and Wave Action

A series of processes affect the coastal formations and shoreline movement that occurs at a particular location, including weather and climate, tidal movements, sea level, waves and currents. The City of Joondalup coastline is characterised by a series of nested parabolic dunes, with each depositional sequence overlying the dunes created during previous periods of deposition[27]. The presence of Tamala limestone gives some coastal areas a rocky aspect, while others are sandy in nature. Wind is one of the major means of sand movement within the foreshore dunes, and is responsible for carrying sand from the beach further inland.

The width of beaches generally relates to the energy of the waves reaching the coast. Areas with offshore reef generally act to reduce the energy of waves. Many of the coastal areas within the northern portion of the City of Joondalup are protected by offshore reefs, and thus have a lower energy. In contrast, the area around the Marmion Aquatic and Angling Club off Watermans Beach is a high energy coast with waves coming into contact with the rocky coastline without the calming effect of a reef, resulting in little beach at this location.

Beaches can also be described as stable, accreting or eroding. A stable beach is one where net erosion and accretion processes balance out in the longer term. An eroding beach is one where there is a net loss of sand, and an accreting beach has a net increase in sand.

Sand movement along the coast usually occurs via the longshore current. Interruptions occur at locations where artificial structures such as groynes, marinas and breakwaters are constructed, with depositional and erosional zones forming around the structure, with examples including the groynes at Sorrento Beach and the installation of Hillarys Marina.

Erosion

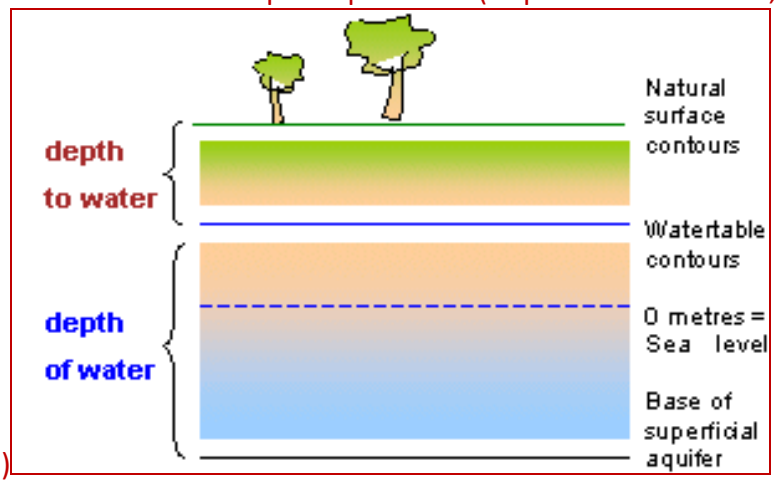
Erosion is usually associated with high winds, tides and storm surges associated with storm events. The City of Joondalup has commissioned a study of the City's entire foreshore reserve. The study will look at range of issues, including historical data relating to shoreline movement, predicted sea level rise and infrastructure on the coast that may be threatened. The purpose of the study, is to identify sections of the coast that may be vulnerable to storm damage and tidal erosion, and ensure mitigation strategies, are in place to limit future risk.

2.2.6 Wetlands

The only wetland area present within the coastal foreshore reserve is located within the southern portion of Hillarys Beach Park towards Northside Drive Sorrento. It is believed to be a surface expression of the superficial aquifer known as the Gnangara Mound, with a depth to groundwater ranging from 0.5 to 3.0 m below ground level[28,29] (Figure 8). This wetland is not listed on the Geomorphic Wetlands of the Swan Coastal Plain Dataset[19].

[27] WAPC and Coastwest, 2003
[28] WA Atlas, 2012

Figure 8: Groundwater Depth Explanation (Department of Water, 2004)



[29] Department of Water, 2004

3.0 Locality Descriptions

This section provides a brief description of the key areas within the coastal foreshore reserve in order to set the management context for the longer term. It is recognised that some features, such as the dual use path, extends throughout the coastal foreshore reserve, while other features are less common or unique to a particular location. Each major location will be discussed.

A dual use path extends the length of the coastal foreshore reserve, commencing at Burns Beach and connecting with the City of Stirling's dual use path at Watermans Bay. Formal access to the beach is provided via access ways from car parks, the dual use path or other facilities at different localities with the City boundaries. Pedestrian paths and tracks in the vicinity of local subdivisions supplements beach access.

Typical community usage activities within the various sectors or designated areas of the coastal foreshore reserve include the following:

- swimming
- surf life saving and sea rescue clubs
- sunbathing
- walking and jogging
- bicycle riding
- picnics
- photography
- bird watching
- snorkelling
- fishing
- para-sailing.

An animal exercise area for dogs and horses is provided at Pinnaroo Point.

3.1 Burns Beach Foreshore

Burns Beach is the northern most coastal foreshore reserve within the City's boundary. It extends from the City of Joondalup boundary south to Shenton Avenue, Iluka. It includes a portion of the foreshore north of Jack Kikeros Hall that was handed back in mid-2013 for ongoing management by the City. Accordingly, assessment of this portion of the foreshore was not carried out during preparation of this Management Plan. Management of this section of the foreshore will be in accordance with the Annual and Weekly Maintenance Schedules. A Natural Area Assessment will be carried out in 2014 and a flora fauna and fungi survey will be carried out within the next five years.

The foreshore is characterised by a narrow beach protected by reef approximately 10 m or more offshore. The beach area includes an extensive area of limestone cliff (Figure 9). The top of the cliff area provides a shallow area of soil that supports typical coastal heath-type vegetation. The vegetated area within the foreshore reserve ranges from 250 – 300 m from the beach to where development occurs.

Figure 9: Burns Beach Foreshore

The main access node for the Burns Beach foreshore is at Ocean Parade near the Burns Beach Caravan Park. This area provides a shallow swimming and snorkelling area, along with a groyne where fishing can occur. During low tide, areas of the reef are exposed that are accessible by people. Facilities include parking areas, grassed areas near Ocean Parade, barbecues, picnic tables, showers, toilets, seating at locations along the dual use path and stairs down to the beach. There is a kiosk associated with the caravan park that is also accessible to beach users, and signage indicates warnings and unacceptable activities. The dual use path in this area is used extensively. Examples of facilities are provided in Figure 10. The coastal reserve in this area includes the northern portion of Bush Forever site 325.

Figure 10: Burns Beach Facilities

3.2 Iluka Foreshore

Iluka is a newer subdivision along the coastal foreshore reserve. The foreshore is similar to that of Burns Beach, as shown if Figure 11, with limestone cliffs and narrow, sandy beaches. The vegetated portion of the foreshore reserve ranges from 120 – 150 m from the beach to Ocean Reef Drive.

Figure 11: Iluka Foreshore

Facilities include the car park at the Iluka Foreshore parking station, the dual use path, sheltered parkland area with barbecues, grassed areas and shaded tables. A boardwalk to the beach provides access to safe areas for swimming and snorkelling (Figure 12).

Another, smaller grassed area with shade huts is also provided closer to the beach a short distance to the south west from the Shenton Avenue facilities (Figure 12). This area is only accessible from the dual use path.

Figure 12: Iluka Facilities

A second car park is provided along Ocean Reef Road near Volante Elbow. Paved access is available to a small grassed area with facilities limited to a large shade hut and bicycle rack. Two shade houses are provided on the beach (Figure 12).

3.3 Ocean Reef Foreshore

The next major access node is that of the Ocean Reef Boat Harbour near Hodges Drive, Ocean Reef. This area includes vegetated areas of primary and secondary dunes and associated swales that range from 120 m to the road near Resolute Way to some 475 m wide in the vicinity of the marina. The coastline is similar to that of Burns Beach and Iluka, in that it includes areas of limestone outcrops and some steep dunes (Figure 13). It should be noted that the City of Joondalup is developing the Ocean Reef Boat Harbour site and expanding it northwards potentially as far as Resolute Way.

Figure 13: Ocean Reef Foreshore

Facilities at the Ocean Reef Boat Harbour site include the marina, boat launching areas, a large parking area that can accommodate boat trailers, a small parkland area with seats, toilets and play equipment (Figure 14).

Figure 14: Ocean Reef Boat Harbour Facilities

This area also includes the Whitfords Sea Rescue site and the Ocean Reef Sea Sports Club. The outflow pipes for the Beenyup Wastewater Treatment Plant some 7 km to the south east enter the ocean through a reserve in the vicinity of the marina wall.

3.4 Mullaloo Foreshore

The foreshore around Mullaloo can be considered in two broad sections, namely those of Key West and Westview, and the main recreational node at Mullaloo.

The nature of the foreshore begins to change in the vicinity of the Key West parking station in the northern portion of Mullaloo. The rocky coastline dominated by limestone outcrops ends with the coast becoming wide and sandy (Figure 15). Dunes are low and the vegetated area narrowed to between 120 – 150 m wide. Despite limited facilities at the site, it is a popular family swimming location, with the parking area reaching and exceeding capacity on occasion. Westview is similar in nature to Key West, with a wide sandy beach and low dunes.

Figure 15: Key West, Mullaloo

The main recreational node at Mullaloo is characterised by a sandy beach, low dunes and a narrow vegetated zone approximately 100 m wide that gives way to the dual use path and large grassed areas. Facilities in this area include the surf lifesaving club, a kiosk, barbecues, shaded tables, and playground areas (Figure 16).

Figure 16: Mullaloo Beach

3.5 Whitfords Nodes Kallaroo

Whitfords Beach is an area of low dunes, sandy beach and a vegetated coastal foreshore reserve approximately 150 m wide (Figure 17). Facilities are limited to a large car park and an ablution block. Slightly north of Whitfords Beach is the Northshore Drive parking station that provides access to the beach.

Figure 17: Whitfords Nodes Kallaroo

3.6 Whitfords Nodes Hillarys

Whitfords Nodes Hillarys includes Pinnaroo Point and the Whitfords Nodes Beach Park. Both are described due the differing conditions and human use at each location.

Pinnaroo Point is similar in nature to Whitfords Beach, with a wide sandy beach, low dunes and the vegetated area extending from 120 – 250 metres depending on the area (Figure 18).

Figure 18: Pinnaroo Point

Facilities include a grassed playground area, ablution block and shaded picnic tables. Access is available for boats and jet skis at nominated days and times (Figure 19). Just south of this area is a location where kite surfing is permitted.

Figure 19: Pinnaroo Point Facilities

An animal exercise beach is located between Pinnaroo Point and Whitfords Nodes Beach (Figure 20). It caters for both dogs and horses in differing locations. Parking in the north section caters to horse floats and includes beach access that is suitable for horses with minimal or no interaction with dogs. Parking in the south caters for those with dogs, with a range of facilities including areas for washing down dogs and an ablution block.

Figure 20: Animal Exercise Beach, Pinnaroo Point

Hillarys Beach Park is located just north of Hillarys Boat Harbour and is strongly influenced by its presence. The boat harbour has resulted in interruptions to the normal flow of sand from Sorrento to the south, and has resulted in Hillarys Beach becoming a predominantly eroding beach. The beach is narrow and dunes are high, with vegetated areas ranging from 150 – 300 metres wide (Figure 21). There is a small wetland to the south of this site near Northside Drive.

Figure 21: Hillarys Beach Park

Facilities at Hillarys Beach Park include an extensive grassed area that includes various picnic and barbecue facilities, along with an ablution block and showers. A lookout is provided in the vegetated secondary dune that sits behind the grassed area. (Figure 22)

Figure 22: Hillarys Beach Park Facilities

3.7 Hillarys Boat Harbour

Hillarys Boat Harbour was built in 1988 and includes a range of facilities such as boat mooring pens, restaurants, cafes, beaches, a water park, and other attractions. It caters for more than 4 million visitors each year, and is considered to be a major tourist attraction[30] (Figure 23). The facility is owned by the State Government and operated by the Department of Transport. Few natural features remain within the boat harbour boundary.

Figure 23: Hillarys Boat Harbour

3.8 Sorrento Foreshore

Sorrento Beach is characterised by a wide, sandy beach and with low, heavily modified dunes (Figure 24), extending immediately south from Hillarys Boat Harbour to Marine Terrace, Marmion. A series of three groynes were installed to protect Sorrento Beach from

[30] Hillarys Boat Harbour, 2012

storm damage and erosion. The presence of the groynes provides a safe and popular swimming location for families.

Figure 24: Sorrento Beach

Facilities at Sorrento Beach include extensive grassed areas, a surf lifesaving club, kiosk, ablution block, and shaded areas (Figure 25). Barbecues and picnic tables are also provided.

Figure 25: Sorrento Beach Facilities

3.9 Marmion Foreshore

Marmion Beach extends from Marine Terrace, Marmion in the north, south to the City of Stirling boundary at Beach Road. It can be considered in two portions, namely Marmion Beach and Marmion South.

The Marmion Beach portion is a narrow sandy beach associated with a narrow but steep vegetated zone that ranges from 30 to 50 m wide that extends from Marine Terrace south to Bettles Street. Facilities include a small car park area in the vicinity of Ross Ave, a shaded lookout with seating and some steps down to the beach. (Figure 26)

Figure 26: Marmion Beach

Marmion South 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 in the vicinity of the Marmion Aquatic and Angling Club extending southwards almost to Troy Avenue where it becomes sandy once again. Tides and wave action mean that on occasion, beach access north of the club is under water. Vegetated areas are associated with high, narrow, steep dunes that range in width from 20 – 50 m (Figure 27). At low tide, it is possible to explore the rocky areas along this part of the coast on foot.

Figure 27: Marmion South

Facilities in the vicinity of the Marmion Aquatic and Angling Club are limited due to the presence of steep dunes, the rocky coastline, and buildings associated with the club. A small parking area, an area of lawn, some seating, an ablution block and access down to the shoreline are provided (Figure 28).

Figure 28: Marmion South Facilities

Bike racks and stairs down to the beach are provided in the vicinity of Troy Ave and Lennard Street. Three shaded lookouts with seating are provided between Bettles St and Troy Ave; however there is no access to the beach at these locations.

4.0 Conservation Values

The coastal foreshore area within the City of Joondalup includes a number of natural and other features that contribute to its overall environmental and conservation values. These are highlighted in this section. Where appropriate, the outcomes of site surveys are discussed.

4.1 Bush Forever

A large portion of the coastal foreshore reserve from Burns Beach down to Hillarys Marina has been recognised as Bush Forever site 325. This section of the foreshore contains a large strip of native coastal vegetation of widths ranging from 100 m to 500 m. Reasons for the Bush Forever listing includes:

- representation of ecological communities,
- rarity,
- maintaining ecological processes or natural systems, and
- general criteria for the protection of coastal vegetation[31].

The listing also recognises that the Ocean Reef Boat Harbour site is a potential development node for recreation.

4.2 Marmion Marine Park

Marmion Marine Park extends from Burns Rocks (Burns Beach) in the north to Trigg Island in the south. The shoreward boundary of the park is the highest high tide mark for the year and the seaward boundary is the limit of State waters. The park is managed by the National Parks and Nature Conservation Authority (NPNCA) with the aim of protecting the natural values of the offshore reef and marine areas. Marmion Marine Park appears on the State Register of Heritage Places.

While the City of Joondalup takes no active management role with Marmion Marine Park, operational personnel liaise with the NPNCA to advise of management issues they become aware of during their normal work activities. The most common issue encountered is the need to repair or replace signage[32].

[31] Government of Western Australia, 2000
[32] Betts, 2012

5.0 Biodiversity Conservation

The coastal foreshore reserve supports an array of plant and animal species (biodiversity). To ensure the long term protection of the biodiversity values of the reserve, it is necessary to ensure their habitat requirements are maintained and enhanced. The preservation of biodiversity will also result in community benefits including the provision of ecological services such as capture of carbon dioxide, cooling of the urban environment and various recreational and cultural experiences.

It is the City of Joondalup's intent that the coastal foreshore reserve continue to be managed for conservation and recreation, incorporating a zoned approach to where various recreational activities can occur whilst minimising further degradation to the natural landscape. In reviewing the Natural Areas Management Plan prepared by Ecoscape[33], along with current site characteristics and conditions, a number of processes and other factors require ongoing management. These include but are not limited to the following:

- flora (native and environmental weeds)
- fauna (native and pest/feral species)
- erosion
- fire
- access (controlled and uncontrolled)
- drainage
- signage
- fencing
- infrastructure.

Each will be discussed.

In suggesting management strategies and best practice management, it is recognised that the City has limitations and constraints associated with human and financial resources. Accordingly, the setting of priorities for management may be required. The following hierarchy is suggested for consideration by the City:

- designated conservation areas within the foreshore reserve
- areas of known conservation and heritage values that are not a designated conservation area
- recreational nodes
- remaining areas.

It is recognised that the City intends to prepare management plans for coastal foreshore reserve areas in each suburb or sector. Their development will provide an opportunity for a

[33] Ecoscape 2002

more detailed assessment and the preparation of action plans for on ground works than has occurred during the development of this plan. When preparing the individual management plans, it would be appropriate to nominate a timeframe associated with their implementation, such as five years.

5.1 Flora

Flora includes all native and non-native species of plant. Vegetation relates to the plant assemblages that typically occur in an area on a given soil type, aspect and microclimate. The south west of Western Australia from Shark Bay in the North to Israelite Bay in the south, including the Joondalup Foreshore Reserve, is one of 34 world biodiversity hotspots, which includes more than 2,900 endemic plant species[37]. Approximately 30% of the original vegetation extent of this area remains, with habitat loss primarily due to agricultural expansion.[34]

For the coastal foreshore reserve, the flora and vegetation relates to the plants and vegetation associated with the foredunes, swales and secondary dunes associated with the Quindalup and Spearwood dune systems (Figure 29). It is the flora and vegetation that provides stability to the dunes and various habitats for the fauna species that occur in the area.

Figure 29: Coastal Flora and Vegetation

5.1.1 Native Flora

There are a small number of significant species within the coastal foreshore reserve, which are detailed in Table 5. One species is considered to be 'threatened' (*Marianthus paralius*) and one is listed as 'priority 3' (*Hibbertia spicata subsp. leptotheca*) under the *Wildlife Conservation Act 1950* (WA). None of these species are listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth). An explanation of conservation codes is provided in Appendix 3.

The locations of some significant species are provided in Figure 30, with detailed maps of the differing sectors provided in Appendix 4. Not all significant species were mapped due to the

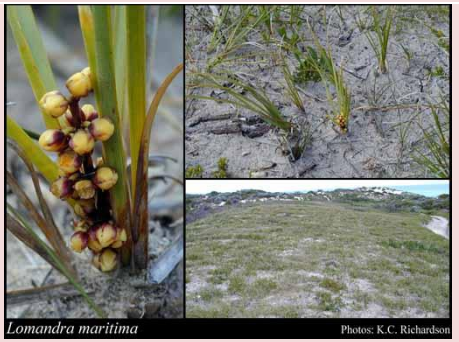
[34] Conservation International, 2012

timing of site assessment activities. The location of known threatened and priority species were not mapped.

Table 5: Significant Flora Species

Species	Common Name	Description[1]	Flowers[1]	Soil Association[1]	Picture[1,2]	Rating	Information Source
Acacia xanthina	White Stemmed Wattle	Dense shrub or tree, 1 – 4 m	Yellow, Aug – Sep	Limestone ridges adjacent to coastal sand dunes		Locally significant	City of Joondalup
Allocasuarina lehmanniana	Dune Sheoak	Shrub 0.5 – 4 m		Coastal areas		Locally significant	City of Joondalup
Alyogyne huegelii var. glabrescens		Slender, erect shrub, 2 – 4 m	Cream & purple & red, Oct – Nov or Jan	Grey or black calcareous sand, limestone hills and sand dunes		Bush Forever	Government of Western Australia, 2000

Species	Common Name	Description[1]	Flowers[1]	Soil Association[1]	Picture[1,2]	Rating	Information Source
Callitris preissii	Rottnest Island Pine	Conifer tree or shrub 1 – 9 m high, 6 m wide	Brown-yellow-orange, Oct to Dec or Jan	Yellow, white, grey sand, and limestone		Bush Forever	Government of Western Australia, 2000
Eucalyptus foecunda	Narrow-leaved Red Mallee	Mallee or tree to 5 m, smooth bark above with flaky bark at base, grey over pale copper	White-cream, Aug to Jan or Feb	white, grey, yellow sand over limestone, sand dunes and plains, limestone ridges, cliffs and hills		Bush Forever	Government of Western Australia, 2000
Hibbertia spicata subsp. leptotheca		Erect or spreading shrub 0.2 – 0.5 m	Yellow, July – Oct	Sand near coastal limestone ridges, outcrops and cliffs		Priority 3	DEC, FloraBase

Species	Common Name	Description[1]	Flowers[1]	Soil Association[1]	Picture[1,2]	Rating	Information Source
Kennedia coccinea	Coral Vine	Twining or trailing shrub or climber, flowers	Orange & pink/red & pink and purple, Aug – Nov	Sandy soils		Bush Forever	Government of Western Australia, 2000
Lomandra maritima		Perennial herb 0.2 – 0.6 m, clumps to 0.2 m wide	Purple and yellow, Aug – Nov	White or grey sand, limestone, coastal sand dunes and hills		habitat for the priority listed Graceful Sun Moth, *Synemon gratiosa*	DEC
Melaleuca cardiophylla	Tangling Melaleuca	Erect to spreading shrub 0.2 – 0.4 – 4 m high to 3 m wide, flowers	White – cream, Aug – Dec or Jan	White or grey sand, limestone ridges and outcrops, and sand dunes		Bush Forever	Government of Western Australia, 2000

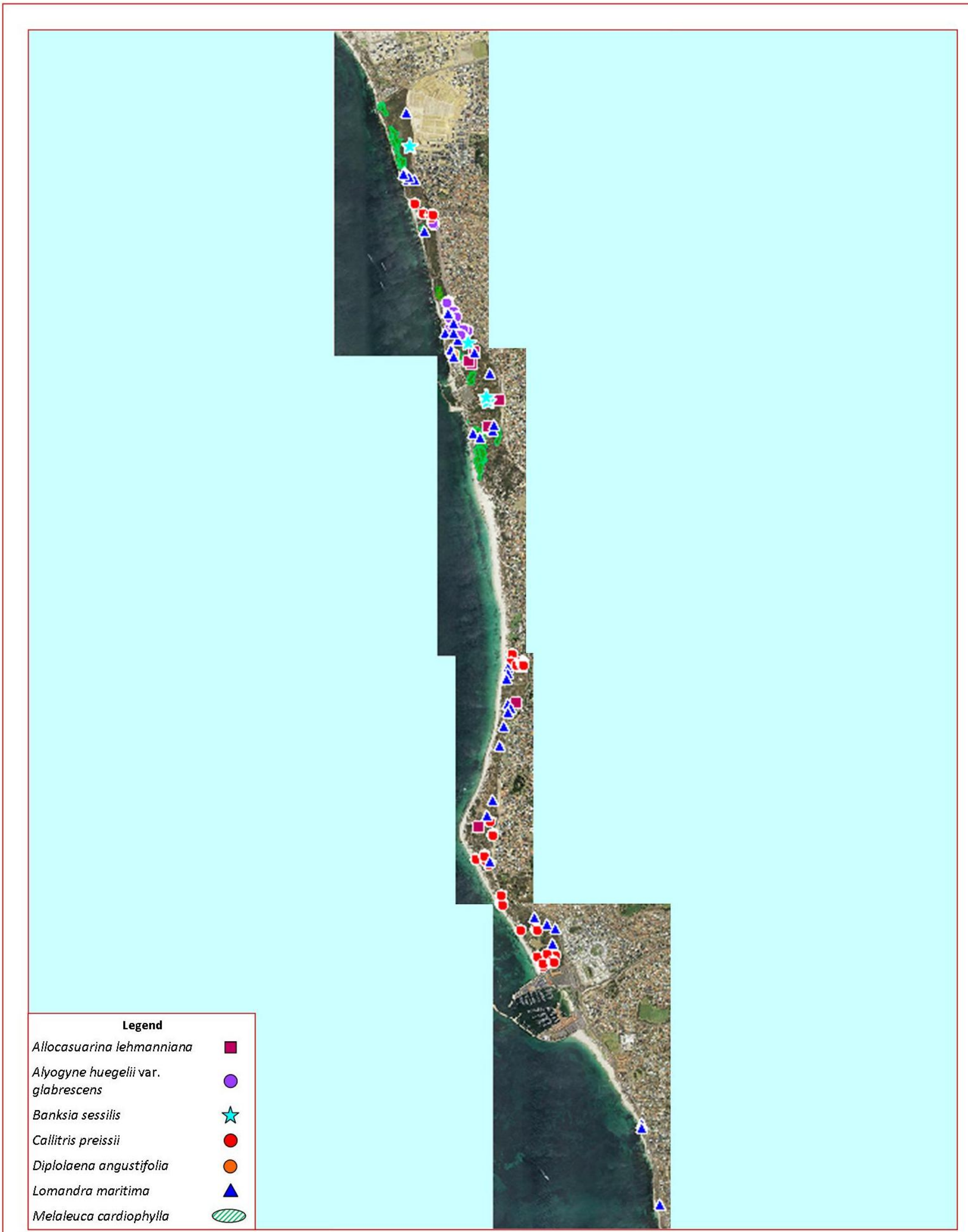
Species	Common Name	Description[1]	Flowers[1]	Soil Association[1]	Picture[1,2]	Rating	Information Source
Marianthus paralius		Prostrate, woody shrub, climbs as it ages	Red, Sept – Nov	White sand over limestone and on low coastal cliffs	Not available	Threatened	DEC, FloraBase
Plantago exilis		Perennial herb 0.05 – 0.2 m high	Green – yellow, Aug – Dec	Sandy loam over granite	Not available	Bush Forever	Government of Western Australia, 2000

Notes:

1 Source: FloraBase, 2012

2 Source: Natural Area Consulting, 2013

Figure 30: Significant Flora, Coastal Foreshore Reserve



Considerations for flora management include:

- species present
- abundance and diversity
- maintaining significant species present
- environmental weeds
- vegetation structure, type and condition
- associations with living and non-living components of the environment
- threatening processes, such as erosion, inappropriate human access and fire.

Management Strategies

Maintaining and where possible improving the range and diversity of species, along with the vegetation structure, type and condition should be the focus of management activities. Regular assessment of threatening processes, such as the presence of environmental weeds and erosion will be required, with action to halt or minimise the impacts of those threats in a timely manner to prevent further degradation. General observations will continue to occur through regular visits by various officers during their normal work duties; however a targeted assessment of flora and vegetation should occur for the entire coastal foreshore reserve at a nominated frequency to determine broader changes over time.

Flora and vegetation will require rehabilitation activities at various times, with the common methods being natural regeneration, direct seeding and/or the planting of tube stock. Natural regeneration will occur most readily in areas of vegetation in good or better condition, as assessed using the vegetation condition rating scale described in *Bush Forever* (Government of Western Australia, 2000), as they are more likely to have a seed bank, for example, as the conservation zones that should be the main priority for attention. The planting of tube stock is more appropriate in larger areas or locations where large scale weed control has occurred as a means of stabilising the soil quicker than would occur through natural regeneration methods.

In order to maintain and enhance the diversity of flora within the foreshore reserve, the choice of species for rehabilitation needs to consider:

- species currently occurring
- species that could occur due to the presence of suitable conditions
- species that may have occurred in the past but lost through a range of threatening processes.

5.1.2 Weeds

The Department of Conservation and Land Management (CALM)[35] describes an environmental weed as:

> ...plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade.

Weed species are found in all major plant types, including grasses, herbs, bulbs (geophytes), climbers, trees and shrubs. Over time, species used for revegetation have included those that are now considered to be weeds or otherwise undesirable within the coastal foreshore reserve, such as *Cakile maritima* (Sea Rocket) and *Eucalyptus utilis* (sometimes mistakenly identified as *Eucalyptus platypus*).

The presence of weeds at a site can significantly impact on biodiversity through a range of mechanisms, including:

- competition for resources including space, nutrients and water, with weed species often out-competing native plants due to more effective dispersal and establishment methods
- preventing the growth of native plant seeds present within the topsoil, even when favourable growing conditions are present
- altering geomorphological processes such as nutrient cycling
- altering the rate of infiltration and the presence of soil moisture
- increasing fire potential through the presence of additional fire fuel loads during warmer months when weeds often die off, leaving dry flammable material that is prone to ignition
- reducing habitat and food sources for native fauna, and thus potentially leading to decreased species and genetic diversity.

Site survey activities included an assessment of significant weeds present. In this context, a significant weed is one that is listed:

- in the Environmental Weed Strategy for Western Australia (EWSWA)38
- on the DEC Swan Region Environmental Weed List 2009 as part of the Invasive Plant Prioritisation Process36
- as a weed of national significance (WoNS)
- on the National Environmental Alert List, and/or
- as a declared plant under the Agricultural and Related Resources Protection Act 1994 (WA).

The weed assessment identified some 36 significant weed species, which are listed in Table 6, with those having a high priority for treatment being highlighted. Locations of weeds are provided in Appendix 5; Cape Tulip locations were provided by the Friends of Iluka.

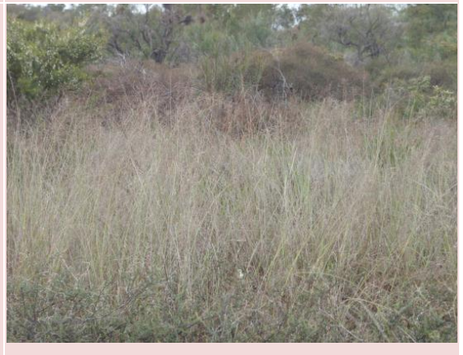
[35] CALM, 1999

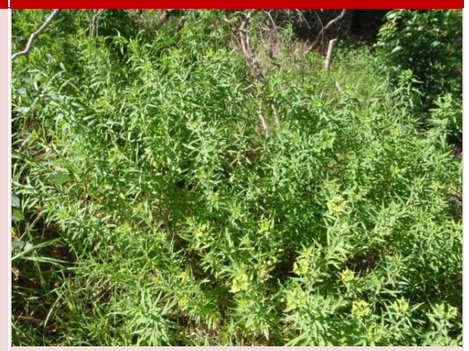
[36] Department of Environment and Conservation, 2009

Table 6: Significant Weeds Identified and their Potential Environmental Impact

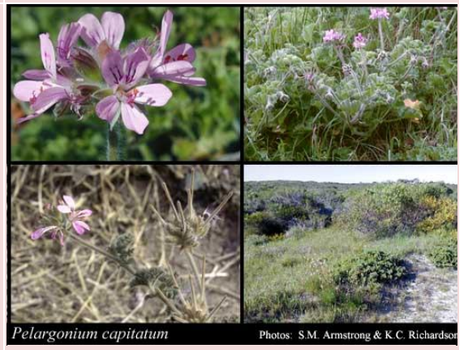
Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			Ecological Impact H: high M: medium L: low U: unknown	Rate of dispersal R: rapid M: moderate S: slow	General trend D: decreasing S: stable I: increasing U: unknown		
Avena barbata	Bearded Oats	Moderate	H	R	I	High	
Brassica tournefortii	Mediterranean Turnip	High	H	R	I	High	
Bromus diandrus	Brome Grass	High	H	R	I	High	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Carpobrotus edulis	Pigface	Moderate	H	S	I	High	
Cenchrus clandestinus	Kikuyu	Unavailable	H	S	I	High	
Cynodon dactylon	Couch Grass	Moderate	H	R	I	High	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Ehrharta calycina	Perennial Veldt	High	H	R	S	High	
Ehrharta longiflora	Annual Veldt	Low	H	R	S	High	
Eragrostis curvula	Love Grass	High	H	R	I	High	

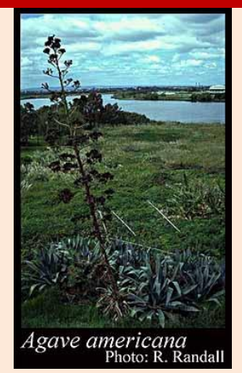
Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			Ecological Impact H: high M: medium L: low U: unknown	Rate of dispersal R: rapid M: moderate S: slow	General trend D: decreasing S: stable I: increasing U: unknown		
Euphorbia terracina	Geraldton Carnation Weed	High	H	R	I	High	
Freesia alba x leichtlinii	Freesia	NA	H	R	I	High	
Fumaria capreolata	Whiteflower Fumitory, Fumaria	Mild	H	R	I	High	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Ipomoea cairica	Morning Glory	Mild	H	M	I	High	
Leptospermum laevigatum	Victorian Tea Tree, Coast Tea Tree	High	H	R	I	High	
Moraea flaccida	One-leaf Cape Tulip	High	H	R	I	High (WA Declared Plant)	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Oxalis pes-caprae	Sour Sob	Unavailable	H	S	I	High	
Pelargonium capitatum	Rose Pelargonium	High	H	R	I	High	
Ricinus communis	Castor Oil	Low	M	R	I	High	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Schinus terebinthifolius	Japanese Pepper Tree	Moderate	H	M	I	High	
Solanum linnaeanum	Apple of Sodom	Moderate	H	R	I	High	
Solanum nigrum	Nightshade	Moderate	M	R	I	High	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Stenotaphrum secundatum	Buffalo Grass	Moderate	H	S	I	High	
Tetragonia decumbens	Sea Spinach	Moderate	H	R	I	High	
Trachyandra divaricata	Dune Onion Weed	Mild	M	R	I	High	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			Ecological Impact H: high M: medium L: low U: unknown	Rate of dispersal R: rapid M: moderate S: slow	General trend D: decreasing S: stable I: increasing U: unknown		
Agave americana	Agave, Century Plant	Low	M	M	S	Moderate	
Arctotis stoechadifolia	Arctotis	Low	U	S	I	Moderate	
Carduus pycnocephalus	Slender Thistle	Moderate	H	R	I	Moderate	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Citrullus lanatus	Paddy Melon	Low	L	S	D	Moderate	
Conyza bonariensis	Fleabane	Low	L	M	I	Moderate	
Euphorbia paralias	Sea Spurge	Moderate	M	M	I	Moderate	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Foeniculum vulgare	Fennel	U	L	M	S	Moderate	
Gazania linearis	Gazania	Mild	H	R	I	Moderate	
Lactuca serriola	Prickly Lettuce	Moderate	H	R	I	Moderate	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Lagurus ovatus	Hares-tail Grass	High	H	R	S	Moderate (difficult to control)	
Lolium rigidum	Rye Grass	Moderate	U	U	U	Moderate	
Nicotiana glauca	Tree Tobacco	Mild	L	R	I	Moderate	

Species	Common Name (where applicable)	ESWA Priority Rating	DEC Swan Region Environmental Weed List			Treatment Priority Recommendation	Picture [1,2]
			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		
Oenothera drummondii	Beach Evening Primrose	Moderate	L	M	I	Moderate	

Notes:

1 Source: FloraBase, 2012

2 Source: Natural Area Consulting, 2013

Considerations for management include:

- target weed type(s)
- population density and area of infestation
- control method(s)
- cumulative effects of residual herbicides such as metsulfuron and triasulfuron, with some species becoming resistant to the their effects
- access considerations
- presence of native flora and fauna species that need to be considered when determining the most appropriate weed control technique for the target area
- management of community members in the vicinity of weed control activities.

Management Strategies

Weed management strategies revolve around the removal of weeds from a designated area by manual, chemical, or biological treatment methods, with manual and chemical treatments being the most common. The control technique for a particular target species will depend on the characteristics of the plant including its rate of growth, regenerative capacity, and the presence of non-target species or other sensitive areas, such as threatened and/or priority flora and/or fauna.

Manual Weed Control

Manual control typically involves the removal of the nominated weed either mechanically (machine) or by hand. Removal of woody weeds (trees, shrubs with woody stems), will often involve the following:

- manual ('hand') removal of plant – physically removing the plant by hand or using hand-operated tools to assist with removal
- cut and paint – removal of woody weeds by trimming and then cutting trunk at the base followed by paint of the stump with a herbicide, the stump will break down over time
- brush cutting/slashing – using a line trimmer or similar for weed control rather than removal, effective on long, grassy weeds
- stump removal – if required, a stump grinder can be used to removal the large woody mass left behind, encouraging faster break down of plant remains.

Advantages of manual weed control:

- particular species can be targeted rather than 'blanket' control
- can significantly reduce the weed seed bank when plants and all seed are removed
- mechanical removal is the most successful method of eradicating rhizomatous weeds as all the root mass can be removed
- plants will not develop a 'resistance' to the control method
- can be used effectively in conjunction with other methods
- avoids the use of chemicals that could pose a risk to non-target areas and operators.

Disadvantages of manual weed control:

- the process can be laborious and time-consuming, meaning that it is not economical for many weed types
- seed bank within the topsoil will provide the basis for new crops
- key areas of plants can be left behind, such as bulbs or corms that can regrow under favourable conditions
- large numbers of people hand weeding can result in greater damage to sensitive bushland areas.

Chemical Weed Control

The use of herbicides is the most common and cost effective method of controlling many environmental weeds because it can be targeted at particular species or weed classes, with large areas being treated in a cost effect manner. There are a range of herbicides in common usage, with differing active ingredient(s) that target different weed types.

Advantages of chemical weed control include:

- results apparent in a short time frame
- more likely to be effective on the entire plant
- can treat large areas in a cost effective manner.

Disadvantages of chemical controls include:

- some plants, particularly those that have tuberous or rhizomatous root systems, may require follow up treatments to ensure effective control
- some plants can develop a resistance to a particular herbicide
- herbicides have the potential to impact non-target flora and fauna species
- potential health effects on operators need to be considered and managed
- the use of herbicides by contractors are subject to complying with:
  - permits for use in bushland areas (Department of Agriculture and Food WA)
  - operator licence requirements by the Department of Health WA.

5.1.3 Revegetation

Site assessment activities included the identification of dune blowouts and areas for potential rehabilitation activities. However, it should be noted that blowouts do occur naturally, that coastal environments include areas of bare sand, and thus not all will be revegetated. Areas to be revegetated will be identified through the development of local management plans.

5.1.4 Current Management Approach

Weeds

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.

Weed monitoring is conducted monthly to establish the extent and distribution of weed species and to identify priority weeds. Natural Areas Initial Assessments are conducted approximately every 5 years 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 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 Maintenance Schedule and Weekly Bushland Maintenance Schedules, on ground weed management occurs through weed spraying and hand weeding methods. In addition to this, contractors are engaged to spray weeds and hand weed. City of Joondalup personnel 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 (WA)
- major threat to vegetation
- major threat to the structure of vegetation communities
- contribute to a high fuel load, for example grasses.

A City of Joondalup Weed Management Plan is to be developed in 2013/14 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.

5.1.5 Recommended Management Actions

Flora

It is recommended that:

- revegetation is carried out through the development of local management plans with actions prioritised according to the conservation zone rating and areas of good or better vegetation
- that the vegetation condition in other areas is at least maintained and enhanced where there are appropriate resources available to do so
- when necessary, rehabilitation occurs using appropriate techniques applied in a timely manner
- significant species are maintained and protected
- a comprehensive list of suitable species according to vegetation type, soils, and location within the landscape is developed and used to guide future revegetation activities
- a seed collection programme is implemented to collect local provenance seed for use in flora and vegetation restoration activities
- signs of disease or other declines in vegetation health that become apparent are investigated and managed if or when they arise
- regular assessment of flora and vegetation occur at a regular frequency, such as every five years, to enable the City to evaluate any changes.

Best Practice Management

Best practice management for flora and vegetation will include:

- regular assessment of flora and vegetation at a nominated frequency to enable an assessment of management strategy effectiveness and monitor change over time
- the use of local provenance seed and cuttings for flora and vegetation restoration works.

Best practice revegetation programs include consideration of the collecting, processing, cataloguing and storage of local provenance seed. The benefits of a seed collection program include:

- having seed available for plant propagation as required
- provenance seed produces the best quality stock that is suited to the conditions in the area that the tubestock will be used, and which will provide the highest survival rate
- a well-structured program will involve the collection of seed of uncommon and difficult to collect species that would otherwise be difficult to purchase from commercial collectors
- allows controlled access to collection areas so that collection can be carried out in a responsible and sustainable way.

Manual Weed Control

It is recommended that:

- ongoing weed removal continues within the foreshore reserve

- that an integrated approach continues to be applied to weed management within the foreshore reserve, with appropriate manual and chemical treatment techniques applied after giving due consideration to the target species and its location within the environment
- in sensitive environmental areas, the number of people undertaking hand weeding activities is kept to a minimum
- where possible, areas treated for weeds are revegetated as a matter of priority to discourage colonisation by other opportunistic weed species.

Chemical Weed Control

It is recommended that:

- chemical weed control methods continue to be used in accordance with the City's operational procedures and guidelines
- that appropriately qualified and experienced contractors be utilised to assist with chemical weed control activities
- liaise with Friends Groups.

Other Weed Control Recommendations

It is expected that the sector management plans will specify priority weeds and detail targeted weed control activities. In addition to the specific recommendations associated with manual and chemical weed control treatment methods, the following are also recommended:

- weed control continue to be carried out as a matter of priority within the foreshore reserve because of their potential impacts to biodiversity if they are not removed
- weed control programs should consider all weed types, including grasses, bulbs, trees and shrubs, so that an integrated plan be developed and implemented
- weed control activities be prioritised in accordance with:
    - priority weed listings provided in Table 6
    - carried out using suggested or similar treatment methods provided in Tables 7 and 8
    - carried out in identified conservation areas as the first priority, then those areas that are rated as having vegetation in 'good' or better condition, followed by those common usage areas
- other undesirable plant species that have previously been used in revegetation activities be progressively removed over time and replaced with more appropriate species
- adequate resources are provided for environmental weed control within the coastal foreshore reserve which is estimated to require between 170 – 207 days of herbicide treatment for a crew of two operators per weed type (based on industry practice of 1 – 1.2 ha being treated per day), not including any hand weeding requirements or inability to spray due to prevailing weather conditions

- during site assessment activities associated with the development of projected individual management plans for each sector, that more detailed weed mapping be carried out and used to formulate targeted management and control strategies.

Table 7: 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	Annual broadleaf weeds and bulbs	Spot spray - selective
4	Triclopyr or Picloram	Woody weeds and trees	Cut and paint or basal bark
5	Manual removal /hand weeding	Carnation Weeds, Fleabane, Pigface, and similar	Gloves required due to caustic sap of Carnation Weed
6	Triasulfuron	Brassicaceae weeds post emergence and other annual broad leaf and grass weeds pre emergence	Spot spray – selective

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

Table 8: Weed Control Methodology

Species	Common Name	Treatment Type	Timing
Highest Priority			
Avena barbata	Bearded Oats	1 or 2	July - October
Brassica tournefortii	Mustard	1 or 6	May - September
Bromus diandrus	Great Brome	1 or 2	June - August
Carpobrotus edulis	Pigface	1 and 5	Manual: Year round Herbicide: June - October
Cenchrus clandestinus	Kikuyu	1 or 2	November – January
Cynodon dactylon	Couch Grass	1 or 2	November – February
Ehrharta calycina	Perennial Veldt	2 or 1	June - August (prior to flower formation)
Ehrharta longifolia	Annual Veldt	2 or 1	June - October (prior to flower formation)
Eragrostis curvula	Love Grass	1	June – October
Euphorbia terracina	Geraldton Carnation Weed	1, 5 and 6	Manual: June-Nov Herbicide: June-Aug

Species	Common Name	Treatment Type	Timing
Freesia alba x leichtlinii	Freesia	3	July - August
Fumaria capreolata	Fumaria	3	July - September
Ipomoea cairica	Morning Glory	1 (cut vines)	June-August
Leptospermum laevigatum	Victorian Tea Tree	4	July - October
Moraea flaccida	One-Leaf Cape Tulip	1	July – September
Oxalis pes-caprae	Sour Sob	3	July – September
Pelargonium capitatum	Rose Pelargonium	1	June - October
Ricinus communis	Castor Oil	4	September - December
Schinus terebinthifolius	Pepper Tree	4	December - February
Solanum linnaeanum	Apple of Sodom	1 or 4	April - October
Solanum nigrum	Nightshade	1 or 5	Manual: June -November; Herbicide: July-December
Stenotaphrum secundatum	Buffalo grass	1 or 2	November-May
Tetragonia decumbens	Sea Spinach	1	June-October
Trachyandra divaricata	Onion Weed	1	June - August
Moderate Priority			
Agave americana	Agave	4	November – January
Arctotis stoechadifolia	Arctotis	1	March-October
Carduus pycnocephalus	Slender Thistle	1	July - November
Citrullus lanatus	Paddy Melon	1	Year round prior to fruiting
Conyza bonariensis	Fleabane	1 and 5	June – September
Euphorbia paralias	Sea Spurge	1	June – October
Foeniculum vulgare	Fennel	1	September - November
Gazania linearis	Gazania	1	June-October
Lactuca serriola	Prickly Lettuce	1	September - November
Lagurus ovatus	Hares Tail Grass	1 or 2	June-October
Lolium rigidum	Rye Grass	1 , 2 or 5	July - October
Nicotiana glauca	Tobacco	1 or 5	July - October
Oenothera drummondii	Primrose	1	July – September

5.2 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 within Western Australia. The type and amount of fungi species present in bushland can be an indicator of ecosystem health.

Fungi are an important component of natural ecosystems as they play a major role in recycling nutrients present in organic material back into the environment to sustain the ecological communities present and others having a symbiotic relationship with plants

present. Some fungi species have a strong interconnection with plant species such as eucalypts, wattles, and orchids. They can also provide food and/or habitat for fauna species such as bandicoots and beetles.

There are a number of different forms of fungi known within the Perth metropolitan region, including the more common mushrooms, toadstools, and puffballs. Other forms include the slime moulds, jelly fungus and flat-type fungus (resupinate). The most common time to see the fruiting bodies of fungi are after autumn or winter rains, however some fungi will also be obvious at other times of the year.

5.2.1 Desktop Study

While no known fungi surveys have been carried out within the coastal foreshore reserve, one has been carried out in the Mindarie foreshore reserve within the City of Wanneroo, with outcomes provided in Table 10 and examples of likely species provided in Table 9. Given the proximity of Mindarie to Joondalup, similar species are likely to be found within the reserve.

Fungi management revolves around managing the flora and vegetation the various species are associated with. However, given that no surveys have been carried out within the coastal foreshore reserve area, there is a need for baseline survey(s) to be carried out.

5.2.2 Current Management Approach

The City of Joondalup currently monitors fungi through surveying for incidental sightings of fungi species every 5 years.

5.2.3 Recommended Management Actions

It is recommended that:

- fungi surveys be carried out at any time a flora and vegetation survey is carried out within the coastal foreshore reserve to determine a species baseline
- as a minimum, the surveys should include photographing and recording the locations of species encountered, recognising that more detailed surveys are preferred
- develop a database of fungi species and locations that can be added to in the future, similar to the City's virtual herbarium, and used as the basis of inferring relationships between the flora and fungi.

Table 9: Examples of Foreshore Fungi Species

Scientific Name	Common Name	Photograph
Bolbitius vitellinus	Egg Yolk Fungus	
Crepidotus eucalyptorum	Eucalypt Crepidotus	
Tremella mesenterica	Yellow Brain Fungi	

Volvariella speciosa	Common Rosegill	

Table 10: Results of Mindarie Foreshore Fungi Survey carried out by Perth Urban Bushland Fungi (PUBF)

Scientific Name	Common Name	Form	Habitat	Life Mode	PUBF Field Book Page
Agrocybe pediades	Common Agrocybe	Mushroom	Litter/ground	Decomposer	J-1
Bolbitius vitellinus	Egg Yolk Fungus	Mushroom	Litter/ground	Decomposer	J-3
Byssomerulius corium	Bysso Skin Fungus	Resupinate/shelf	Dead wood	Decomposer	O-3
Clitocybe semiocculta	Shy Funnel Cap	Shell	Dead wood	Decomposer	J-4
Clitocybe sp.		Mushroom	Litter/ground	Decomposer	
Clitopilus sp.		Mushroom	Litter/ground	Decomposer	
Coprinus cf. Picaceus group (see Coprinopsis aff. stangliana)	WA Magpie Fungus	Mushroom	Litter/ground	Decomposer	J-5
Coprinus sp.		Mushroom	Litter/ground	Decomposer	
Crepidotus eucalpytorum	Eucalypt Crepidotus	Shell	Dead wood	Decomposer	J-13
Crepidotus prostratus		Mushroom/ shell	Dead wood/ litter/ground	Decomposer	J-35
Exidia sp.		Jelly fungus	Dead wood	Decomposer	
Galerina sp.		Mushroom	Litter/ground	Decomposer	
Harknessia uromycoides	Tuart Nut Fungus	Pustules	Dead wood	Decomposer	C-1
Hexagonia vesparia	Wasp Nest Polypore	Bracket	Dead wood	Decomposer	N-3
Inocybe sp.		Mushroom	Litter/ground	Mycorrhizal	
Melanoleuca sp.		Mushroom	Litter/ground	Decomposer	
Mycena sp.		Mushroom	Litter/ground	Decomposer	
Mycoacia subceracea	Golden Splash Tooth	Resupinate	Dead wood	Decomposer	O-4
Myxomycete sp.	Slime Mould	Slime mould	Dead wood	Decomposer	
Plicaria sp.		Cup	Litter/ground	Decomposer	
Polyporus badius		Mushroom	Dead wood	Decomposer	
Poria sp.		Resupinate	Dead wood	Decomposer	
Psathyrella sp.		Mushroom	Litter/ground	Decomposer	

Scientific Name	Common Name	Form	Habitat	Life Mode	PUBF Field Book Page
Pycnoporus coccineus	Scarlet Bracket Fungi	Bracket	Dead wood	Decomposer	N-8
Rhodocollybia sp.		Mushroom	Litter/ground	Decomposer	
Schizophyllum commune	Split Gill Fungus	Shell	Dead wood	Decomposer	R-2
Scleroderma cepa	Earthballs	Puffball	Litter/ground	Mycorrhizal	
Tremella mesenterica group	Yellow Brain Fungus	Jelly fungus	Dead wood	Decomposer	Q-2
Tubaria sp.		Mushroom	Litter/ground	Decomposer	
Unknown Ascomycete		Cup	Litter/ground	Decomposer	
Unknown resupinate		Resupinate	Dead wood	Mycorrhizal	
Volvariella speciosa	Common Rosegill	Mushroom	Litter/ground	Decomposer	J-30
Xeromphalina sp.		Mushroom	Dead wood	Decomposer	

(Source: Perth Urban Bushland Fungi, 2005)

5.3 Plant Diseases

Vegetation can be subject to diseases that result in a decline in their vigour or death in the longer term. Organisms such as fungi, bacteria and viruses that cause plant diseases are known as pathogens. Some occur naturally within soils while others have been introduced into a particular area through the movement of infected plant materials or soils. Some pathogens will result in rapid plant death while others will lead to the slow decline in plant health over time.

5.3.1 *Phytophthora* Dieback

The most common plant disease encountered on the Swan Coastal Plain is dieback caused by various forms the water-borne fungus, *Phytophthora*, particularly *Phytophthora cinnamomi*. While Phytophthora cinnamomi is considered to be the most destructive, other varieties are being described which may have similar impacts, such as *Phytophthora multivora* which is known to attack a variety of species including *Eucalyptus gomphocephala*, *E. Marginata* and *Agonis flexuosa* and a range of Banksia species[37]. The nature of the vegetation combined with the presence of limestone based soils within the foreshore reserve mean that *Phytophthora cinnamomi* is unlikely. However, *Phytophthora multivora* is known to be tolerant of alkaline conditions as it has been found in Tuart forests underlain by limestone soils south of Mandurah and as far as Cape Naturaliste[38]. It has been associated with individual spot deaths and areas of tree decline.

Phytophthora multivora has been recorded is urban areas of Perth, including inland dune systems and within the City's parks. If it is suspected within the coastal foreshore reserve or other natural areas, it should be treated in the same manner as *Phytophthora cinnamomi*.

5.3.2 *Armillaria*

Armillaria is a fungus that causes root-rot in a variety of plant species, including native flora. The fungus is native to Australia and can lead to major damage within natural areas. The only form of Armillaria found in Western Australia is *Armillaria luteobubalina* or Honey Fungus (Figure 31) due to the distinctive colour of the above-ground fruiting body (mushroom). The fungus is usually associated with eucalypt woodlands and forests, but can occur in coastal dune woodland, shrubland and heath communities. Infection results in plant decline, with the presence of the mushrooms usually an indication that the fungus is well established. The fungus is a primary pathogen in that it can infect healthy trees. It can be spread through infected tree stumps and buried plant material that comes into contact with healthy plants, with infection possible from these sources for a number of years[39]. Accordingly, *Armillaria* is difficult to control, with removal of infected materials being the most effective. *Armillaria* has not been recorded within the coastal foreshore reserve.

[37] Scott *et al*, 2009
[38] Stukely, 2012
[39] Smith and Smith, 2003

Figure 31: *Armillaria luteobubalina*

5.3.3 Current Management Approach

The City of Joondalup has developed a *Pathogen Management Plan* to protect vegetation and ecosystems by establishing the level of risk for areas to be infected by pathogens. The development of preventative and management strategies, the identification of treatment measures for infested areas. The plan also encompasses the development of education and communication mechanisms, to raise awareness of pathogens within the City and community.

5.3.4 Recommended Management Actions

It is recommended that:

- Joondalup staff, volunteers and contractors working within City reserves are familiar with and adhere strictly to the management actions contained within the *Pathogen Management Plan,* and the guidelines that are being developed in association with the plan.

5.4 Fauna

Fauna includes native and introduced species or other pests. Native fauna will often have a close association with the flora and vegetation in an area, so management strategies aimed at the protection of flora will contribute to the protection of fauna. The coastal foreshore reserve is known to provide habitat for a range of species, including birds, mammals, reptiles, amphibians and reptiles (Figure 32). Native species are under threat from the fragmentation and/or loss of habitat, human activities, and the presence of non-native predators.

5.4.1 Fauna Survey Activities

A systematic fauna survey has not been carried out for the length of the foreshore; however surveys have been carried out at the proposed Ocean Reef Marina development site. A level 1 survey was carried out by Western Wildlife[40] for the proposed Ocean Reef Marina development site during 2008, which indicated the potential presence of four frog species,

[40] Western Wildlife, 2008

45 reptiles, 89 birds, and 24 mammals. A level 2 survey targeting the presence of the endangered Graceful Sun Moth (*Synemon gratiosa*), which is listed at both State and Commonwealth levels, was carried out by SMEC in 2009[41], with outcomes confirming the presence of the moth. A repeat survey was carried out by Natural Area Consulting in 2011, with similar results[42].

5.4.2 Threatened and Priority Fauna

During the level 1 survey carried out by Western Wildlife and the targeted Graceful Sun Moth survey, a number of species that were listed under the *Wildlife Conservation Act 1950* (WA) and/or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) as being endangered or in need of protection were identified as having the potential of occurring within the coastal foreshore reserve. These are summarised in Table 11, with listing indicated as 'State' or 'Commonwealth' according to which Act species are listed under. An explanation of the various conservation codes is provided in Appendix 3.

5.4.3 Opportunistic Fauna Sightings

During the survey activities associated with the management plan review, a number of opportunistic fauna sightings were made that included native and introduced species. Outcomes are provided in Table 12. Targeted surveys will be required to determine which fauna species occur in which locations, along with an estimation of feral and pest animal populations that need to managed. Locations of fauna activities observed during the site assessment are provided in Figure 33, with detailed maps for the differing sectors provided in Appendix 6.

Figure 32: Bird Species Observed During Site Survey Activities

5.4.4 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

[41] SMEC, 2009
[42] Natural Area Consulting, 2011

diminishing or extinction of native species.[43] Non-native animals such as cats, foxes, rabbits, mice, birds, millipedes and bees inhabit the City's bushland, wetland and coastal areas.

5.4.5 Management Strategies

Considerations for fauna management include:

- species present
- abundance and diversity
- ecological niches present and occupied
- associations with living components of the environment
- threatening processes such as the presence of introduced predators and declining habitat areas
- the City continues to control feral animals, including the removal of cats, under the provision of the *Cat Act 2011* (WA).

The strategy for the protection of fauna is to protect their habitats and food sources from further degradation and fragmentation. Accordingly, the protection of fauna is closely linked to the protection of flora and vegetation. At present, there has been no comprehensive fauna survey along the coastal foreshore reserve within the City of Joondalup. Without baseline data for the area, it is difficult to determine the most appropriate management strategies aimed at the protection of fauna. Fauna surveys are being undertaken as part of the local management plans.

5.4.6 Ecological Linkages

The coastal foreshore reserve provides an ecological linkage with a number of other vegetated areas, including:

- coastal foreshore reserve and other vegetated areas north of Burns Beach Road
- vegetated areas such as the Ern Halliday Recreational Camp
- coastal foreshore reserve areas to the south, in the City of Stirling.

5.4.7 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 its 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 current management practices have greatly reduced the incidence of pest animal populations within the City; however, continued and coordinated action is required to

[43] DSEWPaC 2012

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 of the natural environment.

5.4.8 Recommended Management Actions

It is recommended that:

- detailed surveys be carried out to determine the type, location and species of native and introduced fauna currently present within the foreshore reserve
- formulate appropriate management strategies based on outcome of that process
- commit to repeating fauna surveys at a nominated frequency, such as every five years, as a means of assessing the effectiveness of strategies aimed at controlling impacts on native fauna
- surveys for the Graceful Sun Moth (Synemon gratiosa) be carried out at the appropriate time of year at other locations within the coastal foreshore reserve that contain their preferred habitat, Lomandra maritima, with protection mechanisms put in place to ensure their protection wherever they are found
- eradication or control of introduced species is undertaken as required.

Table 11: Significant Fauna Species with the Potential to Occur at the Proposed Ocean Reef Marina Development Site

Scientific Name	Common Name	Conservation Status	Listing	Comments
Mammals				
Falsistrellus mackenziei	Western Falsistrelle (Bat)	P4	State	▪ inhabits forests and woodlands ▪ roost in groups in tree hollows ▪ may forage, but unlikely to roost due to lack of suitable tree hollows
Isoodon obesulus fusciventer	Southern Brown Bandicoot, Quenda	P5	State	▪ favours areas with dense understorey, and common in areas with dense wetland vegetation ▪ no diggings or other signs noted during the survey
Macropus irma	Western Brush Wallaby	P4	State	▪ may have previously occurred on the site ▪ unlikely to occur due to small size of the site and current level of development
Reptiles				
Morelia spilota imbricata	Carpet Python	P4	State	▪ requires dense vegetation or tree hollows for shelter ▪ no DEC records nearby
Neelaps calonotos	Black-striped Snake	P3	State	▪ restricted to coastal locations between Lancelin and Mandurah ▪ favours sandy soils and occurs in Banksia and Eucalyptus woodlands ▪ recorded by DEC in nearby suburbs
Invertebrates				
Synemon gratiosa	Graceful Sun Moth	P4	State	▪ recorded at the Ocean Reef Marina site
Birds				
Apus pacificus	Fork-tailed Swift	Migratory	Commonwealth	▪ primarily an aerial species
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	Critically endangered	State Commonwealth	▪ DEC databases indicated presence nearby ▪ presence of known food sources on site

Scientific Name	Common Name	Conservation Status	Listing	Comments
				▪ usage likely to be foraging rather than nesting as vegetation present is unlikely to provide suitable nesting hollows
Falco peregrinus	Peregrine Falcon	Specially protected	State	▪ foraging at the site is possible rather than nesting
Haliaeetus leucogaster	White-bellied Sea Eagle	Migratory	Commonwealth	▪ forage in coastal environments ▪ potentially nest in tall trees, but more commonly nesting sites are off-shore islands ▪ recorded in the area by Birds Australia
Merops ornatus	Rainbow Bea-eater	Migratory	Commonwealth	▪ breeds in sandy banks ▪ known to forage and breed in degraded areas, and likely to be breeding at the site ▪ known from other locations within the City of Joondalup
Pandion haliaetus	Osprey	Migratory	Commonwealth	▪ forage in coastal environments ▪ potentially nest in tall trees, but more commonly nesting sites are off-shore islands ▪ recorded in the area by Birds Australia

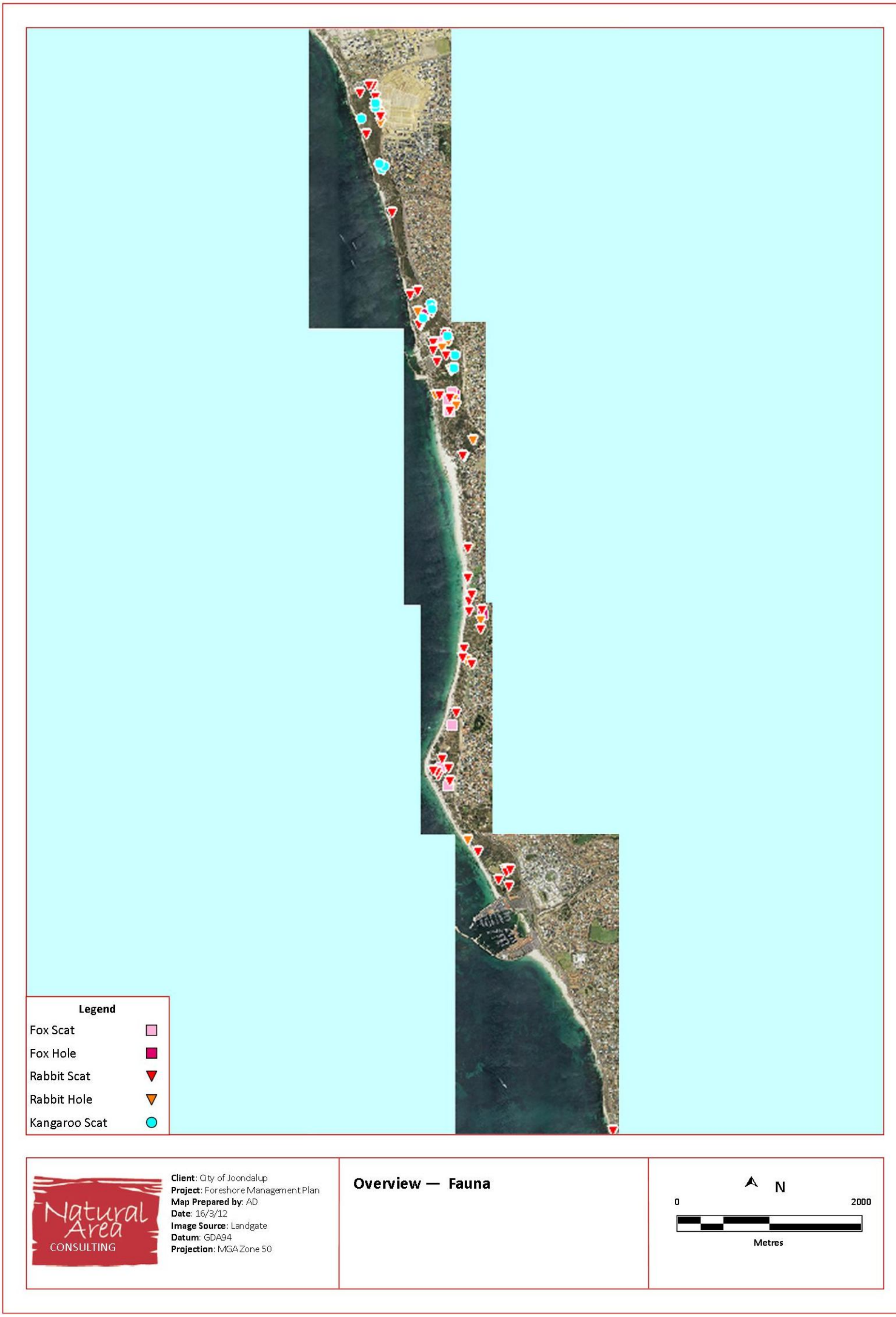
(Source: Western Wildlife, 2008; Natural Area Consulting, 2013)

Table 12: Opportunistic Fauna Sightings, Natural Area Consulting, 2012

Scientific Name	Common Name	Comments
Mammals		
Macropus fuliginosus	Kangaroo	Signs noted from Burns Beach – Iluka south to the Ocean Reef Boat Harbour as far as entry road only
Oryctolagus cuniculus	Rabbit	Signs noted most of the foreshore reserve length, except around Sorrento, probably due to the largely modified environment, and Marmion, probably due to the rocky landform. Rabbits seemed to be particularly common around the Ocean Reef Boat Harbour, including the remains of a number of dead animals.
Vulpes vulpes	Fox	Signs noted along the length of the foreshore reserve, with larger numbers suggested in locations such as Pinnaroo Point and the Ocean Reef Boat Harbour
Reptiles		
Ctenophorus adelaidensis	Southern Heath Dragon	Observed in thick vegetation Ocean Reef Sector
Ctenotus fallens	West Coast Ctenotus	Common over majority of areas surveyed
Egernia kingii	King's Skink	Observed North Mullaloo living within limestone rocks
Birds		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	Observed in thick vegetation in Hillarys sector
Anthochaera carunculata	Red Wattle Bird	Common over majority of areas surveyed
Coracina novaehollandiae	Black-faced Cuckoo-Shrike	Observed in bushland areas in the Whitfords and Pinnaroo Sector
Corvus coronoides	Australian Raven	Common over majority of areas surveyed, particularly in parkland areas
Cacatua roseicapilla	Galah	Common over majority of areas surveyed, particularly in parkland
Falco cenchroides	Australian Kestrel	Observed in Mullaloo Sector foraging for prey
Falco longipennis	Australian Hobby	Observed in the Whitfords Sector foraging for prey
Grallina cyanoleuca	Magpie Lark	Common over majority of areas surveyed, particularly in parkland areas
Gymnorhina tibicen	Australian Magpie	Common over majority of areas surveyed, particularly in parkland areas
Haematopus longirostris	Pied Oyster Catcher	Observed on beach in Mullaloo Sector
Larus novaehollandiae	Silver Gull	Common over majority of areas surveyed
Lichenostomus virescens	Singing Honeyeater	Common over majority of areas surveyed

Scientific Name	Common Name	Comments
Lichmera indistincta	Brown Honeyeater	Observed in bushland in Whitfords Sector
Malurus lamberti	Variegated Fairy Wren	Observed from Ocean Reef to Mullaloo
Malurus leucopterus	White Winged Fairy Wren	Observed from Ocean Reef to Mullaloo
Malurus splendens	Splendid Fairy Wren	Observed from Ocean Reef to Mullaloo
Painted Button-quail	Button Quail	Observed in Pinnaroo sector
Pandion haliaetus	Osprey	Observed along the coast in all sectors, noted to utilise Hillarys Park as a nest site
Phylidonyris novaehollandiae	New Holland Honeyeater	Observed in all sectors
Rhipidura fuliginosa preissi	Grey Fantail	Observed in Whitfords Sector bushland
Rhipidura leucophrys	Willie Wagtail	Common over majority of areas surveyed, particularly in parkland areas
Sterna bergii	Crested Tern	Observed along the coast in all sectors
Sterna caspia	Caspian Tern	Common over majority of areas surveyed, close to coast
Zosterops lateralis	Silver Eye	Common over majority of areas surveyed

Figure 33: Fauna indications, Coastal Foreshore Reserve



5.5 Erosion

Sand within the coastal dune systems are 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 and 4WDing activities (Figure 34). 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 rectification and ongoing maintenance requirements. During site survey activities, an assessment of eroded areas was undertaken, with those locations considered to require attention in the short to medium term identified.

Figure 34: Erosion Examples within the Coastal Foreshore Reserve

5.5.1 Current Management Approach

The City of Joondalup carries out monthly inspections within the coastal foreshore reserve to identify any issues, including those associated with erosion, which need to be addressed. Areas where erosion is apparent are assigned a rehabilitation priority.

5.5.2 Management Strategies

Considerations for management include:

- area affected by erosion
- causes of erosion
- 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 areas affected by erosion.

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

- applying appropriate revegetation techniques that will allow plants to become established and stabilise the soil

- erecting sand trap fencing that allows wind-borne sand to collect and create incipient dunes over time
- applying some form of stabilising material such as biodegradable jute or coir matting, brushing or mulch to exposed areas to provide a stable surface that will allow seedlings to become established and grow
- use of signage
- establishing barriers to deter human (and their pets) access to vegetated areas, and allowing bare areas to regenerate.

5.5.3 Recommended Management Actions

It is recommended that:

- erosion issues 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
- where possible, erosion issues be addressed as early as possible as a means of avoiding larger areas to be rehabilitated later
- consider erosion in the wider context of climate change impacts that could occur over time.

Best Practice Management

Best practice management associated with erosion control will include:

- ensuring any brushing material is free from seed, and of species that break down in the shorter term
- assessing the potential climate change impacts and how they could contribute to erosion and its management in the longer term.

5.6 Social and Built Environment

5.6.1 History and Heritage

Aboriginal Heritage Values

A search of the Aboriginal Heritage Inquiry System (AHIS)[44] indicated the presence of five registered Aboriginal sites within the coastal foreshore reserve, and are summarised in Table 13.

[44] Department of Indigenous Affairs, 2011

Table 13: Summary of Aboriginal Heritage Sites

Site Name	Site Type
Joondalup Waugal Egg	Mythological
Joondalup Caves	Mythological
Bonorin Hill	Man-made structure, historical
Mullaloo Desert North	Artefacts, scatter
Yulema Street, Mullaloo	Artefacts, scatter

(Source: Aboriginal Heritage Inquiry System, 2011)

Other Heritage Values

A number of other locations within or near the coastal foreshore reserve with heritage values are noted in the *Natural Areas Management Plan* prepared by Ecoscape[45]. These include:

- the whaling station that was located at Marmion in 1849
- the Gumboya and Whitfords water holes
- Burns Springs which is south of Burns Beach Road
- recreation use of Mullaloo Beach dating back to 1925.

More recently, signage has been installed at locations along the dual use path highlighting various conservation and landscape values associated with the site. Examples are provided in Figure 35.

Figure 35: Interpretive Signage

5.6.2 Social Value

The social value of the coastal foreshore reserve is significant, with many daily visitors undertaking a range of activities, which were identified in the City of Joondalup *Beach Management Plan 2010*[46], including:

[45] Ecoscape, 2002
[46] City of Joondalup, 2010

- swimming
- walking or jogging along the beach or the dual use path
- cycling along the dual use path
- bird watching
- snorkelling
- surfing
- scuba diving
- fishing
- para-sailing
- picnicking
- photography
- kite-surfing.

'Friends of...' and Other Community Groups

There are a number of 'Friends of' groups that work within the coastal foreshore reserve, including the:

- Joondalup Community Coast Care Forum
- Mullaloo Beach Community Group
- Friends of North Ocean Reef and Iluka Foreshore
- Friends of Sorrento Beach.

Each of these groups has an interest in a particular area, and works to minimise the negative impacts associated with various threatening processes, often through weed control and revegetation works. Friends groups work in degraded and good bushland areas with the aim of improving their environmental values. The City's emphasis is working on maintaining and improving areas in good or better condition because it is more cost effective to prevent further degradation through ongoing maintenance and improvement rather than repairing larger scale environmental damage (i.e. the 'Bradley' method of bushland regeneration). Even though principally the City follows the Bradley methods of bushland regeneration, the City realises the importance of aesthetic appeal of the dunes and therefore undertakes a lot of bushland regeneration in degraded areas that are in public view.

While the work of individuals and groups often go unrecognised, their input contributes significantly to positive environmental outcomes for a particular location. Friends of groups also have access to grant funding when working in partnership with the local land manager to assist with on-ground works through Coastwest and other funding bodies.

The City of Joondalup will continue to work with the various 'Friends of' groups undertaking work in the coastal foreshore reserve; however resource constraints will mean there is a need to prioritise any requests for action received. Each situation will be evaluated on a case

by case basis, and in accordance with over-arching management plan aims and objectives, City policies, and other current available information.

Recommended Management Actions
It is recommended that:

- the work of 'Friends' groups and individuals should complement work undertaken by the City, as well as be guided by broader management principles set out in management plans, policies and guidelines
- ongoing communication between community group and City representatives will continue to be necessary to ensure that outcomes are of benefit for the group and consistent with the City's longer term aims and objectives
- the City continue to have a designated liaison officer to assist with coordinating Friends group activities with those of the City as a means of maximising the compatibility of proposed works and planned timing.

5.6.3 Access and Infrastructure

The City of Joondalup has provided regular locations where people can gain access to the coastal foreshore and the beach. Access includes the provision of parking areas for those arriving by car, as well as pathways or tracks from parking areas and/or the dual use path to the beach. Uncontrolled pedestrian and/or vehicle access can lead to conflicts between user groups as well as erosion issues within the dunes.

Parking
Parking is provided at all key access locations between Burns Beach and Sorrento. Parking areas show signs of hoon behaviour as well as vehicle break-ins. Most sites have sufficient parking for the expected usage, however, on occasion the Key West Parking Station can be filled to capacity. (Figure 36)

Figure 36: Parking Area Management Issues

Considerations for management include:

- balancing the need for provision of facilities whilst also minimising the potential for inappropriate behaviour
- patrolling areas where inappropriate behaviour and break-ins are known to occur
- on-going maintenance requirements.

Management Strategies

The main management strategy associated with the provision of parking areas will be the patrolling of areas showing signs of hoons and where break-ins are occurring. Where possible, patrols should take into consideration when this type of activity occurs.

Fencing

Fencing can be an effective means of controlling access to various dune areas, such as areas of limestone cliffs, along with dune protection and rehabilitation. Where fencing is provided, many will use the designated paths rather than crossing fences and dunes. Fence types used by the City of Joondalup include the black plastic coated conservation fencing, ring-lock with treated pine posts, jarrah posts with stainless steel wire, and limestone fencing (Figure 37).

The majority of fencing is of the ring-lock type with treated pine posts due to cost effectiveness, ease of repair and replacement. A new type of fencing made from plastic has been installed at Mullaloo, Sorrento and Hillarys Beach. It includes a longer plastic post (three metres).The longer posts give the fence more resistance to the erosive actions of the waves

The use of fencing on the beach to protect primary dunes is being reviewed, following storm damage to fencing in the winter 2013. Fencing at accreting beaches, such as Mullaloo and Sorrento is subject to less storm damage than more exposed locations.

Figure 37: Fencing

Fencing Management Strategies

Considerations for management include:

- need for fencing in terms type and frequency of access to be controlled
- type of fencing to be installed
- expected life
- on-going maintenance requirements, particularly as a result of storm damage.

Fencing management strategies include:

- considering the need to assess the state of repair of fencing, and repairing as required or replacing at an appropriate frequency

- considering the use of sand-trap fencing in coastal restoration progress in the longer term and in the context of potential climate change impacts.

Signage

Signage can be an effective means of informing members of the public about conservation values at a site, what activities are acceptable at a particular location, and similar. However, they may require maintenance at various times and can be a target of vandalism in the form of graffiti, damage, removal or destruction (Figure 38). The City of Joondalup is currently reviewing signage with the aim of developing a coordinated signage strategy.

Figure 38: Signage Examples

Management Strategies

Considerations for management include:

- the need for signage
- type and purpose of signs in a particular area
- the ease of reading and interpreting various signs
- construction and ongoing maintenance requirements of signs, including the effects of vandalism.

Signage management includes the following:

- consider the provision of more signage that provides information about the natural values of a location, with some being more likely to follow instructions when the reasoning behind a particular instruction is detailed
- consider the materials signs are made of in terms of ongoing maintenance, graffiti removal and repair
- consider the size and readability of informative signs, for example, those showing a number of smaller symbols at a low level are likely to go unnoticed and/or be difficult to interpret by sectors of the community

- continue to liaise with the Department of Parks and Wildlife (previously Department of Environment and Conservation) in relation to signage they are responsible for maintaining.

Rubbish

While rubbish was evident is some locations, it was generally at a minimum. Inspections are carried out monthly within the foreshore reserve, and any issues responded to.

Paths

Pedestrian access is provided from parking areas and the dual use path to the beach at regular intervals along the coastline. Most are sandy paths from the dual use path; however some are paved for longer distances. Despite this, there are those who choose to cross the dunes rather than keeping to the designated paths (Figure 39). There are also those utilising the dog beach who allow their dogs to roam freely in and around the dunes, with the numbers being allowed to do so over time leading to degradation.

Figure 39: Pedestrian Access Management Issues

Another access issue relates to the abalone season each year, when many trample dunes and reefs around Iluka during the short timeframe available for taking the shellfish. This situation is one that is somewhat different from the typical access issues, in that the abalone season results in larger numbers of people concentrated in one area within a nominated time period, meaning that damage and impacts can be greater than those that occur with the occasional user crossing vegetated dune areas.

The dual use path extends from the length of the coastal foreshore reserve. It is well used by community and contributes to a number of recreational activities carried out within the coastal foreshore reserve (Figure 40). Ongoing maintenance is carried out throughout the year.

Figure 40: Dual-use path

Considerations for management include:

- methods of controlling inappropriate access through vegetated dunes
- identification of areas where informal tracks are common, along with an assessment of those that should be formalised or closed as appropriate
- the use of signage
- the timing and frequency of ranger patrols at problem areas.

Management Strategies

Pedestrian access management will include:

- giving consideration to stabilising sandy access beach paths
- assessing tracks created through dunes, and making a decision to either close and rehabilitate them, or formalise them as appropriate

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.

A beach wheelchair is available at Mullaloo Beach at no cost which allows access to the beach for children and adults with disabilities. The chair is easily pushed over the sand to the water's edge.

Antisocial Behaviour

There are some indications of antisocial behaviour within the coastal foreshore reserve with evidence of burnouts, vehicle break-ins, camp fires on the beach or in the dunes, and the presence of some rubbish. Monthly inspections are carried out and issues responded to when required.

Other Facilities and Infrastructure

In order to cater for human access to the coast and the beach requires the provision of a range of facilities and infrastructure in order to do so safely and ensure common needs are met during visits. Facilities and infrastructure include stairs, groynes, picnic tables, seating, lookouts, barbecues, toilet facilities, showers, and more (Figure 41). All need to be maintained in the short and longer term, and replaced where appropriate at the end of the items usable life. Various structures are also the target of vandalism, and may require repair or replacement.

Figure 41: Management of Facilities and Maintenance Requirements

The provision of facilities and infrastructure is dependent on the use type level by the public, with those areas with large numbers of users having the greater type and number of facilities available. For example, Burns Beach, Mullaloo and Sorrento receive a lot of visitors on a daily basis, so both have a diverse array of facilities to cater to human uses. A designated animal exercise beach has been provided, supported by a car park that is suitable for access by horse floats, and an area where kite skiing can occur has been defined. All need to be maintained to ensure their ongoing suitability for purpose as well as minimising potential injury or other risks to the public.

Considerations for management include:

- type and array of facilities to be provided at a particular location
- capital cost and ongoing maintenance requirements
- inspection requirements, including frequency and level of detail required.

Management of Facilities

Facilities management will revolve around the:

- consideration of what facilities will be installed at a particular site, their location, their construction materials and similar
- ongoing maintenance.

In terms of ongoing maintenance, regular inspections are required to determine the need for repair or replacement, along with any risks damaged equipment may pose to the public if not addressed.

5.6.4 Current Management Approach

The City of Joondalup currently undertakes monthly inspections of the coastal foreshore reserve, and any issues identified are responded to appropriately

5.6.5 Recommended Management Actions

Parking

It is recommended that consideration is given to increasing patrols of car parks in areas where signs of hoon activities and vehicle break-ins are occurring.

Fencing

It is recommended that:

- fencing maintenance continues to be carried out on a regular basis, and replaced when required
- ensure revegetation works are fenced to protect seedlings during their establishment period
- use sand trap fencing in areas where frontal dune restoration work is being carried out.

Signage

It is recommended that:

- consistent, informative signage is installed within the coastal foreshore reserve
- the materials signs are made of are resistant to graffiti in particular
- messages included on signs are informative and readily interpretable
- the placing of signs are such that they are easily read
- where possible, signage includes positive messages as well as an indication of what activities are prohibited.

Beach Access Paths

It is recommended that management of pedestrian access:

- continue to include the provision of information relating to why it is important to keep to paths through a range of mechanisms, including brochures, management plans and signage
- the City in consultation with interested stakeholders assess which informal tracks should be retained and formalised and those that should be closed and rehabilitated
- when replacing signs, consider their location, readability, and include positive messages relating to the importance of maintaining and improving the environmental values at a particular location.

5.7 Fire Management

Fire is an important feature of the Western Australian environment, with many plants having developed adaptations that require the presence of smoke or fire to encourage flowering or germination. However, the incidence of fire in urban areas can result in a greater burning frequency than would occur in a natural system, with the result that weeds are favoured over native species. The presence of the weeds can also increase the fire fuel load present in an area, meaning that the likelihood of fire increases.

Fire has the potential to result in undesirable impacts from smoke and flames to infrastructure and housing in close proximity to the coastal foreshore reserve. Fire can also result in:

- the death of fauna species that do not have the capacity to outrun flames or have a suitable refuge
- the death of flora species after intense or high temperature fires where the natural adaptations that would allow a plant to survive fire are not triggered afterwards and the plant dies
- changes in the vegetative structure
- the increased presence of weeds and other species that respond positively to fire.

Fire can be caused by lightning and by people, with the latter posing the biggest risk to the coastal foreshore reserve. Evidence of fire during site assessment activities was limited to signs of those probably caused by human activities and which are likely to have been deliberately lit (Figure 42).

Figure 42: Evidence of Fire

5.7.1 Objectives

The objectives of fire management within the coastal foreshore reserve are to:

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

5.7.2 Fire Risk

In terms of the coastal foreshore reserve, areas such as Iluka and Ocean Reef, potentially pose the biggest threat from fire to the natural and human values because of the area covered by vegetation. Areas where the coastal foreshore reserve is narrower and/or significantly modified, such as Sorrento and Marmion south of the Hillarys Boat Harbour are unlikely to pose a major fire risk to infrastructure and nearby homes. The City of Joondalup has a duty of care to take all reasonable precautions to prevent bushfires spreading from its reserves to neighbouring property.

5.7.3 Current Management Approach

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 Maintenance Schedule and Weekly Bushland Maintenance Schedules. The City of Joondalup will develop a Fire Management Plan in 2013/14, outlining the City's strategy for assessing fire risk, prevention, response and recovery. There are numerous water hydrants located around the coastal foreshore reserve which are installed and maintained by the Water Corporation.

Fire Occurrence
Fire occurrence within the coastal foreshore reserve appears to be limited to the occasion spot fire associated with arson or camp fires.

Fire Response
The closest DFES fire station will be responsible for responding to and suppressing fires within the coastal foreshore reserve. The Western Australia Police are responsible for the evacuation of visitors and nearby residents if required.

Fire Recovery
Fire is a natural occurrence in Australian ecosystems; however, when they occur at a greater frequency than the vegetation can cope with and there is the potential to promote weed growth and bring about changes in the species present, which may compromise natural regeneration. Weed control is revised 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.

If the interval between fires is too short then fire-killed species will not be able to complete their lifecycle and maintain populations. Fires occurring more frequently than preferred will probably result in a significant reduction in the presence of these species. Fire also facilitates changes in vegetation structure by selecting species adapted to frequent fire events, including weeds. These species are often fast growing disturbance specialists and can form dense monocultures. Frequent fires are also likely to negatively affect the biodiversity of fauna found within the coastal foreshore reserve due to related mortality, loss of food resources, removal of shelter from predators, and a loss of breeding habitat.

5.7.4 Management Strategies

Considerations for the management of fire include:

- frequency and intensity of fires
- vegetation type and area of coverage
- presence of infrastructure
- proximity of buildings, either within or near to the coastal foreshore reserve that could be directly affected by fire
- ease of access by emergency response personnel in the event of a fire

- access to suitable water supplies, such as hydrants, to assist with fire suppression activities.

While the coastal heath type-vegetation will burn, it is not as prone to fires as some of the Eucalypts and other species that have oily leaves. The nature of the vegetation and coastal foreshore reserve precludes the use of controlled burns as a means of managing fire fuel loads within the area.

Fire management within the coastal foreshore reserve is likely to revolve around responding to any that occur as quickly as possible to prevent their spread. Accordingly, access by emergency response personnel will be essential, particularly around the Ocean Reef and Iluka areas where the coverage of coastal vegetation is greatest. The current dual use, pedestrian and vehicle access paths and road reserves act as firebreaks and are considered to provide an adequate access network for emergency responders. However, some of the access paths to the beach are not paved, increasing the potential for vehicles to get bogged (Figure 43). Other management activities, particularly weed control, through reducing the fire fuel load in a particular location.

Figure 43: Unpaved Access Paths, Westview Parking Station and Mullaloo

Consideration of the potential for fire will be required when installing new or upgrading existing facilities and infrastructure. This can occur through the choice of materials they are made from along with their proximity to vegetated areas. Where possible, structures should be a minimum of 20 m away from vegetation and constructed in a manner that enables them to resist fire and ember attack, as outlined in AS 3959 – 2009 or the Building Code of Australia, whichever is the more appropriate.

5.7.5 Recommended Management Actions

It is recommended that:

- when planning the installation of facilities and infrastructure, consider the proposed location from a potential fire damage perspective, ensuring they are sited in locations that provides protection from fire and ember attack and constructed of suitable low-

flammability materials, in accordance with City engineering and other relevant standards and guidelines.

5.8 Education and Training

5.8.1 Community Involvement

Environmental objectives cannot be achieved through the actions of the City alone; the community can also affect the local environment in both positive and negative ways. Environmental objectives require the support of an engaged community that is aware and participating in environmental activities. The community provides significant input into the protection and enhancement of the City's natural areas through the participation in environmental volunteer groups known as Friends Groups, which operate under guidelines set out in the City's Natural Areas Friends Group Manual. The City of Joondalup also actively encourages participation within its community to raise awareness of key environmental issues within the City. It also implements an Annual Environmental Education Program to address key environmental issues and encourage greater environmental stewardship by the community.

5.8.2 Training and Education

Effective management of the coastal foreshore reserves requires those involved to have an appropriate level of training and awareness about the coastal environment and its associated natural processes. Table 14 provides an indication of the type of knowledge and training that is recommended for various categories of personnel working within the coastal foreshore reserve. It does not consider the implementation of daily work procedures and processes, but rather provides information on some of the higher level knowledge, skills and abilities that will contribute to effective foreshore management.

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

Table 14: Recommended Training and Awareness Requirements

Stakeholder Group	Training and Awareness	Why	How
Bushland/foreshore assessment personnel	▪ environmental or horticultural training ▪ native and weed plant recognition ▪ coastal degradation and regeneration processes and management techniques ▪ bushland monitoring and assessment skills such as quadrats, transects and/or photo monitoring techniques	▪ ensure appropriate assessment and monitoring techniques are applied in nominated areas	▪ formal tertiary qualifications (e.g.: university, technical training institutions) ▪ attendance at appropriate training seminars and/or courses
Weed control personnel	▪ pesticide and herbicide training that: ▫ includes content on types of chemical for target plants, application techniques, when not to spray, chemical toxicity information ▫ is acceptable to the Department of Health for the issuing of operator licences ▪ native plant and weed recognition skills	▪ ensure appropriate chemical application techniques are applied to target weed species in the context of a coastal bushland setting	▪ formal training and accreditation (e.g.: technical training institutions) ▪ issuing of Department of Health pesticide operator's licence
Coastal community groups	▪ native plant and weed recognition skills ▪ balancing work programs with the holistic need to protect sensitive environmental values at a particular location ▪ coastal processes, such as erosion, dune formation and sand movement ▪ coastal degradation processes and management strategies ▪ rehabilitation techniques	▪ balancing the need to carry out works in a sensitive environmental location that is prone to damage from human activities	▪ technical seminars and training courses, such as through the community group directly or offered through relevant government agencies
Foreshore works consultants and /or subcontractors	▪ appropriate knowledge, skills, abilities, licences and qualifications according to the works being undertaken within the foreshore reserve	▪ ensure works are carried out appropriately in the required area with little or no secondary impacts to other areas	▪ City contract management processes

5.9 Limestone Cliffs

It is also recognised that the rocky coastline that occurs along parts of the City of Joondalup coastal foreshore can potentially pose a risk to the public through natural and enhanced degradation processes, such as ongoing erosion resulting in cracking and collapse of limestone structures (Figure 44). These areas also need to be inspected and maintained to reduce the potential for injury to the public.

Figure 44: Limestone Cliff Risks and Management Issues

5.9.1 Management Strategies

Considerations for management include:

- the need for and frequency of inspections to determine the level of risk to the public
- the need for signage and other management measures.

Limestone cliffs are a natural part of the landscape that undergo slow erosion processes, thus the potential for collapse could potentially increase over long periods of time as a result of the differential dissolving and/or removal of minerals from the limestone. Day-to-day management will revolve around the provision of signage and preventing or limiting access to those areas where caves have formed, cracks are forming through the formations, and there are the potential for rock falls. In the longer term, however, the need for regular inspection and risk assessment by suitably qualified and experienced practitioners will be essential, with the last inspection being carried out during 2010[47] .

5.9.2 Current Management Approach

The City of Joondalup undertakes regular inspections of limestone cliff areas.

5.9.3 Recommended Management Actions

It is recommended that the City of Joondalup continue to implement a formal inspection and risk assessment of limestone cliff areas within the foreshore reserve at a nominated frequency, such as annually or other frequency suggested by suitably qualified and experienced practitioners. Details of the inspection programme should be documented and

[47] City of Joondalup, 2012

outcomes recorded in procedures and registers as part of the City's ongoing management system.

5.10 Climate Change

It is generally accepted that climate change and associated impacts are occurring, and will have consequences for natural areas and how they are managed in the longer term. Potential impacts could include:

- increased storm events, leading to greater erosion potential along the beach and coastal foreshore areas
- sea level rise and associated encroachment into the coastal foreshore reserve
- as sea levels rise, there is also the potential for the moderating effect of offshore reefs to be decreased, changing the energy levels experienced on shore, and thus the potential for erosion and loss of vegetation
- increased oceanic temperatures resulting in greater amounts of carbon dioxide that can be held in the water and thus reducing the pH, and thus reactivity with limestone cliffs
- differing impacts to facilities and infrastructure, such as stronger winds and more frequent storm events that have the potential to increase wear and reduce life expectancy.

It is recognised that impacts in the short term (i.e.: within the life of this management plan) are not likely to be significant. However, while it is difficult to predict how quickly and to what extent likely climate change impacts will occur, it is necessary to consider potential scenarios and how they will be managed.

The City of Joondalup is currently developing a Climate Change Strategy this document will include a review of the City's current energy use and emissions profile, assessment of the risks posed to the City from climate change and identification of possible climate change management projects to be implemented to address the key risks.

The draft strategy will cover seven key focus areas: infrastructure and assets, parks and reserves, land use planning and development, natural environment, corporate responsibility and good governance, community wellbeing and climate change knowledge and understanding.

5.10.1 Recommended Management Actions

It is recommended that the City continue to explore the potential risks associated with climate change and continue to develop and implement their Climate Change Strategy.

5.11 Conservation Areas

The management plan prepared by Ecoscape in 2002 identified a number of locations that were recommended as local conservation areas within the coastal foreshore reserve. Site assessment activities included an assessment of those areas to evaluate their continued suitability as being designated conservation zones. The suitability of other areas within the

coastal foreshore reserve were also assessed on their merits for consideration as conservation zones. Criteria used during the evaluation process included:

- vegetation type, structure and condition
- presence of significant flora and/or fauna
- landform
- other values

Outcomes indicated that the original zones identified by Ecoscape should still be considered local conservation zones. Two other locations are considered potential conservation zones as a result of the assessment process, namely the area just to the south of the Marmion Aquatic and Angling Club, and an extension of the Whitfords Conservation Area (Figure 45), with detailed maps provided in Appendix 7.

The coastline near the Marmion Aquatic and Angling Club is quite different to other areas within the City of Joondalup, in that it is a high energy rocky coastline without the presence of offshore reefs to reduce the energy of waves before they reach the shore. As the only site that experiences these conditions, consideration should be given to inclusion as a conservation zone.

A small extension in the northeast portion of the Whitfords conservation area would include a small stand of *Callitris preissii*, which includes a mature individual. The significance of this species is that is restricted to the Perth metropolitan area, with the main concentration occurring at Woodman Point in the south, but with scattered individuals occurring elsewhere.

5.11.1 Conservation Zone Management

Management considerations for conservation zones will include:

- setting appropriate priorities for ongoing management, including restoration of flora and vegetation, erosion control, maintenance and similar
- regular assessment of the zones, along with other locations, to determine continued suitability of conservation values under changing conditions.

5.11.2 Recommended Management Actions

Recommendations for management of the current and suggested conservation zones:

- undertaking restoration works as identified during site assessment and regular inspection activities as a matter of priority
- considering the inclusion of the coastline in the vicinity of the Marmion Aquatic and Angling Club as a conservation zone due to its unique landform.

5.12 Constraints with Implementation of Management Strategies

When considering management options, it is recognised that the City may have limited human and financial resources to act on or respond to all management requirements within the coastal foreshore reserve. Accordingly, there is a need to set appropriate priorities for action, and could take into consideration the following:

- whether or not the area is recognised as a conservation area
- the level and intensity of usage of a particular sector or node
- the feasibility of management or mitigation according to the circumstances
- the level and intensity of public interest and involvement about the issue, and whether or not it is valid.

Figure 45: Existing and Recommended Conservation Areas, Coastal Foreshore Reserve

6.0 Implementation Plan

In implementing the *Coastal Foreshore Management Plan 2014 - 2024*, it is recognised that it is an overarching plan for the entire City of Joondalup coastal foreshore reserve and that individual management plans are planned for each of the coastal suburbs, with the first planned for the 2014 – 2015 financial year. Accordingly, implementation will revolve around the following:

- implementing strategic measures included in the recommendations that will assist with broader management aims, and recognising that more detailed measures will occur during the development of the individual management plans
- using the provided information to assist with planning ongoing maintenance (e.g.: fencing, infrastructure) and assessment activities, including the need to suitably resource those activities
- review, and if necessary plan for personnel training and awareness activities.

6.1 Auditing and Inspections

Regular inspections will be necessary to determine whether or not the aims objectives and requirements of the plan are being met. Where possible, these should be carried out in conjunction with other inspection and assessment activities carried out within the coastal foreshore reserve. However, outcomes will need to be reported against plan requirements and recommendations in a manner that allows the City to track and evaluate and overall progress. This could occur through the setting up of some form of template based on the management plan aims, objectives and recommendations.

It is envisaged that City personnel working within the coastal foreshore reserve will report on works carried out in a manner similar to that which currently occurs. This may require some internal adjustments to reporting mechanisms such that tracking of progress against the plan is readily identifiable. It is expected that reporting to Council will occur on an annual basis, with details also being made available to the community via the City's website.

6.2 Key Performance Indicators

This section describes the performance objectives and standards associated with implementation of the *Coastal Foreshore Management Plan 2014 - 2024*. As the City of Joondalup has a strong environmental protection focus, as outlined in strategic documents described in Section 1.6, the overall aim is to maintain and enhance the environmental and biodiversity values within the coastal foreshore reserve. Accordingly, performance objectives and standards will include:

- restoring areas of disturbance to a least a similar or better condition than they were prior to disturbance
- maintaining and enhancing flora and fauna biodiversity within the foreshore reserve
- maintaining appropriate levels of maintenance of facilities and infrastructure

- ensure appropriately detailed flora, fauna and fungi investigations are carried out during the development of individual foreshore management plans
- continuing to work effectively with the various 'Friends' groups for the overall benefit of the local coastal environment
- ensuring contractors and consultants carrying out works within the coastal foreshore do so in a manner that minimises impacts from their activities to the various sensitive environments that make up the reserve
- reporting on implementation of the plan to Council and the wider community
- reviewing the plan at nominated times.
- Joondalup staff, volunteers and contractors working within City reserves are familiar with and adhere to the management actions contained within the *Pathogen Management Plan,* and the guidelines that are being developed in association with the plan.

These and other performance objectives and standards associated with individual management strategies are provided in Table 15. In suggesting management strategies and best practice management, it is recognised that the City has limitations and constraints associated with human and financial resources. Accordingly, the action priorities outlined in Table 15 should also consider the conservation and human use values within the coastal foreshore reserve, with works occurring in designated conservation areas within the coastal foreshore reserve first, then areas of known conservation and heritage values that are not a designated conservation area, recreational nodes, and remaining areas.

Table 15: Performance Objectives, Standards and Criteria

Management Category	Objective	Standard	Management Action	Priority	Measurement Criteria
Vegetation condition	▪ retain and where possible improve overall vegetation condition within the foreshore reserve	▪ Bush Forever	▪ weed mapping, including location and density	▪ high	▪ GIS based weed mapping outcomes ▪ areas of weeds treated ▪ effectiveness of weed control ▪ areas and effectiveness of erosion control ▪ transect or quadrat and photo monitoring of revegetation activities for at least three years post installation
			▪ weed control, as per Table 6, Section 5.1.2	▪ high	
			▪ erosion control	▪ medium	
			▪ regular assessment of vegetation health during regular maintenance and/or inspection activities	▪ ongoing	
			▪ revegetation activities	▪ medium	
Flora species present and vegetation type	▪ ensure no net loss of flora and vegetation within the foreshore reserve	▪ Bush Forever ▪ City of Joondalup planning and management documents ▪ *Wildlife Conservation Act 1950* (WA) ▪ *EPBC Act 1999* (Cwlth)	▪ flora and vegetation surveys during development of individual foreshore management plans	▪ ongoing	▪ flora and vegetation survey outcomes by target area, including development of species list ▪ survey outcomes incorporated in relevant management plan ▪ designation and quantification areas where management /control strategies implemented ▪ use of quadrats, transects and photo monitoring points to measure diversity and weed presence over time ▪ seed collection program developed and implemented ▪ seeds processed, cleaned and stored appropriately ▪ seeds used when commissioning tubestock for revegetation works
			▪ flora and vegetation surveys occur at regular intervals, such as every three years	▪ ongoing	
			▪ development of suitable species lists according to landscape position/soil type for use in revegetation activities within the reserve	▪ high	
			▪ prioritisation of management /control strategies in conservation zones and areas of good or better vegetation	▪ high	
			▪ significant species are protected and maintained	▪ high	
			▪ implement a seed collection program within the reserve to ensure local provenance seedlings can be produced in the longer term	▪ medium - high	
Revegetation activities	▪ restore degraded areas to good or better condition	▪ Bush Forever ▪ City of Joondalup planning and management documents	▪ revegetation activities are implemented when required	▪ medium	▪ area revegetated (i.e.: m^2, ha) ▪ success criteria met (e.g.: 80% seedling survival after two years) ▪ less than 5% weed presence, including priority or declared weeds ▪ use of quadrats, transects and photo monitoring points to measure species diversity over time
			▪ where possible, use local provenance seeds for tubestock to be used in revegetation	▪ medium - high	
Weed management	▪ reduce the presence and impacts of environmental weeds within the foreshore reserve	▪ Bush Forever ▪ Environmental Weed Strategy for Western Australia (CALM, 1999) ▪ *Agriculture and Related Resources Act 1976* (WA) ▪ Weeds of National Significance (WONS) ▪ DEC Weed	▪ weed control via the use of herbicides and hand or manual methods continue within the foreshore reserve in accordance with the City's operational procedures and guidelines	▪ high	▪ areas treated (i.e.: m^2, ha) ▪ success criteria achieved – e.g.: 90% kill or removal rate prior to seed-set ▪ use of quadrats, transects and photo monitoring points to assess weed presence before and after treatment, and over time ▪ weed mapping
			▪ the number of people involved with weed control be kept to a minimum in sensitive environmental and conservation areas	▪ high	
			▪ where necessary, weed control be followed up with revegetation activities as a means of reducing the potential for reinfestation	▪ medium – high	

Management Category	Objective	Standard	Management Action	Priority	Measurement Criteria
		Prioritisation Process (2010)	▪ prioritise weed control activities in accordance with Table 6 in Section 5.1.2 of this plan, with conservation areas being treated first	▪ high	
			▪ adequate resources are provided to carry out weed control activities within the foreshore reserve	▪ high	
			▪ species previously used in revegetation activities that are now considered to be weeds are progressively removed over time, with the areas being allowed to regenerate or are revegetated with suitable species	▪ low – medium	
			▪ detailed weed mapping be carried out during the development of sector management plans	▪ ongoing	
Fauna management	▪ improve the abundance and diversity of fauna species present, with no net loss of species	▪ *Wildlife Conservation Act 1950* (WA) ▪ *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) ▪ City of Joondalup planning and management documents	▪ undertake fauna surveys along the foreshore reserve and at regular intervals afterwards to determine changes over time (e.g.: every 3 – 5 years)	▪ high	▪ baseline fauna species list, updated over time as further surveys are carried out ▪ continued presence of the Graceful Sun Moth at similar or improved population densities over time
			▪ survey for the Graceful Sun Moth at the appropriate time of the year at locations other than the Ocean Reef Marina where their host plant, Lomandra maritima, is found	▪ high	
			▪ eradication or control of introduced fauna species continues in accordance with the City of Joondalup policies and guidelines	▪ ongoing	
Fungi management	▪ Identify and maintain the diversity of fungi species present within the foreshore reserve	▪ *Wildlife Conservation Act 1950* (WA) ▪ *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) ▪ City of Joondalup planning and management documents	▪ undertake incidental fungi surveys within the foreshore reserve whenever flora and vegetation and/or fauna survey activities are carried out	▪ low – medium	▪ baseline fungi species list, updated over time as further surveys are carried out
Erosion control	▪ minimise areas affected by natural and human impacts, particularly within the dunes and their associated vegetation	▪ City of Joondalup planning and management documents ▪ Coastal Planning and Management Manual (WAPC and Coastwest, 2003)	▪ consider erosion holistically, determining treatment techniques on a case by case basis	▪ ongoing	▪ area (i.e.: m^2, ha) treated with erosion control techniques ▪ erosion control undertaken in conjunction with rehabilitation activities
			▪ address erosion as early as possible as a means of avoiding the need to revegetate larger areas at a later stage	▪ ongoing	
			▪ consider erosion in the wider context of climate change and associated impacts over time	▪ low-medium	

Management Category	Objective	Standard	Management Action	Priority	Measurement Criteria
Fire	▪ minimise potential impacts from fire within the foreshore reserve and neighbouring properties	▪ Bush Fires Act 1954 ▪ AS 3959 – 2009 ▪ City of Joondalup planning and management documents	▪ consider the proposed location of facilities from a fire damage perspective, ensuring they are sited such that they are protected from fire and ember attack, constructed from low flammability materials, and in accordance with City of Joondalup engineering and other relevant standards and guidelines	▪ low	▪ documentation associated with planning and installation of infrastructure
Access	▪ minimise damage to dunes and foreshore from inappropriate pedestrian access ▪ provide safe parking areas for beach and foreshore reserve users	▪ Coastal Planning and Management Manual (Western Australian Planning Commission and Coastwest, 2003) ▪ SPP 2.6 – Coastal Planning and Management	▪ consider increasing security patrols in car parks where there is evidence of inappropriate behaviour and vehicle break-ins	▪ medium – high	▪ evidence of inappropriate behaviour and vehicle break-ins after implementing increased patrols ▪ number of informal tracks closed and rehabilitated ▪ number of new tracks created ▪ changes in number and type of signs ▪ indications in behaviour changes as result of new signage, such as less tracks and less litter
			▪ consider closure, rehabilitation or formalisation of some or all informal access tracks in consultation with interested stakeholders	▪ medium – high	
			▪ consider signage information and location when replacing signs	▪ ongoing	
			▪ include positive messages relating to why it is important to keep off dunes and other areas.	▪ Ongoing	
Stormwater management	▪ minimise impacts from stormwater management within the foreshore reserve	▪ Stormwater management manual (Department of Water, 2004)	▪ current stormwater drain locations within the foreshore be assessed to determine what impacts are associated with their presence	▪ medium – high	▪ documented outcomes of the assessment processes ▪ development, implementation and evaluation of remediation activities
			▪ where impacts have occurred, undertake appropriate remediation activities	▪ high	
			▪ give consideration to treating stormwater before discharge, including what options exist for alternative use rather than discharge	▪ low - medium	
Signage	▪ provide appropriate signage within the foreshore reserve	▪ City of Joondalup planning and management documents	▪ over time, consistent, informative signage be installed	▪ ongoing	▪ no of signs installed of varying styles over time ▪ record of sign specifications provided to manufacturers ▪ locations ▪ positive vs. prohibition messages ▪ checking during regular inspection activities
			▪ signage is resistant to graffiti	▪ ongoing	
			▪ messages are informative and easily interpretable	▪ ongoing	
			▪ sign placement allows for easy readability	▪ ongoing	
			▪ signage includes positive environmental messages, not just prohibitions	▪ ongoing	
Fencing	▪ fencing is installed where appropriate	▪ City of Joondalup planning and management documents	▪ revegetation works are fenced to protect seedlings during their establishment period	▪ ongoing	▪ record of areas fenced ▪ checking during regular inspection activities
			▪ use sand trap fencing where frontal dune restoration activities are being carried out	▪ ongoing	
Limestone cliffs	▪ minimise the potential hazards associated with the presence of the limestone cliffs	▪ land manager responsibility/duty of care ▪ City of Joondalup	▪ implement a regular inspection and risk assessment of all limestone cliffs within the foreshore reserve at a nominated frequency (e.g.: annually or at a frequency recommended by a	▪ high	▪ creation of register ▪ outcomes of inspection and risk assessment process, including methodology, experience and expertise of the assessor, recommendations made, and when implemented

Management Category	Objective	Standard	Management Action	Priority	Measurement Criteria
		planning and management documents	suitably qualified professional)		
			▪ outcomes recorded in a suitable register	▪ high	
Climate change	▪ potential risks and impacts associated with climate change are investigated and acted on in a timely manner	▪ City of Joondalup planning and management documents	▪ investigate the potential risks and impacts associated with climate change and how they could impact on foreshore management.	▪ medium	▪ evaluating formulation and implementation of mitigation strategies
			▪ ▪ It is recommended that the City continue to explore the potential risks associated with climate change and develop and implement their Climate Change Strategy.	▪ medium	
Conservation areas	▪ ensure nominated conservation areas are maintained in as good a condition as possible	▪ City of Joondalup planning and management documents ▪ *Wildlife Conservation Act 1950* (WA) ▪ *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth)	▪ undertake required restoration works identified during site assessment and regular inspection activities as a matter of priority	▪ high	▪ restoration works scheduled as soon as practicable after identification ▪ endorsement of the coastline in the vicinity of the Marmion Aquatic and Angling Club as conservation zone, along with required adjustments to ongoing maintenance and inspection activities prioritised
			▪	▪ high	
			▪ consider the inclusion of the coastline in the vicinity of the Marmion Aquatic and Angling Club as a conservation zone	▪ high	
‘Friends of’ and other community groups	▪ ensure work undertaken by ‘Friends of’ or other community groups complement the management aims for the site and work undertaken by the City	▪ City of Joondalup community group standards and procedures	▪ community group on ground activities complement City of Joondalup management aims and objectives, and are guided by broader management principles	▪ ongoing	▪ works carried out by the community group and their relationship to broader management plans and principles ▪ record communication outcomes
			▪ ongoing communication is maintained with the designated contact officer	▪ ongoing	

6.3 Routine Reporting

Assessing the management of the coastal foreshore reserve will be undertaken through annually reporting progress against management of the completion of actions.

6.4 Scientific Research and Monitoring

The dynamic nature of the coastal foreshore reserve is under ongoing pressure from a range of human activities, some directly through trampling of vegetation and erosion, with others are somewhat indirect through greenhouse gas emissions and associated links to climate change and predicted future impacts. Ongoing research and monitoring will enable the City to make judgements about cause/effect relationships and assist with future management decisions. In addition to regular maintenance and other assessment activities, the following ongoing monitoring activities are suggested:

- regular flora and vegetation monitoring through nominated quadrats and transects to measure changes in species and vegetation types along with their general health, the presence of weeds
- success of revegetation and erosion control activities
- undertake a more detailed assessment of the *Lomandra maritima* communities and the Graceful Sun Moth to quantify its presence within the broader coastal foreshore reserve, and if necessary, develop and implement appropriate management strategies to ensure its longer term survival
- undertake a detailed assessment of fauna species within the coastal foreshore reserve to determine a baseline species list, then repeat the surveys at regular intervals (e.g.: five years) to determine what changes are occurring and the reasons for those changes
- undertake fungi surveys at the same time as flora and vegetation surveys, and
- review and assess human usage of the coastal foreshore at regular intervals, such as five yearly intervals and when the management plan is reviewed.

Research projects within the coastal foreshore reserve could include:

- effective weed control trials for sensitive environments in coastal soils
- restoration trials for coastal species
- germination of seed from difficult to propagate coastal flora species
- baseline invertebrate presence and as an indicator of ecosystem health
- investigation of new techniques designed to maintain biodiversity in the longer term whilst experiencing increasing pressure from human activities, such as access control and public awareness and education measures aimed at ‘Gen-Y’.

6.5 Management Plan Review

The coastal foreshore reserve is a dynamic area subject to human and natural influences. The state of knowledge and accepted coastal foreshore management practices are also changing as a result of research outcomes and increased awareness. Accordingly, the requirement to review the *Coastal Foreshore Management Plan 2014 – 2024* will occur on a regular basis to ensure its ongoing suitability. Recommended triggers for review include:

- after five years
- after the completion of any flora, fauna or fungi surveys
- new information or similar relating to aspects of coastal foreshore management that becomes accepted or best practice.

6.6 Implementation of Management Actions

The City of Joondalup coastal foreshore reserve is unique in the Perth metropolitan area in terms of the area reserved and the vegetative diversity that is represented, hence the need for ongoing management. The environmental values of the site have been recognised through the Bush Forever listing, along with the presence of known rare flora and fauna species. At a local level, a number of locations are considered to be, or have been recommended as local conservation areas, and will receive priority attention for implementation of management strategies as required. Overall recommendations for management are summarised in Table 16.

Table 16: Summary of Recommended Management Actions

Recommended Management Action	Biodiversity Conservation Area
Revegetation is carried out at nominated locations and action priorities.	Flora
The vegetation condition in other areas is at least maintained.	Flora
When necessary, rehabilitation is carried out using appropriate techniques applied in a timely manner.	Flora
Significant species are maintained and protected.	Flora
A comprehensive list of suitable species according to vegetation type, soils, and location within the landscape is developed.	Flora
A seed collection programme is implemented to collect local provenance seed.	Flora
Signs of disease or other declines in vegetation health that become apparent are investigated and managed.	Flora
Regular assessment of flora and vegetation occur at a regular frequency, such as every five.	Flora
Ongoing weed removal continues as a matter of priority within the foreshore reserve.	Flora
An integrated approach continues to be applied to weed management	Flora

Recommended Management Action	Biodiversity Conservation Area
with appropriate treatment techniques applied after giving due consideration to the target species and their location.	
In sensitive environmental areas, the number of people undertaking hand weeding activities is kept to a minimum.	Flora
Where possible, areas treated for weeds are revegetated as a matter of priority.	Flora
Chemical weed control methods continue to be used in accordance with the City's operational procedures and guidelines.	Flora
When required, appropriately qualified and experienced contractors are used to assist with chemical weed control activities.	Flora
Weed control programs should consider all weed types, including grasses, bulbs, trees and shrubs.	Flora
Weed control activities be prioritised in accordance with: ▪ priority weed listings ▪ carried out using suggested or similar treatment methods ▪ carried out in identified conservation areas as the first priority, then those areas that are rated as having vegetation in 'good' or better condition, followed by those common usage areas.	Flora
Other undesirable plant species that have previously been used in revegetation activities be progressively removed over time and replaced with more appropriate species.	Flora
During site assessment activities associated with the development of projected individual management plans for each sector, that more detailed weed mapping be carried out and used to formulate targeted management and control strategies.	Flora
Fungi surveys to be carried out any time a flora and vegetation survey is conducted.	Flora
As a minimum, the surveys should include photographing and recording the locations of species encountered.	Flora
Develop a database of fungi species and locations that can be added to in the future, similar to the City's virtual herbarium, and used as the basis of inferring relationships between the flora and fungi.	Flora
Joondalup staff, volunteers and contractors working within City reserves are familiar with and adhere to the management actions contained within the *Pathogen Management Plan,* and the guidelines that are being developed in association with the plan.	Plant Diseases
Detailed surveys to be carried out to determine the type, location and species of native and introduced fauna.	Fauna
Formulate appropriate management strategies based on outcome of fauna surveys.	Fauna
Commit to repeating fauna surveys at a nominated frequency, such as every five years, as a means of assessing the effectiveness of strategies	Fauna

Recommended Management Action	Biodiversity Conservation Area
aimed at controlling impacts on native fauna.	
Surveys for the Graceful Sun Moth (*Synemon gratiosa*) be carried out at the appropriate time of year at other locations within the coastal foreshore reserve that contain their preferred habitat, *Lomandra maritima*, with protection mechanisms put in place to ensure their protection wherever they are found.	Fauna
Eradication or control of introduced species is undertaken as required.	Fauna
Erosion issues to be considered holistically, with the most appropriate management options being determined on a case by case basis.	Erosion
Where possible, erosion issues to be addressed as early as possible.	Erosion
Consider erosion in the wider context of climate change impacts that could occur over time.	Erosion
Where possible, the work of 'Friends' groups and individuals should complement work undertaken by the City, as well as be guided by broader management principles set out in management plans, policies and guidelines.	Social Value
Ongoing communication between community group and City representatives will continue to be necessary to ensure that outcomes are of benefit for the group and consistent with the City's longer term aims and objectives.	Social Value
Fencing maintenance continues to be carried out on a regular basis, and replaced when required.	Social and Built Environment
Use sand trap fencing in areas where frontal dune restoration work is being carried out.	Social and Built Environment
Consistent, informative signage is installed within the foreshore reserve.	Social and Built Environment
The materials signs are made of are resistant to graffiti in particular.	Social and Built Environment
Messages included on signs are informative and readily interpretable.	Social and Built Environment
When planning the installation of facilities and infrastructure, consider the proposed location from a potential fire damage perspective, ensuring they are sited in locations that provides protection from fire and ember attack and constructed of suitable low-flammability materials, in accordance with City engineering and other relevant standards and guidelines.	Fire Management
The City of Joondalup continues to implement a formal inspection and risk assessment of limestone cliff areas within the coastal foreshore reserve at a nominated frequency, as suggested by suitably qualified and experienced practitioners.	Limestone Cliffs
Details of the limestone cliff inspection programme should be documented and outcomes recorded in procedures and registers as part	Limestone Cliffs

Recommended Management Action	Biodiversity Conservation Area
of the City's ongoing management system.	
The City continues to explore potential climate change risks associated with the coastal foreshore, with the outcomes of any investigative processes informing appropriate mitigation strategies.	Climate Change
Undertaking restoration works as identified during site assessment and regular inspection activities as a matter of priority.	Conservation Areas
Considering the inclusion of the coastline in the vicinity of the Marmion Aquatic and Angling Club as a conservation zone due to its unique landform.	Conservation Areas

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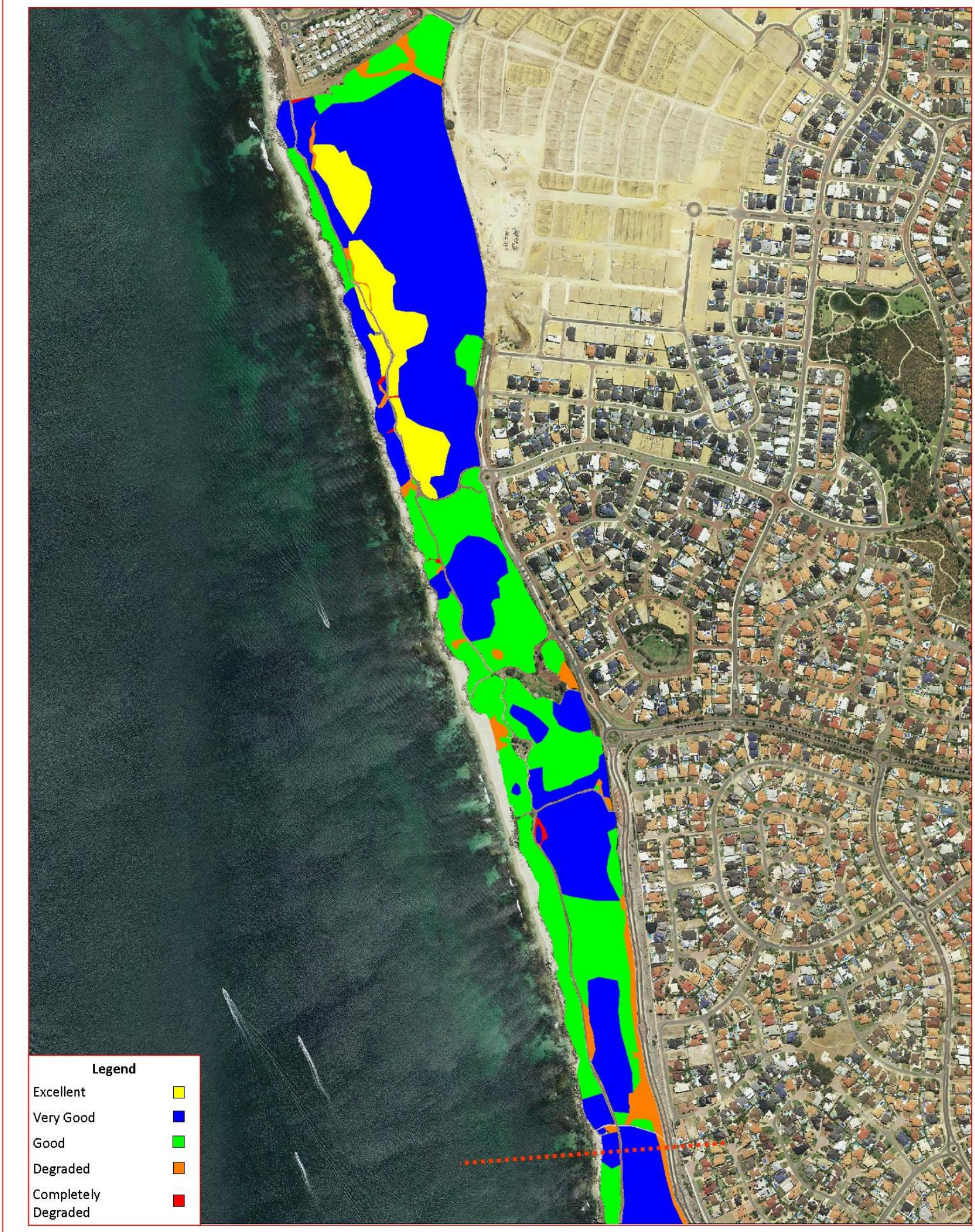
8.0 Appendices

Appendix 1: 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)

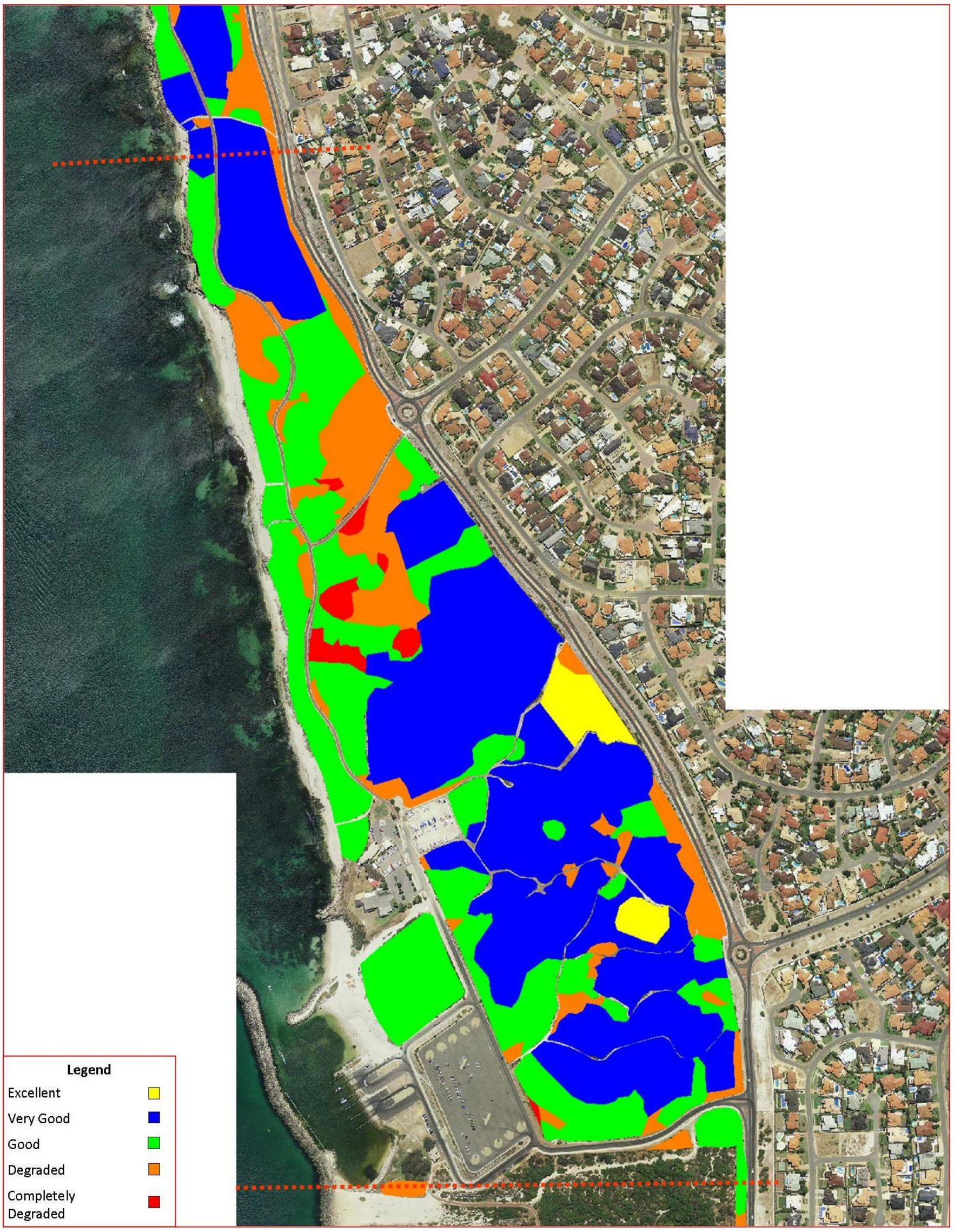
Appendix 2: Detailed Vegetation Conditions Maps



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector —
Vegetation Condition

N
0 400
Metres



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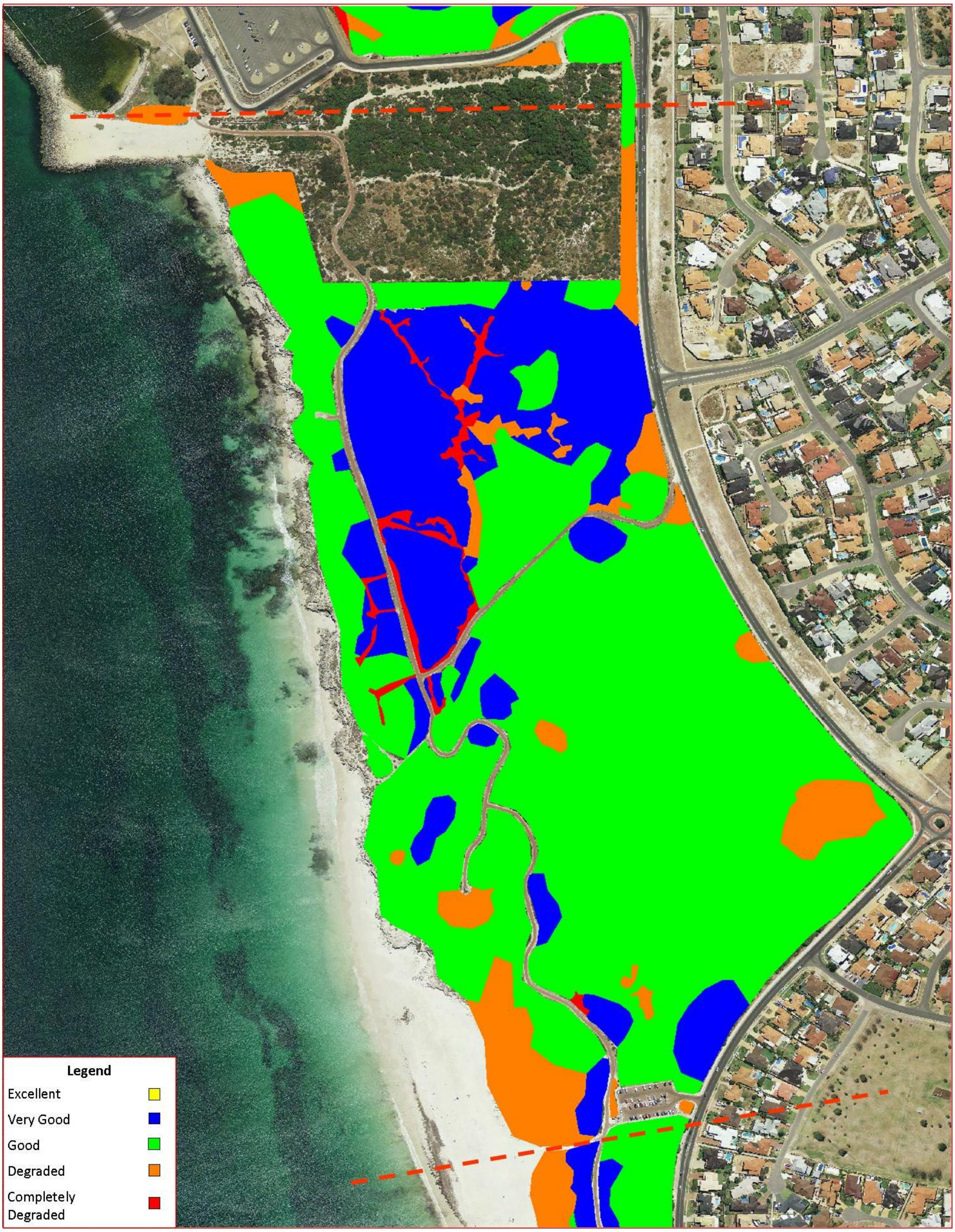
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector — Vegetation Condition

N

0 250

Metres



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Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector — Vegetation Condition

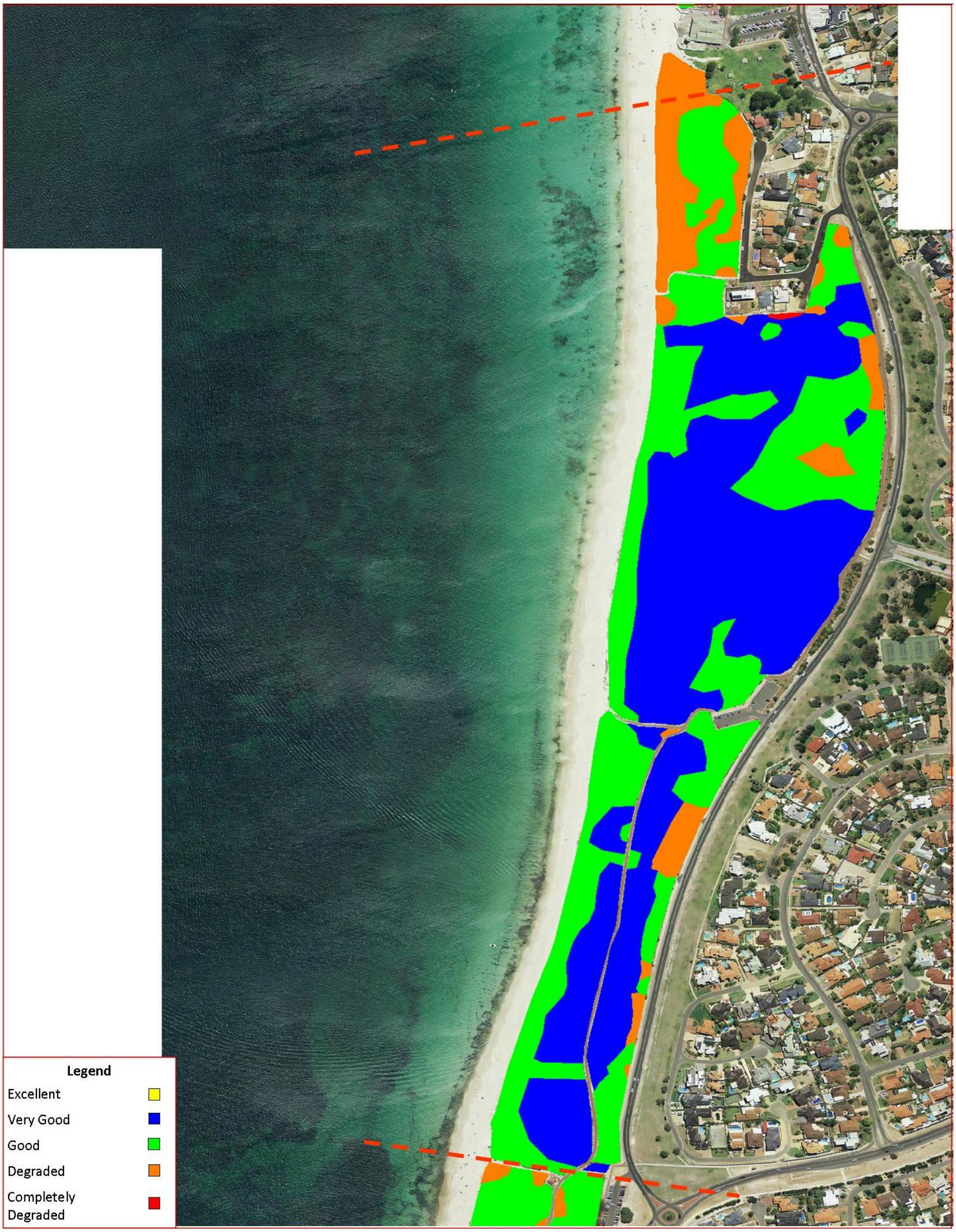
N
0 250
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Mullaloo Sector —
Vegetation Condition

N
0 250
Metres



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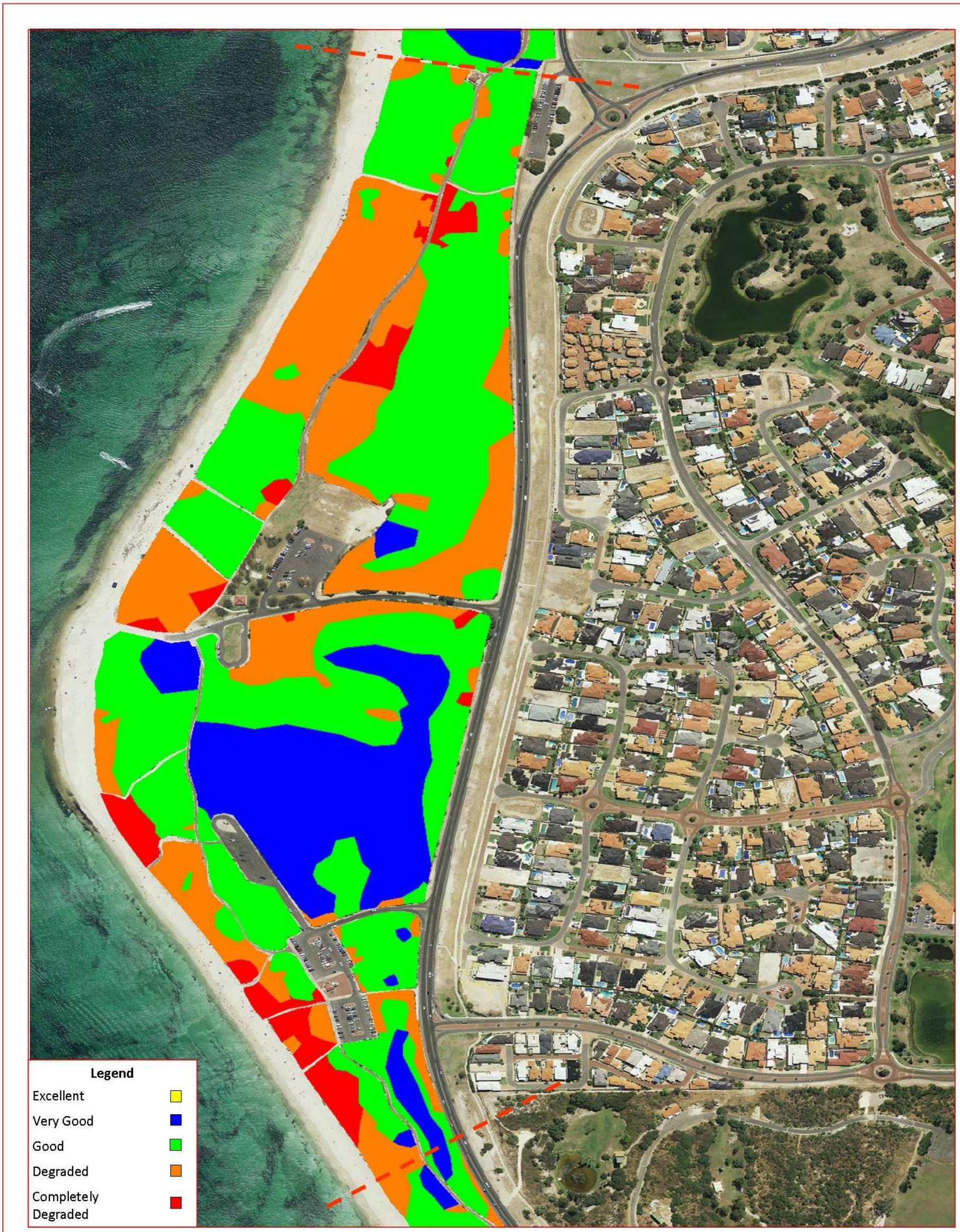
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector — Vegetation Condition

N

0 250

Metres



Natural Area CONSULTING

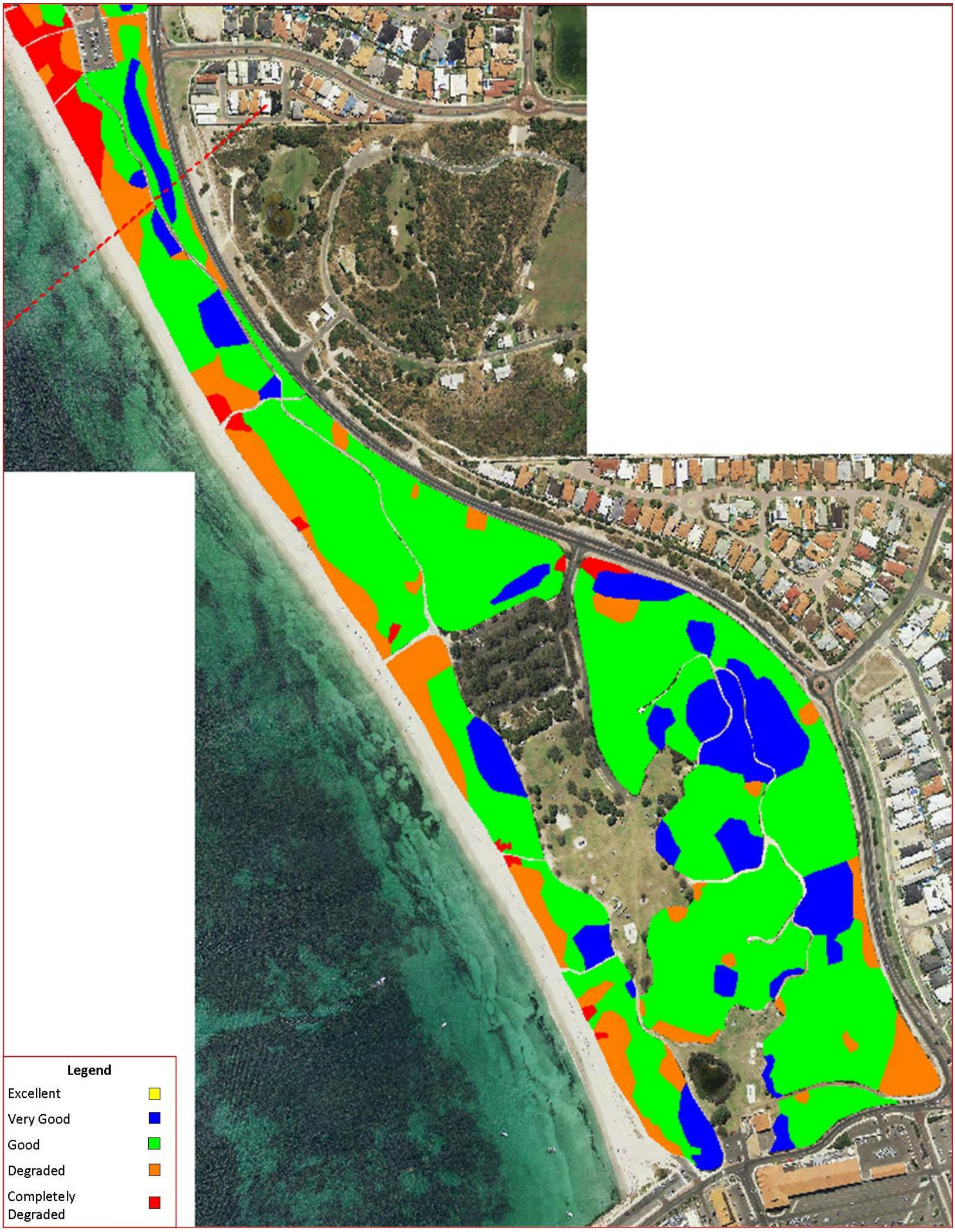
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Pinnaroo Sector — Vegetation Condition

N

0 250

Metres



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector —
Vegetation Condition

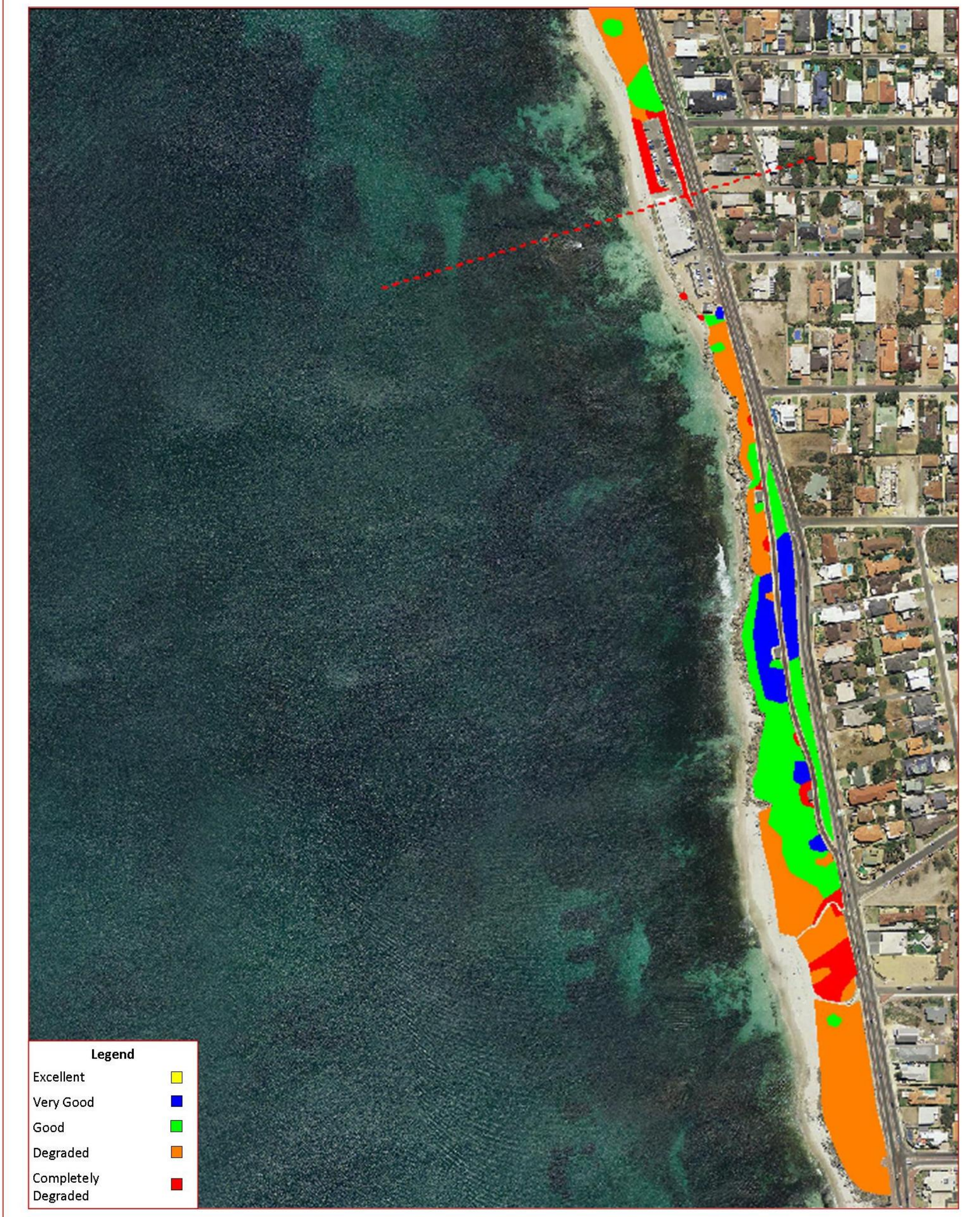
N
0 200
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Sorrento Sector —
Vegetation Condition

N
0 200
Metres



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Marmion Sector — Vegetation Condition

N

0 200

Metres

Appendix 3: Conservation Codes

Western Australia

Conservation Code	Name	Description
T	Threatened	Flora or fauna that is rare or likely to become extinct (Schedule 1 of the *Wildlife Conservation Act* 1950) Taxa that have been adequately searched for and deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.
X	Presumed Extinct	Flora or fauna that is presumed to be extinct in the wild (Schedule 2 of the *Wildlife Conservation Act* 1950) Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such.
IA	International Agreement	Birds protected under international agreement (Schedule 3 of the *Wildlife Conservation Act* 1950) Birds that are subject to an agreement between governments of Australia and other countries relating to the protection of migratory birds and birds in danger of extinction
S	Specially Protected	Other specially protected fauna (Schedule 4 of the *Wildlife Conservation Act* 1950) Fauna that is in need of special protection, otherwise than for the reasons listed in other schedules of the *Wildlife Conservation Act* 1950.

Conservation Code	Name	Description
Schedule 1 species that are ranked by the DEC according to their level of threat using IUCN Red List criteria		
CR	Critically endangered	Species considered to be facing an extremely high risk of extinction within the wild
EN	Endangered	Species considered to be facing a very high risk of extinction within the wild
VU	Vulnerable	Species considered to be facing a high risk of extinction in the wild
Taxa that have not been adequately surveyed for listing under Schedule 1 or 2 of the Wildlife Protection Act are added to the Priority Lists under priorities 1, 2 or 3, according to the priority for further survey and evaluation of their conservation status.		
1	Priority One	Poorly known taxa Taxa which are known from one or a few collections or sight records (generally <5), on all lands not managed for conservation, such as road verges, urban areas, farmland, active mineral lease and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
2	Priority Two	Poorly known taxa Taxa which are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, such as national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves and similar. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes
3	Priority Three	Poorly known taxa

Conservation Code	Name	Description
		Taxa that are known collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
4	Priority Four	Rare or near threatened and other taxa in need of monitoring Rare: Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. Near threatened: Taxa that are considered to have been adequately surveyed and that to not qualify for Conservation Dependent, but that are close to qualifying for vulnerable. Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
5	Priority Five	Conservation Dependent Taxa Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxa becoming threatened within five years.

(Source: Department of Environment and Conservation, 2011)

Commonwealth

Category	Description
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future
Endangered	Taxa facing a very high risk of extinction in the wild in the near future
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium term

(Source: Department of Sustainability, Environment, Water, Population and Communities, 2012)

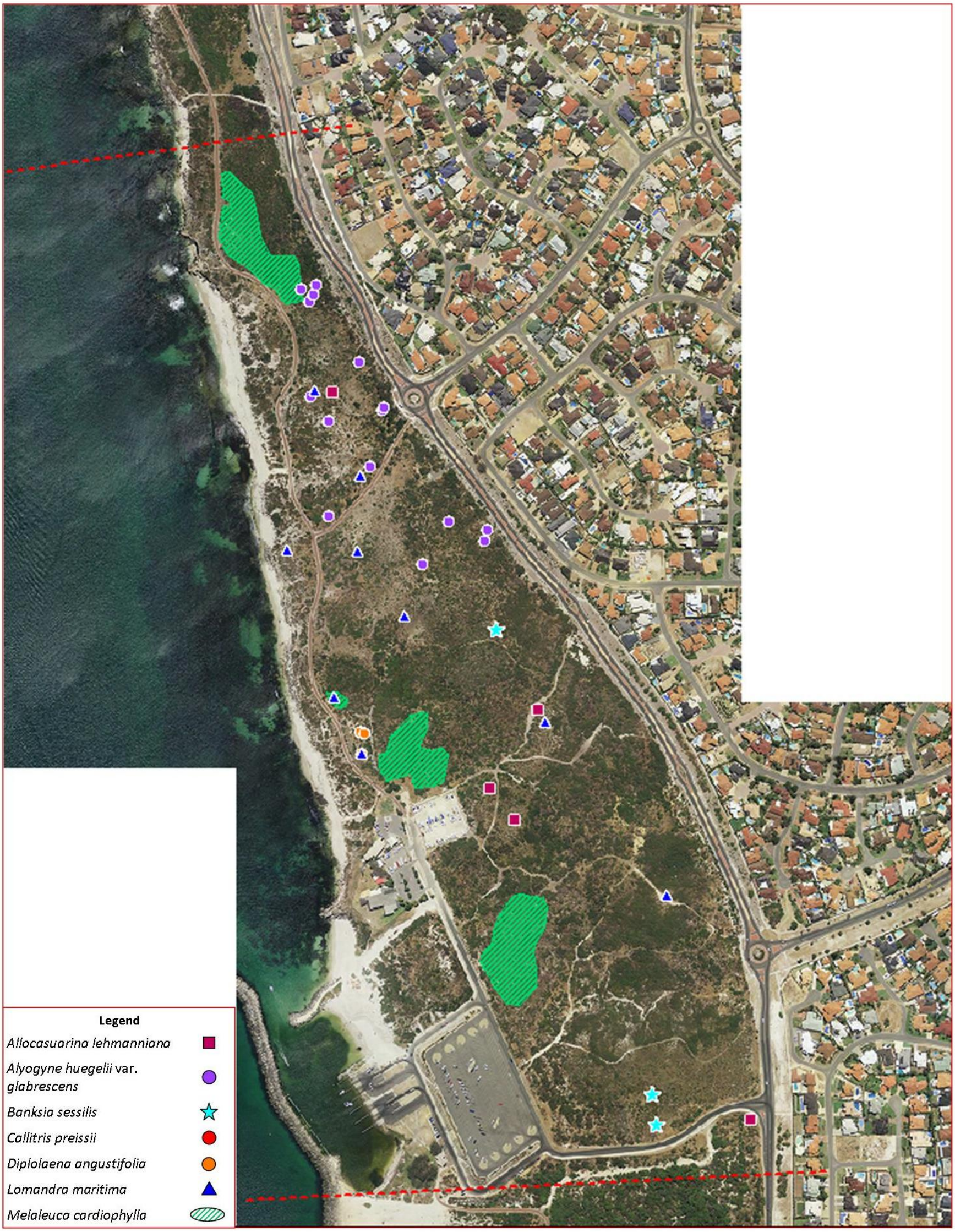
Appendix 4: Significant Vegetation Observations

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector –
Significant Vegetation

N
0 400
Metres



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector – Significant Vegetation

N
0 250
Metres

Natural Area CONSULTING

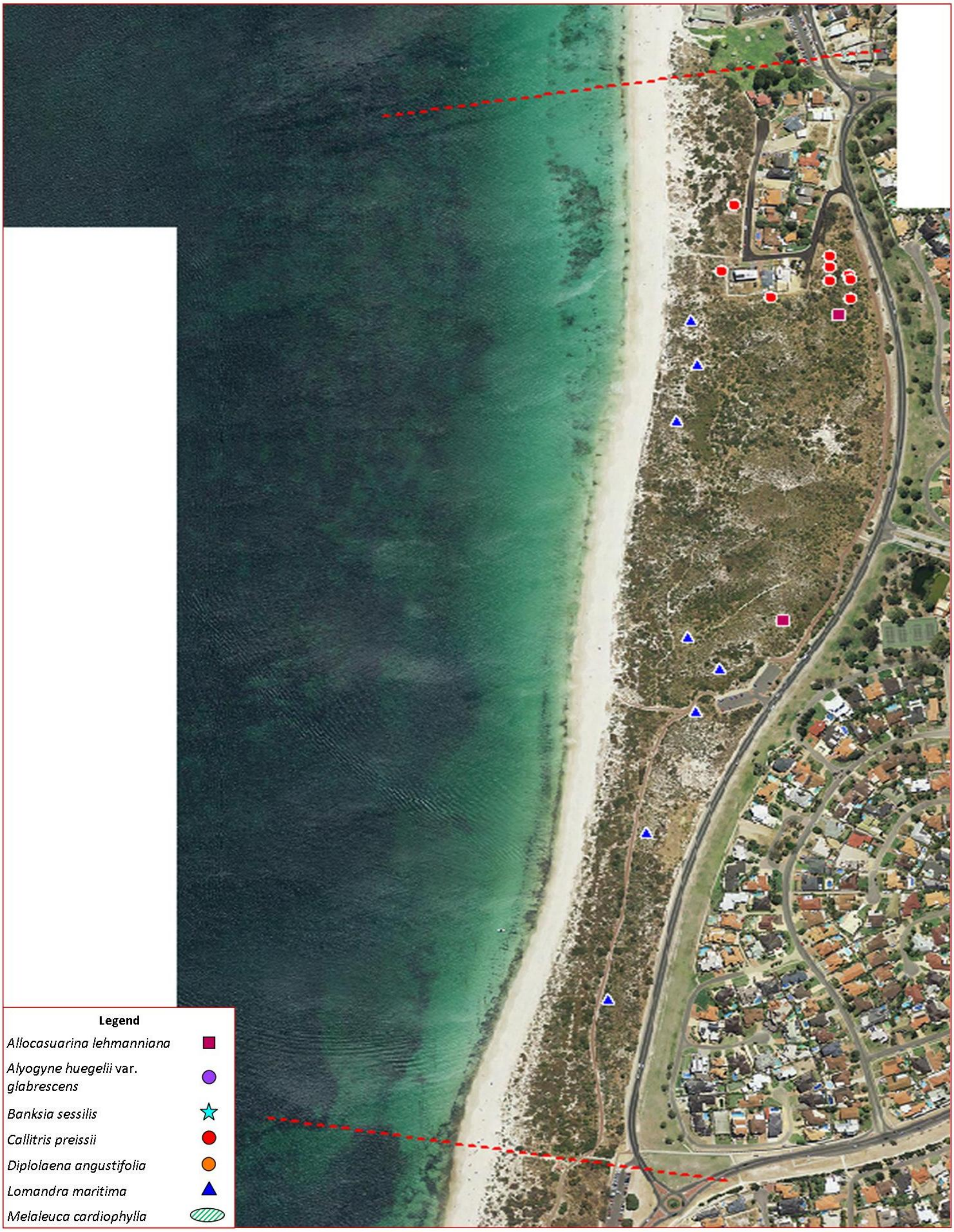
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector – Significant Vegetation

N

0 250

Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector – Significant Vegetation

N

0 250

Metres

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

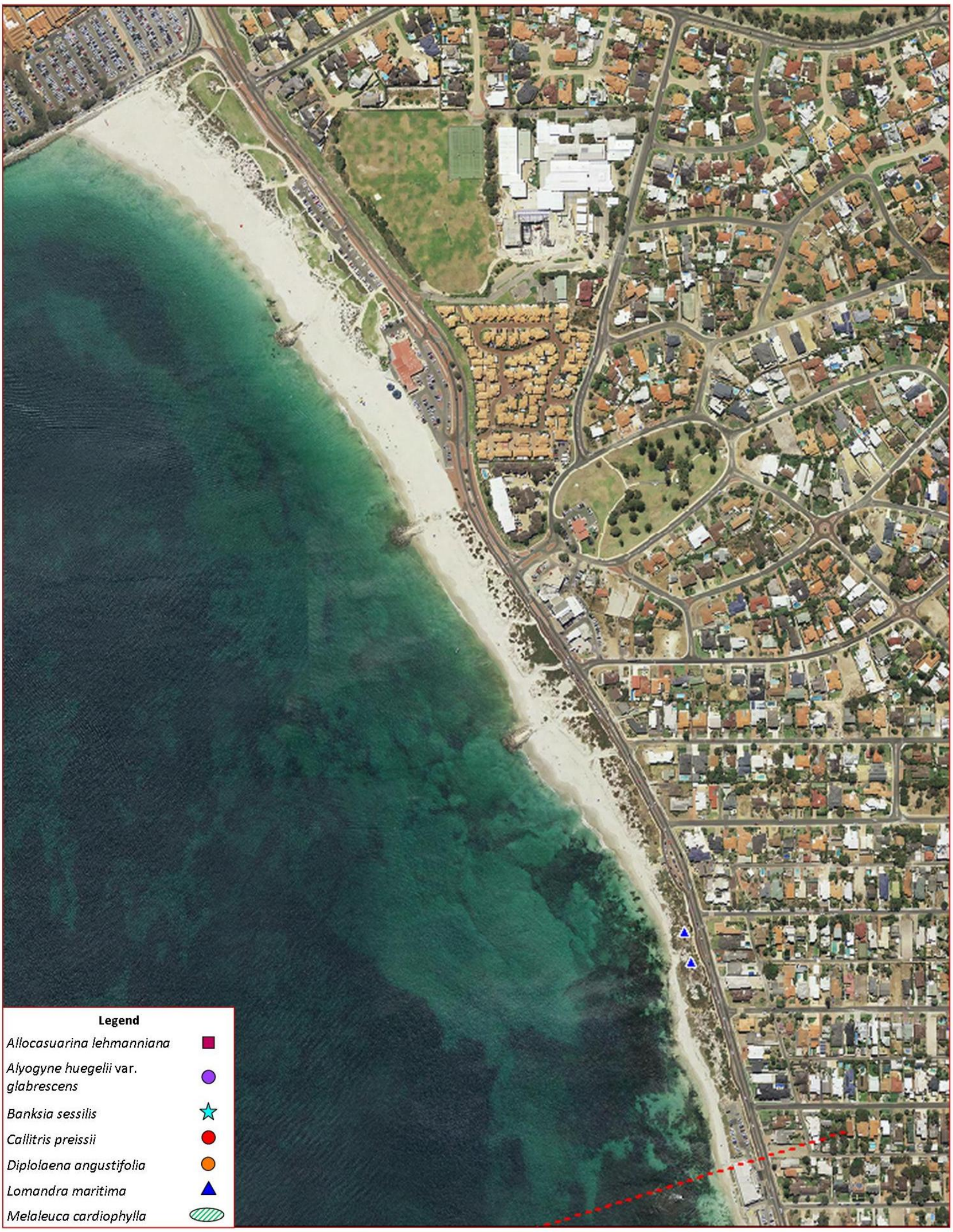
Pinnaroo Sector – Significant Vegetation

N
0 250
Metres

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector –
Significant Vegetation

N
0 200
Metres



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Sorrento Sector – Significant Vegetation

N
0 200
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

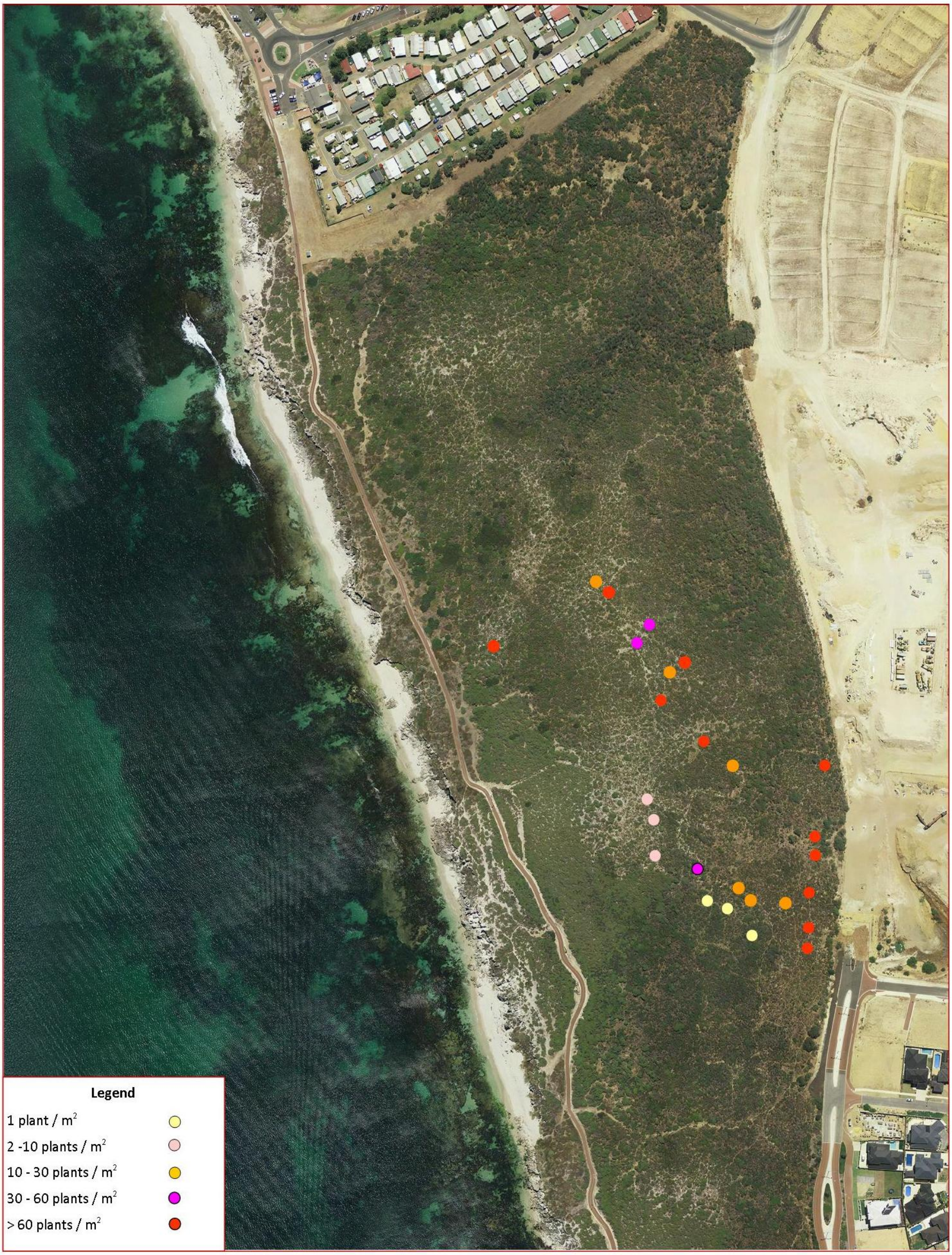
Marmion Sector – Significant Vegetation

N

0 200

Metres

Appendix 5: Weed Maps



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector, North —
One-Leaf Cape Tulip (*Moraea flaccida*)

N
0 400
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector, South —
One-Leaf Cape Tulip (*Moraea flaccida*)

N
0 400
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector Weeds — *Ehrharta longiflora* (Annual Veldt), *Ipomoea cairica* (Morning Glory), *Nicotiana glauca* (Tobacco), *Ricinus communis* (Castor Oil), *Solanum linnaeanum* (Apple of Sodom).

N

0 400

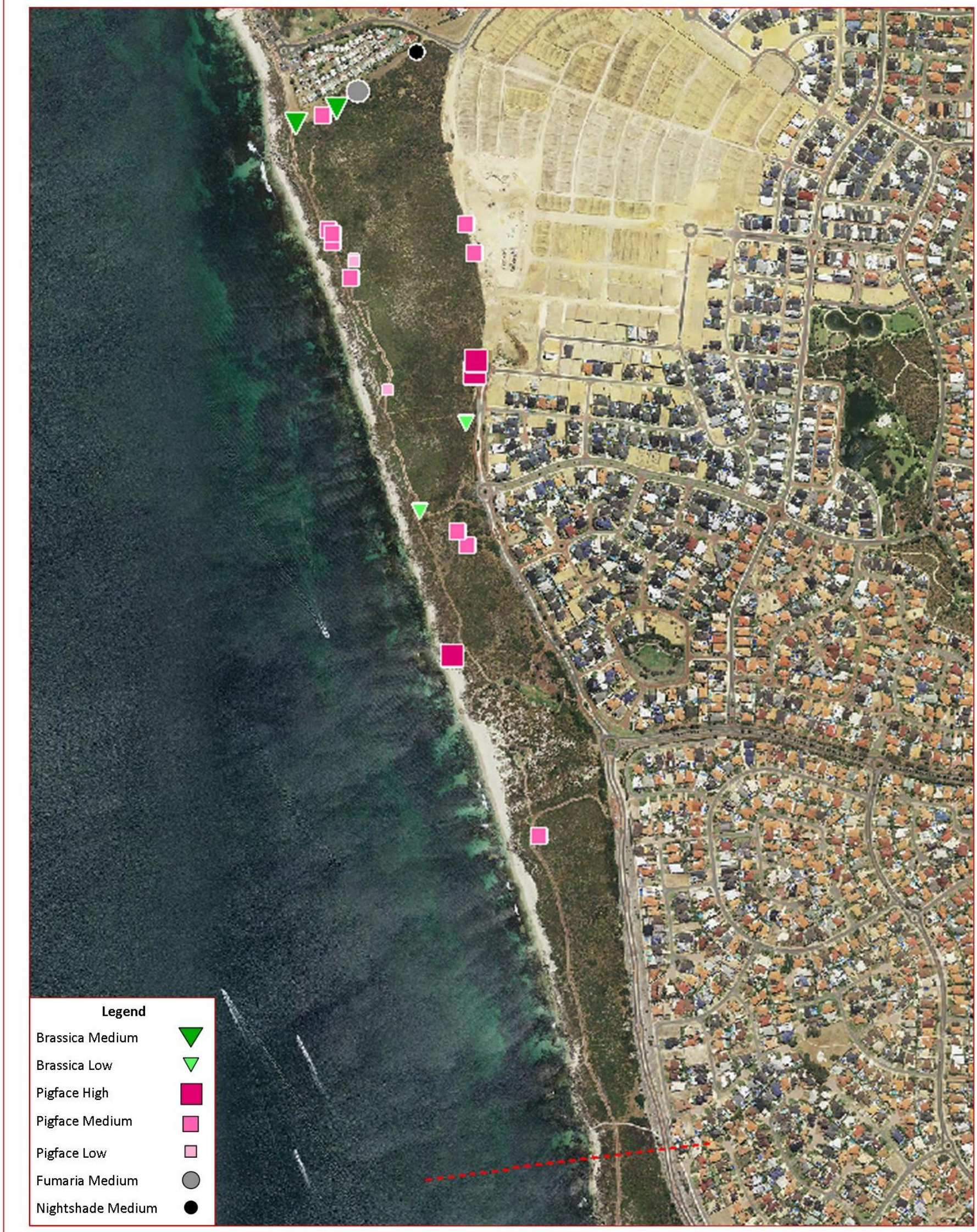
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector Weeds — *Avena fatua* (Oats), *Bromus diandrus* (Brome), *Stenotaphrum secundatum* (Buffalo Grass).

N
0 400
Metres



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector Weeds — *Brassica tournefortii* (Brassica), *Carpobrotus edulis* (Pigface), *Fumaria capreolata* (Fumaria), *Solanum nigrum* (Nightshade).

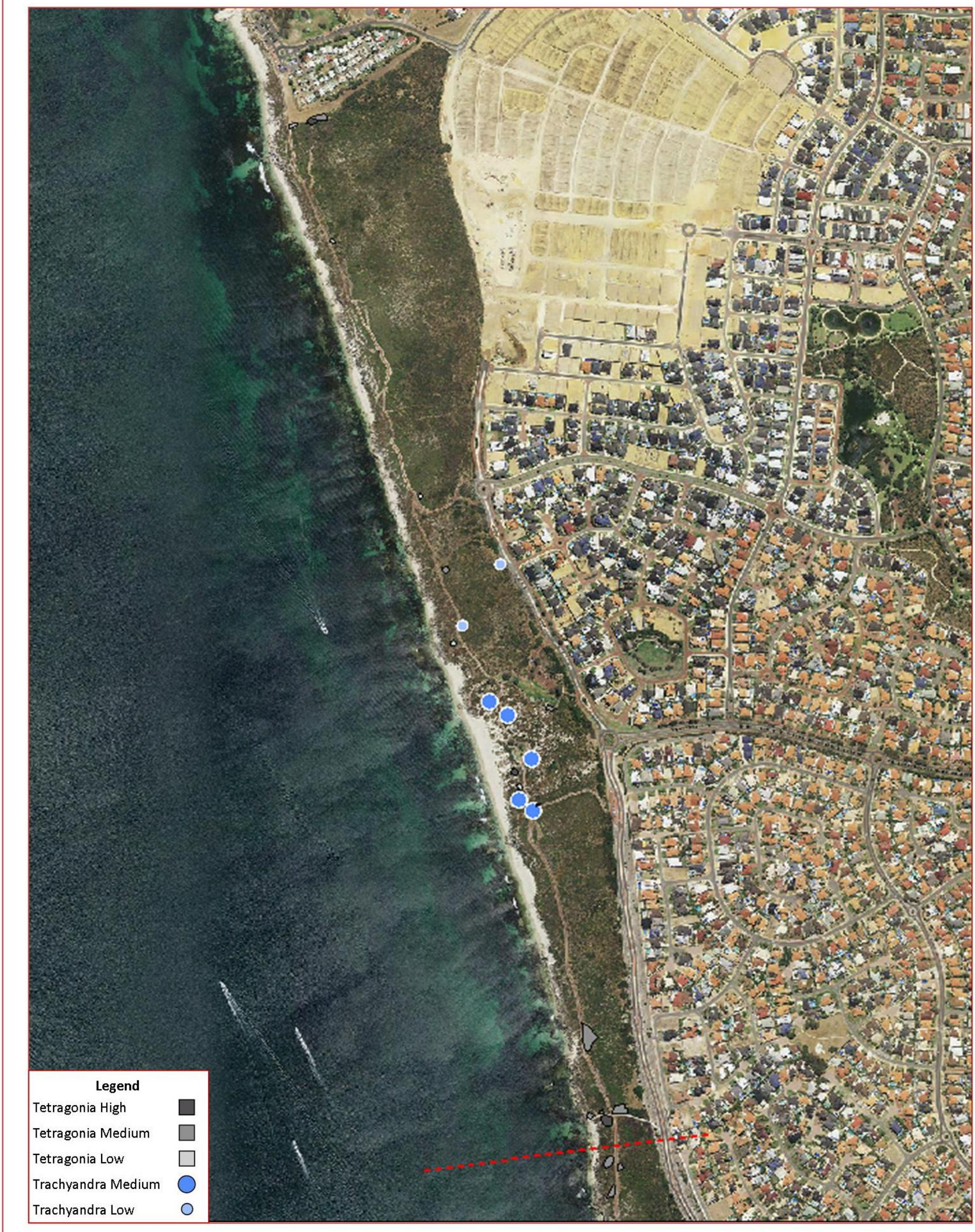
N
0 400
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector Weeds — *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N
0 400
Metres

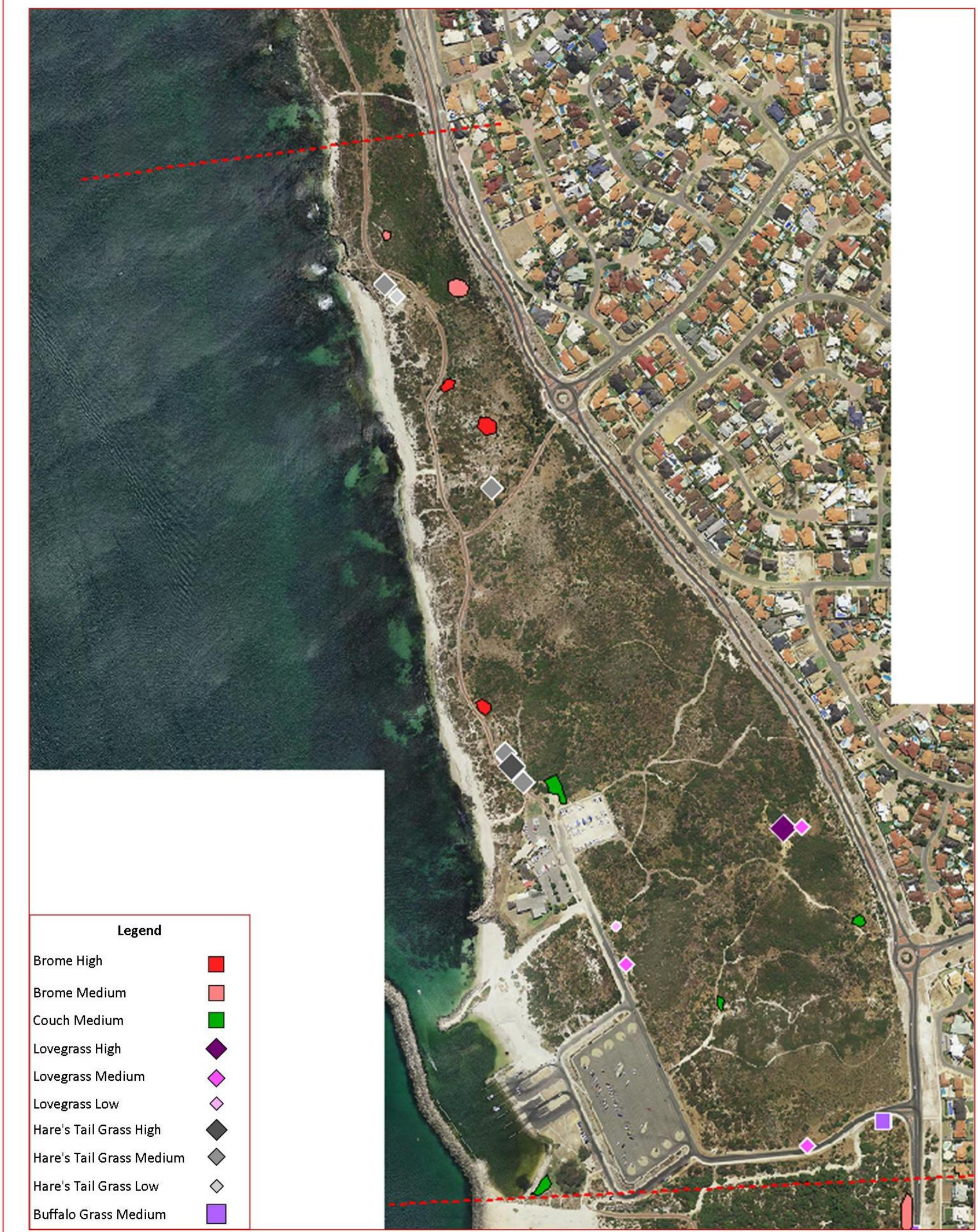


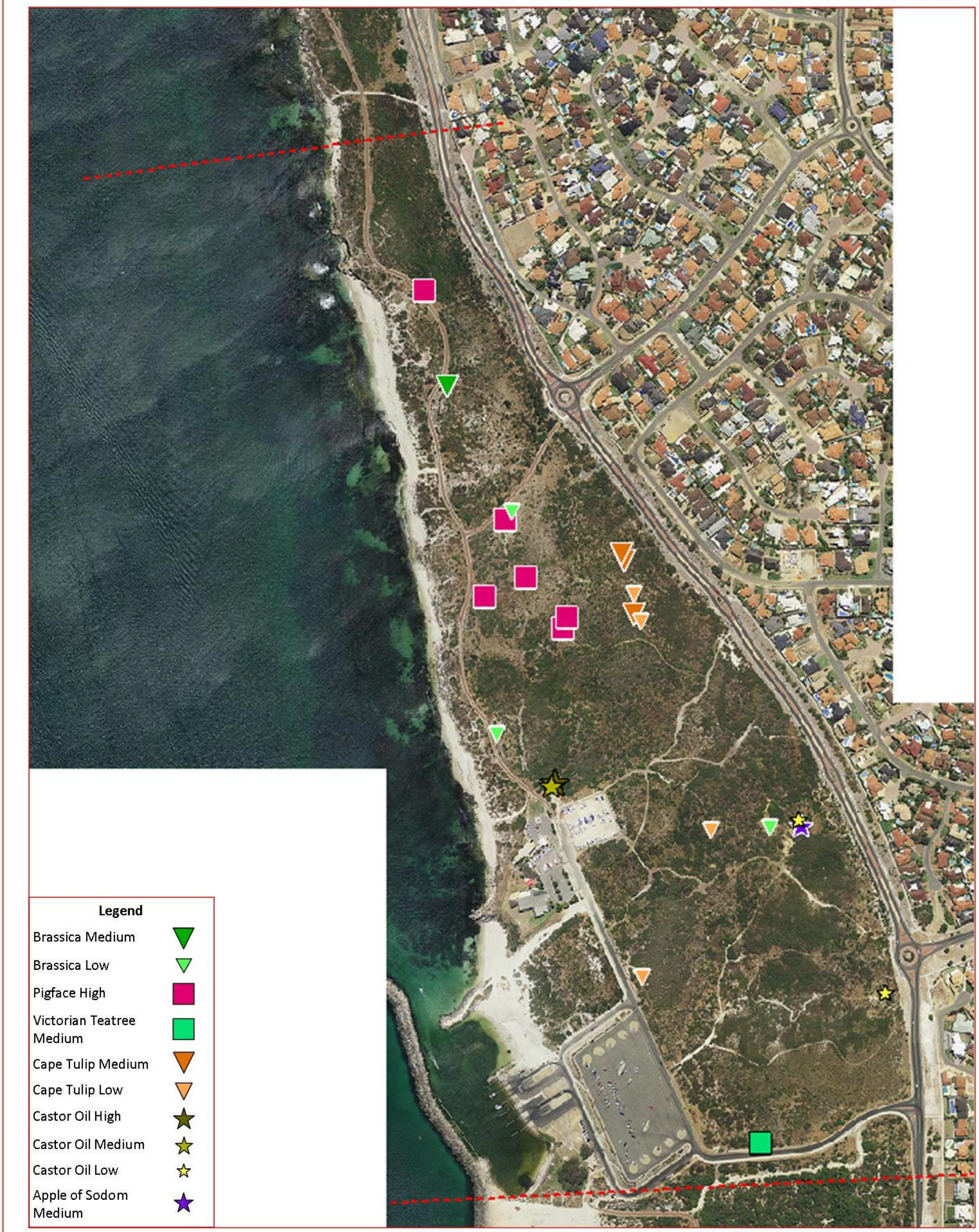
Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

N
0 400
Metres


Legend
Brome High
Brome Medium
Couch Medium
Lovegrass High
Lovegrass Medium
Lovegrass Low
Hare's Tail Grass High
Hare's Tail Grass Medium
Hare's Tail Grass Low
Buffalo Grass Medium
Natural Area CONSULTING
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50
Ocean Reef Sector Weeds — Bromus diandrus (Brome), Cynodon dactylon (Couch), Eragrostis curvula (Lovegrass), Lagurus ovatus (Hare's Tail Grass), Stenotaphrum secundatum (Buffalo Grass).
N
0
250
Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector Weeds — *Brassica tournefortii* (Brassica), *Carpobrotus edulis* (Pigface), *Leptospermum laevigatum* (Victorian Teatree), *Ricinus communis* (Castor Oil), *Solanum linnaeanum* (Apple of Sodom).

N

0 250

Metres

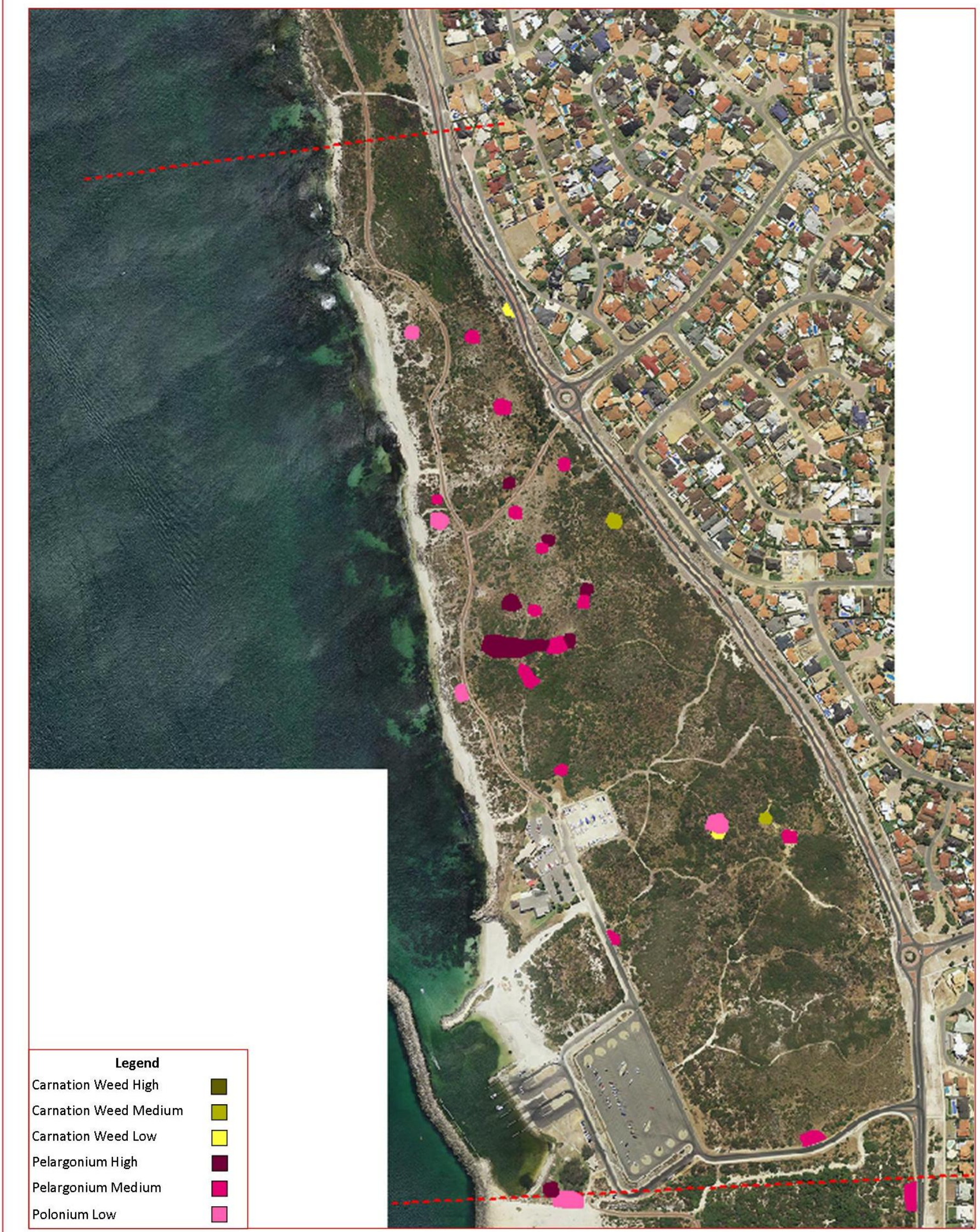
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector Weeds — *Avena fatua* (Oats), *Ehrharta longifolia* (Annual Veldt).

N

0 250

Metres

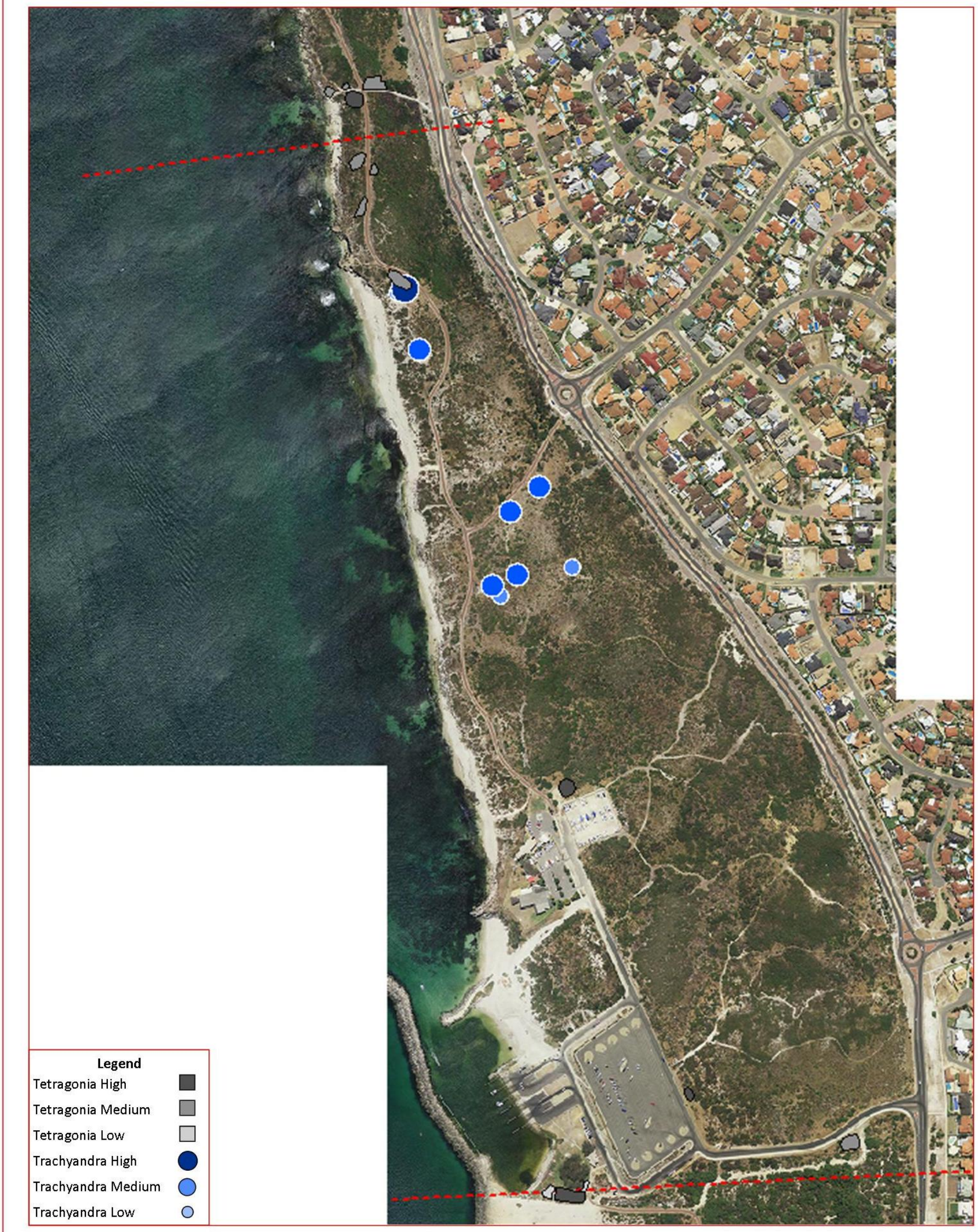


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector Weeds — *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N
0 250
Metres

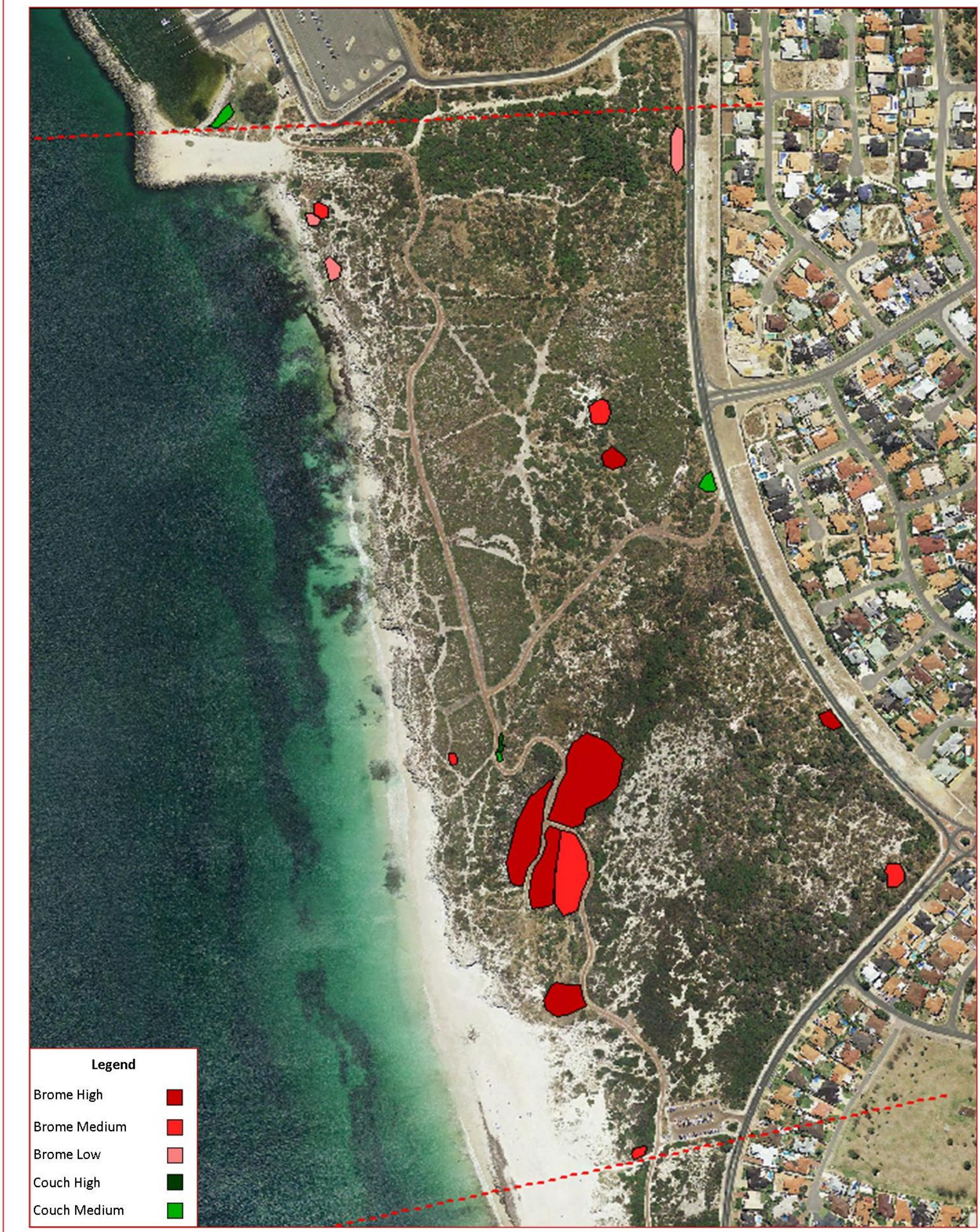


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

N
0 250
Metres

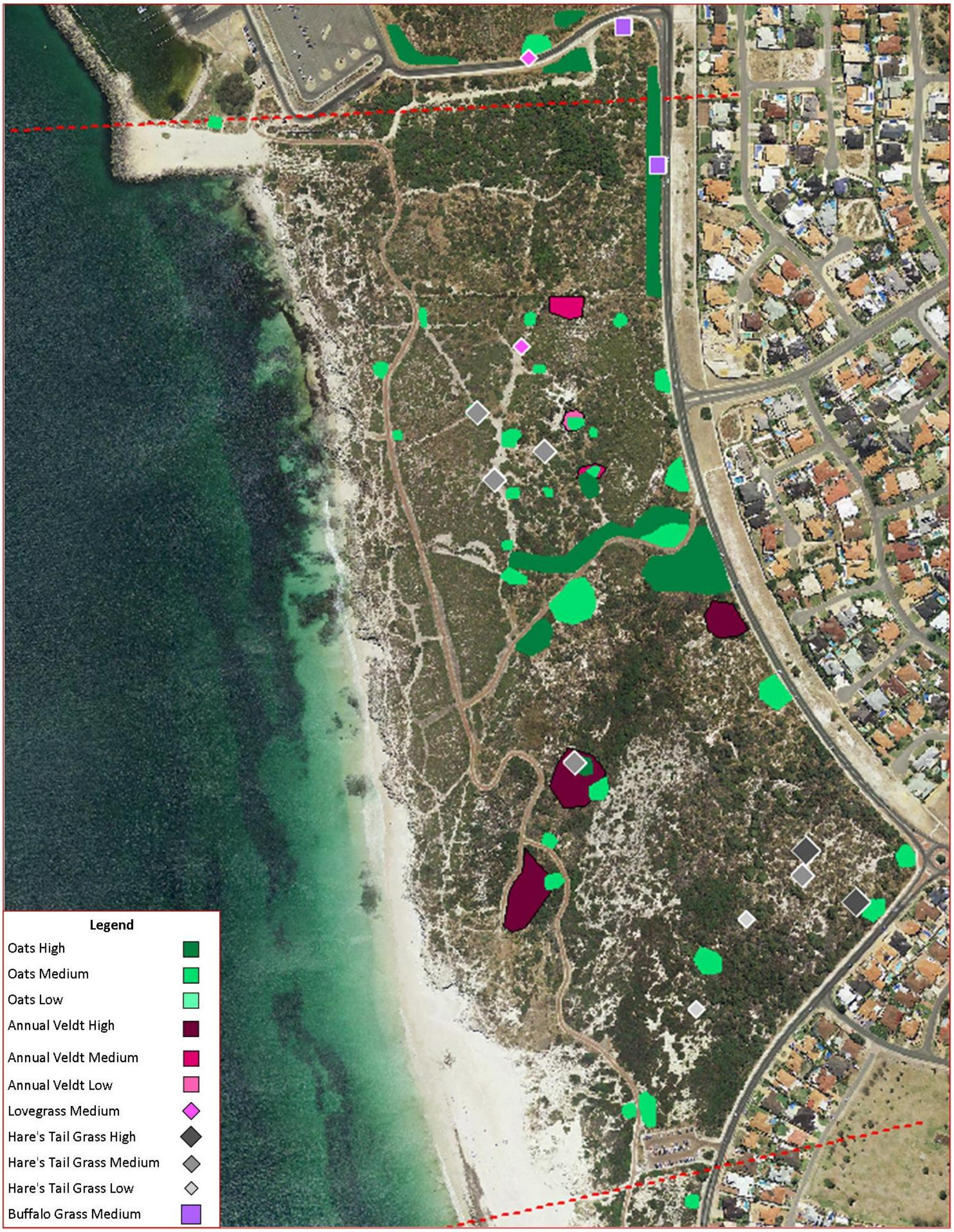


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector Weeds —
Bromus diandrus (Brome), *Cynodon dactylon* (Couch).

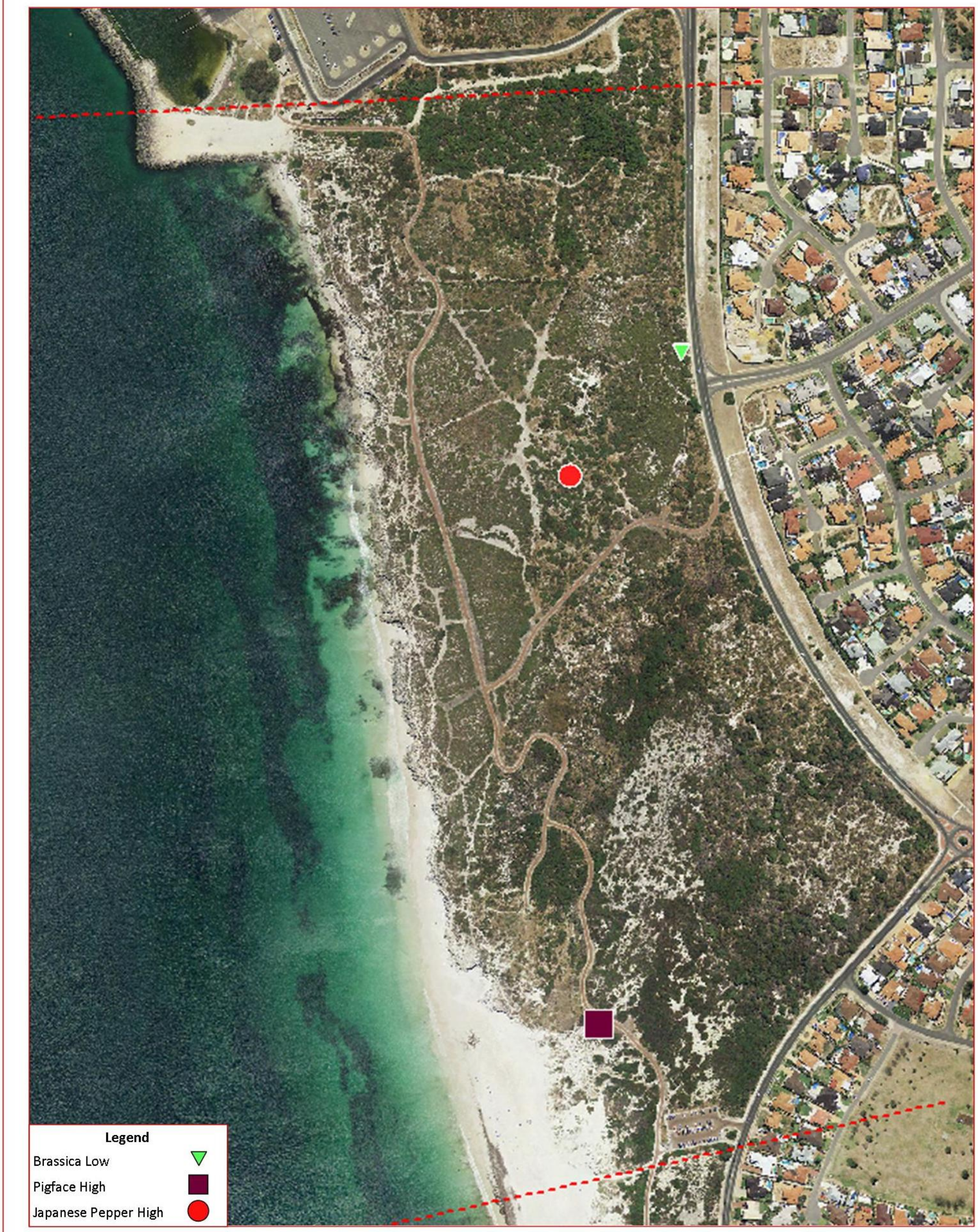
N
0 250
Metres



Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector Weeds — *Avena fatua* (Oats), *Ehrharta longifolia* (Annual Veldt), *Eragrostis curvula* (Lovegrass), *Lagurus ovatus* (Hare's Tail Grass), *Stenotaphrum secundatum* (Buffalo Grass).

N
0 250
Metres

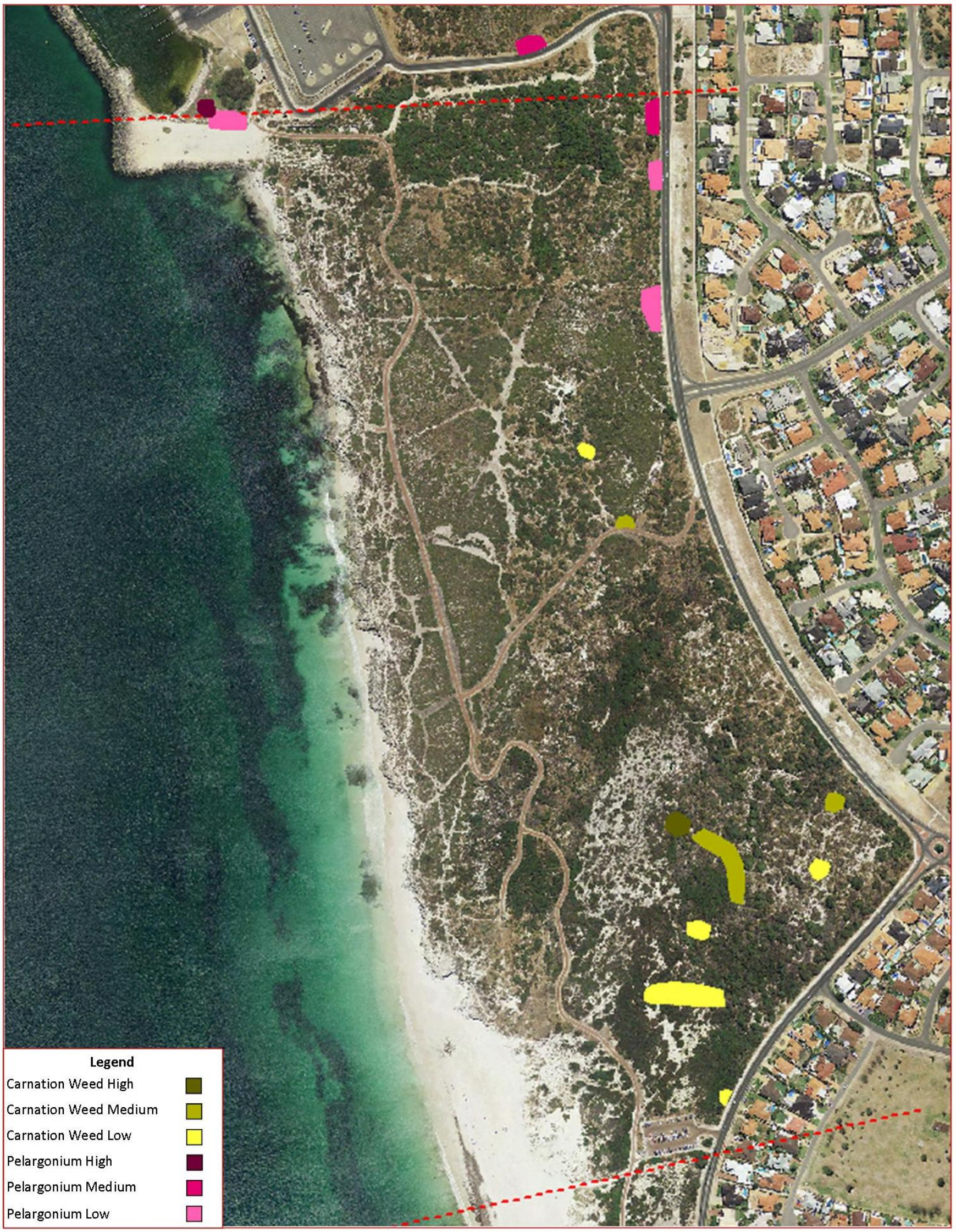


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector Weeds — *Brassica tournefortii* (Brassica), *Carpobrotus edulis* (Pigface), *Schinus terebinthifolia* (Japanese Pepper Tree).

N
0 250
Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector Weeds — *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N

0 250

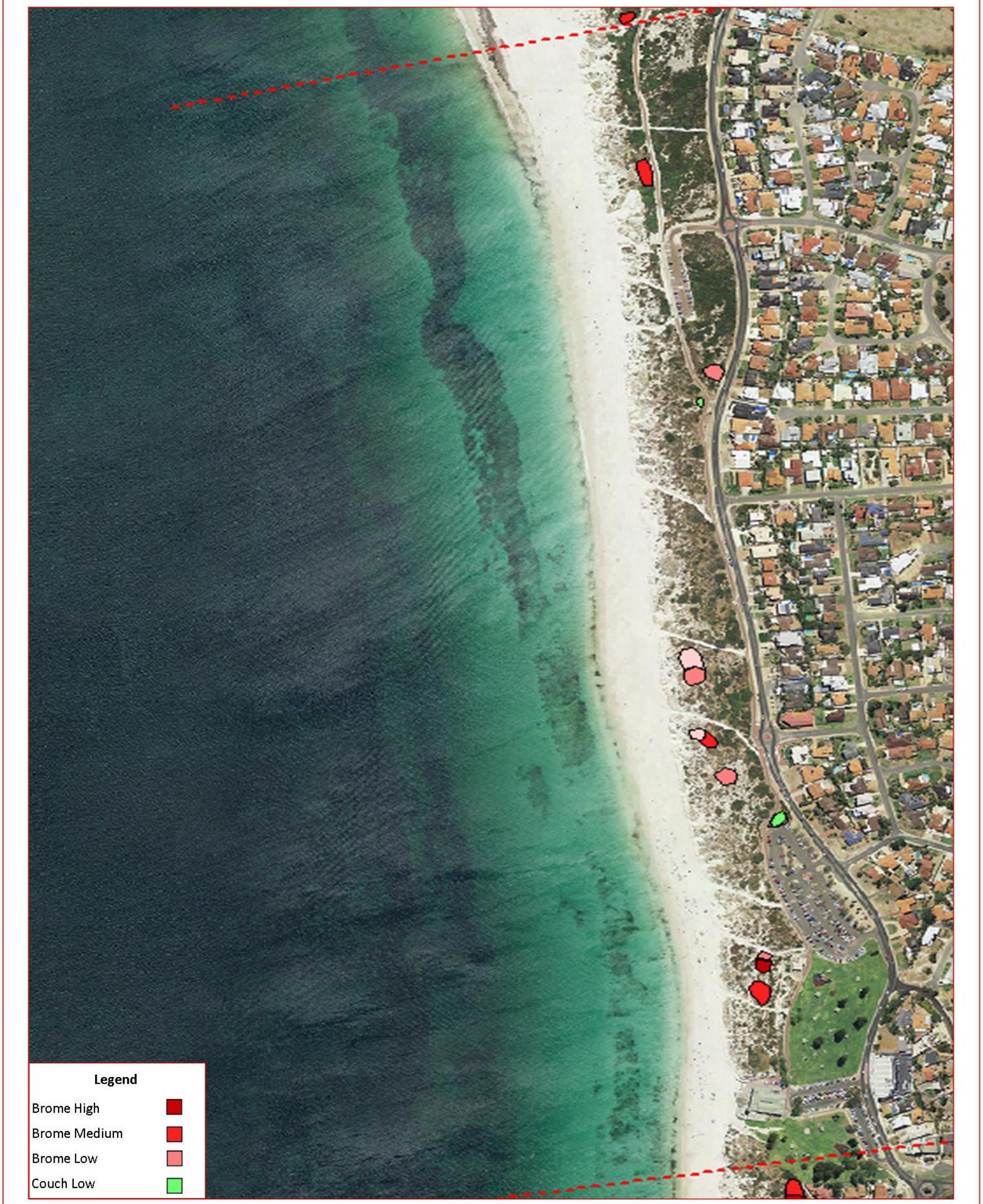
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

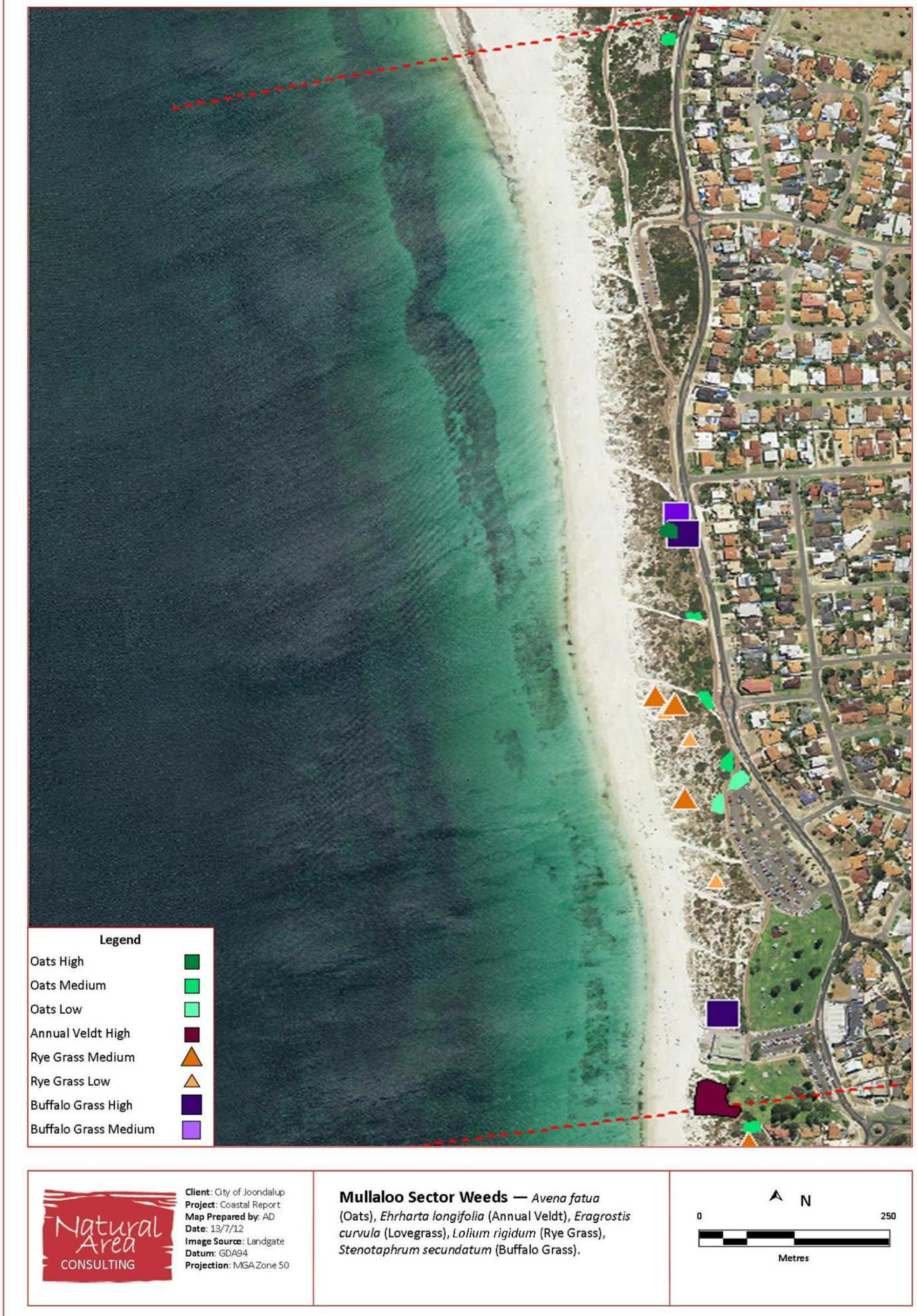
N
0 250
Metres

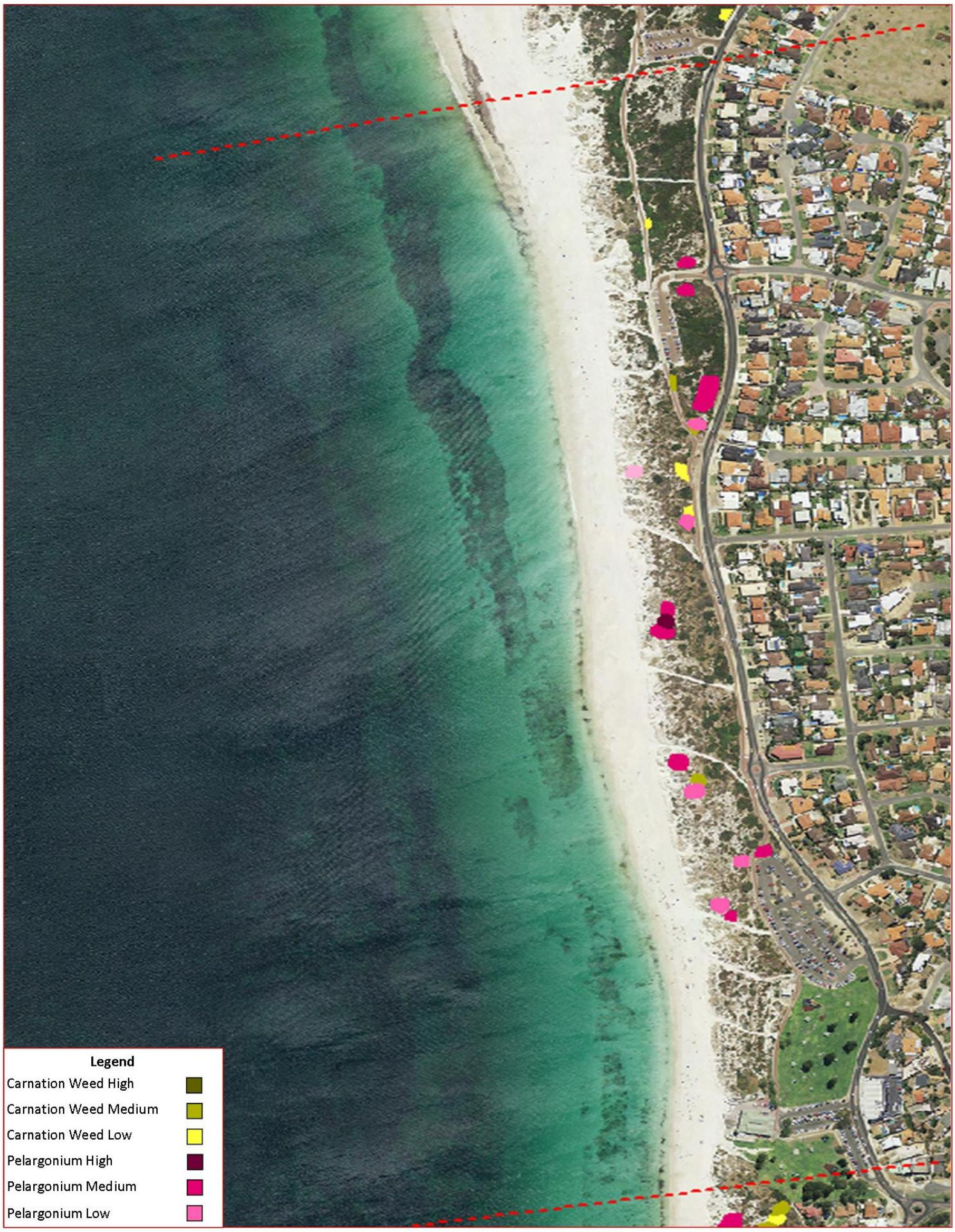


Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Mullaloo Sector Weeds — *Bromus diandrus* (Brome), *Cynodon dactylon* (Couch).

N
0 250
Metres


Legend
Oats High
Oats Medium
Oats Low
Annual Veldt High
Rye Grass Medium
Rye Grass Low
Buffalo Grass High
Buffalo Grass Medium
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50
Natural Area CONSULTING
Mullaloo Sector Weeds — Avena fatua (Oats), Ehrharta longifolia (Annual Veldt), Eragrostis curvula (Lovegrass), Lolium rigidum (Rye Grass), Stenotaphrum secundatum (Buffalo Grass).
N
0
250
Metres



Natural Area CONSULTING

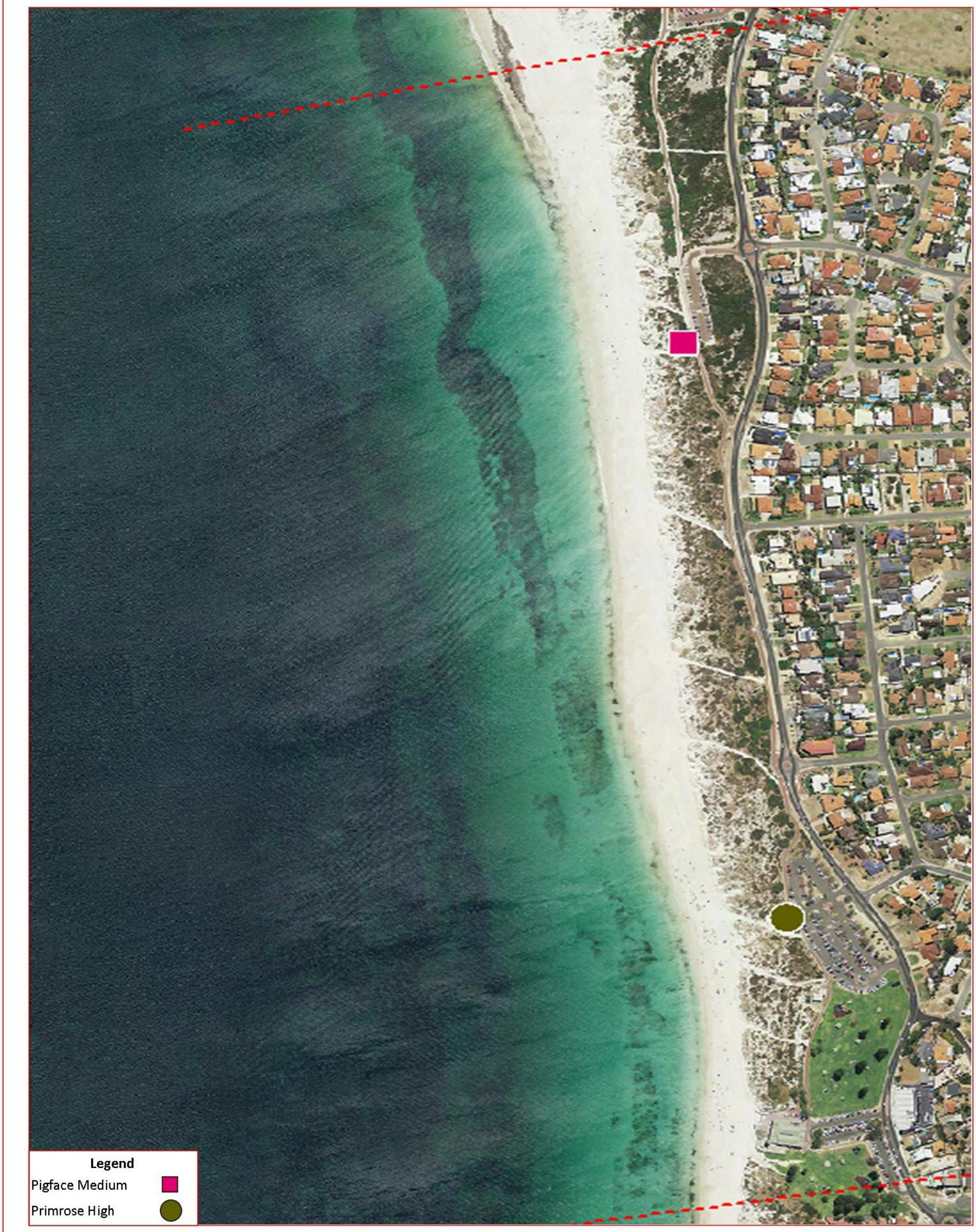
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Mullaloo Sector Weeds — *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N

0 250

Metres

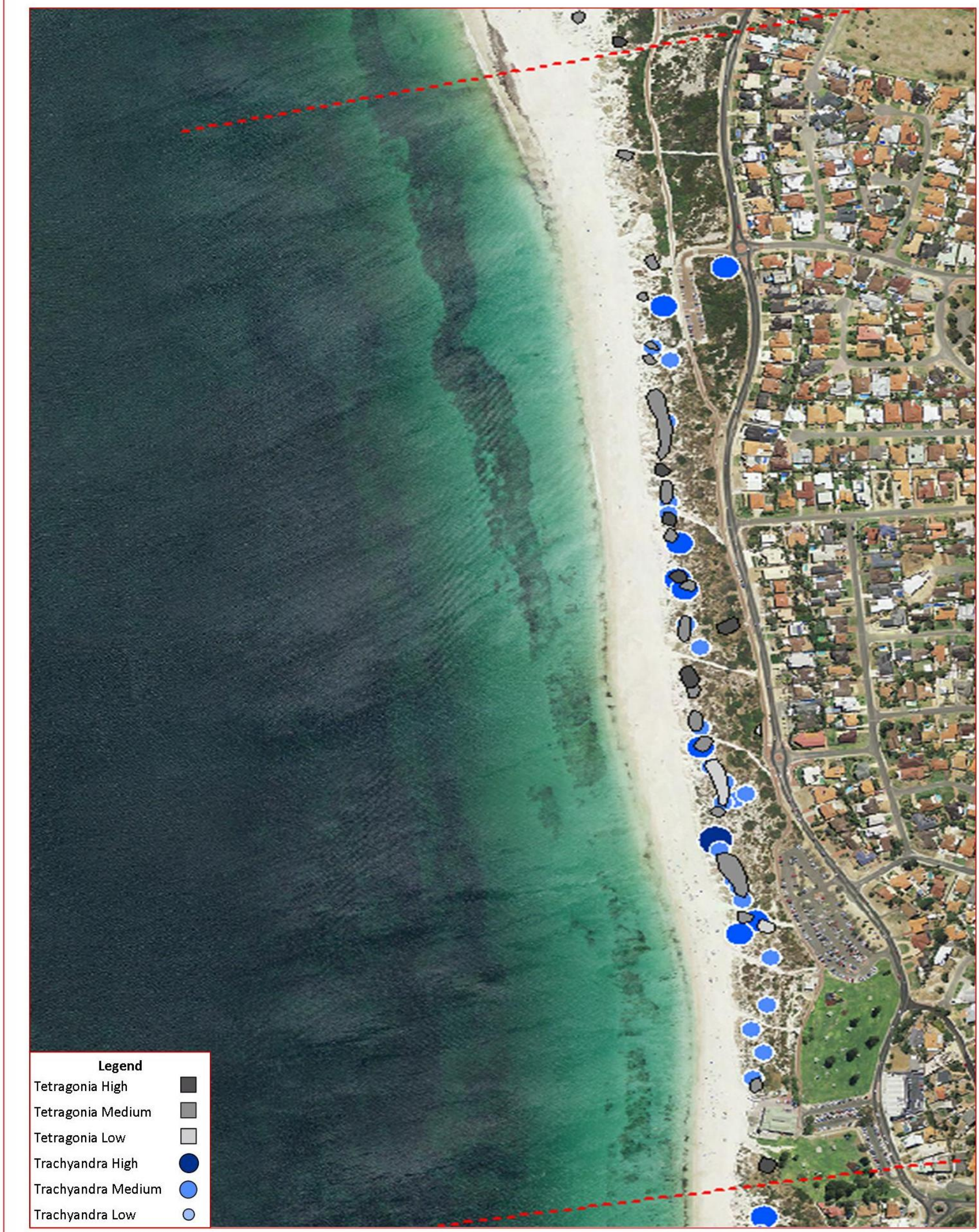


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Mullaloo Sector Weeds — *Carpobrotus edulis* (Pigface), *Oenothera drummondii* (Primrose).

N
0 250
Metres



Natural Area CONSULTING

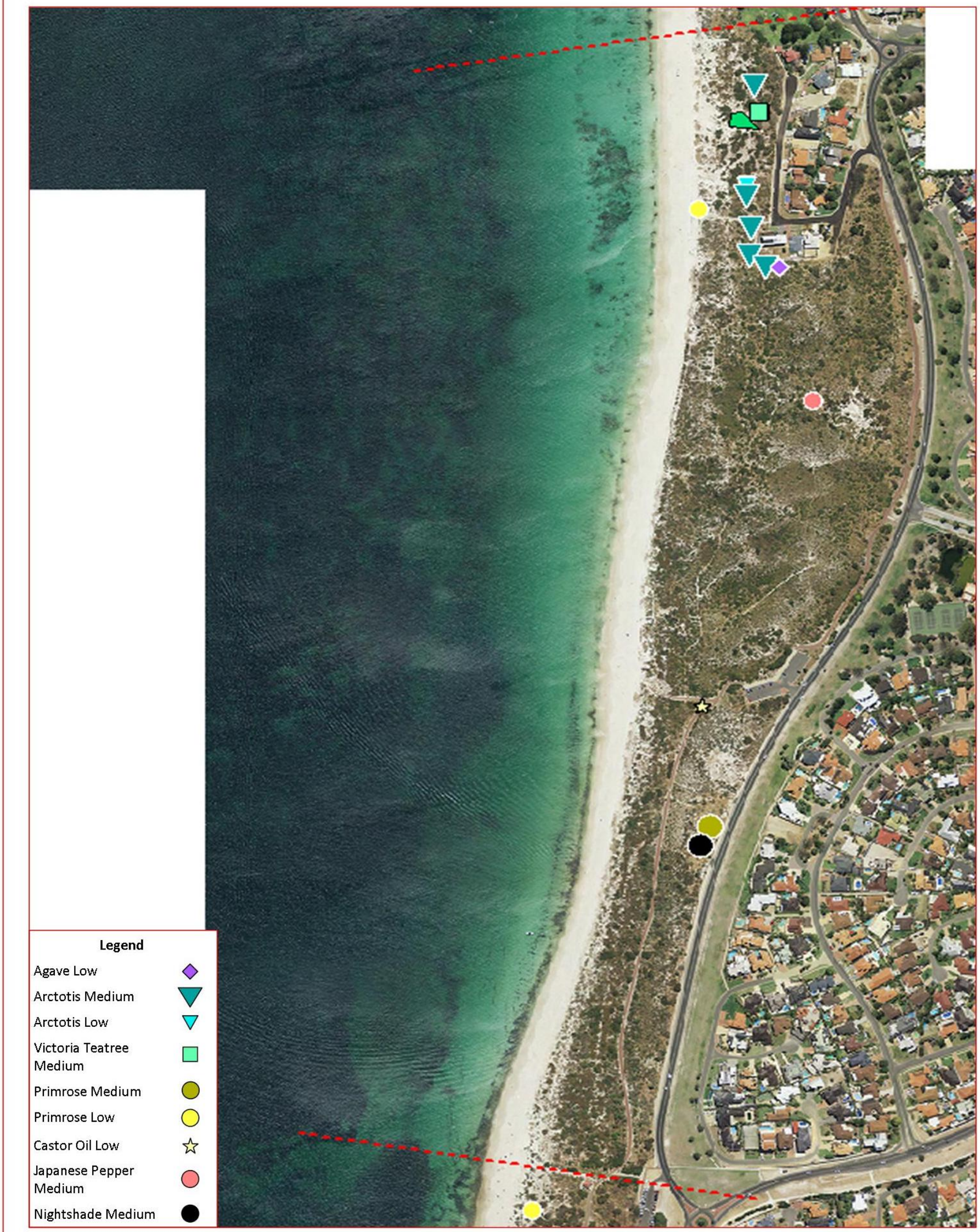
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Mullaloo Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

N

0 250

Metres



Natural Area CONSULTING

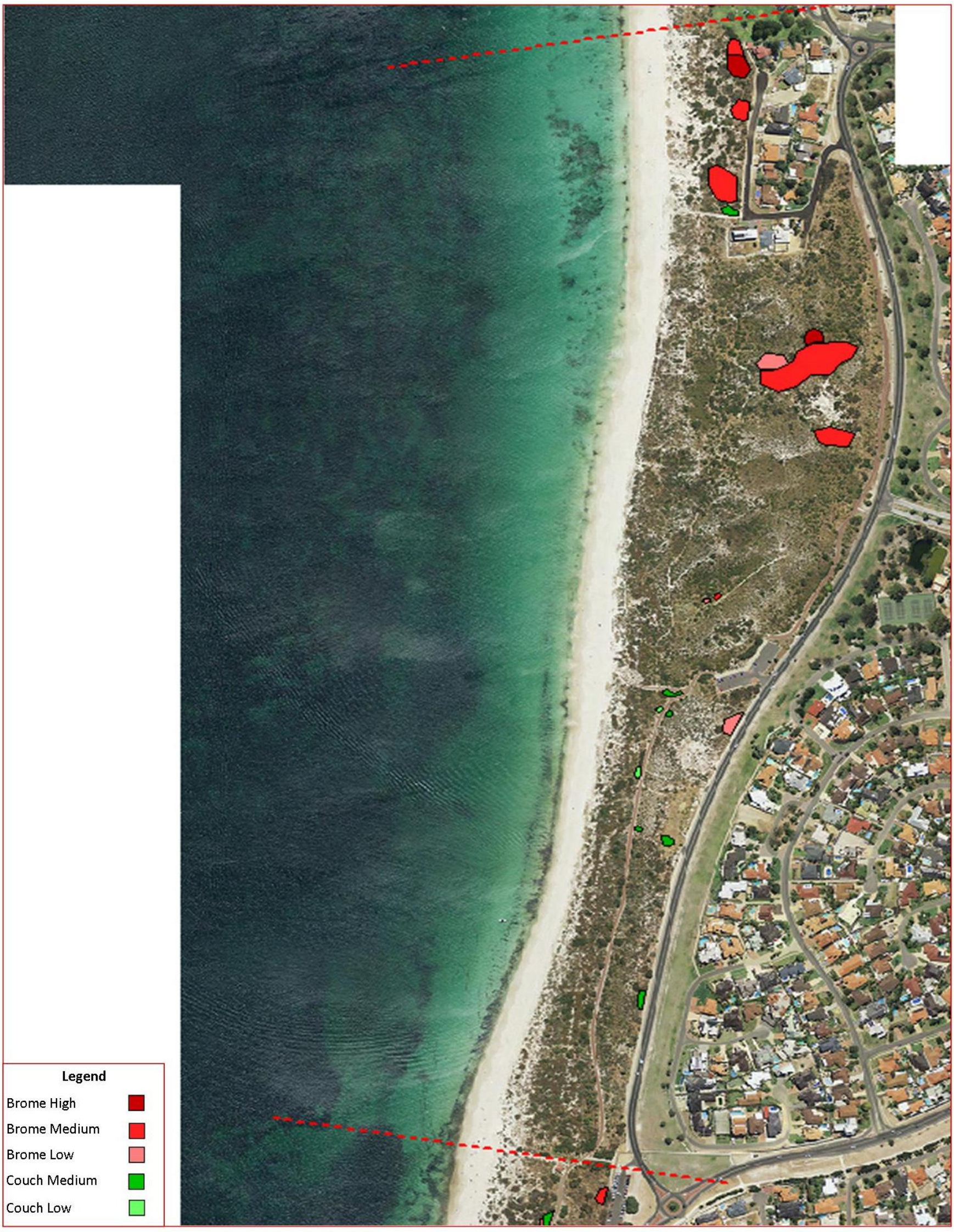
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector Weeds — *Agave americana* (Agave), *Arctotis stoechadifolia* (Arctotis), *Leptospermum laevigatum* (Victorian Teatree), *Oenothera drummondii* (Primrose), *Ricinus communis* (Castor Oil), *Schinus terebinthifolia* (Japanese Pepper), *Solanum nigrum* (Nightshade).

N

0 250

Metres

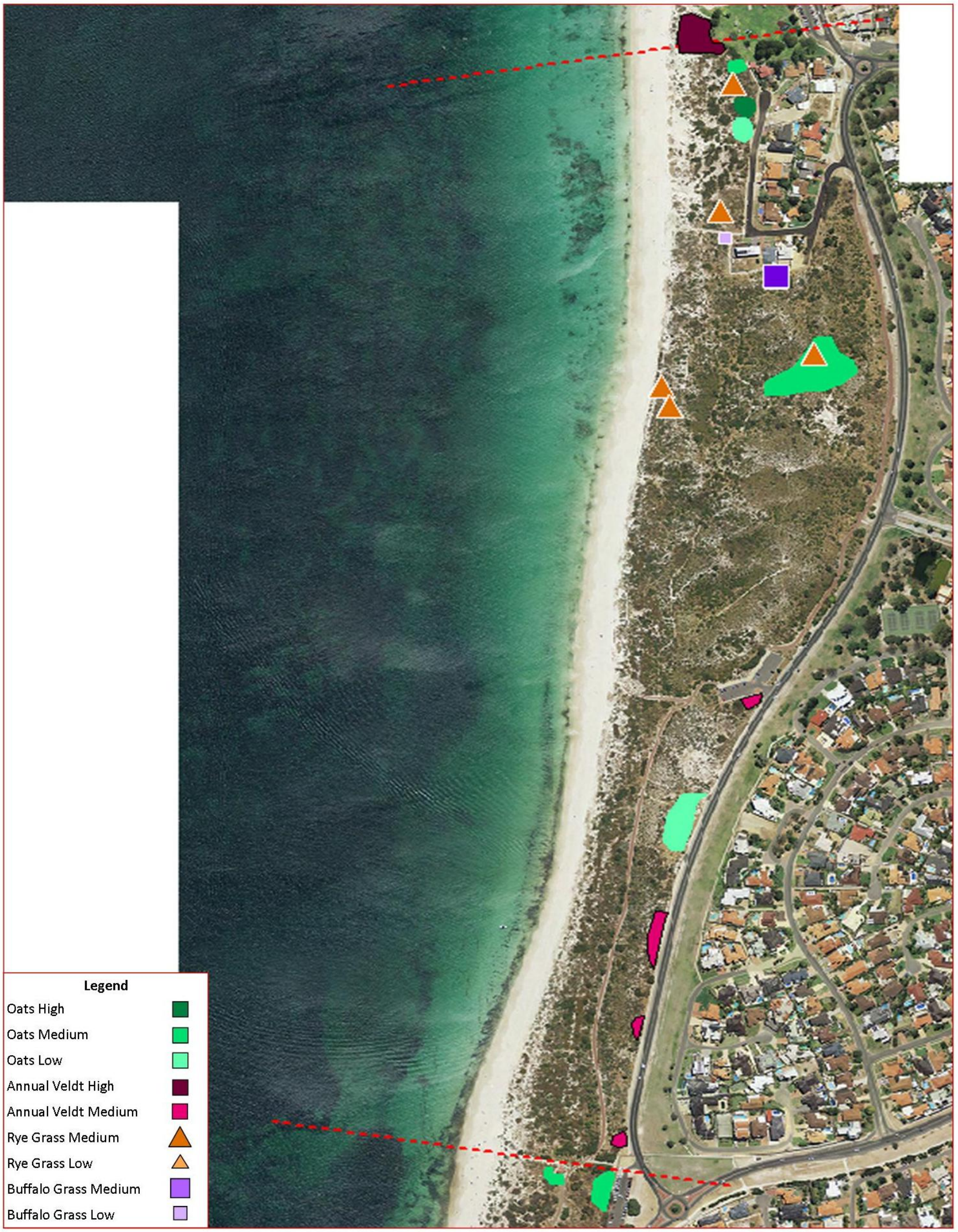


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector Weeds — *Bromus diandrus* (Brome), *Cynodon dactylon* (Couch).

N
0 250
Metres



Natural Area CONSULTING

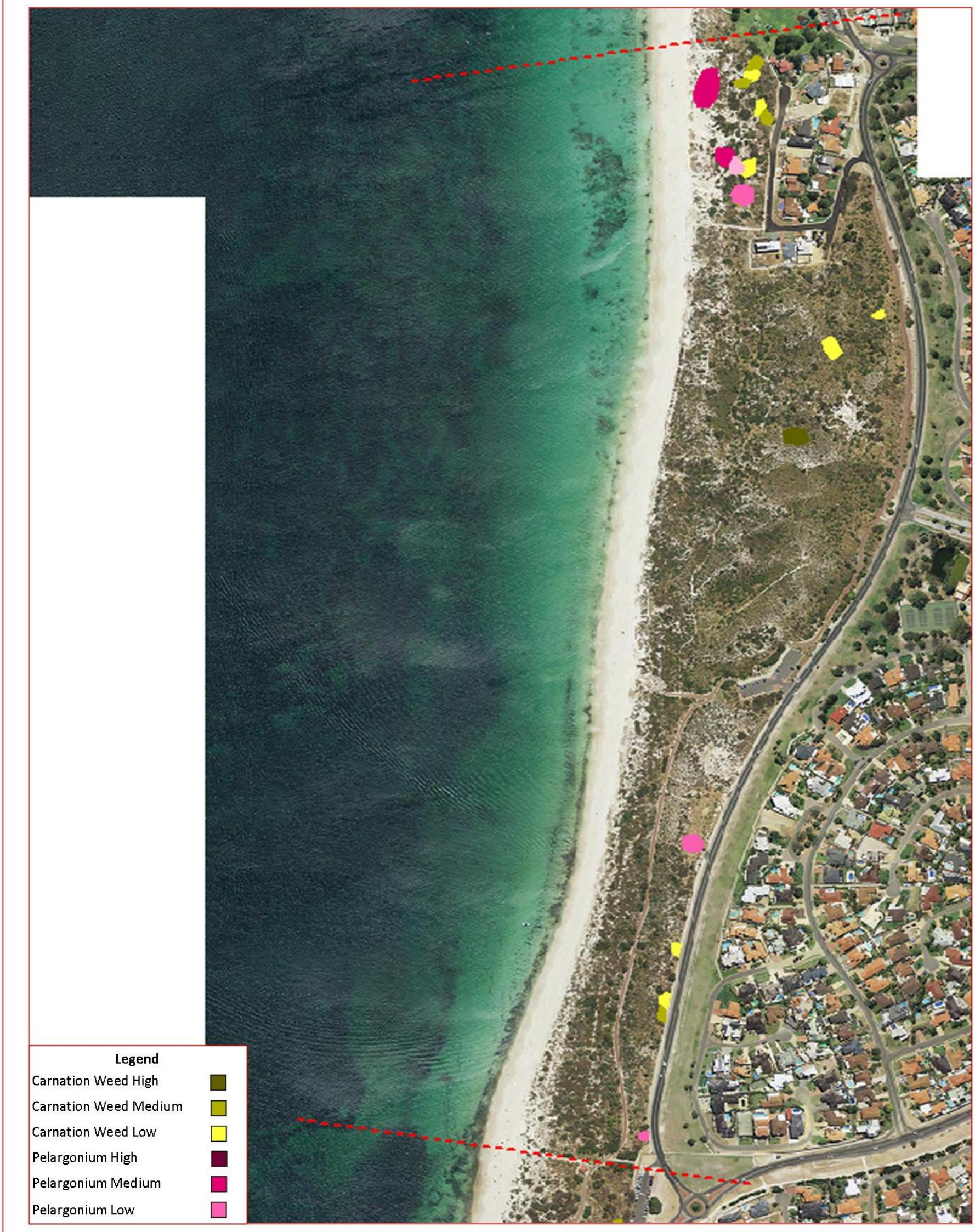
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector Weeds — *Avena fatua* (Oats), *Ehrharta longifolia* (Annual Veldt), *Lolium rigidum* (Rye Grass), *Stenotaphrum secundatum* (Buffalo Grass).

N

0 250

Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector Weeds— *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N
0 250
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

N

0 250

Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Pinnaroo Sector Weeds — *Bromus diandrus* (Brome), *Cynodon dactylon* (Couch).

N
0 250
Metres

Natural Area CONSULTING

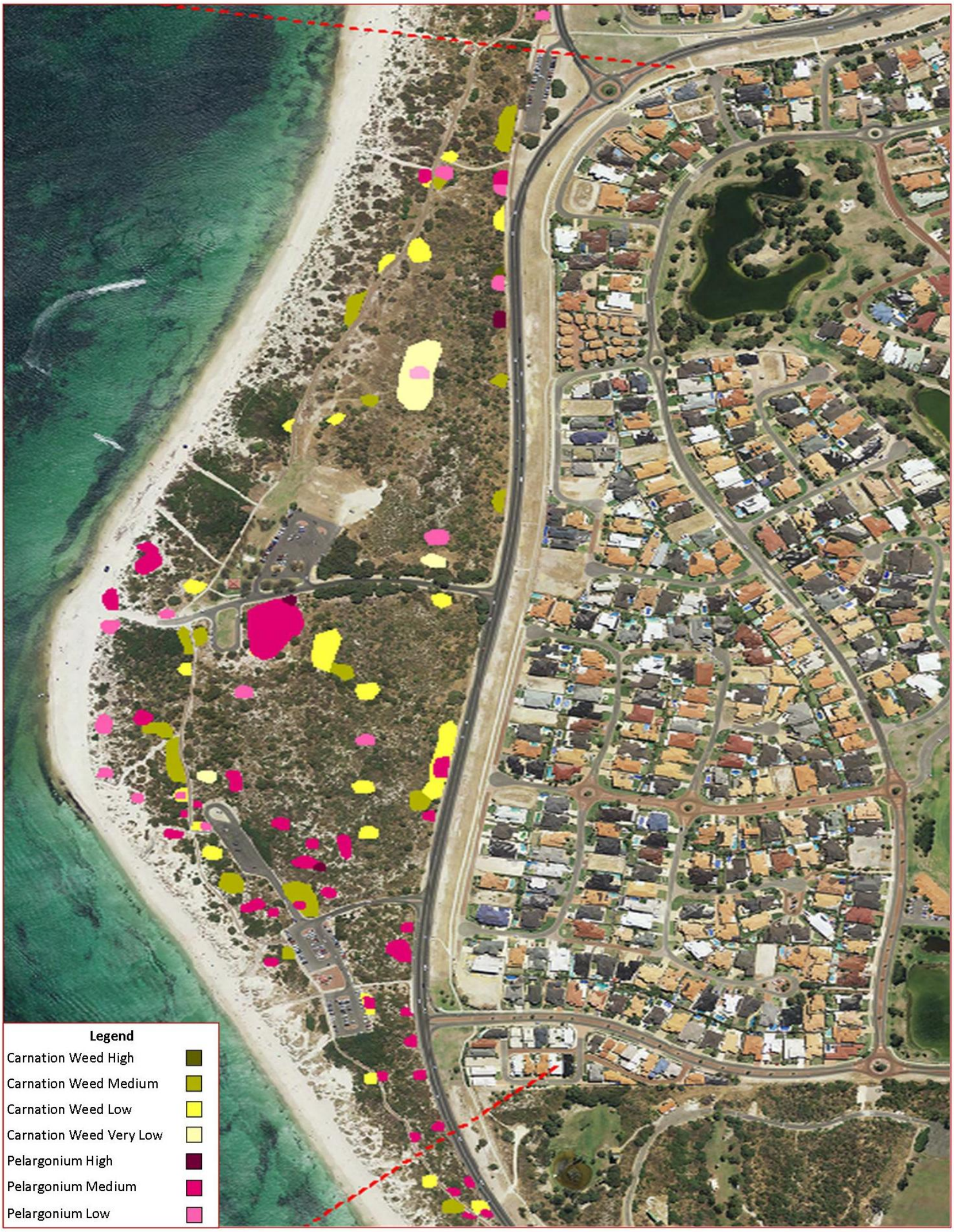
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Pinnaroo Sector Weeds — *Arctotis stoechadifolia* (Arctotis), *Brassica tournefortii* (Brassica), *Carpobrotus edulis* (Pigface), *Oenothera drummondii* (Primrose), *Ricinus communis* (Castor Oil), *Schinus terebinthifolia* (Japanese Pepper), *Solanum nigrum* (Nightshade).

N

0 250

Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Pinnaroo Sector Weeds — *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N
0 250
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Pinnaroo Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

N

0 250

Metres

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector Weeds — *Bromus diandrus* (Brome), *Cynodon dactylon* (Couch).

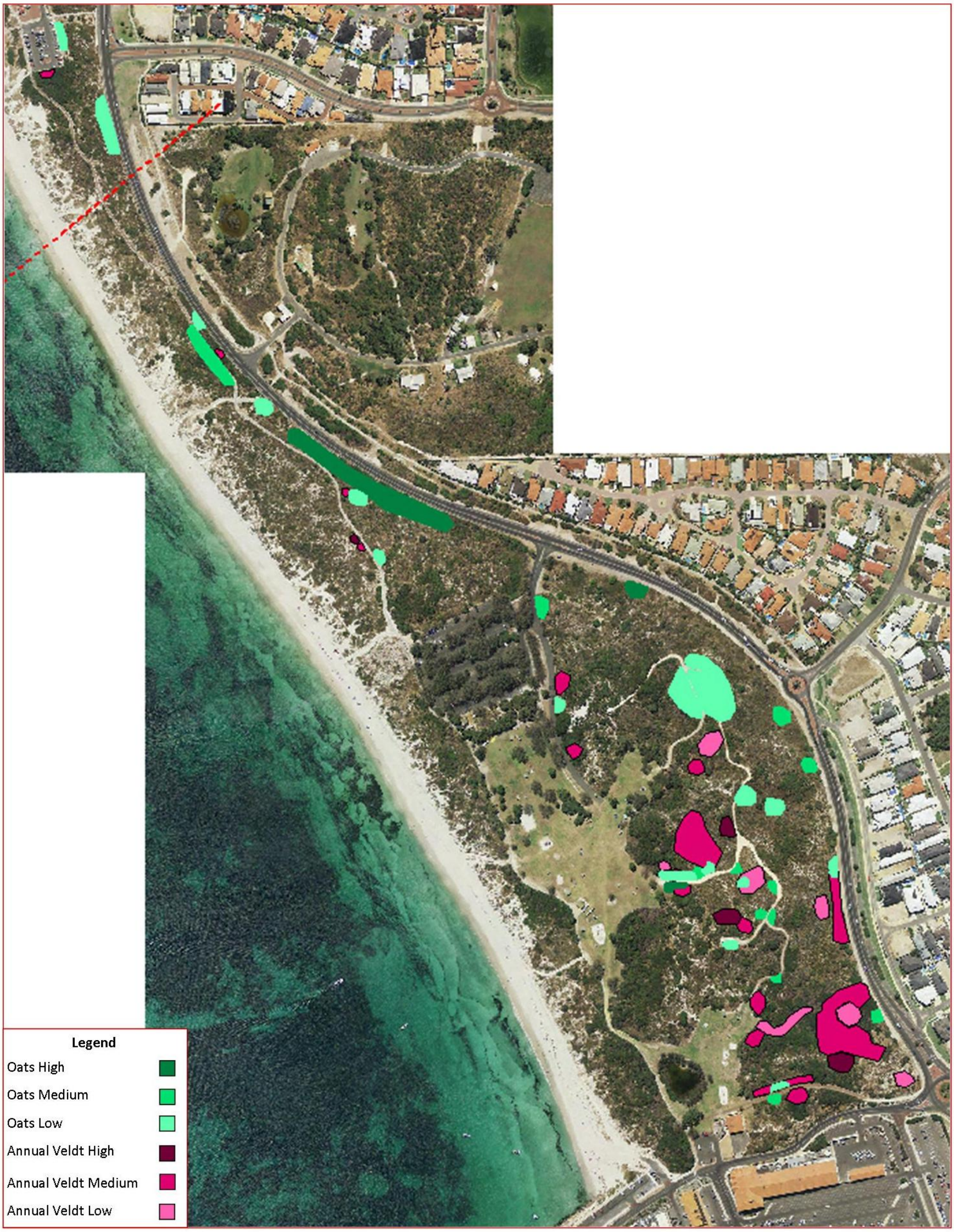
N
0 200
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector Weeds — *Agave americana* (Agave), *Brassica tournefortii* (Brassica), *Carpobrotus edulis* (Pigface), *Fumaria capreolata* (Fumaria), *Lactuca serriola* (Prickly Lettuce), *Leptospermum* laevigatum (Victorian Teatree).

N
0 200
Metres

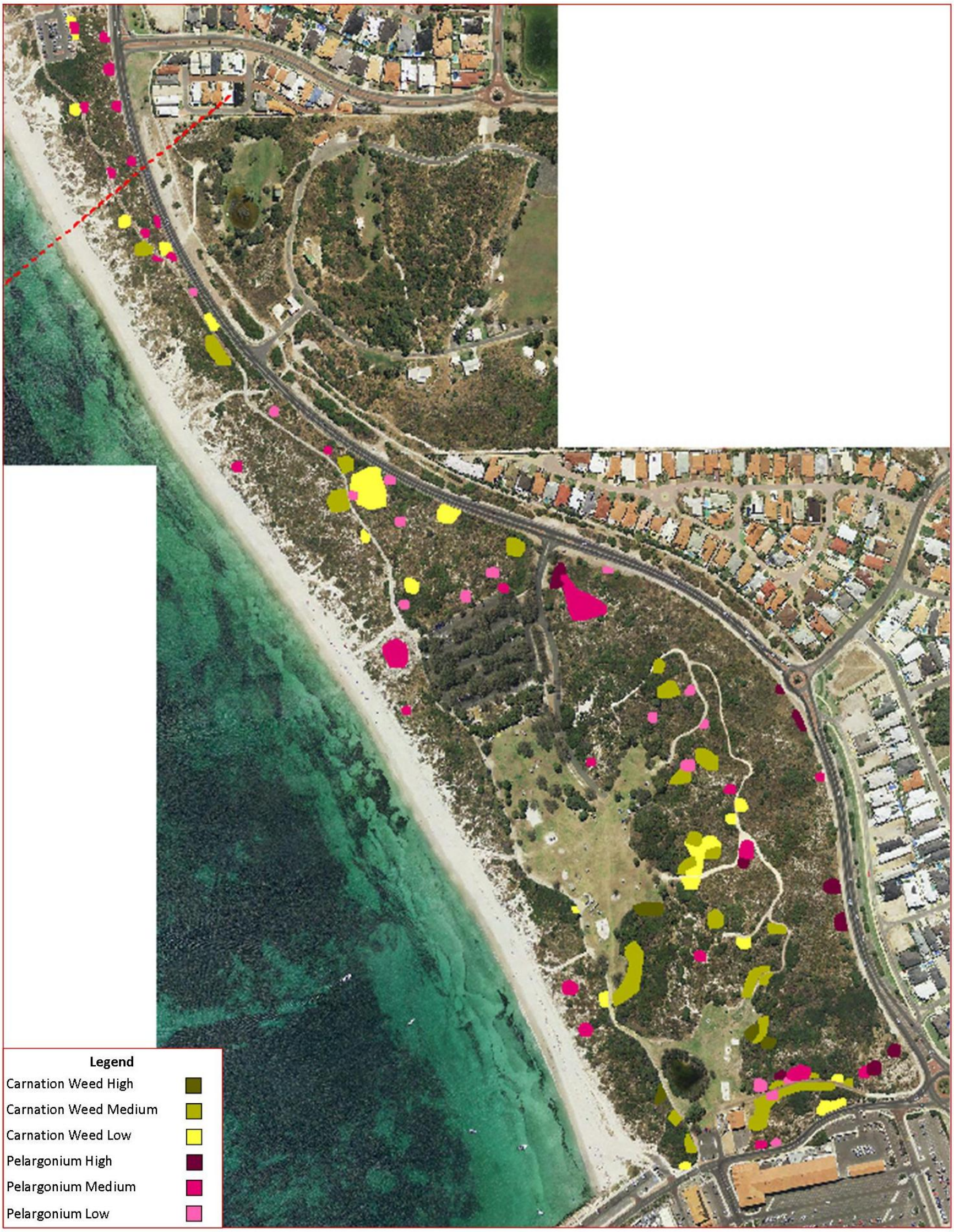


Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector Weeds — *Avena fatua* (Oats), *Ehrharta longifolia* (Annual Veldt).

N
0 200
Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector Weeds — *Euphorbia terracina* (Carnation Weed), *Pelargonium capitatum* (Pelargonium).

N
0 200
Metres

Natural Area CONSULTING

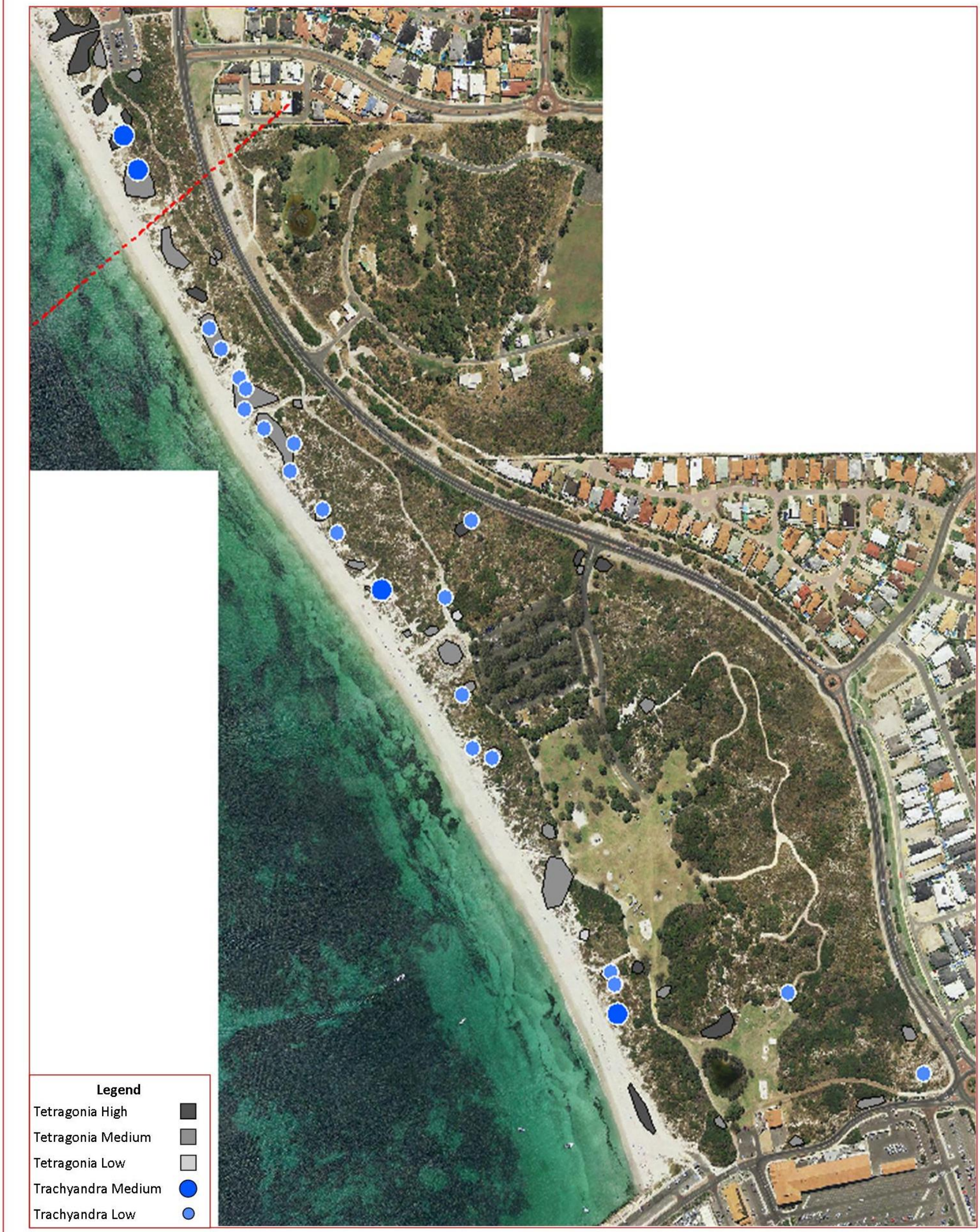
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector Weeds — *Lolium rigidum* (Rye Grass), *Eragrostis curvula* (Love Grass), *Pennisetum clandestinum* (Kikuyu), *Stenotaphrum secundatum* (Buffalo Grass).

N

0 200

Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector Weeds — *Tetragonia decumbens* (Tetragonia), *Trachyandra divaricata* (Trachyandra).

N
0 200
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Sorrento Sector Weeds — *Bromus diandrus* (Brome), *Cynodon dactylon* (Couch), *Gazania linearis* (Gazania), *Stenotaphrum secundatum* (Buffalo Grass), *Trachyandra divaricata* (Trachyandra).

N

0 200

Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 13/7/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Marmion Sector Weeds — *Bromus diandrus* (Brome), *Cynodon dactylon* (Couch), *Ehrharta longifolia* (Annual Veldt), *Stenotaphrum secundatum* (Buffalo Grass).

N

0 200

Metres

Appendix 6: Fauna Observations

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Iluka Sector –
Fauna Activity

N
0 400
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Ocean Reef Sector – Fauna Activity

N

0 250

Metres

Natural Area CONSULTING

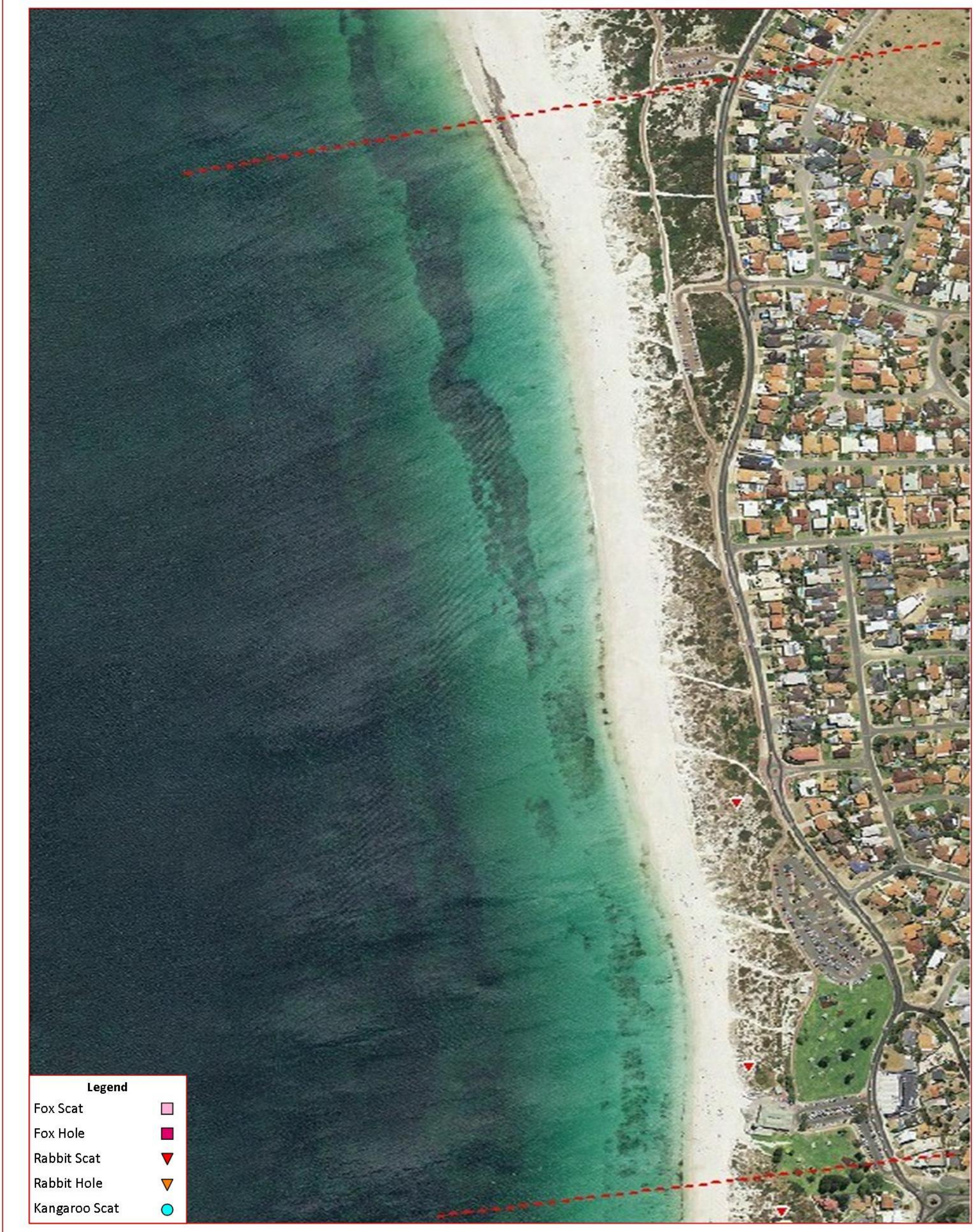
Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

North Mullaloo Sector – Fauna Activity

N

0 250

Metres



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Mullaloo Sector – Fauna Activity

N
0 250
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector – Fauna Activity

N
0 250
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Pinnaroo Sector – Fauna Activity

N

0 250

Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Hillarys Sector – Fauna Activity

N
0 200
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Sorrento Sector – Fauna Activity

N

0 200

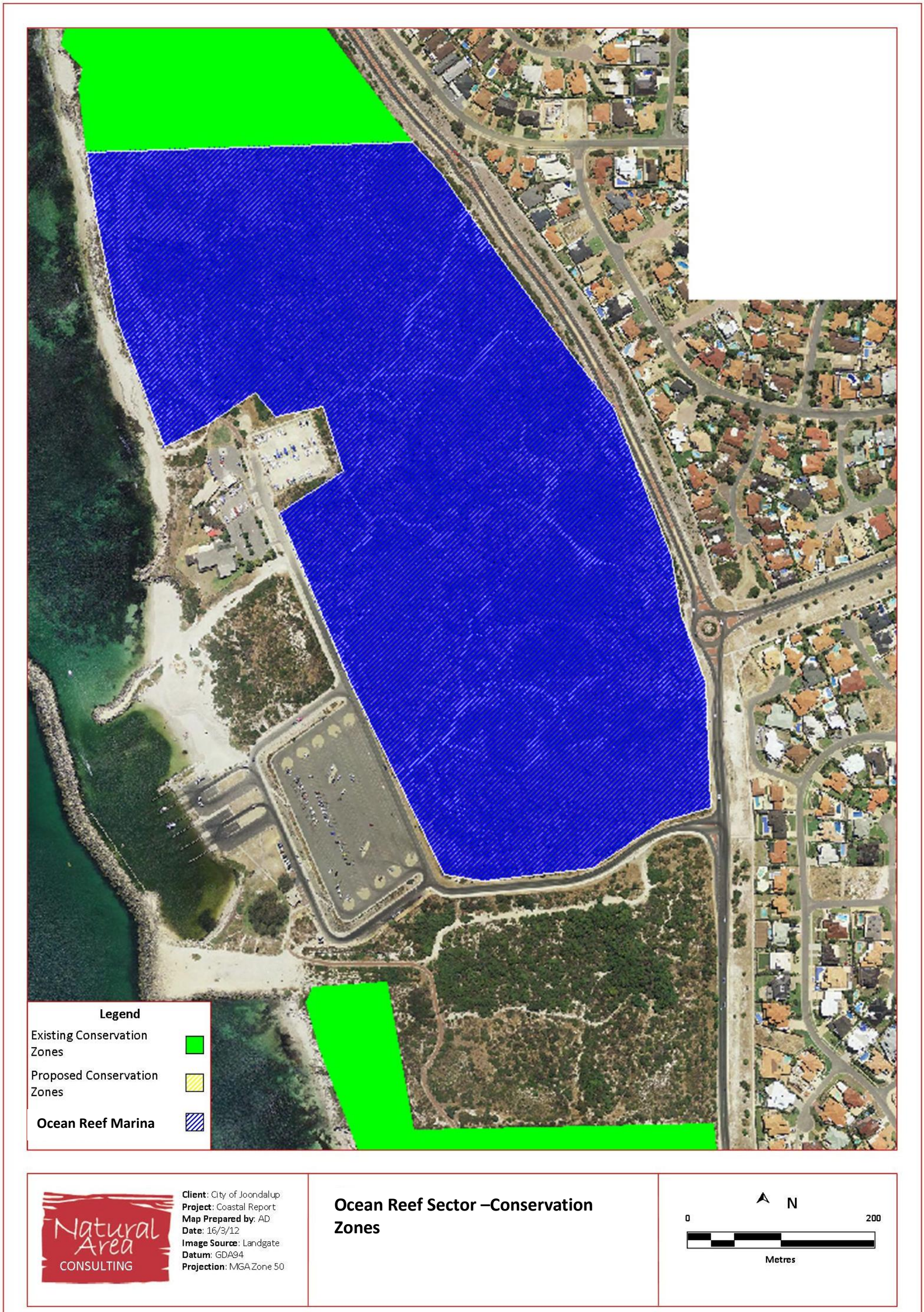
Metres

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Marmion Sector –
Fauna Activity

N
0 200
Metres

Appendix 7: Recommended Conservation Zones



Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

Whitfords Sector –Conservation Zones

N
0 200
Metres

Natural Area CONSULTING

Client: City of Joondalup
Project: Coastal Report
Map Prepared by: AD
Date: 16/3/12
Image Source: Landgate
Datum: GDA94
Projection: MGA Zone 50

City of Joondalup Conservation Zones—Marmion Cliffs

N

0 100

Metres