2016

CITY OF ROCKINGHAM

Foreshore Management Plan

city of Rockingham

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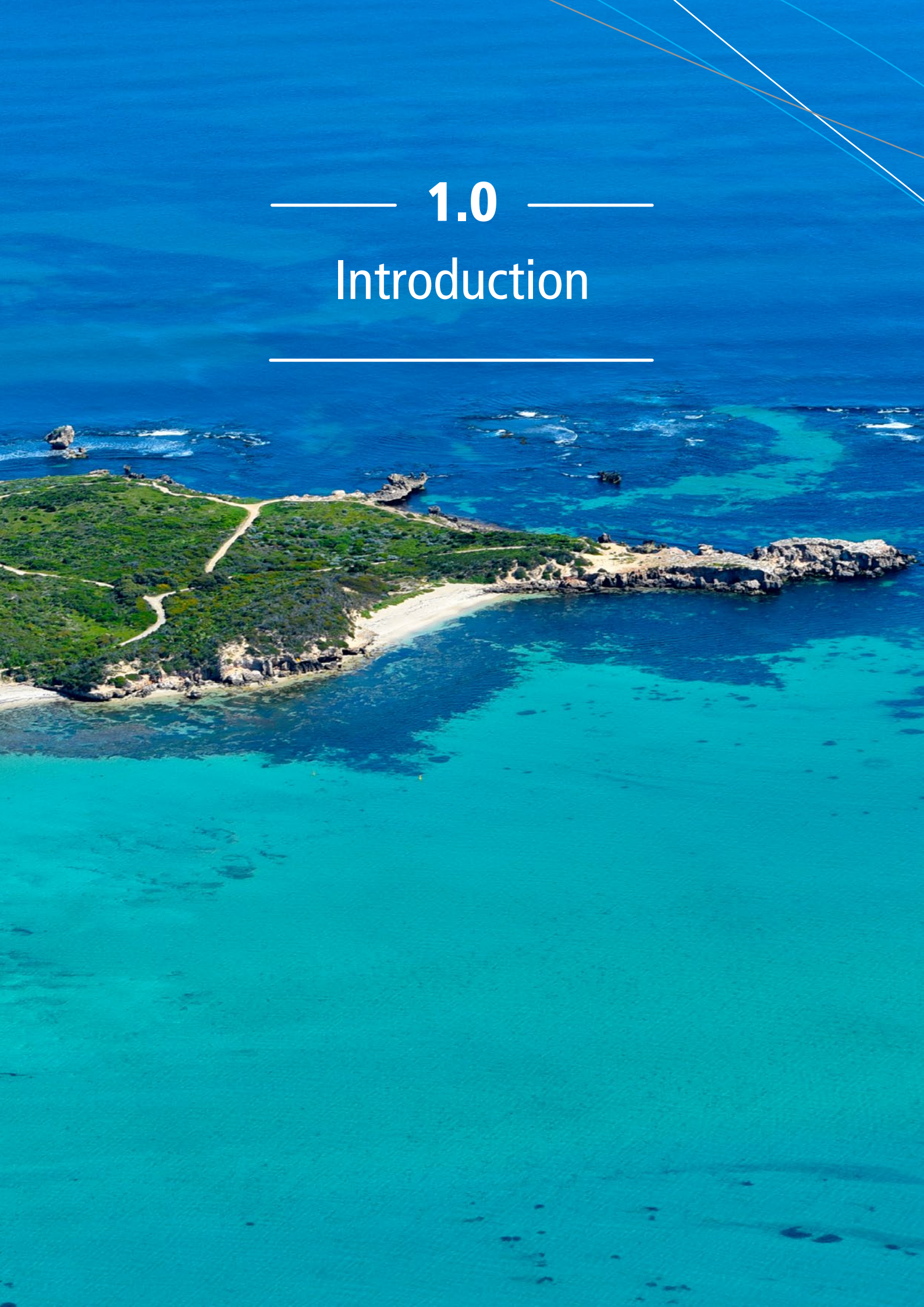


1.0
Introduction

1.0 Introduction

1.1 Executive summary

The City of Rockingham has approximately 37km of coastline, encompassing a range of local and regional foreshore reserves which deliver a variety of recreation, conservation and commercial activities. These reserves are a vital component of the City's natural capital, underpinning its identity, prosperity and lifestyle.

The Foreshore Management Plan (the Plan) outlines the City's continued commitment to the preservation of these environments, providing a framework for the ongoing use and management of the City's foreshore reserves.

The Plan addresses both environmental and land use factors, with due consideration for physical coastal processes, proposed development, recreational infrastructure and the conservation of diverse coastal habitats through the removal of threatening processes, which act as a regional corridor for the movement of flora and fauna.

In addition to these factors, the Plan acknowledges the challenges associated with managing a dynamic coastal environment, together with the need to balance environmental, social and economic values to ensure the long term sustainable use and management of the City's unique coastline.

1.2 Vision

This Plan endeavours to deliver the following aspiration contained in the City's Strategic Community Plan 2015-2025:

Aspiration C: Sustainable Environment

Coastal and Bushland Reserves that are well used and sustainably managed preserving them for future generations to enjoy

1.3 Purpose

The purpose of this Plan is to provide key directions for the ongoing use and management of the City's foreshore reserves over the next five years.

1.4 Overarching objectives

This Plan is to be driven by the following overarching objectives:

- Protect and enhance conservation values through the removal of threatening processes
- Encourage a range of sustainable recreational experiences through suitably located infrastructure and services
- Ensure appropriate protection of coastal landforms against physical coastal processes
- Support well planned development that is compatible with the surrounding environment and sufficient to cater for an increasing population
- Ensure equity and safety of all reserve users

1.5 Legislative and policy framework

Effective management of the coastal environment is reliant on the successful integration of a suite of legislation, policies and guidelines which are regulated at a federal, state and local level. In this regard, the following were given particular consideration during the development of this Plan:

- State Planning Policy 2.6 State Coastal Planning Policy Guidelines (2013)
- Draft Perth Coastal Planning Strategy December (2008)
- Shoalwater Islands Marine Park Management Plan (2007)
- Rockingham Lakes Regional Park Management Plan (2010)
- State Environmental (Cockburn Sound) Policy (2005)
- The Coastal Planning and Management Manual (2003)
- Peron Naturaliste Partnership Project

1.6 Study area

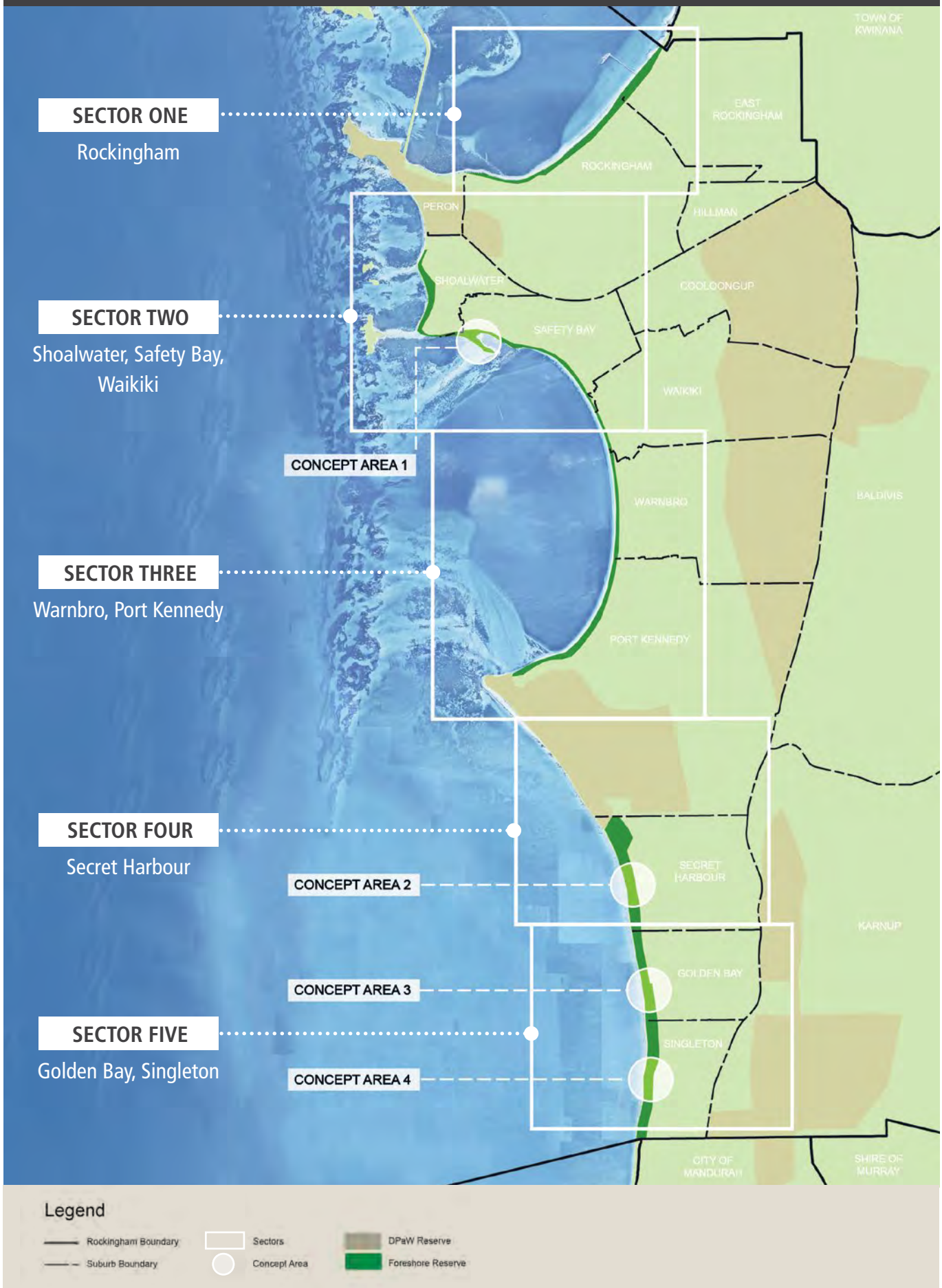
This Plan encompasses approximately 37 kilometres of coastline, including all beaches and foreshore reserves in the City of Rockingham municipality. The City's Foreshore Strategy 2012 originally divided this study area into 11 management sectors, which were delineated based on environmental features and planning objectives.

To simplify the allocation of management resources, this Plan has divided the study area into just five management sectors based on their respective conservation, recreation and land-use planning values.

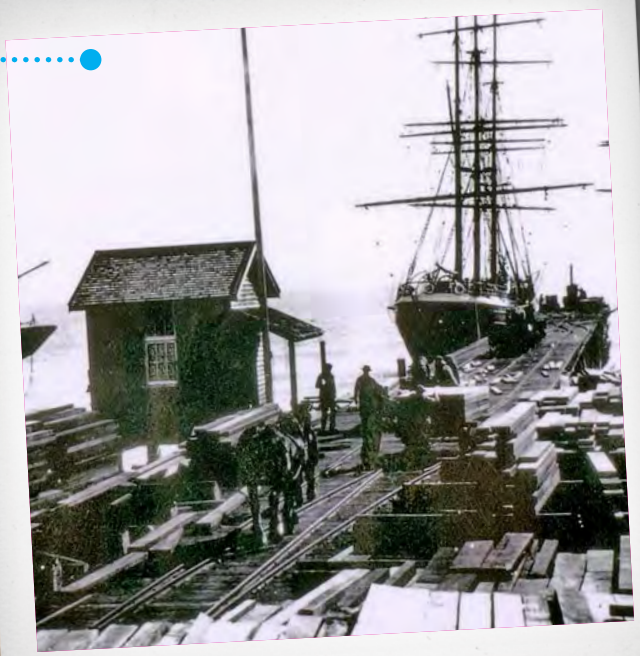
Sector One	Rockingham
Sector Two	Shoalwater, Safety Bay, Waikiki
Sector Three	Warnbro, Port Kennedy
Sector Four	Secret Harbour
Sector Five	Golden Bay, Singleton

The location of these management sectors can be seen in Figure 1. Figure 1 also highlights a number of key concept areas which are presented in more detail in the Sections 6, 8 and 9 of this Plan.

FIGURE 1 - Foreshore management sectors and concept areas



Rockingham Jetty



The jetty and associated railway were constructed in the 1870s, where Railway Terrace is today, to export timber harvested from the region.

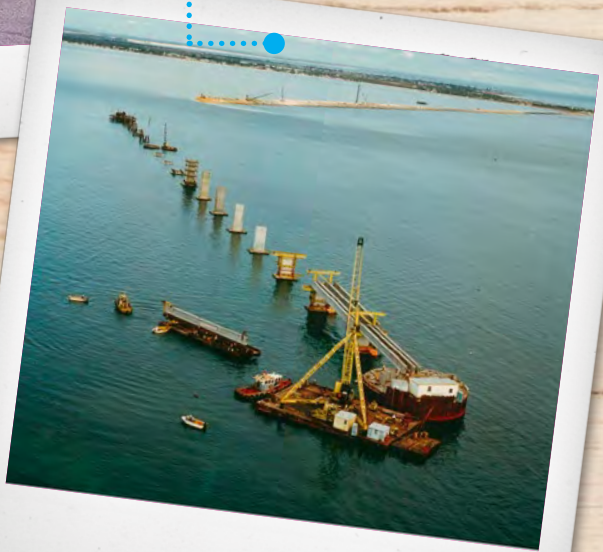
Late 1800s

Late 1800s

1960s, during Miss West Coast competition

Mersey Point Store

Mangles Bay Garden Island Causeway



Rockingham Railway Terrace

Penguin Island
Jetty and Ferry

Palm Beach
Store

Palm Beach
Jetty

Shoalwater
View of Penuin Island

Safety Bay
Jetty and boat ramp

Images courtesy of Rockingham Campus Community Library, Rockingham Historical Society and Museum, Lost Rockingham Facebook, Peter Wachmer and Matt Gill

1.8 Public consultation

To inform the development of this Plan, a community survey was undertaken with the aim of identifying key values and usage of the City's foreshore reserves.

A link to the survey was available for the public to access via the City's Facebook page and website. The survey was also mailed out to a random selection of homes, with a reasonably even distribution across suburbs. Both methods of surveying were utilised for the consultation to gauge an accurate cross section of the City's demographic, not only those who were online.

The results were centred on aspects such as demographics, beach visitation levels, preferred methods of transport, the average amount of time per visit, favoured activities and recommendations for improvement, which together highlight the varying character of beaches along the City's coastline and provide direction for the ongoing use and management of these reserves.

Primary areas of coastal attraction together with relative visitation levels at the City's beaches can be seen in Figure 2.

FIGURE 2 - Areas of coastal attraction and visitation

Legend

- Rockingham Boundary
- Suburb Boundary
- Key Area of Coastal Attraction
- Railway Line
- Major Road
- Key Access Point
- DPaW Reserve
- Foreshore Reserve
- Higher Visitation Rates
- Lower Visitation Rates

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2.0
Biophysical features

2.0 Biophysical features

2.1 Climate

The south west of Western Australia has a Mediterranean climate with hot, dry summers and cool, wet winters. Mean daily maximum temperatures vary from 30˚C in summer and 18˚C in winter. The mean annual rainfall is approximately 730mm, with most falling from May through to October.

2.2 Geology and landform

The Interim Biogeographical Regionalisation for Australia (IBRA) Version 7 recognises 89 geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. The City's foreshore reserves are situated on the Swan Coastal Plain bioregion, which is a long coastal strip that extends from Dunsborough in the south to Gingin in the north.

The area is dominated by the Quindalup dune system, which is a relatively recent landform characterised by a series of low sand dunes made up of marine sands and Aeolian (wind-blown) soils. The Quindalup dunes are underlain by the Safety Bay sand formation which comprises calcareous soils derived from Tamala limestone (Semeniuk 1989).

For the majority of the Swan Coastal Plain, the Quindalup dune system occurs as a thin stretch adjacent to the ocean; however within the City, the dunes form a wide plain known as the Rockingham – Becher Plain (Semeniuk 1989). This plain consists of a series of multiple, parallel, linear sand-ridges that are stranded former beach ridges, providing an important example of Holocene sedimentation and stratigraphic evolution.

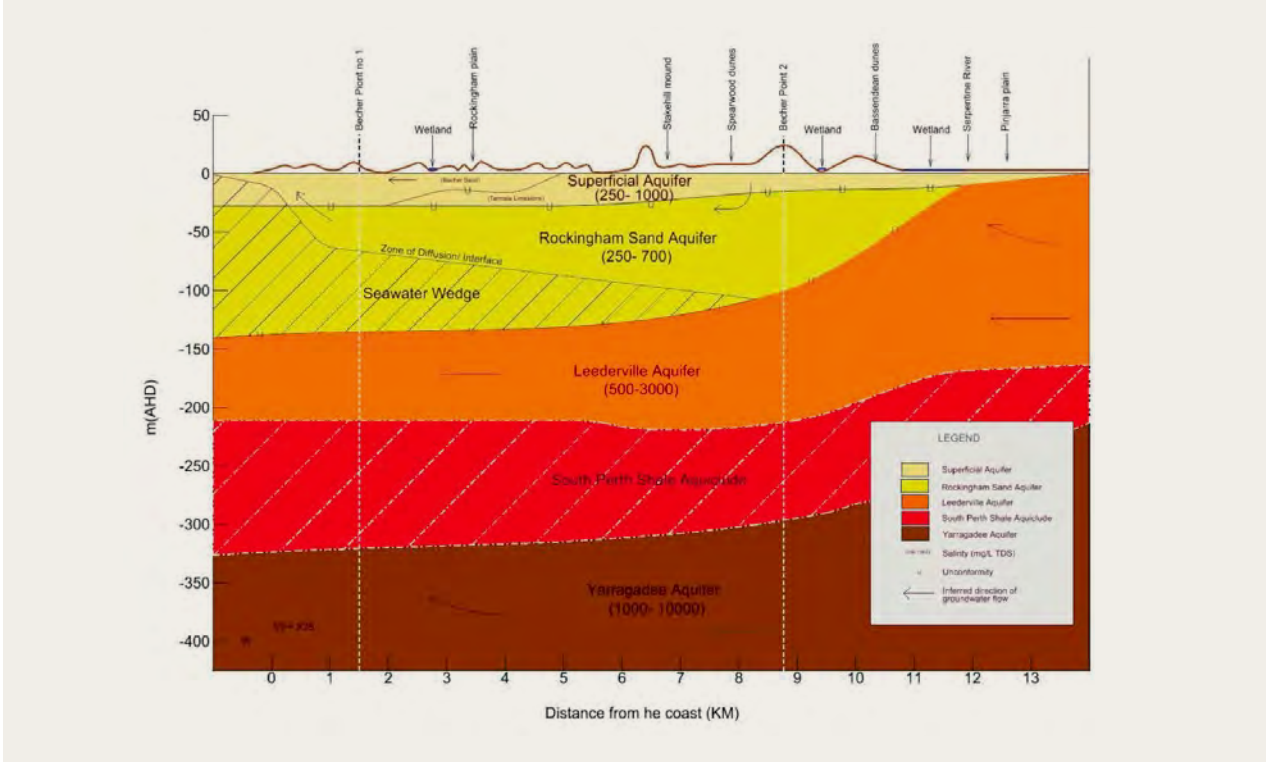
The foreshore has site elevations ranging from 0 m to 20 m AHD (Australian Height Datum) , with higher dunes generally found in the Point Peron area (up to 10 m), Waikiki (up to 20 m), Warnbro (up to 15 m), Port Kennedy (up to 15 m), and Secret Harbour (up to 10 m).

2.3 Hydrology

No natural drainage lines or wetland areas occur within the foreshore. However, the Becher Point Wetlands, an internationally significant Ramsar site, is located in close proximity. Groundwater in the region is comprised of unconfined, semi-confined and confined aquifers that exist as separate layered systems. The aquifers, in order of increasing depth, include:

- The Superficial and Rockingham Sand Aquifers (unconfined)
- The Leederville Aquifer (semi-confined to confined)
- The Yarragadee Aquifer (confined).

FIGURE 3 - Rockingham groundwater profile (Image courtesy of the Rockingham-Stakehill Groundwater Management Plan)



Coastal processes

2.4 Coastal processes

The geomorphological complexity of the City's coastline supports significant biological diversity and a range of recreational opportunities, encompassing highly unique stretches of coastline within the Cockburn Sound, Warnbro Sound and Shoalwater Islands Marine Park. Situated along the coast is a chain of islands, offshore ridges and depressions, which extend from Garden Island in the north to Long Point in the south, providing protection from swell and limiting offshore sediment feeds, resulting in low energy beaches. Conversely, the beaches south of Long Point are high energy as they are not protected by offshore geomorphology and are therefore exposed to significantly more swell.

A detailed understanding of coastal processes which effectively considers past, present and predicted future shoreline change is critical to ensuring appropriate management and the sustainability of coastal development. At varying intensities and magnitudes, the interaction of the following key coastal processes impact on coastal landforms and shoreline movement.

2.4.1 Wind

The nature of local seas, particularly in sheltered areas like Warnbro and Cockburn Sounds, are significantly influenced by the speed, direction and duration of wind. In the summer months, winds are characterised by one of the most dominant sea breeze systems in the world, with strong south to south westerlies which can result in significant longshore movement of sediment (Masselink & Pattiaratchi, 2001).

Sea breezes are generated because land heats up faster than the ocean, resulting in a significant difference between land and sea temperatures in summer, particularly in the afternoon when solar radiation is at its maximum.

During the day, air over the land becomes warm and rises, resulting in an area of low pressure. This air then moves out toward the ocean where the temperature is lower. As the air cools it sinks, resulting in an area of high pressure over the water. The air then moves from the high pressure area over the ocean to the low pressure area over land and it is this movement which is known as the sea breeze. The strength of a sea breeze is therefore dependent on the difference in land and sea temperature. This sea breeze cycle is illustrated in Figure 4.

FIGURE 4 - Sea breeze cycle

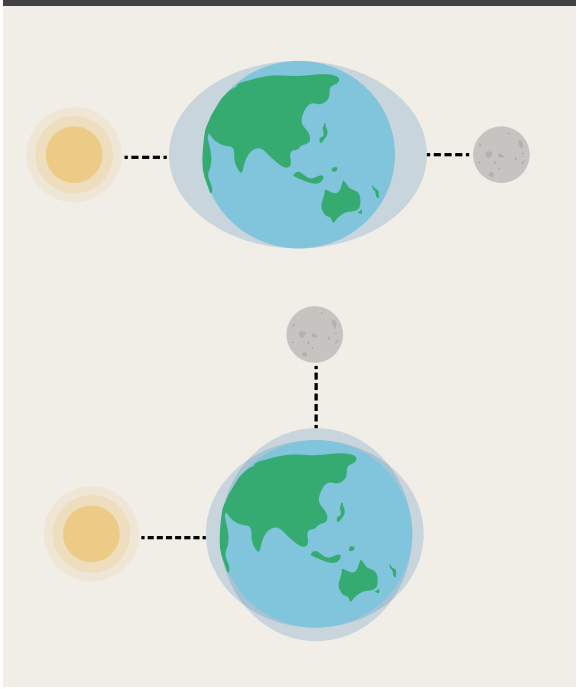
In winter, north westerly winds dominate due to the movement of low pressure systems. While strong, these winds generally result in less sediment movement than the summer winds as the duration is shorter and the sand is usually wet.

Ultimately, the winds which have the most significant impact on nearshore coastal processes are those with extreme speed and these can occur in both summer and winter (WAPC, 2008).

2.4.2 Tides

Tides are caused by the gravitational pull of the sun and moon on the earth. When the sun and moon are aligned, the tidal bulge is large and this is known as a spring tide. When the sun and moon are perpendicular, the tidal bulge is small and this is known as a neap tide. This can be seen in Figure 5.

FIGURE 5 - Neap and spring tides



The tidal environment in Rockingham is known as microtidal, with a range of less than 2m between high and low tides. Tides in the region are predominantly diurnal in form, with one high and low tide each day, although semidiurnal components do occur during certain lunar phases resulting in two high and two low tides per day.

2.0 Biophysical features (continued)

2.4.3 Sea level

While tides cause small, predictable changes in sea level, storm surge can also result in short term sea level rises associated with strong winds and barometric pressure changes. In particular, strong winds generate high steep waves which erode higher sections of beach which are not typically vulnerable. The level of beach impact can be substantial, particularly if storm events occur during high tide. Overall, the impact on beach profile is dependent on the magnitude, intensity and duration of the associated storm system.

As previously mentioned, the beaches of the Warnbro and Cockburn Sounds are largely protected from offshore wave energy by a chain of islands and offshore reef and therefore, an increase in sea level can enable the transfer of more wave energy over the reef and into the nearshore environment. This wave energy can have a significant impact on the coast particularly when combined with strong winds as result of storm surge or sea breeze, further illustrating the potential consequence of interaction between coastal processes.

In this regard, long term projected increases in sea level as result of climate change may result in subsequent exacerbation of existing coastal processes.

2.4.4 Waves

In the south west of Western Australia, swell is primarily generated by large storm systems over the Indian or Southern Ocean. The direction of swell varies seasonally, from south/ south west in summer to west southwest in winter. Within the City, the coastal areas south of Becher Point are exposed to the most wave energy. North of Becher Point, the swell refracts around the series of islands, offshore ridges and depressions which extend north to Garden Island. This refraction results varying energy zones and levels of sediment deposition.

2.4.5 Current

The marine ecology in Western Australia is predominantly driven by the Leeuwin Current, which travels south along the continental shelf transporting warm water from the north. Closer to shore, localised currents caused by winds and tides are responsible for the longshore transport of sediment and are therefore a key consideration for coastal management. These currents can result in a range of erosion or accretion impacts along the shore. The level of these impacts is dependent on a number of factors, including high and low energy zones in the water column and interaction with other coastal processes.

FIGURE 6 - Summary of primary coastal processes for the City of Rockingham

Flora

2.5 Vegetation complex

The vegetation complex that occurs along the City's foreshore is the Quindalup complex, which is associated with the Quindalup dune system. The complex can be divided into two alliances, one associated with beach and foredune areas, and the other with mobile and stable dune formations.

Two regionally significant Bush Forever sites managed by the Department of Parks and Wildlife are located in proximity to the City's foreshore reserves. Point Peron is recognised as Bush Forever Site 355 and Port Kennedy Scientific Park as Bush Forever Site 377, with the Quindalup vegetation complex present in both.

2.6 Vegetation type

Vegetation types are determined based on dominant over, middle and understorey species. Eleven vegetation types were identified within the foreshore reserves, with three represented in all sectors. Sector 2 presented the greatest diversity of vegetation types, with ten identified. All other sectors contained between 5–7 vegetation types. The eleven vegetation types recorded along the foreshore are summarised in Table 1 below.

TABLE 1 - Foreshore vegetation types

Name	Description	Photograph	Sector 1	2	3	4	5
Acacia rostellifera Shrubland	*Acacia rostellifera* over sparse mixed low shrubs and sparse *Lepidosperma gladiatum* and weedy understorey		●	●	●	●	●
Ficinia nodosa Sedgeland	*Ficinia nodosa* with sparse weedy herb and grass understorey			●			
Lepidosperma gladiatum Sedgeland	*Lepidosperma gladiatum* over sparse shrubs and herbs		●	●	●	●	
Scaevola crassifolia Mixed Shrubland	Mixed coastal Shrubland of *Scaevola crassifolia, Olearia axillaris, Spyridium globulosum* and *Acanthocarpus preissii* over *Lomandra maritima* and mixed sedges and grasses		●	●	●	●	●
Nitraria billardierei Shrubland	*Nitraria billardierei* over mixed weedy herb and grass understorey			●			

2.0 Biophysical features (continued)

TABLE 1 - Foreshore vegetation types (continued)

Name	Description	Photograph	Sector 1	2	3	4	5
Olearia axillaris Shrubland	*Olearia axillaris* with *Scaevola crassifolia* over *Carpobrotus virescens* and *Ficinia nodosa* understorey			●		●	●
Acanthocarpus preissii Open Heath	Mixed open heath of *Acanthocarpus preissii, Scaevola crassifolia* and *Olearia axillaris* over sparse sedges and weedy grasses		●	●	●	●	
Spinifex Grassland	*Spinifex longifolius* with scattered shrubs of *Olearia axillaris* and small areas of *Spinifex hirsutus*		●	●	●	●	●
Tall Shrubland	Mixed tall shrubland of *Spyridium globulosum, Acacia cyclops,* and *Acacia rostellifera* over mixed low shrubs, herbs and grasses			●	●	●	●
**Tetragonia decumbens* Herbland	**Tetragonia decumbens* with sparse mixed shrubs and weedy grasses and herbs		●	●			
**Tetragonia decumbens* and **Cenchrus clandestinus* Herbland	**Tetragonia decumbens* and **Cenchrus clandestinus* herbland with scattered mixed shrubs and herbs		●				

2.6 Vegetation type (continued)

Overall, vegetation types were similar to those noted during the previous foreshore vegetation assessment, which was undertaken in 2011. Nine vegetation types were noted in 2011, and eleven identified during 2015. These variations are most likely a result of vegetation growth in rehabilitation areas, increased weed presence and different assessors.

2.7 Vegetation condition

Vegetation condition was assessed using the Keighery scale (Appendix B), with 89.3% of the foreshore vegetation being classified as Good, Very Good or Excellent. Degraded areas were generally found along the boundary of vegetated areas and along the fore dunes, with medium to high densities of weeds located throughout all sectors.

Overall, vegetation condition has improved from the 2011 foreshore assessment when only 77.6% of the foreshore reserve vegetation was classified as Good, Very Good or Excellent. Sectors 2 and 5 contain the largest areas of vegetation rated as Degraded or Completely Degraded (7.12 ha and 8.22 ha respectively), although it is also important to consider vegetation condition with respect to the overall size of the sector. A summary of the vegetation condition rating is provided in Table 2.

2.8 Conservation significant flora

No threatened or priority flora species or communities were recorded in the assessment area; however, it should be noted that the Threatened Ecological Community FCT 19 Sedgelands in Holocene Dune Swales occurs in nearby land currently being developed by Peet on behalf of the Department of Housing in Golden Bay. This TEC and associated Conservation Category Wetland will eventually form part of the Golden Bay foreshore reserve and come under management of the City.

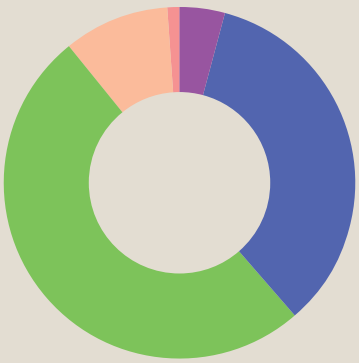
Other significant flora species present are summarised in Table 3.

TABLE 2 - Vegetation condition rating by Sector (hectares)

MAP LEGEND

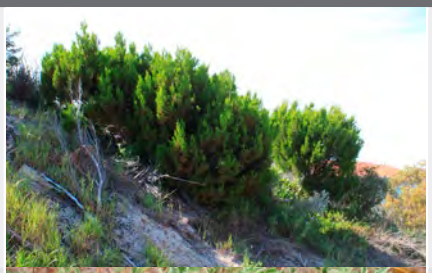
Excellent | Very Good | Good | Degraded | Completely Degraded

Sector	EX	VG	G	D	CD
1	0	6.59	13.36	2.70	0
2	0	7.08	12.33	6.02	1.10
3	1.16	20.39	23.3	2.9	0.23
4	3.98	28.1	13.2	2.33	0.69
5	4.37	15.49	51.78	7.79	0.43
Overall (ha)	9.51	77.65	113.97	21.74	2.45
Overall (%)	4.2	34.5	50.6	9.6	1.1



2.0 Biophysical features (continued)

TABLE 3 - Conservation significant flora recorded along the foreshore

Name	Common Name	Description	Photograph	Sector 1	2	3	4	5
Callitris preissii	Rottnest Island Pine	Distribution restricted to small, isolated populations in the Quindalup Dune System.				●	●	
Diplolaena dampieri	Southern Diplolaena	At the northern end of its range in the Perth metropolitan area.					●	
Lomandra maritima		Habitat for the Priority 4 listed Graceful Sun Moth *(Synemon gratiosa)*				●		

2.9 Weeds

No declared pests or Weeds of National Significance (WoNS) were recorded during 2015 assessments, including the Declared Pest and Weed of National Significance *Lantana camara* that was noted during the 2011 foreshore assessments. Weed densities ranged from low to high in all sectors. Introduced grasses were recorded throughout all of the sectors, with the most abundant species being Great Brome (*Bromus diandrus*). Other abundant weed species included Rose Pelargonium (*Pelargonium capitatum*), Sea Spinach (*Tetragonia decumbens*), Trachyandra (*Trachyandra divaricata*) and Geraldton Carnation Weed (*Euphorbia terracina*).

Three weed suites were mapped for all sectors and were classified according to treatment, as outlined in Tables 4, 5 and 6.

TABLE 4 - Weed Suite One

Weed Suite One

Treatment: Selective fusilade spray areas

Description: Dominated by weedy grasses with higher densities generally occurring in the tertiary dunes further from the beach

Scientific name	Common name	Notes
Avena barbata	Bearded Oat	Occurs in small patches along disturbed edges and clear areas
Bromus diandrus	Great Brome	Wide spread in moderate to high densities
Cenchrus clandestinus	Kikuyu	Occurs on the narrower section of Sectors 1 and 2 in high densities
Cynodon dactylon	Couch Grass	Occurs on the narrower section of Sectors 1 and 2 in moderate densities
Ehrharta longiflora	Annual Veldt	Occurs in moderate densities generally under *Acacia rostellifera* in shady areas
Lagurus ovatus	Hare's Tail Grass	Occurs in small patches in low heath areas, particularly in Sectors 3, 4 and 5
Lolium rigidum	Wimmera Ryegrass	Wide spread in moderate densities; in some locations, populations may be resistant to these herbicides and glyphosate may be needed
Stenotaphrum secundatum	Buffalo Grass	Occurs in Sectors 1 and 2
Thinopyrum distichum	Sea Wheat Grass	Located in moderate to high densities within the foredunes in Sector 5

TABLE 5 - Weed Suite Two

Weed Suite Two

Treatment: Glyphosate spray

Description: Includes herb species where Glyphosate spray treatments are recommended

Scientific name	Common name	Notes
Fumaria capreolata	Whiteflower Fumitory	Located in isolated patches, in the shade under shrubs in low to high densities.
Oenothera drummondii	Beach Evening Primrose	Generally located in the foredunes and secondary dunes in lower densities
Pelargonium capitatum	Rose Pelargonium	Found throughout the dunes in all sectors, with higher densities occurring in the secondary and tertiary dunes
Tetragonia decumbens	Sea Spinach	Recorded in high densities in the foredunes and was the dominant vegetation cover in thinner sections of Sectors 1 and 2, it was also found in smaller patches under shrubs
Trachyandra divaricata	Trachyandra	Generally found in the secondary and tertiary dunes particularly in open and disturbed areas

TABLE 6 - Weed Suite Three

Weed Suite Three

Treatment: Triasulfuron spray/hand weed

Description: Areas of medium to high densities of *Euphorbia* species

Scientific name	Common name	Notes
Euphorbia paralias	Sea Spurge	Recorded in the foredunes of most sectors in lower densities, although moderate to high densities were recorded within the southern half of Sector 5
Euphorbia terracina	Geraldton Carnation Weed	Found in the secondary and tertiary dunes, particularly associated with *Acacia rostellifera* Shrubland areas

2.0 Biophysical features (continued)

2.9 Weeds (continued)

Woody weeds were located in small numbers within Sectors 1, 3 and 5. Two of the woody weed species, *Eucalyptus utilis* and *Melaleuca nesophila* are native to Western Australia but are not native to the Swan Coastal Plain region, occurring naturally on the south coast between Albany and Esperance.

According to the Swan Regional Ranking System (DPaW, 2013), the Japanese Pepper Tree (*Schinus terebinthifolius*) is ranked as having a medium control priority, where the objective is to control, reduce or contain, while the Victorian Teatree (*Leptospermum laevigatum*), was ranked as high, where the objective is eradication.

All other species were ranked as having a low (objective containment at key sites), or negligible (no action to be taken) control priority, particularly *Eucalyptus utilis* which although not native to the region, is desirable for fauna habitat and shade and wind protection. The sector locations of these woody weed species is summarised in Table 7.

TABLE 7 - Woody weed species

Scientific Name	Common Name	Sector 1	2	3	4	5
**Agave Americana*	Agave			●		
**Eucalyptus utilis*	Platypus Gum			●		●
**Melaleuca nesophila*	Mindiyed			●		●
**Schinus terebinthifolius*	Japanese Pepper Tree	●				
**Leptospermum laevigatum*	Victorian Teatree			●		

Fauna

2.10 Fauna

A targeted fauna survey was undertaken in Sectors 3, 4 and 5 as these areas of coastal habitat were considered most likely to support a diverse fauna assemblage. The sample sites were selected according to the broad habitat types present within the sectors, which were defined based on vegetation type and landform in the area, including:

- Habitat 1: Incipient dunes (newly developing foredunes), supporting grassland and open heath vegetation types.
- Habitat 2: Secondary dunes (established dunes developed from incipient dunes), supporting shrubland and sedgeland vegetation types.
- Habitat 3: Parkland/Modified natural lagoon – grassed area and modified natural water body for recreation use.

Database and literature searches yielded a total of 175 potentially occurring vertebrate species, comprising 13 non-volant (ground dwelling) mammal species (including six introduced species), seven volant (bat) mammal species, 44 reptile species, eight amphibian species and 103 avifauna species.

All of the species recorded from the desktop review were assessed for likelihood of occurrence within the study area. Based on these results (Appendix C), 28 species were considered likely to occur, 32 species had the potential for occurrence, 40 species were considered unlikely to occur and 13 species would not occur in the study area (Table 8).

TABLE 8 - Summary of fauna from database and field surveys

Fauna Group	Recorded	Likely to Occur	May Potentially Occur	Unlikely to Occur	Would Not Occur
Native non-volant mammals	2	0	0	1	3
Introduced non-volant mammals	5	2	0	0	0
Volant mammals	2	0	1	0	4
Reptiles	16	11	9	8	0
Amphibians	2	1	0	4	1
Avifauna	41	14	22	27	5
Total	**68**	**28**	**32**	**40**	**13**

2.10 Fauna (continued)

During the field survey, a total of 68 species were recorded, comprising seven non-volant mammal species (including four introduced species), two volant mammal species, 16 reptile species, two amphibian species and 41 avifauna species (including two introduced species). The complete list of species recorded during the field survey can be found in Appendix C.

2.10.1 Non-volant mammal assemblage

Three native non-volant mammal species were recorded in the study area, comprising the Southern Brown Bandicoot (family Peramelidae), the Western Grey Kangaroo (Macropodidae) and one potential native rat species (Muridae). The rat was recorded from motion camera footage, limiting the certainty of species identification. From the images, the species may potentially be the Western Bush Rat (*Rattus fuscipes*), as the tail length to body ratio appeared equal (Figure 7) compared to the introduced Black Rat (**Rattus rattus*) which has a relatively longer tail length to body ratio (van Dyck et al. 2013).

The four species of introduced non-volant mammal species comprised the House Mouse (Muridae), Rabbit (Leporidae), Dog and Fox (Canidae).

The most frequently recorded non-volant mammal was the House Mouse (**Mus musculus*) with nine individual records, accounting for 39% of the total non-volant mammal records. The next most common species recorded was the Priority 4 Southern Brown Bandicoot (*Isoodon obesulus fusciventer*).

FIGURE 7 - *[top]* Southern Brown Bandicoot (*Isoodon obesulus fusciventer*) and *[bottom] Rattus sp.* recorded from motion camera footage.

2.0 Biophysical features (continued)

2.10.2 Volant mammal assemblage

The two species of volant mammals recorded in the study area included one species of evening bat (Vespertilionidae) and one species of freetail bat (Molossidae) (Figure 8).

FIGURE 8 - *[left]* White-striped Freetail Bat (*Austronomous australiss*) and *[right]* Gould's Wattled Bat (*Chalinolobus gouldii*).

2.10.3 Reptile assemblage

Sixteen reptile species were recorded in the study area, including the gecko *Strophurus spinigerus* (Diplodactylidae), two species of flap-footed lizard (Pygopodidae), two species of dragon (Agamidae), nine species of skink (Egerniidae, Eugongylidae and Sphenomorphidae) and two species of front-fanged snake (Elapidae).

The most common species recorded were the gecko, *Strophurus spinigerus* (Figure 9), and Bobtail, Tiliqua rugosa, with 19 records each, representing 22% of all reptile records respectively. The next most common species recorded was the skink *Ctenotus fallens* (Figure 9), with 12 records representing 14% of total reptile records. Five species were recorded once, including one flap-footed lizard: *Aprasia repens*, three skinks: *Acritoscincus trilineatus*, *Menetia greyii* and *Lerista lineopunctulata*, and one snake: *Notechis scutatus*.

FIGURE 9 - *[left] Ctenotus fallens* and *[right]* South-west Spiny-tailed Gecko *(Strophurus spinigerus).*

2.10.4 Amphibian assemblage

Two amphibian species were recorded from the study area: the Sand Frog, *Heleioporus psammophilus* and the Western Banjo Frog, *Limnodynastes dorsalis*. The most common amphibian species recorded was the Sand Frog (*Heleioporus psammophilus*) with five records, followed by the Western Banjo Frog (*Limnodynastes dorsalis*) with three records. The identification of *H. psammophilus* should be taken cautiously as identifying species of the Heleioporus genus based on morphology can be difficult (Anstis 2013). In addition, this species was not recorded during the desktop and literature review. Confirmation that this species occurs would require identification of species-specific calls during April to May. However, it is likely that individuals would move away from the study area in search of wetland areas to breed and calling may not be heard.

FIGURE 10 - *[left]* Western Banjo Frog (*Limnodynastes dorsalis*) and *[right]* Sand Frog (*Heleioporus psammophilus*)

2.10.5 Avifauna assemblage

Forty-one avifauna species including 20 non-passerine species from 12 families, and 21 passerine species (three toes pointing forward and one pointing backward) from 11 families were recorded from the study area (Appendix C). The two introduced species of avifauna were the Rock Dove (**Columba livia*) and Laughing Dove (**Streptopelia senegalensis*).

The most common species recorded was the Silvereye (*Zosterops lateralis*) with 128 records, representing 17% of all total avifauna records. The next most common species recorded was the Silver Gull (*Chroicocephalus novaehollandiae*) with 111 records, representing 15% of total avifauna records. Eight species were recorded once, including Australasian Gannet (*Morus serrator*), Black-shouldered Kite (*Elanus axillaris*), Dusky Moorhen (*Gallinula tenebrosa*), Common Sandpiper (*Actitis hypoleucos*), Red Wattlebird (*Anthochaera carunculata*), Black-faced Cuckoo-shrike (*Coracina novaehollandiae)*, Grey Shrike-thrush (*Colluricincla harmonica*) and Australian Magpie (*Cracticus tibicen*).

FIGURE 11 - *[left]* Red Wattlebird (*Anthochaera carunculata*) and [right] Silvereye (*Zosterops lateralis*)

2.0 Biophysical features (continued)

2.10.5 Avifauna assemblage (continued)

Six avifauna species were recorded from the study area that were not identified in the desktop and literature review. These were: Hardhead (*Aythya australis*), Australasian Gannet (*Morus serrator*), Dusky Moorhen (*Gallinula tenebrosa*), Sanderling (*Calidris alba*), White-cheeked Honeyeater (*Phylidonyris niger*) and Tree Martin (*Petrochelidon nigricans*).

2.10.6 Conservation significant fauna

Native fauna species that are rare, threatened with extinction, or have high conservation value, are specially protected by law under the state *Wildlife Conservation Act 1950* (WC Act). In addition, some of these species are listed for their protection under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The statutory framework relative to matters of conservation significance can be viewed in Appendix A.

The following four species of conservation significance were recorded in the study area during the field survey:

A **Southern Brown Bandicoot**
Isoodon obesulus fusciventer, which is listed as a Priority 4 species by the Department of Parks and Wildlife (Department of Parks and Wildlife 2015).

B **Lined Skink**
Lerista lineata, which is listed as a Priority 3 species by the Department of Parks and Wildlife (Department of Parks and Wildlife 2015).

C **Common Sandpiper**
Actitis hypoleucos, which is listed as a Schedule 5 species under the state WC Act and Migratory under the federal EPBC Act (Department of the Environment 2015b, State of Western Australia 2015).

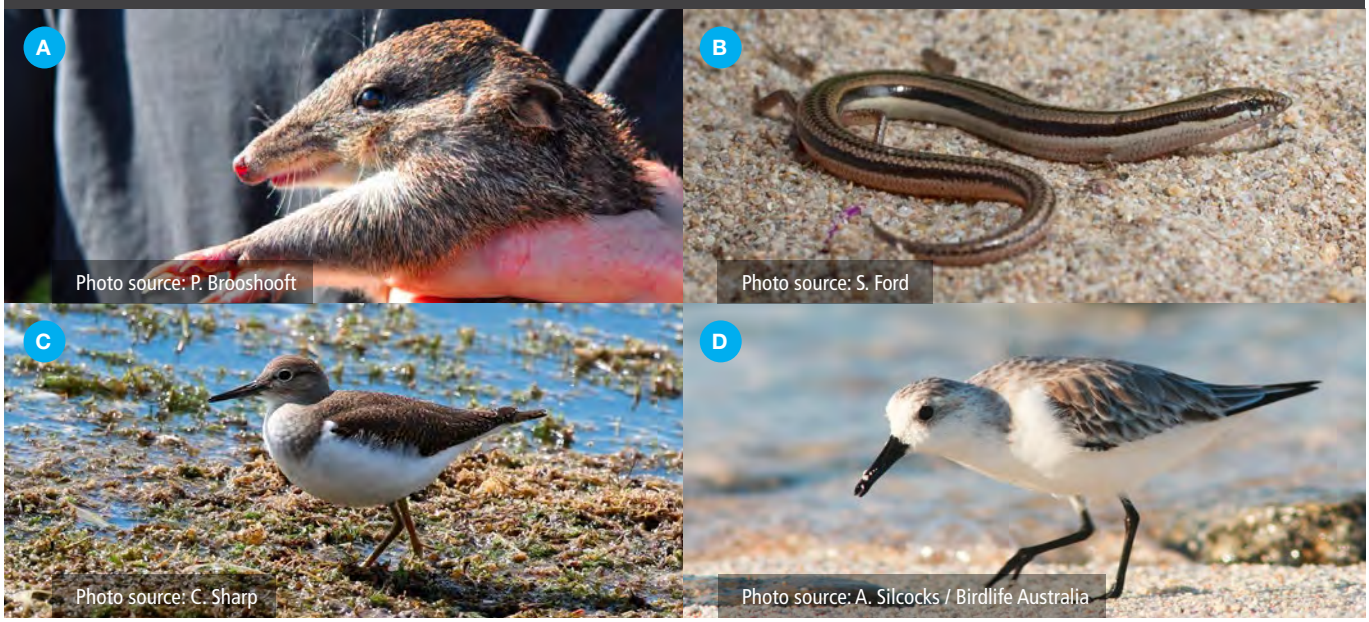
D **Sanderling**
Calidris alba, which is listed as a Schedule 5 species under the state WC Act and Migratory under the federal EPBC Act (Department of the Environment 2015b, State of Western Australia 2015).

A further five conservation significant species were identified from the desktop review as having potential to occur within the study area. These were:

- **Caspian Tern**
  Hydroprogne caspia
  (Schedule 5/Migratory)
- **Eastern Great Egret**
  Ardea modesta
  (Schedule 5/Migratory)
- **Grey Plover**
  Pluvialis squatarola
  (Schedule 5/Migratory)
- **Red-necked Stint**
  Calidris ruficollis
  (Schedule 5/Migratory)
- **Rainbow Bee-eater**
  Merops ornatus
  (Schedule 5/Migratory)
- **Black Striped Snake**
  Neelaps calonotos
  (Priority 3).

Further information regarding species recorded in the study area can be found in Appendix C.

FIGURE 12 - Conservation significant species recorded



Infrastructure

2.11 Reserve infrastructure

Well maintained reserve infrastructure plays an important role in ensuring that recreational uses of our foreshore reserves do not negatively impact on their conservation value.

2.11.1 Fencing

Fencing of sensitive areas is important to prevent impacts from unauthorised access. Fencing is present in the majority of the foreshore reserves and is generally of high quality; however, there are exceptions where fencing is inadequate or in need of repair. In this regard, Sectors 3, 4 and 5 should be prioritised for fencing upgrades.

The extent, type and condition of fencing is summarised in Table 9.

TABLE 9 - Fencing

Sector	Fence type	Good Condition (m)	Poor Condition (m)
One	Post and strand	6,479	4
	Post, strand and metal rail	530	0
	Limestone wall	104	0
	Metal fence	504	0
	Bollards	1,918	0
Two	Post and strand	5,375	13
	Post, strand and metal rail	762	2
	Bollards	1134	0
	Metal rail	144	1
Three	Post and strand	11,949	75
Four	Post and Strand	5,819	213
	Bollards	203	0
Five	Post and strand	9,304	206
	Bollards	792	0

2.0 Biophysical features (continued)

2.11.2 Paths and access

Paths are an important feature in providing access to the foreshore for recreation. However, this access needs to be managed to ensure uncontrolled vehicle and pedestrian access does not lead to the degradation of the foreshore reserves. Paths through the reserves range from well-maintained concrete paths, to limestone walking tracks, to sandy beach access tracks. Poor condition bitumen and concrete paths which present trip hazards should be prioritised for upgrade.

The extent, type and condition of paths are summarised in Table 10.

TABLE 10 - Paths

Sector	Path type	Fenced	Good Condition (m)	Poor Condition (m)
One	Sand	Yes	1,109	0
	Paved	No	502	26
	Concrete	Yes	4,093	13
	Bitumen path	No	674	0
Two	Sand	No	1,177	0
	Concrete	Yes	8,168	4
	Plastic board and chain	Yes	90	0
	Bitumen	No	163	0
	Crushed limestone	Yes	313	0
Three	Sand	Yes	685	0
	Concrete	Yes	2,846	20
	Crushed limestone	Yes	1,114	0
	Bitumen	Yes	3,050	0
Four	Sand	Yes	2,472	0
	Concrete	Yes	2,918	8
	Crushed limestone	Yes	671	0
	Bitumen	No	357	0
Five	Sand	Yes	1,935	0
	Concrete	Yes	1,727	14
	Bitumen	Yes	1,825	21
	Crushed limestone	Yes	296	0

2.11.3 Signs

The use of signs needs to balance the need to educate and inform with the potential for visual clutter. The majority of foreshore areas are well signed and little additional signage is needed. However, a number of the signs are old and have been weathered, resulting in faded and illegible information. The addition of any new signage should consider the coastal environment and ensure the most appropriate signage materials are used to prevent deterioration. The signs recorded in each sector are summarised in Table 11.

TABLE 11 - Signage

Sector	Signage Type	Number Overall	Number Poor Condition
One	Directional	7	1
	Informational	37	12
	Regulatory	111	23
Two	Directional	3	0
	Informational	18	9
	Regulatory	73	13
Three	Directional	2	0
	Informational	7	2
	Regulatory	59	14
Four	Directional	2	0
	Informational	3	1
	Regulatory	28	6
Five	Directional	3	0
	Informational	4	0
	Regulatory	35	11

2.11.4 Other infrastructure and amenities

A range of recreational facilities, including barbeques, picnic tables and children's playgrounds are provided along the City's coastline, particularly in Sectors 1 and 2. The majority of the facilities are in good condition, are provided in appropriate nodes and are harmonious with the natural areas, minimising the impact on areas of conservation value. The type and condition of infrastructure recorded in each sector is summarised in Table 12.

TABLE 12 - Other infrastructure and amenities

Sector	Amenity (total, number in poor condition)
One	Barbeque (18,0), Bench seat (72,0), Bike rack (4,0), Bin (57,1), Bin and dog bags (16,0), Cigarette bin (18,0), Drink fountain (8,0), Drink fountain with dog bowl (2,0), Memorial (3,0), Picnic table (3,0), Playground (14,0), Dog bags dispenser (1,1), Recycle bin (4,0), Shade structure with bench seat (3,0), Shade structure with picnic table (43,0), Shower (13,0), Tap (1,0), Toilet block (6,0)
Two	Barbeque (9,0), Bench seat (89,1), Bike rack (9,0), Bin (35,01), Bin and dog bags (12,0), Drink fountain (5,1), Gym park (1,0), Picnic table (5,1), Playground (6,0), Dog bags dispenser (1,1), Recycle bin (1,0), Shade structure (9,0), Shade structure with picnic table (6,0), Shower (13,0), Toilet block (4,0)
Three	Bench seat (2,0), Bike rack (6,0), Bin (7,0), Bin and dog bags (4,0), Picnic table (1,0), Shower (2,0)
Four	Barbeque (3,0), Bench seat (30,4), Bin (12,2), Bin and dog bags (1,0), Drink fountain (7,0), Lookout (6,0), Picnic table (10,0), Playground (2,0), Shade structure (1,0), Shower (8,0), Surf Club (1,0), Toilet block (1,0),
Five	Barbeque (2,0), Bench seat (6,2), Bike rack (2,0), Bin (14,0), Bin and dog bags (5,0), Drink fountain (2,0), Drink fountain with dog bowl (1,0), Lookout (3,0), Playground (2,0), Shade structure with bench seat (1,0), Shade structure with picnic table (7,0), Shower (2,0), Toilet block (2,0)

2.11.5 Service level provision

It is important that infrastructure provided along the foreshore is compatible with the coastal environment and consistent with respect to style and function. The City's Infrastructure Asset Management Plan outlines detailed information relating to the City's service level provision in this environment and therefore, such information is not provided in this Plan.

3.0
Management considerations

3.0 Management considerations

3.1 Climate change

There is consensus amongst scientists dealing with climate hypotheses and observations that human activities are increasing levels of greenhouse gases which may be contributing to global warming. Changes over the 20th century include increases in global average air and ocean temperature, widespread melting of snow and ice and rising global sea levels. The extra heat in the climate system also has other impacts such as affecting atmospheric and ocean circulation, which influences rainfall and wind patterns (Department of the Environment 2015).

Records show that the decade of 2001-2010 was the world's warmest decade on record and in Australia, each decade has been warmer than the previous decade since the 1950s (DoTE 2015).

These changes to climate are predicted to result in changes like storm frequency, storm intensity and sea levels. Although the magnitude of these changes is difficult to determine with certainty, any increase in storm severity together with a rise in sea level has the potential to impact on the vulnerability of the City's coastline. High sea levels will mean that storm waves are able to erode sections of the beach that were previously vulnerable, an effect which will be exacerbated by the increasing intensity of storm events.

The Western Australian Planning Commission recommend that an allowance for sea level rise be accounted for during coastal planning, as it is generally accepted that a 1cm rise in mean sea level will result in a loss of approximately 1m of beach, with a rise of 0.9m predicted by 2110 (WAPC 2013). The State Planning Policy 2.6 (SPP 2.6) provides a number of management options for coastal management relative to coastal vulnerability risks including:

1. Planned retreat (e.g. building setbacks)
2. Accommodation (e.g. raising vulnerable infrastructure above predicted flood levels)
3. Protection (e.g. through construction of seawalls and other revetment strategies)

To manage coastal vulnerability, the City currently adheres to coastal setbacks and implements a range of coastal protection mechanisms which are outlined in more detail in Sections 5, 6 and 7 of this Plan.

While all recommendations in this Plan were made with due consideration for SPP 2.6 and the potential impacts of climate change, a Climate Change Response Plan is currently being developed by the City to provide specific climate change mitigation and adaptation actions and therefore such actions are not included in this Plan.

3.2 Coastal vulnerability

Effective coastal management must take into account the dynamic nature and vulnerability of the nearshore environment. As discussed in Section 2.4, the interaction of coastal processes results in varying levels of erosion and accretion (accretion is the accumulation of sand on beaches whereas erosion refers to its loss) which have a significant impact on the nearshore environment and particularly on coastal infrastructure.

A number of studies of the Rockingham coast have revealed a relatively fixed pattern of sediment transport, with sand entering from the south under the effects of the dominant prevailing wind. The Department of Transport have estimated that approximately 100,000m^3 of sand enters the Rockingham coast from the south every year, the majority of which accumulates in the Singleton, Golden Bay and Secret Harbour areas.

Accretion can result in jetties and boat ramps becoming inaccessible for boats and erosion can undermine roads, footpaths and car parks. In the shorter term, impacts of accretion can be managed by sand excavation and impacts of erosion can be managed through sand nourishment, which involves bringing in sand to build up the beach in affected areas. Long term solutions typically involve relocation, removal or revetment of affected infrastructure, with such revetment including engineered solutions such as seawalls, rock armour and offshore headlands. However, the long term suitability of such options to manage coastal vulnerability need to take into consideration the associated costs and subsequent benefits, as the implementation of such solutions can be very costly. Details regarding current and future management of coastal vulnerability within the City can be found in Sections 5 - 9 of this Plan.

3.3 Fire management

Fire impacts on native vegetation in a variety of ways, depending on the scale of the fire and the type vegetation. The impacts of fire on vegetation can be very complex with both positive and negative effects.

Where properties are situated in close proximity to native vegetation they are considered to be in a bushfire risk zone. Bushfire risk is defined as the chance of damage or loss to property or life as result of a bushfire. Along the City's coastline there are a number of areas where homes are situated adjacent to large stands of native vegetation, which form an important consideration for management.

In these areas, effective bushfire risk management requires detailed consideration of all the ecological, social and resourcing factors associated with this issue. The City is currently developing a plan to specifically address the management of bushfire risk and therefore such actions are not detailed in this plan. However, general areas of bushfire risk are identified in the individual sector descriptions in Sections 5 - 9 of this Plan.

3.0 Management considerations (continued)

3.4 Conservation of flora and fauna

Urban expansion on the Swan Coastal Plain and associated clearing of vegetation has led to significant habitat fragmentation and degradation of native flora and fauna. As a consequence of this loss, remaining intact habitat on the Swan Coastal Plain is regionally significant for conservation. Small habitat remnants are much more susceptible to disturbance from episodic natural or anthropogenic events.

In particular, this is likely to be the case for a coastal environment like the foreshore, where the habitat is bordered west and east by uninhabitable marine and urban environments. Maintaining continuity in this type of habitat corridor, including linkages with larger blocks of remnant habitat in the locality, is particularly important so that ecological assemblage and genetic diversity are maintained over a wider area in the event that smaller areas are degraded or destroyed.

This plan aims to provide directions and recommendations for the management of the City's coastal habitat. In particular, the recommendations are concerned with the protection and enhancement of native flora and fauna populations through the removal of threatening processes. These threating processes and the corresponding management objectives are discussed in detail in Section 4 of this Plan.

3.4.1 Acacia

A number of Acacia species, commonly known as wattles, occur within the City's foreshore reserves. *Acacia rostellifera* is the species encountered most frequently, with *Acacia cyclops* and *Acacia saligna* also present, but as individuals rather than stands of trees. These acacias are a valuable part of the ecosystem as they minimise erosion impacts by stabilising the dunes while also providing foraging and breeding habitat for native fauna, particularly small birds.

These strands of acacia form small stepping stones of habitat which enables the movement of native bird species along the coastline, offering protected areas for birds to forage and nest, which other low lying coastal species do not allow. This is particularly important to provide protection from predators in a relatively exposed environment and to maintain the connectivity of fauna populations along the coast.

However, while these species are indigenous to the region and provide many benefits, the City recognises that acacia (particularly *A.rostellifera*) has tendency to become locally dominant, outcompete other species and form large strands of vegetation which may be undesirable and reduce the visual amenity in some areas, particularly as acacias only live for 15-20 years resulting in areas of dead wood within the foreshore.

Unfortunately, due to the woody nature of acacia it does not respond well to pruning. However, the City proposes a number of measures to manage the extent of acacia within the foreshore with the aim of satisfying both conservation and aesthetic objectives.

In this regard, the current extent of acacia along the City's coastline has been mapped in this Plan and will be monitored. The use of dominant acacia species in revegetation activities will also be assessed for suitability on a site by site basis.

It is not considered appropriate to remove all dead wood from the foreshore as it provides critical fauna habitat, continues to stabilise the dunes and eventually decomposes transferring nutrients back into the ecosystem; however, limited removal of dead wood may be undertaken where appropriate.

The mapped extent of acacia can be seen on the vegetation type figures in Sections 5 - 9 of this Plan.

3.4.2 Wrack

The City's coastal waters support a range of marine habitat types, including regionally significant seagrass meadows which primarily consist of *Posidonia* spp, *Amphibolis spp* and *Halophila ovalis*, which are a vital component of the marine food web and provide essential habitat for many coastal species. This seagrass, along with other aquatic vegetation, deposits on the beach and forms banks known as wrack, particularly in protected areas such as Palm Beach and Safety Bay. As wrack breaks down it can smell unpleasant but it is this decomposition process which releases nutrients such as carbon and nitrogen back into the ecosystem, which are important for coastal productivity.

While it can be undesirable, the removal of wrack is not permitted under Western Australia's *Conservation and Land Management Act 1984* and therefore is not undertaken by the City.

3.5 Proposed future development

The Department of Planning has assessed all Perth metropolitan coastal areas for potential land use capabilities through the Perth Coastal Planning Strategy (2008). This has divided the coast into 56 precincts according to geographical, natural and cultural characteristics. The report then lists recommended development to be promoted for each precinct. The table below details the recommendations for development for the precincts located in the Rockingham region.

TABLE 13 - Recommended development types for Rockingham's coastal areas

	Precinct	Description	Recommended Development
SECTOR ONE	**North Rockingham**	Passive recreation based around the marine environment.	• Open space • Residential • Tourism • Boat launching • Dog/horse beach • Swimming • Water skiing • Diving and snorkeling.
	Rockingham Activity Centre	High-density activity centre. Residential and mixed use development. Commercial, tourism and passive recreation.	• Residential • Tourism accommodation • Tourism and associated facilities, i.e. BBQ's, shade, paths, change rooms, cafes, shade trees • High level of access.
	Point Peron	This open space precinct is dominated by conservation. Areas within the precinct are subject to the Shoalwater Islands Marine Park and the Rockingham Lakes Regional Park Management Plans.	• Conservation • Short-term low cost accommodation • Holiday camps, environmental/marine education • Tourism • Interpretive boards • Paths and/or boardwalks • Dog beach • Public boat launching facility.
SECTOR TWO	**Shoalwater**	Shoalwater is predominantly residential with conservation on and around Penguin Island and the other Shoalwater Islands. Active marine and land-based recreation is also dominant including provision of cafes and change rooms.	• Residential development • Active recreation on the foreshore • Active marine recreation activities around islands • Conservation on and around the islands • Cultural heritage • Key water sports area • Café and change rooms along foreshore • Diving, boating, snorkeling and fishing.
	Safety Bay	Moderate-intensity mixed-use development. The foreshore area is actively used with cafes, dual-use pathways, grassed picnic areas, BBQs, a boat ramp and jetty.	• Foreshore area is actively used with cafes, grassed areas, BBQ and picnic areas • Dual use path and associated activities • Residential development • Small mixed use area • Boat ramp and jetty.
	Waikiki	Residential with mixed use focus, some retail, entertainment, small offices and tourism and recreation facilities including shade, BBQs and picnic areas.	• Residential with a mixed use focus • Retail • Minor office uses • Entertainment • Tourism and recreation uses • Shade facilities, BBQs and picnic areas • Family friendly and a relaxed atmosphere • Designated water ski area • Dog beach and associated uses.

3.0 Management considerations (continued)

TABLE 13 - (continued)

	Precinct	Description	Recommended Development
SECTOR THREE	**North Warnbro**	Predominantly passive recreational area.	• Sports and recreation • Dog beach • Picnic/BBQ/shade • Car parks and paths.
	South Warnbro	Low access residential land. Passive recreation along the foreshore.	• Residential • Passive Recreation • Car parks and paths • Designated water ski area.
	Port Kennedy Golf Course	Foreshore is reserved Parks and Recreation, with the area of influence reserved as public purpose- special uses and is a private golf course.	• Open space • Walking path along the edge of the dunes • Golf course • Low level access.
	Port Kennedy Resort	Mixed-use precinct. Conservation associated with the Shoalwater Islands Marine Park and Bush Forever site no 377.	• Resort development • Tourism and eco tourism • Golf course • Minor Retail • Conservation • Water sports area • Beach Access Paths and fenced paths.
	Port Kennedy Scientific Park	Bush Forever, Rockingham Lakes Regional Park, Ramsar Wetland, Register of National Estate	• Conservation • Limited access to pedestrians • Boardwalks • Fencing.
SECTOR FOUR	**Secret Harbour**	District Beach. Foreshore area is reserved for Parks and Recreation, with the area of influence zoned urban under the Metropolitan Region Scheme. Urban use is mixed use residential development.	• Residential • Entertainment • Tourism/recreation • Retail • Surfing/beach use • Cafes • Short term low cost coastal accommodation.
SECTOR FIVE	**North Golden Bay**	Foreshore area is reserved for Parks and Recreation, with the area of influence zoned urban under the MRS. Urban use is mixed use residential development.	• Passive recreation • Residential • Conservation • Car parks/paths
	South Golden Bay	Foreshore area is reserved for Parks and Recreation, with the area of influence zoned urban under the MRS. Urban use is mixed use residential development.	• Residential • Retail and office • Tourism • Surf Club and pedestrian paths
	Singleton	Foreshore area is reserved for Parks and Recreation, with the area of influence zoned urban under the MRS. Urban use is mixed use residential development	• Residential • Retail and office use • Passive recreation • Pedestrian paths and Beach Access Paths • Change rooms and BBQ

3.5 Proposed future development (continued)

In addition to these recommendations, proposed future coastal developments should be compatible with the surrounding environment and consistent with State Planning Policy 2.6.

Proposed coastal developments within the City are detailed below:

	Proposed Development	Description
SECTOR ONE	**Port Rockingham Marina**	A new marina facility located at the intersection of Wanliss Street and Rockingham Beach Road. An area of approximately 9 ha of near shore marine environment is to be occupied, which will be designed to accommodate 500 vessels. The conditional environmental and planning approvals for the project expired on 18 February 2015. The proponent would need to renew these approvals prior to the commencement of any project works.
	Mangles Bay Marina	The inland marina, to be located just east of the Garden Island Causeway, is proposed to accommodate more than 500 boats, with the surrounding land development to be mixed use, incorporating residential, commercial and tourism land uses. The project has federal environmental approval and is currently seeking approval for a proposed amendment to the MRS.
	City Centre and Waterfront Village	A range of mixed use and residential multi-story units.
SECTOR THREE	**Kennedy Bay**	Kennedy Bay is a residential and commercial precinct, which includes short stay accommodation, with approximately 660 dwellings to be provided. The project is anticipated to be complete by 2021.
SECTOR FOUR	**Secret Harbour**	Residential development, including multi-story townhouses and apartment buildings
SECTOR FIVE	**Golden Bay**	The Department of Housing owns areas of land that can accommodate approximately 1,400 dwellings, commenced in 2011 with an expected completed date of 2021. A new foreshore recreation node is proposed as part of the development.
	Singleton	The Bayshore Gardens estate is in the process of completion and is expected to accommodate a further 275 dwellings. Additionally, two marinas have been identified as potential future coastal developments.

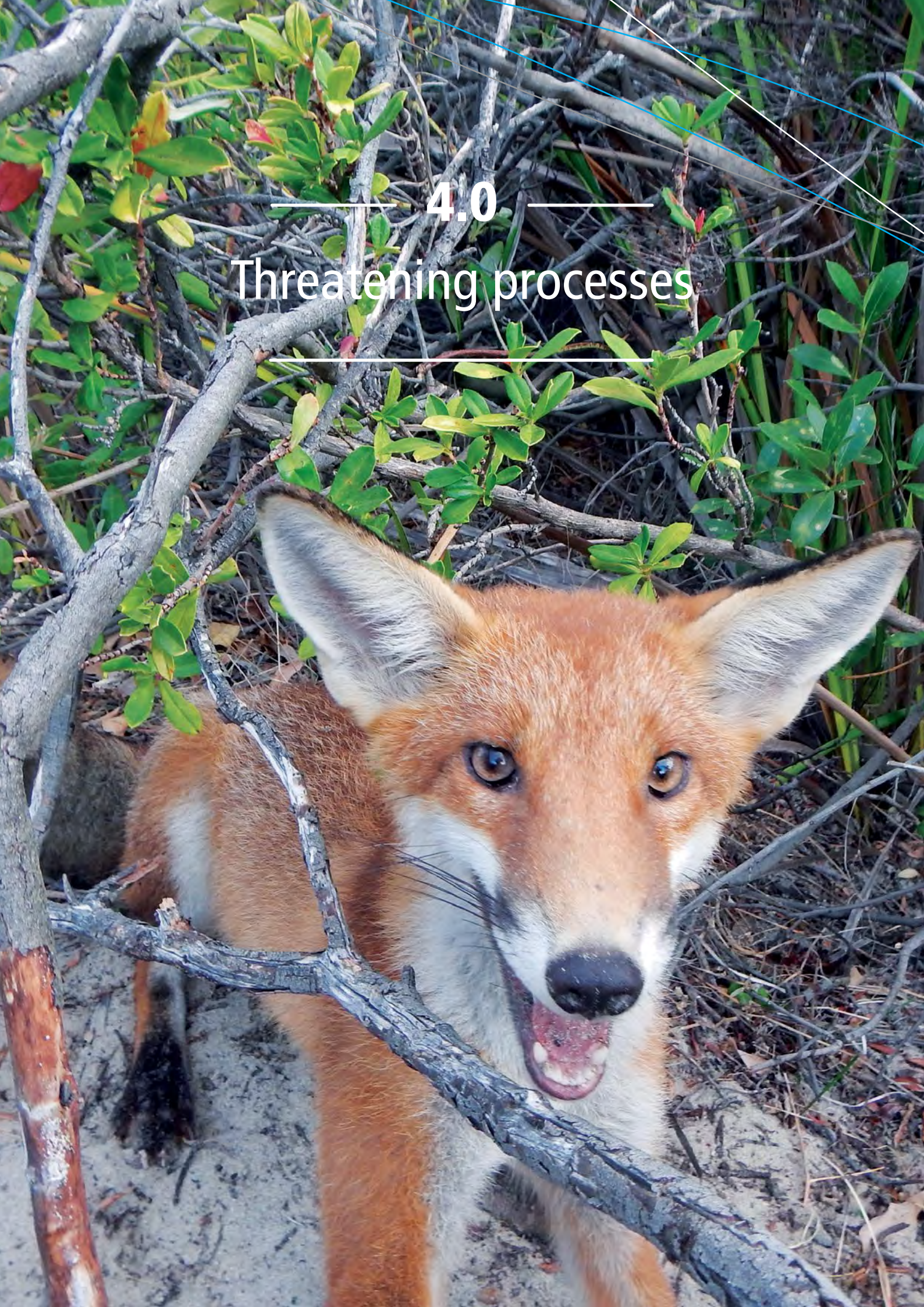
3.0 Management considerations (continued)

3.6 CCTV

Commencing in 2000, closed circuit television (CCTV) systems have been installed in various locations throughout the City. The use of video surveillance in public spaces is an important community safety measure and provides a valuable tool to detect, identify and deter offenders. As the City's population continues to grow, there is a need to consider the installation of additional CCTV infrastructure in certain locations with high visitation and public activity. This is particularly relevant to the City's foreshore reserves as they are pivotal areas for recreation within the community. Any future infrastructure upgrades in key coastal nodes should consider the provision of associated CCTV infrastructure, subject to undertaking a detailed needs based assessment and suitability analysis.

TABLE 14 - Potential locations for additional CCTV infrastructure

Sector	Location
One	Palm Beach boat ramp
	Palm Beach jetty
	Val Street jetty
	Rockingham foreshore
Two	Mersey Point
	Bent Street boat ramp
	Tern Island – Concept Area 1
	Waikiki foreshore park
Three	Port Kennedy boat ramp
Four	Secret Harbour foreshore park – Concept Area 2
Five	Golden Bay foreshore park – Concept Area 3
	Singleton foreshore park – Concept Area 4



4.0
Threatening processes

4.0 Threatening processes

One of the key overarching objectives for the ongoing management of the foreshore is to protect and enhance conservation values through the removal of threatening processes. These threatening processes, management approaches and the corresponding key management objectives are discussed in this section.

4.1 Weeds

Invasive species represent the biggest threat to biodiversity after habitat loss (DotE 2014). Weeds are plants that grow in areas where they are not wanted and where they may have an environmental or economic impact. Weeds can impact on natural values by:

- Out-competing native species for nutrients, water, space and sunlight
- Reducing the natural diversity by smothering native plants or preventing them from growing back
- Reducing habitat for native animals
- Altering fire regimes (DPaW 2014).

Introduced plants occur throughout all of the foreshore reserves but are most dominant in the modified or previously disturbed areas, particularly adjoining paths or parkland areas. In some areas of the coastal foredunes, the weedy species play a role in dune stabilisation. Some introduced species also provide recreational amenity such as shade trees or lawns within the parkland cleared areas.

Dynamic and sensitive environments such as the foreshore should utilise an integrated approach to weed management, which involves a combination of mechanical and chemical systems coupled with revegetation to increase ecosystem resilience and long term viability.

The key objectives for weed management within the foreshore are to:
Prevent the introduction of additional weed species
Reduce the extent of weed suite coverage and density
Ensure weed control actions do not negatively impact flora and fauna
Support weed management with revegetation and erosion control

4.2 Feral Animals

There are a number of introduced fauna species that are likely to occur within the foreshore and these animals can have potential impacts on native species including:

- Predation on native fauna species and grazing of native plants
- Competition with native fauna for food and shelter
- Destroying habitat
- Spreading diseases
- Land degradation including dune erosion and destruction of vegetation.

Introduced fauna species that pose a threat in the foreshore reserves include:

- European rabbit (*Oryctolagus cuniculus*): grazes on native vegetation, may impact on revegetation efforts as well as leading to dune erosion.
- European red fox (*Vulpes vulpes*): preys on native fauna species, competes with native fauna for food, habitat and other resources.
- Feral cat (*Felis catus*): preys on native fauna species, competes with native fauna for food, habitat and other resources.
- European bee (*Apis mellifera*): competition with native fauna species for tree habitat.

Rabbits, foxes and feral cats are listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* as key threatening process to the conservation of biodiversity in Australia. To manage feral animal populations the City engages a suitably trained and licenced contractor, who utilises methods in accordance with the relevant state government regulations and animal ethics requirements.

The key objectives for feral fauna management within the foreshore are to:
Ensure feral animal control methods are suitable for use in an urban environment
Optimise use of limited resources by undertaking monitoring to prioritise areas of high feral animal activity
Prioritise control in areas of Good, Very Good or Excellent vegetation condition to prevent degradation of habitat value
Prioritise areas of known fauna habitat, particularly to support Southern Brown Bandicoot populations in Sectors 3, 4 and 5

4.3 Inappropriate access

Inappropriate access, such as the use of undefined tracks through the dunes, can result in habitat loss through trampling of vegetation. Trampling can damage vegetation, change plant composition, reduce plant cover and may result in the spread of weeds. This loss of vegetation can also lead to dune erosion, which is exacerbated by unauthorised access of 4WDs and motorbikes along the coast.

To manage these impacts, the City aims to fence all foreshore areas with access restricted to designated points for pedestrians, bicycles or authorised vehicles only. The use of rural style 3 strand fencing with a SITA wire is preferred.

The key objectives for access management within the foreshore are to:
Reduce fragmentation by consolidating access tracks where appropriate
Rehabilitate unauthorised tracks through weed control, revegetation and brushing
Ensure all areas of natural vegetation are fenced to restrict unauthorised access
Ensure areas of damaged or absent fencing are attended to in a timely manner, with old fencing upgraded to a rural style where appropriate.

4.4 Erosion

Erosion can be caused by inappropriate access, but also by natural factors such as wind and storm surge. Erosion reduces the ability of the dunes to support vegetation cover, reducing plant biodiversity and fauna habitat. The disturbance caused by erosion may also result in the establishment of weed species within the dunes.

Stabilisation techniques used by the City to control erosion include brushing, windbreak fencing and jute matting. Brushing involves the overlaying of native coastal tree or shrub branches in an interlocking fashion. Brushing is effective because it lies slightly higher than the surface and creates a shaded microclimate where seedlings are protected from the sun and wind.

Jute matting is a biodegradable fabric which is fixed to the dunes to hold sand in place. Holes can then be cut into the matting for seedlings to be planted. This technique is very effective for stabilising exposed sloping dunes that are prone to wind erosion.

Sand trap fencing is used in areas where dunes are susceptible to wind erosion. The windbreak mesh which is fixed to the fencing helps to slow the movement of windblown sand and promotes sand accumulation. The technique can also be used to minimise the build-up of sand on adjoining infrastructure, such as paved or concrete surfaces.

In areas where erosion impacts are severe and impact upon coastal infrastructure, management may include the use of sand renourishment or revetment structures. Management of significant erosion impacts is discussed further in Sections 5 - 9 of this Plan.

The key objectives for erosion management within the foreshore are to:
Utilise stabilisation techniques to support natural regeneration of coastal vegetation and revegetation efforts
Prioritise areas of medium to severe erosion adjoining recreational areas and coastal infrastructure
Ensure safety of foreshore users by stabilising and/or restricting access to significantly eroded areas.

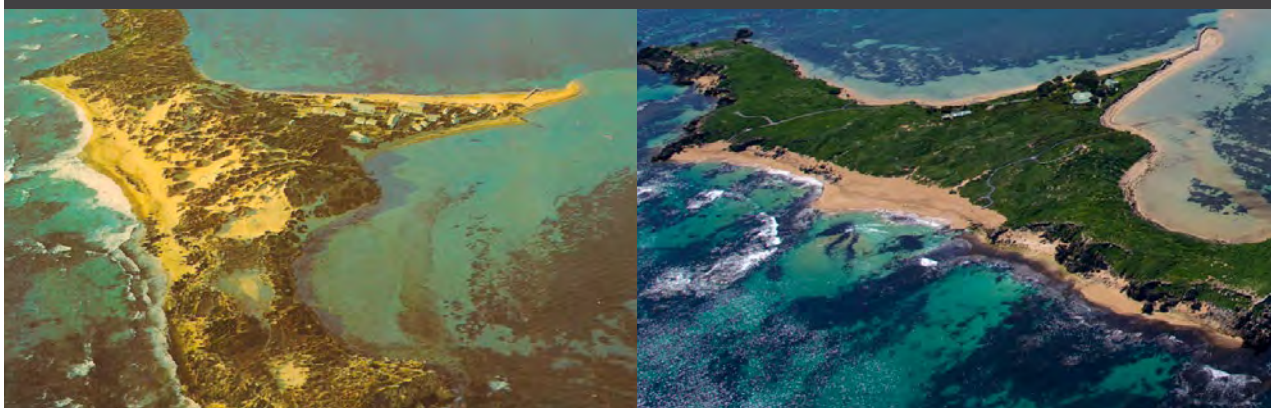
4.0 Threatening processes (continued)

4.4 Erosion (continued)

The aerial photograph below highlights Penguin Island in the early 1970s. During this time the island was a popular destination for holiday makers, with a number of camp buildings evident in the photo. As there were no access restrictions, trampling of vegetation lead to significant areas of erosion.

Today, a boardwalk on Penguin Island provides restricted access through the dunes and areas of erosion are managed with revegetation and other stabilisation techniques. The success of these management measures is evident in the second photograph, which was taken in 2015, providing a clear example of how inappropriate access and erosion can impact native vegetation cover.

FIGURE 9 - Inappropriate access and erosion management Penguin Island, from early 1970s [*left*] to 2015 [*right*] (Historical photo courtesy of the Wachmer family)



4.5 Vandalism and rubbish dumping

Vandalism can include destruction of property and facilities as well as damage to native vegetation, through tree poisoning, campfires and illegal clearing. Dumping of large amounts of rubbish in most of the foreshore reserves is uncommon as access is generally well regulated and the reserves are well used. However, rubbish dumping is an issue in some of the more isolated foreshore areas including parts of Sector 3, 4 and 5.

Dumping of rubbish can spread weeds and diseases, can reduce the visual amenity of the reserves and can constitute a fire hazard. Littering is also a common problem along the foreshore, particularly those areas of high visitation, such as Sectors 1 and 2.

Large scale rubbish dumping and vandalism can be managed through restricting unauthorised access into the foreshore reserve and maximising visual surveillance where possible through Crime Prevention Through Environmental Design techniques, while littering is best managed through ensuring adequate provision of rubbish bins, litter removal and education.

The key objectives for rubbish management within the foreshore are to:
Ensure adequate provision of rubbish bins along the foreshore, particularly around parkland areas, boat ramps and picnic facilities.
Undertake regular removal of litter to minimise the transfer into the ocean
Ensure bins are emptied regularly
Ensure unauthorised access is restricted and aim to increase visual surveillance of foreshore areas where appropriate.

5.0

SECTOR ONE

Rockingham

5.1 Landscape Attributes

FIGURE 14

Val Street jetty

Palm Beach Jetty

Churchill Park

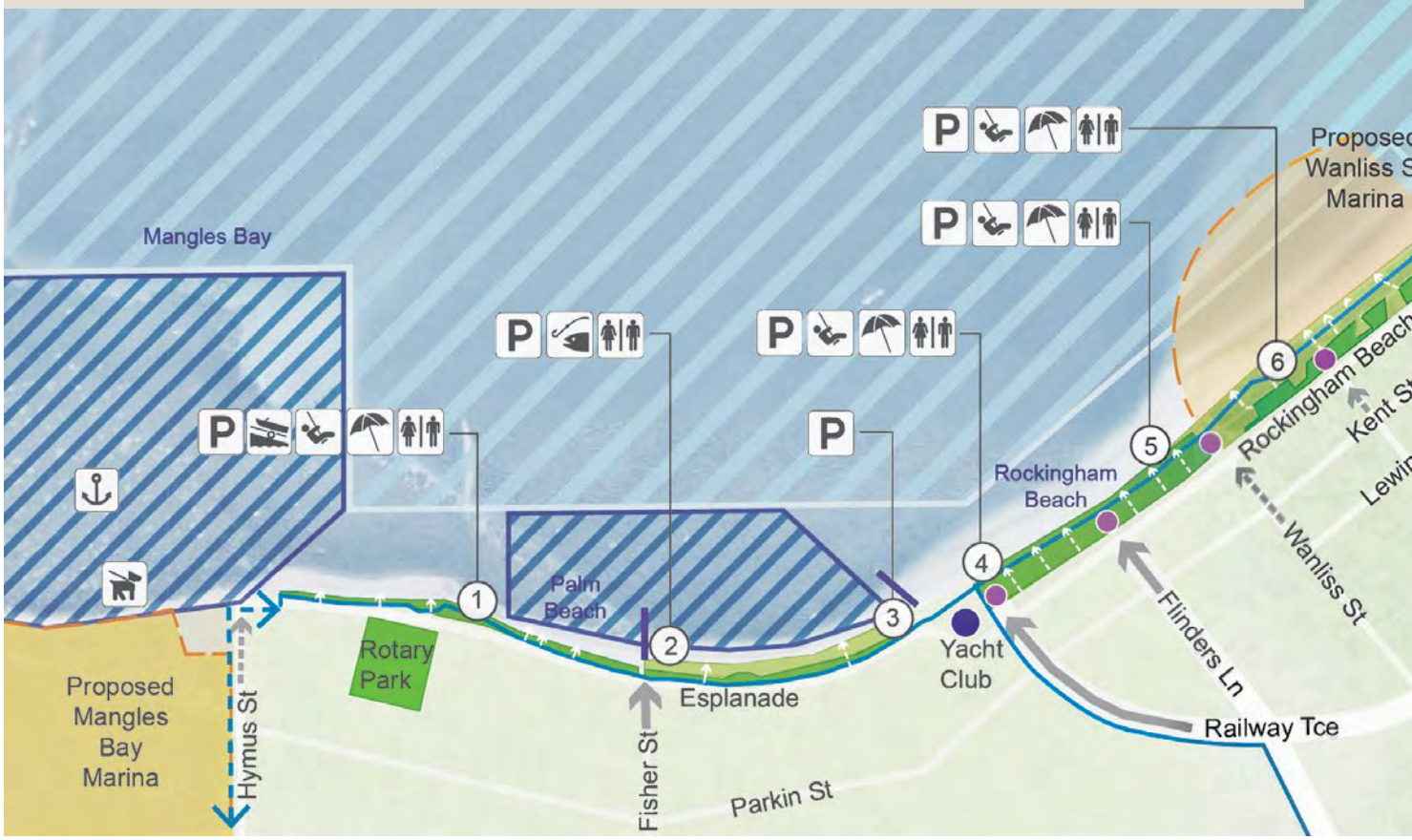
Churchill Park

Bell Park

Rockingham Foreshore Promenade

Rockingham Beach

Naval Memorial Park




CBH Jetty
East Rockingham Beach
CBH Grain Terminal
Caravan Park
Governor Rd
Weld St
Roe St
Hillman St
Victoria St
Ennis Ave
8
7
Legend
DPaW Reserve
Dune Vegetation
Parkland
Existing DUP
Proposed Extention of DUP
Primary Road Connection/ Access
Secondary Road Connection/ Access
Pedestrian Beach Access
Proposed Development
Concept Area
Water Ski Area
Mooring Area
Coastal Infrastructure
Minor Carpark & Pedestrian Entry
Public Toilets
Moorings
Surf Beach
Boat Ramp
Shade/Shelter
Play Equipment
Dog Beach
Fishing Beach
Lookout
Parking
Key Recreation Nodes
1 Palm Beach Boat Ramps
2 Palm Beach Jetty
3 Val St Jetty
4 Churchill Park
5 Bell Park
6 Rockingham Foreshore Reserve Parks
7 Naval Memorial Park
8 Governor Reserve

5.1 Landscape Attributes (continued)

5.1.1 Site characteristics

This sector incorporates unique north and northwest facing beaches, varying from 5 to 20m wide shallow water and sheltered conditions making this area excellent for swimming, particularly for children. The area is characterised by its leafy foreshore parks and range of coastal attractions, such as jetties and boat ramps. The sector is comprised of three distinct character zones which include different features and facilities resulting in unique visitor experiences.

The western zone, from Mangles Bay to Railway Terrace, includes Mangles Bay and Palm Beach which both have high visitation rates, together with coastal infrastructure, including Palm Beach Jetty, Val Street Jetty and Palm Beach boat ramps. These features, along with Point Peron, are key areas of coastal attraction in this sector. Along this stretch of coast the beach is readily accessible from all car parks and at regular intervals along the coastal dual use path (DUP).

Furthermore, ramped beach access is available at Palm Beach Jetty, Peron Park and Val Street Jetty. The Esplanade and DUP, which run parallel to the coast, offer almost uninterrupted views out over Mangles Bay, Cockburn Sound and Garden Island. Along this stretch of coast, the foreshore reserve is narrow, consisting mostly of turfed areas with small areas of native dune vegetation. The stretch includes two public toilets but is lacking in other facilities, such as BBQs, seating and play equipment.

The second character zone, from Railway Terrace to Wanliss Street, is characterised by the shady Churchill and Bell Parks, which offer recreational opportunities and ample access, including several ramps, to the popular Rockingham Beach. The parks are accessible to pedestrians and motorists, with adjacent on-street and off-street parking. Additionally, they are in close proximity to the civic centre and commercial zone and include ample facilities such as BBQs, seating, play equipment, public toilets and water fountains. Both parks contain mature trees and gazebos, providing shade and creating an inviting atmosphere for picnics and recreational activity. In this zone the foreshore reserve is wide and a pedestrian promenade runs parallel to the beach.

The third zone, from Wanliss Street to Governor Road Reserve, is the least developed stretch of the Sector's coastline. In this zone, the CBH Grain terminal is the dominant feature, visible from the entire stretch of beach in Sector One. This stretch contains a significant portion of remnant coastal vegetation and the parks and DUP are set back from the coast behind the dunes. The smaller parks between Wanliss Street and Victoria Street are well serviced with ample parking, gazebos, BBQs, play equipment, toilets and beach access, but unlike the popular Bell and Churchill Parks, these parks have very little shade due to a lack of mature trees. Similarly, Naval Memorial Park and Governor Road Reserve are well serviced but exposed and lacking in mature trees. East Rockingham Beach, a dog beach, is accessible from the car parks and at regular intervals along the DUP but is considerably less visited than the other beaches in this sector.

Due to the proximity of houses to native vegetation, parts of this sector are considered to be bushfire prone areas, such as the houses adjoining Point Peron at Hymus Street and adjoining the foreshore reserve east of Victoria Street.

5.1.2 Aboriginal heritage site

An investigation of Aboriginal Heritage areas in this sector revealed a registered site, Site 3471: Rotary Park Rockingham (mythological), which encompasses Rotary Park and the foreshore reserve from Fisher Street to the Garden Island Causeway.

There were also two sites located close to the coast at Lake Richmond; however, these sites were not within the study area.

Any major development that occurs within the vicinity of a registered Aboriginal Heritage Site will require an ethnographic and archaeological determination. This may involve consultation with aboriginal elders of the Rockingham region. If the assessment confirms specific sites are to be impacted upon, the City may need to apply for consent to use the land from the Minister for Indigenous Affairs under section 18 of the *Aboriginal Heritage Act 1972*.

5.1 Landscape Attributes (continued)

5.1.3 Potential landscape improvements

A key recommendation of the City's Economic Development Strategy (2014-2017) (EDS) was to undertake detailed design and master planning of the Rockingham Foreshore, to establish the area as a regional foreshore destination.

Consequently, the Rockingham Foreshore Master Plan was prepared in 2015 to provide a staged development approach which initially focuses on Churchill and Bell Parks. The Master Plan is informed by objectives and actions which seek to strike the balance between enhancing the public spaces, creating a safe, accessible destination and stimulating investment, with the aim of delivering the following key outcomes:

- A contemporary design using world best practice civic and public place design principles and materials that are complementary to the planning objectives of the Foreshore Precinct of the Waterfront Village area
- A design that is sympathetic to, and makes maximum use of, the uniqueness of the north facing sheltered beach, and the significant shaded areas within the two parks
- A design that is complementary to the functionality and feasibility of existing and future apartment/hotel/food and beverage/retail development
- A design that will be conducive to community events and gatherings
- A design that incorporates latest technology public toilet systems both portable and fixed
- A design that facilitates better linkage between Bell Park and the Palm Beach Jetty
- The feasibility of the establishment of an "ocean pool" in the study area and recommendations on form, scale and location
- Streetscapes that facilitate pedestrian activation and alfresco dining, maximising community interaction and enjoyment
- Streetscapes that facilitate effective linkage between shopfronts and adjacent reserves to complement existing and future retail, food and beverage and tourism activities
- A reduction in vehicular traffic and the impact of vehicles and parking on the amenity of the area generally and options for appropriately relocated parking in the near vicinity
- Development of a title/name for the general area under design consideration that will be used for marketing and promotional purposes in the future.

All potential landscape improvements for Sector One should be consistent with the Rockingham Beach Foreshore Master Plan. The adopted Master Plan covers three separate areas, with 'Area One', being from Val Street to Wanliss Street, 'Area Two' being Hymus Street to Val Street and 'Area Three' being Wanliss Street to Governor Street.

In a general sense, the Master Plan recommends better pedestrian connection throughout the foreshore, consistent street furniture/lighting themes, improved beach access, selective tree planting and coastal protection measures.

'Area One' contains the major transformational items including:

- An upgrade to Railway Terrace, between Kent Street and Rockingham Beach Road, to create a pedestrian orientated space through reconfigured carparking, the introduction of significant tree planting and the widening of footpaths.
- The creation of the Railway Terrace 'Beach Plaza' which transforms the existing carpark to a formal, pedestrian focussed public space.
- Expansion of the pedestrian/alfresco 'Boardwalk' in front of the cafes and restaurants west of The Cruising Yacht Club.
- The new 'Rockingham Beach Jetty', as an extension of the 'Beach Plaza', to provide a distinctive and unique recreational element.
- The Rockingham Beach Road 'Shared-Space', including reduced traffic speeds and changes to the footpath and road profile.
- A regional 'Water-Playground' in the location of the current Flinders Lane foreshore carpark.

Within 'Area Two' the key features include the management of traffic speeds along Esplanade, to better connect Rotary Park and the Palm Beach café to the foreshore, and a series of exercise nodes along the pedestrian path.

'Area Three' will contain a number of new elements including an expanded Wanliss Street carpark, a new 'active node' for wheeled and ball sports and a continuation of the exercise nodes.

Image: Point Peron boat ramp.

5.2 Environmental Attributes

5.2.1 Coastal vulnerability

All future upgrades to the foreshore should be undertaken with consideration for coastal vulnerability and observed coastal processes. The key coastal processes and current and proposed revetment strategies relative to Sector 1 are outlined in Figure 15.

In particular, the Garden Island Causeway has a significant impact on the shoreline movements in Sector 1. The Garden Island causeway was constructed in 1973 to enable vehicle access to naval base on Garden Island. Approximately 75% of the causeway is comprised of impermeable rock fill, with only two trestle openings, one north of the Point Peron boat ramp and the other south of Garden Island.

Historically, sediment was transported east along Point Peron towards Rockingham beach; however, the largely impermeable nature of the Causeway disrupted this natural sediment flow resulting in a significant build-up of sand at the Point Peron Boat Ramp. To manage this accretion, a 200m long groyne was built 100m to the west shortly after the construction of the causeway. In 1986, an almost 90 degree angled, 65m groyne extension was added, with the addition of a 50m spur groyne in 1990.

The area between these groynes in known as the Point Peron Sand Trap, from which approximately10,000m^3 of sand is excavated every year to prevent sedimentation of the boat launching facility. The sand trap area has accreted of the order of 90m since the installation of the causeway, with 50m of this occurring since the installation of the spur groyne extension to the sand trap in 1990. The accretion of this sand trap indicates that the net sediment transport into the trap area has been greater than the volumes excavated over time (MP Rogers, 2010).

Historically, the sand excavated from this trap has been stockpiled and taken to renourish other beaches in the Rockingham and Warnbro areas as well as other erosion hotspots around the metropolitan region.

In addition to this build-up, the Causeway has also resulted in areas of erosion adjacent to the Point Peron Camp School and Hymus Street. The erosion at Point Peron Camp School was managed by the installation of a GSC (Geotextile Sea Container) groyne. To mitigate the effects of erosion at Hymus Street, the City has installed a rough limestone armour seawall and constructed a timber groyne. The City also undertakes beach renourishment in this area, with sand sourced from the nearby Point Peron Sand Trap, while also recognising the need to investigate the construction of an engineering solution to protect Hymus Street in the longer term.

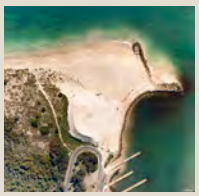
Erosion also occurs on the southern side of Point Peron adjoining the Apex Camp, likely as a result of prevailing winds and localised sediment flow. The erosion in this area was significant and resulted in the loss of a number of camp buildings. Renourishment currently occurs in this area to manage the impacts of erosion.

Furthermore, a range of other coastal revetment structures are present in Rockingham and East Rockingham, including limestone sea walls, nearshore breakwaters and GSC protection. In key areas of erosion, such as between Wanliss and Victoria Street, the City recognises the need to investigate the construction of additional revetment to ensure the long term protection of the foreshore environment. As discussed in Section 3.1, such management of coastal vulnerability should be cognisant of SPP 2.6.

FIGURE 15

A

Spur Groyne and Sand Trap



Saturated

Excavated

C

Buried GSC Seawall

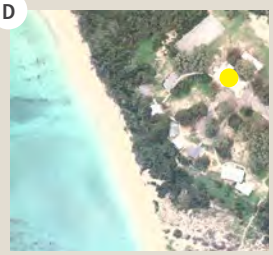
B

Erosion

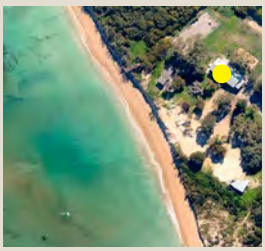
Renourishment

Hymus Street Erosion and Renourishment

D



May 2008
Fully functioning camp with vegetated dunes



Aug 2014
Beach and vegetation eroded, camp buildings removed

July 2015
Beach renourished with sand from the spit groyne sand trap

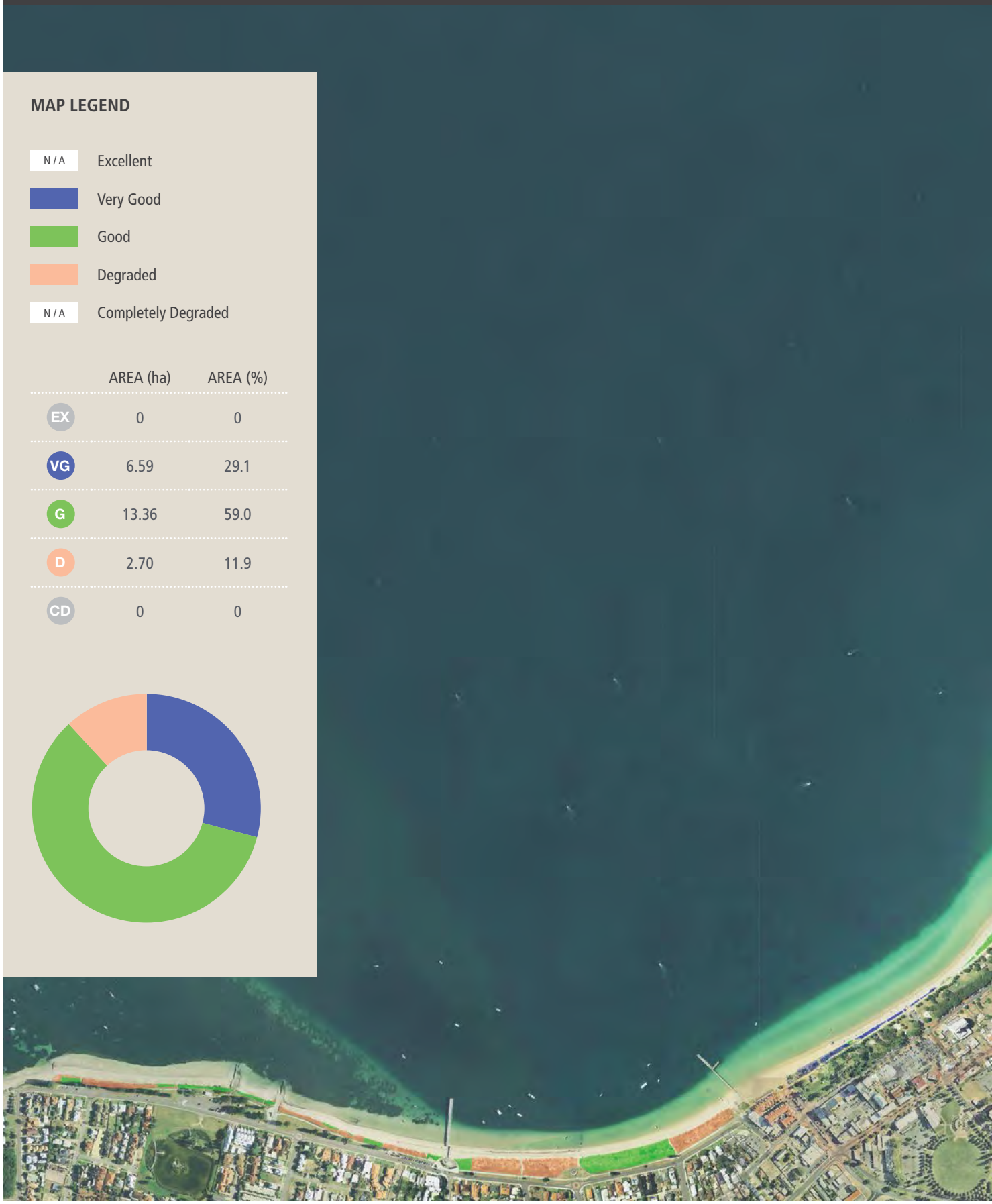
Apex Camp Erosion Impacts and Sand Nourishment

● = point of reference

DPaW Reserve
Key Accretion Area
Key Erosion Area
Existing Coastal Management

5.2.2 Vegetation condition

FIGURE 16



5.2.3 Vegetation type

FIGURE 17

MAP LEGEND

- *Acacia rostellifera* Shrubland
- *Scaevola crassifolia* Mixed Shrubland
- *Acanthocarpus preissii* Open Heath
- *Lepidosperma gladiatum* Sedgeland
- *Tetragonia decumbens* Herbland
- Spinifex Grassland
- *Tetragonia decumbens and Cenchrus cladestinus* Herbland

Acacia rostellifera
Shrubland

Acanthocarpus preissii
Open Heath

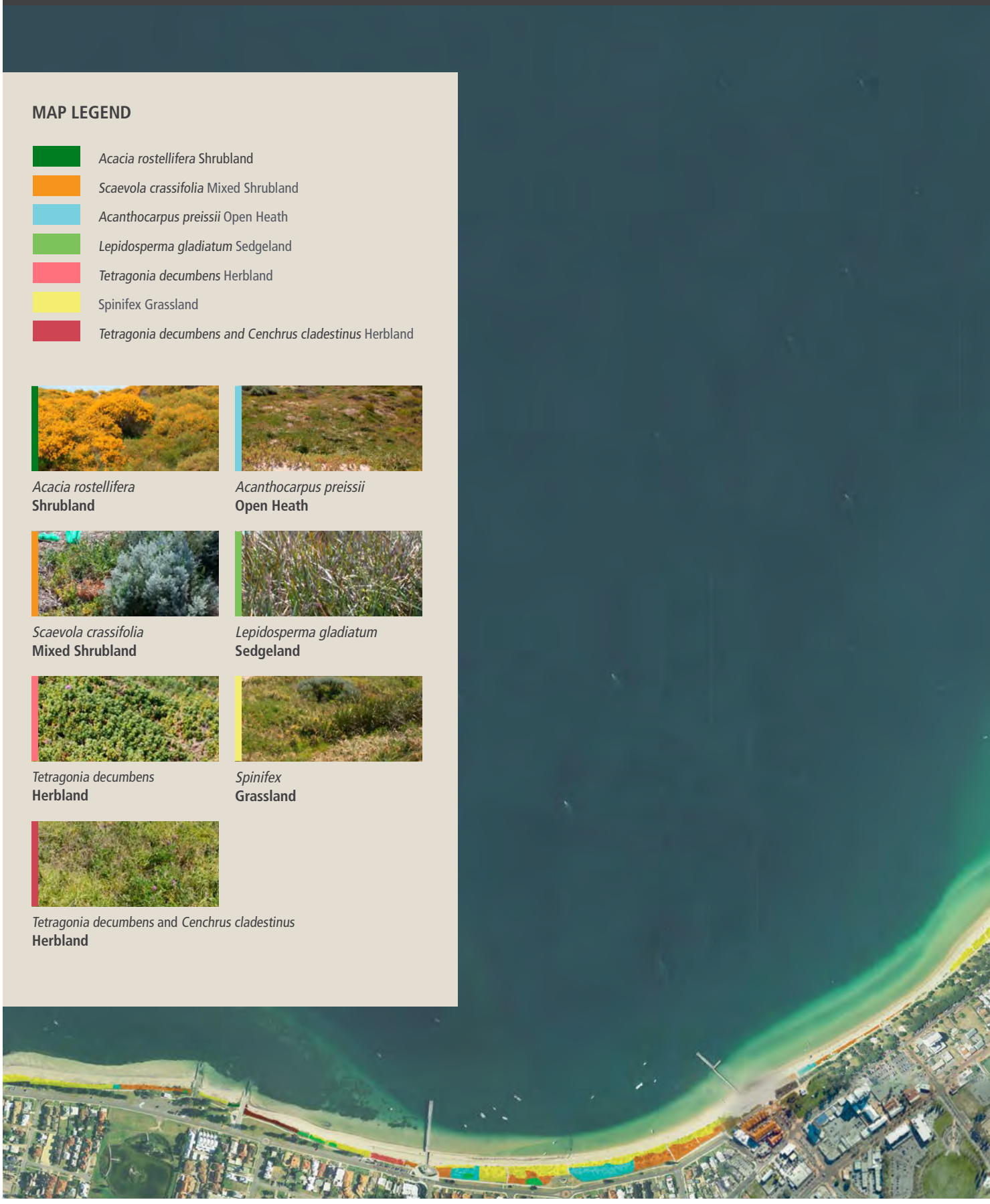
Scaevola crassifolia
Mixed Shrubland

Lepidosperma gladiatum
Sedgeland

Tetragonia decumbens
Herbland

Spinifex
Grassland

Tetragonia decumbens and *Cenchrus cladestinus*
Herbland



5.2.4 Weeds and threatening processes

FIGURE 18

	Species Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Treatment
WEED SUITE ONE - Grasses	*Avena barbata*	Bearded Oat							●	●	●	●			Spray with Fusilade (Fluazifop) at 3-5 leaf stage
	Bromus diandrus	Great Brome						●	●	●					Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Cenchrus clandestinus	Kikuyu	●										●	●	Spray with Fusilade (Fluazifop)
	Cynodon dactylon	Couch Grass	●	●									●	●	Spray with Fusilade (Fluazifop)
	Lolium rigidum	Wimmera Ryegrass						●	●	●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Stenotaphrum secundatum	Buffalo Grass	●	●	●	●	●						●	●	Spray with Fusilade (Fluazifop)
WEED SUITE TWO - Herbs	*Pelargonium capitatum*	Rose Pelargonium						●	●	●	●	●			Spot spray with Glyphosate
	Tetragonia decumbens	Sea Spinach						●	●	●	●	●			Spot spray with Glyphosate
	Trachyandra divaricata	Trachyandra						●	●	●					Spot spray with Glyphosate
	Fumaria capreolata	Whiteflower fumitory						●	●	●	●				Spray with Metsulfuron
WEED SUITE THREE - Euphorbia	*Euphorbia terracina*	Geraldton Carnation Weed						●	●	●					Spray with Logran® at 12.5 g/100 L
	Euphorbia paralias	Sea Spurge	●								●	●	●	●	Spray with Glyphosate (360g/L) and 0.2g Metsulfuron and Pulse in 10L water, or manual removal
POINT LOCATIONS - Woody Weeds	Schinus terebinthifolius	Japanese Pepper Tree	●	●	●								●	●	Basal bark and paint with Garlon and Diesel or cut and paint with 50% Glyphosate


MAP LEGEND
WEED SUITE ONE - Grasses
WEED SUITE TWO - Herbs
WEED SUITE THREE - Euphorbia
WOODY WEEDS
Eucalyptus utilis
EROSION
GRAFFITI

5.2 Environmental Attributes (continued)

5.2.4 Weeds and threatening processes (continued)

Marine couch (*Sporobolus virginicus*), a native coastal grass species, was located at the southern end of Sector One, which is one of the areas recommended for grass spraying. This species is widespread in saline areas along the Western Australian coastline, along foredune areas and banks of the Swan and Canning rivers. marine couch looks very similar to the non-native couch grass (*Cynodon dactylon*), although the native species grows in a more tussock or upright form, has darker blue/green foliage and the seed heads are in a single spike instead of the four-branched head of the weed species (Figure 17) It is recommended that care be taken whilst undertaking weed control to avoid spraying the native marine couch in this Sector.

FIGURE 19 - Native marine couch grass vs invasive couch grass

5.2.5 Reserve infrastructure

The extent and condition of fencing, pathways, signage and amenities which occur along the foreshore in this sector are noted in the tables below.

Table 15 - Fencing

Fence Type	Good Condition (m)	Poor Condition (m)
Post and strand	6,479	4
Post, strand and metal rail	530	0
Limestone wall	104	0
Metal fence	504	0
Bollards	1,918	0

Table 16 - Paths

Path Type	Fenced	Good Condition (m)	Poor Condition (m)
Sand	Yes	1,109	0
Paved	No	502	26
Concrete	Yes	4,093	13
Bitumen path	No	674	0

Table 17 - Signage

Signage Type	Number Overall	Poor Condition
Directional	7	1
Informational	37	12
Regulatory and safety	111	23

Table 18 - Amenities and other infrastructure

Amenity	Number Overall	Poor Condition
Barbeque	18	0
Bench seat	72	0
Bike rack	4	0
Bin	57	1
Bin and dog bag	16	0
Cigarette bin	18	0
Drink Fountain	8	0
Drink fountain with dog bowl	2	0
Memorial	3	0
Picnic table	3	0
Playground	14	0
Dog bag dispenser	1	1
Recycle bin	4	0
Shade structure with bench seat	3	0
Shade structure with picnic table	43	0
Shower	13	0
Tap	1	0
Toilet block	6	0

5.2.6 Native fauna

A targeted fauna survey was only undertaken in Sectors 3, 4 and 5 as these areas of coastal habitat were considered most likely to support a diverse fauna assemblage. However, a full list of species likely to occur along the City's coastline, in addition to a full list of species recorded during the field surveys, can be seen in Appendix C.

5.2.7 Invasive fauna

Rabbits, feral cats and foxes have all been recorded in this sector. The impact of feral animals on the flora and fauna in this sector should continue to be monitored and control undertaken accordingly.

5.3 Management Actions

TABLE 19

Management Actions		Approximate cost	Priority*
1.	Revegetation, prioritising areas of Degraded vegetation condition (2.7 ha)	68,000	h
2.	Progressively undertake weed control activities in areas of Good and Very Good vegetation condition (19.92 ha)	60,000	h
3.	Upgrade areas of poor condition fencing and access paths as required	Cost ongoing	h
4.	Monitor impacts of feral animals and implement control as required	Cost ongoing	h
5.	Progressively upgrade signage as required	Cost ongoing	h
6.	Stabilise 12 key areas of erosion using brushing, jute matting or revegetation	3,600	m
7.	Investigate revetment at Hymus Street and along Rockingham Foreshore towards Victoria Street	-	m
8.	Implement landscape improvements as outlined in the Rockingham Beach Foreshore Master Plan	See RBFMP	m
9.	Install wayfinding and interpretive signage at key locations as outlined in the Rockingham Beach Foreshore Master Plan	See RBFMP	m
		Total: 131,600	

* Priority: h=high, m=medium, l=low

6.0

SECTOR TWO

Shoalwater, Safety Bay, Waikiki

6.1 Landscape Attributes

FIGURE 20

Mersey Point Jetty

Bent Street Boat Ramp

The Pond

Waikiki Foreshore Park - Francis Street

Legend

- DPaW Reserve
- Dune Vegetation
- Parkland
- Existing DUP
- Proposed Extention of DUP
- Primary Road Connection/ Access
- Secondary Road Connection/ Access
- Pedestrian Beach Access
- Proposed Development
- Concept Area
- Water Ski Area
- Mooring Area
- Coastal Infrastructure
- Minor Carpark & Pedestrian Entry
- Public Toilets
- Moorings
- Surf Beach
- Boat Ramp
- Shade/Shelter
- Play Equipment
- Dog Beach
- Fishing Beach
- Lookout
- Parking

Key Recreation Nodes

1. Shoalwater Foreshore Reserve
2. Lions Park
3. Mersey Point
4. Safety Bay Foreshore Park - 'The Pond'
5. Bent Street Boat Ramp
6. Waikiki Foreshore Park - Malibu Road
7. Waikiki Foreshore Park - Francis Street

N

0 m 500 m

6.1.1 Site characteristics

This sector incorporates predominantly west facing beaches with views out to the Shoalwater Islands and Warnbro Sound. The area is characterised by its range of coastal attractions, including two boat ramps, the regionally significant Point Peron, the Shoalwater Islands Marine Park, popular kite and wind surfing destination Tern Island and 'The Pond', in addition to a number of foreshore parks.

The northern zone, Shoalwater, is characterised by the Shoalwater Islands Marine Park with its off-shore reefs, rocky limestone islands, most notably Penguin Island, Seal Island and Shag Rock. As a result, Shoalwater Beach is a sheltered location popular for swimming, kayaking and snorkelling, with the beach accessible by regularly spaced pedestrian paths through the dunes. The scenic Penguin Island is accessible via a ferry from Mersey Point and is a popular tourist destination. The majority of the native dune vegetation of the Shoalwater Foreshore Reserve has been conserved with a continuous DUP set back from the coast behind the dunes. Just two small foreshore parks are present in this zone and both have parking but few facilities and little shade.

The second zone, Safety Bay, includes by two boat ramps, the popular Safety Bay Beach, Tern Island and 'The Pond' which is a popular windsurfing and kitesurfing destination. The Safety Bay Foreshore Park is situated adjacent to 'The Pond' and provides numerous facilities, including a yacht club, parking, public toilets, play equipment and gazebos. Despite ample facilities, Safety Bay Foreshore Park is not as well connected to the beach as other coastal recreation nodes. In this area the parkland is a linear strip, parallel to Safety Bay Road and is characterised by a row of mature Norfolk Island Pines.

Further South along the coast, Waikiki continues to be characterised by Norfolk Island Pines while the foreshore reserve becomes very narrow. Through this section there is a continuous DUP, providing regular beach access, which runs between a narrow strip of coastal vegetation and a narrow strip of parkland, however the strip of parkland offers little shade. Along Safety Bay Road and the foreshore reserve there are expansive views out over Warnbro Sound. Key recreation nodes, including Waikiki Foreshore Park at Malibu Road and Waikiki Foreshore Park at Francis Street, punctuate the stretch of coast provide a range of amenities such as parking, toilets and play equipment.

Due to the proximity of houses to native vegetation, the section of foreshore along Shoalwater to Mersey Point is considered a bushfire prone area, which is an important consideration for future management.

6.1.2 Potential landscape improvements

An opportunity for this sector includes extending the existing DUP to provide access north of Boundary Road. This could potentially be via a direct connection through to Point Peron Road or a pedestrian detour along Safety Bay Road and Memorial Drive. This connection would further enhance the recreational capacity of Sector Two, providing a pedestrian cycle link along the Shoalwater Islands Marine Park to the regionally significant Point Peron, while also strengthening the link to Mersey Point, where an upgrade to the kiosk, jetty and signage is proposed.

Both Liverpool Street and Boundary Road streetscapes could be enhanced through planting to strengthen the visual connection to the foreshore. Additionally, both Arcadia Drive and Safety Bay Road streetscapes could be enhanced and street trees selectively planted in order to form a foreshore promenade. Additional pedestrian paths and crossing points could also be constructed to improve the accessibility and safety of the area.

Opportunities also exist to enhance the recreation nodes at 'The Pond' and the Waikiki Foreshore Parks at Malibu Road and Francis Street. These opportunities include the provision of more shade, potentially in the form of trees and shade structures, and more infrastructure, such as seating and BBQs. In order to preserve the existing coastal vegetation, beach access paths could be consolidated and formalised where possible.

Furthermore, beach access ramps could be considered in particular locations in order to provide universal access. Lastly, the existing cyclone mesh fencing around the foreshore reserve and DUP should be replaced with post and wire fencing, consistent with other foreshore areas.

1. Proposed picnic node with shade shelters and tree planting
2. Enhanced car park (35 no. spaces) and arrival space
3. Look out and interpretation node
4. Re-aligned dual use path
5. Grassed area for rigging
6. Boardwalk access to beach
7. Enhanced beach access paths

FIGURE 21 - 'Concept Area 1' Tern Island

Legend

- Existing Tree
- Proposed Tree
- Proposed Path
- Investigate Shade Provision to Play Area
- Existing Gazebo
- Proposed Gazebo
- Shade Structure

1. Enhanced play area
2. Potential consolidated / enlarged carpark with footpath to roadside
3. Wind/kite surfing rigging and instruction area
4. Potential focal feature to existing roundabout
5. Realign DUP
6. Enlarged carpark and recreation node (refer to inset)
7. Recreation node with seating, trees and beach access
8. Enhanced path connections to Safety Bay Road
9. Rigging and take off area
10. Extend footpath along road and upgrade car park wayfinding
11. Iconic interpretive sign
12. Enhanced overflow carpark
13. Enhanced recreational node and play area with shelter
14. Enhanced promenade/beach front

Concept Area 1. Waimea Road Rockingham looking south east

Concept Area 2. Waimea Road recreation node looking south

6.1 Landscape Attributes (continued)

6.1.2.1 Concept plan 1 - Design rationale

Tern Island is an ephemeral sand spit in Safety Bay, adjacent to a body of water called the Pond. The area is mainly used for kite and wind surfing and has multiple access points to the shoreline. A key priority at the site is to consolidate and manage the access points, particularly from the yacht club and car parks, and manage the circulation of pedestrians using the DUP along the foreshore.

The concept plan concentrates on the Waimea Road car park, which is in an elevated position above the Pond and offers more direct access to the Pond than the car park adjoining the yacht club. The design allows for a focal point lookout and realigns the car park to increase capacity from approximately 16 bays to 35 bays. The design also proposes realigning the existing DUP to increase the areas of grass which can be used for rigging by wind and kite surfers, without interfering with the circulation of the areas.

A boardwalk is proposed as a consolidated primary access point to the Pond from the car park, which will provide a recreational feature, allow ease of access to the water while minimising trampling of dune vegetation. An additional lookout with interpretation opportunities has also been proposed close to the DUP, to allow for pedestrian access and use.

The remainder of the Safety Bay Road foreshore is proposed to have upgraded amenities and key areas with additional shelters and recreational nodes spaced along the foreshore at reasonable distances to allow for opportunities to rest and enjoy the views or access to the beach.

This is an indicative concept plan only and will require further detailed design and community consultation prior to construction. All proposed upgrades are subject to funding availability.

6.2 Environmental Attributes

6.2.1 Coastal vulnerability

Three key areas of shoreline movement are present within Sector Two, with major accretion occurring at Mersey Point and Tern Island, and erosion occurring in between these areas.

Tern Island is a prominent feature of the City's coastal landscape. Historical surveys of the Warnbro Sound highlight the dynamic nature of sediment transport in the region.

When John Septimus Roe surveyed the area in 1893, he highlighted the Tern Island spit similar to its configuration today and labelled it Peel Harbour.

FIGURE 22 - Survey of Peel Harbour by John Septimus Roe in 1893. (Image source: Hollings 2004).

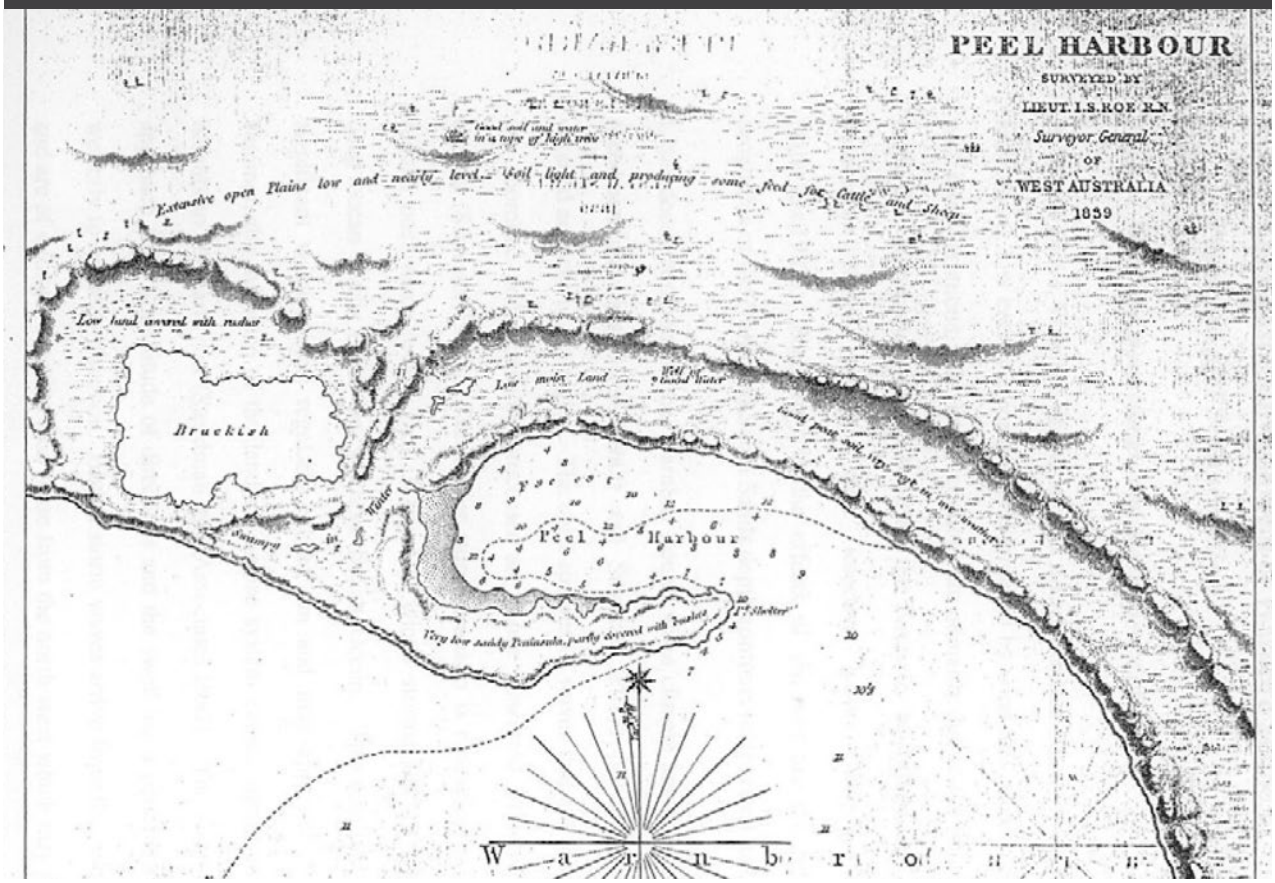


FIGURE 23 - [*left*] Tern Island 1953 and [*right*]: Tern Island 2015

However, historical photos from 1953 highlight the absence of Tern Island altogether (Figure 23). This periodic absence is reflected in the location of the Safety Bay Yacht Club which was once located on the shoreline (Figure 24) and is now over 135m from the shore, as well as a number of jetties which have since been buried. This pattern suggests that the area is influenced by a dynamic long term sediment cycle (Hollings 2004).

Currently, it is estimated that Tern Island is accreting by up to 10,000 m^3 per year. The growth of Tern Island has had a significant impact on the Bent Street boat ramp, with the sedimentation impeding boat access. Consequently, the Bent Street Navigation Channel was dredged in 2013. Tern Island continues to encroach on the new channel and long term management of this area to ensure safe boat passage will require further consideration.

Similarly, it is estimated that Mersey Point is accreting at a rate of about 1m per year which is impeding access for the Penguin Island ferry to dock at the Mersey Point jetty. The jetty has been extended previously, which provided only a short term solution as sedimentation continued in the area. As a result, a new jetty is proposed for construction just north of Mersey Point in an area which experiences significantly less shoreline movement. This is will facilitate the transport of visitors to Penguin Island, which is a significant tourism drawcard for the region.

To manage the impacts of erosion in this sector rock sea walls have been installed along Arcadia Drive east of Mersey Point and at Waikiki. Given the significant value of infrastructure located at Waikiki, additional revetment is being investigated to protect this area in the longer term.

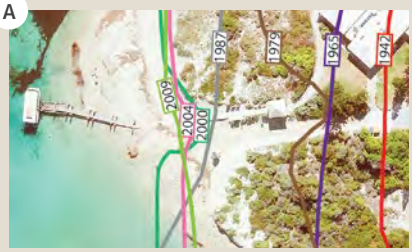
FIGURE 24 - Safety Bay Yacht Club circa 1950

Photo source: Rockingham Campus Community Library and the Rockingham Historical Society and Museum

6.2.1 Coastal vulnerability

FIGURE 25

A



Mersey Point Jetty Vegetation Line Movement

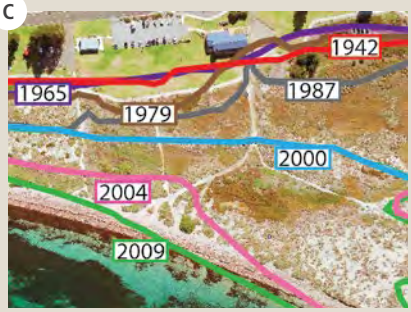
B

Construction of Granite Seawall

Buried Seawall After Sand Renourishment

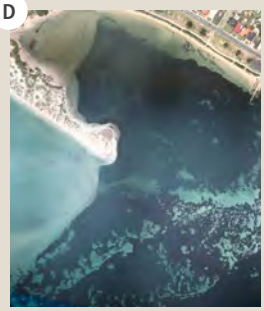
Buried Rock Seawall and Sand Nourishment

C



Tern Island Vegetation Line Movement

D



May 2008
Bent Street Boat Ramp and Tern Island

Feb 2014
Tern Island has grown and navigation channel has been dredged

July 2015
Tern island continues to accrete and encroach on the New channel

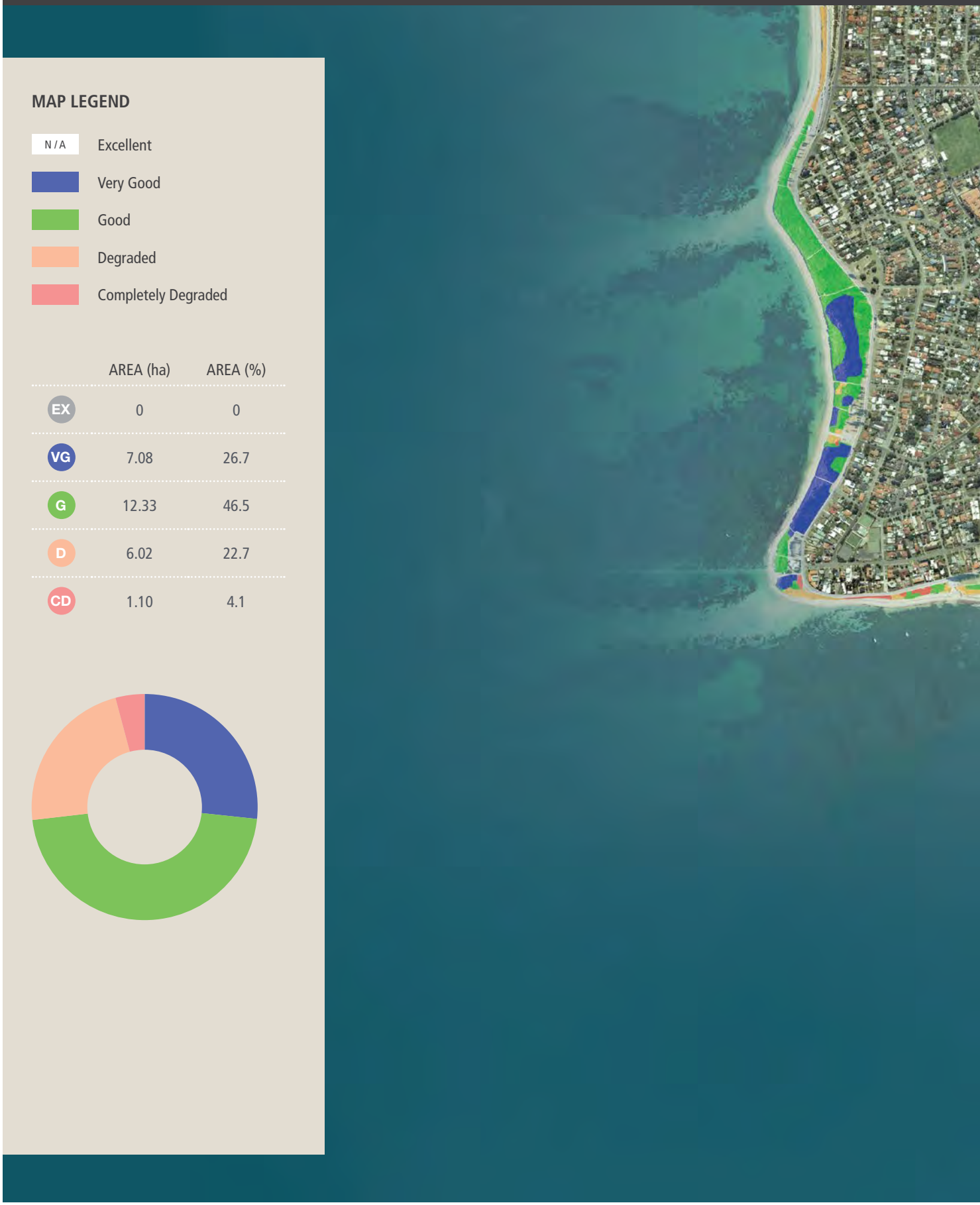
Bent Street Navigation Channel

DPaW Reserve | Key Accretion Area | Key Erosion Area | Existing Coastal Management

N 0m 1000m

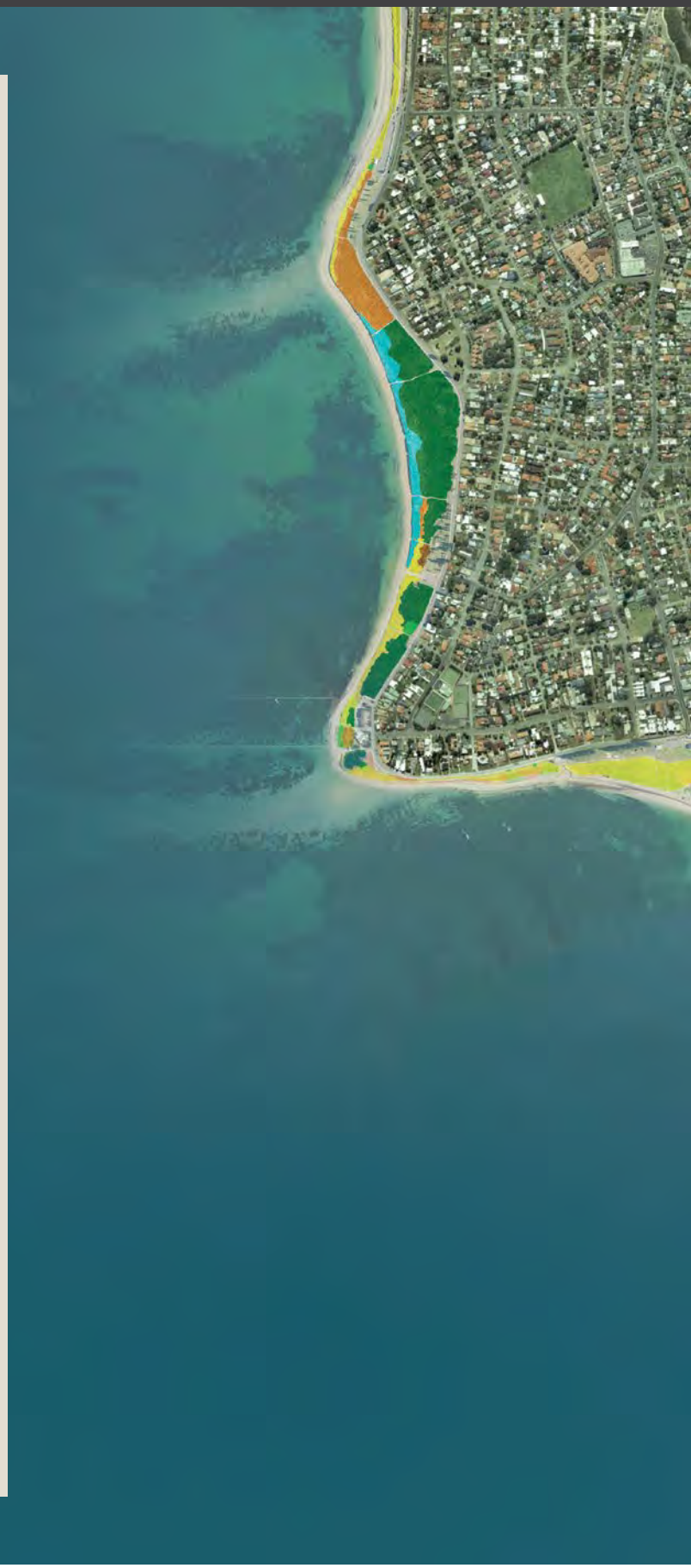
6.2.2 Vegetation condition

FIGURE 26



6.2.3 Vegetation type

FIGURE 27



MAP LEGEND

- *Acacia rostellifera* Shrubland
- *Scaevola crassifolia* Mixed Shrubland
- *Acanthocarpus preissii* Open Heath
- *Lepidosperma gladiatum* Sedgeland
- *Ficinia nodosa Sedgeland*
- Spinifex Grassland
- *Olearia axillaris Shrubland*
- *Nitraria billardierei Shrubland*
- Tall Shrubland

Acacia rostellifera
Shrubland

Acanthocarpus preissii
Open Heath

Ficinia nodosa
Sedgeland

Lepidosperma gladiatum
Sedgeland

Scaevola crassifolia
Mixed Shrubland

Olearia axillaris
Shrubland

Nitraria billardierei
Shrubland

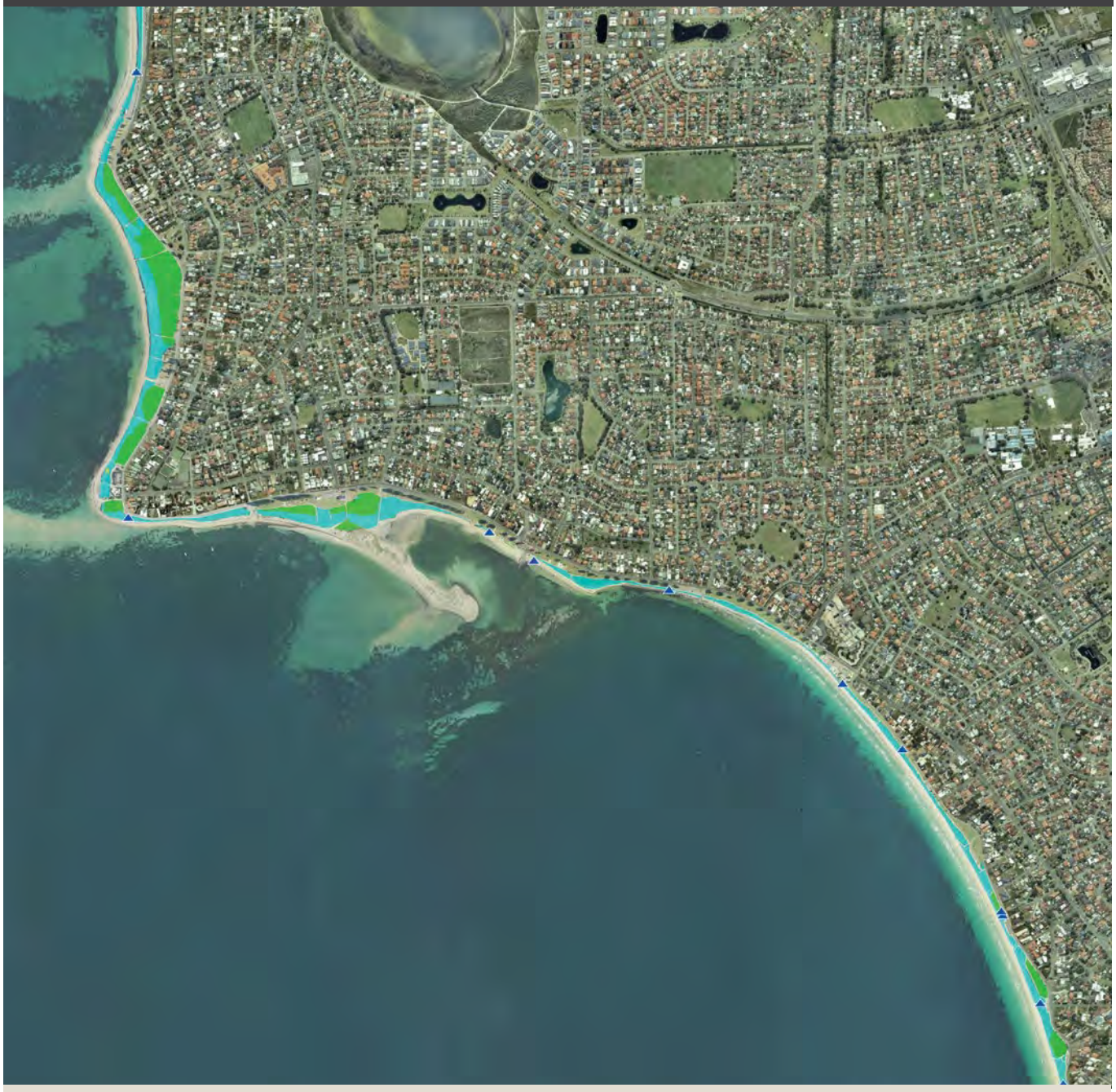
Tall Shrubland

Spinifex
Grassland

N 0m 500m

6.2.4 Weeds and threatening processes

FIGURE 28



MAP LEGEND

- WEED SUITE ONE - Grasses
- WEED SUITE TWO - Herbs
- WEED SUITE THREE - Euphorbia
- EROSION

N

0m 500m

FIGURE 28 (continued)

	Species Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Treatment
WEED SUITE ONE - Grasses	*Avena barbata*	Bearded Oat							●	●	●	●			Spray with Fusilade (Fluazifop) at 3-5 leaf stage
	Bromus diandrus	Great Brome						●	●	●					Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Cenchrus clandestinus	Kikuyu	●										●	●	Spray with Fusilade (Fluazifop)
	Cynodon dactylon	Couch Grass	●	●									●	●	Spray with Fusilade (Fluazifop)
	Ehrharta longiflora	Annual Veldt								●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lagurus ovatus	Hare's Tail Grass							●	●	●	●	●	●	Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lolium rigidum	Wimmera Ryegrass						●	●	●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Stenotaphrum secundatum	Buffalo Grass	●	●	●	●	●						●	●	Spray with Fusilade (Fluazifop)
WEED SUITE TWO - Herbs	*Pelargonium capitatum*	Rose Pelargonium						●	●	●	●	●			Spot spray with Glyphosate
	Tetragonia decumbens	Sea Spinach						●	●	●	●	●			Spot spray with Glyphosate
	Trachyandra divaricata	Trachyandra						●	●	●					Spot spray with Glyphosate
	Fumaria capreolata	Whiteflower fumitory						●	●	●	●				Spray with Metsulfuron
WEED SUITE THREE - Euphorbia	*Euphorbia terracina*	Geraldton Carnation Weed						●	●	●					Spray with Logran® at 12.5 g/100 L
	Euphorbia paralias	Sea Spurge	●								●	●	●	●	Spray with Glyphosate (360g/L) and 0.2g Metsulfuron and Pulse in 10L water, or manual removal

6.2 Environmental Attributes (continued)

6.2.5 Reserve infrastructure

The extent and condition of fencing, pathways, signage and amenities which occur along the foreshore in this sector are noted in the tables below.

Table 20 - Fencing

Fence Type	Good Condition (m)	Poor Condition (m)
Post and strand	5,375	13
Post, strand and metal rail	762	2
Bollards	1134	0
Metal rail	144	1

Table 21 - Paths

Path Type	Fenced	Good Condition (m)	Poor Condition (m)
Sand	No	1,177	0
Concrete	Yes	8,168	4
Plastic board and chain	Yes	90	0
Bitumen	No	163	0
Crushed limestone	Yes	313	0

Table 22 - Signage

Signage Type	Number Overall	Poor Condition
Directional	3	0
Informational	18	9
Regulatory	73	13

Table 23 - Amenities and other infrastructure

Amenity	Number Overall	Poor Condition
Barbeque	9	0
Bench seat	89	1
Bike rack	9	0
Bin	35	0
Bin and dog bag	12	0
Drink fountain	5	1
Gym park	1	0
Picnic table	5	1
Playground	6	0
Recycle bin	1	0
Shade structure	9	0
Shade structure with picnic table	6	0
Shower	13	0
Toilet block	4	0

6.2.6 Native fauna

A targeted fauna survey was only undertaken in Sectors 3, 4 and 5 as these areas of coastal habitat were considered most likely to support a diverse fauna assemblage. However, a full list of species likely to occur along the City's coastline in addition to a full list of species recorded during the field surveys can be seen in Appendix C.

6.2.7 Invasive fauna

Rabbits, feral cats and foxes are all likely to occur in this sector. The impact of feral animals on the flora and fauna in this sector should continue to be monitored and control undertaken accordingly.

Image source: T.Trathen

6.3 Management Actions

TABLE 24

Management Actions		Approximate cost	Priority*
1.	Revegetation, prioritising areas of Degraded vegetation condition (6.02 ha)	160,000	h
2.	Progressively undertake weed control activities in areas of Good and Very Good vegetation condition (19.41 ha)	60,000	h
3.	Upgrade areas of Poor condition fencing and access paths as required	Cost ongoing	h
4.	Install fencing along unfenced Sand paths, prioritising areas adjoining Degraded vegetation condition	16,000	m
5.	Monitor impacts of feral animals and implement control as required	Cost ongoing	h
6.	Progressively upgrade signage as required	Cost ongoing	m
7.	Stabilise 11 key areas of erosion using brushing, jute matting or revegetation	3,300	m
8.	Investigate construction of a new jetty at Mersey Point, a sheet pile wall at Waikiki and the ongoing maintenance of the Bent Street navigation channel	-	h
9.	Investigate the establishment of a DUP connection from Boundary Road to Hymus Street	-	m
10.	Street tree planting (i.e. 30 100L) to enhance Liverpool Street, Boundary Road, Arcadia Drive and Safety Bay Road	9,000	m
11.	Undertake detailed design for Concept Plan 1	15,000	m
12.	Construct Concept Plan 1	198,000	m
13.	Install wayfinding and interpretive signage at key locations along the DUP as per Figure 48 i.e. the Pond and Mersey Point	10,000	m
		Total: 471,300	

* Priority: h=high, m=medium, l=low

7.0

SECTOR THREE

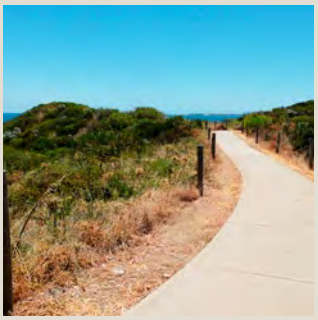
Warnbro, Port Kennedy

7.1 Landscape Attributes

FIGURE 29

Port Kennedy Boat Ramp

Warnbro Beach



Coastal Topography and Vegetation

View From Lookout Along Dual Use Path

Legend

- DPaW Reserve
- Dune Vegetation
- Parkland
- Existing DUP
- Proposed Extention of DUP
- Primary Road Connection/ Access
- Secondary Road Connection/ Access
- Pedestrian Beach Access
- Proposed Development
- Concept Area
- Water Ski Area
- Mooring Area
- Coastal Infrastructure
- Minor Carpark & Pedestrian Entry
- Public Toilets
- Moorings
- Surf Beach
- Boat Ramp
- Shade/Shelter
- Play Equipment
- Dog Beach
- Fishing Beach
- Lookout
- Parking

Key Recreation Nodes

1. Warnbro Foreshore Reserve
2. Port Kennedy Foreshore Park
3. Port Kennedy Boat Ramp

N

0 m 500 m

7.1 Landscape Attributes (continued)

7.1.1 Site characteristics

Along this stretch of coast there is no parallel road providing access, instead the coastal dunes are traversed by a winding DUP which connects Warnbro Beach Road to Port Kennedy Boat Ramp and is punctuated by several lookouts along the way. The coastal dunes retain their native vegetation cover along the entire stretch of foreshore reserve in this sector. Vehicular access to the beaches is gained via secondary roads terminating in minor car parks at the coast. There is direct access to the beach from these car parks and also at regular intervals along the DUP.

The area is characterised by the quietness of the beaches, which experience comparatively low visitation rates relative to other sectors. Port Kennedy boat ramp is a key recreational node in this sector, as the only boat launching facility in the City's south. At this node the beach is accessible and a range of facilities are provided, including parking, public toilets, play equipment and gazebos. This node is reasonably isolated as it is bordered by the Port Kennedy Scientific Park to the south and the Links Golf Corse to the north and east, making it accessible only via Port Kennedy Drive or the coastal DUP.

Due to the proximity of houses to native vegetation, this whole sector is considered a bushfire prone area, which is an important consideration for future management.

7.1.2 Potential landscape improvements

Within this sector there is an opportunity for a second recreation node to be developed that would provide facilities and improved access to the beach. Suitable locations for this node would be the terminus of St Ives Cove or Bayeux Avenue in the Warnbro Foreshore Reserve. At these locations public toilets, picnic facilities, play equipment and shade could be provided.

Additionally, the existing minor car parks could be enhanced by improving the beach access paths and constructing a universally accessible beach access ramp, which could potentially be located at the access adjoining Cote D'Azur Gardens in Warnbro. Tree planting would further enhance the car parks by providing shade. Opportunities also exist to provide more lookouts along the DUP, particularly between Bayeux Avenue and Port Kennedy Boat Ramp. The lookouts could be enhanced through the provision of shade structures or seating.

7.2 Environmental Attributes

7.2.1 Coastal vulnerability

Key areas of erosion in this sector include south of Becher Point and adjoining the Michael Road and View Road car parks. The shoreline south of Becher Point has eroded by up to 250m since 1942, which has been accompanied by some accretion, with an increase of approximately 80m occurring between 1965 and 1989. The erosion south of Becher Point is situated adjacent to Scientific Park and therefore is not an important consideration for coastal vulnerability management, as no infrastructure is susceptible to the impacts of erosion.

Conversely, the erosion experienced near Michael Road and View Road in Warnbro threatens to undermine the car parks which are situated relatively close to the nearshore environment. Beach renourishment does occur in this area as required but this only provides a temporary buffer from storm erosion before the sand is redistributed along the Warnbro Sound shoreline.

Long term solutions to manage erosion in this location continue to be investigated, such as the installation of buried rock or GSC seawall or the realignment of the car parks to increase the buffer for erosion. It is likely that a combination of these options would provide the best long term protection and a cost benefit analysis of these options to protect two relatively small car parks would need to be considered.

The area north of Becher Point experiences accretion, as it is estimated that approximately 30,000m^3 of sediment passes north of Secret Harbour every year and a large percentage of this contributes to the ongoing growth of Becher Bank. Should the area continue to accrete, long term management of sedimentation at the Port Kennedy Boat Ramp will need to be considered.

7.2.1 Coastal vulnerability (continued)

FIGURE 30

MAP LEGEND

View Road Car Park

Michael Road Car Park

Port Kennedy Boat Ramp

Becher Point Vegetation Line Movement

DPaW Reserve

Key Accretion Area

Key Erosion Area

Potential Areas For Future Coastal Management

1. View Road Car Park
2. Michael Road Car Park
3. Port Kennedy Boat Ramp

N

0 m 500 m

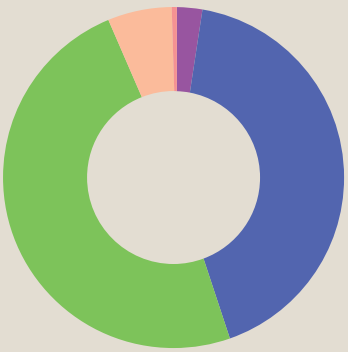
7.2.2 Vegetation condition

FIGURE 31

MAP LEGEND

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

	AREA (ha)	AREA (%)
EX	1.16	2.4
VG	20.39	42.5
G	23.3	48.6
D	2.9	6.0
CD	0.23	0.5



7.2.3 Vegetation type

FIGURE 32

MAP LEGEND

- *Acacia rostellifera* Shrubland
- *Scaevola crassifolia* Mixed Shrubland
- *Acanthocarpus preissii* Open Heath
- *Lepidosperma gladiatum* Sedgeland
- *Lomandra maritima*
- Spinifex grassland
- Tall shrubland
- *Callitris presissii*

Acacia rostellifera Shrubland

Lepidosperma gladiatum Sedgeland

Scaevola crassifolia Mixed Shrubland

Tall Shrubland

Acanthocarpus preissii Open Heath

Spinifex Grassland

7.2.4 Weeds and threatening processes

FIGURE 33

MAP LEGEND

- WEED SUITE ONE - Grasses
- WEED SUITE TWO - Herbs
- WEED SUITE THREE - Euphorbia

WOODY WEEDS

- *Eucalyptus utilis*
- *Melaleuca nesophila*
- *Agave americana*
- *Leptospermum laevigatum*

- EROSION
- GRAFFITI
- RUBBISH DUMPING
- CUBBY

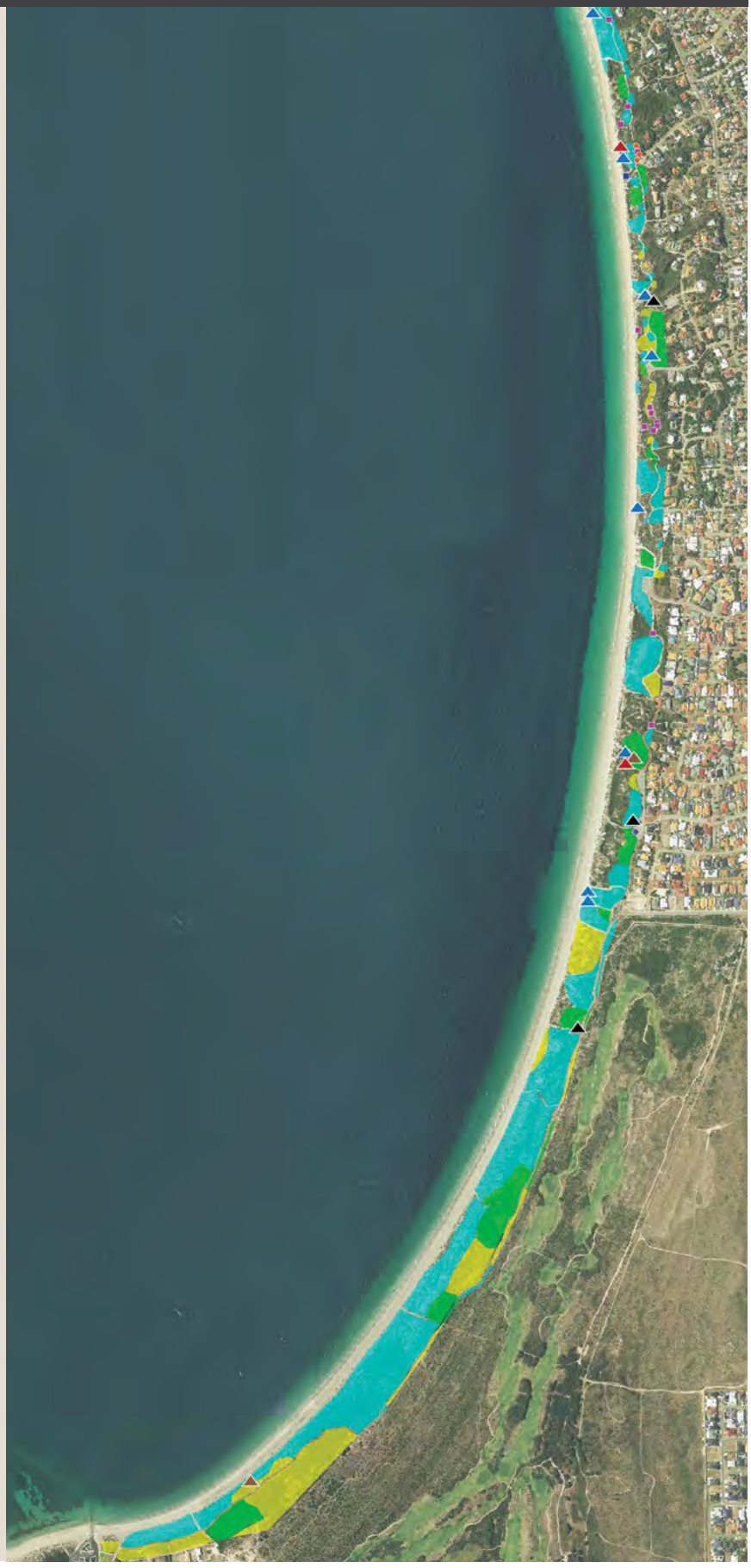


FIGURE 33 (continued)

	Species Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Treatment
WEED SUITE ONE - Grasses	*Avena barbata*	Bearded Oat							●	●	●	●			Spray with Fusilade (Fluazifop) at 3-5 leaf stage
	Bromus diandrus	Great Brome						●	●	●					Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Ehrharta longiflora	Annual Veldt								●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lagurus ovatus	Hare's Tail Grass							●	●	●	●	●	●	Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lolium rigidum	Wimmera Ryegrass						●	●	●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
WEED SUITE TWO - Herbs	*Pelargonium capitatum*	Rose Pelargonium						●	●	●	●	●			Spot spray with Glyphosate
	Tetragonia decumbens	Sea Spinach						●	●	●	●	●			Spot spray with Glyphosate
	Trachyandra divaricata	Trachyandra						●	●	●					Spot spray with Glyphosate
	Fumaria capreolata	Whiteflower fumitory						●	●	●	●				Spray with Metsulfuron
WEED SUITE THREE - Euphorbia	*Euphorbia terracina*	Geraldton Carnation Weed						●	●	●					Spray with Logran® at 12.5 g/100 L
	Euphorbia paralias	Sea Spurge	●								●	●	●	●	Spray with Glyphosate (360g/L) and 0.2g Metsulfuron and Pulse in 10L water, or manual removal
Point Locations - Woody Weeds	*Agave americana*	Century Plant	●								●	●	●	●	Basal bark and paint with Garlon and Diesel or cut and paint with 50% Glyphosate
	Melaleuca nesophila	Mindiyed	●	●	●	●	●	●	●	●	●	●	●	●	Basal bark and paint with Garlon and Diesel or cut and paint with 50% Glyphosate
	Leptospermum laevigatum	Victorian Teatree							●	●	●	●			Basal bark and paint with Garlon and Diesel or cut and paint with 50% Glyphosate.

7.2 Environmental Attributes (continued)

7.2.5 Reserve infrastructure

The extent and condition of fencing, pathways, signage and amenities which occur along the foreshore in this sector are noted in the tables below.

Table 25 - Fencing

Fence Type	Good Condition (m)	Poor Condition (m)
Post and strand	11,949	75

Table 26 - Paths

Path Type	Fenced	Good Condition (m)	Poor Condition (m)
Sand	Yes	685	0
Concrete	Yes	2,846	20
Crushed limestone	Yes	1,114	0
Bitumen	Yes	3,050	0

Table 27 - Signage

Signage Type	Number Overall	Poor Condition
Directional	2	0
Informational	7	2
Regulatory and safety	59	14

Table 28 - Amenities and other infrastructure

Amenity	Number Overall	Poor Condition
Bench seat	2	0
Bike rack	6	0
Bin	7	0
Bin and dog bags	4	0
Picnic Table	1	0
Shower	2	0

7.2.6 Native fauna

The complete list of species recorded during the fauna surveys can be found in Appendix C and a number of the species recorded in this sector are described in detail overleaf.

Photo source: T. Morrisey

7.2.6 Native fauna (continued)

Sand-plain Worm-lizard
Aprasia repens


Image source: S. Ford

Ecology

This species is a pale silvery brown colour, flushed with yellow to pale pink on its tail and yellow on its throat. Each scale has a dark dash that forms a longitudinal series of dashed lines. The breeding biology of this species is largely unknown, but similar to other species of Aprasia, it is oviparous, probably laying eggs in ant nests.

Distribution

It is distributed from southwest WA, north to Kalbarri and east to Esperance.

Habitat

Pale coastal sandplains, where they dwell in insect holes, ant nests, beneath logs, rocks and stumps.

Burton's Snake-lizard
Lialis burtonis


Image source: S. Ford

Ecology

Very distinctive species, being the sole member of the genus in Australia. It has a long pointed, wedge shaped snout and very small limb-flaps. It is highly variable in colour and pattern. It is a lizard specialist, feeding on geckos, dragons, other pygopods and small snakes.

Distribution

Australia's most widespread reptile, it is distributed almost Australia wide, from southern WA to New Guinea.

Habitat

Almost all habitats.

Southern Brown Bandicoot
Isoodon obesulus fusciventer


Image source: P. Brooshooft

Ecology

Priority 4 ground dwelling marsupial. The species has disappeared from most of its former range due to land clearing, changed fire regimes and the introduction of domestic and feral animals. It is mostly nocturnal, however is sometimes active during the day, when it searches for invertebrates, fungi and subterranean plant material to feed upon.

Distribution

Patchy throughout its range, where it occurs from just north of Perth to east of Esperance.

Habitat

Sandy soil supporting dense vegetation in the lower stratum.

7.2.6 Native fauna (continued)

Perth Lined Slider
Lerista lineata

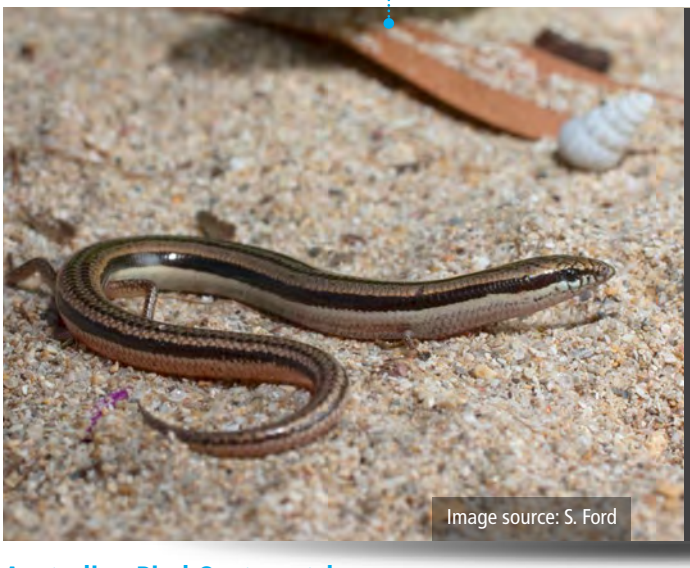


Image source: S. Ford

Ecology

Priority 3 species. Slender skink, with broad black upper lateral strips and prominent black lines on its back. Distinguished from similar Lerista species by the number of digits on its limbs. The restricted distribution of this species places it at risk of further habitat loss from development along the Swan Coastal Plain.

Distribution

Occurs in a small coastal area between Perth and Mandurah and on Rottnest Island, and in isolated populations at Woodleigh and Busselton.

Habitat

Favours sandy coastal heath and shrubland.

Australian Pied Oystercatcher
Haematopus longirostris

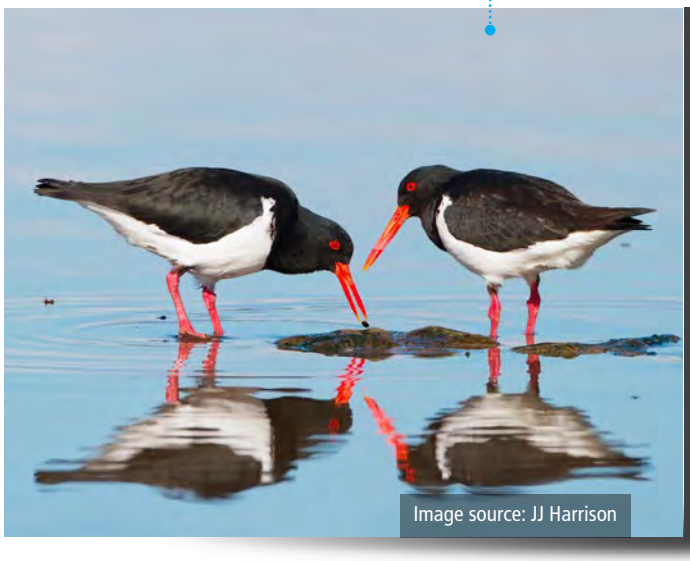


Image source: JJ Harrison

Ecology

Distinctive shorebird with a bright orange-red bill, black chest, back and wings, white belly and red legs. It feeds on mussels, which they pry open with their bills. It nests in sand above the high tide water mark, where it lays a clutch of two eggs from July to early September. Eggs are well camouflaged with surrounding sand and shell grit.

Distribution

Occurs along coastal areas throughout Australia.

Habitat

Sandy beaches and tidal reefs and short grasslands adjacent to coastal areas.

Dwarf Bearded Dragon
Pogona minor


Image source: P. Brooshooft

Ecology

Slender, narrow headed species, with a poorly developed 'beard' comprised of spines confined to the rear edges of its jaw. Pogona species are typically territorial, defending territories atop shrubs, small trees or fence posts. It is omnivorous, feeding on insects and plant material. Breeding is oviparous, with a clutch size of around 5-9 eggs laid in spring.

Distribution

It is distributed from the western portion of SA through to WA and north to the western Kimberley, excluding the Nullarbor and lower southwest.

Habitat

Occurs in woodlands and shrublands.

7.2 Environmental Attributes (continued)

7.2.7 Invasive fauna

Rabbits, feral cats and foxes are also likely to occur in this area and the City's annual Feral Animal Control Program currently includes the area of foreshore reserve adjacent to the Port Kennedy boat ramp. A bee hive has also been recorded in the northern area of this sector, which is recommended for removal.

The impact of feral animals on the flora and fauna in this sector should continue to be monitored and control undertaken accordingly.

7.3 Management Actions

TABLE 29

	Management Actions	Approximate cost	Priority*
1.	Revegetation, prioritising areas of Degraded vegetation condition (2.9 ha)	73,000	h
2.	Progressively undertake weed control activities in areas of Good and Very Good vegetation condition (43.69ha)	131,000	h
3.	Weed control in areas of *Lomandra maritima*	5,000	h
4.	Upgrade areas of poor condition fencing and access paths as required	Cost ongoing	h
5.	Remove bee hive, monitor impacts of feral animals and implement control as required	-	h
6.	Progressively upgrade signage as required	Cost ongoing	m
7.	Stabilise 8 key areas of erosion using brushing, jute matting or revegetation	2,400	m
8.	Investigate access restrictions in 2 key rubbish dumping areas	-	h
9.	Investigate Michael Road and View Road car park revetment	-	m
10.	Investigate the provision of an additional recreational node along the Warnbro foreshore	-	l
11.	Investigate the feasibility of installing a universal beach access ramp	-	h
12.	Investigate potential locations for additional lookouts along the DUP	-	l
13.	Install wayfinding and interpretive signage at key locations along the DUP as per Figure 48 i.e. Port Kennedy Boat Ramp	10,000	m
		Total: 221,400	

* Priority: h=high, m=medium, l=low

8.0

SECTOR FOUR

Secret Harbour

8.1 Landscape Attributes

FIGURE 34

Secret Harbour Surf Life Saving Club

Secret Harbour Beach

Secret Harbour Foreshore Park

Secret Harbour Foreshore Park

Legend

- DPaW Reserve
- Dune Vegetation
- Parkland
- Existing DUP
- Proposed Extention of DUP
- Primary Road Connection/ Access
- Secondary Road Connection/ Access
- Pedestrian Beach Access
- Proposed Development
- Concept Area
- Water Ski Area
- Mooring Area
- Coastal Infrastructure
- Minor Carpark & Pedestrian Entry
- Public Toilets
- Moorings
- Surf Beach
- Boat Ramp
- Shade/Shelter
- Play Equipment
- Dog Beach
- Fishing Beach
- Lookout
- Parking

Key Recreation Nodes

1. Lagoon park
2. Secret Harbour Surf Life Saving Club
3. Secret Harbour Foreshore Park

N

0m 300m

8.1 Sector Four - Landscape Attributes (continued)

8.1.1 Site characteristics

This sector consists of west-facing beaches with tracts of natural, protected dunes running along the foreshore. The coastline is largely inaccessible by car as the roads are situated behind the dunes. The wide foreshore reserve is traversed by regularly spaced pedestrian beach access paths, as the DUP runs alongside the roads behind the dunes. Similar to Sector Three, the coastal dunes in this sector retain their native vegetation cover along the entire stretch of foreshore reserve.

Several lookouts punctuate the foreshore reserve south of the Secret Harbour recreation node providing panoramic ocean views. Within this sector there are two key recreation nodes located in close proximity to each other; at Lagoon Park and the Secret Harbour Foreshore Park. Both areas are positioned behind the dunes and provide amenities such as parking, play equipment, public toilets, BBQs and gazebos. The recreational capacity of this area will be further enhanced through the new Secret Harbour Surf Lifesaving Club, which will become a focal point for the community.

These recreational nodes are well serviced with amenities, however, there is little shade provision and the spaces feel exposed, dry and undefined. The beach is accessible from both recreation nodes but there is little visual connection due to the height of the dunes.

Due to the proximity of houses to native vegetation, this whole sector is considered a bushfire prone area, which is an important consideration for future management.

8.1.2 Potential landscape improvements

A significant opportunity exists in this sector to increase the connectivity of the DUP, which currently only runs alongside roads, predominantly Secret Harbour Boulevard and Bankoura Parkway, without access to the beach or lookouts. There is potential to provide a DUP that runs through the foreshore reserve, connecting Siracusa Court with Turtles Bend.

Siracusa Court streetscape could be enhanced through planting and the construction of an adjacent DUP. Furthermore, the minor car park at the terminus of Siracusa Court, that provides access to the northern area of Lagoon Park, has the potential to support another recreation node. This could be achieved through the provision of toilets, tree planting and shade over the play equipment. The car park at the terminus of Palisades Boulevard provides a similar opportunity.

Furthermore, the main car park which services both Lagoon Park and the Secret Harbour Foreshore Park could be enhanced through additional shade tree planting. This should include species other than Norfolk Island Pines to create visual interest and differing levels of shade.

Legend

- Existing Tree
- Proposed Tree
- Proposed Path
- Investigate Shade Provision to Play Area
- Existing Gazebo
- Proposed Gazebo
- Shade Structure

1. DUP connection
2. Proposed tree planting to existing car park
3. Enhance access/connectivity
4. Existing beach access
5. Arrival plaza
6. Reinstated car park and arrival space
7. Selective reconfiguration of existing trees
8. Timber boardwalk and seating area
9. Enhance frontage and edge to dunes with boardwalk and seating opportunities
10. Proposed surf club building plaza/ frontage
11. New surf club building
12. Informal coastal planting to residential site boundary
13. Urban play with basketball, soccer, four square, children's play, trampoline and skate amenities
14. BBQ area
15. Selective reconfiguration of existing trees.
16. Stage area for events
17. Central focus feature aligned with carpark central access paths
18. Pedestrian timber boardwalk to edge of dunes and recreation area with seating opportunities and access points
19. Event lawn
20. Secondary boardwalk loop
21. Proposed all abilities play
22. Formalise park entrance arrival with proposed bicycle parking and wayfinding
23. Connection to DUP
24. Existing car park with proposed tree planting for enhanced shade provision
25. Future access/connection to adjacent residential development

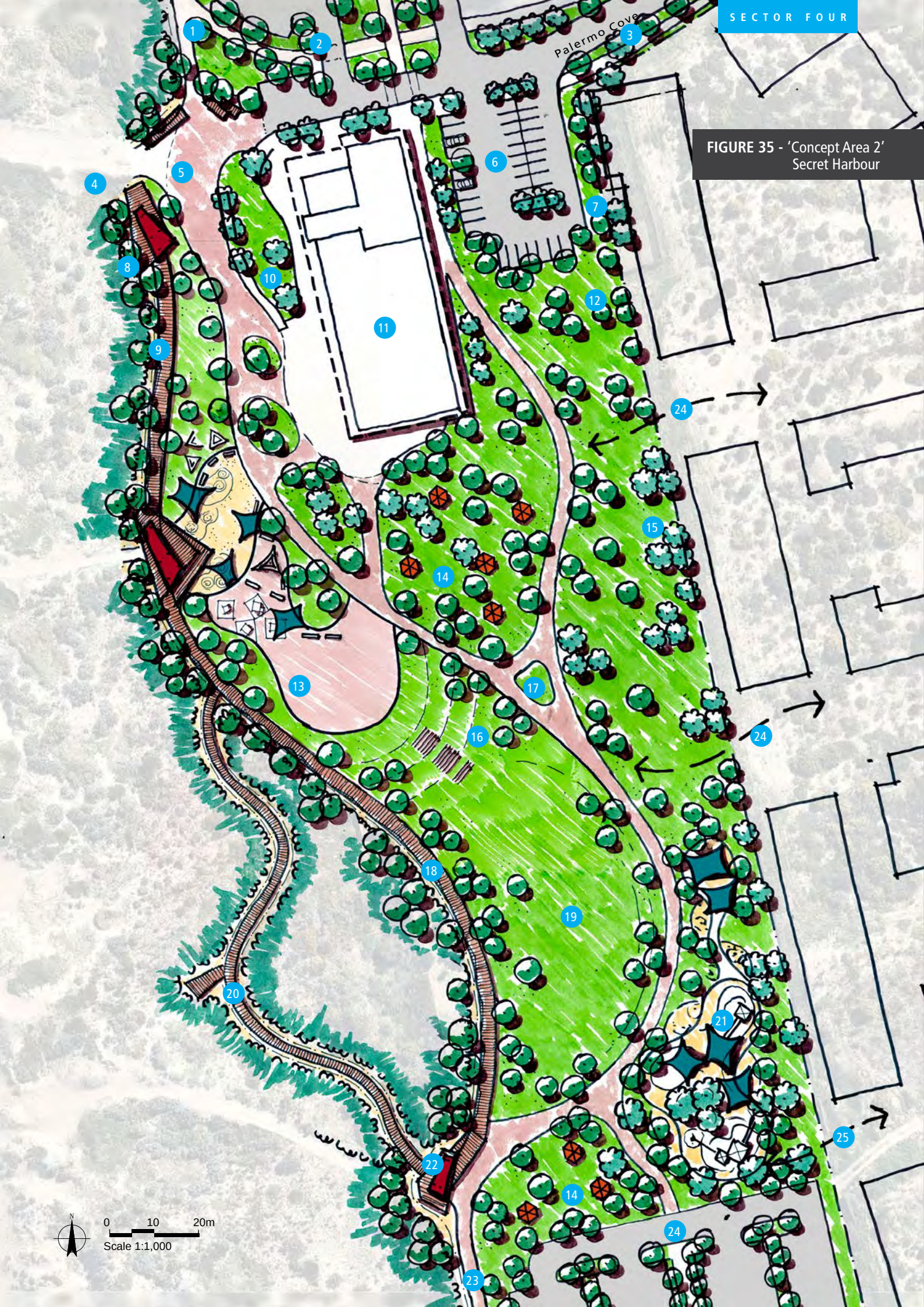


FIGURE 35 - 'Concept Area 2' Secret Harbour

Concept Area 2. Park entry and boardwalk looking north

Concept Area 2. Arrival plaza looking south

8.1 Landscape Attributes (continued)

8.1.2.1 Concept plan 2 - Design rationale

The Secret Harbour concept plan aims at reclaiming an underutilised public opens space and creating activation through the introduction of interesting active play areas, community event spaces and recreation nodes throughout the public open space.

The recent construction of the Secret Harbour Life Saving Club offers renewed functionality and activation on the northern boundary of the site, allowing for the creation of a community hub and arrival plaza to the beach, but also to the public open space. A foreshore promenade pathway is proposed to extend the full length of the site as a central spine connecting north south and allowing for a series of active and passive recreation opportunities along its length.

The northern area, adjacent to the new Surf Club, focusses upon active play, with the addition of play elements and structures to cater for children of various ages. These will be located adjacent to a multipurpose event space which will utilise the existing grade difference and elevation to create an informal stage area and amphitheatre. To the west of the amphitheatre, the concept plan proposes an interpretive boardwalk along the dunes, which will also provide some wind and sun protection through selective planting along the western boundary of the site, adjacent to the amphitheatre.

The southern portion of the site encompasses a combination of active and passive recreation opportunities. A regional level, all abilities playground is proposed adjacent to the existing children's play space, providing a destination point for families, to work in unison with the passive recreational BBQ facilities and open space in this portion of the park.

Adjacent to this is an interpretive node, with a shade shelter, way finding signage and bicycle parking facilities, which connections to the boardwalk and the DUP. Existing vegetation is proposed to be retained, with selective restructuring and planting to provide shade and improve the overall visual amenity of the area.

This is an indicative concept plan only and will require further detailed design and community consultation prior to construction. All proposed upgrades are subject to funding availability.

8.2 Environmental Attributes

8.2.1 Coastal vulnerability

The Department of Transport estimates that approximately 100,000m^3 of sand enters the Rockingham area from the south every year. A large proportion of this sand accumulates in this sector, with Secret Harbour shoreline having accreted up to 250m since 1942. However, there is no coastal infrastructure which is negatively affected by this accretion and therefore coastal vulnerability is not a primary consideration in this sector with respect to other areas of the City's coastline.

8.2.1 Coastal vulnerability (continued)

FIGURE 36

MAP LEGEND

Secret Harbour Vegetation Line Movement

DPaW Reserve

Key Accretion Area

N

0m 250m

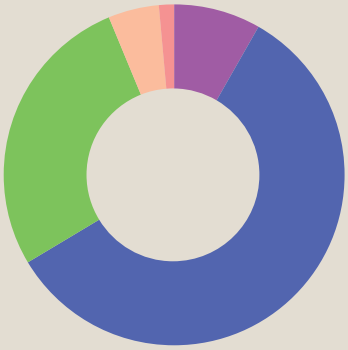
8.2.2 Vegetation condition

FIGURE 37

MAP LEGEND

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

	AREA (ha)	AREA (%)
EX	3.98	8.3
VG	28.1	58.1
G	13.2	27.4
D	2.33	4.8
CD	0.69	1.4



N

0m 250m

8.2.3 Vegetation type

FIGURE 38

MAP LEGEND

- *Acacia rostellifera* Shrubland
- *Scaevola crassifolia* Mixed Shrubland
- *Acanthocarpus preissii* Open Heath
- *Lepidosperma gladiatum* Sedgeland
- *Olearia axillaris* Shrubland
- Spinifex grassland
- Tall shrubland
- *Callitris presissii*
- *Diplolaena dampieri*

Acacia rostellifera
Shrubland

Acanthocarpus preissii
Open Heath

Spinifex
Grassland

Lepidosperma gladiatum
Sedgeland

Scaevola crassifolia
Mixed Shrubland

Olearia axillaris
Shrubland

Diplolaena dampieri
Signicant flora

Tall Shrubland

Callitris preissii
Signicant flora

8.2.4 Weeds and threatening processes

FIGURE 39

8.2.3 Weeds and threatening processes:

FIGURE 39 (continued)

	Species Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Treatment
WEED SUITE ONE - Grasses	*Avena barbata*	Bearded Oat							●	●	●	●			Spray with Fusilade (Fluazifop) at 3-5 leaf stage
	Bromus diandrus	Great Brome						●	●	●					Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Ehrharta longiflora	Annual Veldt								●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lagurus ovatus	Hare's Tail Grass							●	●	●	●	●	●	Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lolium rigidum	Wimmera Ryegrass						●	●	●	●	●			Spray with Fusilade (Fluazifop) or manual removal prior to seed set
WEED SUITE TWO - Herbs	*Pelargonium capitatum*	Rose Pelargonium						●	●	●	●	●			Spot spray with Glyphosate
	Tetragonia decumbens	Sea Spinach						●	●	●	●	●			Spot spray with Glyphosate
	Trachyandra divaricata	Trachyandra						●	●	●					Spot spray with Glyphosate
	Oenothera drummondii	Beach Evening Primrose						●	●	●					Spot spray with Glyphosate
	Fumaria capreolata	Whiteflower fumitory						●	●	●	●				Spray with Metsulfuron
WEED SUITE THREE - Euphorbia	*Euphorbia terracina*	Geraldton Carnation Weed						●	●	●					Spray with Logran® at 12.5 g/100 L
	Euphorbia paralias	Sea Spurge	●								●	●	●	●	Spray with Glyphosate (360g/L) and 0.2g Metsulfuron and Pulse in 10L water, or manual removal

8.2 Environmental Attributes (continued)

8.2.5 Reserve infrastructure

The extent and condition of fencing, pathways, signage and amenities which occur along the foreshore in this sector are noted in the tables below.

Table 30 - Fencing

Fence Type	Good Condition (m)	Poor Condition (m)
Post and strand	5819	213
Bollards	203	0

Table 31 - Paths

Path Type	Fenced	Good Condition (m)	Poor Condition (m)
Sand	Yes	2,472	0
Concrete	Yes	2,918	8
Crushed limestone	Yes	671	0
Bitumen	No	357	0

Table 32 - Signage

Signage Type	Number Overall	Poor Condition
Directional	2	0
Informational	3	1
Regulatory and safety	28	6

Table 33 - Amenities and other infrastructure

Amenity	Number Overall	Poor Condition
Barbeque	3	0
Bench seat	30	4
Bin	12	2
Bin and dog bags	1	0
Drink Fountain	7	0
Lookout	6	0
Picnic table	10	0
Playground	2	0
Shade structure	1	0
Shower	8	0
Surf Life Saving Club	1	0
Toilet block	1	0

8.2.6 Native fauna

The complete list of species recorded during the fauna surveys can be found in Appendix C and a number of the species recorded in this sector are described in detail overleaf.

8.2.6 Native fauna

Western Heath Dragon
Ctenophorus adelaidensis


Image source: S. Ford

Ecology

Small species of dragon, with short limbs and tail. It is grey coloured, with a broad vertebral strip edged by triangular blotches. Breeding would most likely occur over summer, like other similar species. It is relatively slow compared to most other species of Ctenophorus.

Distribution

Distributed along coastal and adjacent areas from Kalbarri to Perth.

Habitat

Sandplains with heath or banksia.

Elegant Slider
Lerista elegans


Image source: S. Ford

Ecology

A red tail is typical of juvenile individuals in many Lerista species. It has a thick black upper later stripe, similar to L. lineata, but differs in the number of digits on its limbs. Not a lot of data is available on the breeding biology of the Lerista, however breeding probably occurs in late spring to early summer. Identification of Lerista species can be difficult, often requiring microscopic examination.

Distribution

Occurs along the coast of WA, from Monte Bello Islands in the north to Augusta in the south.

Habitat

Prefers sandy coastal plains under rocks, logs and leaf litter.

Common Sandpiper
Actitis hypoleucos


Image source: C. Sharp

Ecology

A Schedule 5 Migratory species. Small with brown head, chest, wings and back, white belly and distinct white eye ring. It feeds on molluscs and invertebrates. It nests close to water, usually in vegetation. It migrates to Europe and Asia during April to August to breed.

Distribution

When present in Australia, it is found along coastlines mainly in northern and western Australia.

Habitat

Estuaries, rocky coasts, swamps, flood waters, coastal wetlands.

8.2.6 Native fauna (continued)

Black-shouldered Kite
Elanus axillaris


Image source: Frankzed

Ecology

Medium sized bird of prey, with black wing shoulders, pale grey back and all white belly and head. It feeds primarily on rodents, but will feed on reptiles and small birds as well. Its nest is made from sticks and usually seen atop eucalypt trees. A clutch of one to four eggs is laid from June to December. This species has benefitted from land clearing, with the increase in rodents associated with urbanisation.

Distribution

Occurs in the northwest, southwest and eastern Australia.

Habitat

Grasslands, woodlands and coastal areas.

Nankeen Kestrel
Falco cenchroides


Image source: A Silcocks/BirdlifeAustralia

Ecology

Relatively small bird of prey, wings and back a rufous brown colour, tail barred with black. It feeds on small invertebrates, reptiles and small rodents. It nests in tree hollows, cliffs, caves and termite mounds. A clutch of two to six eggs is laid in July to October. It is a successful species, owing to its varied preference for food, nesting sites and habitat.

Distribution

Occurs throughout Australia and many islands, excluding the far southwest of WA.

Habitat

Sparsely wooded areas, open agricultural areas and waterway areas in deserts.

Splendid Fairy-wren
Malurus splendens


Image source: A Silcocks/BirdlifeAustralia

Ecology

Males of this species have a distinctive blue colour, and females are mostly light brown with a slight blue tail. It feeds on invertebrates, foraging through vegetation and on the ground. Nests are a loose dome built of spider webs, dry grass, leaves, flowers and fine bark. It lays two to four eggs during September to mid January. Breeding males sometimes carry colourful petals as a form of display.

Distribution

In WA there are two populations, one near the Pilbara and one in the southwest. It also occurs through eastern Australia.

Habitat

Dense shrubland, woodlands and forest undergrowth.

8.2 Environmental Attributes (continued)

8.2.7 Invasive fauna

Signs of rabbit activity were recorded in this sector during field surveys and feral cats and foxes are also likely to occur in this area. The City's annual Feral Animal Control Program does currently include the Secret Harbour Foreshore Reserve. A bee hive has also been recorded in the northern area of this sector, which is recommended for removal.

The impact of feral animals on the flora and fauna in this sector should continue to be monitored and control undertaken accordingly.

8.3 Management Actions

TABLE 34

	Management Actions	Approximate cost	Priority*
1.	Revegetation, prioritising areas of Degraded vegetation condition (2.33 ha)	60,000	h
2.	Progressively undertake weed control activities in areas of Good and Very Good vegetation condition (41.3 ha)	125,000	h
3.	Upgrade areas of poor condition fencing and access paths as required	Cost ongoing	h
4.	Continue to monitor impacts of feral animals and implement feral animal control measures, including removal of bee hive	Cost ongoing	h
5.	Progressively upgrade signage as required	Cost ongoing	m
6.	Stabilise 8 key areas of erosion using brushing, jute matting or revegetation	2,400	m
7.	Investigate access restrictions in 2 key rubbish dumping areas	-	h
8.	Undertake detailed design for Concept Plan 2	50,000	m
9.	Construct Concept Plan 2	660,000	m
10.	Investigate the provision of a DUP from Siracusa Court to Turtles Bend	-	m
11.	Additional shade tree planting (i.e. 20) to enhance foreshore car parks	6,000	m
12.	Investigate potential enhancements for Lagoon Lake Park	-	l
		Total: 903,400	

* Priority: h=high, m=medium, l=low

9.0

SECTOR FIVE

Golden Bay, Singleton

9.1 Landscape Attributes

FIGURE 40

Golden Bay Foreshore Park

Singleton Foreshore Park

View from Golden Bay Lookout

Dual use path between Golden Bay and Singleton

9.1 Landscape Attributes (continued)

9.1.1 Site characteristics

The beaches in this sector, Golden Bay Beach and Singleton Beach, experience lower visitation rates than beaches in other sectors and are mainly utilised by local residents. This sector is characterised by its wide foreshore reserve that retains its natural vegetation cover, with a continuous DUP run which runs through the dunes intersecting with the coastal car parks, between the terminus of Singleton Beach Road and Dampier Drive. This path however, does not link in with the coastal DUPs of Sector 4 to the north, Secret Harbour, or to Madora Bay (City of Mandurah) to the south. Pedestrian paths provide beach access from the car parks and at regular intervals along the DUP. There are three lookouts situated along the pedestrian paths in this sector which offer panoramic views of the coastline.

Both Singleton Beach, located at the terminus of Singleton Beach Road, and Golden Bay, located at the terminus of Dampier Drive, both provide beach access and facilities including parking, play equipment, public toilets, seating and gazebos, but the areas lack shade and are quite exposed. Set behind the dunes, Marillana Drive and Foreshore Drive run parallel to the coast and these roads link the two recreation nodes, providing regular access to coastal car parks and pedestrian paths that lead to the beach.

Due to the proximity of houses to native vegetation, this whole sector is considered a bushfire prone area, which is an important consideration for future management.

9.1.2 Aboriginal heritage site

An investigation of Aboriginal Heritage areas in this sector revealed a registered site, Site 3519: Golden Bay Camp, which encompasses a former camp site next to a water source with reed beds. The site adjoins existing residential development in Golden Bay and is outlined as a significant area for protection in the Golden Bay Foreshore Management Plan (2012).

Any major development that occurs within the vicinity of a registered Aboriginal Heritage Site will require an ethnographic and archaeological determination. This may involve consultation with aboriginal elders of the Rockingham region. If the assessment confirms specific sites are to be impacted upon, the City may need to apply for consent to use the land from the Minister for Indigenous Affairs under section 18 of the Aboriginal Heritage Act 1972.

9.1.3 Potential landscape improvements

Opportunities for this sector include extending the DUP to connect with the wider coastal network, from Marillana Drive north through the foreshore reserve to Turtles Bend, and from the terminus of Singleton Beach Road south along Foreshore Drive. The recreation nodes present an opportunity for enhancement, specifically the construction of shade, either through tree planting or shade structures.

The enhancement of these nodes is explored in more detail in concept plans 3 and 4. Existing lookouts along the DUP could be enhanced through the provision of seating and shade structures. Furthermore, along the DUP between the terminus of Dampier Drive and the terminus of Singleton Beach Road, additional lookouts could be constructed to capitalise on the expansive views and provide nodes for rest and interpretation.

In terms of improving the existing coastal carparks, shade could be provided and beach access improved, while minor reconfigurations could enhance the overall connectivity and functionality of the space. At Golden Bay, the opportunity exists for a ramp to be constructed to provide universal beach access.

Furthermore, the major roads leading to the coast, including Dampier Drive, Crystaluna Drive and Singleton Beach Road could be enhanced through street tree planting to establish a visual connection to the coastal recreation nodes. Lastly, the streetscape of Foreshore Drive, south of Singleton Beach Road could also be enhanced.

FIGURE 41 - 'Concept plan 3' Golden Bay

Legend

- Existing Tree
- Proposed Tree
- Proposed Path
- Investigate Shade Provision to Play Area
- Existing Gazebo
- Proposed Gazebo
- Shade Structure

1. Existing access to Golden Bay Beach
2. Future DUP connection to Secret Harbour
3. Existing path to Ivanhoe St
4. Enhanced play area for children and toddlers with shade
5. Central path spine link beach access and amenities
6. BBQ area with existing gazebos
7. Open grass lawn area with trees (gazebos removed)
8. On-street carparking to park boundary
9. Existing toilets with more open frontage and spill out area
10. Re-contoured grass lawn area and visual connection with carpark
11. Park entrance & DUP wayfinding signage
12. Enhance existing lookout to be universally accessible
13. Formalise arrival area with signage and bicycle parking
14. Consolidated large car park
15. Connection to DUP
16. Revegetation area

Concept Area 3. Enhanced entrance looking west

Concept Area 3. Enhanced play area and BBQ area looking south east

9.1 Sector Five - Landscape Attributes (continued)

9.1.3.1 Concept plan 3 - Design rationale

The Golden Bay concept plan proposes to reconnect the car park and public open space through selective thinning of existing vegetation to the north of the existing car park, creating line of sight to the car park and public open space. This will improve the visual connection to the space and provide a more inviting entry to the park.

The plan proposes a staged upgrade and consolidation of the car parking facilities, to ensure more efficient vehicular use while also applying Crime Prevention Through Environmental Design (CPTED) principles to the site, increasing passive surveillance and overall connectivity. Formalisation of the on road car parking through parallel bays is also proposed along Marillana Drive, where visitors are currently parking beneath shade trees in an informal parking area closer to the park amenities.

The concept plan also aims to strengthen existing DUP connections to the south and the Singleton node, but also allowing for a north/south connection through the park, adjacent to Marillana Drive and the proposed new DUP connection to Secret Harbour.

The concept design proposes to retain the existing amenities, but allows for upgrades around the site to allow for potential shading of play areas, and opening up views and access to the existing public toilets. The existing lookout is proposed to be upgraded, which a universal access path will loop past to the beach.

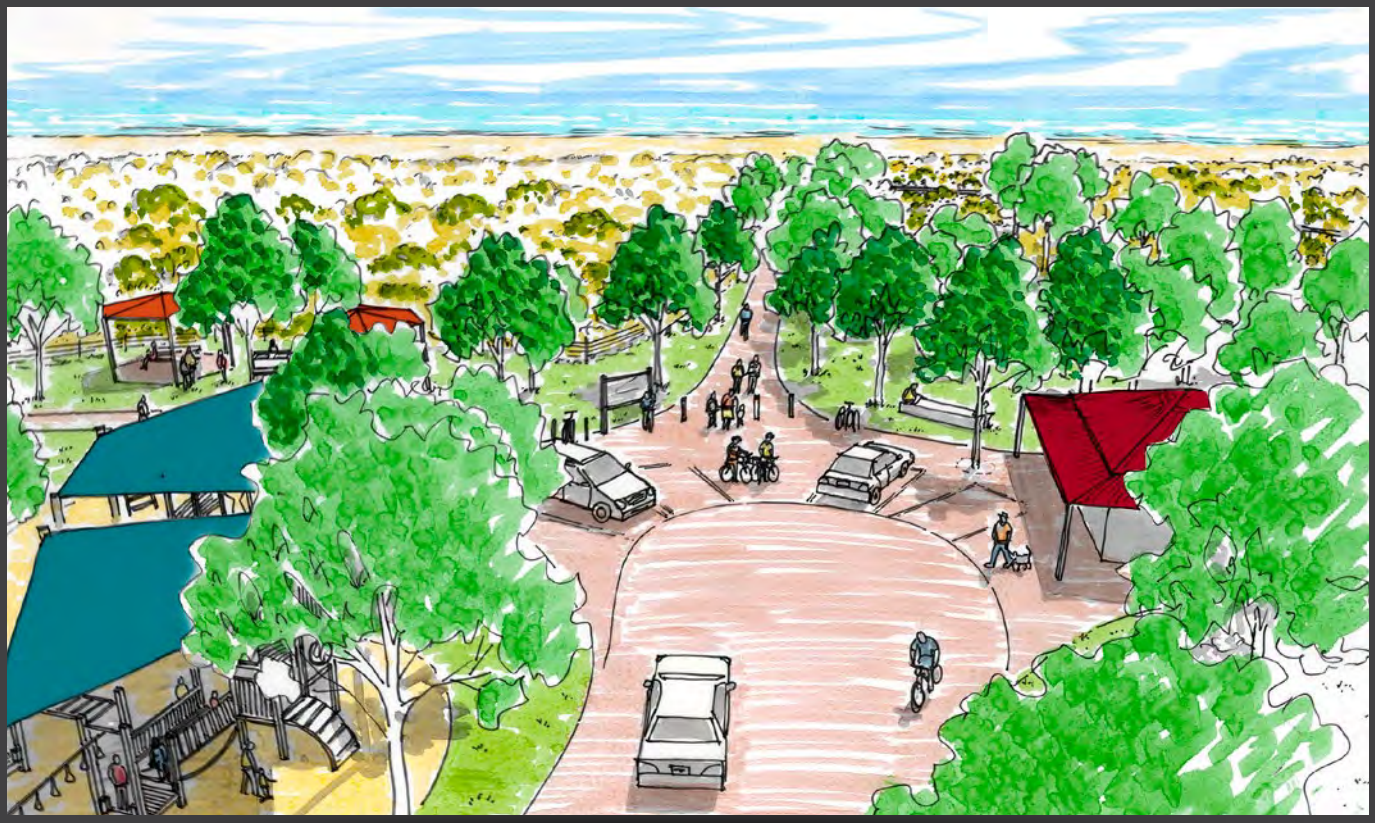
This is an indicative concept plan only and will require further detailed design and community consultation prior to construction. All proposed upgrades are subject to funding availability.

FIGURE 42 - 'Concept Area 4' Singleton

Legend

- Existing Tree
- Proposed Tree
- Proposed Path
- Investigate Shade Provision to Play Area
- Existing Gazebo
- Proposed Gazebo
- Shade Structure

1. Potential loop access path to existing lookout
2. Existing path
3. Existing toilets with open grass lawn area (selective vegetation removal/planting)
4. Upgraded connection to DUP
5. Additional tree planting around perimeter of grass area
6. Beach access and wayfinding signage
7. Shared surface arrival area with short term and bicycle parking
8. BBQ area
9. Shared access road/path
10. Enhanced play area and shade provision
11. New park entrance path and signage
12. Ground cover planting opportunity for WSUD for carpark
13. Reduced width car park with tree planting
14. Footpath connecting park entrances
15. Existing BBQ area and gazebo
16. Beach access, bicycle parking and wayfinding signage
17. Enhanced entry with pedestrian path access and entrance signage
18. Potential focal feature to existing roundabout



Concept Area 4. Shared surface arrival area looking west

Concept Area 4. Enhanced play area and arrival area looking south

9.1 Landscape Attributes (continued)

9.1.3.2 Concept plan 4 - Design rationale

The proposed concept plan for Singleton Beach proposes two major elements to the existing car park; reducing the overall width of the car park and the addition of street trees. The car park reconfiguration is proposed to discourage antisocial behaviour by constraining the area and creating a low speed environment, and street trees to provide shade to the area in the heat of the day.

The connections to the existing toilet block are strengthened by opening up the vegetation surrounding the building, using CPTED principles, and the introduction of a low speed, shared space with short term parking adjacent to the amenities, creating an arrival node to the beach. This allows for wayfinding and interpretive opportunities with bicycle parking at the main access point to the beach.

At the apex of the car park and shared space, an upgraded play area is proposed with adjacent shade trees to take advantage of the shared space and access point to the beach.

The DUP connections to the site are strengthened through a north/south access path, which links the passive recreation spaces adjacent to the west of the car park. The introduction of additional shade trees in this area will also increase the overall amenity of the site and provide some wind protection to the passive recreation areas.

This is an indicative concept plan only and will require further detailed design and community consultation prior to construction. All proposed upgrades are subject to funding availability.

9.2 Environmental Attributes

9.2.1 Coastal vulnerability

Of the 100,000m^3 of sand which is estimated to enter the Rockingham area from the south every year, a large proportion of this sand accumulates in this sector, with the Golden Bay and Singleton shorelines having accreted up to 250m since 1942. However, like Sector 4, there is no coastal infrastructure which is negatively affected by this accretion and therefore coastal vulnerability is not a primary consideration at this time with respect to other areas of the City's coastline.

9.2.1 Coastal vulnerability (continued)

FIGURE 43

MAP LEGEND

Golden Bay Vegetation Line Movement

Singleton Vegetation Line Movement

Key Accretion Area

N

0 m 500 m

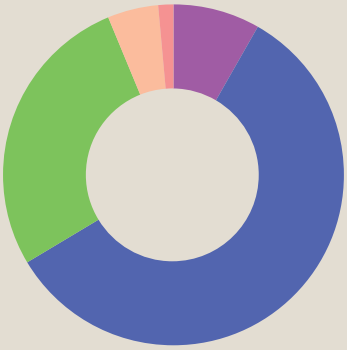
9.2.2 Vegetation condition

FIGURE 44

MAP LEGEND

- Excellent
- Very Good
- Good
- Degraded
- Completely Degraded

	AREA (ha)	AREA (%)
EX	4.37	5.5
VG	15.49	19.4
G	51.78	64.8
D	7.79	9.8
CD	0.43	0.5



9.2.3 Vegetation type

FIGURE 45

MAP LEGEND

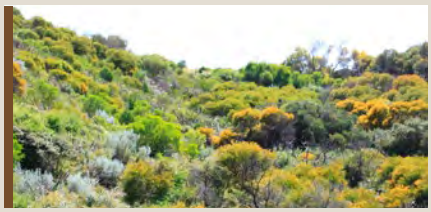
- *Acacia rostellifera* Shrubland
- *Scaevola crassifolia* Mixed Shrubland
- *Olearla* Axillaris Shrubland
- *Spinifex* Grassland
- Tall Shurbland

Acacia rostellifera **Shrubland**

Olearia axillaris **Shrubland**

Scaevola crassifolia **Mixed Shrubland**

Spinifex **Grassland**



Tall Shrubland

N 0 m 500 m

9.2.4 Weeds and threatening processes

FIGURE 46

9.2.4 Weeds and threatening processes (continued)

FIGURE 46 (continued)

	Species Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Treatment
WEED SUITE ONE - Grasses	*Avena barbata*	Bearded Oat							●	●	●	●			Spray with Fusilade (Fluazifop) at 3-5 leaf stage
	Bromus diandrus	Great Brome						●	●	●					Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Lagurus ovatus	Hare's Tail Grass							●	●	●	●	●	●	Spray with Fusilade (Fluazifop) or manual removal prior to seed set
	Thinopyrum distichum	Sea Wheat Grass			●	●	●	●	●	●	●	●	●		Spray with Fusilade (Fluazifop) or manual removal prior to seed set
WEED SUITE TWO - Herbs	*Pelargonium capitatum*	Rose Pelargonium						●	●	●	●	●			Spot spray with Glyphosate
	Tetragonia decumbens	Sea Spinach						●	●	●	●	●			Spot spray with Glyphosate
	Trachyandra divaricata	Trachyandra						●	●	●					Spot spray with Glyphosate
	Oenothera drummondii	Beach Evening Primrose							●	●	●				Spot spray with Glyphosate
	Fumaria capreolata	Whiteflower fumitory						●	●	●	●				Spray with Metsulfuron
WEED SUITE THREE - Euphorbia	*Euphorbia terracina*	Geraldton Carnation Weed						●	●	●					Spray with Logran® at 12.5 g/100 L
	Euphorbia paralias	Sea Spurge	●								●	●	●	●	Spray with Glyphosate (360g/L) and 0.2g Metsulfuron and Pulse in 10L water, or manual removal
POINT LOCATIONS - Woody Weeds	*Melaleuca nesophila*	Mindiyed	●	●	●	●	●	●	●	●	●	●	●	●	Basal bark and paint with Garlon and Diesel or cut and paint with 50% Glyphosate

9.2 Sector Five - Environmental Attributes (continued)

9.2.5 Reserve infrastructure

The extent and condition of fencing, pathways, signage and amenities which occur along the foreshore in this sector are noted in the tables below.

Table 35 - Fencing

Fence Type	Good Condition (m)	Poor Condition (m)
Post and strand	9,304	206
Bollards	792	0

Table 36 - Paths

Path Type	Fenced	Good Condition (m)	Poor Condition (m)
Sand	Yes	1,935	0
Concrete	Yes	1,727	14
Bitumen	Yes	1,825	21
Crushed limestone	Yes	296	0

Table 37 - Signage

Signage Type	Number Overall	Poor Condition
Directional	3	0
Informational	4	0
Regulatory and safety	35	11

Table 38 - Amenities and other infrastructure

Amenity	Number Overall	Poor Condition
Barbeque	2	0
Bench seat	6	2
Bike rack	2	0
Bin	14	0
Bin and dog bags	5	0
Drink Fountain	2	0
Drink fountain with dog bowl	1	0
Lookout	3	0
Playground	2	0
Shade structure with bench seat	1	0
Shade structure with picnic table	7	0
Shower	2	0
Toilet block	2	0

9.2.6 Native fauna

The complete list of species recorded during the fauna surveys can be found in Appendix C and a number of the species recorded in this sector are described in detail overleaf.

9.2.6 Native fauna (continued)

White-striped Freetail-bat
Austronomus australiss

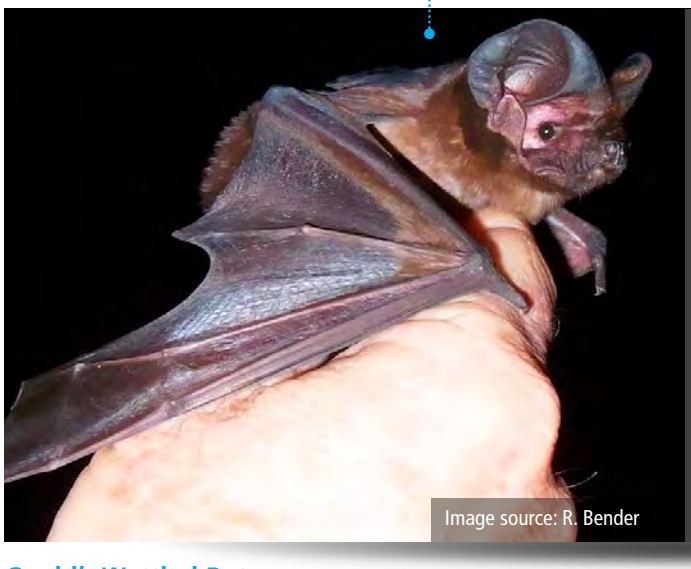


Image source: R. Bender

Ecology

A large, distinctive bat species, with black-brown fur and white stripes along the sides of the belly. It breeds in August and young are born mid December to late January. Young are weaned by May. It forages on moths, bugs, beetles, grasshoppers and ants. It has the lowest call frequency in Australia that is audible to humans.

Distribution

Most of southern Australia except Tasmania. It migrates seasonally south in response to heat.

Habitat

Urban areas, forests woodland, shrubland, grasslands and deserts.

Gould's Wattled Bat
Chalinolobus gouldii


Image source: R. Bender

Ecology

This species gets its name 'wattled bat' by the presence of a large lobe of skin at the corner of its mouth, referred to as a 'wattle'. It forages for bugs and moths in the lower levels of tree canopies and along forest edges. It roosts most commonly in tree hollows as well as buildings. Females are able to store sperm over the winter hibernation period. It is predated upon by birds of prey and cats.

Distribution

Almost ubiquitous distribution throughout Australia

Habitat

Virtually in all habitats throughout Australia.

Sand Frog
Heleioporus psammophilus


Image source: P. Brooshooft

Ecology

Males 33-62 mm, Females 41-60. It is brown to dark grey with marbling of white or grey. Eggs are laid in burrows before the onset of winter in wetland areas that would later be flooded. Tadpoles metamorphose during September and October. Tadpoles can survive in moist burrows until late development if flooding occurs later in the season.

Distribution

It occurs in the southwest, along the coastal and western side of the Darling Scarp.

Habitat

Associated with fine sand or sandy clay soils near dry swampy or ephemeral water bodies.

9.2.6 Native fauna (continued)

Sanderling
Calidris alba


Image source: A. Silcocks / Birdlife Australia

Ecology

A Schedule 5 Migratory species. Very small pale grey wader with white chest, belly and face. It is an active feeder along the shoreline, feeding on small crustaceans, invertebrates and seeds. Birds migrate to northern America to breed. They arrive in Australia during September and depart in March to May.

Distribution

Occurs in coastal regions of Australia

Habitat

Sandy beaches, inlets, estuarine sandbanks and coastal saltlakes.

South-west Spiny-tailed Gecko
Strophurus spinigerus

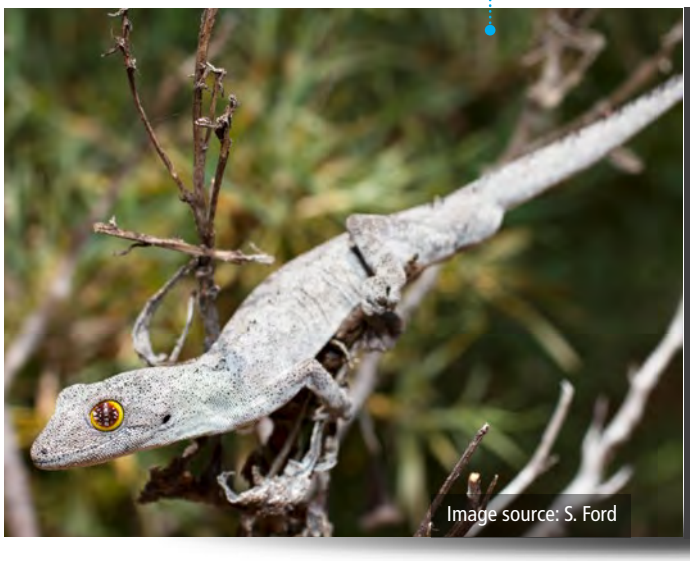


Image source: S. Ford

Ecology

This species has a soft spiny tail with two rows of short black spines. Breeding in this species is known from captivity, where reproduction occurs in spring and summer. One or two eggs are deposited in a clutch, with two or three consecutive clutches each season being common. It can excrete a harmless, odourless fluid from its spines if it feels threatened.

Distribution

It is distributed along the lower west coast and offshore islands from Shark Bay to the south coast of WA.

Habitat

Commonly seen on the stems of shrubs.

Bobtail
Tiliqua rugosa


Image source: S. Ford

Ecology

Robust, broad angular head, short blunt tail and large 'shingle' like scales. It is omnivorous, feeding on vegetation, invertebrates and small vertebrates. It is viviparous, typically producing one or two live young. Breeding occurs in spring, and gestation is approximately five to six months. Breeding pairs mate for life. It is one of the world's largest skinks.

Distribution

Occurs in the southwest extending through SA into central Vic., NSW and Qld.

Habitat

Occurs in most open habitats, from woodlands to shrublands and coastal dunes.

9.2 Environmental Attributes (continued)

8.2.7 Invasive fauna

Signs of rabbit activity were recorded in this Sector during field surveys. Feral cats and foxes are also likely to occur in this area. The impact of feral animals on the flora and fauna in this sector should continue to be monitored and control undertaken accordingly.

9.3 Management Actions

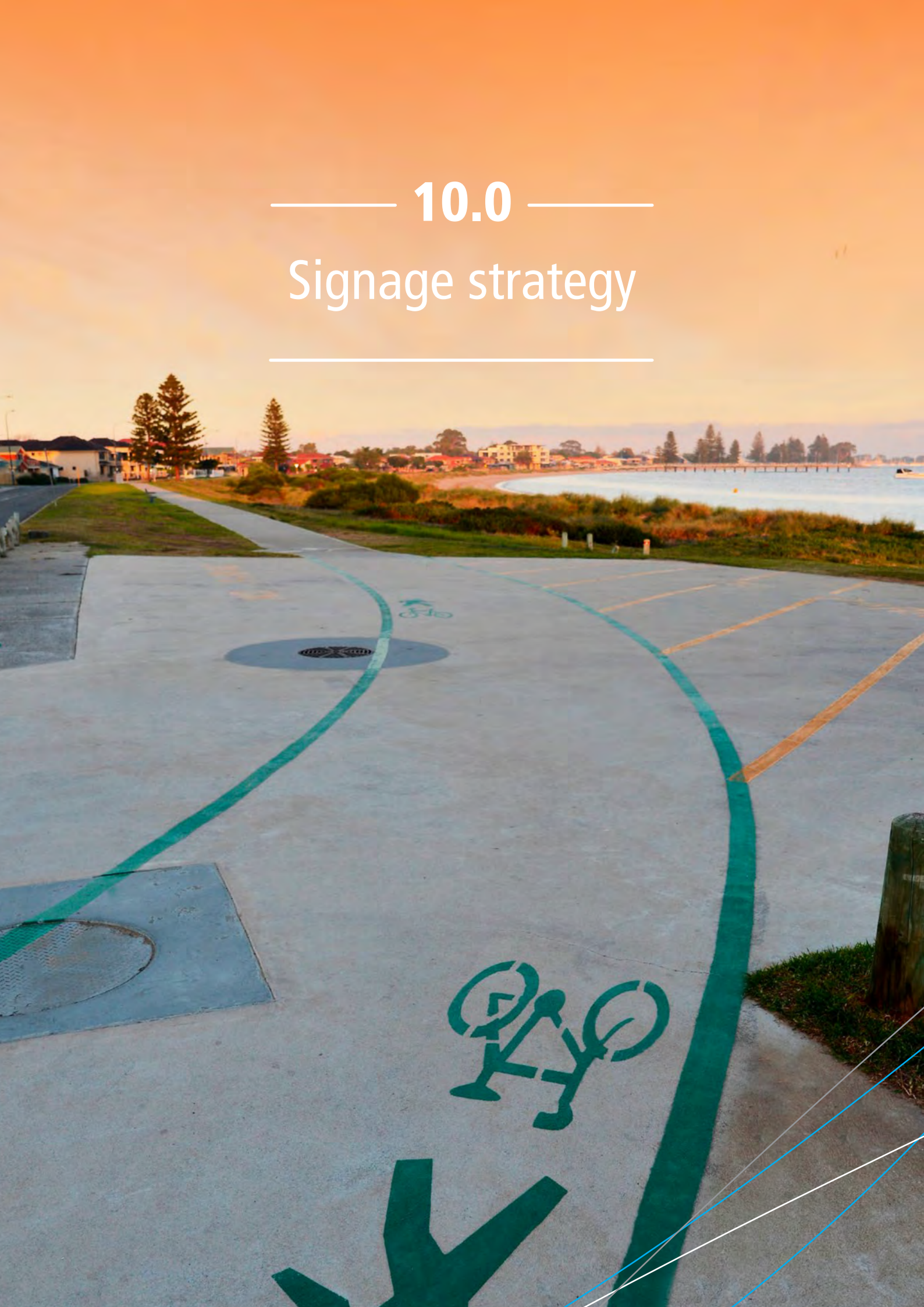
TABLE 39

	Management Actions	Approximate cost	Priority*
1.	Revegetation, prioritising areas of Degraded vegetation condition (7.79 ha)	200,000	h
2.	Progressively undertake weed control activities in areas of Good and Very Good vegetation condition (67.21 ha)	200,000	h
3.	Upgrade areas of poor condition fencing and access paths as required	Cost ongoing	h
4.	Monitor impacts of feral animals and implement control as required	Cost ongoing	h
5.	Progressively upgrade signage as required	Cost ongoing	m
6.	Investigate access restrictions in 7 key rubbish dumping, dirt bike and 4WD impact areas areas	-	h
7.	Initiate detailed design for Concept Plan 3	40,000	m
8.	Initiate detailed design for Concept Plan 4	15,000	m
9.	Construct Concept Plan 3	490,000	m
10.	Construct Concept Plan 4	200,000	m
		Total: 1,145,000	

* Priority: h=high, m=medium, l=low

10.0

Signage strategy



10.0 Signage strategy

The signage strategy aims to fulfil a number of management objectives through the provision of regulatory, directional and interpretive information in a format which is clear, consistent and interesting.

It is important that any signage installed in this location has design elements sympathetic to the natural environment which are durable enough to withstand the harsh coastal conditions.

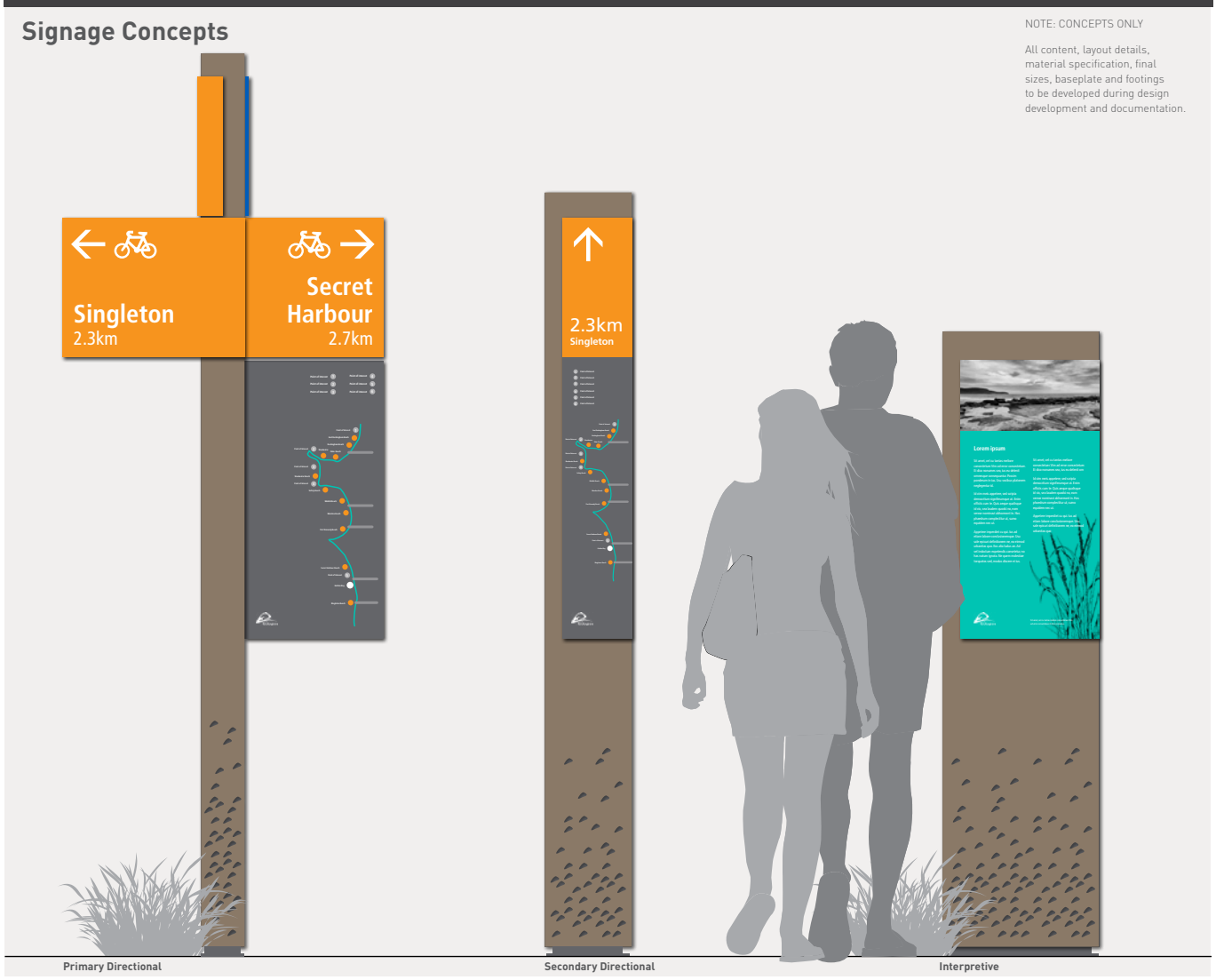
With this in mind, the signage strategy for the City's foreshore incorporates:

- Concepts for primary and secondary directional signs and interpretive sign.
- Perforated steel panels to create texture and interest (laser cut design to be determined).
- Metal signage panels which can be easily replaced for maintenance or repair.
- The use of bright colours from the City's style guide to differentiate signage types, establish a hierarchy for information and provide obvious wayfinding cues in the surrounding landscape.
- Inclusion of interpretive elements along walkways at major coastal attractions.

An alternative design for each of the signage types is also proposed, which incorporates a flat steel panel with a perforated design as an alternative to a perforated design over a powder coated inner. However, as these designs are conceptual only such elements would ultimately be finalised during detailed design.

The signage concepts are accompanied with an overall wayfinding map (Figure 48), which highlights proposed locations for primary and secondary signage, relative to sections of existing DUP networks and major coastal attractions. The wayfinding map takes into consideration DPaW managed areas of coastline and connections via alternative routes utilising existing path infrastructure, with the ultimate aim of establishing a contiguous path network along the City's remarkable coastline.

FIGURE 47 - Signage Concepts



10.0 Signage strategy (continued)

FIGURE 47 - Signage Concepts

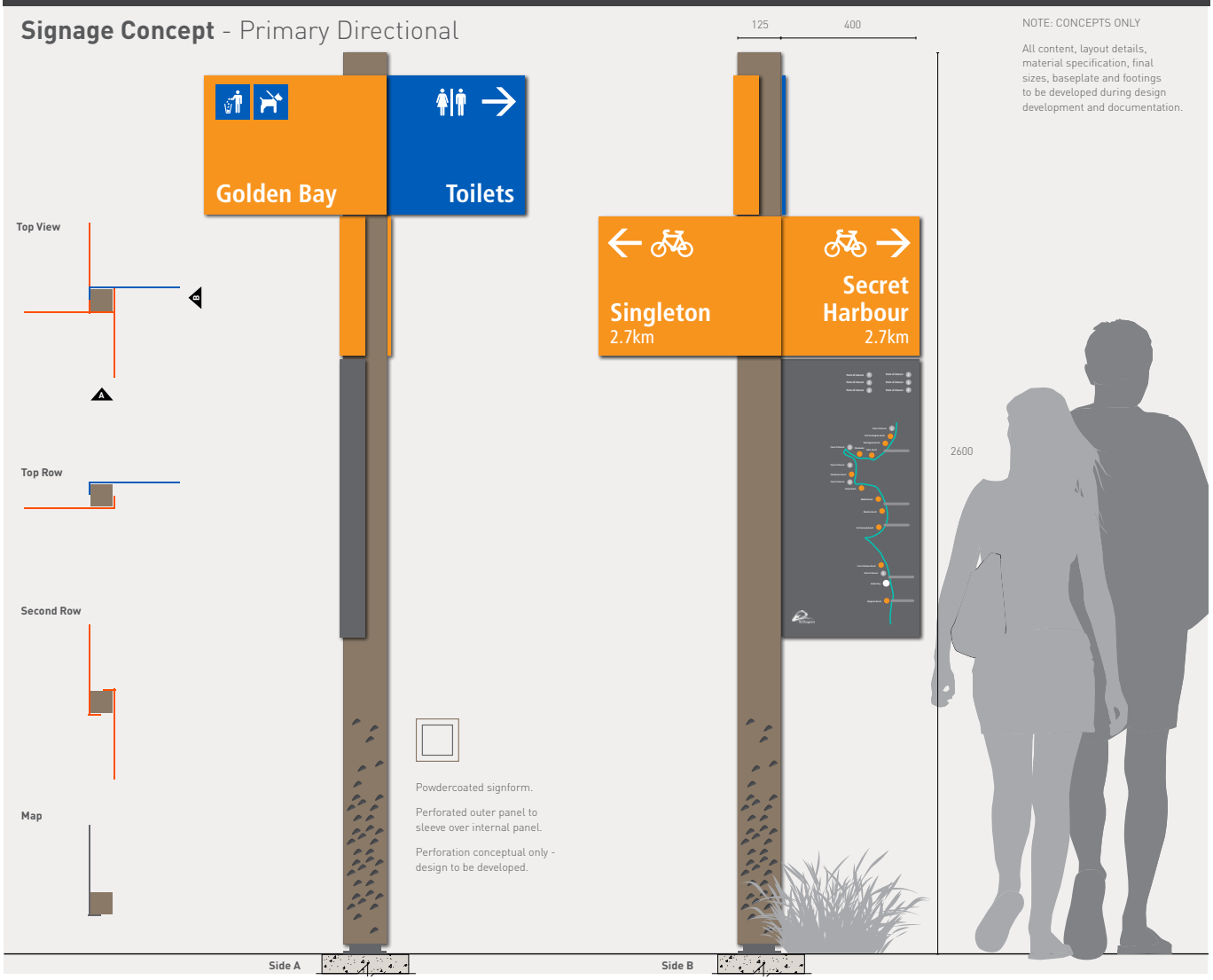
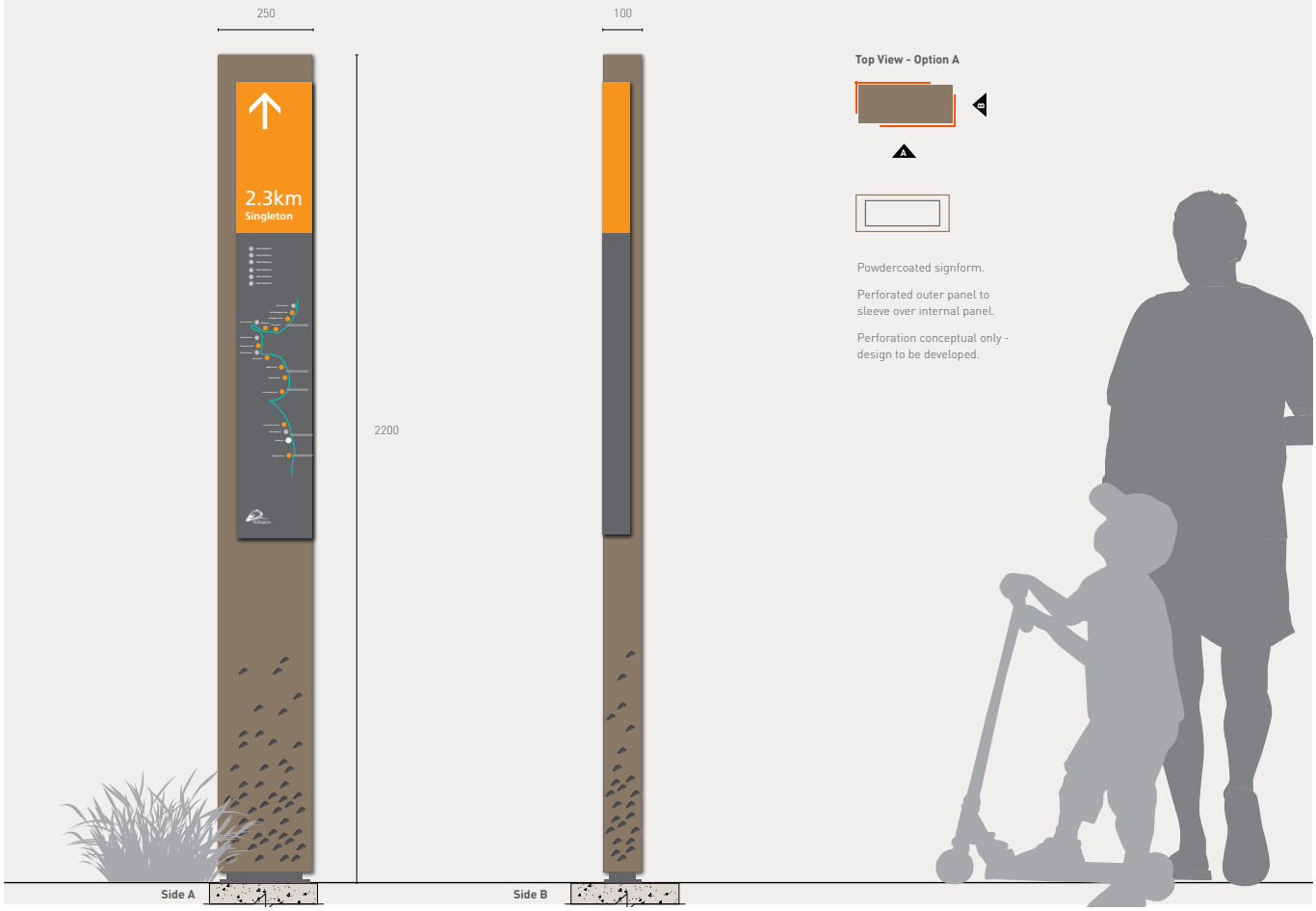


FIGURE 47 - Signage Concepts

Signage Concept - Secondary Directional

NOTE: CONCEPTS ONLY

All content, layout details, material specification, final sizes, baseplate and footings to be developed during design development and documentation.



10.0 Signage strategy (continued)

FIGURE 47 - Signage Concepts

Signage Concept - Interpretive

NOTE: CONCEPTS ONLY

All content, layout details, material specification, final sizes, baseplate and footings to be developed during design development and documentation.

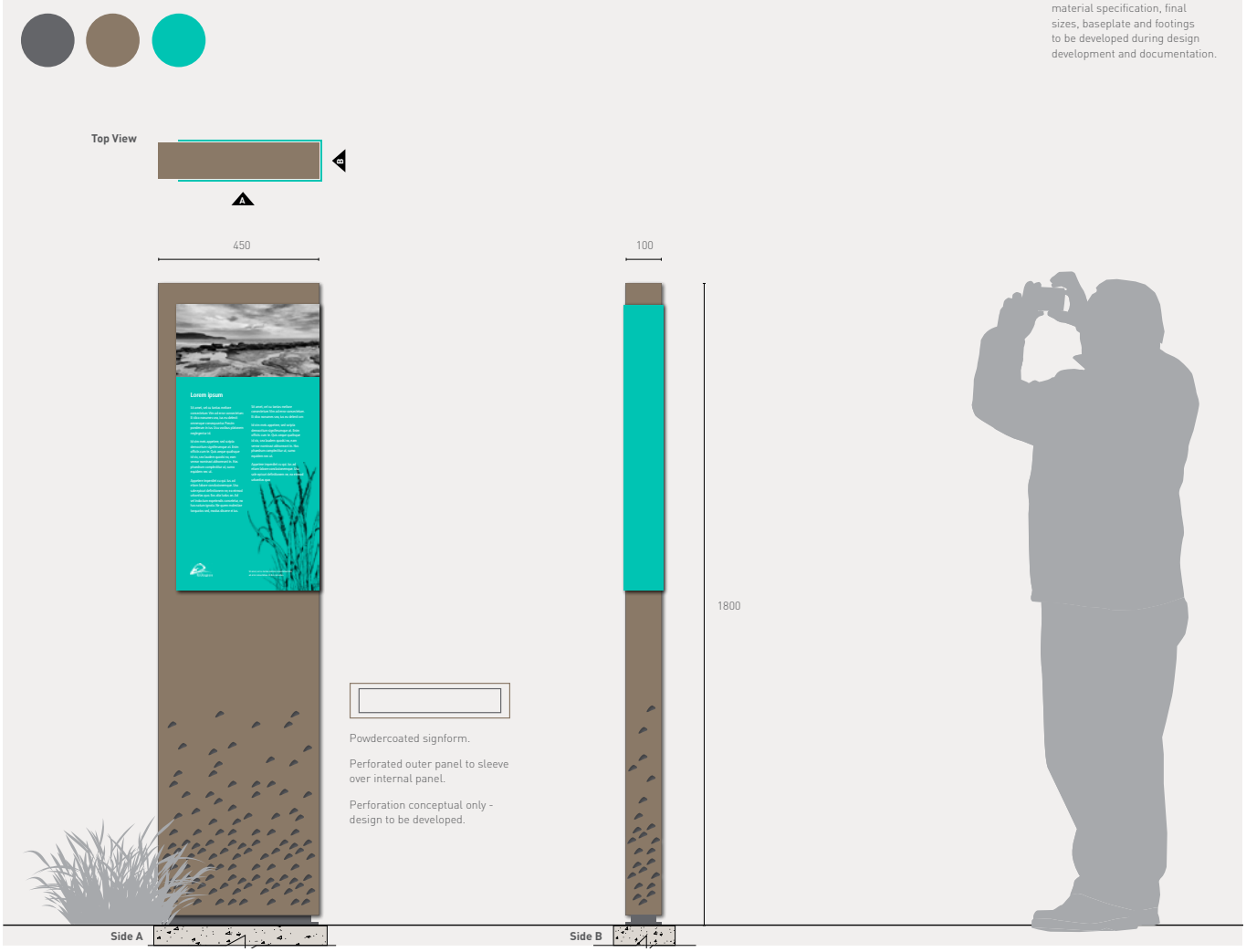
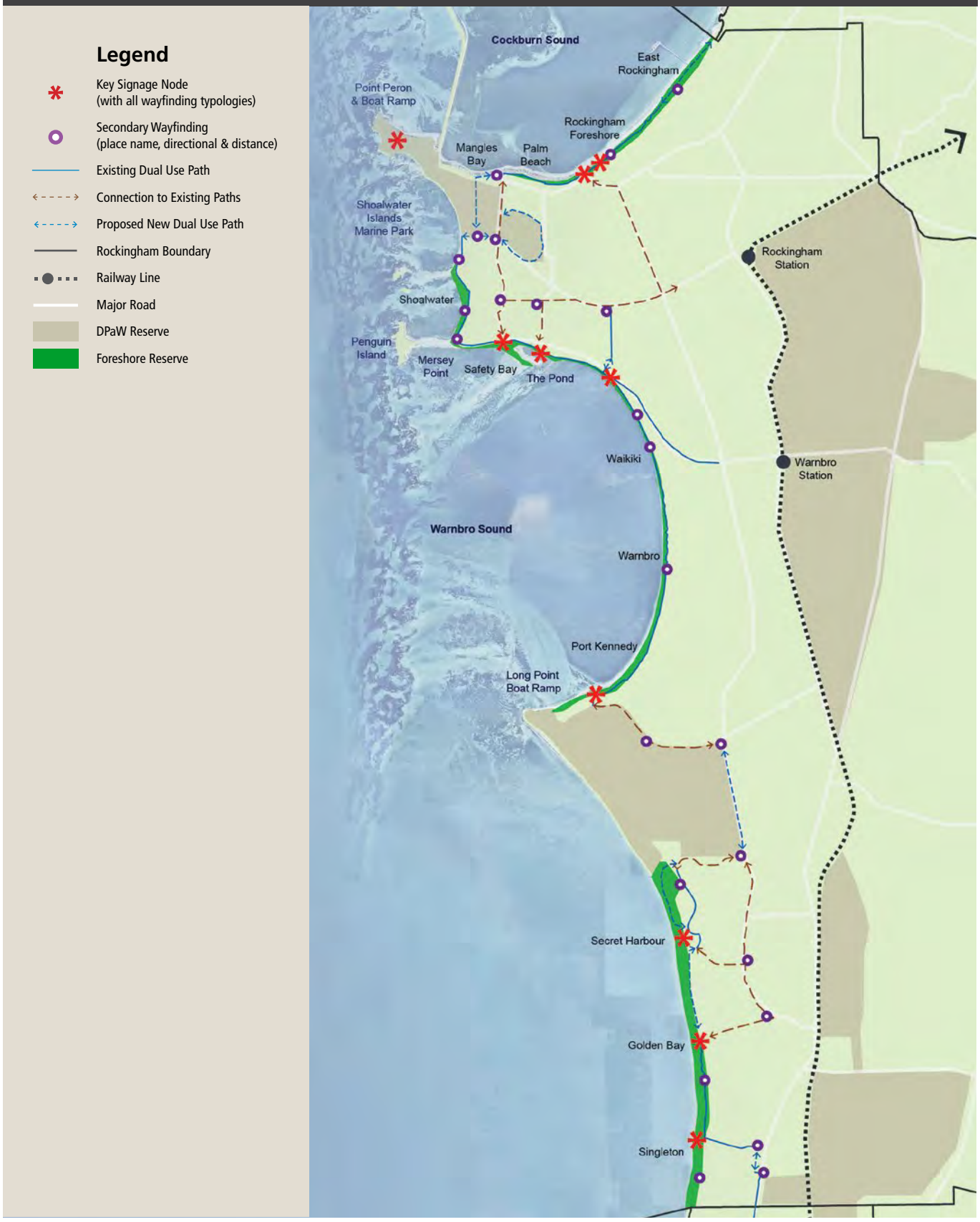


FIGURE 48 - Wayfinding and indicative signage locations



11.0

Recommendations and Implementation

11.0 Recommendations and Implementation

11.1 Revegetation

It is recommended that revegetation focus on vegetated areas classed as Degraded, particularly next to paths and car parks to enhance native biodiversity, fauna habitat and aesthetics. In addition, infill planting is recommended in areas of Good or Very Good vegetation condition with the aim of increasing vegetation condition to Very Good or Excellent. The removal of threatening processes in these areas will also encourage natural regeneration and improvement in overall vegetation condition.

Seed or tubestock is to be sourced from local provenance seed, hardened off and in good condition prior to planting. Propagation of plants from provenance seed improves the potential for success, as the plants are suited to site conditions.

Weed control should be undertaken in these areas prior to revegetation activities to increase the plant survival rate and minimise further weed infestation, as all recommended areas had high densities of weeds present. A few locations on steep narrow banks in Sectors 1 and 2 have high densities of the invasive Sea Spinach (Tetragonia decumbens*), which is currently stabilising the areas. It is recommended revegetation in these areas be undertaken in a staged approach in conjunction with erosion control measures such as biodegradable matting, to minimise erosion and provide dune destabilisation.

It is recommended that:

- Tubestock be sourced from local provenance seed.
- Revegetation to focus on Degraded areas adjacent paths to reduce edge effects, weed colonisation and to enhance native biodiversity and visual aesthetics.
- Infill planting to occur in areas of Good and Very Good vegetation condition to increase the vegetation of these areas to Very Good or Excellent.
- Removal of threatening processes be undertaken to encourage natural regeneration and support revegetation.
- Revegetation of thin, steep dunes with high weed cover to be undertaken in a staged approach to minimise erosion.
- All staff members and contractors are trained in hygiene practices while undertaking works in the revegetation areas to reduce potential for pathogen introduction.

TABLE 40 - Appropriate species for revegetation in coastal environments

Scientific name	Common name	Form	Dunes	Parkland/ shade tree
Acacia cochlearis	Rigid Wattle	Shrub	●	
Acacia lasiocarpa	Panjang	Shrub	●	
Acanthocarpus preissii	-	Herb	●	
Agonis flexuosa	WA Peppermint Tree	Tree		●
Araucaria columnaris	Cook Island Pine	Tree		●
Araucaria heterophylla	Norfolk Island Pine	Tree		●
Atriplex cinerea	Grey Saltbush	Shrub	●	
Atriplex isatidea	Coast Saltbush	Shrub	●	
Banksia attenuata	Slender Banksia	Tree	●	●
Callitris preissii (C)	Rottnest Island Pine	Tree	●	●
Calothamnus quadrifidus	One-sided Bottlebrush	Shrub	●	
Carpobrotus virescens	Coastal Pigface	Herb	●	
Casuarina equisetifolia	Horse-tail Sheoak	Tree		●
Conostylis candicans	Grey Cottonhead	Shrub	●	
Diplolaena dampieri (C)	Southern Diplolaena	Shrub	●	
Ficinia nodosa	Knotted Club Rush	Sedge	●	
Hemiandra pungens	Snakebush	Shrub	●	
Hibbertia cuneiformis	Cutleaf Hibbertia	Shrub	●	
Lepidosperma gladiatum	Coast Sword-sedge	Sedge	●	
Lomandra maritima (C)	-	Herb	●	
Melaleuca huegelii	Chenille Honeymyrtle	Shrub/Tree	●	●
Melaleuca lanceolata	Rottnest Teatree	Tree	●	●
Melaleuca systena	-	Shrub	●	
Nitraria billardierei	Nitre Bush	Shrub	●	
Olearia axillaris	Coastal Daisybush	Shrub	●	
Rhagodia baccata	Berry Saltbush	Shrub	●	
Scaevola crassifolia	Thick-leaved Fan-flower	Shrub	●	
Spinifex hirsutus	Hairy Spinifex	Grass	●	
Spinifex longifolius	Beach Spinifex	Grass	●	
Sporobolus virginicus	Marine Couch	Grass	●	
Spyridium globulosum	Basket Bush	Shrub	●	

**(C) - Conservation significant flora species.*

11.0 Recommendations and Implementation

(continued)

TABLE 41 - Implementation

	Management Aspect	Actions	Priority	Estimated Cost
	Revegetation			
OBJECTIVE	To maintain and improve the condition of vegetation within the foreshore.	Undertake revegetation, focusing on areas of Degraded vegetation condition (21.74 ha).	High	550,000
		Undertake revegetation activities following disturbance events such as fire, erosion or extensive weed control to stabilise dunes.	High	Costs will vary depending on frequency and scale of disturbance.
		Ensure species used in revegetation are indigenous and consistent with existing vegetation types.	High	N/A
		Map of areas of revegetation undertaken within the foreshore reserve and upload data to the City's Intramaps system.	Medium	N/A
	Fauna			
OBJECTIVE	To maintain and protect existing populations of native fauna and aim to improve species abundance and diversity.	Undertake detailed fauna surveys to determine baseline species richness and evenness data within selected foreshore areas, particularly Sectors 3, 4 and 5.	Medium	$60,000
		Repeat detailed fauna surveys using the same methodology after 5 years and analyse changes.	Medium	$60,000
		Undertake biannual population monitoring of a priority target species, such as the Southern Brown Bandicoot (Isoodon obesulus fusciventer) and/or Lined Skink (Lerista lineata), within the foreshore reserve to provide an indication of population abundance and viability over time.	Medium	$40,000 per survey Costs will vary according to survey effort required.
	Invasive flora			
OBJECTIVE	Minimise the impacts of invasive flora on native vegetation by reducing the overall extent and density of weed species.	Progressively undertake weed control activities outlined for each Sector in accordance with the detailed weed suite maps.	High	$550,000 per annum
		Prioritise areas of Good and Very Good vegetation condition to prevent degradation and promote natural regeneration.	High	N/A
		Undertake weed control after disturbance events such as fire and prior to revegetation activities.	High	Costs will vary depending on frequency and scale of disturbance.
		Support weed management with revegetation and erosion control to stabilise dunes and reduce the potential for reinfestation, particularly in areas of Degraded condition.	High	Costs are ongoing according to need.
		Ensure weed control actions do not negatively impact native flora and fauna.	High	N/A
	Invasive fauna			
OBJECTIVE	Ensure consistent and active management of feral fauna populations to minimise the impacts on native flora and fauna.	Ensure feral animal control methods are suitable for use in an urban environment.	High	$37,000 per annum
		Optimise use of limited resources by undertaking monitoring to prioritise areas of high feral animal activity.	High	$15,000 per survey Costs will vary according to survey effort required.
		Prioritise control in areas of Good, Very Good or Excellent vegetation condition to prevent degradation of habitat value.	High	N/A
		Prioritise areas of known fauna habitat, particularly to support Southern Brown Bandicoot populations in Sectors 3, 4 and 5.	High	N/A

TABLE 41 - Implementation

	Management Aspect	Actions	Priority	Estimated Cost
	Inappropriate access			
OBJECTIVE	Minimise environmental degradation caused by inappropriate and unauthorised access into the foreshore reserves.	Reduce fragmentation by consolidating access tracks where appropriate.	Medium	N/A
		Rehabilitate unauthorised tracks through weed control, revegetation and brushing.	Medium	Costs are ongoing according to need.
		Ensure all areas of natural vegetation are fenced to restrict unauthorised access.	High	Costs covered in existing operational budgets.
		Ensure areas of damaged or absent fencing are attended to in a timely manner, with old fencing upgraded to 3 strand with SITA wire style.	High	Costs covered in existing operational budgets.
		Undertake regular maintenance of designated beach access paths and identify key areas that require upgrading/resurfacing.	High	Costs covered in existing operational budgets.
	Erosion			
OBJECTIVE	Ensure timely identification and management of erosion to minimise potential impacts on native vegetation, infrastructure and public safety.	Utilise appropriate site specific stabilisation techniques.	High	N/A
		Progressively implement erosion control for the 39 key erosion areas identified in Sectors 1-4 of this plan.	Medium	Cost will vary depending on scale and severity.
		Prioritise areas of medium to severe erosion adjoining recreational areas and coastal infrastructure.	High	Costs are ongoing according to need.
		Ensure safety of foreshore users by stabilising and/or restricting access to significantly eroded areas.	High	Costs are ongoing according to need.
	Vandalism and rubbish dumping			
OBJECTIVE	Minimise the impact of vandalism and rubbish dumping on the environmental value and visual amenity of the foreshore reserves.	Ensure adequate provision of rubbish bins along the foreshore, particularly around parkland areas, boat ramps and picnic facilities.	Medium	Costs are ongoing according to need.
		Undertake regular removal of litter to minimise the transfer into the ocean.	High	N/A
		Ensure bins are emptied regularly.	High	N/A
		Ensure unauthorised access is restricted and aim to increase visual surveillance of foreshore areas where appropriate.	Medium	Costs are ongoing according to need.
		Undertake mechanical beach cleaning as required in priority areas.	Medium	Costs covered in existing operational budgets.
	Signage			
OBJECTIVE	Provide appropriate interpretive, directional and regulatory signage along the City's foreshore.	Initiate detailed design of specific signage content and source readily available materials in collaboration with a sign writer.	Medium	$10,000
		Progressively install signage using the indicative signage typology and wayfinding plan outlined in Section 10 as a guide.	Medium	$30,000
		Ensure all signage is resistant to graffiti.	High	N/A
		Prioritise installation in locations of high visitation and public amenity.	High	N/A
	Community engagement			
OBJECTIVE	Encourage community understanding and stewardship of the foreshore environment through engagement and education.	Offer volunteering opportunities through Conservation Volunteers Australia.	Medium	N/A
		Use the City Chronicle and the City's Facebook page to communicate environmental activities being undertaken along the foreshore.	Medium	N/A
		Support community involvement in coastal rehabilitation activities through initiatives such as Perth NRM Coastcare and the 'Adopt a Beach' program.	High	$10,000 per annum

11.0 Recommendations and Implementation

(continued)

TABLE 41 - Implementation

	Management Aspect	Actions	Priority	Estimated Cost
	Recreation			
OBJECTIVE	Upgrade key recreational areas along the coastline to provide a range of sustainable experiences which are compatible with the surrounding environment.	Initiate detailed design and community consultation for Concept Areas 1, 2, 3 and 4 outlined in this plan.	Medium	Detailed design per area: 1: $15,000 2: $50,000 3: $40,000 4: $15,000
		Construct Concept Areas 1, 2, 3 and 4	Medium	Construction per area: 1: $198,000 2: $660,000 3: $280,000 (+$210,000 for universal access path) 4: $200,000

11.2 Key performance indictors

The evaluation of the following key performance indicators will provide a quantifiable measure of the delivery and efficacy of environmental management practices being undertaken in accordance with this plan.

Parameter	Assessment Method	Performance Criteria	Frequency
Vegetation condition	10m x 10m monitoring quadrats (minimum of two per Sector) Vegetation condition should be assessed according to the Keighery scale	Vegetation condition ≥ baseline condition identified in this Plan	Annually
	Comprehensive vegetation condition survey for all foreshore reserves according to the Keighery scale	Vegetation condition ≥ baseline condition identified in this Plan	As part of the Foreshore Management Plan review after 5 years
Revegetation species representation	10m x 10m monitoring quadrats (minimum of one per revegetation area)	80-90% of species planted being evident in any area of 100m2 during monitoring compared to baseline data	Annually
Revegetation survival	10m x 10m monitoring quadrats (minimum of one per revegetation area)	Minimum 80% seedling survival rate after 12 months	Annually
Weeds	10 x 10m monitoring quadrats (minimum of two per Sector)	Percentage weed coverage should be ≤ baseline data collected from first monitoring round	Annually
	Comprehensive survey of dominant weed suites and priority weed species consistent with the survey approach demonstrated in this Plan	Extent of weeds suites and priority weed species ≤ baseline identified in this Plan	As part of the Foreshore Management Plan review after 5 years

The GPS location of all monitoring quadrats should be noted and recorded on the City's Intramaps system, with the same quadrats to be used annually. Photo monitoring points should be established in all quadrats, with photographs to be taken as part of the annual quadrat assessments to visually document changes in vegetation composition over time.

An annual summary report should be prepared, commencing in September 2016, to be saved in HPRM container PKR/46-02.

12.0
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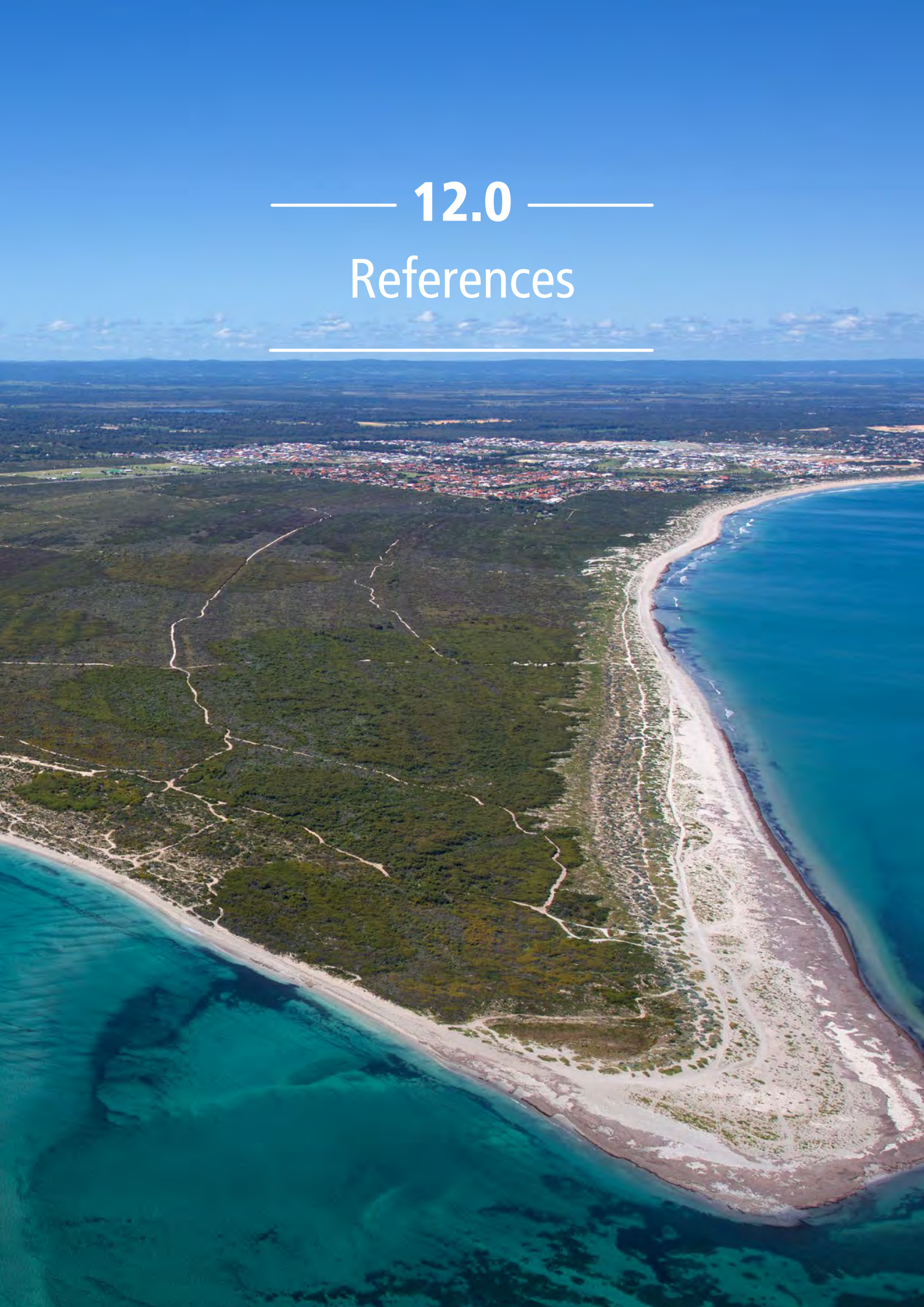

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13.0
Appendices

13.0 Appendices

Appendix A - Legislation, Background Information and Conservation Codes

Federal *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as matters of national environmental significance (MNES).

There are currently nine MNES protected under the EPBC Act, these include:

- World heritage properties
- National heritage places
- Wetlands of international importance (listed under the Ramsar Convention)
- Listed Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- The Great Barrier Reef Marine Park
- Nuclear actions (including uranium mines)
- A water resource, in relation to coal seam gas development and large coal mining development.

State *Wildlife Conservation Act 1950*

The *Wildlife Conservation Act 1950* (WC Act) provides for the conservation and protection of wildlife. It is administered by the DPaW and applies to both flora and fauna. Any person wanting to capture, collect, disturb or study fauna requires a permit to do so. A permit is required under the WC Act if removal of threatened species is required.

State *Biosecurity and Agriculture Management Act 2007*

The *Biosecurity and Agriculture Management Act 2007* (BAM Act) provides for the declaration of Declared Pests by the Department of Agriculture and Food Western Australia (DAFWA) which are prohibited organisms or organisms for which a declaration under Section 22(2) is in force.

The BAM Act replaces the repealed *Agriculture and Related Resources Protection Act 1976* (ARRP Act).

Vegetation and Flora

Species of significant flora, fauna and communities are protected under both Federal and State Acts. The Federal EPBC Act provides a legal framework to protect and manage nationally important flora and communities. The State WC Act is the primary wildlife conservation legislation in Western Australia.

Areas of native vegetation may also be classified as Bush Forever by the Western Australian Planning Commission. Over 51,000 hectares are currently protected across 287 Bush Forever sites, which represent a minimum (where possible) of 10% of each of the 26 vegetation complexes on the Swan Coastal Plain. Areas of Bush Forever are afforded statutory definition under the Metropolitan Region Scheme Amendment for Bush Forever and Related Lands (MRS 1082/33).

Significant vegetation

Vegetation may be significant for a range of reasons, other than a statutory listing as a Threatened Ecological Community or because the extent is below a threshold level. The Environmental Protection Authority (2004) states that significant vegetation may include vegetation that includes the following:

- Scarcity
- Unusual species
- Novel combinations of species
- A role as a refuge
- A role as a key habitat for threatened species or large population representing a significant proportion of the local to regional total population of a species
- Being representative of the range of a unit (particularly, a good local and/or regional example of a unit in 'prime' habitat, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- A restricted distribution.
- This may apply at a number of levels, so the unit may be significant when considered at the fine-scale (intra-locality), intermediate-scale (locality or inter-locality) or broad-scale (local to region).

13.0 Appendices (continued)

Conservation significant flora and fauna

Species of significant flora are protected under both Federal and State legislation. Any activities that are deemed to have a significant impact on species that are recognised by the EPBC Act, and/or the WC Act can warrant referral to the DotE and/or the EPA. According to the DPaW (WA Herbarium): "Threatened flora are plants which have been assessed as being at risk of extinction. In Western Australia the term Declared Rare Flora (DRF) is applied to Threatened flora due to the laws regarding threatened flora conservation. The WC Act is the primary wildlife conservation legislation in the State and the Minster for the Environment can declare taxa (species, subspecies or variety) as "Rare Flora" if they are considered to be in danger of extinction, rare or otherwise in need of special protection." For the purposes of this Plan, flora listed by the WC Act as DRF is described as Threatened.

The Federal conservation level of flora and fauna species and their significance status is assessed under the EPBC Act. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN).

The State conservation level of fauna species and their significance status is assessed under the State WC Act (Wildlife Conservation (Specially Protected Fauna) Notice 2010(2)). This Act uses a set of Schedules but also classifies species using some of the IUCN categories. Schedule 3 fauna species are those which are "subject to an agreement between the Government of Australia and the Governments of Japan, China and the Republic of Korea relating to the protection of migratory birds, are declared to be fauna that is in need of special protection".

In Western Australia, the DPaW also maintains a list of Priority listed flora species. Conservation codes for Priority species are assigned by the DPaW to define the level of conservation significance. Priority species are not currently protected under the WC Act.

For the purposes of this assessment, all species listed under the EPBC Act, WC Act and DPaW Priority species are considered conservation significant.

TABLE A1 - Conservation codes and descriptions for DPaW priority listed species

Code	Conservation category	Description
1	Priority One: Poorly-known taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases 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 that 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, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. 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	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population 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, Near Threatened and other taxa in need of monitoring	(a) Rare. Taxa that 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. (b) Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) 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 taxon becoming threatened within five years.

Migratory species listed under the EPBC Act

The EPBC Act also protects land and migratory species that are listed under International Agreements. The list of migratory species established under section 209 of the EPBC Act comprises:

- Migratory species which are native to Australia and are included in the appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals Appendices I and II).
- Migratory species included in annexes established under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China–Australia Migratory Bird Agreement (CAMBA).
- Native, migratory species identified in a list established under, or an instrument made under, an international agreement approved by the Minister, such as the republic of Korea–Australia Migratory Bird Agreement (ROKAMBA).

Other significant flora and fauna

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, other than as Threatened (Declared Rare) Flora or Priority Flora. The EPA (2004) states that significant flora may include taxa that have:

- A keystone role in a particular habitat for threatened species or supporting large populations representing a significant proportion of the local regional population of a species
- Relic status
- Anomalous features that indicate a potential new discover
- Being representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
- The presence of restricted subspecies, varieties, or naturally occurring hybrids
- Local endemism/a restricted distribution
- Being poorly reserved.

The application of the degree of significance may apply at a range of scales.

Introduced plants (weeds)

Declared Pests

The Department of Agriculture and Food Western Australia (DAFWA) maintains a list of Declared Pests for Western Australia that have been declared under the BAM Act. If a Pest is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to comply with the specific category of control. Declared Pests are gazetted under categories, which define the action required. The category may apply to the whole of the State, districts, individual properties or even paddocks. Among the factors considered in categorising Declared Pests are:

- The impact of the plant on individuals, agricultural production and the community in general
- Whether it is already established in the area
- The feasibility and cost of possible control measures.

Table A2 Department of Agriculture and Food (Western Australia) Categories for Declared Pests under the Biosecurity and Agriculture Management Act 2007.

Weeds of National Significance

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. The assessment of Weeds of National Significance (WoNS) is based on four major criteria:

- Invasiveness
- Impacts
- Potential for spread
- Socio-economic and environmental values

Australian state and territory governments have identified thirty two Weeds of National Significance (WoNS); a list of 20 WoNS was endorsed in 1999 and a further 12 were added in 2012
(Australian Government 2012)

Environmental weeds

"Environmental weeds are plants that establish themselves in natural ecosystems (marine, aquatic and terrestrial) and proceed to modify natural processes, usually adversely, resulting in the decline of the communities they invade" (CALM 1999). The Environmental Weed Strategy for Western Australia (EWSWA) was published in 1999. This document provides direction and an approach to tackling environmental weeds in WA (CALM 1999). Following on from this strategy (in 2008), in an effort to address invasive weeds and implement an integrated approach to weed management on DPaW managed lands in WA, the Weed Prioritisation Process was developed. A series of workshops were held in each of the nine DPaW regions with the purpose of scoring all weeds which occurred in each of the DPaW regions according to the following key attributes:

- Potential distribution and impact
- Invasiveness
- Current distribution
- Feasibility of control
- Weed management ability
- Weed risk.

This process resulted in the following five ratings for each weed species:

- Very high (VH)
- High (H)
- Medium (M)
- Low (L)
- Negligible (N)

The suggested management actions for each species range from no action required (the weed species ranking is as low as to not warrant any investment in regional strategic management actions), through targeted control to reduce infestation or spread, to species requiring state-wide eradication. A total of 1350 weeds were rated through this process as high, moderate, mild or low, with 34 weed species being rated as high.

The prioritisation for individual weeds within a DPaW region should be treated as a guide and does not diminish any other requirements of land managers or developers e.g. Declared Plants requirements of the BAM Act or Ministerial requirements under Part IV of the EP Act.

TABLE A2 - Department of Agriculture and Food (Western Australia) Categories for Declared Pests under the *Biosecurity and Agriculture Management Act 2007*

Control Code	Class	Description
C1	(Exclusion)	Pests will be assigned to this category if they are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	(Eradication)	Pests will be assigned to this category if they are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	(Management)	Pests will be assigned to this category if they are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Appendix B - Flora

TABLE B1 - Summary of Vegetation Condition Scale as developed by Keighery (1994) and as summarised in Bush Forever (Government of Western Australia 2000) Condition Scale Description

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
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.
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.
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 frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
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.

Field survey methodology

The field survey was conducted during spring and undertaken using the NAIA template to identify vegetation type, vegetation condition and existing infrastructure. The methodology for the field assessment and for completing the NAIA templates followed that detailed in the Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region (Del Marco et al. 2004).

Field survey limitations

The assessment of the foreshore reserves was not a comprehensive assessment and not all of the species present at each site would have been recorded. The assessment was done at a level appropriate for the need to assess the natural values of the reserves and to determine management measures.

Appendix C - Fauna

Database Searches

The following databases were searched to assist with compilation of a potential species list for the study area:

1. NatureMap (www.naturemap.dpaw.wa.gov.au): collaboration between the Department of Parks and Wildlife and the Western Australian Museum (WAM). This database represents the most comprehensive source of information on the distribution of Western Australia's fauna, comprising records from the Fauna Survey Returns database and WA Threatened Fauna Database (both of the Department of Parks and Wildlife), the WAM Specimen Database, and the BirdLife Australia Atlas. The database search (Appendix 1) was conducted on 2 October 2015 and requested the return of records from a rectangle bounded by the coordinates 50H 6422636 N 382147 E and 6408409 N 385855 E.
2. The EPBC Act Protected Matters database (Appendix 2): this database was searched to identify fauna species listed as Matters of National Environmental Significance (MNES) that may occur in the study area locality. The search was conducted on 27th November 2015 and requested the return of records from the rectangle created by the centreline 50H 332971 E 6423046 N and 383763 E 6408796 N with a 5 km buffer.

Literature Review

Six fauna surveys conducted in the locality of the study area were included in the desktop review (Table C1). As far as possible only surveys conducted within foreshore habitat similar to the study area were included.

The following documents were also consulted for information relevant to the management of foreshore habitats and urban bushland remnants for fauna:

- Urban bushland remnants on the Swan Coastal Plain: How and Dell (1994), How (1998).
- Management strategies for Rockingham and other coastal centres: City of Rockingham Foreshore Management Plan (2012), Trigg Bushland Reserve Management Plan (2014), City of Cockburn Natural Area Management Strategy 2012 – 2022 (2012), Beeliar Regional Park Proposed Final Management Plan 2005-2014 (2005), Rockingham Lakes Regional Park Proposed Final Management Plan (2010).
- Accounts of species' biology were obtained from the following resources:
    - Australian Bats (Churchill 2008),
    - Field Companion to the Mammals of Australia (van Dyck et al. 2013),
    - The Mammals of Australia (van Dyck and Strahan 2008),
    - Handbook of Western Australian Birds (Johnstone and Storr 1998, 2004),
    - A Complete Guide to Reptiles of Australia (Wilson and Swan 2013),
    - Reptiles and Amphibians of Australia (Cogger 2014),
    - Field Guide to Frogs of Western Australia (Tyler and Doughty 2009),
    - Species Profile and Threats Database (Department of the Environment 2015a),
    - Birds in Backyards BirdLife Australia 2015).

TABLE C1 - Fauna surveys conducted in the locality of the study area.

Report Title	Author	Survey Dates	Survey Effort	Fauna Group Surveys	Distance from Study Area	Habital Surveyed
Ground vertebrate fauna of Perth's vegetation remnants: impact of 170 years of urbanisation	How and Dell (2000)	Oct-Dec, Feb-Mar for 1 – 3 years (1993 – 1996)	67 pit-fall trap sites	Ground vertebrate fauna	25 km east to 75 km north	Swan Coastal Plain but only records from coastal sites included in desktop review
Bird surveys in selected Perth metropolitan reserves.	Perth Biodiversity Surveys (Gole 2004)	2002 – 2004	932 volunteer surveys across 78 sites	Birds	10 km east to 75 km north	Perth metropolitan area but only records from coastal sites included in desktop review
Binningup bat survey 2009: Echolocation survey of bat activity in the Lake Clifton and Lake Preston localities on the Swan Coastal Plain	Bullen (2009)	Jan-Apr 2009	Call recordings	Bats	40 – 60 km south	Coastal heath and shrublands and woodlands of varying maturity and composition
An assessment of herpetofauna on near-coastal landforms between Dawesville and Binningup, southern Swan Coastal Plain	How et al. (2009)	Mar 2009	8 pit-fall trap and funnel trap sites	Reptiles and Amphibians	25 km south	Quindalup, Spearwood, Vasse and Yoongarillup Vegetation, Cottesloe, Karrakata vegetation complexes.
An assessment of the non-volant mammal fauna of the area between Dawesville and Binningup, southern Swan Coastal Plain	Hyder and Dell (2009)	Trapping Jan – Jul 2009, Opportunistic records 2003 – 2008	12 sites searched	Ground mammals	25 km south	Quindalup, Spearwood, Vasse and Yoongarillup Vegetation Complexes (Heddle et al. 1980)
Fauna trapping at Trigg Bushland.	Friends of Trigg Bushland Reserve (2015)	Summer and Autumn 1994 – 1997, 2013	Pit-fall trapping	Ground vertebrate fauna	48 km north	Coastal dunes

13.0 Appendices (continued)

Nomenclature

Species nomenclature for mammals, reptiles and amphibians follows that of the Western Australian Museum (WAM) fauna taxonomic checklist, which was last revised in September 2015. Species nomenclature for avifauna follows that of Christidis and Boles (2008).

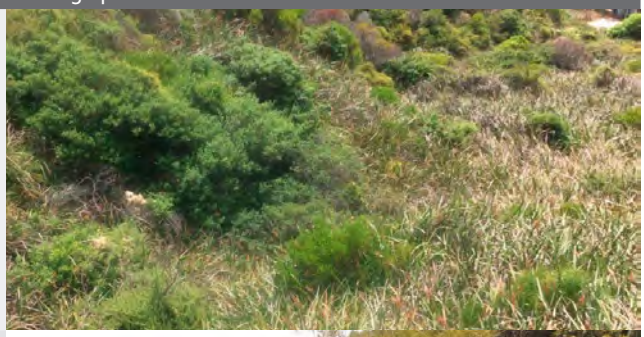
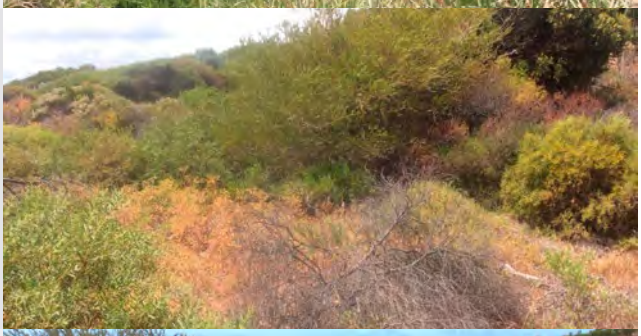
Assessment of Likelihood of Occurrence

The likelihood of occurrence of species identified in the desktop review was based on the known occurrence of the species within the local area (defined as the coastal strip north and south of the study area), known habitat preferences and last known records. For each species considered, a set of rankings and criteria was applied to assess the likelihood of occurrence within the study area (Table C2). Detection of any given species is based on current approaches and typical sampling effort. In some instances these methods of detection may not be adequate to target inconspicuous or rare species, therefore the categorisation of a species as 'unlikely to occur' should be interpreted with caution.

TABLE C2 - Ranking system used to assign the likelihood that a species would occur in the study area.

Rank	Criteria
Recorded	1. The species has been previously recorded in the study area.
Likely to occur	1. There are existing records of the species in close proximity to the study area (coastal strip north and south of the study area); and • the species is strongly linked to a specific habitat, which is present in the study area; or • the species has more general habitat preferences, and suitable habitat is present.
May potentially occur	1. There are existing records of the species from the locality (within 40 km); however, • the species is strongly linked to a specific habitat, of which only a small amount is present in the study area; or • the species has more general habitat preferences, but only some suitable habitat is present. 2. There is suitable habitat in the study area, but the species is recorded infrequently in the locality.
Unlikely to occur	1. The species is linked to a specific habitat, which is absent from the study area; or 2. Suitable habitat is present but there are no existing records of the species from the locality despite reasonable previous search effort in suitable habitat; or 3. There is some suitable habitat in the study area; however, the species is very infrequently recorded in the locality.
Would not occur	1. The species is strongly linked to a specific habitat, which is absent from the study area; and/or 2. The species' range is very restricted and does not include the study area.

TABLE C3 - Description of fauna sampling locations in Sector 3

	Site Name	Description	Photograph
SECTOR THREE	**Roc01**	*Lepidosperma gladiatum sedgeland* with scattered *Acacia* sp. shrubs and low shrubland of *Acanthocarpus preissii*.	
	Roc02	Scattered low *Agonis flexuosa* trees over tall shrubland of *Acacia* sp., *Callitris preissii* and *Melaleuca nesophila* over scattered *Spinifex longifolius* and mixed grasses.	
	Roc03	Tall open shrubland of **Melaleuca nesophila* over scattered low *Olearia axillaris* and *Acacia* sp. shrubland over **Pelargonium capitatum* and *Carpobrotus virescens*.	
	Roc04	Scattered low **Eucalyptus utilis* trees over *Acacia* sp. open heath over low open *Scaevola crassifolia* shrubland over scattered low **Pelargonium capitatum*.	
	Roc05	Mixed *Acacia* sp. and *Scaevola crassifolia* shrubland over scattered *Lomandra maritima* herb over *Carpobrotus virescens*.	

13.0 Appendices (continued)

TABLE C3 - Description of fauna sampling locations in Sector 3

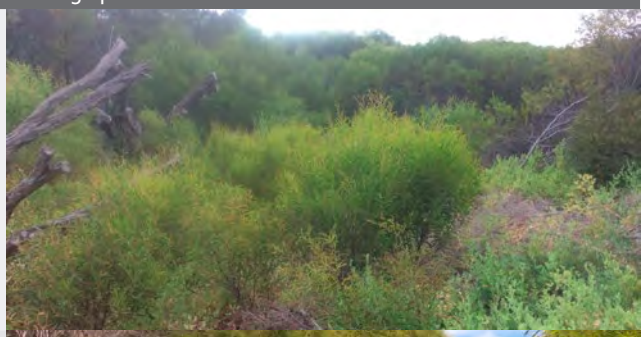
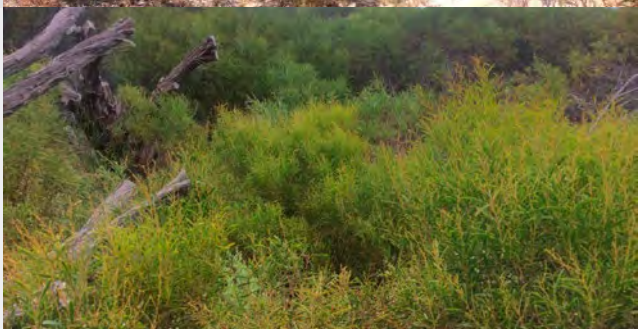
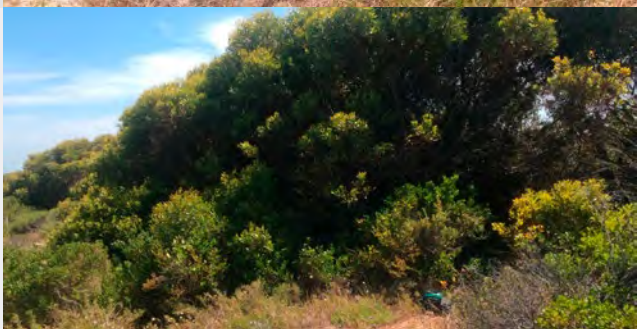
	Site Name	Description	Photograph
SECTOR THREE (continued)	**Roc06**	Tall open *Acacia* sp. shrubland over open *Rhagodia baccata* subsp. *baccata* shrubland over mixed introduced grasses.	
	RocMC-01	*Lepidosperma gladiatum* sedgeland with scattered *Acacia* sp. shrubs and *Cassytha racemosa* over low shrubland of *Acanthocarpus preissii.*	
	RocMC-02	Mixed *Acacia* sp. and *Scaevola crassifolia* shrubland over scattered *Lomandra maritima* herb over *Carpobrotus virescens.*	
	RocMC-04	Scattered low **Eucalyptus utilis* trees over scattered low *Acacia* sp. shrubs over scattered *Acanthocarpus preissii* and mixed introduced grasses.	
	RocBAT-01	Tall open *Acacia* sp. shrubland over mixed introduced grasses.	

TABLE C3 Description of fauna sampling locations in Sector 4

	Site Name	Description	Photograph
SECTOR FOUR	**Roc07**	Open shrubland of *Spyridium globulosum* and scattered low *Olearia axillaris* shrubland and *Cassytha racemosa* vine over *Lepidosperma gladiatum* sedgeland.	
	Roc08	Shrubland of *Spyridium globulosum* over scattered tall *Olearia axillaris* shrubland over scattered **Pelargonium capitatum*.	
	RocMC-03	Shrubland of *Spyridium globulosum* over scattered tall shrubs of *Olearia axillaris* over scattered **Pelargonium capitatum*.	
	RocBAT-02	Low open woodland of *Allocasuarina* sp. over *Ficinia nodosa* sedgeland.	
	Roc09	Open shrubland of *Spyridium globulosum* and *Acacia* sp. over *Carpobrotus virescens, Lomandra maritima* and mixed introduced grasses.	

13.0 Appendices (continued)

TABLE C3 Description of fauna sampling locations in Sector 5

	Site Name	Description	Photograph
SECTOR FIVE	**Roc10**	Open heath of *Acacia* sp., *Spyridium globulosum* and scattered *Olearia axillaris* over open *Lomandra maritima* herbs and mixed grasses.	
	Roc11	Closed mixed heath of *Acacia* sp. and *Acanthocarpus preissii* over open *Lomandra maritima* herbs and scattered *Carpobrotus virescens*.	
	Roc12	Open heath of *Spyridium globulosum* over *Scaevola crassifolia* shrubland and scattered *Leptomeria preissiana* over scattered *Carpobrotus virescens* and mixed grasses.	
	RocMC-05	Low scattered **Eucalyptus utilis* trees over low open *Olearia axillaris* and *Scaevola crassifolia* shrubland over *Acanthocarpus preissii* and scattered *Carpobrotus virescens* and mixed introduced grasses.	
	RocBAT-03	Low scattered **Eucalyptus utilis* trees over open shrubland of *Spyridium globulosum* and scattered *Olearia axillaris* shrubs over low scattered *Scaevola crassifolia* and mixed perennials.	

Survey Limitations

The following limitations should be recognised with regard to this Plan:

- Not all sections of the study area were ground-truthed or sampled for fauna; therefore this Plan should not be treated as an exhaustive or conclusive account of the fauna assemblage occurring in the study area.
- Seven days of sampling, in a single season, is generally considered limited to only document the most common and abundant species present within an area (How 1998).

13.0 Appendices (continued)

TABLE C4 Mammals

Family Species	Common Name	Conservation Status	Nature Map	How and Dell 2000	Hyder and Dell 2009	Bulletin 2009	Natural Area 2015	This Survey	Likelyhood of Occurence
Dasyuridae									
Dasyurus geoffroii	Chuditch, Western Quoll	Schedule 3	●						Would not occur
Phascogale tapoatafa tapoatafa	Southern Brush-tailed Phascogale, Wambenger	Schedule 3	●						Would not occur
Peramelidae									
Isoodon obesulus fusciventer	Quenda, Southern Brown Bandicoot	Priority 4	●	●				●	Recorded
Macropodidae									
Macropus fuliginosus	Western Grey Kangaroo				●			●	Recorded
Phalangeridae									
Trichosurus vulpecula	Common Brushtail Possum		●	●					Unlikely to occur
Pseudocheiridae									
Pseudocheirus occidentalis	Western Ringtail Possum				●				Would not occur
Vespertilionidae									
Chalinolobus gouldii	Gould's Wattled Bat		●			●		●	Recorded
Falsistrellus mackenziei	Western False Pipistrelle					●			Would not occur
Nyctophilus geoffroyi	Lesser Long-eared Bat					●			May potentially occur
Nyctophilus major	Greater Long-eared Bat					●			Would not occur
Vespadelus regulus	Southern Forest Bat					●			Would not occur

13.0 Appendices (continued)

TABLE C4 Mammals

Family Species	Common Name	Conservation Status	Nature Map	How and Dell 2000	Hyder and Dell 2009	Bulletin 2009	Natural Area 2015	This Survey	Likelyhood of Occurence
Molossidae									
Mormopterus sp.(form sp. 4	South-western Free-tailed Bat					●			Would not occur
Austronomus australis	White-striped Free-tailed Bat					●		●	Recorded
Muridae									
Mus musculus	House Mouse		●	●				●	Recorded
Rattus fuscipes	Western Bush Rat		●					●	May potentially occur
**Rattus rattus*	Black Rat		●	●					May potentially occur
Leporidae									
**Oryctolagus cuniculus*	Rabbit		●	●	●			●	Recorded
Canidae									
**Vulpes vulpes*	Fox			●	●			●	Recorded
Felidae									
**Felis catus*	Cat		●	●					Likely to occur
Canidae									
**Canis familiaris*	Dog						●	●	Recorded

TABLE C5 Reptiles

Family Species	Conservation Status	Nature Map	Trigg Friends	How and Dell 2009	How et al.	Natural Area 2015	This Survey	Likelyhood of Occurence
Diplodactylidae								
Lucasium alboguttatum			●					May potentially occur
Strophurus spinigerus		●	●	●	●		●	Recorded
Gekkonidae								
Christinus marmoratus			●	●	●			Likely to occur
Pygopodidae								
Aprasia repens				●	●		●	Recorded
Delma fraseri					●			May potentially occur
Delma grayii					●			May potentially occur
Lialis burtonis			●	●	●	●	●	Recorded
Pygopus lepidopodus				●				May potentially occur
Agamidae								
Ctenophorus adelaidensis			●	●			●	Recorded
Pogona minor		●	●	●	●	●	●	Recorded
Egerniidae								
Cyclodomorphus celatus			●	●				Likely to occur
Egernia napoleonis					●			Unlikely to occur
Tiliqua occipitalis		●	●	●			●	Recorded
Tiliqua rugosa		●	●	●	●	●	●	Recorded
Eugongylidae								
Acritoscincus trilineatus					●		●	Recorded
Cryptoblepharus buchananii			●		●			Likely to occur
Cryptoblepharus plagiocephalus				●		●		Likely to occur
Menetia greyii			●	●	●		●	Recorded
Morethia lineoocellata				●	●		●	Recorded
Morethia obscura			●	●	●			Likely to occur

13.0 Appendices (continued)

TABLE C5 Reptiles								
Family Species	Conservation Status	Nature Map	Trigg Friends	How and Dell 2009	How et al.	Natural Area 2015	This Survey	Likelyhood of Occurence
Sphenomorphidae								
Ctenotus australis		●	●	●	●			Likely to occur
Ctenotus fallens			●	●			●	Recorded
Hemiergis quadrilineata		●	●	●	●			Likely to occur
Lerista distinguenda					●			Unlikely to occur
Lerista elegans		●	●	●	●		●	Recorded
Lerista lineata	Priority 3	●					●	Recorded
Lerista lineopunctulata			●	●			●	Recorded
Lerista praepedita			●	●				Likely to occur
Boidae								
Morelia spilota imbricata		●						May potentially occur
Varanidae								
Varanus gouldii				●				May potentially occur
Varanus rosenbergi					●			Unlikely to occur
Varanus tristis tristis				●	●			Unlikely to occur
Typhlopidae								
Anilios australis			●	●				Unlikely to occur
Anilios pinguis				●				Unlikely to occur

TABLE C5 Reptiles								
Family Species	Conservation Status	Nature Map	Trigg Friends	How and Dell 2009	How et al.	Natural Area 2015	This Survey	Likelyhood of Occurence
Elapidae								
Brachyurophis fasciolatus				●				Likely to occur
Brachyurophis semifasciatus			●	●				Unlikely to occur
Demansia psammophis		●				●		Unlikely to occur
Echiopsis curta			●	●	●			May potentially occur
Neelaps bimaculatus				●				May potentially occur
Neelaps calonotos	Priority 3	●	●	●				Likely to occur
Notechis scutatus		●					●	Recorded
Parasuta gouldii		●		●				May potentially occur
Pseudonaja affinis		●	●	●	●		●	Recorded
Simoselaps bertholdi		●	●	●	●			Likely to occur

13.0 Appendices (continued)

TABLE C6 Amphibians

Family Species	Common Name	Nature Map	Trigg Friends	How and Dell 2009	How et al.	This Survey	Likelyhood of Occurence
Hylidae							
Litoria adelaidensis	Slender Tree Frog	●					Unlikely to occur
Litoria moorei	Motorbike Frog	●			●		Unlikely to occur
Limnodynastidae							
Heleioporus eyrei	Moaning Frog	●		●	●		Likely to Occur
Limnodynastes dorsalis	Western Banjo Frog	●		●	●	●	Recorded
Heleioporus psammophilus	Sand frog					●	Recorded
Boidae							
Crinia glauerti	Clicking Frog	●					Unlikely to occur
Crinia insignifera	Squelching Froglet	●			●		Unlikely to occur
Myobatrachus gouldii	Turtle frog		●	●			Would not occur

TABLE C7 Avifauna							
Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Casuariidae							
Dromaius novaehollandiae	Emu		●				Would not occur
Anatidae							
Biziura lobata	Musk Duck		●				May potentially occur
Cygnus atratus	Black Swan		●	●		●	Recorded
Tadorna tadornoides	Australian Shelduck		●				May potentially occur
Chenonetta jubata	Australian Wood Duck		●	●			May potentially occur
Anas rhynchotis	Australasian Shoveler		●				May potentially occur
Anas gracilis	Grey Teal		●				Likely to occur
Anas superciliosa	Pacific Black Duck		●	●		●	Recorded
Aythya australis	Hardhead					●	Recorded
Podicipedidae							
Tachybaptus novaehollandiae	Australasian Grebe		●			●	Recorded
Poliocephalus poliocephalus	Hoary-headed Grebe		●				May potentially occur
Columbidae							
Columba livia	Rock Dove			●	●	●	Recorded
Streptopelia senegalensis	Laughing Dove		●	●		●	Recorded
Streptopelia chinensis	Spotted Dove						Likely to occur
Phaps chalcoptera	Common Bronzewing		●				Unlikely to occur
Ocyphaps lophotes	Crested Pigeon		●	●			May potentially occur
Sulidae							
Morus serrator	Australasian Gannet					●	Recorded
Phalacrocoracidae							
Phalacrocorax carbo	Great Cormorant		●	●			Likely to occur
Phalacrocorax sulcirostris	Little Black Cormorant		●	●			Likely to occur

13.0 Appendices (continued)

TABLE C7 Avifauna							
Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Pelecanidae							
Pelecanus conspicillatus	Australian Pelican		●	●			Likely to occur
Ardeidae							
Ardea pacifica	White-necked Heron		●	●			May potentially occur
Ardea modesta	Eastern Great Egret	Schedule 5	●	●			May potentially occur
Egretta novaehollandiae	White-faced Heron			●			Likely to occur
Threskiornithidae							
Threskiornis molucca	Australian White Ibis		●				Likely to occur
Threskiornis spinicollis	Straw-necked Ibis		●				Likely to occur
Platalea flavipes	Yellow-billed Spoonbill		●				Unlikely to occur
Rallidae							
Porphyrio porphyrio	Purple Swamphen		●	●	●	●	Recorded
Gallinula tenebrosa	Dusky Moorhen					●	Recorded
Fulica atra	Eurasian Coot		●		●	●	Recorded
Accipitridae							
Elanus axillaris	Black-shouldered Kite		●			●	Recorded
Haliastur sphenurus	Whistling Kite		●				May potentially occur
Accipiter fasciatus	Brown Goshawk		●				May potentially occur
Accipiter cirrocephalus	Collared Sparrowhawk			●			Unlikely to occur
Circus approximans	Swamp Harrier		●	●			Unlikely to occur
Aquila audax	Wedge-tailed Eagle			●			Unlikely to occur
Hieraaetus morphnoides	Little Eagle						Unlikely to occur

TABLE C7 Avifauna							
Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Falconidae							
Falco cenchroides	Nankeen Kestrel		●	●		●	Recorded
Falco longipennis	Australian Hobby		●	●			Unlikely to occur
Recurvirostridae							
Himantopus himantopus	Black-winged Stilt		●				Unlikely to occur
Recurvirostra novaehollandiae	Red-necked Avocet		●				Unlikely to occur
Cladorhynchus leucocephalus	Banded Stilt		●				Unlikely to occur
Charadriidae							
Pluvialis squatarola	Grey Plover	Schedule 5	●				May potentially occur
Charadrius ruficapillus	Red-capped Plover		●	●			Likely to occur
Vanellus tricolor	Banded Lapwing		●	●			Unlikely to occur
Haematopodidae							
Haematopus longirostris	Australian Pied Oystercatcher		●			●	Recorded
Scolopacidae							
Limosa lapponica	Bar-tailed Godwit		●				Unlikely to occur
Actitis hypoleucos	Common Sandpiper	Schedule 5	●	●		●	Recorded
Tringa nebularia	Common Greenshank	Schedule 5	●	●			Unlikely to occur
Calidris alba	Sanderling	Schedule 5				●	Recorded
Calidris ruficollis	Red-necked Stint	Schedule 5	●				May potentially occur
Laridae							
Hydroprogne caspia	Caspian Tern	Schedule 5		●			Likely to occur
Thalasseus bergii	Crested Tern						Likely to occur
Larus pacificus	Pacific Gull			●			Likely to occur
Chroicocephalus novaehollandiae	Silver Gull			●	●	●	Recorded

13.0 Appendices (continued)

TABLE C7 Avifauna

Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Cacatuidae							
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Schedule 2	●				Unlikely to occur
Eolophus roseicapillus	Galah			●		●	Recorded
Cacatua tenuirostris	Long-billed Corella		●	●			Would not occur
Cacatua sanguinea	Little Corella		●			●	Recorded
Psittacidae							
Trichoglossus haematodus	Rainbow Lorikeet		●	●			May potentially occur
Polytelis anthopeplus	Regent Parrot		●			●	Recorded
Barnardius zonarius	Australian Ringneck			●	●		Likely to occur
Purpureicephalus spurius	Red-capped Parrot			●		●	Recorded
Neophema elegans	Elegant Parrot		●				Unlikely to occur
Cuculidae							
Chalcites lucidus	Shining Bronze-Cuckoo			●			Would not occur
Cacomantis pallidus	Pallid Cuckoo		●				Unlikely to occur
Cacomantis flabelliformis	Fan-tailed Cuckoo		●	●			Would not occur
Halcyonidae							
Dacelo novaeguineae	Laughing Kookaburra		●				Unlikely to occur
Todiramphus sanctus	Sacred Kingfisher						May potentially occur
Meropidae							
Merops ornatus	Rainbow Bee-eater	Schedule 5	●				May potentially occur
Maluridae							
Malurus splendens	Splendid Fairy-wren		●		●	●	Recorded
Malurus leucopterus	White-winged Fairy-wren			●			May potentially occur
Malurus lamberti	Variegated Fairy-wren						Likely to occur

TABLE C7 Avifauna

Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Acanthizidae							
Sericornis frontalis	White-browed Scrubwren		●	●		●	Recorded
Smicrornis brevirostris	Weebill		●				Unlikely to occur
Gerygone fusca	Western Gerygone		●	●		●	Recorded
Acanthiza chrysorrhoa	Yellow-rumped Thornbill			●			Unlikely to occur
Acanthiza inornata	Western Thornbill			●			May potentially occur
Acanthiza apicalis	Inland Thornbill		●	●		●	Recorded
Pardalotidae							
Pardalotus punctatus	Spotted Pardalote		●	●			Unlikely to occur
Pardalotus striatus	Striated Pardalote		●	●			Unlikely to occur
Meliphagidae							
Acanthorhynchus superciliosus	Western Spinebill		●				May potentially occur
Lichenostomus virescens	Singing Honeyeater			●	●	●	Recorded
Anthochaera lunulata	Western Wattlebird		●				Unlikely to occur
Anthochaera carunculata	Red Wattlebird		●			●	Recorded
Lichmera indistincta	Brown Honeyeater		●	●		●	Recorded
Phylidonyris novaehollandiae	New Holland Honeyeater		●			●	Recorded
Phylidonyris niger	White-cheeked Honeyeater					●	Recorded
Neosittidae							
Daphoenositta chrysoptera	Varied Sittella		●	●			Unlikely to occur
Campephagidae							
Coracina novaehollandiae	Black-faced Cuckoo-shrike		●			●	Recorded
Pachycephalidae							
Pachycephala pectoralis	Golden Whistler		●				May potentially occur
Pachycephala rufiventris	Rufous Whistler		●	●		●	Recorded
Colluricincla harmonica	Grey Shrike-thrush		●			●	Recorded

13.0 Appendices (continued)

TABLE C7 Avifauna

Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Artamidae							
Artamus cinereus	Black-faced Woodswallow		●				Unlikely to occur
Artamus cyanopterus	Dusky Woodswallow			●			May potentially occur
Cracticus torquatus	Grey Butcherbird		●		●	●	Recorded
Cracticus tibicen	Australian Magpie		●			●	Recorded
Strepera versicolor	Grey Currawong		●	●			May potentially occur
Rhipiduridae							
Rhipidura albiscapa	Grey Fantail		●			●	Recorded
Rhipidura leucophrys	Willie Wagtail		●	●		●	Recorded
Corvidae							
Corvus coronoides	Australian Raven		●			●	Recorded
Monarchidae							
Grallina cyanoleuca	Magpie-lark		●		●	●	Recorded
Petroicidae							
Petroica boodang	Scarlet Robin						Unlikely to occur
Petroica goodenovii	Red-capped Robin			●			May potentially occur
Acrocephalidae							
Acrocephalus australis	Australian Reed-Warbler		●				Unlikely to occur
Megaluridae							
Megalurus gramineus	Little Grassbird		●	●			Unlikely to occur

TABLE C7 Avifauna							
Species Name	Common Name	Conservation Status	Nature Map	Perth Biodiversity Surveys	Natural Area 2015	This Survey	Likelyhood of Occurence
Timaliidae							
Zosterops lateralis	Silvereye		●			●	Recorded
Hirundinidae							
Hirundo neoxena	Welcome Swallow		●			●	Recorded
Petrochelidon nigricans	Tree Martin					●	Recorded
Nectariniidae							
Dicaeum hirundinaceum	Mistletoebird		●				Would not occur

Acknowledgements

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Matthew Donaldson - *Coastal Engineering Officer*

CITY OF ROCKINGHAM

Foreshore Management Plan

city of Rockingham

where the coast comes to life