Leschenault Peninsula

Management Plan

1998–2008

MANAGEMENT PLAN N0 38

Department of Conservation
and Land Management

National Parks and Nature
Conservation Authority

LESCHENAULT PENINSULA

MANAGEMENT PLAN

1998-2008

Department of Conservation and Land Management
for
The National Parks and Nature Conservation Authority
Perth, Western Australia 1998

PREFACE

This management plan proposes that Leschenault Peninsula be managed in accordance with the *Conservation and Land Management Act 1984* (CALM Act) and in accordance with the criteria outlined in CALM's Central Forest Region's Regional Management Plan.

Conservation parks are vested in the National Parks and Nature Conservation Authority (NPNCA) and managed by the Department of Conservation and Land Management (CALM). The NPNCA is responsible for preparing management plans for all lands vested in it, including conservation parks. These plans are prepared by CALM for the NPNCA and released as management plans for public comment.

With the agreement of the Leschenault Peninsula Community Advisory Committee and consistent with the CALM Act and the criteria for management of conservation parks, much of the recreation development work has commenced. This plan seeks community input and feedback to guide development of the Park from this point on.

ACKNOWLEDGEMENTS

The draft of this Management Plan (CALM, 1995) was prepared and written by Paul de Tores and Suzanne Rosier and edited by Richard Grant. It was prepared with significant contribution from the former Leschenault Peninsula Technical Committee, comprising Noel Ashcroft (DRD and Chairman), Milka Klobucar (DRD), Sir Donald Eckersley (LIMA), Eric Wright (LIMA), Roger Freeman (WRC), John Quilty (Quilty Environmental Consulting, formerly DRD and former chairman of the Technical Committee), Harry Walta (Environmental Field Services and formerly LIMA), Charles Lockwood (HSC), Bob Chandler, Paul de Tores and Scott Wood (CALM). Considerable advice and expertise were given by Bill Carr (former Chairman of the Technical Committee) and Jenna Brooker (formerly with Environmental Field Services and LIMA). Further advice was given by members of the Leschenault Peninsula Community Advisory Committee, comprising Don Spriggins (Chairman), Sir Donald Eckersley, Fred Robinson, Maurie Johansen, Steve Prosser, Emily Hill, Morgan Smith, Dr Ray George, Trevor Slater and Dr. Geoff Shannon.

In preparing the draft and final versions of this plan, specialist expertise, advice and assistance have been provided by the following persons within CALM: Roger Armstrong, Ken Atkins, Andrew Burbidge, Bob Chandler, Ray Cranfield, Gary Davidson, Jeanette Gilmour, Richard Ford, Stuart Halse, Richard Hammond, David Hampton, Peter Henderson, Greg Keighery, Luisa Liddicoat, Peter Morris, Alex Moylett, Kate Orr, Chris Portlock, Robert Powell, Grant Revell, Alan Sands, Wayne Schmidt, Tony Start, Allana Stingemore, Neil Taylor, Kim Williams, Jim Williamson and Scott Wood. Angela Doust, Sue Howell, Toni Jones, Marie Michael and Jasmine Moylett assisted in preparing the numerous preliminary drafts of this plan.

Maps and figures were produced by Rod Properjohn and Steve Jones of CALM's Land Information Branch.

Much of the information on visitor use was collected with assistance from a team of volunteers comprising Jude Davidson, Anthony Garrett, Lisa Gilbee, Don Mason, Justine Morris, Suzanne Rosier, Maidee Smith, Morgan Smith, Nick Spackman, Dennis Sully, Meredith Sully, Sandra Swain and Tamara Swain.

The preparation of this final plan was coordinated by Robert Powell, with advice from Chris Portlock, and the Planning Team, comprising Scott Wood, Peter Henderson and Peter Morris.

The picture on the front cover, of the Western Ringtail Possum, was taken by Paul de Tores.

NOMENCLATURE

The names included on the maps or within the text of this publication have not necessarily been approved by the relevant nomenclature authority.

CONTENTS

ABBREVIATIONS

AMIC:	Australian Mining Industry Council
CALM:	Department of Conservation and Land Management
CAMBA:	Agreement between the Government of Australia and the Government of the People's Republic of China for the protection of Migratory Birds and their environment
CLAG:	Contiguous Local Authority Group
DOLA:	Department of Land Administration
DRD:	Department of Resources Development
DSD:	Department of Strategic Development
HSC:	Harvey Shire Council
JAMBA:	Agreement between the Government of Australia and the Government of Japan for the protection of Migratory Birds in danger of extinction and their environment
LIMA:	Leschenault Inlet Management Authority
LPCAC:	Leschenault Peninsula Community Advisory Committee
NPNCA:	National Parks and Nature Conservation Authority
ORV:	Off-Road Vehicle
PWD:	Public Works Department
VRM:	Visual Resource Management
WCWA:	Water Corporation of Western Australia
WRC:	Water and Rivers Commission

SUMMARY AND KEY STRATEGIES

KEY ISSUES

All strategies proposed in this management plan have been formulated to protect and enhance all of the Leschenault Peninsula's significant values and features. The Peninsula is a prominent visual resource and provides a range of recreational experiences including camping and isolation even though it is quite close to urban and industrial centres. Highest priority has been given to resolving and managing the key issues listed below.

Land Tenure

The current diversity of vesting and interests reflect the range of use of the Peninsula over the past 150 years. The Leschenault Peninsula covers an area of about 1071 hectares. Of this, about 580 hectares is vested in the NPNCA as conservation park and nature reserve. A mineral rights title and caveats exist over a further 490.9ha of land held in fee simple by the State. The State's fee-simple land is managed by CALM under authority delegated by the Minister for Lands, consequently all of the Peninsula is being planned for under this one management plan.

Zoning

Two Park zones are proposed: a Natural Environment Zone and a Recreation Zone. This zoning provides a management framework to protect the Park's natural and cultural values and provide recreation opportunities and facilities. Six areas of development have been identified within the Recreation Zone.

Native Flora and Fauna

The conservation values of several vegetation communities have been recognised; for example, mangroves, fringing estuarine vegetation and mature Tuart forest. Strategies are developed to protect these communities and to conduct research to determine what measures should be taken to protect these values.

Control measures will be implemented to minimise the effect of introduced plant and animal species.

Rehabilitation

To date, various government agencies have spent over $2.4 million to complete rehabilitation of the former effluent disposal sites.

The primary rehabilitation objectives were to stabilise the disposal sites, to create a safe physical environment, and to enable natural ecological processes of plant development to continue. Having achieved these objectives, management of Leschenault Peninsula was transferred to CALM. Rehabilitation will now be directed towards:

- allowing natural ecological processes to continue, including natural erosion processes;
- regulating recreational and other human activities to minimise disturbance to recently rehabilitated and erosion sensitive areas; and
- continuing rehabilitation of selected areas, protecting threatened vegetation species and communities and protecting infrastructure.

Recreation Development

A wide range of nature-based recreational opportunities will be provided consistent with protecting the Park's natural and cultural values.

Six recreation areas have been identified for development during the term of this plan. These areas are the Park entry, Buffalo Beach, Belvidere Beach, Belvidere (Waterloo Head), Tuart Grove, and The Cut Picnic and Camping Area. Development has commenced at all areas and ranges from minimal to extensive. For example, there is minimal development (car parking bays) at Buffalo Beach whereas there are more extensive camping, day-use and interpretive developments at Belvidere.

Facilities are available for public use at the Park entry (at the northern end of the Park), Buffalo Beach, The Cut Picnic and Camping Area (at the southern end of the Park), Belvidere Beach, Belvidere (Waterloo Head), and Tuart Grove.

The camping sites at Belvidere and The Cut will be further developed in stages.

Public Access

Previously inaccessible areas of Leschenault Peninsula have been opened to the public. Vehicle access has been extended 3 km south to Belvidere Beach and Belvidere (Waterloo Head). Access by 4WD vehicles to the coastal strip on the western side of the Peninsula (excluding the dunes) will be maintained, except for the provision of areas for pedestrians only at Buffalo and Belvidere Beaches.

The Cut Picnic and Camping Area and the Tuart Grove picnic site will remain accessible to walkers and cyclists, and also by boat.

A series of bicycle and pedestrian paths will be developed as part of the recreation site developments.

Information, Communication and Public Involvement

A comprehensive interpretation plan is proposed. The plan will focus on specific areas and interpretation of the physical and biological values of the Park and the Park's historical significance.

The establishment of an advisory committee to advise on implementation of the final plan is recommended. Membership of the committee should be such as to ensure that a wide range of community interests are represented. The advisory committee will be encouraged to take an active interest in the Park.

KEY STRATEGIES

Tenure, Vesting and Zoning

To discuss the State’s fee-simple land with the interested parties, to enable the caveats to be lifted and the land reserved as conservation park.

To change the existing nature reserve, reserve 40564, to Class A conservation park.

To arrange for the Leschenault Peninsula to be officially named as ‘Leschenault Peninsula Conservation Park’.

Flora and Fauna

To monitor the condition and status of the Closed Mangrove Scrub.

Cultural Resources

To train staff in recognising Aboriginal sites.

To liaise with Aboriginal groups and carry out appropriate measures to protect any Aboriginal sites identified.

Physical Environment

To assess and map the components of the Park's landscape.

To direct rehabilitation towards establishing self-sustaining plant communities.

To favour naturally occurring species in rehabilitation. To use non-local plant species only where they are demonstrably advantageous and pose no threat to natural plant species or communities; monitor the use of any non-local species, and discontinue their use if they show any signs of becoming weeds.

To carry out rehabilitation to arrest natural processes only where essential.

To monitor the effects of major winter storms and develop strategies to rehabilitate the areas affected.

To identify areas for brush-harvesting, and develop a seed store.

To rehabilitate the blowout threatening the stand of Closed Mangrove Scrub.

To develop and implement a program to assess the effectiveness of rehabilitation.

Fire

To prepare and implement a program for suppressing wild fires.

Non-local Plants and Animals

To prepare and implement a program to control non-local plants and animals.

To maintain the existing program for controlling rabbits, foxes and cats.

Domestic Pets, Horseriding

To prohibit the entry into the Park of domestic pets, and to prohibit horseriding and the exercising of horses.

Recreation

To restrict recreation developments to areas capable of sustaining them.

To provide an increased management presence.

Access

To restrict sites for boat-landing on the eastern shore to protect sensitive estuarine vegetation.

To seek funding to upgrade and maintain Buffalo Road.

Information, Communication and Public Involvement

To prepare and implement an interpretation plan, using different ways of providing information.

To encourage the local community's awareness of and interest in the Park.

Public Safety

To remove redundant infrustructure and debris that present a hazard to public safety.

To provide information on protection against mosquitoes, and to implement, where required, measures to control mosquitoes.

Funding, Staffing; Implementing the Plan

To monitor and investigate the need for additional ranger staff as the use of the Park increases.

To enter into cooperative agreements with other organisations and groups.

INTRODUCTION

1. LOCATION

Leschenault Peninsula is about 150 km south of Perth and is within a two-hour drive of the City of Perth. By road it is 22 km north of Bunbury, the State's second-largest city (see Figure 1). The Peninsula lies on longitude of 115° 41' east and between latitudes 33° 12' and 33° 18' south. It forms a north-south, finger-like projection that separates the Indian Ocean from Leschenault Estuary. It is about 11 km long, varies in width from 600 m to 1600 m, and covers an area of about 1071 ha.

The Peninsula is located within the Shire of Harvey. Road access is via Buffalo Road, off the Old Coast Road, 22 km north of Bunbury, and 30 km south-west of Harvey.

From 1963 until 1990 Leschenault Peninsula was used as a disposal site for acid effluent produced as waste from the production of titanium dioxide. Now that such use has ceased, and in recognition of the Peninsula's conservation and recreation values, the Peninsula is being managed in accordance with the goals for management of conservation parks.

With continued urban and industrial growth of Perth, Bunbury, Australind and Eaton, the Peninsula's importance for recreation will increase. Its role as a conservation and recreation area has been acknowledged in numerous reports and studies (CALM 1995, pp. 69-72).

In the context of regional strategic planning by the Western Australian Planning Commission, the Leschenault Peninsula lies within the area encompassed by the *Bunbury-Wellington Region Plan* (Ministry for Planning 1995). Chapter 8 of that document contains a structure plan for 'Greater Bunbury', to cater for the city's urban expansion. The Planning Commission has initiated action to have a statutory region scheme prepared for Greater Bunbury, similar in concept to that developed for Perth in 1963. The Leschenault Peninsula and the adjoining Leschenault Estuary fall within that area, and this management plan is consistent with proposals in the current structure plan (Leschenault Estuary planning unit).

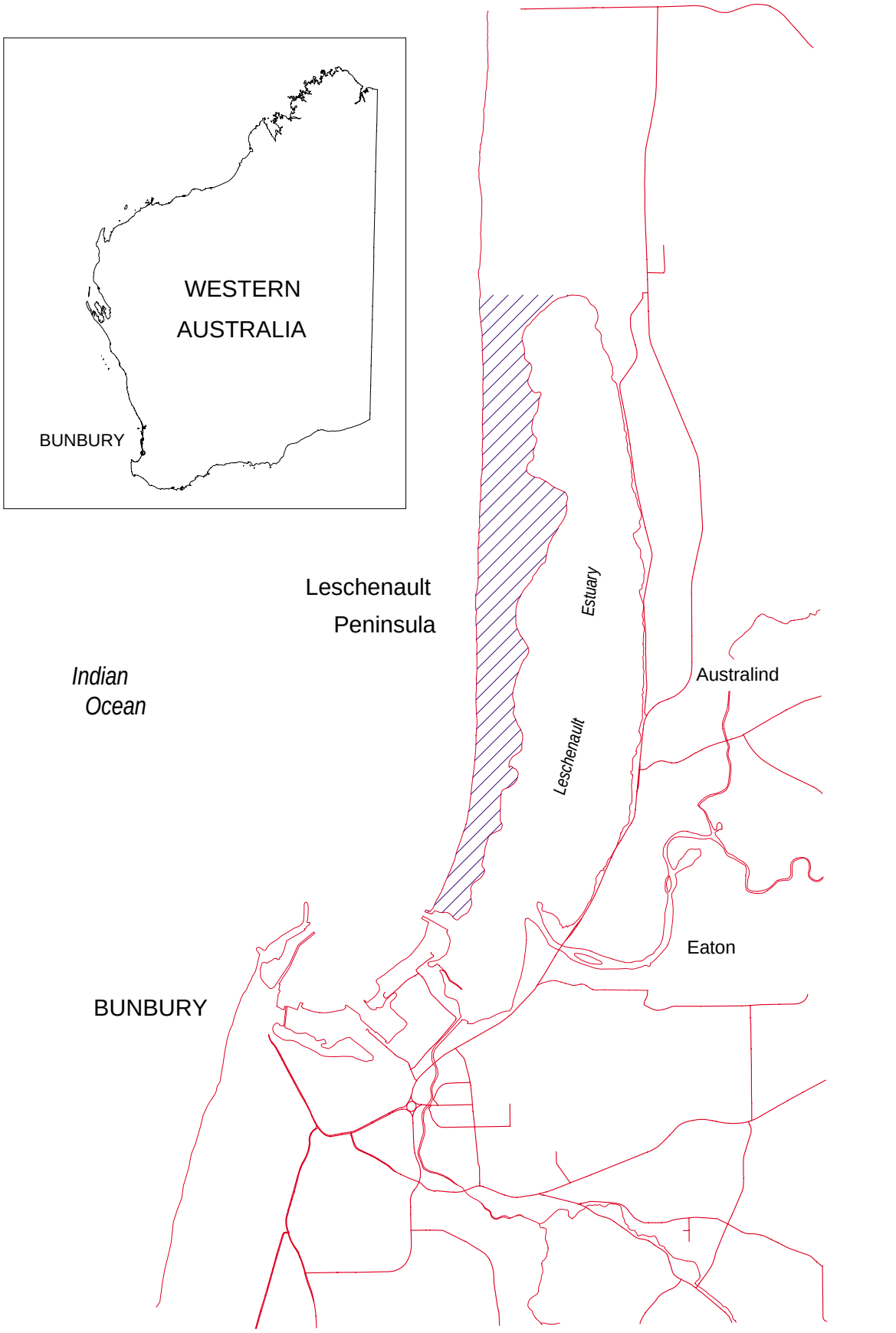
2. VALUES

Leschenault Peninsula's geomorphological and biological importance are well documented, for example:

- the Quindalup Dunes form a unique extensive linear barrier (Semeniuk and Semeniuk 1990);
- the Peninsula supports 201 species of native plant (G. Keighery, pers. comm.);
- plant species of special interest include *Carex pumila*, the only record in Western Australia, and a previously unrecorded species of the family Brassicaceae (*Rorippa* sp.) (G. Keighery, pers. comm.);
- well developed stands of Peppermint and Tuart exist on the Peninsula and are inadequately reserved elsewhere on the Swan Coastal Plain;
- the Peninsula contains one of the largest and healthiest populations of the annual Native Pellitory (*Parietaria debilis*) in south-western Australia, and thus one of the most significant breeding areas in the region for the Yellow Admiral Butterfly (*Vanessa itea*) (R. Powell, pers. comm.);
- the Peninsula also contains extensive samphire marshes and Quindalup Dune vegetation in excellent condition (G. Keighery, pers. comm.)
- the occurrence of the White Mangrove, *Avicennia marina*, coupled with the stands in Leschenault Inlet, Bunbury, represent the southernmost occurrence of this species on the west coast; and
- the Peninsula/Estuary interface provides significant waterbird breeding areas (Ninox Wildlife Consulting 1989).

The Peninsula is historically significant. Its history encompasses early settlement by the Prinsep family, grazing, a tie with Irishman John Boyle O'Reilly, alternative lifestyles and, more recently, a link with industry.

The Peninsula provides the opportunity for a diverse range of recreational activities including ocean and estuary-based water activities. The Park has developed a clientele of visitors from the local, regional and Perth metropolitan area (Rosier and de Tores 1992). The Peninsula is also a prominent visual resource and displays a spectacular silhouette when viewed at sunset from the estuary's eastern shore.



LOCATION

1 0 1 2 3 4 5km

Scale

Figure 1

PRINCIPAL MANAGEMENT DIRECTIONS

3. GOALS

This management plan for Leschenault Peninsula outlines the goals and objectives for management and is based on the overall role for management of national parks and conservation parks [CALM Act, Section 56(c)]. The management goals below apply to conservation parks and national parks and specifically to Leschenault Peninsula.

Management Goals for Conservation Parks and National Parks

The goals are to:

- Conserve biological, physical, cultural and landscape values.
- Facilitate public enjoyment of natural and cultural values in a manner compatible with conservation and other goals.
- Promote awareness, appreciation and understanding of natural and cultural values and facilitate liaison with the community.
- Ensure that commercial and other uses are controlled and managed in a manner that has the least effect on other values, and that, following disturbances, measures are taken to restore the natural environment.
- Promote cooperation, and minimise conflicts in matters associated with use of nearby lands and waters.
- Seek a better understanding of the natural and cultural environment and the impacts of management activities and visitor use.

Management Goals for Leschenault Peninsula Conservation Park

Specific goals for Leschenault Peninsula are to:

- Provide security of purpose, vesting and tenure;
- Maintain the existing range of native plant and animal species, vegetation structure types and vegetation communities;
- Develop appropriate strategies to protect fauna species that are "threatened", "in need of special protection" or otherwise in need of specific management attention;
- Control and, where practicable, eradicate introduced plant species that pose a threat to native species;
- Control and, where practicable, eradicate introduced animal species;
- Rehabilitate and stabilise disturbed and damaged areas to protect infrastructure and conservation values;
- Preserve the Park's cultural values;
- Provide a range of appropriate recreational activities that complement facilities on CALM managed land and other public estate within the Region;
- Provide a wide range of appropriate information and interpretation facilities with particular attention to the educational potential of the Park's unique natural and cultural values;
- Determine and implement fire management regimes to protect people, Park infrastructure and neighbours, and to maintain conservation values;
- Carry out and encourage research that will facilitate Park management; and
- Establish and maintain effective liaison with other organisations to facilitate Park management.

4. PURPOSE, VESTING AND TENURE

The objectives are to:

- **Ensure the gazetted purpose, vesting and tenure of the Leschenault Peninsula and its surrounds protect the Peninsula's values.**
- **Incorporate appropriate lands within the Conservation Park where possible.**

The Leschenault Peninsula has an area of about 1071 ha, comprising 580.5 ha of conservation park and 490.9 ha of land held in fee simple (effectively freehold) by the State.

The Conservation Park (Reserve A 42470) is vested in the National Parks and Nature Conservation Authority. It extends to low-water mark on both its ocean and estuary sides.

The purpose ‘conservation park’ reflects the reserve’s significant regional value for conservation and recreation. Conservation parks are similar to national parks but have less national or international significance. This conservation park is much smaller than most national parks, and parts of it have been disturbed in the past by human activities.

The fee-simple land (Leschenault Location 24, Lots 3 and 4) is subject to a mineral rights title and caveats relating to the mineral rights.

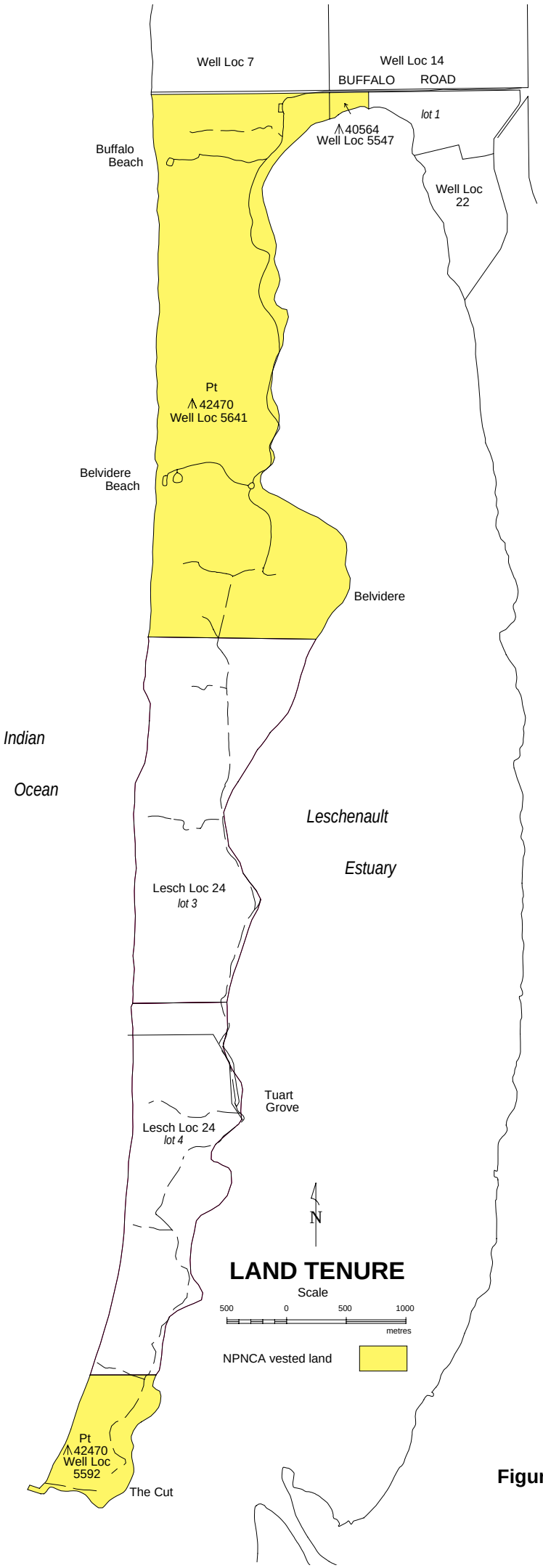

Well Loc 7
Well Loc 14
BUFFALO ROAD
lot 1
40564
Well Loc 5547
Buffalo Beach
Well Loc 22
Pt
42470
Well Loc 5641
Belvidere Beach
Belvidere
Indian Ocean
Leschenault Estuary
Lesch Loc 24
lot 3
Tuart Grove
Lesch Loc 24
lot 4
N
LAND TENURE
Scale
500 0 500 1000
metres
NPNCA vested land
Pt
42470
Well Loc 5592
The Cut

Figure 2

Reserve 40564 (5.5 ha abutting the north eastern end of the Peninsula) is vested in the NPNCA as a Class C nature reserve (see Figure 2).

CALM manages the Conservation Park and the Nature Reserve in accordance with the CALM Act; interim developments for recreation are in accordance with the 'necessary operations' provisions of the Act. It also manages the State's fee-simple land under authority delegated by the Minister for Lands. The entire Leschenault Peninsula, therefore, is planned for under this management plan.

The northern estuary (north of Belvidere) is of high value to conservation as habitat for waterbirds; including it in the conservation estate will help maintain these values. It will also be important to liaise closely with the Water and Rivers Commission's Leschenault Inlet Management Authority (LIMA). LIMA's management area comprises the neighbouring Leschenault Estuary, including the Peninsula's eastern foreshore (Figure 2) (although LIMA is unlikely to deal itself with matters affecting the Peninsula foreshore, but rather refer them to CALM). Two areas of the Leschenault Estuary — the northern part, north of Waterloo Head, and Vittoria Bay, near the Cut — are considered to be very important areas for waterbirds and mangroves and worthy of marine nature reserve status (Report of the Marine Parks and Reserves Selection Working Group, 1994).

Issues

The 490.9 ha of land held in fee simple by the State cannot be declared as a conservation park until the caveats are removed.

STRATEGIES

1. **Manage the State's fee-simple land (Leschenault Loc. 24, Lots 3 and 4) as part of the entire Leschenault Peninsula and consistent with the adjacent areas of conservation park; pursue a solution that will allow the land to be reserved as conservation park.**
2. **Negotiate to cancel unnecessary road reserves that run through the Conservation Park or along its boundaries, and add these to the Park.**
3. **Retain vesting of the 5.5 ha nature reserve (reserve no. 40564) with the NPNCA, and change its security of tenure to Class A (subject to approval of the relevant Government agencies) and its purpose to conservation park.**
4. **Subject to 1 above, name the area as the "Leschenault Peninsula Conservation Park".**
5. **Liaise with the Water and Rivers Commission, through the Leschenault Inlet Management Authority, to manage the northern part of Leschenault Estuary to maintain its conservation values.**

5. PARK ZONING

The objectives are to implement a zoning system that will:

i) **Recognise the Park's conservation and recreational values.**

ii) **Minimise conflict between conservation values and recreational use.**

iii) **Minimise conflict between recreational users.**

Management zones establish a framework to protect conservation values and provide recreation facilities and uses.

A zoning system facilitates management and use of the Park to meet the primary management objectives. Although each zone has a different management emphasis, there is some degree of overlap between zones.

STRATEGIES

Two zones are proposed in the Park: a Natural Environment Zone and a Recreation Zone. Table 1 outlines the criteria by which the zones will be managed and the type and level of development appropriate in each. Below is a summary of each zone. The zones are shown in Figure 3.

The Natural Environment Zone will be managed to maintain and restore the natural diversity of plant and animal species. Limited vehicular public access will be permitted within this zone, primarily to provide access to the Recreation Zone. Recreational activities and facilities of minimal effect on the environment will be permitted.

The Recreation Zone will be managed to enable the public to use and enjoy the Park and to provide activities that are compatible with maintaining the Park's conservation values.

Management access will be provided to and within both zones.

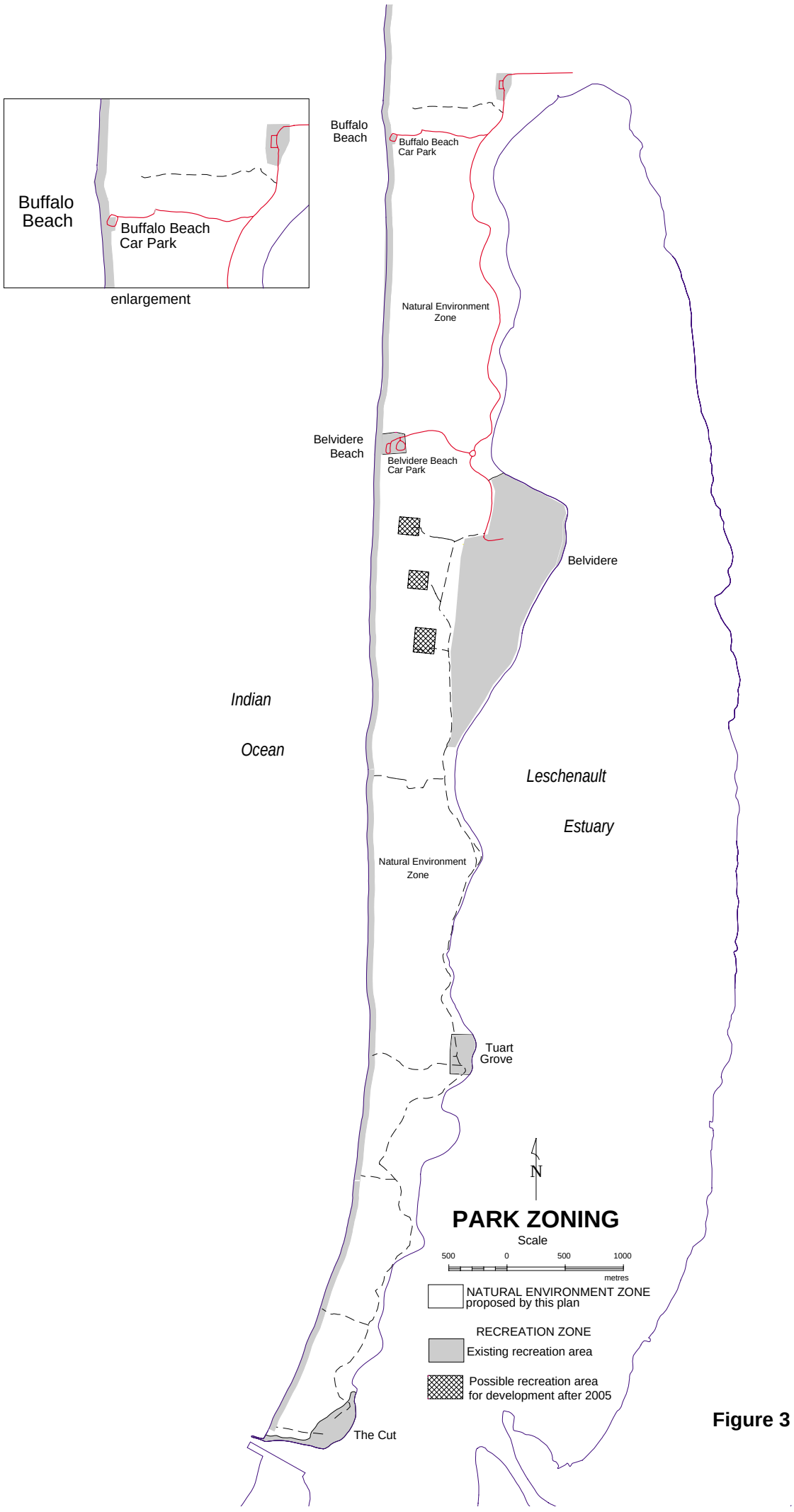

Buffalo Beach
Buffalo Beach Car Park
enlargement
Buffalo Beach
Buffalo Beach Car Park
Natural Environment Zone
Belvidere Beach
Belvidere Beach Car Park
Belvidere
Indian Ocean
Leschenault Estuary
Natural Environment Zone
Tuart Grove
N
PARK ZONING
Scale
500 0 500 1000
metres
NATURAL ENVIRONMENT ZONE proposed by this plan
RECREATION ZONE
Existing recreation area
Possible recreation area for development after 2005
The Cut

Figure 3

Table 1: Park Zoning — Criteria Guiding Management of Zones

Criteria	Zones	
	Natural Environment Zone	**Recreation Zone**
Environmental setting	Two broad settings: 1. Natural setting with minimal disturbance of the natural environment. 2. Previously disturbed areas, rehabilitated or partially rehabilitated. Rehabilitation aimed at restoring natural ecological processes.	Developed in two broad settings: 1. Natural environment setting where the recreation experience is enhanced by that environment and where recreational use will not significantly affect the environment. 2. Formerly disturbed and subsequently rehabilitated areas. Rehabilitation advanced to a stage capable of sustaining recreational use or the disturbed area adds to the recreation experience, e.g. the historic precinct at Belvidere.
Social setting	No developed recreation areas or facilities. Infrequent contact with other users. Limited evidence of management other than rehabilitation work and roads and tracks providing access to the Recreation Zone.	Developed facilities at designated areas. Continuous contact with other users during peak periods.
Type of use	Low-impact and dispersed recreational pursuits, e.g. walking, nature study, photography.	Picnicking, barbecueing, fishing, 4WD based fishing, boating, swimming, camping, beach combing, nature study, bicycling.
Access	Guided pedestrian access within this zone. The motor vehicle and bicycle access within or through this zone is primarily to provide access to the Recreation Zone.	Vehicle access to and within this zone.
Facilities	Low-impact management support facilities. Minimal site hardening. No developed recreation facilities. Minimal on-site interpretive facilities.	Hardened and formed road access and carparks. Facilities include on-site interpretation, information and toilets. Overnight facilities at designated areas.
Level and type of regulation	No regulatory on-site structures other than those regulating vehicles. Regulation primarily from outside this zone.	Regular on-site management presence including management vehicles, Ranger patrols and regulatory signs and structures.
Max. level of development (see note below)	Minimal site hardening. Path development constructed to "route" or "track" standard. Unobtrusive, subtle interpretive facilities.	Formed roads and carparks. Pedestrian paths constructed to "track" and "walk" standard. Camping facilities at designated areas.
Examples	Peppermint and Tuart woodlands away from developed recreation nodes.	Buffalo Beach, Belvidere.

Note: The terms "route", "track" and "walk" are used as defined in CALM's Recreation, Tourism and Visitor Services Policy (CALM 1991).

MANAGEMENT FOR CONSERVATION: THE PHYSICAL RESOURCES

6. CLIMATE AND COASTAL PROCESSES

The objectives are to:

i) **Understand the effect of climate on the Park and its values.**

ii) **Protect the Park's natural values from the detrimental effects of changing climatic conditions.**

Leschenault Peninsula has a Mediterranean climate of hot dry summers and mild wet winters. The mean annual rainfall is 840-871 mm (based on local recordings collected over the past 76 years and Bunbury Meteorological Station data). This rainfall occurs mostly between May and September and is associated with frequent winter storms.

The mean maximum daily temperature varies from 16.9°C in July to 27.7°C in February. Overnight minimum temperatures range from 9.0°C in July to 17.0°C in February (Bureau of Meteorology). Because of the influence of the sea breeze the daily summer maxima are often substantially lower than inland areas and infrequently exceed 35°C.

During summer the prevailing winds are generally moderate south-easterly land breezes in the mornings, changing to south-westerly to westerly sea breezes in the afternoons. The winter wind patterns are characterised by variable winds in the mornings and moderate to strong north-westerly to south-westerly wind in the afternoons, with frontal storms common.

The topography and landforms of the Peninsula have a strong influence on the microclimate. On many days of the year, through all seasons, the Peninsula can have two different climate characters within the space of 500 metres: an exposed wind-swept ocean shoreline; and a protected, tranquil estuarine shore.

Issues

Severe winter storms can restrict recreational use of, and management activities on, the ocean foreshore.

Winter storms have, and will continue to cause erosion. In several instances winter storms have initiated the erosion stage of the cyclic erosion/stabilisation sequence. Although such storms and the damage created are natural phenomena, they may necessitate major labour intensive and costly rehabilitation work and sever beach access to the southern end of the Park.

Potential impacts of the greenhouse effect are unclear; however, a rise in water levels has the potential to affect dramatically the Peninsula's vegetation communities.

Although summer temperatures are moderated by sea breezes, extreme fire-hazard conditions occur.

STRATEGIES

1. **Monitor erosive weather patterns, particularly storms, and determine their effects on the physical environment.**
2. **Develop appropriate strategies to deal with winter storms and the damage they cause.**
3. **Prepare and implement appropriate strategies to manage and suppress fire (see Section 14).**

7. GEOLOGY, LANDFORMS AND SOILS

The objectives are to:

i) **Protect the Park's geological features and landforms from degradation through human use.**

ii) **Provide interpretive information on the Park's geomorphological features.**

The geology, landforms, and to a lesser degree, the soils of the Peninsula have been extensively studied and documented (see McArthur and Bartle 1980; McArthur and Bettenay 1974; Oma 1989; Playford *et al.* 1976; Semeniuk 1983; and Semeniuk and Semeniuk 1990).

The landform of the Peninsula is dominated by a Holocene coastal barrier dune system overlying Pleistocene sediments which, in turn, rest on Early Cretaceous sediments. The geology of the Peninsula is shown (as an idealised geological cross section) in Figure 4.

The Holocene sediments forming the barrier dune system are composed of two types:

i) The Safety Bay Sands (known as the Quindalup Dune System) which are up to 40 m thick and form the bulk of the barrier dune system; and

ii) The Leschenault formation (also known as the Vasse Soil Association) which are estuarine or lagoon sediments up to 6 m thick (Oma 1989; Semeniuk and Semeniuk 1990).

The Quindalup dunes are believed to be remnants of a 7000 year old oceanic barrier that moved, and is continuing to move, eastward. This eastward migration and subsequent formation of Leschenault Peninsula has resulted in an "extensive linear barrier composed solely of Quindalup Dunes" (Semeniuk and Semeniuk 1990). The Peninsula and Lake Preston barrier is the only example on the Swan Coastal Plain of such a barrier (Semeniuk and Semeniuk 1990).

The continued eastward migration through aeolian activity has resulted in a mosaic of landforms and soils on the Peninsula that in turn have had significant effect on the vegetation.

The geomorphology/landform of the Peninsula, although a continuum, is recognised as having the following components:

The Submarine Shelf-Beach Zone: this zone is dominated by wave action and is retreating (moving eastward) at an estimated rate of 1-2 m a year. This has resulted in a submarine shelf of exposed Tamala Limestone, outliers of beachrock and outliers of estuarine mud (Semeniuk and Semeniuk 1990).

Foredunes: these are usually present as a single ridge at the eastern margin of the beach. The foredunes are conspicuous north of Belvidere but less common (because of wave erosion) to the south. The sands are calcareous and have negligible soil development.

Vegetated Parabolic Dunes: McArthur and Bartle (1980) recognised four age classes within these dunes. The youngest of these (termed Q4) vegetated parabolic dunes are relatively small and steep sided. The soils are deep, calcareous and with minimal humus development. The oldest (termed Q1) occur along the eastern margin of the barrier and are more ribbon to crescent shaped. These Q1 dunes are lower in profile, have more gentle slopes and more pronounced soil development than the Q4 dunes (Oma 1989).

Deflation Basins: these are small, densely vegetated hollows, most common within the younger vegetated parabolic dunes (Q4). Soil development is variable.

Mobile Dunes (Blowouts): these are actively east-west moving parabolic dunes that engulf the vegetated parabolic dunes (Oma 1989; Trudgen 1984). Towards the northern section of the Peninsula these blowouts occur as discrete entities. Throughout the southern half they are contiguous. These blowouts supply sand to the estuary and contribute to the establishment of marine pasture.

Sand Plains: these are relatively flat areas that generally occur along the eastern margins of the Peninsula. Soil development is most pronounced in these areas and the sands are highly leached. These sand plains have been interpreted as being formed during the Holocene period (Semeniuk and Meagher 1981) or the Pleistocene (McArthur and Bartle 1980). Oma (1989) believed "the pronounced leaching and calcretisation indicates that these sandplain soils have been strongly weathered, and originally comprised undifferentiated calcareous dunes sand that therefore belong to the Quindalup Dune System" (that is, are Holocene in origin).

Estuarine Terraces (or Saline Flats): these are estuarine sediments at the interface of the Peninsula and Estuary. They also occur beneath the barrier dune system and, therefore, support Semeniuk's (1983) assertion that there is an eastward migration of the barrier dune system (Oma 1989).

The Peninsula's soils and landforms have been presented in map form in several of the studies referred to above. However, some inconsistencies occur between reportings. The soil-landform map and terminology used for the purposes of this plan are as outlined by Oma (1989) and shown in Figure 5.

The 11 soil-landform mapping units identified by Oma (1989) were also assessed for their recreational land use capabilities. Most were assessed to be of either low, or very low capability. The exceptions to this were the deflation basin, sand plain, and subdued parabolic dune mapping units (see Figure 5). These units were considered to have moderate capability to sustain recreation as a land use.

Issues

The Peninsula's geomorphology has significant educational, research and interpretive value.

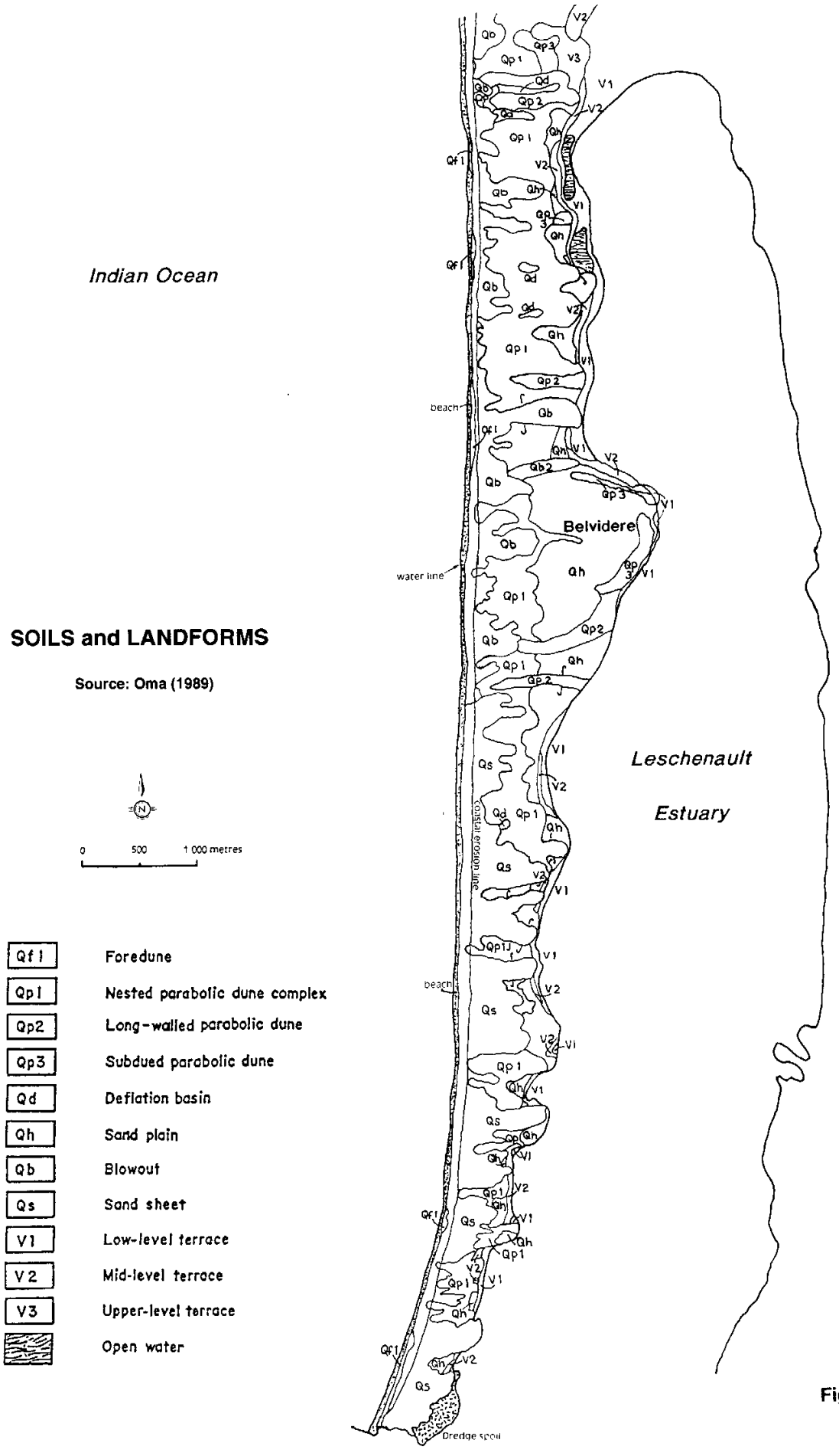

Indian Ocean
Leschenault
Estuary
Belvidere
beach
water line
coastal erosion line
Dredge spoil
0
500
1 000 metres
SOILS and LANDFORMS
Source: Oma (1989)
Qf1 Foredune
Qp1 Nested parabolic dune complex
Qp2 Long-walled parabolic dune
Qp3 Subdued parabolic dune
Qd Deflation basin
Qh Sand plain
Qb Blowout
Qs Sand sheet
V1 Low-level terrace
V2 Mid-level terrace
V3 Upper-level terrace
Open water

Figure 5

The Peninsula's landforms and soils have only a limited capability to sustain intensive recreational use.

Rehabilitating natural dune formations is slow, labour intensive and often results in landforms with unnatural appearances; for example, machine made, artificially straight foredunes; and dunes with shapes influenced by Marram Grass.

STRATEGIES

Many strategies for managing the Park's geology, landforms and soils are dealt with in section 16 (Rehabilitation). The following specific strategies are also proposed:

- **Develop an interpretive program on the Park's geology, landforms and soils.**
- **Minimise disturbance of natural landforms and reduce the need for rehabilitation.**
- **Assess all proposed major earthworks and consider the potential effect on the Park's geology, landforms and soils.**
- **Assess all site design and development work and consider the potential effect on the geology, landforms and soils. Minimise work in areas with low or very low ratings for land-use capability.**
- **Restrict recreational development and use to areas capable of sustaining it.**

8. HYDROLOGY

The objectives are to:

i) **Allow continued improvement of the water quality of surface water, freshwater seeps and the surficial aquifer.**

ii) **Maintain the quality of the aquifers of the Leederville and Yarragadee formations.**

The hydrological effects of effluent disposal at Leschenault Peninsula have been reviewed by Le Provost *et al.* (1987), Meagher and Le Provost (1975) and Semeniuk and Semeniuk (1990). Most of the reported studies have concentrated on known and potential contamination of the surficial aquifer. This aquifer is contained within the Holocene sediments and is recharged by rainfall. It is bounded by marine waters on the west and estuarine waters on the east. Excess annual recharge is discharged into the ocean and estuary (Semeniuk and Semeniuk 1990).

Le Provost *et al.* (1987) identified 6 major and 10 minor seepage sites on the eastern shore of the Peninsula. Throughout the past 150 years these seeps have been excavated at numerous points to provide fresh water for stock and human consumption. Although some freshwater seeps have been excavated, drainage patterns have not been significantly altered. This may have contributed to maintaining the fringing forest (*Melaleuca*) and Shore-rush (*Juncus*) at various points where the Peninsula meets the Estuary. On the eastern shore of the Estuary the decline in fringing forest and Shore-rush and replacement by Samphire and salt-marsh species probably resulted from changes to drainage patterns (Pen 1992).

The hydrological effects of industrial effluent disposal have been predominantly confined to the surficial aquifer. Effluent disposal has led to:

i) **Waterlogging of surface soils.** This has occurred where effluent has displaced natural groundwater and caused a raising or mounding of the surface water table. In some cases, where the adjacent land is low lying, this displacement has led to waterlogging of the surface soils (Semeniuk and Semeniuk 1990). This effect was localised and has not been observed since effluent disposal ceased.

ii) **Staining of the ocean and less frequently the Estuary**. As acid effluent percolates through the surficial aquifer, iron as ferrous sulphate reacts rapidly and precipitates as a range of chemical compounds, including iron sulphates, oxides, hydroxides and carbonates, and acid in the solutions would liberate carbon dioxide from the calcareous sands. The result is an aquifer contaminated with varying quantities of neutralised and unneutralised acidic effluent and chemically altered sediments. As the natural groundwater is progressively displaced by effluent, seepage of water high in iron content occurs. This seepage is predominantly towards the ocean where any unneutralised effluent causes discolouration due to precipitation of red ferrous sulphate on contact with salt water.

With the eastward migration of the Peninsula (see Section 7) the erosion processes will eventually expose the chemically altered sediments. By this time, however, "the contaminated groundwater system should have been replaced by freshwater recharge" (Semeniuk and Semeniuk 1990).

Two bores, one at the north end of the Peninsula and the other south of Belvidere, are monitored by the Water Corporation for the Water and Rivers Commission. Water level and salinity are measured, to guage the effects of groundwater extraction near Leschenault, on the east side of the Leschenault Estuary, for the town of Australind.

Issues

Restrictions may be placed on use of groundwater because the surficial aquifer is contaminated, supplies from the Leederville aquifer are limited, and access to the Yarragadee aquifer is limited.

The current data-storage system for monitoring groundwater is inadequate for reviewing the data. Upgrading the storage and retrieval system will enable the analysis of data on the rate of decontamination of the acid effluent, and the rate of freshwater recharge.

The effects of acid effluent disposal may include modification of the surficial aquifer as a result of chemical alterations to the underlying limestone. There may also be increased water retention in areas overlying sludge deposits.

Altered drainage patterns have the potential to significantly alter the existing relatively undisturbed vegetation mosaic of the Peninsula/Estuary interface.

The excavated and exposed freshwater points may be of:

i) biological significance as freshwater supply for native fauna, breeding areas for waterbirds, and food sources for waterbirds (see Section 11); and

ii) historical significance as evidence of former land uses (see Section 18).

STRATEGIES

i) **Assess all proposed operations and developments that have the potential to affect the Park's hydrology, especially those that will, or have the potential to, alter drainage patterns.**

ii) **Consult with the Water and Rivers Commission on all proposals that may affect water quality.**

iii) **Limit groundwater extraction to that essential for recreational and management purposes. Extraction for these purposes should be from uncontaminated zones of the aquifer and at rates that do not cause excessive drawdown or saltwater intrusion.**

iv) **Assess the excavated and exposed freshwater points for their biological or historical significance.**

9. LANDSCAPE

The objective is to maintain, restore or enhance the Park's landscape[1] qualities.

The Park's landscape qualities are exemplified by a diverse mosaic of landform and vegetation often with a sand and sea backdrop creating breathtaking scenery. Inadequate planning or execution of operations can permanently degrade an area's landscape qualities. These detrimental effects can be minimised or avoided altogether through the application of Landscape Management principles and procedures.

Landscape Management recognises that a landscape's visual quality is a resource in its own right and can be assessed and managed in much the same way as other natural resources (CALM 1989).

Many of the past land-use activities on Leschenault Peninsula have degraded its landscape. Rehabilitation strategies, particularly those related to areas of effluent disposal, have incorporated principles to ameliorate this effect. Future rehabilitation and other works can be significantly improved by incorporating landscape-management procedures.

[1] The term 'landscape' in this context refers to the appearance, scenery or visual expression of the environment.

Issues

Potential detrimental effects on the Park's landscape qualities include:

iv) developments and operations, particularly roads and buildings that are visible from the Estuary or Australind;

v) redundant infrastructure, discarded materials and disused buildings from past land uses; and

vi) Marram Grass and its ability to create a beach berm or frontal dune shapes that are different from those created by naturally occurring species.

STRATEGIES

i) **Incorporate the principles and procedures of Landscape Management when assessing the effect of proposed management operations and actions.**

ii) **Ensure Landscape Management procedures assess the Park's visual qualities as seen from the Estuary, Australind, the ocean and vantage points at Bunbury.**

iii) **Train the Park's staff to use and apply Landscape Management procedures.**

iv) **Assess and map the Park's landscape component according to the Departmental System.**

v) **Remove redundant infrastructure and debris, after assessment of their historic value (see also Strategy 8, Section 18).**

MANAGEMENT FOR CONSERVATION: THE BIOLOGICAL RESOURCES

10. FLORA AND VEGETATION

The objectives are to:

vii) **Maintain the existing diversity of plant species, structural types and range of age classes.**

viii) **Assess the conservation status of plant species and communities known to occur in the Park.**

ix) **Protect species and communities that are known to be rare, geographically restricted, at the limit of their known range, or otherwise in need of protection.**

x) **Enhance public awareness of the conservation value and ecology of coastal plant communities.**

Aeolian (wind) activity has developed the barrier dune system that has in turn resulted in a mosaic of landforms and soils (see Section 7). Semeniuk and Semeniuk (1990) believed that this activity originally established the Peninsula as an oceanic barrier and through continued activity this barrier has moved, and is continuing to move, eastward. Semeniuk and Semeniuk (1990) further believed that prior to this barrier's "collision" with the coastline it supported an oceanic island vegetation assemblage, and that the Peninsula is of biological and conservation significance as it displays the dynamics of a progressive invasion of mainland species into the remnants of the oceanic islands assemblage.

Regardless of the origin of the vegetation assemblage, the mosaic of landforms and soils has, in turn, resulted in a corresponding mosaic of vegetation types.

The floristics and structure of this mosaic have been outlined by Trudgen (1984) and Semeniuk and Meagher (1981) and are shown in Figure 6. The broad vegetation units shown in Figure 6 are described in detail by Trudgen (1984), and can be broadly summarised as:

i) colonisers of the beach, mobile dunes and poorly stabilised dunes disturbed by waste disposal or other activities;

ii) low closed heath on the western parabolic dunes;

iii) closed scrub on parabolic dunes;

iv) woodland/low open forest to low closed forest on the plains;

v) low closed forest on older dunes and deflation basins;

vi) Melaleuca low open forest;

vii) *Avicennia marina* (White Mangrove) closed scrub; and

viii) closed sedgelands, closed herblands and low open forest.

Two hundred and one species of native flowering plant are known to occur on the Peninsula (G. Keighery, pers. comm.). Many of the 201 species occur elsewhere on the Swan Coastal Plain. However, as only a small percentage of the Swan Coastal Plain is reserved in the conservation estate, the conservation status of those species restricted to the Swan Coastal Plain is, at best, insecure.

Plant species on the Peninsula of special interest include *Carex pumila*, the only known record in Western Australia, and *Rorippa* sp., a previously unrecorded species in the family Brassicaceae (G. Keighery, pers. comm.). The Park's population of the annual Native Pellitory (*Parietaria debilis*) — a species in decline in the Perth area — is one of the largest and healthiest in the south-west (R. Powell, pers. comm.).

Trudgen (1984) identified three of the Peninsula's vegetation types as warranting immediate conservation, viz. Mangrove Closed Scrub, Coastal Salt Marshes, and Tuart Forest. The Mangrove Closed Scrub occurs within the Conservation Park, bordering the Leschenault Estuary north of Belvidere. This mangrove stand (when incorporated with the stands occurring near by, at Leschenault Inlet, Bunbury) is at its southernmost occurrence on the west coast of Australia; the next southernmost occurrence is on the Abrolhos Islands, over 500 km further north.

Industrial effluent disposal on the Peninsula has resulted in:

xi) vegetation dissected by numerous access tracks;

xii) contaminated groundwater and altered or killed vegetation adjacent to disposal lagoons;

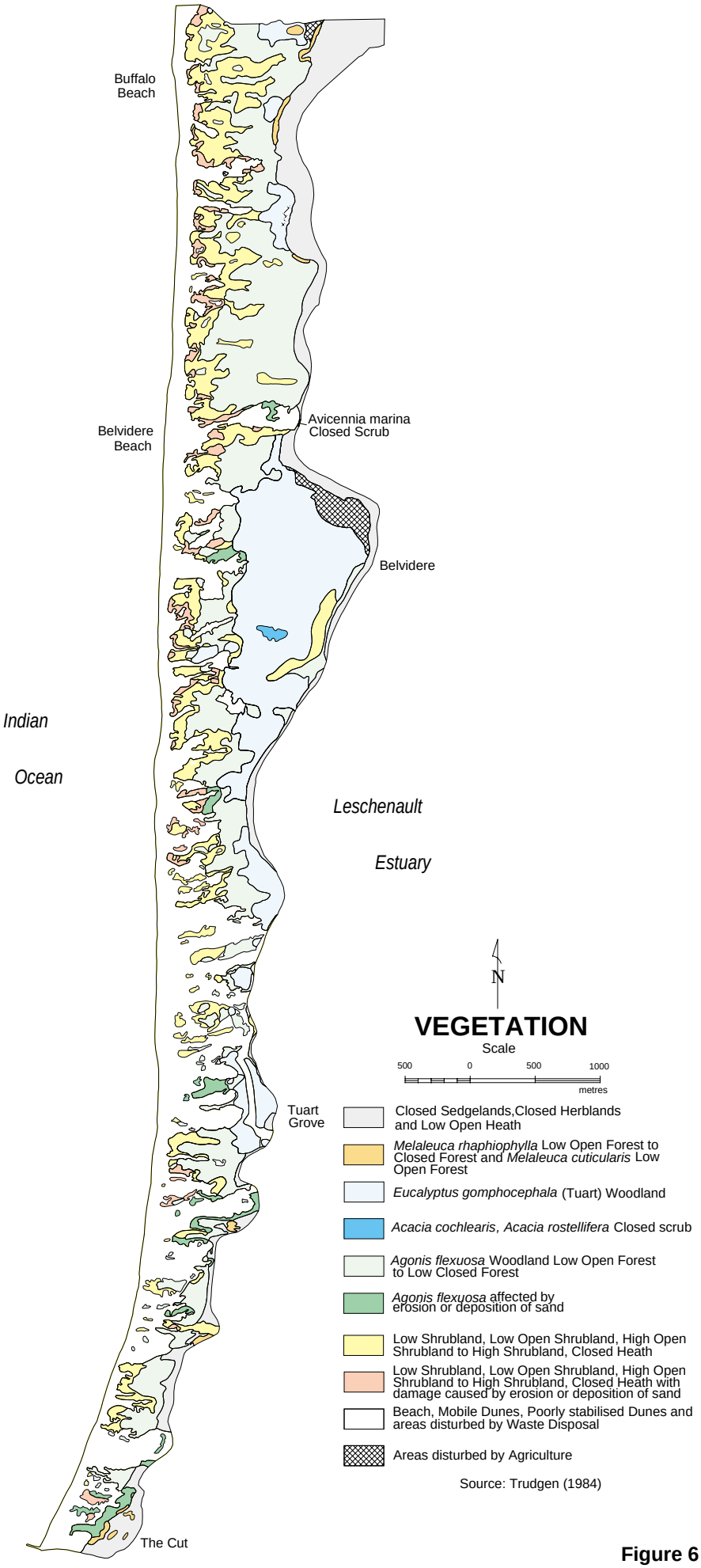

Buffalo Beach
Belvidere Beach
Avicennia marina Closed Scrub
Belvidere
Indian Ocean
Leschenault Estuary
Tuart Grove
The Cut
N
VEGETATION
Scale
500 0 500 1000
metres
Closed Sedgelands,Closed Herblands and Low Open Heath
Melaleuca rhaphiophylla Low Open Forest to Closed Forest and Melaleuca cuticularis Low Open Forest
Eucalyptus gomphocephala (Tuart) Woodland
Acacia cochlearis, Acacia rostellifera Closed scrub
Agonis flexuosa Woodland Low Open Forest to Low Closed Forest
Agonis flexuosa affected by erosion or deposition of sand
Low Shrubland, Low Open Shrubland, High Open Shrubland to High Shrubland, Closed Heath
Low Shrubland, Low Open Shrubland, High Open Shrubland to High Shrubland, Closed Heath with damage caused by erosion or deposition of sand
Beach, Mobile Dunes, Poorly stabilised Dunes and areas disturbed by Waste Disposal
Areas disturbed by Agriculture
Source: Trudgen (1984)

Figure 6

i) damaged foliage; and

ii) waterlogged roots (Semeniuk and Semeniuk 1990).

With the effluent disposal now ceased and rehabilitation programs continuing, the impacts of effluent disposal will progressively diminish.

Issues

Only a small portion of the Swan Coastal Plain is reserved for conservation. With increasing land clearing and urbanisation, many species of the Plain have the potential to become rare, threatened or geographically restricted. This places greater conservation significance on those remaining species and communities in the conservation estate.

The very small stand of Mangrove Closed Scrub (*Avicennia marina*), when seen as part of the estuarine populations near Bunbury, represents the southernmost limit of its range in Western Australia. As a result of changes to the natural flow patterns of the Inlet and Estuary, the Inlet population, in Bunbury, is no longer subject to the environmental conditions that enhance its regeneration (L. Pen, pers. comm.). This places greater significant conservation value on the small stand at Leschenault Peninsula.

In some circumstances there may be a requirement to protect plant species and communities from inundation by mobile sand dunes.

The *Rorippa* sp. occurs in well developed moss swards in undisturbed Tuart woodland. To maintain this plant species, careful attention should be given to protecting these areas from disturbance.

Native Pellitory has died out or become scarce in many Coastal Plain bushlands within the Perth Metropolitan Region (R. Powell, pers. comm.); this may relate to the invasion of weeds or to other factors in the environment that have altered. The abundance of this species on the Peninsula should be monitored, particularly in areas of increased human use or where management measures are being applied to the vegetation.

The areas of mature Tuart have previously been grazed and have a disturbed understorey. Much of this Tuart and understorey *Hakea* is senescing. Within the understorey there is little Tuart and negligible *Hakea* regeneration. This may be due not only to competition from weeds but also to grazing by kangaroos.

Increasing public use of the Park may degrade sensitive vegetation communities of the Peninsula/Estuary interface.

STRATEGIES

i) **Assess all proposed operations and developments to consider their effect on the Park's flora and vegetation.**

ii) **Direct rehabilitation at establishing self-sustaining plant communities and incorporate flora and vegetation conservation principles in rehabilitation works (see Section 16 for specific strategies).**

iii) **Minimise development of new roads (public and management) and rationalise the existing network of management roads and tracks. Close and rehabilitate those not required for access (see Sections 16 and 23 for specific strategies).**

iv) **Restrict boat landings on the Peninsula's eastern shore to locations where public access can be managed and sensitive vegetation communities protected.**

v) **Provide information to Park visitors on the Park's botanical values (see Section 26 for specific strategies).**

vi) **Assess the conservation status of the Park's plant species and communities.**

vii) **Protect from disturbance the areas where *Carex pumila* or *Rorippa* sp. occurs.**

viii) **Monitor the abundance of Native Pellitory, particularly in areas of increased human use or where management measures are being applied to the vegetation.**

ix) **Assess the effects of weeds and kangaroo grazing on inhibiting the regeneration of Tuart and *Hakea* and the need for regeneration strategies; implement such strategies where appropriate.**

x) **Rehabilitate and stabilise the mobile dune (blowout) immediately north of Waterloo Head to prevent**

it inundating the stand of Mangrove Closed Scrub (*Avicennia marina*).

xi) **Monitor the status and condition of the stand of Mangrove Closed Scrub.**

xii) **Liaise with LIMA to determine management strategies to expand and protect the Mangrove Closed Scrub community.**

xiii) **Investigate the possibility of using seed from the population of White Mangrove in Leschenault Inlet to try to establish further populations in Leschenault Estuary.**

11. FAUNA

The objectives are to:

i) **Protect all native animal species, with particular management emphasis on species that are 'threatened', 'in need of special protection', or 'vulnerable to disturbance'.**

ii) **Assess the Park's suitability as a location to re-introduce species in need of specific management programs, and establish such programs where appropriate.**

iii) **Manage the Park's flora, vegetation and pest species to facilitate long term viability of the Park's existing native fauna, and native fauna released into the Park in accordance with release programs.**

iv) **Encourage a greater community awareness of the Park's fauna and fauna management programs.**

No formal surveys of the fauna of the Peninsula have been undertaken. All information on species has been gathered from incidental observations, anecdotal accounts, or from education or interpretation programs.

The vertebrate fauna recorded from the Park are listed in Appendix 1. Also listed in Appendix 1 are mammal, reptile and amphibian fauna that are not known from, but may be present within, the Park.

Mammals

Ten species of native mammal are known or thought to occur in the Park (Appendix 1). Two of these — the Rakali, or Water-rat (*Hydromys chrysogaster*), and the Lesser Long-eared Bat (*Nyctophilus geoffroyi*) — have been reported from the Park, but their presence has not been confirmed. The Mootit, or Bush Rat (*Rattus fuscipes*), is known from one record only, and the Australian Sea-lion (*Neophoca cinerea*) is rarely recorded. The Chuditch (*Dasyurus geoffroii*) has been recorded recently.

Two of the above ten species — the Quenda, or Southern Brown Bandicoot (*Isoodon obesulus*), and the Western Ringtail Possum (*Pseudocheirus occidentalis*) — have been translocated to the Park.

Three of the Park's mammal species — the Chuditch, the Quenda and the Western Ringtail Possum — are declared under the *Wildlife Conservation Act 1950* as 'fauna that is rare or likely to become extinct'. The Australian Sea-lion is declared as 'other specially protected fauna'.

The Western Grey Kangaroo (*Macropus fuliginosus*) occurs at high density; measures to reduce its numbers in the Park may be required (see section 16: rehabilitation).

The two translocated species in the Park are part of CALM's Western Shield program, for the recovery of native fauna through the control of feral predators. The first release of Western Ringtail Possums was in September 1991 and followed the commencement of a 1080 baiting program to control foxes. This has been maintained and is carried out monthly.

Subsequent releases of Ringtail Possums were carried out in 1992, 1993, 1994, 1995 and 1997. Monitoring of the released possums has shown the translocation to be successful and the population to be increasing (de Tores, Rosier and Payne, unpublished). The monitoring also resulted in the first record of the Brush-tailed Phascogale or Common Wambenger (*Phascogale tapoatafa*). It has shown, moreover, that the density of the population of the Common Brushtail Possum (*Trichosurus vulpecula*) in the Park is now ten times what it was when the fox control program began.

The release of Quendas was in June 1996. Monitoring is carried out through regular trapping programs, and the capture of specimens in February 1998 suggests that the species is becoming established.

Other species may be translocated to the Park.

Birds

One hundred and thirty species of bird are recorded within the Park or the area abutting it

(see Appendix 1). One of these, Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*), is a threatened species, declared under the *Wildlife Conservation Act 1950* as 'fauna that is rare or likely to become extinct'. A further species, the Peregrine Falcon (*Falco peregrinus*), is declared as 'other specially protected fauna'. Both these species have been recorded on parts of the Peninsula that are within the Park.

The relatively large number of bird species reflects the diversity of habitat that ranges from sparsely vegetated coastal sand dunes, through mature Peppermint and Tuart woodland, to sheltered estuarine sedgelands and saltmarshes.

The Estuary's northern wetlands and western shoreline are significant for waterbirds (Ninox Wildlife Consulting 1989). This is primarily attributed to the low disturbance and high productivity of the fringing estuarine vegetation. These areas include known mosquito breeding sites. Of the 62 waterbirds known to use the Estuary, 60 have been shown to use these mosquito breeding sites (Ninox Wildlife Consulting 1989).

Reptiles and Amphibians

Nine reptile and three amphibian species have been recorded within the Park (see Appendix 1). One of the known reptile species, the Carpet Python (*Morelia spilota imbricata*), is included on the gazetted list of fauna in need of special protection and is frequently observed in the Park during the summer months.

Other reptiles and amphibians species may occur within the Park but the lack of recorded sightings may, as for other fauna, reflect the lack of surveys.

Invertebrates

The Park's invertebrate animals have not been studied in detail. A conspicuous insect is a large introduced species of butterfly, the Monarch, or Wanderer (*Danaus plexippus*), whose larvae feed on introduced cottonbushes (family Asclepidaceae) in the general region.

The larvae of another butterfly species, the Yellow, or Australian, Admiral (*Vanessa itea*), feed on Native Pellitory (*Parietaria debilis*). Because of the health and abundance of Native Pellitory on the Peninsula, the Park is likely to be one of the most significant breeding areas for the Admiral in south-western Australia (R. Powell, pers. comm.).

Estuarine Fauna

The wetlands of the Estuary/Peninsula interface, along with the shallow mudflats and seagrass meadows, contribute to the estuarine fish food supply by providing insect larvae and plant material. In many instances, waterbirds of the open estuary breed in these fringing wetland areas. These wetlands are considered a key part of the estuarine system (Atkins 1990).

The Estuary is recognised as a nursery for many of the commercially and recreationally important fish species (LIMA u.d.; Chalmer and Scott 1984).

The commonly observed invertebrates of the Estuary are the crustaceans including the Blue Manna Crab (*Portunus pelagicus*), Shrimp (*Palaemonetes australis*) and the King Prawn (*Penaeus latisulcatus*). Other common smaller invertebrates are the bivalves, gastropods and polychaetes (LIMA u.d.). Comprehensive surveys of invertebrate estuarine fauna have been conducted, and species recorded are listed in Chalmer and Scott (1984) and Halse, Pearson and Pinder (unpublished).

Issues

Resource information relevant to management of terrestrial fauna (invertebrate and vertebrate) is inadequate. To prepare and implement effective fauna management programs further information is required on:

v) the range of species occurring in the Park;

vi) species known to occur in the area, the surrounding area and the region;

vii) species no longer occurring but known to have formerly occurred in the area, the surrounding area and the region; and

viii) the conservation status (locally, regionally and nationally) of the species known and formerly known to occur in the area.

The reported detrimental effect of large numbers of grazing kangaroos will need to be verified and quantified. The largest numbers have been reported within and near cleared areas, for example, at Belvidere, where the area was previously cleared for grazing. Grazing by kangaroos at high densities may have a detrimental effect on areas naturally rehabilitating and areas subject to intensive rehabilitation works. The number of kangaroos may need to be reduced. Culling is one strategy, and, if necessary, can be implemented to release grazing pressure on native vegetation communities and

significantly decrease the breeding rate. Should culling be employed, removal rates and procedures will need to be defined and monitored.

The large diversity of the bird species within the Park, and the availability of several suitable waterbird viewing points provides an educational and interpretive opportunity.

The excavated and exposed freshwater points may be of value to wildlife (see Section 8).

Mosquitoes are a potential risk to public health, because of their ability to transmit Ross River virus. With increasing public use of the Park there is the possibility of further pressure for control of mosquitoes at their known breeding sites. However, the sites where mosquitoes breed are important to ducks, the Black-winged Stilt and several species listed under CAMBA and JAMBA, including the Greenshank and the Common Sandpiper (Halse, pers. comm.). Control or eradication measures, if implemented, could adversely affect food supply for these and other waterbirds using the Estuary.

The Carpet Python is frequently seen in the Park, particularly on roads and tracks. With the anticipated increase in public access there is a risk to its numbers.

STRATEGIES

i) **Undertake a comprehensive terrestrial fauna survey program and disseminate information where appropriate.**

ii) **Maintain the existing introduced predator baiting program, monitor its effectiveness and adjust the regime where and when appropriate (see Section 13 for further strategies on the control of introduced animals).**

iii) **Continue, as far as possible, the current Western Ringtail Possum research program, and assess the feasibility of introducing or re-introducing fauna into the Park for other species that are:**

   iii) **threatened or in need of special protection or otherwise vulnerable; or**

   iv) **no longer occurring in the Park but known, or are thought to have occurred in the Park.**

iv) **If fauna releases are considered feasible, they should only be carried out in accordance with CALM Policy Statement No. 29: *Captive Breeding and Cultivation of Threatened Species and their Re-establishment or Translocation in the Wild.***

v) **Initiate research to determine whether grazing kangaroos are causing damage, and if so, quantify the extent of that damage. If damage is occurring at unacceptable levels assess means by which it can be reduced and implement appropriate measures.**

vi) **Provide interpretive information on the Park's fauna. Emphasise the Carpet Python (*Morelia spilota imbricata*) and fauna subject to release or re-introduction programs. Highlight the conservation status and aspects of the ecology of each species.**

vii) **Provide information on the Park's bird species.**

viii) **Provide bird viewing stations.**

ix) **Provide information on the conservation value of mosquitoes, with specific reference to their significance to waterbirds.**

x) **Ensure that research and control programs on mosquitoes and midges are approved by CALM's Director of Nature Conservation in accordance with NPNCA policy (NPNCA, 1993).**

xi) **Provide Park visitors with information on alternative measures for protection against mosquitoes.**

MANAGEMENT FOR CONSERVATION: PROTECTION

12. INTRODUCED PLANTS

The objectives are to:

- **Preserve the existing range of native plant species and communities.**
- **Control, and where practicable, eradicate existing weed infestations.**
- **Prevent additional introductions and spread of weed species.**

Sixty-nine introduced plant species are recorded within the Park. Six of these species — Doublegee (*Emex australis*), Arum Lily (*Zantedeschia aethiopica*), Cape Tulip (*Homeria* sp.), Apple of Sodom (*Solanum sodomeum*), Silverleaf Nightshade (*S. elaegnifolium*) and Narrowleaf Cottonbush (*Gomphocarpus fruticosus*) — are listed under the *Agriculture and Related Resources Protection Act 1976* as declared plants (noxious weeds).

The four major sources of introduction of these species are:

- by vehicles, especially along roadsides;
- as wind-blown seeds;
- as water-borne seeds or vegetative material; and
- as imported seeds in brushing used for rehabilitation.

Many of the Park's introduced species are naturalised species and some are used in rehabilitating or stabilising degraded areas.

A weed is defined as:

> *"any plant which is disadvantageous from the viewpoint of effective management for the land use concerned"* (CALM 1986).

By this definition, introduced species used to rehabilitate areas where indigenous species cannot carry out the same role are not weed species.

Issues

Several introduced species occur in the Park, some of which have the potential to spread rapidly, displace native species and alter vegetation structure. This can have a significant adverse effect on conservation values. However, not all introduced species are detrimental.

Adverse effects may result from the use or lack of control of introduced species. For example, Marram Grass when used to stabilise beach berms or frontal dunes can create a berm or dune shaped differently from those created by naturally occurring species. This may eventually result in an unnatural visual landscape.

Measures to control introduced species should also consider the effect, or potential effect, on the environment. The detrimental effects of some control measures may outweigh the benefits of control. For example, control may result in mobilisation or remobilisation of sand dunes.

Some introduced plant species previously used to rehabilitate or stabilise dunes may continue to be of value, provided they do not pose any threat to native plant communities.

Some of the known occurrences of introduced species are of historical significance, for example the plantings of Olives and Date Palms at Belvidere. The Olives, however, are reproducing and spreading. Immediate action should be taken to remove those specimens that are not part of the original plantings.

STRATEGIES

iii) **Prepare and regularly update a register of all weeds and other introduced species to record all known infestations and the severity of infestation.**

iv) **Prepare and implement a program to control introduced plant species. Allocate priority to control or eradicate on the basis of:**

v) **threats posed to conservation values;**

vi) **the species concerned and CALM's legal and moral obligation to control those species;**

vii) **the adverse effects, both existing and potential, on the environment; and**

viii) **the efficacy of control options.**

- **Protect introduced species and plantings that are considered to have historical significance and no adverse environmental or aesthetic effects.**
- **Monitor any spread of the species referred to in Strategy 3, through natural regeneration and, where necessary, introduce control measures to prevent infestation of other areas.**

13. INTRODUCED ANIMALS

The objectives are to:

ix) **Protect the Park's native fauna.**

x) **Control, and where practicable, eradicate existing populations of introduced fauna.**

xi) **Prevent further introductions of non-native fauna.**

The known introduced vertebrates of the Park are shown in Appendix 1. Included are the fox and rabbit. Both are declared animals under the Agriculture and Related Resources Protection Act.

Christensen (1980) suggested a link between foxes and the decline of medium sized native animals (body weight 0.15 to 5 kg). Research in Western Australia shows that removing foxes or reducing their numbers correlates with increases in the numbers of native animals (Kinnear *et al.* 1988).

As part of CALM's research program on re-introducing the Western Ringtail Possum (see Section 11), a baiting program using sodium monofluoroacetate (or 1080) was initiated. Prior to this, the frequency with which cats and foxes were reported and observed indicated that the population densities were relatively high. The baiting program has significantly reduced the number of foxes within the Park. Its effect on cats has not been quantified.

Cats are considered opportunistic predators, feeding on invertebrates, fish, reptiles, birds and mammals (native and introduced) and are known to prey upon mammals up to the size of the Brushtail Possum (Jones 1983). Availability of food determines the feral cat's population density (Jones 1983). The presumed large population of feral cats within the Park therefore indicates an availability of food. This food, or prey, may include native and introduced mammals.

Grazing of stock also presents a threat to conservation values as it increases the potential to introduce weeds and can cause or exacerbate erosion.

Feral bees have been recorded within the Park. Feral bees and bees from apiary sites can compete with endemic invertebrate species for food resources. Currently a moratorium exists on new apiary sites in the conservation estate.

Issues

Relatively high densities of cats and rabbits have been observed within the Park. The presence of these species can reduce the Park's conservation value. The 1080 baiting has reduced the number of foxes within the Park; however, further research is required to assess its effect on cats.

STRATEGIES

i) **Prepare and implement a program to control introduced animals, with particular emphasis on:**

  i) **controlling rabbits;**

  ii) **controlling or eradicating foxes; and**

  iii) **controlling or eradicating cats.**

ii) **Maintain the 1080 fox-baiting program while it is necessary to protect re-introduced and other native fauna (see strategy 2, Section 11).**

iii) **Prohibit grazing of domestic stock within the Park.**

iv) **Do not grant apiary licences within the Park.**

14. FIRE

The objectives are to:

xiii) **Protect human life (Park visitors, neighbours, fire fighters and staff) from wildfires entering or burning within the Park.**

xiv) **Minimise the risk of wildfires burning large areas within the Park.**

iii) **Implement fire management regimes that will assist in**

achieving the Park's flora and fauna management objectives.

Australian ecosystems have evolved with the presence of fire, and many plant species and vegetation types have evolved specific adaptations to fire. Natural fire regimes (regimes evolved in the absence of human intervention) contribute to creating a mosaic of vegetation types and age classes.

Throughout Australia use of fire by Aboriginal people has brought about changes to fire frequencies and intensities, and fire was used as a management tool for specific purposes. The use of fire at Leschenault Peninsula by Aboriginal people is not known and its use since first European settlement is poorly documented. Between 1954 and 1964 fire was used on a regular basis to stimulate grass growth for stock (Morgan Smith, pers. comm.). In recent times, subsequent to the Peninsula's use for grazing, there has been no recorded incidences of wildfire and no use of fire as a management tool.

Issues

With increasing recreational use of the Park it is anticipated there will be an increase in the risk of wildfires occurring. Risk of wildfire is significantly increased by unregulated use of campfires.

Risk to human life can be reduced by regulating visitor use and implementing strategies to reduce fuel levels within and abutting the Park.

Suppression of wildfires within the Park, should they eventuate, will be facilitated by the landforms present. These landforms, primarily the mobile and partially stabilised sand dunes, act as natural barriers to fire movement. These barriers effectively divide the Park into discrete blocks and, together with the existing and proposed public road and management road and track network, minimise the possibility of wildfire spreading throughout the Park. These barriers also negate the need to construct additional firebreaks and greatly reduce the need to burn to reduce fuel.

Fuel-reduction burning on the eastern shore of the Estuary may have contributed to *Acacia saligna* becoming a weed species. *Acacia saligna* is present at several locations along the Estuary/Peninsula interface. There is therefore the potential for it to become a weed species in the Park as a result of inappropriate fire management regimes.

STRATEGIES

1. **Prepare and implement a wildfire suppression plan identifying:**
   - vi) **strategic roading and access points;**
   - vii) **strategic water points (including water points on neighbouring private property);**
   - viii) **specific strategies to be implemented to protect human life, infrastructure, the visual resources, geographically restricted vegetation communities (for example, mangroves) and fauna habitat (for example, mature stands of Tuart or Peppermint);**
   - ix) **fire suppression support units (for example local brigades);**
   - x) **evacuation procedures; and**
   - xi) **procedures to detect wildfire.**
2. **Carry out prescribed burning where necessary for:**
   1. **vegetation management: to enhance the conservation status of flora and fauna species, habitat or communities; or**
   2. **fuel reduction: to protect people, Park infrastructure and neighbouring properties (see Figure 7).**
3. **Liaise with private property land holder(s) to ensure appropriate measures are taken to reduce fuel levels within private property abutting the Park and minimise the possibility of wildfire entering the Park.**
4. **Allow campfires at designated fire places only.**
5. **If necessary close the Park to the public during periods of extreme fire risk.**

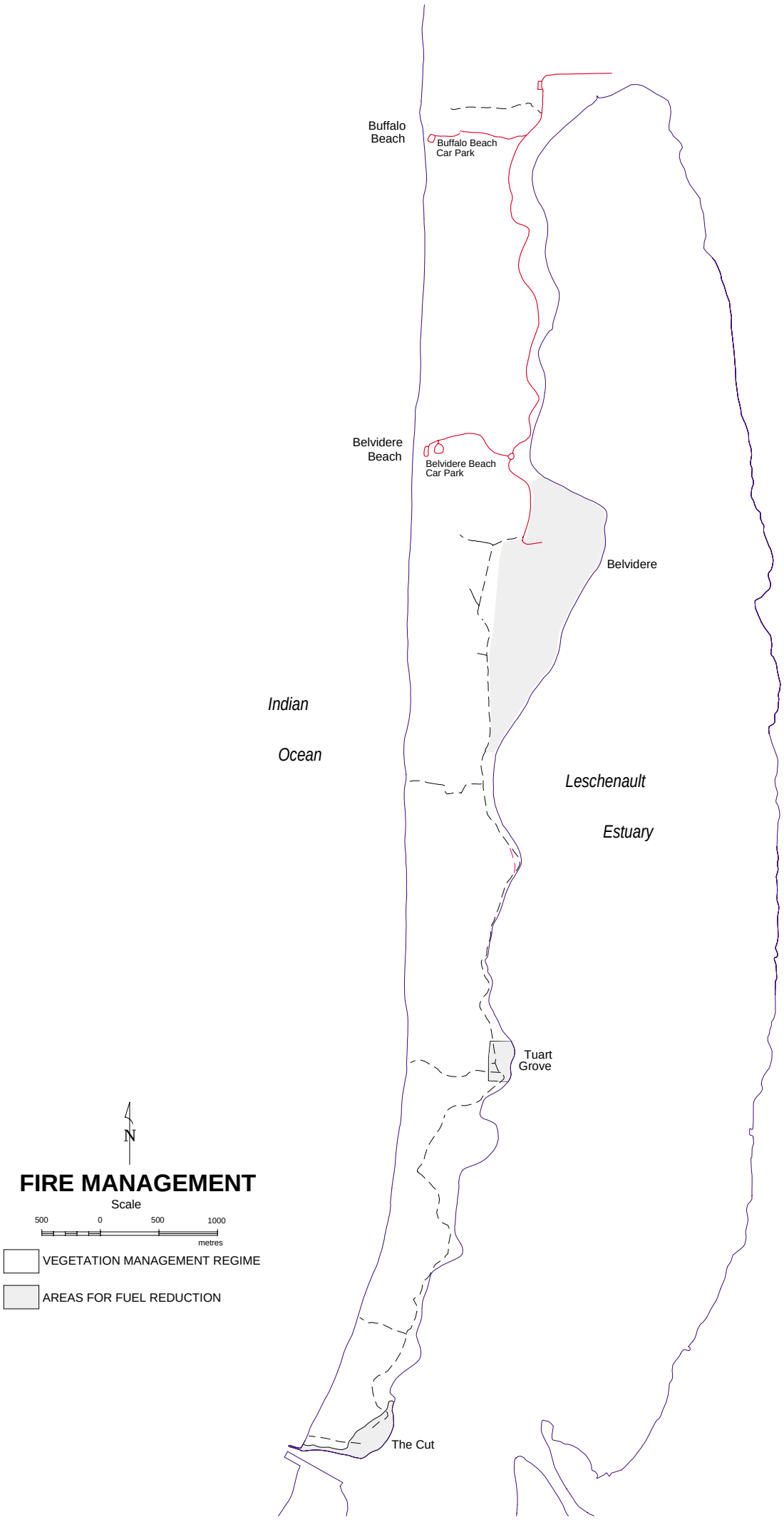

Buffalo Beach
Buffalo Beach Car Park
Belvidere Beach
Belvidere Beach Car Park
Belvidere
Indian Ocean
Leschenault Estuary
Tuart Grove
The Cut
N
FIRE MANAGEMENT
Scale
500 0 500 1000
metres
VEGETATION MANAGEMENT REGIME
AREAS FOR FUEL REDUCTION

Figure 7

15. DISEASE

The objectives are to:

i) **Minimise the spread and intensification of *Phytophthora* and other diseases where they may be present in the Park.**

ii) **Prevent disease from being introduced into disease-free areas.**

Fungi belonging to the genus *Phytophthora* are exotic to Western Australia. The most widely known species is *Phytophthora cinnamomi* (the cause of dieback disease).

A wide range of plant species is known to be susceptible to *Phytophthora* species; the Proteaceae, Myrtaceae and Epacridaceae are particularly susceptible. There are no known occurrences of dieback in the Park. However, the decline of Swamp Banksia (*Banksia littoralis*), a susceptible species, may indicate this disease. This species was formerly present in small stands but occurs now only as isolated specimens towards the Park's northern end. Many specimens died circa 1960-1970 (Walta, personal communication); this may be attributable to various causes, including dieback and waterlogging.

Some waterlogging of surface soils has occurred as a result of effluent disposal. In these areas, and areas where freshwater seeps have been exposed there will be a marginally increased risk of dieback infection or intensification.

The Park's vegetation associations consist of species that do not reliably indicate the presence of dieback disease. However, because of the vegetation and soil types present, the hazard rating for introducing *Phytophthora* into the Park is considered negligible to low.

All vegetation units (as described by Trudgen 1984) are considered to have a low hazard rating for dieback disease (CALM, 1993).

These vegetation units contain few species considered to be susceptible to *Phytophthora* In addition environmental and site factors are such that only a few (if any) individuals would be killed if *Phytophthora* were introduced and managed to establish an infection.

Within any vegetation community there is usually a number of dead and dying plants. These deaths are not necessarily a result of *P. cinnamomi* infection and are referred to as "background deaths".

Armillaria, a known native pathogen of Tuart, may occur in the Park. *Armillaria luteobubalina* has been associated with blowouts in Yalgorup National Park (30 km north of Leschenault Peninsula). Aerial canker disease is also affecting Tuarts and Banksias south of Mandurah (Shearer, pers. comm.).

Hygiene conditions are relevant to all CALM management vehicles and activities, as well as those from other organisations and operators.

Issues

The risk of introducing and spreading *Phytophthora* dieback is greatly increased when soil is moved. Implementing strict dieback hygiene conditions greatly reduces the risk of its introduction and spread. Similarly, using brushing material free of *Armillaria* reduces the risk of introducing and spreading *Armillaria*.

STRATEGIES

i) **Survey the Park to determine the presence and extent of *Phytophthora cinnamomi* (dieback) and *Armillaria*.**

ii) **Determine and implement disease hygiene requirements for all operations including the operations of other organisations. Place particular emphasis on minimising the possibility of introducing or spreading *Phytophthora* and *Armillaria*.**

iii) **Include disease hygiene requirements in all contract specifications.**

iv) **Implement a minimum strategic roading network to reduce the risk of introducing *Phytophthora* (see Sections 23 and 28 for specific strategies).**

16. REHABILITATION

The objectives are to:

v) **Carry out rehabilitation and mobile sand stabilisation to protect conservation values.**

vi) **Allow the natural erosion and stabilisation processes to continue**

as far as practicable while meeting other management objectives.

- **Protect infrastructure and public facilities.**
- **Apply rehabilitation techniques such that rehabilitated areas progress to a stage where vegetation communities are self-sustaining.**

Importance of Rehabilitation

Rehabilitation has been a major management activity at Leschenault Peninsula for over 20 years, and significantly so for over 10 years. This has been primarily a result of the Peninsula's use as a disposal area for industrial waste. Even though the disposal of industrial effluent has ceased, rehabilitation continues to be a major aspect of management.

Industrial Use

Laporte Titanium commenced operating a sulphate process plant at Australind in 1964. The *Laporte Industrial Factory Agreement Act 1961* provided the legislative framework for the operation. In accordance with this Agreement Act, the Western Australian Government was to be responsible for disposal of the acidic effluent from the plant until the year 2011.

From 1963 until October 1990 the acidic effluent was disposed of on Leschenault Peninsula. The trestle and causeway formerly spanning Leschenault Estuary were constructed to support the pipeline transporting the effluent to the Peninsula.

Throughout the plant's operation a range of disposal techniques was employed. Initially, once transported to the Peninsula, the effluent was discharged onto the ocean beach from where it flowed directly into the Indian Ocean. The result of this was substantial iron staining of the ocean as unneutralised effluent precipitated iron compounds on contact with salt water. Disposal by this technique was deemed to be unacceptable and in 1968 direct discharge onto the ocean beach was terminated.

From 1968 until the disposal of effluent ceased in 1990, acidic effluent was deposited onto, or within lagoons excavated into, the calcareous sands which had the capacity to neutralise it.

The technique of disposal into the neutralising sands was progressively refined over time. Initially effluent was deposited in channels constructed slightly off the natural contour lines. Later disposal was through a sprinkler network, discharging effluent onto the dune surface. Ultimately effluent disposal utilised a series of lagoons excavated into areas of exposed sand.

With each of these approaches, sulphuric acid percolated through the calcareous sand and formed gypsum. Iron precipitated as ferrous sulphate and carbon dioxide was emitted. The aquifer was therefore receiving predominantly neutralised liquid with smaller amounts of unneutralised effluent.

This groundwater aquifer, with neutralised and unneutralised acid, flows predominantly in a westerly direction and eventually makes contact with the ocean. Consequently, the unneutralised effluent within the aquifer periodically caused minor ocean staining.

Solids carried in the effluent periodically sealed off the floor of the receiving lagoons, preventing further infiltration of effluent. These solids were removed by dragline and dumped to one side of the receiving lagoons.

In 1986 a central receiving reservoir was established. Effluent carrying entrained solids was discharged initially into this reservoir where the solids settled before the supernatant liquor was pumped to infiltration lagoons. The solids were then pumped separately into their own receiving lagoons (Quilty *et al.* 1991).

Through the early 1980s the Western Australian Government researched alternative means of dealing with effluent. This ultimately led to an agreement with SCM Chemicals Ltd (now Millennium Inorganic Chemicals Ltd), who had taken over the sulphate plant from Laporte in 1984, whereby the Australind plant would cease production by the end of 1990 and would be replaced with a chloride process pigment plant.

The chloride plant opened in 1989 and is located within Kemerton Park, 10 km north of Australind. The liquid waste generated from this plant is an innocuous brine and is discharged directly into the ocean. The solid waste is currently deposited in sand dunes at Dalyellup, south of Bunbury, pending a permanent solution to its disposal.

The sulphate plant at Australind ceased operating in October 1990. A three-month period of plant decommissioning ensued, and discharge of all liquids to the Peninsula ceased on 28 January 1991. The decommissioning of the effluent-disposal infrastructure then began.

Rehabilitation of Blowouts and Disposal Sites

The earliest work undertaken on Leschenault Peninsula to rehabilitate and stabilise blowouts is reported to have been carried out in the late 1920s to early 1930s. This may have been when Marram Grass was first introduced to the Peninsula. The hummocks of Marram now visible towards the southern end of the Peninsula may be remnants of the original introductions (see Figure 8).

Rehabilitation and sand stabilisation work was carried out by the Western Australian Department of Agriculture in the period from the early 1960s to early 1980s. This work trialled various rehabilitation and stabilisation techniques. The work concentrated on frontal and mobile dune stabilisation, notably the transverse ridges west of Lagoon 16 and the then large mobile dune immediately north of Waterloo Head (Belvidere). Areas where this and subsequent rehabilitation works were carried out are shown in Figure 8.

From the early to mid 1980s rehabilitation and stabilisation work was co-ordinated by the Public Works Department and Leschenault Inlet Management Authority.

In 1986, as a result of the decision to close the sulphate plant at Australind and recognising Leschenault Peninsula's conservation and recreation values, the Western Australian Government commenced an intensive rehabilitation program of disposal sites and adjacent areas of sand drift.

About 100 ha of the Peninsula was identified as requiring rehabilitation as a result of industrial effluent disposal. The locations of the former effluent disposal areas are shown in Figure 8.

An overview of the rehabilitation process has been documented (Quilty *et al.* 1991).

The Agencies Involved in Rehabilitation

Several State departments and authorities have been involved in managing effluent disposal and rehabilitating disposal sites. Initially the obligation for effluent disposal was vested with the Public Works Department (PWD). In 1984/85 responsibility was transferred to the Department of Resources Development (DRD), although the PWD [subsequently the Water Authority of Western Australia (WAWA), and now the Water and Rivers Commission (WRC)] was still contracted by DRD to manage "on the ground" effluent disposal operations. From 1988, however, on-ground management was transferred from WAWA to the Waterways Commission (WWC; now part of the WRC) through LIMA.

Later the WWC assumed administrative responsibility for decommissioning (removal of effluent disposal infrastructure) and rehabilitation. Decommissioning was completed in 1991 and rehabilitation of former effluent lagoons reached hand-over stage to CALM in September 1992. The rehabilitation carried out and the agencies responsible are shown in Figure 8.

Prior to this handover, and in consultation with the agencies formerly and at the time involved in rehabilitation, CALM initiated a program for rehabilitation of areas outside the effluent disposal zone. This program utilises the expertise and techniques that have been developed over the preceding rehabilitation period.

Management of "The Erosion and Restabilisation Cycle": The Walta Wheel

The natural cyclic pattern of erosion and stabilisation can be interrupted at any stage. Rehabilitation practises can be implemented to reverse or accelerate the cycle.

The Walta Wheel is a model which has been developed by observing natural dune progression on Leschenault Peninsula. It can be used to identify the stage of erosion of any dune, to plan its rehabilitation, and to predict its future stability.

A description and diagrammatic representation of the Walta Wheel is given in Appendix 2.

Issues

The requirement to rehabilitate areas within the Park arises as a result of natural causes and those induced by human beings. Rehabilitation required as a result of natural causes has included responses to major storms. The rehabilitation work required is labour intensive and costly. The frequency and extent of this requirement is unpredictable.

The programs conducted to date have been intensively managed and although rehabilitation has been carried out elsewhere, it has been primarily focused on rehabilitating effluent disposal areas. Short and longer term maintenance will be required to protect some of these (rehabilitated) areas. Priority for further rehabilitation will need to be determined.

All rehabilitation involving earthworks has the potential to create landforms with unnatural

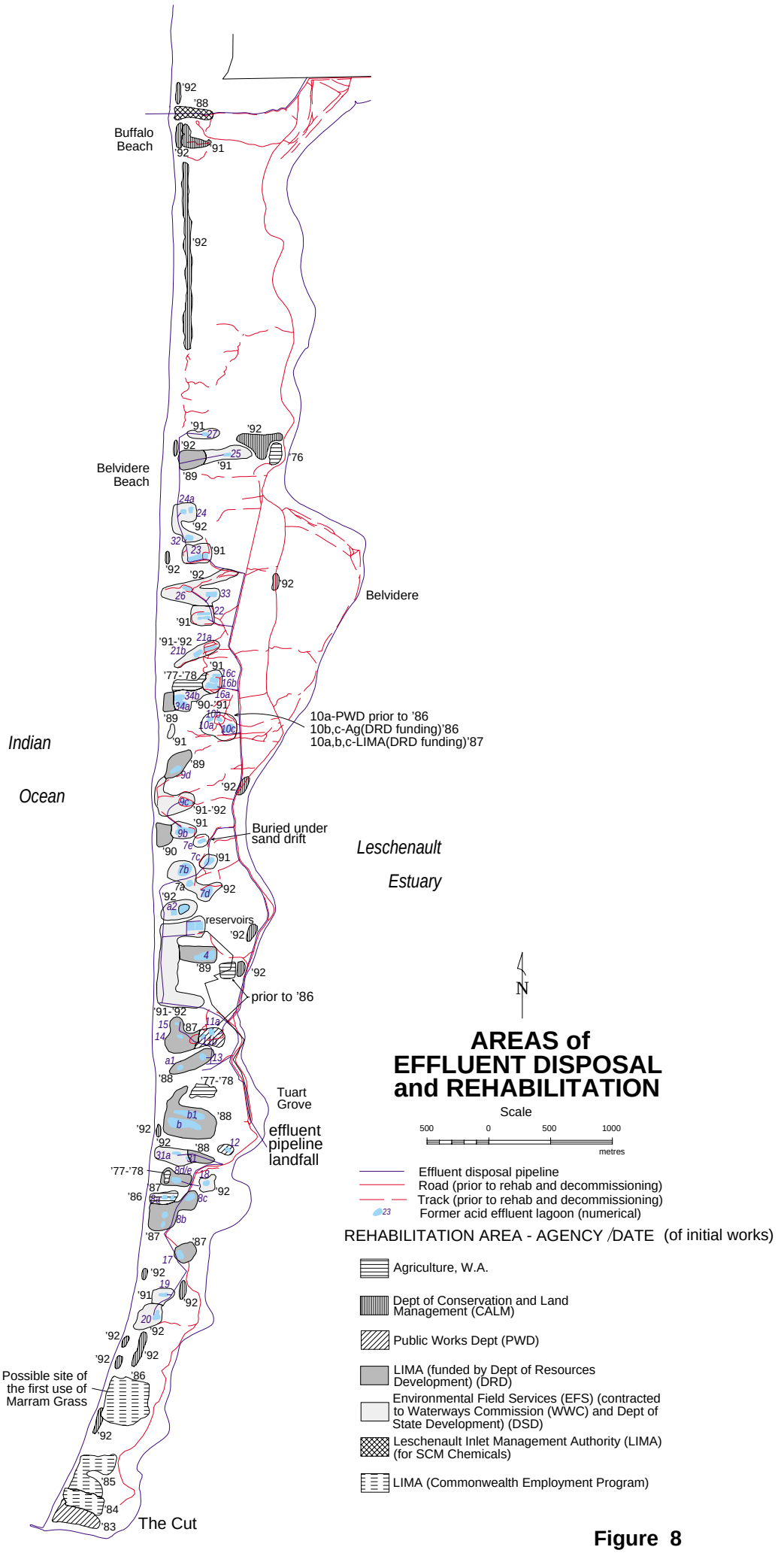

Buffalo Beach
Belvidere Beach
Belvidere
Indian Ocean
Leschenault Estuary
10a-PWD prior to '86
10b,c-Ag(DRD funding)'86
10a,b,c-LIMA(DRD funding)'87
Buried under sand drift
reservoirs
prior to '86
Tuart Grove
effluent pipeline landfall
Possible site of the first use of Marram Grass
The Cut
N
AREAS of EFFLUENT DISPOSAL and REHABILITATION
Scale
500 0 500 1000
metres
Effluent disposal pipeline
Road (prior to rehab and decommissioning)
Track (prior to rehab and decommissioning)
Former acid effluent lagoon (numerical)
REHABILITATION AREA - AGENCY /DATE (of initial works)
Agriculture, W.A.
Dept of Conservation and Land Management (CALM)
Public Works Dept (PWD)
LIMA (funded by Dept of Resources Development) (DRD)
Environmental Field Services (EFS) (contracted to Waterways Commission (WWC) and Dept of State Development) (DSD)
Leschenault Inlet Management Authority (LIMA) (for SCM Chemicals)
LIMA (Commonwealth Employment Program)

Figure 8

appearances, for example straight foredunes (as constructed by machines).

The use of introduced plant species can cause weed infestations and, in the case of Marram Grass, create unnaturally steep foredunes. However, some introduced species are more effective than naturally occurring species. For example, Marram Grass efficiently accumulates sand, preventing sand from inundating other vegetation communities. Its long term viability depends on sand supply and, once the supply ceases its vigour is reduced and it may eventually die out. Marram Grass can be managed to arrest sand movement, provide a protected micro-environment for naturally occurring species to become established, and then lose its vigour and allow the next stage to develop. Other introduced species have also proved to be effective in rehabilitation. Some of these are included in the list of species recommended for rehabilitation (see Appendix 2). Use of these species should be monitored to detect potential weed species.

Rehabilitation work often requires large quantities of brushing which, if collected from within the Park when it is required, may lead to adverse effects at the collection sites. The effects of collecting brushing from within the Park should therefore be closely monitored. Use of naturally occurring and introduced species from sources outside the Park may continue to be necessary. Species currently used for rehabilitation are listed in Appendix 2.

The task for managers of the Park is to strike a cost effective, socially and environmentally acceptable balance between the major factors influencing rehabilitation. The major factors influencing rehabilitation within the Park are:

The Industrial Legacy

The industrial history of the Park has resulted in a legacy of about 40 sites at which effluent disposal lagoons were located, and several more sites where effluent was discharged into canals or sprayed onto the surface. Rehabilitation of most of these sites was carried out between 1986 and 1992. A small number of disposal areas was, however, rehabilitated in earlier pilot work in the 1970s and 1980s.

In most cases rehabilitation aimed to reinstate self-sustaining vegetation communities with stabilising groundcovers complemented by shrubs and, in more protected locations, trees native to the Peninsula. However, for some sites — those located in areas of mid-stage degradation, or where natural blowouts were occurring — rehabilitation involved no more than the establishment of primary groundcover as a short-term stabilisation option.

By the end of the rehabilitation program and transfer of rehabilitation and stabilisation responsibilities to CALM, rehabilitation of all former lagoon sites advanced to a stage where only follow-up or maintenance rehabilitation will be required. Rehabilitation at all former lagoon sites will, however, require monitoring.

Regardless of the immediate and short term success of rehabilitation of effluent lagoons, the natural erosion processes may well result in re-exposure of some lagoons in the future. The debris exposed will be in the form of the unreacted sediments transported in the acidic effluent (primarily silt, residual mineral sands and titanium dioxide).

The strategy adopted to deal with this material throughout the rehabilitation program has been to bury it at the former lagoon sites.

The radiation levels of this debris are slightly elevated above background levels. Burial under 500 mm of sand ensures reduction of radiation, at the new ground surface, to background levels. The debris also provides a more suitable growth medium for initial seed germination and seedling establishment. At the same time it is important to recognise that radiation levels measured in the residue deposits have, with the exception of two lagoons, been below the Radiological Council's "maximum acceptable background" standard of 35 microrem per hour. They have also equated with levels measured in naturally occurring ilmenite strands towards the southern end of the Peninsula.

The two exceptions, lagoons 7A and 7B (see Figure 8), exhibited levels up to 50 microrems per hour owing to the greater thickness of residue (the magnitude of radiation emissions is increased with increasing thickness of the deposit of the emitting material). This level is still below the Radiological Council standards specified for schools (assumed occupancy 50%) and for "other areas" (assumed occupancy 25%).

Thus, although the residue may exhibit radiation levels above background if re-exposed at some stage in the future, these levels will not be hazardous to human health. Exposed residue may nonetheless be considered a social and aesthetic irritation owing to its grey colour, contrasting with the white sand, and its potential to cause a milky discolouration on contact with the ocean.

The Management Goal of Allowing Natural Biological Processes to Continue

To meet the above management goal the natural cyclic processes of erosion and stabilisation would be left unchecked.

This cycle is a continuum, and all stages of the cycle are represented within the Park at any given time. The consequences of allowing this natural cyclical process to occur are:

- the Park's infrastructure (roads, buildings, recreation facilities, monitoring bores) may be inundated with sand; and
- vegetation communities in need of special protection, for example the isolated stand of White Mangrove (*Avicennia marina*), stands of mature and senescing Tuart (*Eucalyptus gomphocephala*), and Peppermint (*Agonis flexuosa*) may be inundated.

This natural erosion and stabilisation cycle may be influenced by human activity. For example, unregulated vehicle use of the Park may disturb the vegetation of the frontal dune system and initiate the erosion component of the cycle. Conversely, Marram Grass may be used to arrest naturally occurring erosion initiated as a result of wind or storm activity.

The effect of grazing native fauna may also be detrimental to rehabilitation programs. The relatively high density of kangaroos (see Section 11) grazing on recently planted rehabilitation areas may jeopardise the success of that rehabilitation.

The Requirement to Protect Infrastructure and Public Facilities

Management of the Park will require protection of management infrastructure and recreational facilities. This will involve initiating rehabilitation or stabilisation measures to arrest sand movement. In some instances these measures will be arresting natural processes.

STRATEGIES

1. **Continue to employ the principles and techniques identified on the Walta Wheel and other techniques proven to be successful to rehabilitate the Park.**
2. **Prepare a works schedule to identify areas where rehabilitation is required. Review this schedule annually and assign priority for rehabilitation work on the basis of:**
   - i) **available funding;**
   - ii) **efficacy of the proposed work and previous work (this may depend upon the stage within the natural erosion-stabilisation cycle that areas proposed for rehabilitation work are currently at);**
   - iii) **maintaining, as far as practicable, the natural ecological processes of the Peninsula and Estuary;**
   - iv) **protecting Park facilities and infrastructure; and**
   - v) **minimising the long-term effect of damage resulting from recreational use, infrastructure maintenance and inappropriate use.**
3. **Rehabilitate or intervene to arrest natural erosion only where there is a threat to:**
   - vi) **areas of recognised biological significance; or**
   - vii) **safety of Park users; or**
   - viii) **Park facilities and management infrastructure.**
4. **Seek additional funds to be made available, if required, to rehabilitate storm damage particularly in the central section of the Peninsula.**
5. **Develop and implement a program to assess the effectiveness of rehabilitation work. This program should:**
   3. **monitor the success (in terms of plant growth rates, species diversity and native plant species recruitment rates) of rehabilitated effluent disposal areas and areas exposed to natural erosion where rehabilitation work has been carried out;**
   4. **assess the need to maintain previously rehabilitated areas (including those areas not formerly subject to effluent disposal);**
   - i) **monitor erosion and naturally restabilised areas not previously rehabilitated;**
   - ii) **assess the effect of kangaroo grazing on rehabilitated,**

partially rehabilitated and recently planted areas; and

iii) trial and evaluate existing and new technologies and techniques.

6. Minimise major earthworks. All rehabilitation earthworks carried out should attempt to create landforms that approximate the aerodynamically stable naturally occurring landforms, while meeting the other objectives of rehabilitation.

7. For brushing, seeding and planting, favour use of plant species known to occur in the Park.

8. Identify areas within the Park where brushing material can be harvested. Use this, and brushing material made available from other management activities, in rehabilitation work.

9. Collect seed from species indigenous to the Park where such species have a role in rehabilitation, and ensure seed is stored for propagation in accordance with the rehabilitation works schedule requirements.

10. Plant areas within the Park to quick-growing indigenous species (for example, *Acacia cyclops*). Manage these areas for future brush harvesting.

11. Continue to use introduced plant species previously used for rehabilitation and stabilisation work provided they are demonstrably advantageous for that work and do not pose a threat to native plant communities in the Park. Monitor their use and discontinue that use if there are signs of these species becoming weed species. Where necessary, introduce control measures to prevent their spread to other areas.

12. Locate and map all Marram Grass (*Ammophila arenaria*) areas.

13. Harvest selected areas of Marram Grass for rehabilitation work in the Park. Plant additional areas of Marram Grass for subsequent harvesting and use. Where appropriate, complement harvesting with plantings of native grasses and shrubs to facilitate development of the next seral stage.

14. Allow harvesting of Marram Grass for rehabilitation purposes outside the Park.

15. Allow areas where sludge or gypsum is re-exposed (as a result of storm events or progressive erosion of berms and frontal dunes) to dissipate naturally, provided they pose no threat to public safety or conservation values.

16. Regularly review public and management access. Where costs are prohibitive to maintain access or costs are prohibitive to rehabilitate areas subject to environmental degradation from such access, that access should be re-routed or terminated.

17. Rehabilitate all areas where infrastructure has been removed.

18. Rehabilitate roads and tracks constructed in response to emergency events (for example, wildfire suppression).

19. Provide interpretive information on:

v) the natural dynamics of erosion and stabilisation;

vi) the role rehabilitation has had, and will continue to have, in managing the Park;

vii) the history of effluent disposal and rehabilitation; and

viii) the Park's environmental values, with particular reference to the damage that can be caused by unregulated recreational use.

MANAGEMENT FOR CONSERVATION: THE CULTURAL RESOURCES

17. ABORIGINAL SITES

The objectives are to:

- **Protect Aboriginal sites within the Park.**
- **Encourage an understanding, awareness and appreciation of Aboriginal culture.**

In March 1998 Aboriginal bones, 100 years old, were accidentally discovered at the northern end of Leschenault Peninsula, during earthworks associated with the construction of the new pipeline (see Section 28). The site where they were uncovered contained fill as well as undisturbed soil, and it is not certain whether or not the bones might have been deposited there in the fill. However, the fill is likely to have come from elsewhere on the Peninsula, rather than further afield. The find therefore suggests that Aborigines inhabited the Peninsula. (The bones have since been reburied, at the request of the local Aboriginal people.)

Otherwise little is known of Aboriginal use of the Peninsula, as neither archaeological nor ethnographic surveys have been undertaken. There are, however, historical accounts of Aboriginal occupation of the Bunbury and Leschenault Inlet and Estuary area when Europeans first arrived.

The letters and journal of Lieutenant Henry William Bunbury, after whom Bunbury is named, refer to large numbers of Aboriginal people on the estuary banks:

> *"...The numerous and well beaten paths near the bank of the estuary indicated the constant presence of considerable numbers. Indeed, nowhere had I hitherto seen, even on the Murray [River], where the natives are numerous, such distinct paths as here or so many deserted huts..."* ("Early Days in Western Australia, being the Letters and Journal of Lieut. H.W. Bunbury, 21st Fusiliers", as cited by Wood 1990).

Lieutenant Bunbury's letters and journal also referred to Aboriginal use of the estuary for fishing (Wood 1990). Similarly, Crawford (1986) noted that historical evidence indicates Aboriginal people used the estuary for fishing. The number of Aboriginal people in the area prior to 1830 is not clear. F. Robert Austin, former assistant surveyor in Western Australia and present in the Koombana Bay area in the early 1840s, believed there were never more than 20 Aboriginal groups between Koombana Bay and the Murray River (Wood 1990). Crawford (1986), however, noted there is historical evidence that Bunbury was a popular gathering place in the 1830s.

The use of the Park by Aborigines was possibly restricted to within the last 5,000 to 7,000 years, after the Peninsula collided with the mainland (see Section 7).

Issues

Aboriginal sites and objects in Western Australia, including those within the Park, are protected by the *Aboriginal Heritage Act 1972*, which is administered by the Department of Aboriginal Affairs.

Although no Aboriginal sites are recorded within the Park, it is possible that they do exist. The detection of any such sites, however, will be made difficult as a result of:

ix) the dynamic nature of the Peninsula's natural environment, in particular vegetated areas being inundated by mobile sand dunes; and

x) the specialist skills required to identify Aboriginal sites.

STRATEGIES

1. **Report all information obtained on Aboriginal sites within the Park to the Department of Aboriginal Affairs.**
2. **Assess the effects, both existing and potential, of all proposed operations and developments on known Aboriginal sites.**
3. **Establish contact and consult with local Aboriginal groups on issues pertinent to managing Aboriginal sites.**
4. **Train Park operational staff in recognition of Aboriginal sites.**
5. **Protect identified Aboriginal sites in the Park, in consultation with**

the local Aboriginal community and the Department of Aboriginal Affairs, and assess their suitability for interpretation.

6. Interpret suitable Aboriginal sites.

18. COLONIAL HISTORY

The objectives are to:

iv) **Identify former land uses and activities and determine their historical significance.**

v) **Protect historic sites.**

vi) **Encourage greater understanding and appreciation of the Park's cultural history.**

Early Settlement

Nicolas-Thomas Baudin, Commander of the French exploration ship, the "Geographe", is recorded as the first European to make a landfall in Koombana Bay (Bunbury). Baudin arrived on 11 March 1803 (Wood 1990) and named Leschenault Inlet after Jean Baptiste Louis Claude Theodore Leschenault, the botanist on board the "Geographe".

The first European settlers to the area were the Scott family. In late 1837 the Scotts settled on land adjoining Lieutenant-Governor Stirling's grant on the Preston River.

In February, 1838, Thomas Little arrived at Fremantle. Little had journeyed from Calcutta and arrived to establish an estate for Charles Robert Prinsep. The estate was to be managed to raise horses for the British Army in India. Little bought 741.4 ha on Leschenault Peninsula and named the homestead "Belvidere"[1] in honour of the Prinsep mansion in Calcutta (Staples 1977, as cited by Wood 1990).

Little developed the estate as a horse and cattle venture. There were two cattle herds, one of which was Bengali cattle or water-buffalo. The water-buffalo were kept at the Bengal Station, at the northern end of the property and were used for ploughing and as beasts of burden. The dwelling on Bengal Station was named Buffalo Homestead (Wood 1990). Buffalo Homestead was later rented to an English settler named Jackson. Evidence of this homestead still exists. It is located on private property about 50m north of the northern boundary of the Park, and is known colloquially as "Buffalo Hut".

The success of the horse export trade based at Belvidere is unclear. Thomas Hayward's diary (1910; as cited by Wood 1990) noted that in the 1870s horses were sent to India *"all of which were sold to the Government for a good price"* and *"several lots were taken to Singapore and Mauritius ... but this trade was abandoned eventually as it was not very remunerative"*.

Henry Charles Prinsep (son of Charles Robert Prinsep, see below) was later to record:

> *"Of course, my main occupation was breeding horses for the Indian market, though I had to farm a good deal of land to support the employees, and also did a good deal of dairying"* (Prinsep 1918; as cited by Wood 1990).

Kimberly (1898; as cited by Wood 1990) recorded that Prinsep's *"exportation of horses was proving a large source of revenue, and shipments were sent to India almost every year"*. However, *"in time the market appeared not to be there for Belvidere horses and the venture died"* (Wood 1990).

Little left Prinsep's Estate in 1854 and the estate was then managed by William Owen Mitchell until 1860. From 1861 to 1869 William Bedford Mitchell (not related to William Owen Mitchell) managed Prinsep's estate. The estate duties over this period included continuing the horse trade and export of jarrah railway sleepers to India.

Henry Charles Prinsep (C.R. Prinsep's son) managed the estate from 1869 until about 1878 when it was sold to William Henry Venn of Dardanup.

Agricultural Use

At the time when William Henry Venn bought Belvidere he also purchased the properties of Thomas Little.

The Venns chose to reside at Little's former residence at Dardanup Park. Belvidere was used by the Venns for grazing and managed for seasonal rotation of stock between Dardanup and the coast. The Belvidere homestead was used as a base for stockwork and as a summer holiday retreat (Fletcher unpublished).

Belvidere, along with Henry William Venn's Dardanup properties, was passed on to his son Frank Evans Venn. Frank Venn managed

[1] Research into the derivation of the name Belvidere has indicated that the correct spelling is Belvidere, not Belvedere (Johansen personal communication). Therefore, "Belvidere" has been used throughout this Plan.

Belvidere in much the same manner as his father had, with seasonal grazing and as a summer retreat (Fletcher unpublished).

The original Belvidere homestead is believed to have burnt down prior to 1900. The homestead subsequently built for the Venns was also destroyed by fire. The exact year is unclear, but is thought to be about 1936. The jetty built by Frank Venn was destroyed by the same fire (Fletcher unpublished). Remains of the jetty are still present.

It is unclear when the Date Palms and Fig trees, still prominent at Belvidere, were planted and by whom. Similarly, reports of the existence of graves of the Indian labourers employed by Thomas Little are unsubstantiated.

In November 1920 the Venns sold Belvidere Estate to Lewis McDaniel, a farmer from Dardanup. McDaniel used Belvidere as an extension of his Dardanup properties, and, like his neighbours on the Peninsula (the Garvey and the Harris families) seasonally grazed stock (Fletcher unpublished). Ownership of Belvidere was later transferred (April 1954) to a D.M. McDaniel (Fletcher unpublished). Presumably Lewis McDaniel and D.M. McDaniel were related and the property managed for grazing.

In March 1967 Belvidere was bought by Albert Thomas Bastow and, in November of the same year, by Wallace (Wally) Greenham and Shirley Rodda. They were the last private owners of Belvidere. The history of Belvidere's use throughout the period of their ownership is briefly described below (Belvidere: the alternative lifestyle era).

Throughout the period between the 1886 and the mid 1960s, the area south of Belvidere was owned by the Harris family.

Thomas Harris, born in Northampton, England, about 1836, arrived at the Swan River Colony on June 1, 1858. He was one of some nine and a half thousand convicts transported to Western Australia between 1850 and 1868.

Harris was sent to Wellington District to work as a labourer, but by 1860 had been granted a "ticket of leave". By 1871 Thomas Harris had bought 300 acres in the Ommaney Road area (now the Southwest Highway), near Benger. He was known to be strongly opposed to the discrimination displayed by employers who were unwilling to employ former convicts.

Thomas Harris's son, Thomas William (Bill) Harris, bought the southern section of Leschenault Peninsula in 1886. Throughout the period of his ownership, and later (in 1929) when the property was passed on to his sons, the southern end of the Peninsula was used for stock grazing. The Harrises also grazed their coastal properties as alternative pasture to the wetter lands at Waterloo and Dardanup (Fletcher unpublished).

In 1965 the Harris property was bought to facilitate the disposal of acid effluent from Laporte's titanium dioxide plant (now Millennium Inorganic Chemicals Ltd's finishing plant) at Australind (see Section 16).

Belvidere: The Alternative Lifestyle Era

For a large period of its ownership by Wallace Greenham and Shirley Rodda, Belvidere was used as a site to foster alternative lifestyles. A small commune developed and by the late 1970s the number of members had grown sufficiently to warrant employment of a teacher. At its peak occupancy the commune comprised fourteen houses.

A series of paintings exists depicting the houses built on the commune. The series was painted by a local artist and is now held in a private collection.

With increasing demand for suitable effluent-disposal sites, the Western Australian Government indicated its wish to buy Belvidere. The commune occupants subsequently moved from the area. In 1984 the Government negotiated to purchase the land to facilitate effluent disposal.

The history of the alternative lifestyle era has recently been documented by Fletcher (unpublished).

Evidence of the former land uses of the Peninsula, and Belvidere in particular, are still present. Much of this evidence may be of educational and interpretive value.

John Boyle O'Reilly

John Boyle O'Reilly, born on 28 June 1844, was one of the 62 Irish political prisoners among the 279 convicts who arrived at Fremantle on 9 January 1868.

O'Reilly was a member of the Irish Republican Brotherhood, known as the Fenian Movement - *"an organization dedicated to the ideal of an independent Irish Republic"* (Waters 1976). He had been tried and sentenced to death on 9 July 1866 for his involvement in converting English soldiers to Fenianism.

In the same year as his arrival in Fremantle, O'Reilly was transferred to Bunbury to work as a member of a road crew. O'Reilly's success in preventing the clearing of *"a particularly fine specimen of a jarrah tree standing right in the middle of the surveyed path of the roadway"* (Waters 1976) is well documented.

The road crew was strictly disciplined, but not closely guarded, as it was believed that there was nowhere for prisoners to escape to. However, during O'Reilly's time with the road crew there were 25 escapes, of which O'Reilly was the 25th. All escapees prior to O'Reilly were recaptured (Waters 1976).

As part of a well prepared and assisted escape plan, O'Reilly made his way to Leschenault Peninsula from where he had planned to row out to sea and board an American whaling ship. O'Reilly made several unsuccessful attempts to board the *"Vigilant"*. Throughout this period he sheltered, with the assistance of the Jackson family, in the dense peppermint woodland in the vicinity of Buffalo Homestead (Buffalo Hut). He made his escape by boarding the American whaler, the *"Gazelle"*, on 3 March 1869 and he eventually settled in Boston, USA.

In America, O'Reilly established himself as a humanitarian, writer, poet and orator. O'Reilly arranged for the purchase and fitting out of the *"Catalpa"*, which, on 17 April 1876 was involved in the rescue of six of the 10 remaining Fenians held in Fremantle Prison (Waters 1976).

O'Reilly died in Boston on 10 August 1890. Some of his writings are available through specialist commercial outlets. Some of these publications may be of historical significance and of value for educational and interpretive purposes. A monument erected to the memory of John Boyle O'Reilly stands at the northern entry to Leschenault Peninsula, within 200 m of the site of the Jackson family's hut.

The Cut

Prior to dredging and construction of "The Cut", the natural outflow from Leschenault Estuary (fed by the Collie and Preston Rivers) entered the ocean at Point McLeod, Koombana Bay.

Seasonal flooding of the Collie and Preston Rivers resulted in deposition of fine silts where the estuary entered the ocean. The accumulation of these silt deposits contributed to harbour siltation and in 1934-36 a groyne (the "North Shore Groyne") was constructed to trap littoral drift entering the harbour from the north. Access for construction of this groyne was by rail across a rail bridge spanning the estuary at Point McLeod.

In 1949 the rail bridge was upgraded and the railway line extended northward, from the North Shore Groyne to the site of the northern groyne of The Cut. The Cut's northern groyne was constructed in 1950-51, before The Cut was excavated.

While the northern groyne of The Cut was under construction the North Shore Groyne was extended. During construction and extension of these groynes the cutter suction dredge "Stirling" entered Leschenault Estuary at Point McLeod and proceeded to dredge its way through shallow areas of the estuary to the site of The Cut. This enabled the dredge to work from the estuary side in calm waters when excavating The Cut.

Dredging and excavation work on The Cut commenced on 3 April 1950 and breakthrough to the sea was made one year later, on 12 April 1951.

In 1971 a groyne and rock revetment were constructed on the southern bank of The Cut to protect the bank from erosion. This groyne was extended by 150 m in 1972.

In 1983 The Cut's northern revetment was constructed. To enable this construction a temporary road of limestone rubble was constructed along the southern 2.5 km of beach on the Peninsula. The construction material for the North Shore Groyne and the groynes and revetments at The Cut was granite from Roelands Quarry (Brown 1990).

Issues

Leschenault Peninsula is of historical significance through the associations with Prinseps' Estate and John Boyle O'Reilly. Interpretation of this history and significance can enhance Park visitors' awareness, appreciation and understanding of the Park.

There is physical evidence of some of the former land uses of the Park. Much of this evidence may be of interpretive value.

Some of the physical evidence, for example, discarded materials and remains of disused buildings, may present a hazard to public safety, particularly in the Belvidere area.

The excavated and exposed freshwater points may be of historical value (see Section 8).

STRATEGIES

Many of the specific strategies related to managing historic sites depend on an interpretation plan (see Section 26). Subject to that plan's preparation the following general and specific strategies are proposed:

1. **Preserve the Park's cultural values provided such measures do not conflict with conservation of the Park's natural values.**

2. **Review and document existing information on the history and use of the Park.**

3. **Assess and document the historical significance of past land use and evidence of that land use, and investigate ways of protecting features and artefacts of value.**

4. **Interpret the historical significance of former land uses and evidence of those uses.**

5. **Display, at suitable locations (for example, CALM regional and district offices), documents and items of historical value .**

6. **Consider displaying, acquiring or buying:**
   - **historical accounts;**
   - **writings and works of John Boyle O'Reilly; and**
   - **paintings and artefacts relevant to the Park.**

7. **Develop interpretive walks at Belvidere and in the vicinity of the existing monument to John Boyle O'Reilly.**

8. **Remove all materials that have not been deemed to be of historical significance and are:**
   - **(i) a hazard to public safety; or**
   - **(ii) otherwise detrimental to the management of the Park.**

MANAGEMENT FOR VISITOR USE

19. GENERAL RECREATION PHILOSOPHY

Recreation management within the Park is based on the concept of the Recreation Opportunity Spectrum (Clark and Stankey 1979), and adopts the following principles as outlined in the Department's Recreation Tourism and Visitor Services Policy (CALM 1991):

i) Development work carried out to facilitate public access and recreational use shall be in accordance with this plan. All development work will be such that the existing biota will be able to sustain the type and intensity of recreation which is occurring or proposed.

ii) Recreational activities consistent with purpose of vesting will be permitted.

iii) The widest range of activities consistent with the purpose of vesting will be allowed. However, existing recreational opportunities outside the Park will be identified and duplication of these opportunities will be avoided or minimised. Uses and activities which impair other forms of use or jeopardise the safety of other users will be controlled or prohibited.

iv) Activities permitted or facilities developed will be those that the Department can adequately supervise and maintain. Where this cannot be achieved the activities and facilities will be restricted, relocated or eliminated.

Previous planning studies identified the possibility of cabin and hostel accommodation at Belvidere and the former effluent pipeline terminus, and chalet accommodation at The Cut Picnic and Camping Area. Therefore, subject to successful rehabilitation, plant establishment and detailed site design and planning, these areas may be appropriate for camping. However, given:

i) the above [(i)-(iv)];

ii) the Department's policy on commercial concessions, leases for associations and clubs, and overnight stays (CALM 1991; see also Section 27); and

iii) the defined limits to development as outlined in Table 1 (Section 5),

these previously proposed developments may be appropriate in the future, but may be premature in this ten year plan. Conditions under which these developments may be considered are further discussed in Section 27 (Commercial Concessions).

Previous planning proposals for the Park also identified three former effluent disposal areas as future camping areas, shown in Figure 3 (CALM, 1995). Development of these sites is probably outside the term of this plan. However, rehabilitation prescriptions for these areas have included provision for camping. Therefore, subject to successful rehabilitation, plant establishment and detailed site design and planning, these areas may be available for camping in the future.

Issues

Opportunities exist to provide a wide range of appropriate recreation facilities within the Park, consistent with meeting the primary conservation management objectives.

Since the Conservation Park extends to low-water mark, CALM is responsible for managing the foreshore of Leschenault Estuary within the Park. However, the eastern foreshore of Leschenault Peninsula is also included in the area of LIMA's responsibility (see Purpose, Vesting and Tenure). Any proposal for development on the Estuary foreshore should be referred to LIMA for its consideration and comments on potential effects on the vegetation fringing the Estuary, the stability of the Estuary bank or increases in nutrient import to the Estuary.

STRATEGIES

1. **Undertake recreation management and development in accordance with the general recreation philosophy.**

2. **Refer to LIMA for consideration and comment any proposal for development on the Estuary foreshore.**

20. RECREATIONAL SITES AND FACILITIES

The objectives are to:

- **Provide recreational opportunities and facilities that are consistent with the Conservation Park's management.**
- **Provide a range of recreation facilities and opportunities that will encourage and enhance appreciation of the Park's values.**

Until recently, minimal recreation facilities were provided at Leschenault Peninsula and recreational use was concentrated on the ocean foreshore, primarily at Buffalo Beach. The minimal provision of facilities and limited use was a reflection of the Peninsula's former land use and restrictions on public access.

Recreational development has commenced at several locations within the Park. Much of the landscape restoration and plant establishment necessary for recreational development was undertaken as part of the effluent disposal decommissioning and rehabilitation program. This program recognised the change in land use and the proposed change in land tenure. By proceeding with recreation development when effluent disposal decommissioning and rehabilitation was undertaken, recreation design requirements were able to be accommodated.

The design, development and upgrading of facilities was undertaken in consultation with the LPCAC.

Sites have been designed and developed at 6 nodes. All nodes are within the recreation zone and all are in accordance with the zoning outlined in Section 5.

Development for recreation will occur in stages, to match demand and the resources to manage the area.

Issues

The recreational use patterns of Leschenault Peninsula are evolving rapidly as the effects of land use changes are realised. Since 1987 there has been regular and increasing use of the Peninsula. The dominant activity is fishing (by recreational and professional fishers). A wide range of other recreational uses are now emerging ¾ some of which are creating conflict with management objectives; for example, use of 4WD vehicles in areas sensitive to disturbance, use of off-road recreation vehicles, and unregulated camping.

A visitor survey some years ago (Rosier and de Tores 1992) at the ocean beach at the northern end of the Park revealed that:

i) The number of two-wheel drive (2WD) and four-wheel drive (4WD) vehicles entering the Park was nearly equal (53 per cent 2WD, 47 per cent 4WD).

ii) Eighty per cent of all returned visitor survey questionnaires were in favour of a restriction on 4WD use of the beach.

iii) Eighty-four per cent of 4WD beach use was within the northern 2.5 km of beach.

iv) Conflicting views exist between recreationists, particularly about development thought to be appropriate for the Park.

v) Some recreational demands such as providing more day-use facilities and more beach access points, that are consistent with management objectives for conservation parks are currently not provided in the Park.

vi) An increased management presence is required to deal with overuse and inappropriate use of existing facilities.

vii) Information and interpretive facilities are inadequate.

The survey predates the opening of access for conventional vehicles to Belvidere Beach, and does not reflect the bulk of public comment on the draft of this plan. It would be of interest to carry out a further visitor survey to assess the public's current views.

Vandalism is occurring at campsites, and the destructive behaviour (mainly at night) of some is spoiling the experience for others.

STRATEGIES

1. Monitor use of the Park to:

- **detect and assess patterns of use;**
- **ensure adequate appropriate facilities are provided; and**
- **measure any environmental degradation.**

2. Subject to the interpretation plan (see Section 26), provide interpretive information on:

- **the Park's recreation opportunities and facilities;**
- **natural hazards; and**
- **the history of the Park (specifically the historical link between the northern end of the Park and John Boyle O'Reilly — see Section 18).**

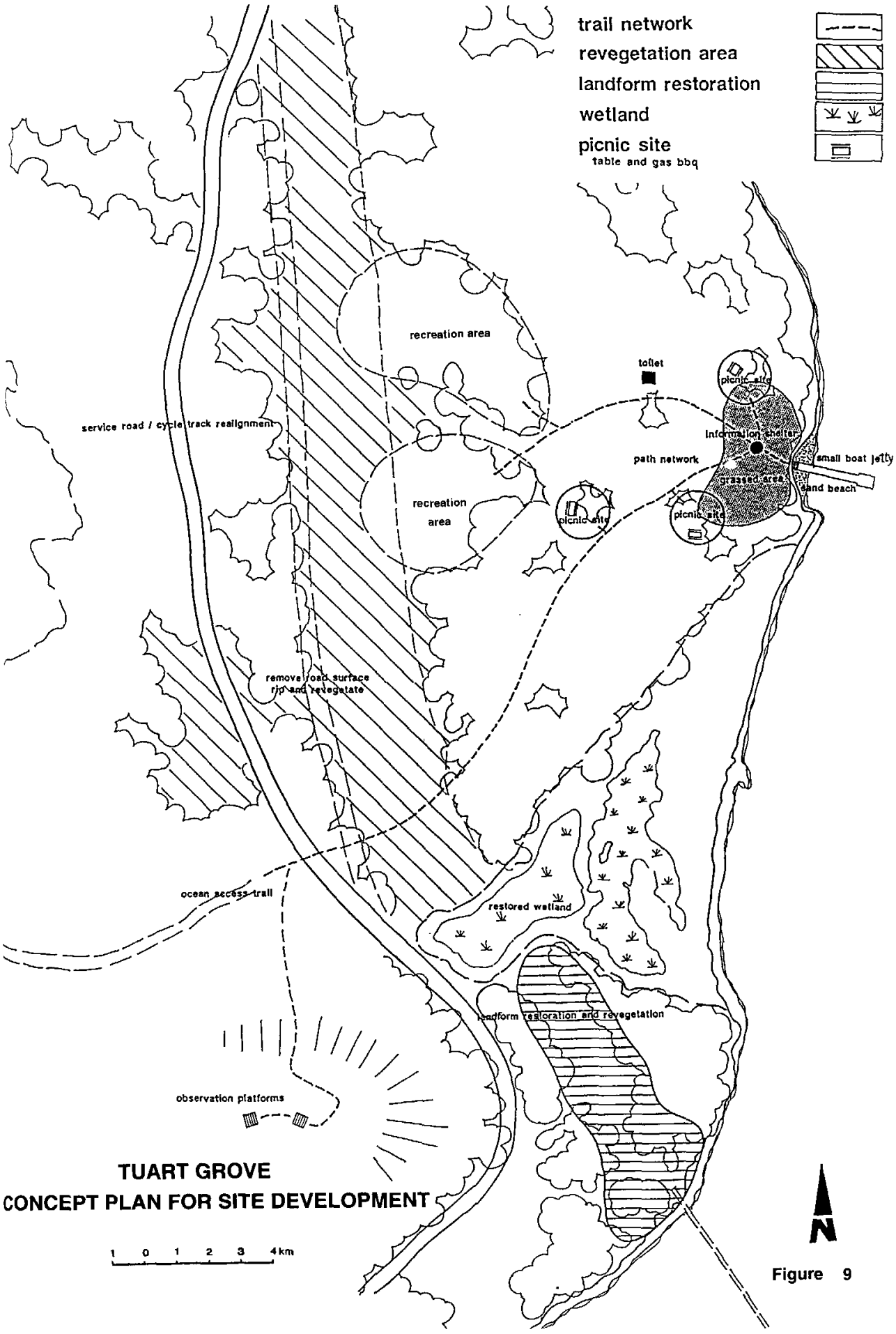

trail network
revegetation area
landform restoration
wetland
picnic site
table and gas bbq
recreation area
toilet
picnic site
service road / cycle track realignment
information shelter
path network
small boat jetty
grassed area
sand beach
recreation area
picnic site
picnic site
remove road surface
rip and revegetate
ocean access trail
restored wetland
landform restoration and revegetation
observation platforms
TUART GROVE
CONCEPT PLAN FOR SITE DEVELOPMENT
1 0 1 2 3 4km
N

Figure 9

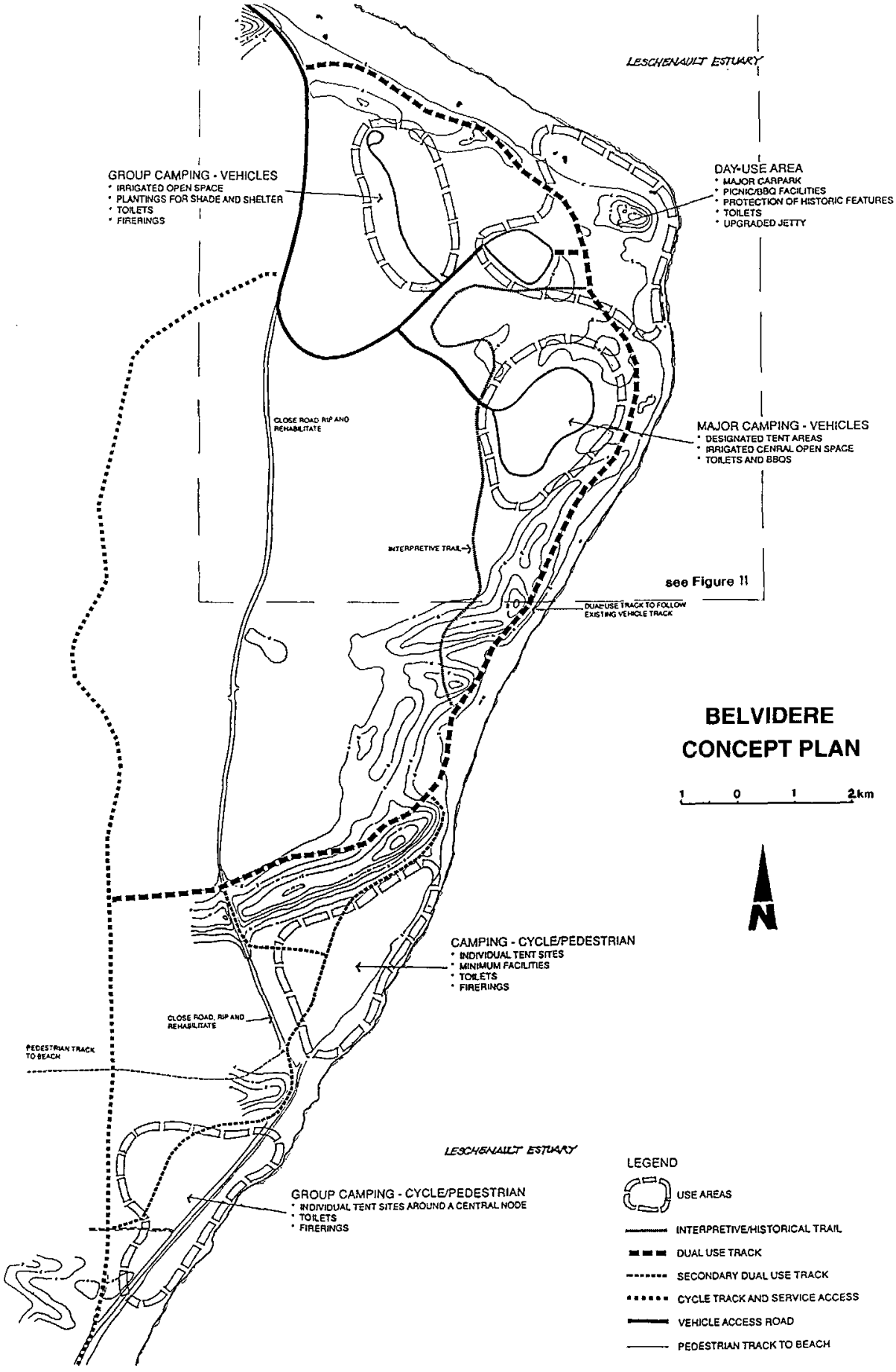

LESCHENAULT ESTUARY
GROUP CAMPING - VEHICLES
* IRRIGATED OPEN SPACE
* PLANTINGS FOR SHADE AND SHELTER
* TOILETS
* FIRERINGS
DAY-USE AREA
* MAJOR CARPARK
* PICNIC/BBQ FACILITIES
* PROTECTION OF HISTORIC FEATURES
* TOILETS
* UPGRADED JETTY
CLOSE ROAD RIP AND REHABILITATE
MAJOR CAMPING - VEHICLES
* DESIGNATED TENT AREAS
* IRRIGATED CENRAL OPEN SPACE
* TOILETS AND BBQS
INTERPRETIVE TRAIL
see Figure 11
DUAL USE TRACK TO FOLLOW EXISTING VEHICLE TRACK
BELVIDERE
CONCEPT PLAN
1 0 1 2km
N
CAMPING - CYCLE/PEDESTRIAN
* INDIVIDUAL TENT SITES
* MINIMUM FACILITIES
* TOILETS
* FIRERINGS
CLOSE ROAD, RIP AND REHABILITATE
PEDESTRIAN TRACK TO BEACH
LESCHENAULT ESTUARY
GROUP CAMPING - CYCLE/PEDESTRIAN
* INDIVIDUAL TENT SITES AROUND A CENTRAL NODE
* TOILETS
* FIRERINGS
LEGEND
USE AREAS
INTERPRETIVE/HISTORICAL TRAIL
DUAL USE TRACK
SECONDARY DUAL USE TRACK
CYCLE TRACK AND SERVICE ACCESS
VEHICLE ACCESS ROAD
PEDESTRIAN TRACK TO BEACH

Figure 10

BELVIDERE

CONCEPT PLAN FOR SITE DEVELOPMENT

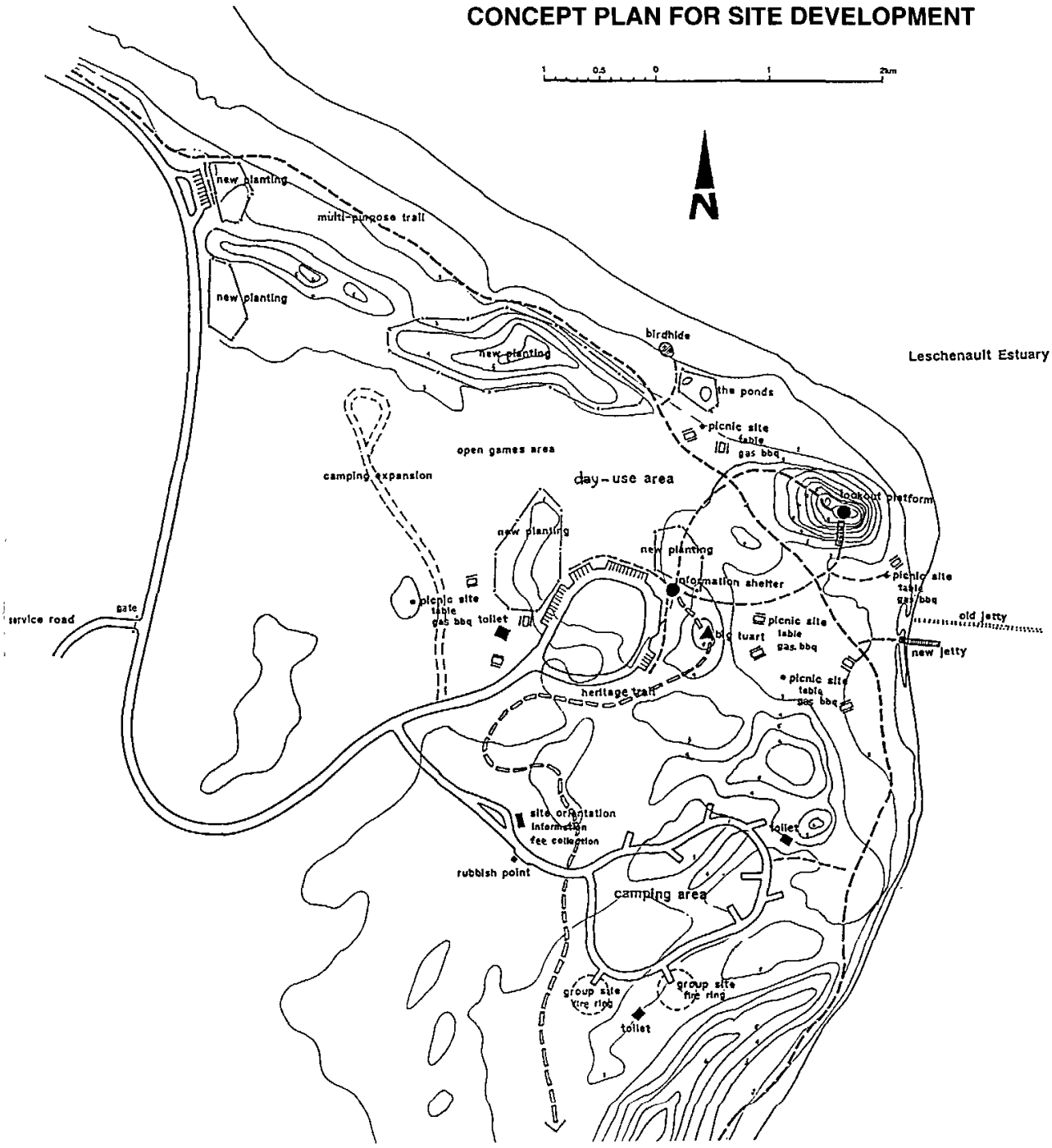
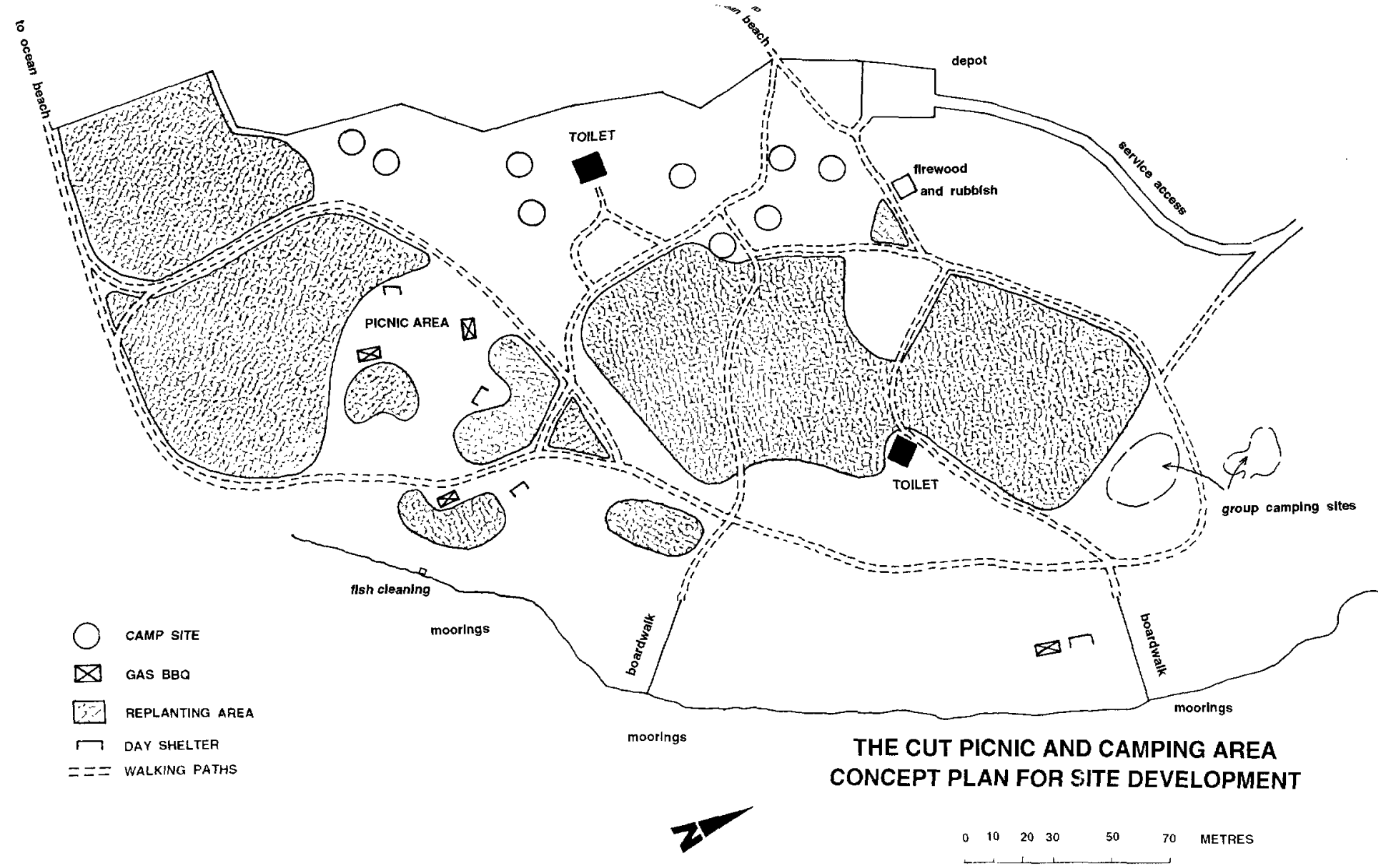


Figure 11



THE CUT PICNIC AND CAMPING AREA
CONCEPT PLAN FOR SITE DEVELOPMENT

Figure 12

3. **Take measures to curb vandalism, such as providing an increased management presence.**

21. DAY USE AND BUSH WALKS

The objective is to provide day-use and bushwalking facilities appropriate to the environmental setting of the Park that will encourage and enhance understanding of its values.

Facilities exist at the Park entry, Buffalo Beach, Belvidere Beach and Tuart Grove. All existing and new day-use areas will incorporate interpretive bush walks where possible. The site plan for Tuart Grove is shown in Figure 9.

STRATEGIES

1. **Provide rubbish bins at camping areas only. Day visitors will be required to remove their own rubbish from the Park.**

2. **Identify, throughout the Park, opportunities for bushwalking, and incorporate interpretive walks into site-development plans where practicable. The degree of development for each bushwalking path should be in accordance with the criteria outlined in Table 1 (Section 5).**

3. **Review site-development plans and specifications for the following recreation sites for day visitors, in the light of their current use:**
   - **the Park entry;**
   - **Buffalo Beach;**
   - **Belvidere Beach carpark; and**
   - **Tuart Grove.**

22. CAMPING, CAMPFIRES AND GROUP ACTIVITIES

The objective is to provide low-impact camping facilities and facilities suitable for group activities at designated sites in the appropriate environmental setting.

Facilities have recently been developed at The Cut, where work began in 1989. The Cut camping and picnic area was opened in January 1991. It is accessible by boat or bicycle. It currently has 11 sites available for use and a further 19 proposed. Firewood is supplied at designated fire places only and fires are permitted with seasonal restrictions.

Camping facilities have recently been opened at Belvidere (the only other site where they are proposed). Ten sites are available, with two being suitable for small groups. The campsite is accessible by car.

Group activities and competitive events will be permitted with prior approval required where the group is 15 or more people. Competitive events will be permitted if they are orientated to appreciation and understanding of the natural environment and if the impact from the event is considered to be minimal.

STRATEGIES

1. **Complete development of camping sites at:**
   - **The Cut Picnic and Camping Area; and**
   - **Belvidere.**
2. **Permit camping at the designated campsites at The Cut Picnic and Camping Area and Belvidere only.**
3. **Collect camping fees. Determine fees in accordance with CALM's policy on fees and charges.**
4. **Permit fires only at designated fire places. Supply firewood for designated fireplaces from sources outside the Park and from timber available as a result of management activities (for example, debris from road construction, roadside clearing for public safety purposes). Do not cut or collect firewood from within the Park specifically to supply recreation sites.**
5. **Permit group activities under the following conditions:**

   General

   Activities involving groups of 15 or more people will require written approval from CALM prior to the activity commencing.

   Camping

Groups of 15 or more people will be required to book in advance. A maximum of two group bookings will be permitted at The Cut Picnic and Camping Area at any one time.

Competitive activities

Permit recognised competitive activities only where they enhance understanding and appreciation of the natural environment (see also Section 26).

To minimise conflict with other Park users, prior written approval from the Department will be required for all competitive activities.

Permit Orienteering, Rogaining and Cross-Country Running where the potential either for conflict with other recreational uses or for an unacceptable effect on the environment can be avoided or minimised.

23. PUBLIC ACCESS

The objectives are to:

- **Provide safe public access to the Park's features and recreation sites without jeopardising its value.**
- **Minimise conflict between users.**

Recreational use of the estate managed by CALM is largely determined by the access available. The majority of visitors rely on some form of vehicle transport; for example, conventional 2WD vehicles, 4WD vehicles, vans, buses, trucks, motorcycles, bicycles and motorised or unmotorised boats.

Unregulated use of any of these forms of transport can degrade the natural environment and lead to conflict between recreational user groups.

The existing public access to the Park is shown in Figure 13.

Buffalo Road, at the northern end of the Park, provides the only vehicle access. Until the late 1970's it was a limestone track subject to regular winter flooding. In the late 1970's the Public Works Department (PWD) upgraded the road to provide all-weather access and prevent saltwater inundation of the agricultural properties to the north. Prior to this upgrading, vehicle access to the Peninsula was physically difficult. Access to the beach (the most heavily used area) was by foot, 4-wheel drive (4WD) vehicle or by boat.

Issues

Different parts of the Park are capable of sustaining different intensities of use and access (Oma 1989).

Because of the dynamic nature of the natural erosion-stabilisation cycle there will always be areas highly susceptible to erosion, areas rehabilitating under the natural regime, and areas subject to rehabilitation work. Consequently much of the Park will be unsuited to, and incapable of, sustaining public access in any form. Moreover, some areas of previous effluent ponds that have been allowed to dry out and then be covered by dunes may not be stable enough to withstand access by vehicles.

The road network within the Park originally provided restricted access to effluent disposal and rehabilitation areas. It was not designed to cater for public use and, in some sections, including some now proposed for public use, it is narrow, has sharp corners and is unsafe.

The upgrading of Buffalo Road and an increase in local awareness of the recreation opportunities available has resulted in a significant increase in recreational use of the Park. This use has increased maintenance requirements, particularly for Buffalo Road.

The 1991 visitor survey identified the poor condition of Buffalo Road as the most frequently listed "least liked feature" of the Park.

Harvey Shire Council has carried out maintenance for the section of Buffalo Road outside the Park and CALM has carried out maintenance within the Park. Currently an informal agreement exists between the Shire and CALM. However, there is no clear distinction of responsibilities nor co-ordination of maintenance. The road is a high maintenance road, and will remain so unless it is sealed. The cost and maintenance of public facilities and access to Buffalo Beach will be a matter for negotiation between CALM and Harvey Shire Council.

Much of the Park's recreational activity is currently creating, or has the potential to create, environmental damage. Use of unregistered off-road vehicles, use of 4WD vehicles on sensitive foredunes, and unregulated camping are examples.

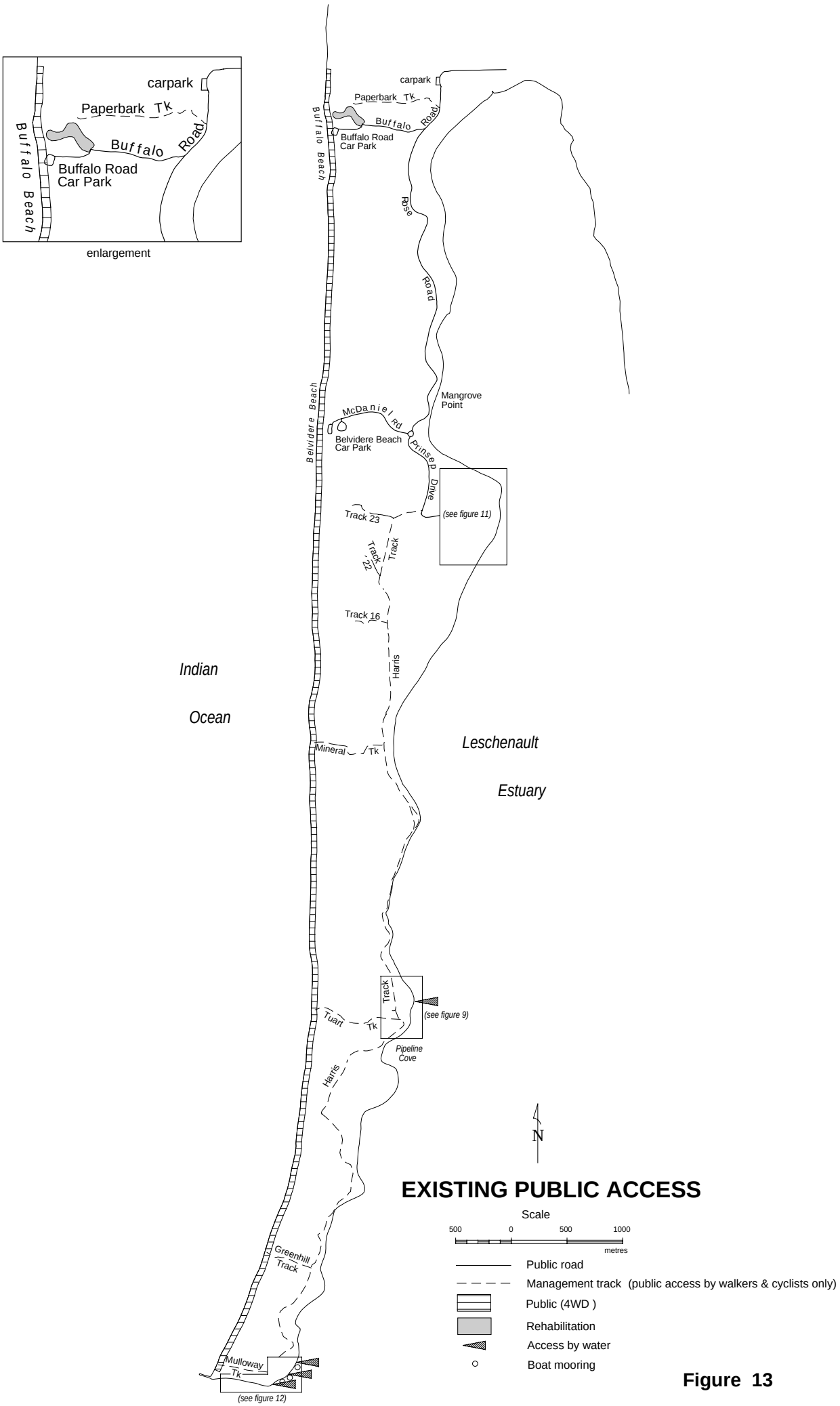

carpark
Paperbark Tk
Buffalo Road
Buffalo Road Car Park
Buffalo Beach
enlargement
carpark
Paperbark Tk
Buffalo Road
Buffalo Road Car Park
Buffalo Beach
Rose Road
Belvidere Beach
McDaniel Rd
Belvidere Beach Car Park
Mangrove Point
Prinsep Drive
(see figure 11)
Track 23
Track 22
Track
Track 16
Harris
Indian Ocean
Mineral Tk
Leschenault Estuary
Track
(see figure 9)
Tuart Tk
Pipeline Cove
Harris
N
EXISTING PUBLIC ACCESS
Scale
500 0 500 1000
metres
Public road
Management track (public access by walkers & cyclists only)
Public (4WD)
Rehabilitation
Access by water
Boat mooring
Greenhill Track
Mulloway Tk
(see figure 12)

Figure 13

The term 'four-wheel drive' (4WD) is used to describe a vehicle capable of being driven in a four-wheel-drive mode and registered in accordance with the *Road Traffic Act 1974*. The term does not apply to unregistered vehicles or to vehicles registered in accordance with the *Control of Vehicles (Off-Road Areas) Act 1978*. By implementing various means to regulate use, 4WDs can be restricted to designated use areas, for example, the ocean foreshore. Provided 4WD access to the beach is via designated roads, and use is restricted to part of the beach, or restricted to particular times/seasons, conflict within and between recreationists can be reduced and environmental damage minimised.

Use of Off-road Recreation Vehicles (or ORVs), as defined by the Control of Vehicles (Off-Road Areas) Act, is more difficult to regulate and has the potential to cause extensive environmental damage, particularly to areas subject to rehabilitation work.

A number of organizations are keen to retain access to the beach along the western side of the Peninsula. CALM invited them to discuss this matter; as a result, a meeting was held on 11 September 1997 between CALM officers and representatives of the South-West Regional Recreational Fishing Advisory Committee and the South-West Licensed Fishermen's Association. It was agreed that, provided there is cooperation between the groups concerned and CALM, the protection of the fragile dune system and the minimizing of conflict between the users of the beach could probably be combined with allowing access to the beach along the western side of the Peninsula. That cooperation is proposed to take the form of the joint preparation of a 'Code of the Coast'. The code will include the following:

- the reporting to the CALM ranger of deleterious activities (e.g. vandalism, the driving of vehicles in the dunes);
- the participation of the organizations in the Friends of Leschenault Peninsula, once it is formed; and
- invitations to CALM to attend meetings of the Fishermen's Association.

Buffalo and Belvidere Beaches will be set aside for pedestrians only, with provision made for vehicles to bypass these spots.

Where public access is provided there will be no restrictions on fishing access.

Sandboarding down dune slopes is an activity that is increasing on the Peninsula. Dune vegetation is being damaged by the boards and by people walking up vegetated slopes to the dune-tops. This has the potential to accelerate the erosion of the dunes and to initiate new blowouts.

Increased boat-landing along the Estuary side of the Peninsula may increase the disturbance of estuarine sediments. This disturbance can have a detrimental effect on the estuarine ecosystem. The disturbance can be reduced by restricting boat access to unmotorised boats, as well as by not constructing any boat access. Similarly, the intertidal zone of the estuary/peninsula interface is sensitive to disturbance from collecting of worms for bait.

Provision of interpretive material relating to access can significantly decrease the environmental degradation caused by unregulated access. Much of this information can be provided by CALM either independently or in conjunction with other organisations. For example, CALM and LIMA could jointly provide information on use of motorised and unmotorised watercraft.

The diversity of purpose of road and track use has resulted in confusion over road and site names.

STRATEGIES

1. **Manage the public access network and adopt the site and road nomenclature as shown in Figure 14.**

2. **Carry out road re-alignment works from the Park entry to Belvidere Beach and if necessary install mechanisms to regulate vehicle speed.**

3. **Seek combined funding and an inter-agency agreement with the Shire of Harvey for sealing and maintaining Buffalo Road.**

4. **Regularly review public access use and requirements.**

5. **In providing access for vehicles, take account of the possible instability of areas that were previously effluent ponds.**

6. **Permit bicycle riding on public roads (see Figure 14), bicycle paths (Belvidere) and some management tracks south of Belvidere. Signpost all management roads and tracks to**

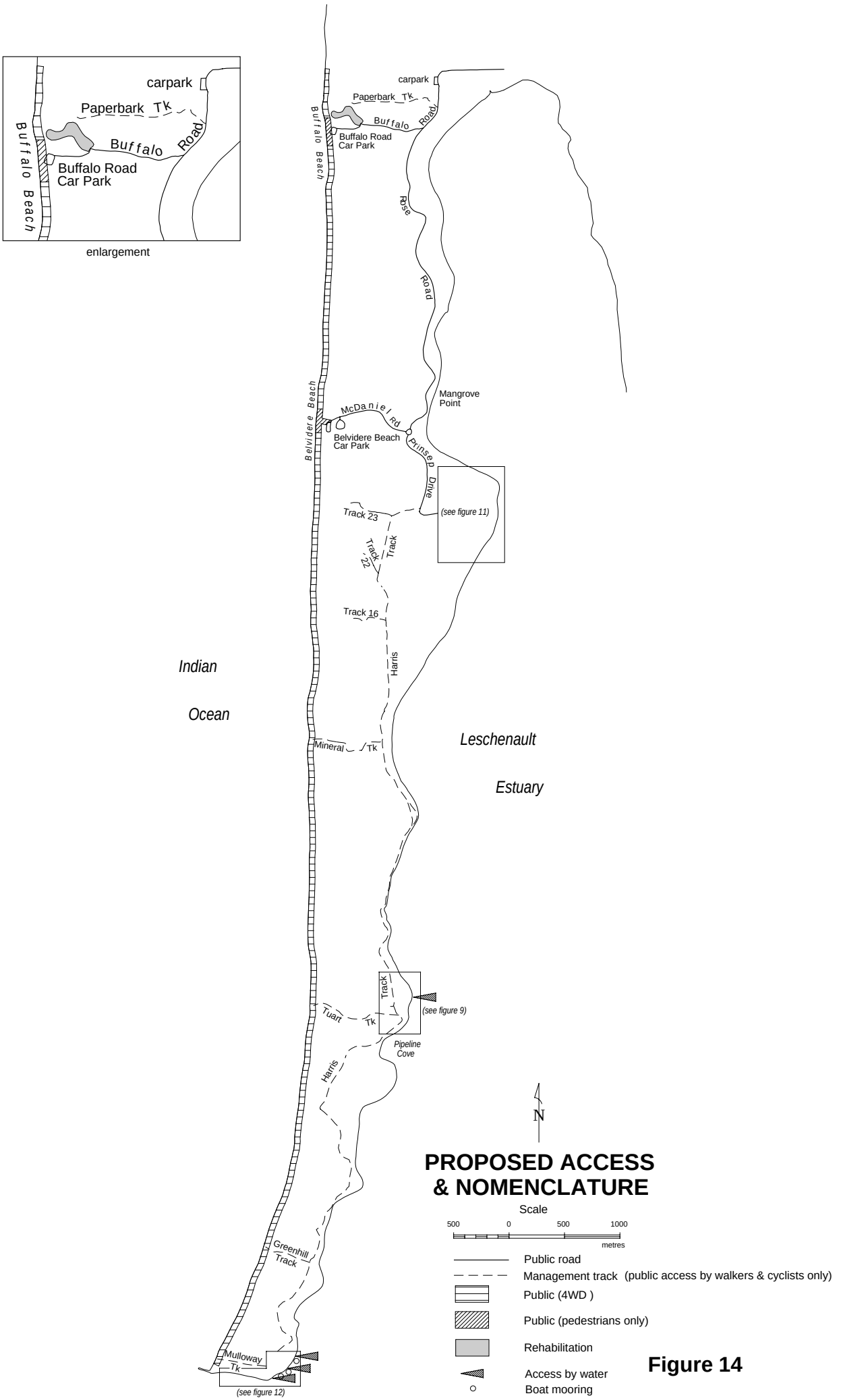

carpark
Paperbark Tk
Buffalo Road
Buffalo Road Car Park
Buffalo Beach
enlargement
carpark
Paperbark Tk
Buffalo Road
Buffalo Road Car Park
Buffalo Beach
Rose Road
Belvidere Beach
McDaniel Rd
Belvidere Beach Car Park
Mangrove Point
Prinsep Drive
(see figure 11)
Track 23
Track 22
Track
Track 16
Harris
Indian Ocean
Leschenault Estuary
Mineral Tk
Track
(see figure 9)
Tuart Tk
Pipeline Cove
Harris
N
PROPOSED ACCESS & NOMENCLATURE
Scale
500 0 500 1000
metres
Public road
Management track (public access by walkers & cyclists only)
Public (4WD)
Public (pedestrians only)
Rehabilitation
Access by water
Boat mooring
Greenhill Track
Mulloway Tk
(see figure 12)

Figure 14

indicate where bicycling is permitted.

7. **Permit 4WD vehicles on all public roads in the Park and on the beach (between low-water and high-water marks) within the Recreation Zone (see Figures 3 and 14). Prohibit 4WD and other motor vehicles elsewhere in the Park, including the foredunes.**

8. **Permit motorcycle riding on all public roads in the Park, provided they are registered in accordance with the Road Traffic Act. Permit trail bikes, registered in accordance with the Road Traffic Act, on all public roads in the Park and on the beach within the Recreation Zone where 4WDs are permitted (see Figures 3 and 14). Prohibit motorcycles and other motor vehicles not registered in accordance with the Road Traffic Act.**

9. **Prohibit sandboarding in the Park. If the demand persists, liaise with the groups concerned, with the aim of locating suitable areas and providing funds to manage the activity. If no area or funding arrangements suitable to both CALM and the groups can be found, sandboarding will remain prohibited.**

10. **Do not provide launching or landing sites at Belvidere for motorised watercraft.**

11. **Restrict professional fishers' 4WD beach access to the areas designated for public 4WD beach access.**

12. **Do not provide any access for the collection of worms for bait from the intertidal zone of the estuary/peninsula interface.**

13. **Declare the Park a "Prohibited Area" to ORVs, pursuant to Section 16 of the Control of Vehicles (Off-Road Areas) Act. Consistent with the Department's policy on ORVs, there may be instances where approval is given to use ORVs to enable a person(s) with a physical disability(ies) access to a particular event or activity.**

14. **Provide information and interpretive material on public access.**

24. DOMESTIC PETS AND HORSERIDING

The objective is to minimise the impact of domestic animals and horses.

Under some circumstances domestic pets, and in particular dogs, are permitted in national parks in Western Australia. Such situations exist under special conditions, generally as a result of pre-existing use, prior to creation of the particular park. These parks are usually large, and dogs are permitted on a leash in designated areas only, where visitor use and, therefore, the impact of dogs, can be monitored and regulated. This leaves most of the rest of these parks free of dogs. Leschenault Peninsula is relatively small, and allowing dogs into the Park can pose a threat to the Park's fauna. Allowing dogs within the Park could also impose restrictions on, and hence reduce the effectiveness of, the existing fox-baiting program. Even with a reduction in the area baited, if dogs are permitted within the Park, there will be a risk of poisoning them.

Dogs brought into the Park also create conflict between Park visitors. Visitors can have their recreational experience diminished by the presence of dogs and the fouling of areas by their excreta.

In Leschenault Conservation Park, dogs will be restricted to the beach area on the western side of the Park, and will be required to be on a leash.

Horseriding is permitted within designated areas of some national parks. Because of the relatively small size of Leschenault Peninsula and the limited capability of the soils to support recreational use (see Section 7), horseriding has the potential to compromise the Park's conservation values.

Issues

Domestic pets can affect native fauna directly through predation and indirectly by imposing restrictons on fox baiting programs. Domestic pets can also affect native fauna through other disturbances and as a result of introducing smell. The smell of domestic pets can impede native fauna activity (CALM 1991).

The riding or exercising of horses also presents a threat to conservation values as it increases the

potential to introduce weeds and can cause or exacerbate erosion.

STRATEGIES

1. **Allow no domestic pets in the Park except dogs; restrict dogs to the beach areas on the western side of the Park, and require that they should be on a leash.**
2. **Prohibit the riding of horses or other animals within the Park.**

25. PUBLIC SAFETY

The objective is to provide a safe environment for visitors to the Park and for the Park's management staff.

Like many wetland areas in the south-west, recreation activities in the Park can be hampered by mosquitoes. Sites where mosquitoes breed are known to occur at various points of the Estuary/Peninsula interface. These sites present an increased risk of exposure to mosquitoes, and thus possible infection by diseases they transmit. However, these places are significant to waterbirds known to use the Estuary (Ninox Wildlife Consulting 1989). As mosquitoes are an essential part of the Park's ecosystem and mosquito control has the potential to jeopardise the conservation value of these sites, CALM would prefer not to take direct measures to reduce mosquito numbers. The NPNCA is opposed in principle to the control of mosquitoes in wetlands of high conservation value (NPNCA 1993).

Risks to public health and safety exist at:

- The ocean beach, where a limestone reef exists off shore and numerous limestone and beachrock outliers are submerged close to the shore; and
- "The Cut", where strong tidal currents regularly occur and the rock groyne can become slippery.

STRATEGIES

1. **Advise Park visitors to use repellents and mosquito-proofed tents.**
2. **Ensure appropriate information is in place to advise Park visitors of hazards.**
3. **Follow NPNCA policy if any measures are taken to manage mosquitoes.**

26. INFORMATION, EDUCATION AND INTERPRETATION

The objectives are to:

- **Increase community understanding, awareness and enjoyment of the Park's natural, cultural and historical values.**
- **Increase community understanding and awareness of CALM's approach to managing the Park.**
- **Develop positive behaviour and support within the community towards the environment and management of the Park.**
- **Encourage use of the Park for educational purposes.**

Dissemination of information is an essential component of managing the conservation estate. It is a means by which the community's awareness and appreciation of the natural environment can be increased. It is also a means by which adopted or proposed management strategies can be explained, and regulatory and safety information presented. At the same time it fosters appropriate behaviour that minimises detrimental effects on the environment.

Prior to CALM's involvement in managing Leschenault Peninsula it had been used as a research site and, to a lesser extent, was used for educational purposes. Educational programs concentrated on rehabilitation techniques.

Since CALM's involvement, the Peninsula has played a role in environmental education and interpretation programs. It has been used by school groups, local government, local environmental interest groups and naturalist groups. The Park has been a venue for instruction in recreation planning and rehabilitation principles and techniques.

Interpretive information is currently being prepared for The Cut (with emphasis on the history of the Estuary to Ocean Cut) and Belvidere (with emphasis on historical significance).

Issues

The 1991 visitor survey identified a need to provide and upgrade on-site and off-site information, particularly in the following areas:

- pre-visit information;
- on-site orientation information;
- on-site regulatory information;
- on-site interpretive information;
- on-site interpretive programs; and
- on-site directional information.

Inappropriate recreational use and vandalism need to be addressed, in part, through interpretation and educational measures. A plethora of signs occurs throughout the Park, of which many are a legacy of previous land uses, and are now redundant. No information that addresses the natural physical or biological values of the Park, or the acid-effluent disposal and rehabilitation era, is currently available to Park users.

STRATEGIES

i) **Prepare and implement an interpretation plan for the Park to identify the key sites and stories and determine the media for communication. Ensure that areas where deficiencies have been identified are addressed: see Section 7 (Geology, Landforms and Soils), 10 (Flora and Vegetation), 11 (Fauna), 16 (Rehabilitation), 17 and 18 (History), 21 (Day Use and Bush Walks), 23 (Public Access), and 32 (Emergency Events). Consider a regional interpretation link with other Parks (e.g. Yalgorup National Park).**

ii) **Employ a range of communication techniques throughout the Park. Integrate this information to:**

1. **have maximum effect;**
2. **avoid unnecessary duplication of information (throughout the Park, other CALM estate and non-CALM estate); and**
3. **provide communication relevant to the site and the needs of visitors.**

iii) **Review existing information and, where necessary, have it replaced, amended, upgraded, relocated or removed.**

iv) **Prior to implementing the interpretation plan, restrict the provision of new information to that essential for public safety and management purposes.**

v) **Prepare and implement a sign plan.**

27. COMMERCIAL CONCESSIONS

The objective is to allow concessionaires to operate where they will facilitate Park management, enhance Park users' recreation experience and be consistent with other Park management objectives.

A commercial concession is a right granted by way of a licence for occupation or use, under appropriate conditions, of an area of land or water managed by CALM. Commercial concessions can increase the range of recreation opportunities and facilities within conservation parks.

STRATEGIES

1. **Consider concessions that:**
   6. **are consistent with CALM's policy on commercial activities and the Park's management objectives;**
   7. **facilitate Park management; or**
   8. **provide a service or facility that CALM would otherwise be unable to provide.**
2. **Include a lease or licence agreement as part of all approved commercial operations and review all operations regularly.**

MANAGEMENT SUPPORT

28. MANAGEMENT ACCESS AND INFRASTRUCTURE

The objectives are to:

- **Provide and maintain access and infrastructure to facilitate management activities and minimise the adverse environmental effects of roads, and their construction, maintenance and use.**
- **Rationalise the existing roads used for management activities, and the existing road-network for management access.**
- **Enable access to infrastructure managed and maintained by other organisations.**

The existing network of access roads and tracks within the Park and the existing infrastructure are a legacy of the industrial use of the Peninsula. Figure 8 (Section 16) shows the pattern of roads and tracks (public and management) existing before effluent disposal infrastructure was decommissioned and access roads were rehabilitated.

Most roads and tracks associated with rehabilitation or the disposal of effluent, with the exception of those retained for Park management, have been closed and rehabilitated. Effective management of the Peninsula may require further changes to the roading pattern.

Issues

Access and infrastructure requirements are determined by the level of use and the level of management intervention required. Access proposed by this plan has acknowledged major changes in land use (much more of the Park will be available for public use), and major changes in management requirements (much less of the Park will require management intervention). In addition to identifying the potential need for further road closures and rehabilitation, changing use patterns and management requirements may result in the need to construct additional tracks or roads.

A formal easement may be required for the Kemerton pipeline (through which brine from the chloride plant of Millennium Inorganic Chemicals Ltd is discharged into the ocean — see Section 16). Since the pipeline serves a project subject to a State Agreement Act [the *Pigment Factory (Australind) Agreement Act 1986*], there is a need to consult the Department of Resources Development. Approval has been granted to Western Power to construct another pipeline alongside the existing one, for the disposal of slightly saline washdown water from the new Collie Power Station.

STRATEGIES

xii) **Implement the proposed network of management roads shown in Figure 14.**

xiii) **Regularly review the roads used for management activities and requirements. This review should assess the purposes of roads and tracks, their maintenance requirements and their effects on the environment. Tracks and roads without an essential management function or with an environmental impact or maintenance requirement exceeding management value should be closed and rehabilitated. Additional tracks should only be provided where they are essential to management.**

xiv) **Provide management access to the beach at the following points (see Figure 14):**

- **in the vicinity of former lagoon site 9B (by upgrading and realigning the existing access track);**
- **in the vicinity of rehabilitation area A/B (behind the existing rehabilitation works compound);**
- **between area 8 and the location of former lagoon 17; and**
- **rehabilitation area stage 3 (about 1 km north of The Cut).**

xv) **For management activities, ensure that means of access to the southern end of the Park exist other than the present north-south road.**

xvi) **In addition to the management tracks shown in Figure 14, provide management access tracks to bores used to monitor groundwater.**

Remove bores no longer needed for monitoring, and rehabilitate tracks not needed.

xvii) **Investigate the need for a formal easement for the Kemerton pipeline.**

29. RESEARCH AND MONITORING

The objectives are to:

- **Identify and initiate research programs that will facilitate management of the Park's resources.**
- **Obtain information relevant to the Park's past, current and future management.**

Research and monitoring programs obtain information to prepare strategies and actions and to assess their effectiveness. Compiling the resource data for this plan has identified some deficiencies in the availability of information.

Research programs in the Park currently being undertaken, or proposed by this plan, are:

- assessing the conservation status of the Park's plant species and communities (Section 10);
- surveying the Park's fauna (Section 11);
- introducing Western Ringtail Possums (Section 11);
- assessing kangaroo grazing damage.
- Existing or proposed programs will monitor:
- weather patterns (Section 5);
- groundwater (Section 8);
- the status of the Mangrove Closed Scrub Community (Section 10);
- the spread of introduced plants protected because of their historical significance (Section 12);
- rehabilitation success (Section 16);
- radiation levels at former effluent lagoons (Section 16);
- natural and induced erosion and associated vegetation decline (Section 16);
- recreational use (Section 20); and
- use of public and management roads and tracks (Sections 23 and 28).

Monitoring will allow assessment of the value and success of management programs and strategies.

Issues

Research is needed to rectify deficiencies in information about the Park and how it should be managed. Currently, insufficient funds are available to carry out all the desired research with the potential to assist management. Priority for research, including that proposed by this plan, will need to be determined and additional funding obtained.

Allocating priority for research and monitoring may result in conducting programs that have relatively little direct management application to the Park, but have significant direct application to the conservation estate and species or communities elsewhere.

Effective management of the Park's resources will depend on implementing the findings and strategies of research and monitoring.

STRATEGIES

1. **Encourage research and monitoring where it will facilitate Park management and provide a greater understanding of:**
   4. **natural ecological processes;**
   5. **rehabilitation management;**
   6. **cultural resources; and**
   7. **recreational use.**
2. **Determine the priority for all existing and proposed research and monitoring programs and co-ordinate their implementation.**
3. **Seek funding, in accordance with allocated priorities, to implement or continue research and monitoring programs.**
4. **Incorporate research and monitoring findings into management operations and interpretive material. Where research or monitoring programs indicate activities or operations (including those proposed by this plan) are having an adverse effect on the Park's resources, review, and if necessary, modify or discontinue those activities or operations.**

30. INTERACTION WITH OTHER ORGANISATIONS

The objectives are to:

- **Develop and maintain relations with other organisations to ensure the Park is well managed.**
- **Assist other organisations to meet their objectives while meeting Park management objectives.**

The use of Leschenault Peninsula has involved various Government agencies, departments and authorities (see Section 16).

Many of these organisations will continue to be involved in managing the Peninsula, either through assisting CALM meet Park management objectives or through liaison with CALM to meet their own objectives.

Issues relevant to rehabilitation and decommissioning of effluent disposal operations and the effective transition of management responsibilities from the Department of Resources Development (DRD) and the Water and Rivers Commission (WRC) to CALM were previously addressed through the Leschenault Peninsula Technical Committee. When WRC's supervision of rehabilitation work associated with effluent disposal and decommissioning was completed the Technical Committee was discontinued.

Issues

CALM will continue to require technical expertise to address rehabilitation issues.

Many of the planning issues in the vicinity of the Park have direct relevance to the Park and its management.

Other organisations may wish to operate and locate infrastructure in, or have access to, the Park. Not all of these actions or activities will be consistent with CALM's Park management objectives. Some, if permitted, may lead to adverse effects on Park values.

STRATEGIES

1. **Continue to seek technical advice from relevant government departments, agencies and authorities and from non-government organisations with expertise in rehabilitation management.**
2. **Liaise with Water and Rivers Commission (WRC), Leschenault Inlet Management Authority (LIMA), Harvey Shire Council (HSC) and the Ministry for Planning where they are involved in planning issues likely to affect the Park, Leschenault Estuary or its foreshores.**
3. **Introduce provisions whereby other organisations proposing to conduct activities or operations within, or affecting, the Park are required to submit a written application outlining the proposal.**
4. **Assess the environmental impact of all proposed activities or operations.**
5. **Approve only those activities or operations that:**
   - **are consistent with, and do not jeopardise, CALM's management objectives for the Park; and**
   - **facilitate management of the Park; and**
   - **could not be conducted more effectively outside the Park.**

31. ADVISORY COMMITTEE AND COMMUNITY LIAISON

The objectives are to:

- **Enhance community awareness of, and involvement in, management of the Park.**
- **Develop a community based Park support network that will actively pursue issues that facilitate management of the Park.**

The former Leschenault Peninsula Community Advisory Committee (LPCAC) provided advice on management. It was established prior to CALM being responsible for managing Leschenault Peninsula. Its role was to:

- provide advice on preparation of the management plan;
- provide advice on matters referred to it; and
- liaise with local government, local community and interest groups.

The LPCAC was discontinued in September 1992 with a view to establishing a new community advisory committee whose membership was representative of the diverse range of community interests.

Numerous organisations and individuals have expressed an interest in the Park's management. Similarly, views concerning management have been sought during preparation of this plan and continuing liaison is essential to enable effective management.

A range of volunteer programs have been introduced, including seed collection for rehabilitation, track and fence construction and visitor surveys. Continuing these activities will greatly assist management of the Park.

Issues

With transfer of management responsibilities of the Park to CALM and the proposed increase in areas available to the public, it is inevitable that the number of visitors to the Park and range of visitor groups will increase. Continuing liaison between CALM and the local community and Park user groups is essential. A community advisory committee provides a means by which the diversity of interests can be represented. With increased interest in, and use of, the Park there is now opportunity to re-establish a community advisory committee and ensure it is representative of the wide diversity of community interests.

STRATEGIES

1. **Re-establish the Leschenault Peninsula Community Advisory Committee and ensure membership reflects the wide range of local community interests. Regularly review membership of the committee to ensure it reflects community interests.**

2. **Encourage the local community to be directly involved in management issues. This may be achieved by widely disseminating information on proposed management activities within the Park and actively seeking community involvement by establishing a *"Friends of the Park"* group and seeking volunteer assistance.**

32. EMERGENCY EVENTS

The objectives are to:

- **Minimise the likelihood of emergency situations arising.**
- **Facilitate response to emergency events.**

Emergency situations may arise as a result of wildfires, storms (and other natural phenomena), poorly planned or executed recreational activities or through a range of other unforeseen circumstances.

CALM will respond to emergency situations at a level appropriate to the situation.

STRATEGIES

1. **Establish effective links with local Police, State Emergency Services and other relevant bodies to enable the appropriate response to emergency events.**

2. **Provide information to Park visitors to minimise the likelihood of emergency situations arising.**

3. **Train operational staff in rescue procedures and techniques and regularly update training.**

IMPLEMENTING THE PLAN

33. FUNDING AND STAFFING

The objectives are to:

v) **Obtain sufficient funds to staff the Park and implement this plan.**

vi) **Obtain funds for ongoing maintenance and upgrading of Park facilities and infrastructure.**

In recognition of Park establishment costs, the Western Australian Government, through the South West Development Authority, allocated Park establishment funds over the three financial years 1987-88, 1988-89, and 1989-90.

In 1990 the State Government allocated funds for a further three years to enable CALM to develop recreation facilities and initiate rehabilitation work to protect the Park's infrastructure and conservation values.

The Park is presently managed by CALM's operational, maintenance and ranger staff that service the Park and other areas within the District. Other CALM operational and specialist staff (for example, recreation planners, research scientists) visit the Park to examine specific management issues and conduct research.

Some of the Park's operational expenditure can be recouped by adopting and implementing the "user pays" principle. Camping fees are proposed in Section 22, and further fees can be introduced for other services provided. Given that access to Leschenault Peninsula Conservation Park can be gained both by road and along the beach, it would be difficult to collect entry fees from any one single point. It is therefore not proposed at the present time to charge any fees for entry to the Park.

Co-operative arrangements with other organisations can also result in cost-effective management.

Issues

To implement this plan successfully a commitment to staffing resources will be needed (see Section 35) and additional funding provided. It may be possible to attract external sources of funding for much of the work required within the Park.

The use of the Park can be expected to increase. Additional ranger staff may be needed to manage visitors and protect the Park environment.

Additional sources of funding may also be needed to ensure appropriate measures are implemented to deal with the effects of natural disasters; for example, the rehabilitation work necessary as a result of storms or fire suppression as a result of wildfire.

Entry fees are being introduced to parks throughout Western Australia. Fees are a means by which visitors to the parks contribute directly to the budget needed for the provision of facilities and the protection of the park environment.

STRATEGIES

1. **Identify, prioritise and annually review funding requirements.**

2. **Identify potential sources of funding and projects or areas of operation capable of attracting external funding. Pursue these according to Departmental policies and procedures.**

3. **Investigate fees (such as a Park entry fee and collection system) or other ways of gaining revenue to recoup costs where specific services or opportunities are provided to the public and special interest groups.**

4. **Monitor and investigate the need for additional ranger staff as the use of the Park increases.**

5. **Seek additional funding if necessary to prepare and implement an interpretation plan for the Park (see Section 26).**

6. **Enter into partnerships with local organisations, community groups, and local and State Government departments where economies of scale can be obtained in co-operative operations.**

7. **Seek additional funding to allow appropriate responses to natural disasters.**

34. PLAN REVIEW AND MONITORING

The objectives are to:

- **Review the plan annually to determine whether long- and short-term goals and objectives are being met and strategies being adopted.**
- **Review the plan within 10 years of its adoption.**

Issues

Throughout the 10-year term of this plan new information will be made available, particularly as a result of research and monitoring. This information may direct management in a direction not identified by this plan. The NPNCA has a standard monitoring procedure that guides the review of progress, priority and relevance of strategies and enables management deficiencies, should they be present, to be addressed. This includes a mid-term review. Management direction may also be altered by changes in community attitudes and expectations. By implementing the review process, required changes can be incorporated into the following year's works program. If reviews indicate it is necessary, the CALM Act provides for the plan to be amended as required but only with further public involvement.

STRATEGIES

1. **Prepare an implementation plan and evaluate the management plan's implementation.**

2. **Annually review implementation and present this review as a report to the LPCAC outlining:**
   - **the degree to which management actions were achieved;**
   - **any new information which may affect management; and**
   - **expenditure and works proposed for the following year.**

3. **Assist the NPNCA to monitor the plan's implementation.**

4. **Review strategies in light of new information. If a major change in the direction of the plan is required prior to the end of the 10 year term, prepare changes for public comment.**

35. PRIORITIES

The objective is to manage the Leschenault Peninsula according to assigned priorities.

The previous sections of this management plan propose a wide range of strategies. Some are guidelines for management; others prescribe specific measures and developments. These prescriptions need funding, and will be implemented according to priority by CALM's Central Forest Region, subject to the availability of staff and funds. The section 'Summary and Key Strategies' sets out matters of particular importance in managing the Leschenault Peninsula; these will be among the highest priorities.

STRATEGY

1. **Prepare a 10-year implementation plan, taking into account the matters set out in 'Summary and Key Strategies'. Prepare an annual progress report and review the implementation plan annually or as circumstances change.**

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APPENDICES

APPENDIX 1. VERTEBRATE FAUNA OF LESCHENAULT PENINSULA

MAMMALS

The taxonomic groupings used are those described by Walton (1988), with the exception of *Pseudocheirus occidentalis*, where local convention is used (WA Museum).

Native Mammals Known to Occur:

Macropus fuliginosus	Western Grey Kangaroo
Trichosurus vulpecula	Common Brushtail Possum
Isoodon obesulus[t,*]	Quenda, or Southern Brown Bandicoot
Phascogale tapoatafa	Brush-tailed Phascogale
Pseudocheirus occidentalis[t,*]	Western Ringtail Possum
*Dasyurus geoffroii**	Chuditch
Hydromys chrysogaster[†]	Rakali, or Water Rat
Rattus fuscipes	Mootit, or Bush Rat
Nyctophilus geoffroyi[†]	Lesser Long-eared Bat
Neophoca cinerea[o]	Australian Sea-lion

Native Mammals that May Occur:

Antechinus flavipes	Yellow-footed Antechinus
Sminthopsis sp.	Dunnart
Nyctinomus australis	White-striped Mastiff-bat
Mormopterus planiceps	Little Mastiff-bat
Nyctophilus gouldi	Gould's Long-eared Bat
Chalinolobus gouldii	Gould's Wattled Bat
Chalinolobus morio	Chocolate Wattled Bat
Falsistrellus mackenziei	Great Pipistrelle
Eptesicus regulus	King River Eptesicus

Introduced Mammals Known to Occur:

Mus domesticus	House Mouse
Rattus rattus	Black Rat
Oryctolagus cuniculus	Rabbit
Vulpes vulpes	Fox
Felis catus	Cat

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[t] Present as the result of a translocation.

* A species of 'threatened' fauna, declared under the Wildlife Conservation Act as being 'fauna that is rare or likely to become extinct'.

[o] A species declared under the Wildlife Conservation Act as 'other specially protected fauna'.

[†] Unconfirmed report.

BIRDS

Taxonomic groupings used are those described by Slater, Slater and Slater (1986). The species list was compiled from Morris (1992), Ninox Wildlife Consulting (1989) and Shannon (personal communication) and includes waterbirds recorded on Leschenault Estuary and Inlet. Common names are those recommended by Schodde, Glover, Kinsky, Marchant, McGill and Parker (1977).

PODICIPEDIDAE:	
Poliocephalus poliocephalus	Hoary-headed Grebe
Tachybapus novaehollandiae	Australasian Grebe
SPHENISCIDAE:	
Eudyptula minor[u]	Little Penguin
PROCELLARIIDAE	
Daption capense	Cape Petrel
Macronectes giganteus	Southern Giant Petrel
SULIDAE:	
Morus serrator	Australasian Gannet
PHALACROCORACIDAE:	
Phalacrocorax melanoleucos	Little Pied Cormorant
P. sulcirostris	Little Black Cormorant
P. carbo	Great Cormorant
P. varius	Pied Cormorant
ANHINGIDAE:	
Anhinga melanogaster	Australian Darter
PELECANIDAE:	
Pelecanus conspicillatus	Australian Pelican
ARDEIDAE:	
Egretta garzetta	Little Egret
E. alba	Great Egret
Ardea novaehollandiae	White-faced Heron
A. pacifica	Pacific Heron
Nycticorax caledonicus	Rufous Night Heron
PLATALEIDAE:	
Platalea flavipes	Yellow-billed Spoonbill
Threskiornis spinicollis	Straw-necked Ibis
T. aethiopica	Sacred Ibis
ANATIDAE:	
Cygnus atratus	Black Swan
Tadorna tadornoides	Australian Shelduck
Chenonetta jubata	Maned Duck
Anas superciliosa	Pacific Black Duck
A. rhynchotis	Australasian Shoveler
A. gracilis	Grey Teal
A. castanea	Chestnut Teal
Biziura lobata	Musk Duck
PANDIONIDAE:	
Pandion haliaetus	Osprey

ACCIPITRIDAE:	
Accipiter cirrhocephalus	Collared Sparrowhawk
A. fasciatus	Brown Goshawk
Circus approximans	Marsh Harrier
Milvus migrans	Black Kite
Haliastur sphenurus	Whistling Kite
Lophoictinia isura	Square-tailed Kite
Hieraaetus morphnoides	Little Eagle
Haliaeetus leucogaster	White-breasted Sea Eagle
Aquila audax	Wedge-tailed Eagle
Elanus notatus	Black-shouldered Kite
FALCONIDAE	
Falco berigora	Brown Falcon
F. cenchroides	Australian Kestrel
F. longipennis	Australian Hobby
F. peregrinus[#]	Peregrine Falcon
PHASIANIDAE	
Coturnix pectoralis	Stubble Quail
Turnix varia	Painted Button-quail
RALLIDAE:	
Porzana tabuensis	Spotless Crake
Rallus philippensis	Buff-banded Rail
Fulica atra	Eurasian Coot
Gallinula tenebrosa	Dusky Moorhen
Porphyrio porphyrio	Purple Swamphen
CHARADRIIDAE:	
Pluvialis dominica	Lesser Golden Plover
P. squatarola	Grey Plover
Erythrogonys cinctus	Red-kneed Dotterel
Vanellus tricolor	Banded Lapwing
Charadrius melanops	Black-fronted Plover
C. leschenaultii	Large Sand Plover
C. ruficapillus	Red-capped Plover
Peltohyas australis	Inland Dotterel
SCOLOPACIDAE:	
Calidris ruficollis	Red-necked Stint
C. acuminata	Sharp-tailed Sandpiper
C. ferruginea	Curlew Sandpiper
C. canutus	Red Knot
C. tenuirostris	Great Knot
Arenaria interpres	Ruddy Turnstone
Limosa lapponica	Bar-tailed Godwit
Numenius phaeopus	Whimbrel
N. madagascariensis	Eastern Curlew
Tringa brevipes	Grey-tailed Tattler
T. stagnatilis	Marsh Sandpiper
T. nebularia	Common Greenshank
T. hypoleucos	Common Sandpiper
RECURVIROSTRIDAE:	
Cladorhynchus leucocephalus	Banded Stilt
Himantopus himantopus	Black-winged Stilt
Recurvirostra novaehollandiae	Red-necked Avocet
HAEMATOPODIDAE:	
Haematopus longirostris	Pied Oystercatcher

STERCORARIIDAE:	
Stercorarius skua	Great Skua
LARIDAE:	
Larus novaehollandiae	Silver Gull
Sterna bergii	Crested Tern
S. nereis	Fairy Tern
Hydropogne caspia	Caspian Tern
COLUMBIDAE:	
Phaps chalcoptera	Common Bronzewing
Streptopelia senegalensis[i]	Laughing Turtle-Dove
CACATUIDAE:	
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo
Cacatua roseicapilla	Galah
Glossopsitta porphyrocephala	Purple-crowned Lorikeet
PLATYCERCIDAE:	
Platycercus zonarius	Port Lincoln Ringneck
P. icterotis	Western Rosella
Purpureicephalus spurius	Red-capped Parrot
Neophema elegans	Elegant Parrot
CUCULIDAE:	
Cuculus pyrrhophanus	Fan-tailed Cuckoo
C. pallidus	Pallid Cuckoo
Chrysococcyx basalis	Horsefield's Bronze Cuckoo
ALECINIDAE:	
Dacelo novaeguineae[ie]	Laughing Kookaburra
Halycon sancta	Sacred Kingfisher
MEROPIDAE:	
Merops ornatus	Rainbow Bee-eater
STRIGIDAE:	
Ninox novaeseelandiae	Southern Boobook
Tyto alba	Barn Owl
PODARGIDAE:	
Podargus strigoides	Tawny Frogmouth
HIRUNDINIDAE:	
Hirundo neoxena	Welcome Swallow
Cecropis nigricans	Tree Martin
MOTACILLIDAE:	
Anthus novaeseelandiae	Richard's Pipit
CAMPEPHAGIDAE:	
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Lalage sueurii	White-winged Triller
MUSCICAPIDAE:	
Petrocia multicolor	Scarlet Robin
Eopsaltria griseogularis	Western Yellow Robin

PACHYCEPHALIDAE:	
Pachycephala pectoralis	Golden Whistler
Colluricincla harmonica	Grey Shrike-thrush
MONARCHIDAE:	
Rhipidura fuliginosa	Grey Fantail
R. leucophrys	Willy Wagtail
SYLVIIDAE:	
Megalurus gramineus	Little Grassbird
MALURIDAE:	
Malurus splendens	Splendid Fairy-wren
ACANTHIZIDAE:	
Sericornis frontalis	White-browed Scrubwren
Gerygone fusca	Western Gerygone
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
A. apicalis	Inland Thornbill
MELIPHAGIDAE:	
Anthochaera carunculata	Red Wattlebird
A. chrysoptera	Little Wattlebird
Lichenostomus virescens	Singing Honeyeater
Lichmera indistincta	Brown Honeyeater
Phylidonyris novaehollandiae	New Holland Honeyeater
Acanthorhynchus superciliosus	Western Spinebill
ZOSTEROPIDAE:	
Zosterops lateralis	Silvereye
EPHTHIANURIDAE:	
Ephthianura albifrons	White-fronted Chat
PARDALOTIDAE:	
Pardalotus striatus	Striated Pardalote
GRALLINIDAE:	
Grallina cyanoleuca	Magpie-Lark
ARTAMIDAE:	
Artamus cyanopterus	Dusky Woodswallow
A. cinereus	Black-faced Woodswallow
CRACTICIDAE:	
Cracticus torquatus	Grey Butcherbird
Strepera versicolor	Grey Currawong
Gymnorhina tibicen	Australian Magpie
CORVIDAE:	
Corvus coronoides	Australian Raven

[u] Unconfirmed report.

■ A species of fauna declared under the Wildlife Conservation Act as being “fauna that is rare or likely to become extinct”.

[#] A species of fauna declared under the Wildlife Conservation Act as being "fauna that is in need of special protection".

[i] Introduced species.

[ie] Introduced from eastern Australia to the south-west of Western Australia.

REPTILES AND AMPHIBIANS

Taxonomic groupings and common names used are those described by Storr *et al*. (1990) for reptiles and Cogger (1992) for amphibians.

Amphibians Known to Occur

MYOBATRACHIDAE (Southern Frogs):

Heleioporus eyrei	Moaning Frog
Lymnodynastes dorsalis	Western Banjo Frog

HYLIDAE (Tree Frogs):
Litoria sp.

Reptiles Known to Occur

CHELONIIDAE (Sea Turtles):

Caretta caretta[1,2]	Loggerhead Turtle

PYGOPODIDAE (Snake Lizards):

Lialis burtonis	Burton's Snake-Lizard

AGAMIDAE (Dragon Lizards):
Pogona minor

SCINCIDAE (Skinks):

Egernia kingii	King's Skink
Tiliqua rugosus rugosus[3]	Shingle-Back

TYPHLOPIDAE (Blind Snakes):
Ramphotyphlos australis

BOIDAE (Pythons):

Morelia spilota imbricata[4]	Carpet Python

ELAPIDAE (Elapid Snakes):

Notechis ater occidentalis	Black Tiger Snake
Pseudonaja affinis	Dugite

Reptiles and Amphibians that May Occur[5]

MYOBATRACHIDAE (Southern Frogs):
Crinia glauerti[6]
Crinia insignifera[7]
Geocrinia leai

Pseudophryne guentheri	Gunther's Toadlet

HYLIDAE (Tree Frogs):
Littoria adelaidensis
Littoria moorei

CHELIDAE (Side-necked Tortoises):

Chelodina oblonga	Oblong Turtle

GEKKONIDAE
Christinus marmoratus[8]

SCINCIDAE
Cryptoblepharus plagiocephalus
Ctenotus labillardieri
Egernia napoleonis
Egernia luctuosa
Hemiergis initialis
Hemiergis peronii

Lerista distinguenda
Morethia obscura
Morethia lineoocellata
Bassiana trilineata[9]

ELAPIDAE

Echiopsis curta	Bardick
Simoselaps bertholdi	Desert Banded Snake
Simoselaps bimaculatus	Western Black-naped Snake

[1] A species of "*threatened*" fauna, declared under the Wildlife Conservation Act 1950 as being 'fauna that is rare or likely to become extinct'.

[2] Recorded infrequently as hatchlings washed ashore on the ocean beach as a result of major storms.

[3] Listed by Storr, Smith & Johnstone as *Tiliqua rugosa*, Bobtail.

[4] A species of fauna declared under the Wildlife Conservation Act 1950 as being "*fauna that is in need of special protection*" as declared in the Western Australian Government Gazette.

[5] This list comprises reptiles that have not been recorded from within the Park, but (based on the known geographic range of the species and the availability of suitable habitat) may be present there. Many of these species have been recorded within Kemerton Park (5 km east of Leschenault Peninsula) by Bamford and Watkins (1983) and Watkins (1983).

[6] Listed by Bamford and Watkins (1983) and Watkins (1983) as *Ranidella glauerti.*

[7] Listed by Bamford and Watkins (1983) and Watkins (1983) as *Ranidella insignifera*.

[8] Listed by Watkins (1983) as *Phyllodactylus marmoratus*.

[9] Listed by Watkins (1983) as *Leiolopisma trilineatum*.

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APPENDIX 2. THE WALTA WHEEL

The cyclic pattern of dune erosion-stabilisation as documented by Quilty, Walta and Carr (1991) is reproduced below. The description selected a starting point at the stable dune stage, where no significant erosion is occurring:

> *"If the vegetation on a portion of the dune is destroyed (by natural processes, e.g. wind or wave erosion or a major storm event) the sand is exposed to the elements and erosion begins. If this erosion is not checked, more vegetation is destroyed and dune deterioration increases. In time its vegetative cover is totally removed to leave barren sand.*
>
> *As this occurs the dune becomes increasingly mobile, adopting a parabolic shape which deepens in a downwind direction. Sand blows further inland until the parabolic dune blows out into two parallel transverse ridges with a swale between them.*
>
> *Re-stabilisation of the consequent blowout begins at the upwind end where a berm forms close to the shoreline. This is fed with incoming sand brought onto the beach by wave action.*
>
> *Coastal grasses and beach annuals establish and thrive in this sand accumulating environment and assist in trapping the sand and developing a new frontal dune. This dune provides some protection in its lee where the [species of the next] stage begin to establish. These species will tolerate minor sand feed and the hot, dry summer environment.*
>
> *If the new dune continues to grow the next seral stage colonisers begin to establish further downwind. These are nutrient scavengers and nitrogen fixers which produce copious quantities of humus that conditions the soil. They also attract birds and mammals which introduce seed of climax species that will grow in the shelter of the established shrubs.*
>
> *The vegetation which has thus developed will remain stable until further disruption occurs to initiate the erosion cycle again"* (Quilty, Walta and Carr 1991).

The Walta Wheel is a model developed as a result of observations of the cyclic erosion-stabilisation process and depicts this process in a diagrammatic form. The model has direct management application. It can be used to identify the stage of erosion-stabilisation of any dune, to plan the appropriate management strategies, and to predict its future stability. The Walta Wheel is shown in Figure 15.

The coloured, outer circle of the wheel depicts four overlapping categories of plants, with each category primarily determined by the degree of protection required for the plants to become established. Each of these categories is composed of species that typify a recognisable seral stage. The categories are as described by Walta (1993) and listed below. Species listed have been successfully used in rehabilitation work at Leschenault Peninsula. Subject to their continued effectiveness in rehabilitation, and subject to monitoring of growth and rates of spread, these species are recommended for future rehabilitation work (see Strategy 11, Section 16).

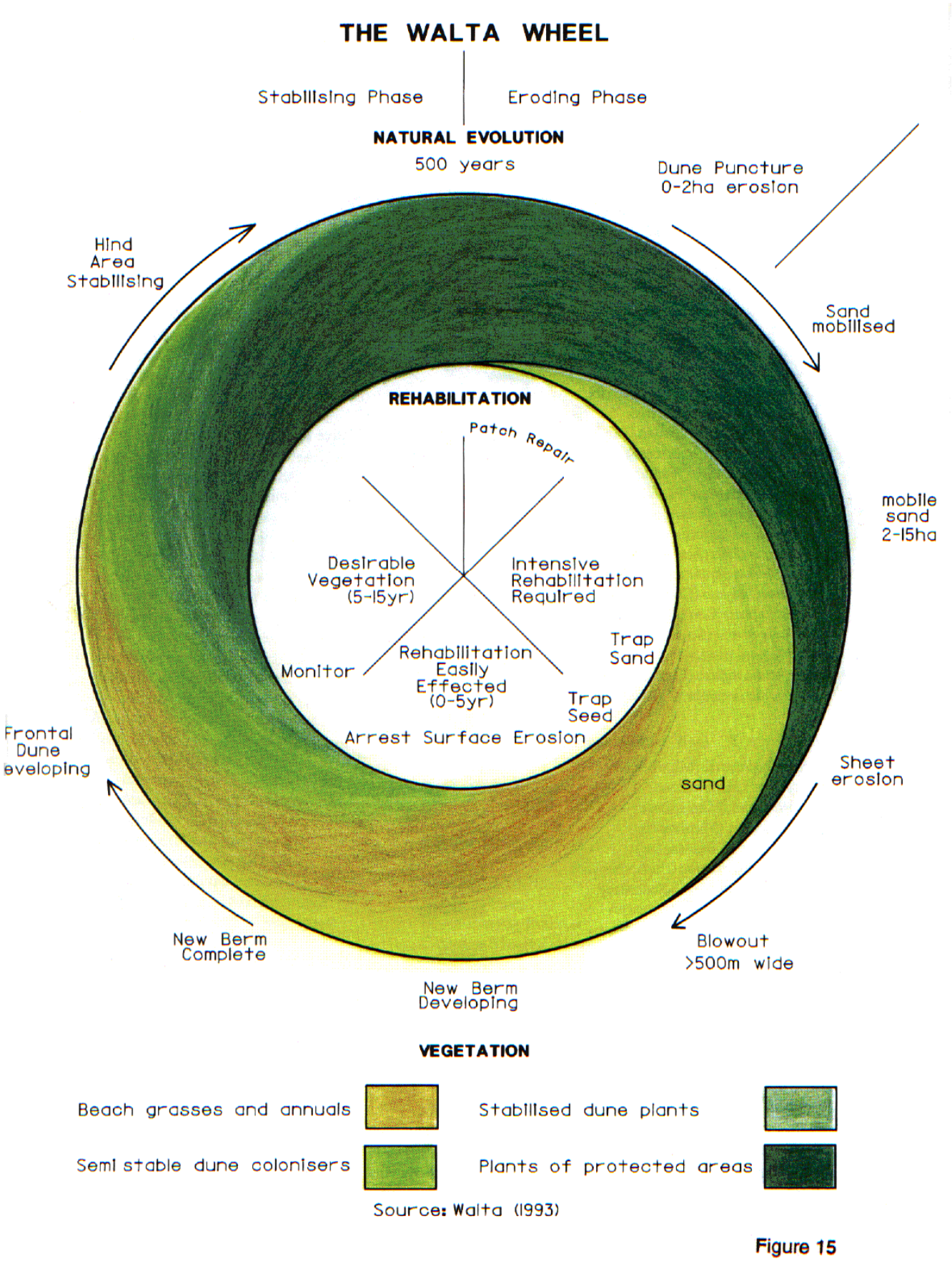
The inner circle of the Wheel shows the type and intensity of the rehabilitation required and the processes involved to stabilise the erosive component and direct the cycle to a stable vegetated state. At any stage within the cycle rehabilitation or stabilisation measures can be employed. The intensity of the rehabilitation and the category of plant species required will be determined by the stage within the cycle.

Plant Species Used for Rehabilitation

Categories are as defined by Walta (1993). Common names are as listed by Marchant, Wheeler, Rye, Bennett, Lander and Macfarlane (1987).

Category 1 (beach grasses and annuals: the accumulators of foredune sand):

Ammophila arenaria[1] (Poaceae)	Marram Grass
Arctotheca populifolia[1] (Asteraceae)	Dune Arctotheca
Atriplex isatidea (Chenopodiaceae)	
Cakile maritima[1] (Brassicaceae)	Sea Rocket
Carpobrotus virescens (Aizoaceae)	



Source: Walta (1993)

Figure 15

Oenothera drummondii[1] (Onagraceae)	Beach Evening Primrose
Olearia axillaris (Asteraceae)	
Spinifex hirsutus (Poaceae)	Hairy Spinifex
S. longifolius (Poaceae)	
Tetragonia decumbens[1] (Aizoaceae)	
Thinopyrum distichium[1,2] (Poaceae)	

Category 2 (colonisers of semi-stable dunes):

Acacia cochlearis (Mimosaceae)	
A. cyclops (Mimosaceae)	Coastal Wattle
A. rostellifera (Mimosaceae)	
A. sophorae[3] (Mimosaceae)	
Anthocercis littorea (Solanaceae)	Yellow Tailflower
Arctotheca populifolia (Asteraceae)	Dune Arctotheca
Atriplex isatidea (Chenopodiaceae)	
Cakile maritima[1] (Brassicaceae)	Sea Rocket
Calocephalus brownii (Asteraceae)	
Carpobrotus virescens (Aizoaceae)	
Hakea prostrata (Proteaceae)	
Hardenbergia comptoniana (Papilionaceae)	Wild Sarsaparilla, Native Wisteria
Isolepis nodosa (Cyperaceae)	Knotted Club-rush
Jacksonia furcellata (Papilionaceae)	
Kennedia prostrata (Papilionaceae)	Running Postman, Scarlet Runner
Oenothera drummondii[1] (Onagraceae)	Beach Evening Primrose
O. stricta[1] (Onagraceae)	Common Evening Primrose
Olearia axillaris (Asteraceae)	
Pelargonium capitatum[1] (Geraniaceae)	Rose Pelargonium
Rhagodia baccata (Chenopodiaceae)	
Scaevola crassifolia (Goodeniaceae)	
Solanum simile (Solanaceae)	Oondoroo
Templetonia retusa (Papilionaceae)	Templetonia
Threlkeldia diffusa (Chenopodiaceae)	
Tetragonia decumbens[1] (Aizoaceae)	

Category 3 (soil conditioners, and plants of stabilised dunes):

Acacia cochlearis (Mimosaceae)	
A. cyclops (Mimosaceae)	Coastal Wattle
A. lasiocarpa (Mimosaceae)	
A. rostellifera (Mimosaceae)	
A. sophorae[3] (Mimosaceae)	
Adriana quadripartita (Euphorbiaceae)	
Anthocercis littorea (Solanaceae)	
Cakile maritima[1] (Brassicaceae)	Sea Rocket
Calocephalus brownii (Asteraceae)	
Carpobrotus edulis[1] (Aizoaceae)	Pigface
C. virescens (Aizoaceae)	Pigface
Eucalyptus gomphocephala (Myrtaceae)	Tuart
Guichenotia ledifolia (Sterculiaceae)	
Hakea prostrata (Proteaceae)	
Hardenbergia comptoniana (Papilionaceae)	Wild Sarsaparilla, Native Wisteria
Isolepis nodosa (Cyperaceae)	Knotted Club-rush
Jacksonia furcellata (Papilionaceae)	
Kennedia coccinea (Papilionaceae)	Coral Vine
K. prostrata (Papilionaceae)	Running Postman, Scarlet Runner
Oenothera drummondii[1] (Onagraceae)	Beach Evening Primrose
O. stricta[1] (Onagraceae)	Common Evening Primrose

Olearia axillaris (Asteraceae)
Pelargonium capitatum[1] (Geraniaceae) Rose Pelargonium
Phyllanthus calycinus (Euphorbiaceae)
Pittosporum phylliraeoides (Pittosporaceae)
Rhagodia baccata (Chenopodiaceae)
Santalum acuminatum (Santalaceae) Sweet Quandong
Scaevola crassifolia (Goodeniaceae)
Senecio lautus (Asteraceae) Variable Groundsel
Solanum simile (Solanaceae) Oondoroo
Spyridium globulosum (Rhamnaceae)
Templetonia retusa (Papilionaceae) Templetonia
Threlkeldia diffusa (Chenopodiaceae)
Trachymene coerulea (Apiaceae) Blue Lace Flower

Category 4 (plants of protected areas):

Acacia cochlearis (Mimosaceae)
A. cyclops (Mimosaceae) Coastal Wattle
A. lasiocarpa (Mimosaceae)
A. rostellifera (Mimosaceae)
A. saligna (Mimosaceae) Orange Wattle, Golden Wreath Wattle
A. sophorae[3] (Mimosaceae)
Acanthocarpus preissii (Dasypogonaceae)
Agonis flexuosa (Myrtaceae) Peppermint
Anthocercis littorea (Solanaceae) Yellow Tailflower
Calocephalus brownii (Asteraceae)
Carpobrotus edulis[1] (Aizoaceae) Pigface
C. virescens (Aizoaceae) Pigface
Casuarina obesa (Casuarinaceae) Swamp Sheoak
Clematis microphylla (Ranunculaceae) Old Man's Beard
Diplolaena dampieri (Rutaceae)
Eucalyptus gomphocephala (Myrtaceae) Tuart
Exocarpos sparteus (Santalaceae) Broom Ballart
Guichenotia ledifolia (Sterculiaceae)
Hakea prostrata (Proteaceae)
Hardenbergia comptoniana (Papilionaceae) Wild Sarsaparilla, Native Wisteria
Hibbertia cuneiformis (Dilleniaceae) Cutleaf Hibbertia
Isolepis nodosa (Cyperaceae) Knotted Club-rush
Jacksonia furcellata (Papilionaceae)
Kennedia coccinea (Papilionaceae) Coral Vine
K prostrata (Papilionaceae) Running Postman, Scarlet Runner
Lepidosperma gladiatum (Cyperaceae) Coast Sword-sedge
Melaleuca cuticularis (Myrtaceae) Saltwater Paperbark
M. hamulosa[4] (Myrtaceae)
M. huegelii (Myrtaceae) Chenille Honeymyrtle
M. preissiana (Myrtaceae)
M. rhaphiophylla (Myrtaceae) Swamp Paperbark
Myoporum insulare (Myoporaceae) Blueberry Tree
Oenothera drummondii[1] (Onagraceae) Beach Evening Primrose
O. stricta[1] (Onagraceae) Common Evening Primrose
Olearia axillaris (Asteraceae)
Pelargonium capitatum[1] (Geraniaceae) Rose Pelargonium
Phyllanthus calycinus (Euphorbiaceae)
Pittosporum phylliraeoides (Pittosporaceae)
Rhagodia baccata (Chenopodiaceae)
Santalum acuminatum (Santalaceae) Sweet Quandong
Scaevola crassifolia (Goodeniaceae)

Solanum simile (Solanaceae)	Oondoroo
Spyridium globulosum (Rhamnaceae)	
Templetonia retusa (Papilionaceae)	Templetonia

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[1] Indicates introduced species

[2] *Thinopyrum* is listed by Marchant *et al*. as *Agropyron*.

[3] **Note:** *Acacia sophorae* is an eastern Australian species, and has become a rampant weed in places.

[4] *Melaleuca hamulosa* is not recognised by Marchant *et al*. as a separate species. Other authors have considered it a synonym for *M. viminea* or treated *M. viminea* and *M. hamulosa* as separate species (Ray Cranfield, personal communication).