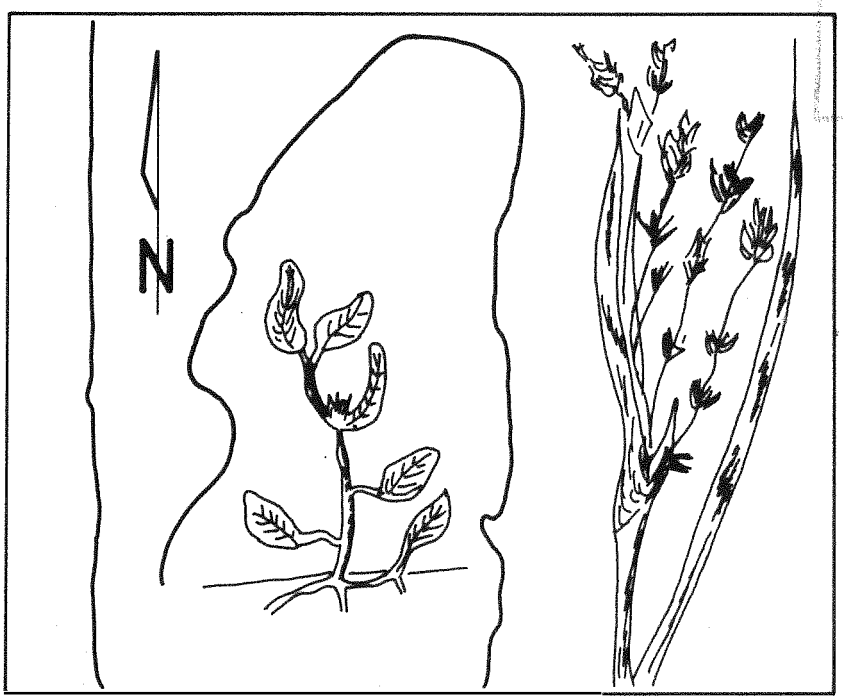
SHIRE OF HARVEY AND LESCHENAULT INLET MANAGEMENT AUTHORITY

Draft Cathedral Avenue and Northern Estuary Planning Study



Waterways Commission
Report No 33
1994

SHIRE OF HARVEY

WATERWAYS COMMISSION

216 St Georges Terrace
PERTH
Western Australia 6000
Telephone: (09) 327 9777
Fax: (09) 327 9770

Postal address
Box 7248, PO
Cloister Square
Perth
Western Australia 6850

MANAGEMENT AUTHORITY OFFICES

Albany Waterways Management Authority

Port Authority Building
85 Brunswick Road
ALBANY
Western Australia 6330
Telephone: (098) 414 988
Fax: (098) 421 204

Postal address:
Box 525, PO
ALBANY
Western Australia 6330

Avon River Management Authority

Lot 12 York Road
NORTHAM
Western Australia 6401
Telephone (096) 22 6119
Fax (096) 22 1902

Postal address
Box 497 PO
NORTHAM
Western Australia 6401

Leschenault Inlet Management Authority

Inner Harbour Road
BUNBURY
Western Australia 6230
Telephone: (097) 211875
Fax: (097) 218 290

Postal address:
Box 261, PO
BUNBURY
Western Australia 6230

Peel Inlet Management Authority

Sholl House
21 Sholl Street
MANDURAH
Western Australia 6210
Telephone: (09) 535 3411
Fax: (09) 581 4560

Postal address:
Box 332, PO
MANDURAH
Western Australia 6210

Wilson Inlet Management Authority

Suite 1
55 Strickland Street
DENMARK
Western Australia 6333
Telephone (098) 481 866
Fax (098) 481 733

Postal address
Box 353, PO
DENMARK
Western Australia 6333

DRAFT CATHEDRAL AVENUE AND NORTHERN ESTUARY PLANNING STUDY

Report prepared for the Shire of Harvey and the Leschenault Inlet Management Authority by the Cathedral Avenue and Northern Estuary Working Group

Waterways Commission
216 St Georges Terrace
Perth WA 6000
Report 33
September 1994

ACKNOWLEDGMENTS

The following members of the Working Group assisted with the preparation of the report:

Sir Donald Eckersley	Chairman Leschenault Inlet Management Authority
Councillor Maidee Smith	Shire of Harvey
Councillor Emily Hill	Shire of Harvey
Peter Eckersley	Leschenault Environmental Study Group
John Saunders	Local resident
Pat Rutherford	Leschenault Inlet Management Authority
John Evans	Leschenault Inlet Management Authority

Technical assistance was provided by the following people:

Keith Leece	Shire of Harvey
Brad Gleeson	Shire of Harvey
Marian Gartrell	Shire of Harvey
Bev Thurlow	Waterways Commission
Scott Woodcock	Waterways Commission
Eric Wright	Leschenault Inlet Management Authority
Greg Baxter	Cartographic Officer Waterways Commission
Brett Harisson	Cartographic Officer Waterways Commission
June Hutchison	Editor
Mike Schramm	Department of Planning and Urban Development

ISBN 0 7309 6413 2

ISSN 0814-6322

FOREWORD

The Cathedral Avenue and Northern Estuary Planning Study is one of the important planning tools for identifying issues and concerns surrounding development in the northern Leschenault Estuary area. The Shire of Harvey and the Leschenault Inlet Management Authority agreed that this area needed detailed and careful planning to protect and manage private, community and environmental values.

During the 1980's, significant pressures were mounting with landowners wanting to develop and subdivide land adjacent to the estuary, and the community wanting to protect landscape and wildlife values.

A working group was formed with representation from the Shire, LIMA, landowners and the Leschenault Environmental Study Group. It was decided at an early stage that the Planning Study would form a part of the Town Planning Scheme for this area, an d fit within Policy Area 1 - Leschenault.

The Shire and LIMA both wanted overall community input and acceptance of the final development scenario for this area, so agreed to incorporate the Planning Study into the review of the District Planning Scheme No 1. This would ensure that the community had ample opportunity to be informed on land use and management for this area, and that development followed proper planning principles.

The Planning Study addresses both the Shire's and LIMA's concerns by investigating physical and biological relationships within the area, considering planning and environmental studies, guidelines and reports, and presenting a range of development and protection options for consideration by the general community.

the development and management policies and guidelines established as a result of this study will provide planning and management authorities with a vision for the Cathedral Avenue area for the next twenty years.

It is essential now for the community to respond to the large amount of work that has been carried out to prepare this Planning Study by providing input on its vision for this area, and how you want to see it developed and managed.

John Sabourne
President
Shire of Harvey

Sir Donald Eckersley OBE
Chairman
Leschenault Inlet Management Authority

GUIDE FOR READERS

The coloured pages

The coloured pages contain a summary of the issues, solutions considered and the recommendation of the Working Group for zoning of the area.

The main body of the document

Section 1-5 These sections outline background information, the aim and objectives of the project, a description of the study area, a summary of how land and waterways planning and management occurs and existing land use of the study area.

Section 6 Issues affecting the study are discussed in this section.

Section 7 Solutions to the issues listed in the previous section are outlined.

Section 8 This section outlines the options considered to implement the various solutions and the reason why Town Planning Scheme No 1 was chosen.

Section 9 Zoning and development options using Town Planning Scheme No 1 are outlined and the preferred option is determined.

Section 10 Resource maps of the area are included. These maps detail existing lots, reserves, roads and buildings. Planning issues relevant to the area are listed adjacent to each map.

Abbreviations

Many organisations are mentioned in this document including state government agencies, local government authorities and community groups. For brevity, initials are used in most references. To aid the reader a foldout sheet listing all abbreviations is provided at the back of the document.

HOW TO MAKE A SUBMISSION

Public submissions on the Draft Cathedral Avenue and Northern Estuary Planning Study are now invited. All public submissions received will be considered before preparation of the final report. The Working Group will then report to the Department of Planning and Urban Development regarding draft Town Planning Scheme No 1.

If you would like to make a submission towards preparation of the final report please comment on any part of the document you agree or disagree with. A tearout form is provided on the following page for this purpose. Send this to the Shire of Harvey by **December 13, 1994** at the address provided on the top of the form. Please note that submissions do not have to be confined to the length or lay out of the form provided.

If more information is required prior to making your submission, officer s of the Leschenault Inlet Management Authority and the Shire of Harvey will be available to discuss any aspect of the Draft planning study.

Where can I get other copies of this document?

Further copies of the report are available for viewing at:

- Shire of Harvey Offices
- Leschenault Inlet Management Authority

Copies of the document can also be obtained free of charge from:

Leschenault Inlet Management Authority
Inner Harbour Road
Bunbury 6230

Shire of Harvey
1 Uduc Road
Harvey WA 6230

Shire of Harvey-Australind Office
Mulgara Street
Australind WA 6230

Draft Cathedral Avenue and Northern Estuary Planning Study
Public submission form

Project Officer
Shire of Harvey
PO Box 163
Harvey WA 6230

Name: .....

Title: .....

Organisation: .....

Address: .....

.....

.....

I would like to make the following comments on the Draft Cathedral Avenue and Northern Estuary Planning Study and would like them considered in the preparation of the final report and Town Planning Scheme No 1.

Comments:

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

I would like a copy of the final report sent to the above address on its completion.

Signed

.....

SUMMARY

BACKGROUND

The northern section of Leschenault Estuary forms an integral part of the scenic character of the Bunbury region. The estuary and its associated foreshore provides a habitat for a myriad of flora and fauna. It also offers a unique lifestyle for a number residents living along Cathedral Avenue.

The need for this plan arose from Leschenault Inlet Management Authority's (LIMA) desire to protect the estuary from detrimental public use and establish the area for conservation purposes; and from the Shire of Harvey's (HSC) concerns regarding pressure for development and subdivision of properties along Cathedral Avenue.

AIM

The aim of the planning study is to:

> Develop a plan to assist in determining development and conservation of all land and waters within the study area.

OBJECTIVES

Land use planning

Primary Objective

Identify land uses that are compatible with the conservation of the estuary and foreshores.

Specific Objectives

- Identify areas suitable for particular land uses.
- Determine suitable sizes for subdivision lots.
- Ensure as far as possible that people have the freedom to make decisions as to how they enjoy tenure of their land without adversely impacting on the surrounding land uses and estuary.

Conservation

Primary Objective

Conserve and enhance the natural environment.

Specific Objectives

- Implement relevant System 6 recommendations.
- Develop a strategy to protect the public and foreshore vegetation from fires.
- Enhance wetland areas.
- Maintain and enhance fauna habitats.

Water quality

Primary Objective

Protect the estuary and its foreshores from pollution.

Specific Objectives

- Determine nutrient leaching to the estuary from particular land uses and develop criteria.
- Recommend land use controls for areas outside the study area.
- Investigate alternative technologies to reduce nutrients reaching the estuary.

Recreation

Primary Objective

Provide opportunity for environmentally sensitive recreational use and public enjoyment of the estuary and foreshore areas.

Specific Objectives

- Manage public open space.
- Enhance existing recreation areas and features.

Public education and involvement

Primary Objective

Educate the public on the environmental value of the area.

Specific Objectives

- Involve the public with the ongoing management of the area.

Landscape protection

Primary Objective

Conserve and enhance the scenic and aesthetic values of the estuary, foreshores and escarpment.

Specific Objectives

- Maintain the rural character of the flood plain.
- Ensure appropriate zoning to maintain the natural character of the area.
- Determine what aspects of the landscape are important to the public.

SOLUTION

The Working Group, subject to public review, favour the inclusion of a Special Use (Special Rural and Landscape Protection Zone) zoning in the Shire of Harvey Town Planning Scheme Review and Rural Strategy No 1 to appropriately control the type and extent of development along Cathedral Avenue.

(Plate 1 : View from Crimp Crescent across to Leschenault Estuary)

CONTENTS

List of Appendices

List of figures

List of plates

1. BACKGROUND

1.1 Need for the plan

The need for a plan has arisen from the Leschenault Inlet Management Authority's (LIMA) and the Shire of Harvey's (HSC) concerns regarding pressure for development and subdivision of properties along Cathedral Avenue. The Authorities identified a need to control the development in a manner sympathetic to the estuary's conservation and landscape values.

1.2 How the plan was developed

The Shire of Harvey and the Leschenault Inlet Management Authority formed a Working Group to oversee the development of a planning study for the area. The plan was funded by the Shire of Harvey and LIMA.

Figure 1 provides an outline of how the plan was prepared and how the draft document relates to the overall process.

1.2.1 The study team

The Working Group has representatives from the following groups:

Leschenault Inlet Management Authority (LIMA)

Harvey Shire Council (HSC)

Cathedral Avenue landowners (CAL)

Leschenault Environmental Study Group (LESG)

Additional assistance has been provided by government and local government agencies and community groups.

Technical support was provided to the Working Group by officers of the Harvey Shire Council, the Leschenault Inlet Management Authority and the Waterways Commission.

1.2.2 Public Input

A press release was prepared outlining the study. A pamphlet was posted to people living in the study area. A display was mounted in the Australind Shopping Centre. People were asked for comments on the study area, the aim and objectives of the study and issues they thought should be considered. The Working Group was also keen to hear from people on how they considered the area should look in 20 years time and beyond. The public were invited to comment on the pamphlet and aspects of the study from June to July of 1991. People were also invited to contact members of the Working Group to express interest to avoid the problem of preparing a written submission. Twenty two submissions were received. Issues raised in the public submissions are presented in Appendix 1.

Generally the submissions supported the aim and objectives. A few changes were made to clarify the intent. Also specific objectives have been developed under each primary objective. This provides further clarification.

There were a number of concerns regarding the study area. It was considered that the study area boundary was artificial and if the study was limited to this area it would be impossible to address the issue of nutrient input to the estuary. This is acknowledged and the boundary should not be restricted when reviewing nutrient and ground and surface flow to the estuary.

Figure 1: Development of the Cathedral Avenue and Northern Estuary Planning Study

Step	Task
1 Collection of information relating to the study area 2 Public consultation	Fact finding study
2 Identification of management issues 3 Development of aim and objectives 4 Development of strategies (Recommendations for management action) General strategies / Site specific strategies 5 Negotiation with affected parties	Draft Planning Study
6 Release of draft study for public comment- advertise (to bcoincide with release of draft Town Planning Scheme No 1) 7 Public workshop	Public consultation
8 Produce summary of public comment 9 Redraft - taking into account comment	Final planning study
10 Release final document 11 Implementation and monitoring	Works programme,research projects, day to day operations
12 Review	Annual report Redraft of study when necessary
☐ Indicates the status of the project	

1.2.3 Regional values

In the South West Strategy (SWDA, 1991) the comment was made that people have sought to settle in the region to realise personal aspirations of lifestyle and to seek recreation through the region's natural attractions. Moreover, the implications of development carry with it a perceived or actual threat to a chosen lifestyle because of deterioration in environmental values or social problems.

These responses correlate well with the findings of the Draft Bunbury-Wellington Regional Planning Study (DPUD, 1992). For example, aspects people like most about living in the Region include :

* rivers, lakes and estuaries
* bushland and rural outlook
* close proximity to a variety of environmental features.

Aspects which people like least about living in the region include :

* environmental and noise pollution
* clearing of natural bushland to make way for other land use
* inadequate provision of parklands / open space.

The estuary, wetlands and rivers were seen as important assets. Their protection, clearing control of natural bushland and planning for interlinked parkland / open space system were seen as examples of good planning.

Examples of bad planning within the region include :

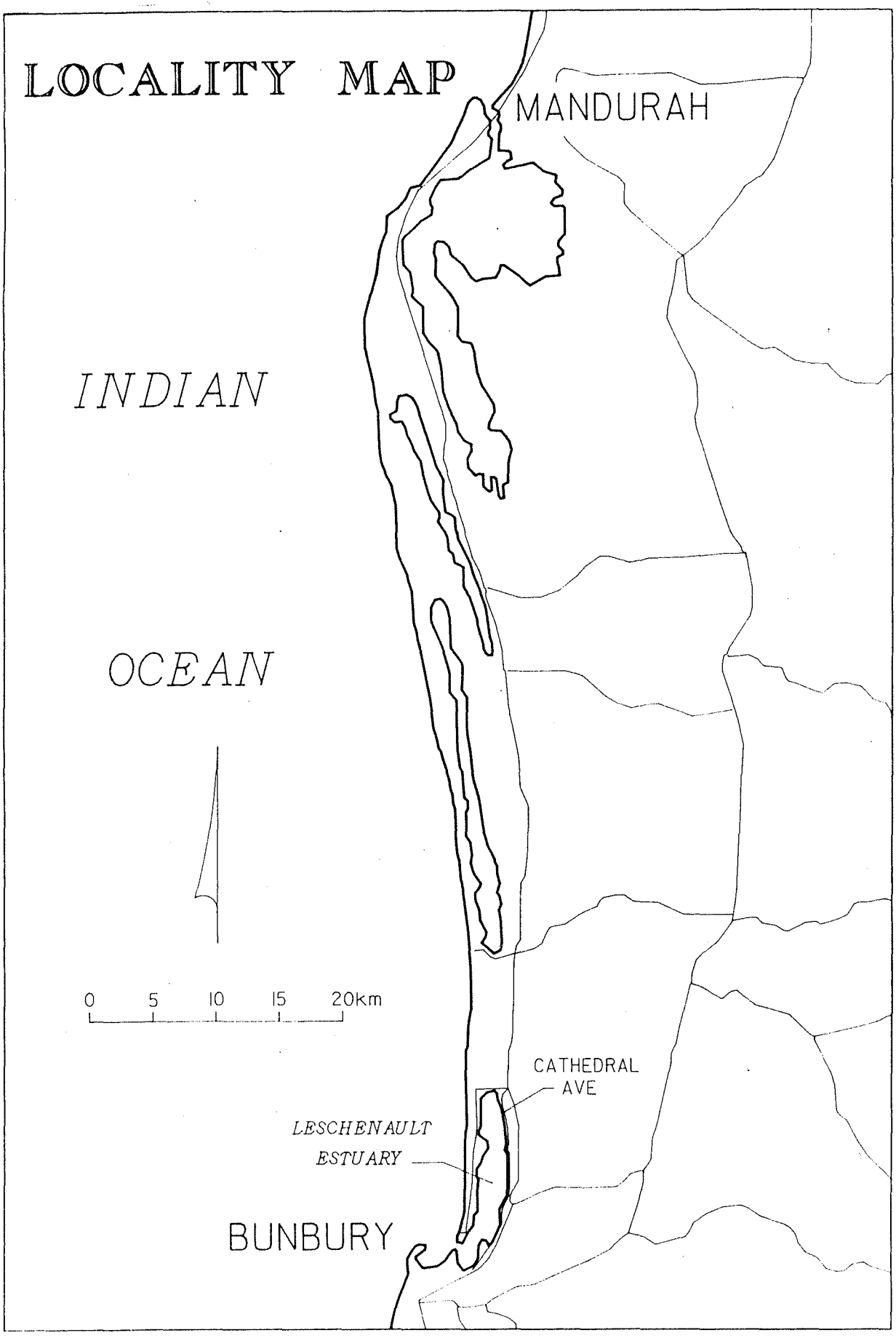
* urban encroachment near wetlands and rivers
* lack of concern for preserving the natural environment and wildlife movement corridors
* loss of wetlands.

Suggested changes included:

* developing flora and fauna corridors to protect species diversity, such as along roadsides and river systems
* conservation remnant vegetation
* protection of wetlands, river systems and groundwater
* consideration of flexible approaches where competing land uses occur.

A number of submissions to the present study made the comment that the area should remain 'natural'. The Working Group found that it was difficult to define what was natural. For this reason a series of photographs have been taken of the area and other places around the estuary and rivers. A workshop will be conducted during the public comment period to enable people to say on what aspects of the landscape they consider are important and how these may be enhanced if appropriate.

Figure 2


LOCALITY MAP
MANDURAH
INDIAN
OCEAN
0 5 10 15 20km
CATHEDRAL AVE
LESCHENAULT ESTUARY
BUNBURY

2. AIM AND OBJECTIVES

The aim of the planning study is to:

> **Develop a plan to assist in determining development and conservation of all land and waters within the study area.**

The plan will provide a vision for the future as well as guiding development for the next 20 years and beyond.

It is recognised that the estuary is a living system and its integrity should be maintained and sustained to the greatest extent possible and that all proposed uses should be evaluated in terms of their capacity to adversely affect the system. The estuary forms the basis of a landscape unit which is of regional importance.

2.1 Objectives

2.1.1 Land use planning

Primary objective

Identify land uses that are compatible with the conservation of the estuary and foreshores.

Specific objectives

- Identify areas suitable for particular land uses.
- Determine suitable sizes for subdivision lots.
- Ensure as far as possible that people have the freedom to make decisions as to how they enjoy tenure of their land without adversely impacting on the surrounding land uses and estuary.

2.1.2 Conservation

Primary Objective

Conserve and enhance the natural environment.

Specific Objectives

- Implement relevant System 6 recommendations.
- Develop a strategy to protect the public and foreshore vegetation from fires.
- Enhance wetland areas.
- Maintain and enhance fauna habitats.

2.1.3 Water quality

Primary Objective

Protect the estuary and its foreshores from pollution.

Specific Objectives

- Determine nutrient leaching to the estuary from particular land uses and develop criteria.
- Recommend land use controls for areas outside the study area.
- Investigate alternative technologies to reduce nutrients reaching the estuary.

2.1.4 Recreation

Primary Objective

Provide opportunity for environmentally sensitive recreational use and public enjoyment of the estuary and foreshore areas.

Specific Objectives

- Manage public open space.
- Enhance existing recreation areas and features.

2.1.5 Public Education and Involvement

Primary Objective

Educate the public on the environmental value of the area.

Specific Objectives

- Involve the public with the ongoing management of the area.

2.1.6 Landscape Protection

Primary Objective

Conserve and enhance the scenic and aesthetic values of the estuary, foreshores and escarpment.

Specific Objectives

- Maintain the rural character of the flood plain.
- Ensure appropriate zoning to maintain the natural character of the area.
- Determine what aspects of the landscape are important to the public.

3. THE STUDY AREA

The study area is defined as the land and waters contained within the area bounded by Buffalo Road in the north, the immediate catchment area to the escarpment in the east, the road on Leschenault Peninsula and Elinor Bell Road to the south (See Figure 3).

The study area is limited to these boundaries in terms of planning and development, however for issues of water quality and nutrient enrichment the relevant drainage area will be used.

The Leschenault Estuary is located in the Bunbury region of Western Australia (33° C 21' S 115° C 42' E). The region experiences a Mediterranean climate with rainfall mainly occurring from May to August (871 mm annually). The average annual rainfall is about 1000 mm.

The two main tributaries of the estuary are the Collie River and the Preston River. The former flows in from the east. The Preston River feeds into the estuary from the south-east. Parkfield Drain feeds into the north of the estuary within the study area.

During the initial round of public consultation concern was expressed about the boundary of the study area. Comments indicated that it was not possible to relate it to nutrient leaching problems to the estuary. Accordingly this report will draw upon relevant studies and will report to Leschenault Catchment Coordinating Group (previously called the Leschenault Integrated Catchment Management Steering Committee) regarding the issue of nutrient leaching etc. Alternatively if the report of LICMSC is available these recommendations will be included.

3.1 The Physical Environment

3.1.1 Soils and Geomorphology

The Australind-Leschenault Estuary area is situated in the southern part of the Swan Coastal Plain.

The study are contains three major geomorphic units.

1 Leschenault Estuary which is a narrow, protected intertidal lagoon

Leschenault Estuary is described by Wurm (1987) as having developed behind a Holocene barrier dune system 8000 years ago, and has been an estuarine lagoon ever since. The estuarine lagoon contains samphire and sedge flats (tidal), sand shoal and platforms and an interior basin (Semeniuk and Meagher, 1981).

The Leschenault Estuary contains three main geomorphic subunits, the main features of which are related to depth of water (Semeniuk and Meagher, 1981).

The samphire and sedge flats are shoreline flats covered by high tide and storm event water levels. Sediments underlying the surface in this zone are variable and include root structured muds, sand mud mixtures and muds mixed with organic detritus. Substrates are grey to black sand sediments containing organic detritus and iron sulphide (Semeniuk and Meagher, 1981).

Sand shoals and platforms occur along both sides of the estuary between mean high water mark and 0.2 m below mean low water mark. Sediments of shoals and platforms are derived from quartz calcareous sands along the west shore, quartz sand along the eastern shore and coarse quartz and feldspar sand entering the estuary from river systems (Semeniuk and Meagher, 1981; Wurm, 1987).

The top layers of sediment are well bioturbated by crustaceans, worms and fish. Benthic fauna contribute shells and skeletal silt to the sand sediment, resulting in sediments having proportions of shelly sand, muddy sand and burrowed sand (Semeniuk and Meagher, 1981).

The interior basin occupies the deeper part of the estuary, below the 0.2 m mark and reaches a maximum depth of 1 m below mean low water mark (2.5 to 3 m deep at times of high water levels). Grey to brown mud and muddy sand make up the basin floor, and benthic fauna bioturbate the sediment, and contribute some shell to the muddy sand.

2 Leschenault Peninsula, which is a narrow barrier of dunes recognised as the Quindalup System.

The western margin of the estuary features migrating dunes of Quindalup Dune System. Intermittent migration of the dunes has created exposed sand promontories and sheltered embayments in the estuary (Wurm, 1987).

Only the eastern perimeter of the Leschenault Peninsula lies within the study area. This area contains mostly samphire and sedge flats, with some vegetated dunes, woodland plain and occasional bare and mobile dunes (Semeniuk and Meagher, 1981).

The Quindalup Dune System consists of calcareous sand and is characterised on the Peninsula by both mobile parabolic dunes and vegetated, smooth profile older dunes (McArthur and Bartle, 1980). The samphire and sedge flats area fringing the peninsula consists of deep mud substrates, and sediments composed of sand mud mixtures.

3 A hinterland, composed of Bassendean, Spearwood and Blythewood units.

The eastern margin of the estuary is composed of low lying quartz sand plain within the Spearwood Dune System. The main landform units are composed of sedimentary materials and are described by Semeniuk and Meagher (1981) as:

Tamala Limestone (Spearwood System), and

Quartz sands overlying the Spearwood Dune System and Bassendean Dune System, and

Estuarine lagoon and river sediments - Vasse and Blythewood Systems.

The Tamala Limestone Formation consists of wind blown and marine sediments, and is represented by ridges in the Spearwood Dune System (McArthur and Bartle, 1980).

McArthur and Bartle (1980) describe the main ridge in the Australind area as one occurrence of the Spearwood Dune System. The system consists of a core of Tamala Limestone with a capping of secondary calcite, overlain by siliceous sand.

The soils developed in the sands of the Spearwood Dunes are described by McArthur and Bartle (1980) as being podzolic (poor acidic forest soil). The deeper soils (Karrakatta Sand are divided into two phases. The grey has a typical undulating landscape with grey sandy surface and a very light grey to white subsurface passing into pale yellow sand within 1 metre. Limestone can occur below the yellow sand, but varies in depth (McArthur and Bartle, 1980).

The yellow phase of Karrakatta Sand occurs in a hilly landscape of higher topographical position than the grey phase. It consists of a grey-brown surface passing into a bright yellow sand and limestone usually occurs within one metre (McArthur and Bartle, 1980).

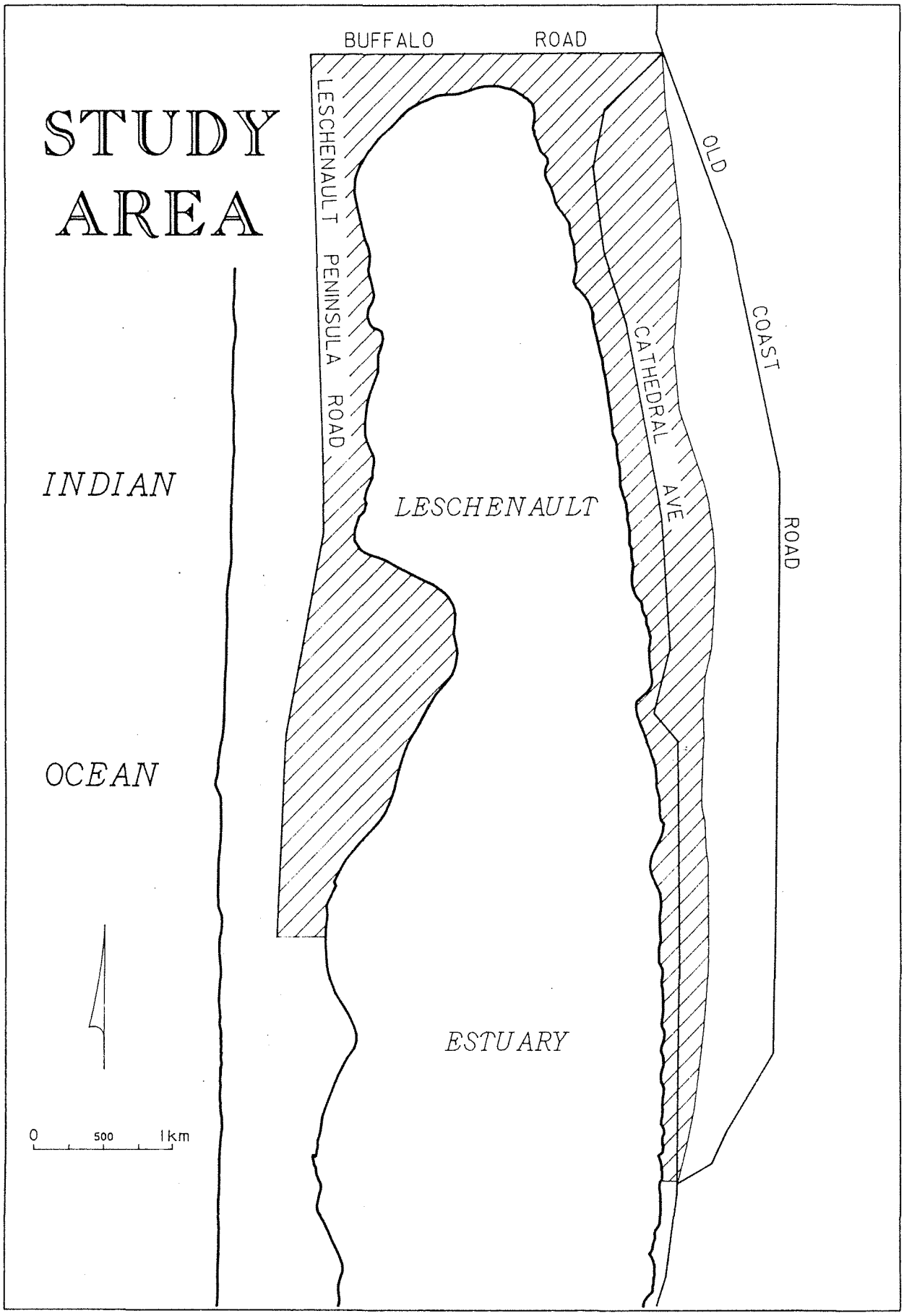
McArthur and Bartle (1980) show the soils between the Collie River and the Australind townsite as being yellow phase Karrakatta Sand. The ridge to the north of the Australind townsite (Leschenault Escarpment) is shown as being grey phase Karrakatta Sand.

The estuary fringe (including the estuary flats along Scenic Drive) are described by McArthur and Bartle (1980) as being grey siliceous and overlying soft shelly limestone, and may also include a thin layer of yellow sand over the limestone.

In November 1989, Australian Groundwater Consultants (AGC) carried out an environmental study of a small area on the eastern margin of the Leschenault Estuary. The study found that the Leschenault Escarpment consisted of Karrakatta Sand System to 30 m elevation, with soils consisting of yellow and brown medium grained sands overlying limestone at depth.

Wetlands and swamp areas between the estuary and the higher ground to the east of the study area have soils consisting of surface peaty sand of approximately 0.3 m depth, overlying a blue/grey or grey sand with orange or brown mottling decreasing with depth. The estuary shore consists of dark grey to black peaty sand at the surface, grey and blue/green slightly

Figure 3


STUDY AREA
BUFFALO ROAD
LESCHENAULT PENINSULA ROAD
CATHEDRAL AVE
OLD COAST ROAD
INDIAN OCEAN
LESCHENAULT ESTUARY
0 500 1km

clayey medium grained sand to one metre, and grey or grey/brown slightly clayey sand and shell fragments to two and a half metres.

AGC describe a low sand dune immediately east of the estuary shoreline alluvial deposits. The low dune is approximately 3 m relief and has soils of dark grey medium grained sand to 0.3 m, with light orange/brown medium grained sand to greater than 2.5 m depth. Although this soil type is generally associated with limestone, AGC did not find any in this zone during their investigation.

The AGC descriptions of the higher ground to the east of the study area coincide with McArthur and Bartle's (1980) description of Karrakatta grey phase soils. The two reports also coincide in the descriptions of soils along the estuary fringe and flats area.

3.1.2 Landscape

The vegetation of the region is determined by the soil types and landforms. Much of the area has been cleared for agricultural purposes.

Along the coast associated with the Quindalup Dunes, the main species are wattles, Swan River cypress and Rottnest Island tea-tree. Inland one or two kilometres eucalypts occur on the Spearwood Dune System. Initially these are tall open stands of tuarts and peppermints, however the number of jarrah and marri increase to the east on the deeper soil.

Further inland on the Bassendean Dune System are open forests of banksia, pricklybark and sheoak, with diverse understorey shrubs.

On the Pinjarra Plain and Ridge Hill Shelf, the vegetation was originally jarrah and marri. Large areas have been cleared for agriculture, however some Marri has been retained as open grassed woodland. Wandoo occurs on the clay fields, swamp sheoak on the more poorly drained saline soils and flooded gum along the watercourse (Taylor and Burrell, 1985).

Salim (1985 in Klemm et al 1987) estimates that the majority of the coastal plain and approximately 20% of the plateau forests have been cleared for agriculture.

3.1.3 Estuarine Hydrology

Water depth in the estuary varies from 0.3 m on the shallow sand flats on the eastern edge to 2.0 m in the central channel. Due to the shallow nature of the estuary, water temperature is dictated by air temperature resulting in a diurnal and seasonal change. Summer water temperature is about 25 ^{o} C and winter 14 ^{o} C.

The salinity of the estuary changes seasonally and according to distance from the Cut. The salinity of the river waters varies seasonally, depending on whether the runoff is from cleared land or from the forested coastal plain. During heavy winter rainfalls fresh water flows from the rivers into the estuary forming a fresh layer over the salt water. In summer when freshwater flow is minimal the salt water from the estuary penetrates upstream sliding in underneath the fresher river water. As summer progresses mixing of fresh and salt water occurs. In winter fresh water also flows from the Parkfield Drain into the northern estuary. In contrast this area tends to become hypersaline in summer due to tidal influence and evaporation.

The tidal regime of the estuary is similar to that of the ocean indicating good water exchange with the ocean.

3.1.4 Groundwater and Surface Water Characteristics

LIMA is undertaking an extensive and long term study to estimate nutrient inputs to the Leschenault Estuary. As part of this study Geological Survey was contracted in 1991 to estimate the groundwater nutrient input to the estuary.

Results indicate that groundwater discharge via submarine discharge direct to the estuary occurs south of the study area. In contrast groundwater discharge in other areas around the estuary occurs via discharge to fringing vegetation or springs occurring on the foreshore. For example, adjacent to Waterloo Head groundwater appears to be discharged to springs where waterbirds congregate.

FIG. 4

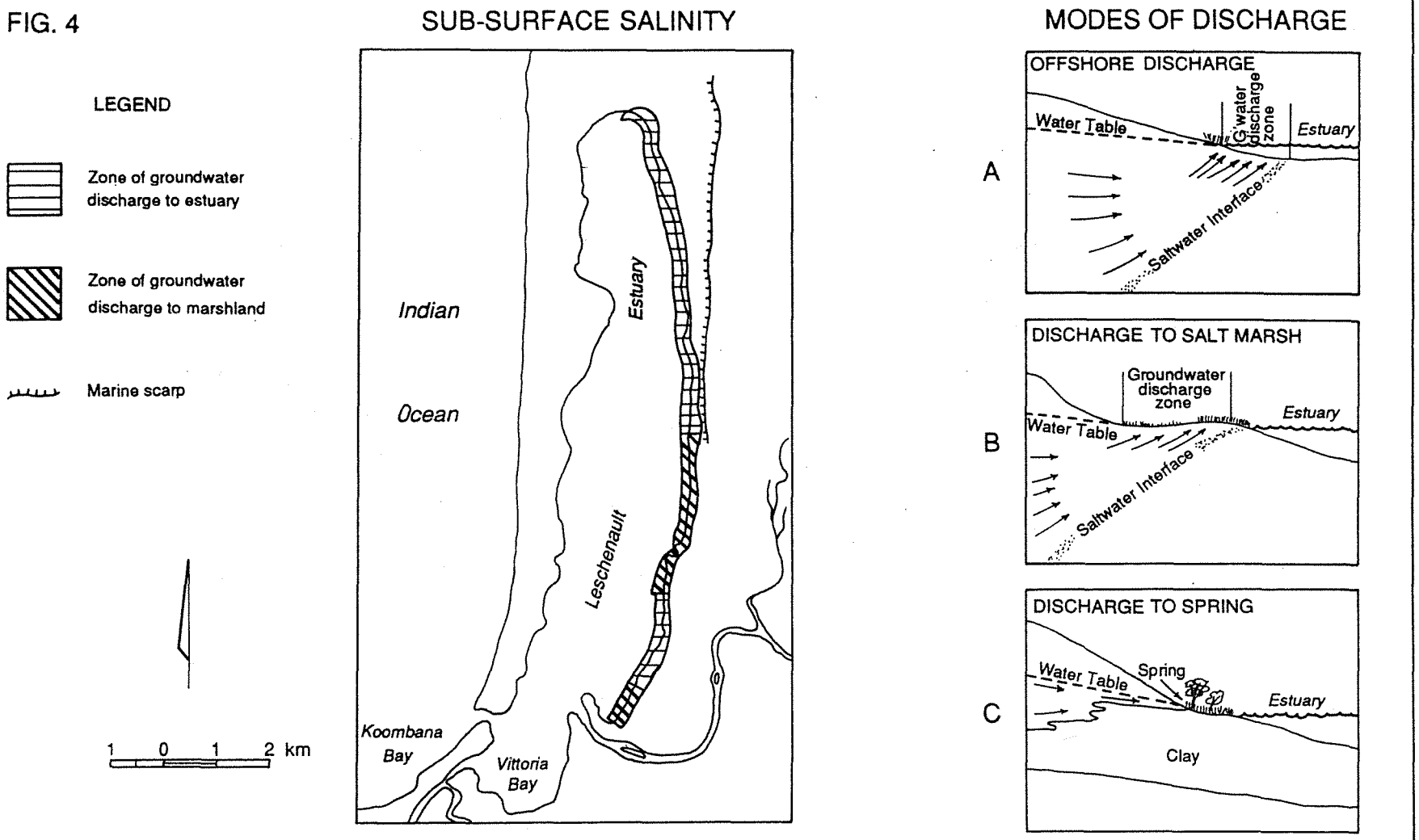


Figure 4 Sub surface salinity / modes of groundwater discharge

(Appleyard,1992)

Appleyard (1992) comments that it is likely that groundwater discharge on the eastern shore of the estuary is partially controlled by topography and the degree of urban development. A low, north-south trending scarp runs along the eastern side of the estuary. In the south, this scarp is located close to the estuary, but to the north the distance between the scarp and the estuary increases, and a broad area of low lying, marshy land borders the estuary.

Fresh groundwater discharge to salt water estuaries takes place at a salt water interface, where low density, fresh groundwater is forced by gravity to ride over a wedge of denser salt water. What this means is that the groundwater is able to rise to the surface along the low lying land on the north-eastern foreshore. This surface water then enters the estuary via a network of small drains running into the estuary. In contrast further south it appears groundwater is discharging into the estuary or very close to it.

3.1.5 Interrelationships

Geological examinations of the study area indicate that the soils have a limited capacity to bind the nutrients phosphorus and nitrogen. This combined with the fact that groundwater is being discharged to the surface on the low-lying lands along land to the east of the estuary means that nutrients can reach the estuary in surface waters. Currently nutrient levels from this source appear to be low and nutrient levels in this part of the estuary are considered acceptable given the hydrological characteristics of the area. However changes in land use may increase nutrients coming from these lands. Strategies need to be developed to minimise nutrients entering the estuary via this mechanism. These strategies should be twofold. First to minimise nutrients coming from these lands and second to intercept nutrients coming from these lands before they reach the estuary.

The landscape of the study area has been cleared since early European settlement. It still however remains a landscape of regional importance because of its proximity to the estuary and the pressure from urban development. Attempts to intercept nutrients before they reach the estuary need to consider the current and past landscape of the area.

3.2 The Biological Environment

3.2.1 Flora

The flora of the estuary can be divided into two broad categories: aquatic and terrestrial. The greatest mass of living plant material in most estuaries is the seagrasses and the fringing salt marsh plants. Plants play an important role in the ecosystem of the estuary by:

- recycling nutrients,
- filtering pollutants, sediments and nutrients,
- providing a habitat and food source for bacteria and fauna, and
- protecting the foreshore from erosion.

Salt marsh vegetation is extremely productive and a source of detritus and bacteria. within the salt marsh the vegetation supports a range of detritivores and herbivores, such as amphipods, mosquitoes and grass hoppers. In turn a range of invertebrates, such as spiders, and vertebrates, such as birds and fish, will visit the marsh to prey upon these animals. Aquatic plants such as seagrass and alga may be present in tidal pools and provide seasonal food for ducks and other animals. On exposed banks micro-algae will almost certainly be present. These will be washed out on ebb tides to become a temporary part of the estuarine plankton available to filter feeders. Any decrease in this biomass can reduce the productivity of the estuarine system.

3.2.1.1 Aquatic

The aquatic flora (plants) of the estuary can be divided into three main groups:

- phytoplankton (microscopic algae),
- seaweed (macroscopic algae), and
- seagrasses.

The dominant types of seagrasses and algae occur mainly on shallow water marginal shoals and platforms which form the majority of the area within the northern Leschenault Estuary. Figure 5 shows the distribution of aquatic plants of the estuary. Compared with the northern estuary the southern waters are low in both species diversity and biomass.

3.2.1.2 Terrestrial

A recent study by Pen (1992) indicated that there are 28 plant communities fringing the estuary. Eight of the vegetation types are characterised by a high degree of replacement of native species by weeds, particularly grasses.

Since 1941 many changes have occurred to the vegetation the main ones being:

- a decline of estuarine fringing forest, the encroachment of the estuary by the shore-rush *Juncus kraussii*,
- colonisation of sandy river deltas by native vegetation,
- the formation of a vegetated tidal lagoon, and
- between 1941 and 1989 about 346 ha (approximately half) of the fringing vegetation has been lost through clearing, chiefly in the northern and southern regions of the estuary.

A variety of grasses are invading the *Juncus kraussii* closed rushland along the eastern foreshore and there are local infestations of *Acacia saligna, Typha orientalis, Bolboschoenus caldwellii, Paspalum distichum* and *Asparagus asparagoides*. Changes to the drainage regime in the north-eastern corner of the estuary foreshore have had minimal effect on the native vegetation in that region.

The most substantial losses of fringing vegetation have occurred to the north of Buffalo Road through clearing and drainage for agriculture. Although stands of vegetation currently exist north of Buffalo Road these communities no longer constitute the fringing vegetation of the estuary. This is due to the imposition of the Parkfield Drain and Buffalo Road which altered the ecological and hydrological characteristics of the northern estuarine system. Substantial stands of the *H. halocnemoides* low closed heath and fringing forests of most probably *M. cuticularis*, *M. rhaphiophylla* and *Agonis flexuosa* have been lost north of Buffalo Road. Much of the narrow strip fringing vegetation along the eastern foreshore has been cleared on the landward side leaving an even more narrow strip today. Relic trees present over pastured flood plain along Cathedral Avenue and south of Buffalo Road, which falls within the study area, indicate that this area once supported *Melaleuca rhaphiophylla* low closed forest, *M. rhaphiophylla - A. flexuosa* low closed forest, and forests and woodlands dominated by *E. gomphocephala* and/or *A. flexuosa*.

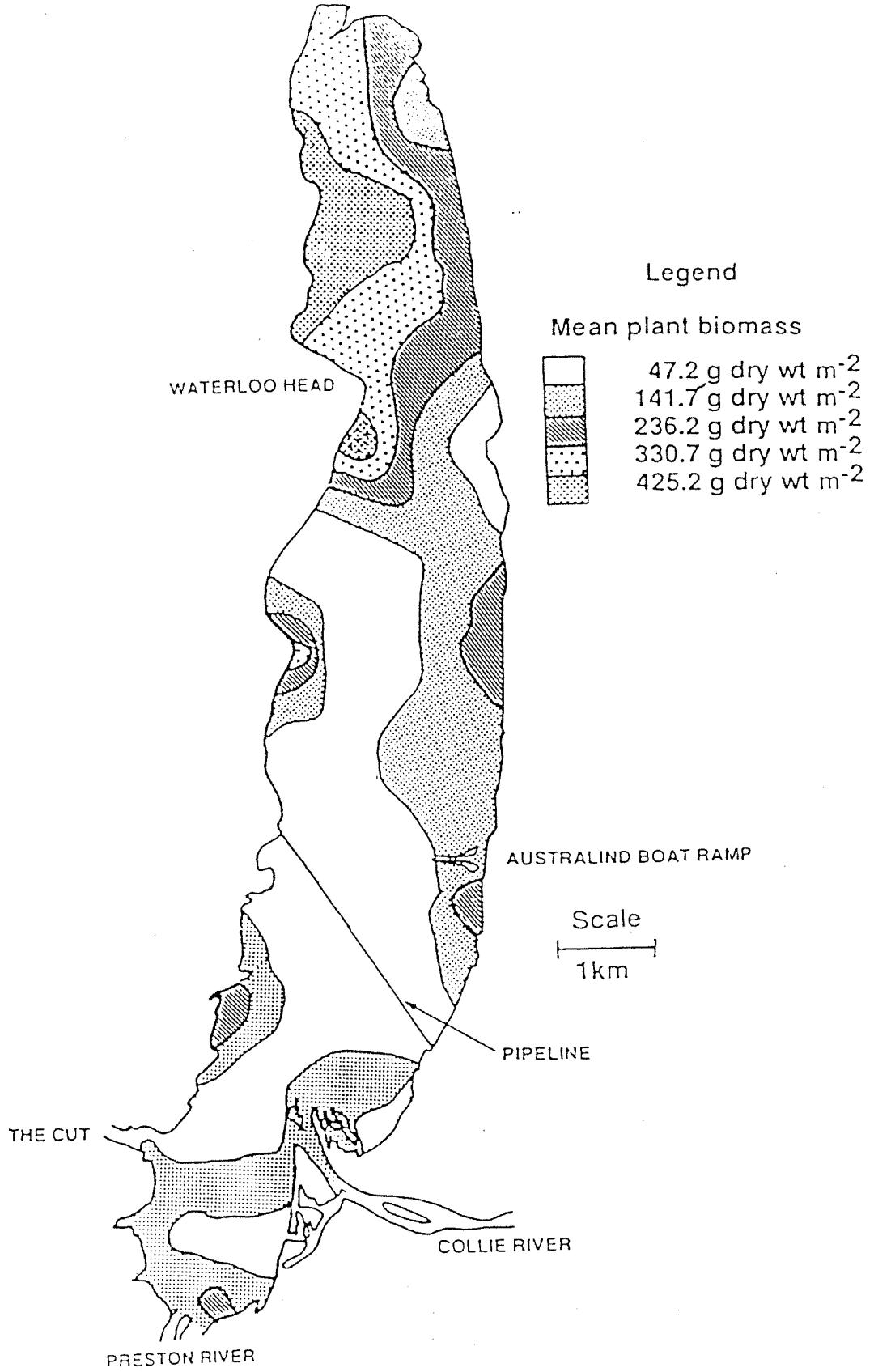


Figure 5 Plant biomass

Distribution of plant biomass in Leschenault Inlet on 13 November, 1984. The data are divided into 5 equal size classes between 0.01 and 472.4 g dry weight m^{-2}.

The death of fringing forest in the lagoon area north of Crimp Cr. is almost certainly due to a general increase in salinity brought about by artificial drainage (Fig 6). This is also indicated by the death of *J. kraussii* which very probably once formed the understorey of the forest, and its replacement by samphire species and by a stand of Typha in one corner of the lagoon. The replacement of Juncus by samphire indicates a recent increase in salinity while the bulrush infestation suggests strong localised flushing caused by artificial drainage of the adjacent waterlogged pastures. In other words a steady year long flushing of the lagoon area by groundwater has been replaced by a more centralised drainage, causing an increase in salinity over most of the area and a decrease in salinity in specific areas, probably at certain times of the year only.

There is some evidence of recent fringing forest regeneration. A small stand near Crimp Cr. of *M. viminea* low open-closed forest, which is associated with very saline conditions, has been slowly growing in size since at least 1941.

In most areas of the estuary where the foreshore is fringed with *J. kraussii,* the species is growing into the estuary, moving across the *Sarcocornia quinqueflora* complex beach sands or the sandy estuarine substrate. This can be seen clearly by the growth of rhizomes and tapering leaf height; the smaller leaves being present at the growing end of the rhizome. Photographic evidence suggests a rate of growth into the estuary of the order of 5-20 m over the last 50 years. This encroachment of fringing sedges and rushes may be caused by a reduction in mean water level over the winter months as a result of the Cut.

The small tree and native weed *Acacia saligna* is enjoying considerable success along the north-eastern foreshore where it is favoured by frequent fires. It is common member of freshwater fringing forest communities and has formed its own fringing forest in some areas.

3.2.2 Fauna

3.2.2.1 Aquatic

A number of studies have been undertaken to assess invertebrate populations in and around Leschenault Estuary. A study by Van der Wiele (1988) showed much higher counts for both species and number of individuals in northern Leschenault Estuary. Counts appear to decrease towards the southern end of the estuary. Core samples indicate that the top 100 mm of sediment contained the majority of benthic animals with some larger molluscs found below this level.

Halse et al. (1989) recorded 101 species of invertebrates from their study of the intertidal zones around the estuary (mudflats and saltmarsh). The diverse invertebrate fauna of these areas indicate a high environmental quality. Studies conducted on both the waterbird usage and the invertebrate fauna of the estuary have demonstrated that the estuary has significant value in a regional context.

The estuary and rivers are used in three ways by fish and crustaceans: permanent breeding, nursery habitat for juveniles, and occasional feeding area for maturing and mature adults. Factors influencing utilisation and distribution of fish and crustaceans are salinity, temperature, the amount of oxygen available in the water, turbidity and available food and shelter.

For most species making up the commercial and amateur catch the estuary is a nursery habitat for juveniles. Species include the mullets, whitings, silver bream, tailor, mulloway and the blue manna crab. Abundant food, and shelter from both predators and the less protected marine environment influence the utilisation of the waterways by these species.

Species which visit the estuary as a feeding area for maturing and mature adults include herring, skipjack, scaly mackerel, blue mackerel and most sharks and rays. This group forms only a minor part of the commercial and amateur catch from the estuary, only venturing into the estuary when salinities are similar to sea water.

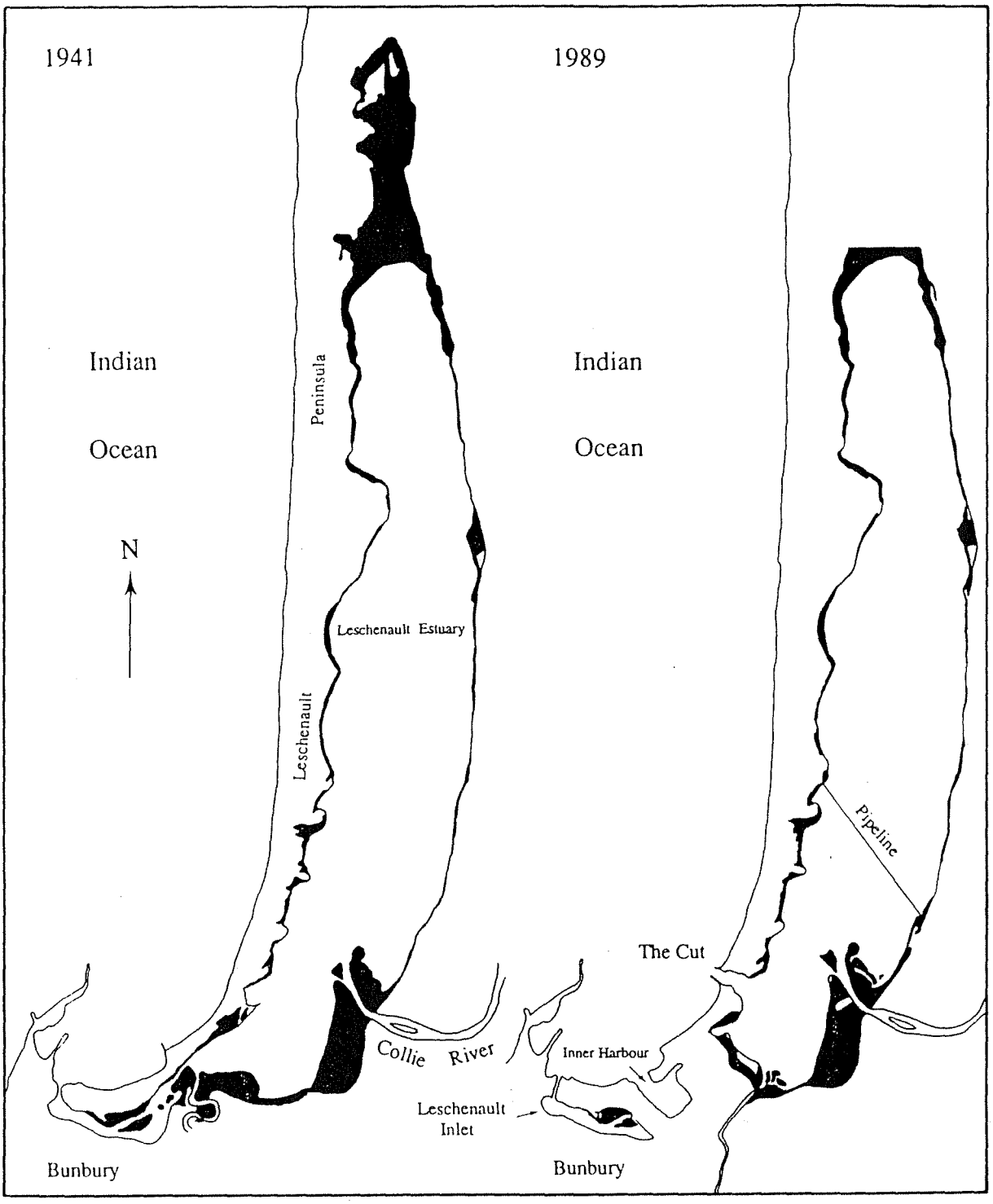


Figure 6 Extent of fringing vegetation

Schwinghammer (1982) reports that the shallow banks and platforms supporting seagrass and algae are important nursery habitats for many fish species. Crabs appear to rely to some extent on algae (Meagher, 1971) and the benthic invertebrates (fauna) (LeProvost et al., 1983) for their food source.

In contrast there are six basic food sources in the estuary for fish. These are benthic fauna, zooplankton, macroalgae, phytoplankton, seagrass and organic matter. The northern estuary has an abundance of these food sources.

Salt marshes are the major source of mosquitoes in the Leschenault Estuary region. Mosquitoes can be a major nuisance to people living near or visiting parts of the estuary. They are also carriers of disease. Two species which occur in the Leschenault Estuary region:

Aedes vigilax and

Aedes camptorhynchus

These are known to carry the Ross River virus. Mosquitoes breed in pools and puddles left behind after high tides. Eradication of mosquitoes and their habitats is not a simple solution to the problem. The areas where mosquitoes breed are important feeding areas for birds and mosquitoes are a major part of the diet of some species.

Mosquito breeding sites and control options have been identified by Chester and Klemm (1990). Sites are marked on Figure 7. Recommended control is by aerial larviciding. Currently Abate is being used however a formula is being developed for use of Bti by air. Physical modification is not recommended.

3.2.2.2 Terrestrial

Terrestrial fauna is mainly restricted to waterbirds. Snakes, waterrats, lizards and kangaroos would be expected to be present however these have not been documented. Populations of feral animals such as foxes, rabbits and cats exist on the peninsula and would therefore be expected within the study area. CALM has a control programme for feral animals on the peninsula.

Ninox (1989) reports that 62 species of waterbirds use the estuary and that the tidal saltmarshes are an integral and necessary part of the estuarine system providing rich intertidal and freshwater feeding areas for a large proportion of these species. These tidal marshes are the only areas where breeding takes place and which can provide refuge for young waterbirds. The estuary is considered important for the little egret, grey plover, bar-tailed godwit and great knot. These birds have been counted in higher numbers at very few wetlands besides Leschenault. It is a crucial feeding area for the Great Egrets which breed at Mongarel (Laporte) Swamp. As a permanent wetland, it is a significant drought refuge for ducks, swans and other groups of waterbirds.

Ninox (1989) listed as areas of conservation significance all fringing wetlands along the extreme northern and western shoreline, the Preston River mouth, Laporte Swamp, Marriott Road Swamp, Anglesea Island and associated mud flats. Waterbird sites are marked on Figure 7.

Site 22 is a large composite sampling area established to cover the highly disturbed eastern shoreline of the estuary. In general, this shoreline is unproductive in species because of a lack of diversity of habitat. However, within Site 22 there is a dense, relatively undisturbed area of sedgeland, samphire marsh and *Melaleuca rhaphiophylla* low, closed forest situated on the portion of the shoreline projecting into the estuary. This area, and several other small, unsurveyed patches on the eastern shoreline, may appear to be of low significance during periods of low tidal amplitude but act as rich feeding, breeding and refuge areas when flooded. At this time they also support high levels of mosquito breeding which necessitates them being treated.

Van der Wiele (1988) reports that the northern Leschenault Estuary is an important spring and summer refuge for ducks and swans which feed on the seagrasses and filamentous algae. Other birds such as pelican, greenshank, white egret, white-faced heron, pied stilt and white-headed stilt also utilise the northern estuary as an important feeding area, at certain times of the year (Van der Wiele, 1987; Ninox, 1989; Morrissy; 1970).

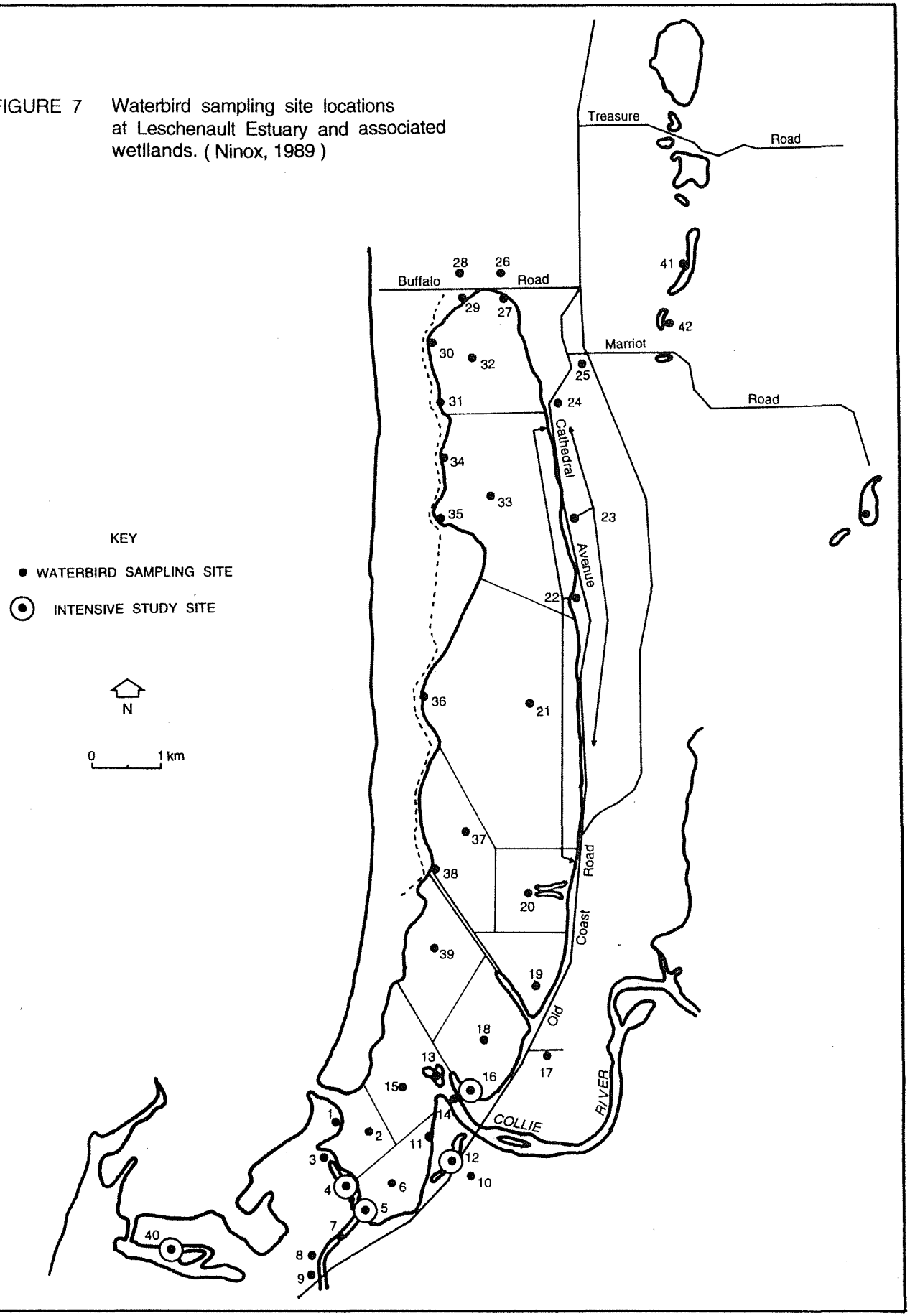
The area along the north-eastern side of the estuary (Cathedral Avenue) has been identified as being the most productive duck breeding area found. The presence of seagrasses and high numbers of invertebrates in the northern Leschenault Estuary is significant for black swans and many species of duck that require a relatively shallow water depth and profile for successful feeding.

Darters and great cormorants breed in the wetlands at Kemerton and feed their young mainly on small fish from Leschenault Estuary. Leschenault is the only estuarine fish nursery close to Kemerton where large concentrations of suitable sized fish occur (Ninox, 1989).

Most wading birds feed on polychaetes, amphipods and occasionally molluscs from tidal mudflat areas (Halse et al., 1989).

(Plate 2 : Exposed tidal flats are important feeding grounds for wading birds.)

FIGURE 7 Waterbird sampling site locations at Leschenault Estuary and associated wetlands. (Ninox, 1989)



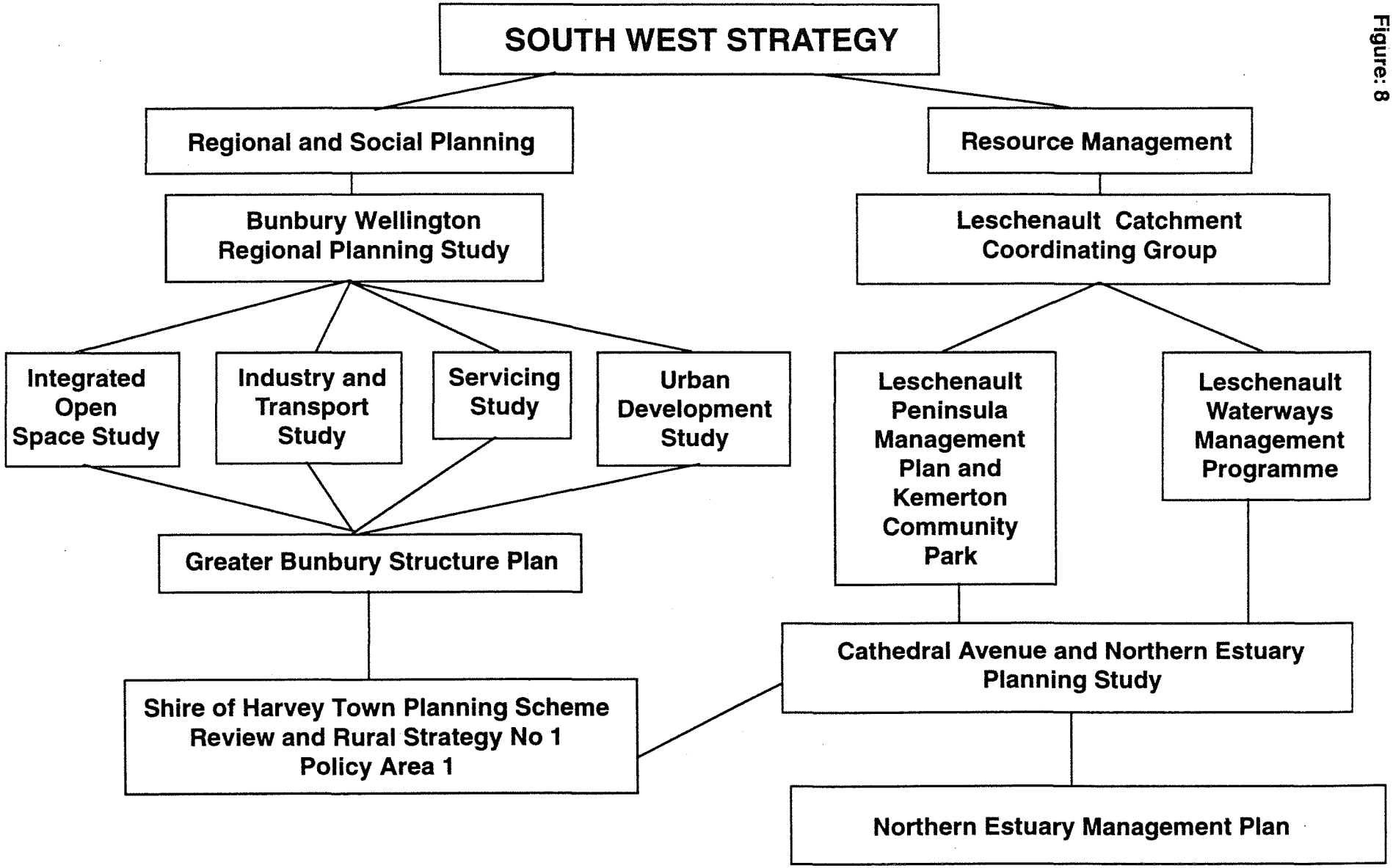

SOUTH WEST STRATEGY
Regional and Social Planning
Resource Management
Bunbury Wellington Regional Planning Study
Leschenault Catchment Coordinating Group
Integrated Open Space Study
Industry and Transport Study
Servicing Study
Urban Development Study
Leschenault Peninsula Management Plan and Kemerton Community Park
Leschenault Waterways Management Programme
Greater Bunbury Structure Plan
Cathedral Avenue and Northern Estuary Planning Study
Shire of Harvey Town Planning Scheme Review and Rural Strategy No 1 Policy Area 1
Northern Estuary Management Plan

Figure: 8

4. LAND AND WATERWAY PLANNING AND MANAGEMENT

4.1 Roles and Responsibilities

The management of the estuary and its foreshore is undertaken through the co-operation of a number of agencies. In respect to the study area, management responsibilities are distributed amongst :

* the Leschenault Inlet Management Authority (LIMA)
* Shire of Harvey
* Department of Conservation and Land Management (CALM)
* Department of Transport (DOT)
* Fisheries Department
* Department of Planning and Urban Development (DPUD)
* South West Development Authority (SWDA)
* Water Authority of Western Australia (WAWA)

Each is involved to differing degrees at various stages in the planning process. To detail every agency's role and responsibilities would require a greater proportion of the document than its present import justifies. Suffice, an explanation of the interrelationships shall be limited to the principal players, SWDA, LIMA, DPUD and the Shire of Harvey. A more comprehensive description can be found in the Leschenault Waterways Management Programme 1992.

The South West Development Authority encourage, promote, facilitate or assist economic and social development in the South West Region. The release of the South West Strategy created a blueprint by which all other agencies could develop policies consistent with the proposed vision of the South West.

The Department of Planning and Urban Development's role in relation to the Leschenault area is to :

* control the subdivision and development of land
* promote and provide for the appropriate use and zoning of land
* ensure public access to and around the waterways
* ensure compatibility of any proposed development within the waterway environment
* minimise the environmental impact of development
* develop and promote the Bunbury-Wellington Region Plan and the Greater Bunbury Structure Plan

The Shire of Harvey have a similar role to that of DPUD but their responsibilities are focused toward an increasingly local level. Furthermore, local authorities provide recreational facilities as well as manage and maintain foreshore reserves. The Shire of Harvey formalise their planning policies through their current Town Planning Scheme No 10, soon to be superseded by the proposed Town Planning Scheme No1 which will incorporate their Rural Strategy.

Finally, the Leschenault Inlet Management Authority is involved in the planning process purely at an advisory level. LIMA's technical expertise in environmental matters relating to waterways is often used by other agencies such as DPUD and the Shire of Harvey to minimise the impact of developments on the estuary and rivers. LIMA is also responsible for estuarine and river

water quality, catchment management and the day-to-day management of the foreshore. The concerns, subsequent policy and recommendations of the Authority are outlined in the Leschenault Waterways Management Programme 1992.

4.2 Studies and Recommendations

A number of other studies are occurring concurrently with this study. In an effort to clarify the role of each study and determine how they relate the following explanation is provided. Figure 8 illustrates their relationship to each other.

4.2.1 Leschenault Waterways Management Programme

The Leschenault Inlet, Estuary and its tributaries provide a major recreational focus for the population of the Bunbury Region. The safe waters, abundant crabbing and fishing and proximity to Perth and the South West make it an ideal holiday destination. It is important that the waterways and catchments are managed in order to maintain their recreational importance as well as conserve the flora and fauna.

The Leschenault Inlet Management Authority was established in 1977. Its primary role is to conserve and enhance the waterways and associated foreshores.

The first Leschenault Inlet Management Programme was gazetted in 1983. In 1990 it was reviewed to bring it up to date with the current issues facing the Leschenault waterways.

Since the original programme was gazetted the population of the Bunbury Region has grown and a number of new industries have been established or are planned for the area. In addition a number of studies have been completed which add to the knowledge of the estuary and its flora and fauna.

The 1992 Management Programme supersedes the 1983 report.

It is the aim of the programme

> "To fulfil the demands for use and development in so far as they are consistent with the conservation and enhancement of a functional healthy estuarine environment for the enjoyment of present and future generations."

In order to achieve this aim it is recognised that the waterways are a living system and their integrity should be maintained and sustained to the greatest extent possible. This means that a wide range of biological and physical functions should be retained and all proposed uses should be evaluated in terms of their capacity to adversely affect the system.

A wide range of issues were addressed in preparing the management programme.

- LAND USE AND WATERWAY PLANNING
- CONSERVATION AND ENVIRONMENTAL PROTECTION
- RECREATION AND TOURISM
- PUBLIC EDUCATION
- NAVIGATION AND BOATING SAFETY
- FISHERY MANAGEMENT
- LIAISON AND CO-ORDINATION
- MANAGEMENT

General recommendations relating to this study include:

- It is proposed that environmental considerations be incorporated into town planning schemes. Similarly policies detailing the planning, development and maintenance of foreshore areas are recommended for incorporation into local town planning schemes.

- The programme sets criteria for the establishment of foreshore reserves to ensure these reserves are of sufficient size to provide for public access and recreation while conserving and enhancing flora and fauna.

- The need to fund alternatives to acquisition is recognised. Given the broader nature of this problem it is recommended that it be addressed on a Statewide basis.

- Criteria are identified for assessing commercial development proposals for the foreshores and waterways. Similarly, criteria for urban development will ensure that the impact on foreshore areas is minimal.

- The mud and shallow banks of the estuary are an important shelter and feeding habitat for the fauna of the estuary. It is essential that these areas are protected. A mechanism to ensure their protection is identified in the report.

- Many aspects of water quality management are examined in the report. The key recommendation is the establishment of an integrated catchment management group to ensure that the waterways are managed on a catchment basis.

- Dredging can have a devastating impact on an estuarine system by removing mud flats and shallow banks. In addition dredging may release nutrients from the sediments resulting in algal blooms. It is recommended that an Environmental Protection Policy be established to ensure that dredging proposals undergo adequate environmental assessment.

- It will be LIMA's strategy to accommodate recreational demands through the establishment of joint development programmes with local government. LIMA will promote activities which are considered compatible with the protection of the environment.

- In order to preserve the mud flat areas LIMA will restrict the establishment of ramps and channels in upstream areas of the Collie River and the northern 3 kilometres of the estuary.

- Control of jetski use in the estuary, inlet and rivers will be sought.

- Public access will be provided to and along the foreshore where appropriate. The establishment of dual-use paths and walkways will follow set criteria.

- Education programmes involving public participation will be developed. Where possible, they will be integrated with the programmes of other government agencies.

- Boating use will be monitored in the northern 3 kilometres of the estuary. LIMA is planning for this area to be set aside as a conservation reserve and controls may be exercised if necessary on motorised craft in the conservation area.

- There will be close liaison with the Department of Fisheries regarding the establishment of aquaculture proposals, policies pertaining to professional and recreational fishing, protection of shallow areas and education programmes.

- Community involvement will be encouraged in the preparation and review of plans and programmes.

- A close working relationship will be established with interested community groups.

- Agreements will be reached with local government authorities regarding foreshore reserves.

- Options for the leaseback of some foreshore areas will be examined.

In addition to the general recommendations a series of specific area recommendations were developed for sections of the management area. Those relating to the study are listed below:

- Liaise with CALM on the development of a management plan for the Peninsula ensuring it is complementary to the Leschenault Waterways Management Programme.

- Ensure mosquito control is in accordance with the recommendations of the Mosquito Control Advisory Committee.
- Monitor nutrient levels in Parkfield Drain. Encourage changes in land use and land use practices in order to reduce nutrient levels in the drain.
- Maintain the policy of reducing boat channels to a maximum of eight.
- Restrict unauthorised boat launching .
- Develop a co-ordinated landscape plan for the area to:
- Stabilise foreshore erosion;
- Provide scenic views across the estuary and
- Minimise bush fires.
- Ensure that Cathedral Avenue does not become a major road as a result of subdivision in the vicinity.
- Develop a management plan for the Cathedral Avenue area and eastern escarpment addressing issues including nutrient input and landscape protection.

4.2.2 South West Strategy

The South West Strategy (SWDA, 1991) outlines the proposed direction of development within the South West Region. The document released in 1991 by the South West Development Authority was designed to provide broad policy statements to ensure sustainable social and economic growth for the region. The strategies described reflect the result of varied and comprehensive submissions, both verbal and written from government agencies, local authorities, businesses, community groups and individuals.

In effect, the South West Strategy functions to guide every facet of development within the South West as well as providing a framework to co-ordinate planning by all agencies, at all levels within the region.

4.2.3 Bunbury-Wellington Regional Planning Study

The Department of Planning and Urban Development (DPUD) is undertaking a major planning study to prepare a regional plan for the Bunbury-Wellington region.

The aim of the study is to develop a regional plan that provides a framework for land use and social and economic development consistent with responsible environmental management.

The Bunbury Region Plan was adopted as a Policy Statement in 1987. The Bunbury-Wellington plan includes the City of Bunbury and the Shires of Harvey, Collie, Dardanup, Donnybrook/Balingup and Capel. The Bunbury Region Plan (SPC, 1987) will be reviewed as part of the Bunbury-Wellington Study.

The main objectives of the study are:

- To provide a comprehensive, general plan for social and economic development and conservation in the Bunbury region.
- To review the Bunbury Region Plan.
- To guide local authority town planning schemes, rural strategies and other local planning and development matters.
- To provide a planning framework within which all local authorities, government agencies and private sector organisations operating in the region may formulate co-ordinated, complementary and co-operative action programmes.
- To provide a rational basis for decision making, especially on land use matters, and to clarify decision making processes.

- To address current issues and avoid future problems such as:
    - The growing demand for urban land and housing to accommodate a rapidly growing resident population.
    - Potential conflicts between regional and local transportation needs.
    - Competition for land between agricultural, rural living, industry, forestry, mining, conservation and other uses.
    - Environmental degradation including pressures on sensitive wetlands and the coast.
    - Growing demands for tourist and recreational facilities.
    - The need to provide for new education and employment opportunities.
    - Shortages of community and health facilities in some areas.
    - High costs of public utilities and infrastructure, requiring the allocation of priorities and more efficient use.

The focus of the Bunbury Region Plan period is 20 years (1991-2011). The Bunbury-Wellington Regional Plan has not been released for public comment to date and it is therefore necessary to refer to the Bunbury Region Plan (1987) which contains recommendations pertaining to the study area.

Policy Area 9 (North Australind)

The predominant use should be rural/or low density residential with due regard for landform and landscape constraints.

The policy area is divided into precincts. The only one which relates to the study area is zone A.

- Special Residential Zones with reservation of the Spearwood Dunes and larger rural homesites on the flatter Leschenault Estuary margins.
- Provision should be made for the Australind By-Pass Road and the proposed access points. Landscape buffers along the road should be provided where appropriate.

Policy Area 10 (Leschenault Conservation Area)

The Leschenault Regional Park (as identified in the System 6 Report, DCE, 1983) should include the peninsula, Turkey Point, the estuary and its foreshores and margins, the northern wetlands and the scenic drive (Cathedral Avenue) along the eastern edge. The park should be the subject of an overall management plan.

Any management plan for the land uses within the Leschenault Regional Park should be consistent with the recommendations of the System 6 report and Leschenault Inlet Management Authority's management programme and have particular regard to the following:

Precinct A

- The primary objective should be conservation and recreation.
- Rehabilitation of the peninsula dunes including those affected by effluent disposal.
- Conservation of the waterbird and fish habitats including the Mongarel (Laporte Egret) Swamp.
- Monitoring of phased out effluent disposal lagoons.
- Managing recreation and resort activity and development within the framework of the more important preceding objectives.

Precinct B

- Provision should be made for the floodways of the lower Preston and Collie Rivers within the management plans of the southern or Vittoria Bay end of the estuary.

Precinct C

- The northern end of the estuary should be retained for passive recreation and natural environment uses whilst the southern end including the foreshore at Australind, Samphire Bay and Pelican Point should be used for more active recreation and resort activities.

4.2.4 Greater Bunbury Structure Plan

The Greater Bunbury Structure Plan, in preparation, is a more detailed examination of the planning concerns that were discussed in the Bunbury-Wellington Regional Plan. The study area is considerably smaller and therefore it provides a comprehensive appraisal of the issues affecting the Leschenault Estuary.

The primary objective in the "Conservation, Open Space and Recreation" section of the document is :

> To conserve the environmental systems, natural features and important landscapes of Greater Bunbury, and provide opportunities for their enjoyment and use for recreation and leisure.

The Greater Bunbury Structure Plan describes the proposed system of regional open space. It comprises two land use categories :

* Parks, Recreation and Drainage.

* Areas under consideration for conservation, scenic protection and reservation.

The first category is already substantially in Crown ownership, whilst the second requires further assessment as to precise areas required and the most appropriate tenure, use and management. Action statements are then derived to resolve such issues.

Furthermore the document makes provision for a Special Amenity Area. This category is designated to apply over existing and proposed rural residential areas at Leschenault. Amenity provisions are important in all rural residential areas, however special consideration is required for the subject land for the following reasons :

* Prominent location as backdrop to Leschenault Estuary and Cathedral Avenue (scenic drive) and exposure, in part, to Old Coast Road;

* Potential environmental impacts on Leschenault Estuary, particularly the risk of excess nutrients entering surface and groundwater.

4.2.5 Shire of Harvey Town Planning Scheme No 10

The Coastal Lakeland Study (Shire of Harvey, 1983) formed the basis for the current Town Planning Scheme No 10. The Shire of Harvey Town Planning Scheme is currently being reviewed. The objectives of the new scheme are:

- To encourage and control the continued orderly development of land within the Shire in a manner that enhances the quality of life in the Shire community;

- To ensure that the existing standard of roads, water and electricity supply and other community services is sufficient for the additional demands that the proposed development would create;

- To promote economic development and tourism within the Shire and increase local employment opportunities;

- To provide opportunities for a wide range of lifestyles by providing areas for urban and rural living;
- To retain the pre-eminence of agriculture, and restrict development that detracts from the potential of significant agricultural land;
- To preserve and enhance places of natural beauty particularly along the coast, the rivers and inlets and the scarp, and to preserve historic buildings and objects of historical and scientific interest; and
- To protect and preserve the more important natural flora and fauna habitats and other environmentally sensitive areas that are prone to degradation on the principle that the extent and manner of use of these areas should be kept within their capabilities of being sustained without degradation in the long term.

Zonings

The following zones are proposed within the study area.

Special Residential Zone - Leschenault Parklands

Further subdivision of existing lots will be supported by the Council where:

- the minimum lot size to be created is 4 000 square metres.
- all lots created will be connected to a reticulated water supply system.

No vehicular access shall be permitted onto the Old Coast Road from the Scheme area unless from gazetted Road Reserves approved by the Main Roads Department.

No dwelling house with a floor area of less than 108 sq. metres shall be permitted within the Scheme area.

Ashmere Heights Estate

No person shall remove any trees or shrubs within that area designated as the Vegetation Preservation Area on the plan of subdivision.

No dwelling house with a floor area of less than 150 sq. metres shall be permitted within the Scheme area.

Subdivisions shall generally be in accordance with the Subdivision Guide Plan appended to the Scheme and certified by the Shire Clerk.

No person shall remove trees from within those areas designated as Tree Preservation Area on the Subdivision Guide Plan.

Cathedral Avenue, Leschenault

Subdivision shall generally be in accordance with the Subdivision Guide Plan certified by the Shire Clerk.

No dwelling house with a floor area of less than 108 sq. metres shall be permitted within the Scheme area.

No person shall remove any trees or shrubs from those areas designated as Vegetation Preservation Area on the Subdivision Guide Plan.

Scenic Road Visual Protection - Cathedral Avenue (otherwise known as Scenic Drive), 50 metres on eastern side between Buffalo Road and Old Coast Road.

Development near coast and shores

Other than on land zoned Residential a person shall not commence or carry out any development within 200 m of the winter flood line of Leschenault Inlet (Estuary).

Policies

Council has the power to make District Planning Scheme policies relating to control of development.

4.2.6 Shire of Harvey Proposed Town Planning Scheme Review and Rural Strategy No 1

The Shire of Harvey is currently reviewing its Town Planning Scheme. This is a statutory document which binds the Shire of Harvey in its assessment of development applications. The Department of Planning and Urban Development also requires the preparation of a local rural strategy. This document guides rural land use within the municipality. The Shire of Harvey has chosen to incorporate the rural strategy into its new Town Planning Scheme.

The strategy should aim to address the needs of the local rural economy, community and environment and provide a framework within which desirable change can be planned for, desirable activities promoted, service requirements considered and conflicting land uses managed. Applications for major development, subdivision, strata titles and town planning scheme amendments will be assessed in the context of these local rural strategies.

The Shire of Harvey has been identified as one such area requiring the preparation of a local rural strategy. Council has prepared and adopted a draft rural strategy for the consideration of the Department of Planning and Urban Development for preliminary approval to advertise. Policies relating to the study area are listed in Section 4.3.2. It should be noted that the policies contained in the rural strategy are not finalised and are currently advertised for public comment.

4.2.7 System 6 Report

This report is composed of two parts. Part II identifies specific locations of regional significance adjacent to or in the waterways, to be managed for the purposes of conservation and recreation. General recommendations in Part I suggest the designation of some reserves as Regional Parks. Cabinet has agreed in principle to the recommendations in Part I and that specific locality recommendations contained in Part II should be implemented as far as possible.

The study area is affected by System 6 Recommendation C66. In 1983 when the report was prepared the area was considered of high conservation value because of the extensive samphire area to the north, the vegetation on the peninsula, its value as a waterbird habitat and fish nursery area. Unfortunately much of the northern samphire area has been lost to agricultural development. The area was also identified as being of high recreation value and providing a wide scenic vista. Management considerations for the area included: rehabilitation and restoration of the dunes on the peninsula, maintaining the waterbird and fish habitats, monitoring the effects of effluent disposal; allowing only passive recreation; and recognising the fragility of the dune system of the peninsula region. Since 1983 the situation has changed, however the recommendations should still be considered indicative of government policy.

Recommendations in the report are:

C66.1 General recommendations on planning and management of Regional Parks be applied to this area.

C66.2 That the vacant Crown land be made a Class C Reserve for Conservation of Flora and Fauna, and that the Reserve be vested in the WA Wildlife Authority.

C66.3 That Reserve A18414 be vested in the Shire of Harvey.

C66.4 That urban development be prevented on the Leschenault Peninsula and only allowed in other areas if associated with deep sewerage systems which do not lead to pollution of the Inlet (estuary).

C66.5 That the effluent disposal area is not to extend northwards beyond the existing disposal area boundary, and that the disposal of effluent on the existing area be phased out as soon as possible.

C66.6 That the Public Works Department, in consultation with the Department of Conservation and Environment, produce a programme for the restoration of the effluent disposal area on the Peninsula.

A number of Regional Parks have been set up in the metropolitan area however funding for such schemes is limited in the current economic climate. Work is still continuing on establishment of the proposed Peel Regional Park. The success of this exercise will influence the establishment of a similar park around the Leschenault Estuary. The Regional Park proposal should only be considered a long term option.

4.2.8 Leschenault Peninsula Management Plan and Kemerton Community Park

The Department of Conservation and Land Management is preparing interim management guidelines for the above areas. The development of these plans is overseen by a Community Committee. It is intended that both these areas be vested in CALM when the management plans are complete.

4.2.9 Leschenault Catchment Coordinating Group

The Leschenault Integrated Catchment Management Steering Committee (LICMSC) was formed in 1989 by the South West Development Authority after an approach by the Leschenault Inlet Management Authority. LIMA was concerned about the establishment of regional rubbish disposal sites, the occurrence of algal blooms and agricultural and industrial sources of nutrient entering the estuary. The terms of reference for the committee were:

- To identify all present sources of pollutants including industrial, domestic and agricultural wastes.
- To identify current local and State government authorities' responsibilities and practices in the management of water and wastes in the catchment area.
- To develop strategies for effectively disposing of industrial, domestic and agricultural wastes in the catchment area.
- To develop an integrated catchment management plan for the Leschenault catchment area, comprising the Preston, Wellesley, Ferguson, Collie and Brunswick River basins.
- To involve the community in the development of the management plan and to increase awareness of the problem and solutions in the community.

The Committee has undertaken an assessment of the annual nutrient load reaching the Leschenault Estuary. A report detailing results of this assessment is in preparation. Sampling is continuing. More recently the Committee changed its named to the Leschenault Catchment Coordinating Group (LCCG). This group is preparing a draft catchment plan which should be completed in early 1995. The plan will address the status of nutrient loads to the estuary and make recommendations on management practices for different land uses.

4.3 Policy

4.3.1 Leschenault Inlet Management Authority Policy

The policy for development west of Old Coast Road is as follows:

a) LIMA is opposed to further private residential development on the eastern foreshore of the estuary between Buffalo Road (north end) and the Preston River (south end). Further residential development of the foreshore would conflict with the aims and objectives of the Waterways Conservation Act Section 24(4)(a).

"In performing its functions the Commission shall have regard to - The interests of navigation, fisheries, agriculture, water supply, natural beauty and amenity of the area, and the preservation of the public right of access."

b) The area bounded by Buffalo Rd, the Leschenault Escarpment to the east and Crimp Crescent to the south and within the Waterways Protection Precinct (WPP) should be set aside at the time of subdivision for wildlife habitat, vegetation buffer between developed areas and the estuary, and to provide additional recreation and public access functions.

c) The area of the estuary flats south of Crimp Crescent should not be subdivided further.

d) The area of the estuary flats north of Crimp Crescent not shown within the draft WPP may be developed for special rural use with a minimum lot size of 6 hectares, subject to controls on land use, clearing and development.

- A building envelope to be determined for each lot at the time of subdivision.
- Only one house per lot.
- Subdivision design to have elongated blocks in east-west alignment with the building envelope located on higher ground (if available) at the eastern end.
- Nutrient attenuating systems to be used.
- No intensive agriculture to be permitted (eg. piggery, dairy, horticulture).
- Stock may be permitted under controlled conditions which limit the number of head per hectare to a grass control function. Advice from Department of Agriculture.
- A small chalet development may be permitted involving a maximum of eight chalets per 6 hectare lot. A maximum of one such development will be permitted within the area from Elinor Bell Rd and Buffalo Rd. No other commercial business will be permitted.
- No clearing of existing vegetation will be permitted except for the prescribed building envelope.
- A landscape plan to be developed for each lot detailing special features such as wetlands, areas bordering the WPP zone and the escarpment.
- Significant wetland areas to be identified and set aside for conservation at time of subdivision.

e) The area bounded by Buffalo Rd, Old Coast Rd to the east and Crimp Crescent to the south and following the general line of the Leschenault Escarpment back to Old Coast Rd (including Lots 21 & 24) adjacent to the intersection with Rosamel Rd may be developed for special residential with a minimum lot size of 4000 m2 and an average lot size of 6000 m^2. (Similar to existing development above the escarpment.)

- A building envelope to be determined for each lot at time of subdivision.
- Only one house per lot.
- Nutrient attenuating systems to be used.
- No clearing of existing vegetation will be permitted except for within the prescribed building envelope
- Significant wetland areas to be identified and set aside for conservation at time of subdivision.
- A significant proportion of this land area has been cleared for agricultural purposes in the past, and any future development for special residential purposes should include a revegetation programme to improve and preserve aesthetics and landscape values for the northern estuary area.

f) The area on the eastern foreshore between Old Coast Rd and the estuary south of Elinor Bell Rd down to and including Pelican Point (Lots 26 & 11) should focus on recreational and tourist activity and generally limit private residential development on the foreshore.

g) The area from Pelican Point around to Turkey Point near the Cut should not be developed for residential purposes given the proximity of the port, the port service corridor and the need for public access to Turkey Point.

h) There should be no private residential development anywhere on the western foreshore of the estuary. The Leschenault Peninsula should remain a conservation park managed by CALM.

i) Nutrient attenuating systems (ATUs) are acceptable domestic waste treatment for rural subdivisions with lot sizes greater than 4000 m^2. All subdivisions with lot sizes of less than 4000 m^2 should be deep sewered.

j) Refer to Stormwater Disposal Policy for details of disposal of stormwater from residential developments.

4.3.2 Shire of Harvey Policy

Rural Strategy Policy Area 1 Leschenault

The area bounded on the west by the coast and the southern point of the Leschenault Peninsula then follows the Shire Boundary across the Inlet (estuary) to the Australind Bridge, northwards along the western boundary of Old Coast Road to the same side of Cathedral Avenue, east along the northern boundary of Cemetery Road to the east side of Reserve 36031, then northwards along the eastern boundary of this reserve to meet the western edge of the park strip which has been defined on the Scheme Maps for North Australind, South Leschenault and North Leschenault, to Old Coast Road, then northwards along the western Boundary of Old Coast Road to Treasure Road, then westwards along the line of the northern boundary of Lots 14 and 7 to the coast. The area is approximately 4 650 hectares.

Policies

The major policy for this area is conservation and recreation to the extent that the latter activity is sustainable without further degradation to the inlet (estuary) and environs. To this end it is the policy that:

- A minimum lot size of two hectares should apply for lots south of Crimp Crescent and a minimum of five hectares north of Crimp Crescent.

- Measures be taken as soon as practical to reclaim the areas of the Leschenault Peninsula currently used for waste water disposal and to develop the peninsula for limited recreation and conservation purposes.

- Recreational uses of the inlet (estuary) and its perimeter be controlled to confine activity to specific areas on the perimeter of the inlet (estuary) which can sustain such activity and be properly managed.

- The natural wilderness environment as perceived from the northern parts of the inlet (estuary) and from Cathedral Avenue scenic drive be maintained by screening urban development north of Australind behind a vegetation barrier on the scarp and maintaining rural land between these and the foreshore areas. West of Cathedral Avenue, between Australind Road and Buffalo Road, the land use be confined to conservation, controlled recreation and low intensity rural uses in the northern part.

- Low intensity tourist development on parts of the better drained soils of Lot 7 Buffalo Road, east of the line of primary foreshore dunes, would be appropriate subject to the stringent environmental assessments and ongoing management. Clearing of this area shall be discouraged. The eastern side of Lot 12 be incorporated in the Leschenault Wetland Protection area.

- Provision be made for a scenic road to be constructed through Lot 12 linking Buffalo Road to Binningup.

- The western portion of Lot 4 Buffalo Road be incorporated into the Leschenault Wetland Protection area. Replanting of trees shall be encouraged over the remainder of the land to

Old Coast Road. Further subdivision shall be limited to be compatible with conservation or agricultural purposes.

- South of Buffalo Road, the land between the inlet (estuary) and Old Coast Road be considered a conservation area to the inlet (estuary) and buffer area to the Goodchild's abattoir which is located just east of Old Coast Road.

In addition to the general policy statements, for this particular area, the following requirements apply to the Cathedral Avenue Area, which is bounded by Buffalo Road to the north; Cathedral Avenue to the west; Elinor Bell Road to the south ; and the public open space ridge to the east.

- A minimum lot size of two hectares for lots south of Crimp Crescent and a minimum of five hectares north of Crimp Crescent.
- Building envelopes will be allocated for the lots, in accordance with Council's Scheme requirements and the location of the building envelope, and will be subject to the following:-
- Clause 7.2 related to set backs from shores or coasts (200 m);
- Clause 7.1 (b) related to building envelopes;
- Clause 7.1 (a) related to setbacks along a scenic drive (50 m);
- Clause 7.3 the 1:100 year floodline, as published in documentation from the Water Authority of Western Australia, adopted by Council, and
- The amount of vegetation cover/buffer on site.

Any development on lots within this area will be subject to revegetation proposals.

A new planned carriageway will be established along Cathedral Avenue. Its construction will account for the existing vegetation within the present road reserve, such that the road alignment will have due regard to the existing natural features, will preserve the remnant vegetation and will protect the scenic value of the area.

5. LAND USE

5.1 Current Land Use

Land uses currently occurring within the study area include:

- residential
- tourism (caravan park)
- horticulture
- farming and grazing

At the time of the study certain lots were vacant (ie. not grazing), however it is not conclusive that these lots are never used for farming purposes. Generally land uses along the estuary are predominantly of a Special Rural nature with dwellings on larger parcels of land. Some lots are still used for grazing purposes, however this is mainly to control the vegetation and fire hazards on the lots as the majority of the lots are not large enough to be viable farming properties.

5.2 Current Zoning

Zoning under Scheme No 10 is marked on the Zoning and Index Map.

The zonings along the ridge vary from General Farming in the extreme north and south, with a large amount of Special Residential zoned land in the vicinity of the Australind Road area. A caravan park is located in the southern part of the study area and is zoned Tourist.

Under Shire of Harvey Town Planning Scheme No 10 a variety of land uses are possible. These are listed below.

Town Planning Scheme No 10 as published in the Government Gazette June 1983 permits the following under the General Farming and Special Residential zonings as a right and accordingly they require no specific Council approval:

viticulture, horticulture, market gardening

commercial stable

public recreation

plant nursery

veterinary clinic

private stables

art and craft studio

rural pursuits

dwelling house

Possible uses after special approval by Council:

service station and roadhouse

dog kennels

health farm

residential building

caravan park

chalet park

camping area

radio TV installation

stock holdings and sale yards

veterinary hospital

Use which can be given special approval after advertising:

forestry

extractive industry

private zoo

institutional home or building

motel

consulting room attached to a dwelling

piggery

Uses not permitted unless it is incidental to predominant use as determined by Council:

way side stall

duplex house

5.2.1. Lot Sizes

At the time of the study the lot sizes, along Cathedral Avenue range from 0.2891 ha to 34.4279 ha and reflect the numerous land uses and different zonings. The average lot size of lots in the study area is approximately 5.5 ha (or 13.5 acres), smaller lots having been created as a result of subdivision of land east of the ridge.

Some of the smaller lots in the southern area are zoned General Farming whereas lots along the Australind Road entrance into Leschenault Parklands are larger and zoned Special Residential. Some of these are included in Town Planning Scheme No 4 and further subdivision is not possible. Some others however are not included in that scheme, and theoretically subdivision and development could be permitted.

5.3 Landownership

Lots to the east of Cathedral Avenue are generally in private ownership. A small area of Crown reserve runs along the escarpment. Land to the west of Cathedral Avenue is either Crown reserve or road reserve being vested in the Shire of Harvey or unvested. Private and public lands are marked on Maps 1-9.

5.4 Recreational and Commercial Use

A survey of recreational use (Thurlow, 1989) indicated that the 'most important activities' to users of the estuary were:

- relaxing
- crabbing/prawning from boats
- line fishing from boats
- swimming/paddling
- socialising
- barbecuing/picnicking
- enjoying view/scenic driving
- powerboating

- walking/hiking

In addition, the '10 Most Appealing Aspects' and '11 Least Appealing Aspects' of a visit to the waterway were:

Appealing	**Least Appealing**
Quiet/peaceful	Litter/pollution
Fishing	Toilets
Crabbing	Other people's behaviour
Natural surroundings	Access roads
View/picturesque	Lack of fish or crabs
Close to home	Lack of shade
Flat water	Insects
Foreshore	Low water level
Clean/well kept	Crowding
Toilet facilities	Drinking water
	Lack of parking

Professional fishing on the estuary has operated as a Restricted Entry Fishery since 1970. This means that no new estuarine fishing licences are issued and that individual licences are not transferred if a fisherman chooses to leave the fishery.

Only two professional fishermen operate full-time on the estuary, the remaining eight jointly working the beach and estuary fishery. Complaints often surface from recreational fishermen that the professionals are taking all the fish. Target species are, however, different for both groups with perhaps the exception of King George whiting. Conflict between these two user groups needs to be monitored.

(Plate 3 : Cathedral Avenue provides an enjoyable scenic drive beside the estuary.)

5.5 Foreshore Reserves

A number of foreshore reserves exist along the foreshore. However these are not continuous. In places the road is very close to the estuary. The width of the foreshore reserve means that little area is available for recreation areas, parking, or foreshore vegetation. Some of the reserves are vested in the Shire of Harvey, others are unvested Crown land, other parts are road reserves and controlled by Council. Foreshore reserves are marked on Maps 1-9.

5.6 Services

The area does not have sewerage and most residences are connected to septic systems. There are no records relating to the failure of these systems due to high water tables. In one determination by the EPA it was recommended that lots in the area should be serviced by modified septic systems using red mud. This would reduce the amount of phosphorus entering the water table and subsequently draining to the estuary. It does not however reduce the nitrogen getting into the system.

The area is connected to reticulated water.

Power is also available. Large powerlines run through the study area along the flats.

The main roads leading into the area are Cathedral Avenue and via Old Coast Road. The Shire of Harvey requires that new subdivisions are accessed via Old Coast Road and not Cathedral Avenue. It is the intention of Council to upgrade Cathedral Avenue to a dual carriageway for low traffic volumes in the long term. Cathedral Avenue is noted for its scenic values. Mature paperbarks along the road verge create a canopy over the road.

6. ISSUES

Issues raised by the Working Group or in public submissions are listed in Appendix 1. These have been investigated by the Working Group and incorporated into the plan where appropriate.

6.1 Water Quality of the Estuary

Nutrient enrichment of estuaries in the south-west of Western Australia is an increasing problem. Nutrients from years of fertiliser application to farm land, urban stormwater runoff and discharge from industry are entering many of these estuaries via rivers and streams, enriching them and causing a decline in the natural seagrasses and an increase in algal growth. The growth of algae can reach nuisance proportions, fouling fishing nets and beaches where decomposition of dead algae causes unpleasant odours.

A review of three years water quality data from the Leschenault Estuary indicated that at present the Leschenault Estuary is a healthy environment (Klemm et al., 1987). This is in part due to the proximity of the Cut to the river discharge point. However the Leschenault system has the potential to develop a nuisance algal problem and is vulnerable to further nutrient enrichment.

The northern estuary in contrast is not as well flushed with the ocean. It is also fed by the Parkfield Drain which drains agricultural areas to the north of the estuary. *Hormophysa triquetra* is the dominant brown alga and is widely distributed in the northern estuary. Lukatelich (1989) reports that if conditions change to reduce the dominance of free floating green algae then the estuary may experience beach fouling problems especially in the northern section.

6.1.1 Potential Sources of Pollutants

Water from right across the catchment eventually finds its way into the estuary. This means that pollutants from all land uses in the catchment can also end up in the estuary. The river system mostly drains into the area opposite the Cut and flushes out to sea in times of heavy discharge.

Pollutants enter a river system from a range of land uses across its catchment. Often, poor water quality is the result of the combined effects of a variety of activities across the catchment.

Pollutants can be divided into four types: nutrients, toxins, pathogens and physical pollutants. Nutrients are the main concern within the study area. The remaining three types have been grouped together.

6.1.1.1 Nutrients

Nutrients are required by plants and animals for growth. Algae in the estuary take their nutrients from the water. When excessive amounts of nutrients, especially nitrogen and phosphorus, enter the estuary it is called 'eutrophication'. Large stores of nutrients can build up in the sediment of the estuary floor, forming a nutrient 'bank'. Under certain conditions these can be released for use by algae.

Nutrients entering the northern estuary may come from the following sources:

- stormwater drainage,
- fertilisers from parks and gardens,
- sewage,
- septics,
- agricultural runoff containing fertilisers and animal wastes,
- phosphate detergents,
- leachate from rubbish tips and septic tanks, organic industrial wastes,

- sediment banks in estuary.

The quality of water from Parkfield Drain is not fully documented, however it is considered that changes in land use to more intensive agriculture/horticulture in the catchment feeding the drain could result in greater nutrient loading to this part of the estuary.

Septic Systems

The study area is unsewered and serviced only by septic systems. Septic systems have the potential to leach phosphorus, nitrogen and some bacteria into groundwater and into the estuary. This depends on the water table, soil type and maintenance of the system itself. In a recent Consultative Environmental Review for Lots 3 and 4 Cathedral Avenue it was reported that use of septic systems in the area would increase nutrients leaching into the estuary.

Sewering of an area is financially prohibitive unless lots are smaller than 4000 m^2. The soil type in the area means that only small amounts of phosphorus will be bound to the soil, the rest leaching into the groundwater network.

Parkfield Drain

Monitoring of Parkfield Drain has only recently begun and no data are available. However soil types and land use suggest that nutrient leaching from the soils into the drain is highly probable. There have also been a number of applications for more intensive horticulture in the catchment of the drain. Such land uses have the potential to significantly increase nutrient loading to the drain and estuary. Combined with the fact that this part of the estuary is not as well flushed with the ocean there is increased potential for algal blooms in this part of the estuary.

Stormwater Drainage

Besides Parkfield Drain there is only a small stormwater drainage network on the eastern foreshore of the estuary. These drains drain the flat land at the base of the escarpment which is used for General Farming and Special Residential land uses. One lot is also used as a caravan park and has a evaporative septic system. Stocking rates on these areas are low and consequently little phosphorus and nitrogen are expected to enter from animal wastes. The drains currently discharge directly to the estuary maximising the nutrient loss from the pastured areas.

6.1.1.2 Other

Toxins are substances which are poisonous to living organisms. Sources of toxins are:

- pesticides and herbicides in runoff from urban areas, agriculture, horticulture, forestry;
- spills of industrial waste discharges of petroleum products or toxic chemicals;
- anti-fouling paint from boats;
- leachates from tip sites.

Public comments raised the issue of toxins entering the estuary. Under current land uses there is only limited potential for pesticides and herbicides to enter the estuary via the drainage system. Spraying of verge side vegetation to control weeds also has the potential. Some heavy metals could enter the system from extremely high fertiliser use.

Pathogens are microscopic organisms (bacteria and viruses) which cause disease in plants and animals. Sources are:

- sewage and septic tank effluent,
- animal wastes,
- organic wastes from industry (eg. food processing),
- runoff from stock holding areas.

Use of septic tanks has the potential for bacteria to enter the estuary. However if systems are constructed and maintained to Health Department standard such problems should be negligible. Animal wastes flushed into the drainage system during winter and heavy summer downpours also have the potential to introduce bacteria into the system. Current low stocking rates mean that there is little animal waste entering the system.

It should be noted that bacterial contamination from these sources is extremely uncommon in any estuarine waterways in Western Australia.

Physical pollutants include rubbish, litter and sediment (soil particles) from dredging activities and erosion. Sources are:

- rubbish and litter dumped or blown into waterways,
- sediments from erosion of foreshores, catchment soil loss, dredging, mining, building, road construction,
- suspended solids in industrial wastes,
- oil spills.

LIMA and Council periodically clean the foreshores of rubbish which gets stuck amongst the rushes. Some of this appears to come from boats on the estuary and some from foreshore users.

Aerial photographs of the drains do not indicate any sediment plumes forming at the mouth of the drains. This would indicate that sediment loading from the current land uses is quite low. More intensive use of agricultural areas particularly by stock may however increase sediment transport.

6.2 Conservation of Flora and Fauna

6.2.1 Mosquito Control

Only the foreshore area is affected by mosquito breeding. Preferred options are detailed in the Draft Integrated Mosquito Control Strategy (Chester and Klemm, 1990). Issues to consider in relation to mosquito control are:

- The top end of the estuary and western foreshore are mosquito breeding habitats. Mosquitoes are known to fly up to 10 km for a food source. It may therefore not be sensible to increase population density near these breeding habitats as this would create an unreal expectation in the minds of residents that the mosquitoes would be controlled.
- Creation of artificial wetlands as nutrient filters could exacerbate mosquito problems.

6.2.2 Fire Management

All landowners are required to maintain firebreaks around their properties to the satisfaction of Council. In areas zoned General Rural and Special Rural stock grazing is generally used to keep vegetation down and reduce the fire hazard. A too high stocking rate can lead to problems of dust control and erosion. If these zonings were to change it is likely these areas would be revegetated to some extent although weed and grasses in the understorey would still need to be controlled probably through mowing.

6.2.3 Loss of Habitat and Species

Pen (1992) reports that approximately 346 hectares of foreshore fringing vegetation has been lost on the estuary since 1941. Only a thin strip of vegetation remains within the study area. This is mostly between the estuary and Cathedral Avenue.

The area to the east of Cathedral Avenue is mainly pasture with natural vegetation remaining on the escarpment. One of the issues associated with this delineation between escarpment and foreshore is the lack of vegetation corridor for fauna. In addition there is little suitable vegetation for a breeding habitat for birds. Much of the understorey vegetation has also been

lost and there is little regrowth of trees. This is particularly relevant along the northern part of Cathedral Avenue where the trees provide an attractive canopy. Lack of regrowth means that there will be no new trees to replace the older ones as they die.

Pen's findings (1992) include:

- The most substantial losses of vegetation are to the north of Buffalo Road and to the south around the estuary mouth.
- The pastured flood plain along Cathedral Avenue and south of Buffalo Road was probably *Melaleuca rhaphiophylla* low closed forest, *M. rhaphiophylla-A. flexuosa* low closed forest, and forests and woodlands dominated by *E. gomphocephala* and/or *A. flexuosa*.
- The death of fringing forest in the lagoon area north of Crimp Cr. is almost certainly due to a general increase in salinity brought about by artificial drainage.
- There is some evidence of recent fringing forest regeneration near Crimp Cr. of *M. aff. hamulosa* low open-closed forest.
- There is encroachment of *Juncus kraussii* closed rushland upon the estuary suggesting a rate of growth into the estuary of 5 - 20 m since 1941.
- Foreshore grasses and other weeds are invading from parkland into the landward side of the narrow shoreline strip of *J. kraussii* closed sedgeland. These weeds are replacing species such as *B. juncea, I. nodosa and M. rhaphiophylla.*
- The small tree and native weed *Acacia saligna* is enjoying considerable success along the north-eastern foreshore where it is favoured by frequent fires.
- Two weeds *Typha orientalis* and *Bolboschoenus caldwellii* are not a major threat to native plant communities at present.
- The climber *Asparagus asparagoides* is abundant in the vicinity of Crimp Cr. On the Canning River it smothers native plants and has the potential to do so in this location.
- No general major increase in salinity brought about by the drains through reduced freshwater flushing has occurred.

6.2.4 System 6 Recommendations

Cabinet has adopted Part II System 6 recommendations wherever practical. The study area is affected by Recommendation C66. The major element of this is the Regional Park recommendation. No firm guidelines have been established for the implementation of this recommendation although the EPA is still supporting the concept. In the metropolitan area a number of Regional Parks have been established, not without some difficulty. None have covered both private and public land. However, the concept of Regional Parks in country areas is inhibited through inadequate funding.

6.2.5 Vegetation Rehabilitation

LIMA is undertaking rehabilitation works however it does not have an overall, concept plan. The Pen study (1992) will allow the development of such a plan. This will cover such issues as rehabilitation of complexes not just particular trees, control of invasive species, erosion and fire management as well as habitat protection and enhancement of flora.

6.2.6 International Agreements

The Federal Government is a signatory to international agreements with China (CAMBA) and Japan (JAMBA) as well as the RAMSAR agreement in relation to protection of bird habitats and wetlands. LIMA is bound in its decision making to protect and enhance such habitats.

6.3 Recreation and Commercial Use

6.3.1 Fishing

The Department of Conservation and Land Management are currently preparing a management plan for the peninsula area which proposes that Waterloo Head be developed as a recreation node with possible boat access if environmental concerns can be resolved.

A survey by Van der Wiele (1988) and aerial surveys by LIMA both observed consistent although low numbers of boats using the northern Leschenault Estuary during the summer period. There are insufficient data to draw firm conclusions however there appears to be an increase trend in boat usage and the number of boats entering the northern estuary at this time of the year. LIMA placed signs in this northern section requesting that boaters not enter. It may be possible that the combination of shallow water and signs are deterring some boaters from entering this area.

The pattern of usage determined by Van der Wiele (1988) shows high boat numbers on the estuary at times when crab catches are good, combined with good weather conditions. Recreational use of the estuary is higher over the established holiday period between Christmas Day and the end of January. In addition, the number of boaters may increase at times prior to or after this period, should crab catches be significant.

Van der Wiele's study (1988) shows small boat users have a preference for the northern estuary for a variety of reasons, including:

- to minimise wind effect during summer afternoons with strong sea breezes,
- the belief that fishing/crabbing effort will have greater success in this area,
- to escape congestion of boats and traffic in the central estuary area around Ridley Place (Paris Road).

One interesting point raised by Schwinghammer (1982) and confirmed by Thurlow (1989) is that the majority of users of recreational facilities adjacent to the waterways lived in the Bunbury region, 65% and 69% respectively.

The area is also used by commercial fishermen although only two really use the estuary on a continuous basis.

6.3.2 Public Access to the Foreshore

Further population increase in the area may lead to increased demand for access to the foreshore. There is only one recreation area abutting the estuary. Opportunities for walking, cycling and bird watching are also limited because of the width of the reserve. CALM is establishing a cycleway network on the peninsula and there may be a need to link in with this facility.

The strong policy by CALM of only low key recreation on the peninsula may mean that people seeking alternative activities will look for opportunities on the eastern foreshore.

Similarly access to the peninsula may also increase use of the eastern foreshore as a stopping place or as a scenic drive through to Buffalo Road.

Increased public access brings a number of problems although these are not insurmountable.

- Car parking on the reserve damages vegetation compacts the soil and causes wheel ruts for mosquito breeding.
- Walking can cause damage to the foreshore particularly if the area is wet. Vegetation becomes damaged and breaks in the reeds can occur causing erosion.
- Weeds can be introduced to vegetation.
- Rubbish is often left behind by visitors.

- Indiscriminate fires may spread. Alternatively more people may discourage irresponsible people from damaging the area.
- Landowners may walk their dogs along the foreshore disturbing wildlife.

6.3.3 Boating Access

In an effort to protect the bed of the northern estuary from disturbance LIMA has installed signs above Waterloo Head asking people to keep out of the area. This has had some effect although when people see commercial fishing occurring in the area they justifiably feel aggrieved. Fisheries Department policy is for equitable use of the fish resource and this criterion should apply to use of the northern estuary.

LIMA also has a policy on boating facilities which precludes the establishment of further boat launching facilities and channels in the area.

6.3.4 Increasing Population

The Bunbury population is increasing and surveys indicate that most users of the estuary are from this region. This will increase the pressure for use of the area. Options are to open up the area for every activity or to establish nodes for particular activities based on environmental constraints. In reality the former option pleases nobody as there are no controls. The second option is just that; an option for the future. People may be concerned that their rights have been impinged upon but if fully aware of the facts most will accept the need for some form of management control.

An increasing population means that a laissez-faire approach to recreation as well as conservation planning is not an option.

6.4 Land Use Planning

6.4.1 Pressure for Rezoning

A number of landowners applied for rezoning of their properties along Cathedral Avenue. These applications were in conflict with the current TPS and the proposed TPS and Rural Strategy recommendations for the area. At the time LIMA was also concerned about the lack of sewerage available in the area and any concentration of development along the escarpment. LIMA sought formal assessment by the EPA of these applications.

As a consequence the Shire of Harvey imposed a moratorium on the area, to enable Council to carry out this particular study and solve some of the problems associated with the area. Rather than prohibit development altogether, each development application is referred to Council's Health, Building and Town Planning Committee for consideration and the proposals are treated on their merit. Several proposals have been granted approval by Council during that time, subject to several conditions. The moratorium was lifted in August 1992.

Opinion varies among landowners as to the most appropriate zoning. Some consider that the scenic character of the area should be retained. If the area was to be rezoned then some people could be disadvantaged by an increase in rates.

Alternatively there are landowners who consider that the current size of properties in the area makes the General Rural zoning economically unviable. The market value of land zoned General Farming within the study area is far greater than any financial returns that could be achieved through agricultural use. It is likely that plans by the owners to change land use practices in the area, perhaps to intensive horticulture, while still being permitted within the zoning would be environmentally unacceptable. The comment among landowners is that land should not be subdivided into lots of less than two hectares.

The current situation with land use is that Council through its TPS has zoned land for particular uses. In preparing these zonings Council has looked carefully at the nature of the land and determined an appropriate zoning. A landowner has the right to approach Council for land to be rezoned. However Council can reject the rezoning proposal if it is not consistent with the intent of the current TPS and the landowner has no right of appeal.

6.5 Landscape Protection

The area is considered to form one landscape composed of the estuary flats, the escarpment and the estuary. The width of the estuary flats varies from a few metres up to 800 m.

6.5.1 Rural Outlook

The rural character of the area appears to be an attraction to existing residents and visitors to the area. An increase in land use density could result in a loss of this landscape. There is a need to retain the rural outlook but ensure that rural land uses such as grazing and horticulture do not have a detrimental impact on the environment in terms of over grazing and nutrient export.

6.5.2 Natural Outlook

Submissions indicated strong support for retention of the escarpment and associated vegetation as a backdrop to the estuary. There was also support for the retention of the wetland system on the flats. Enhancement and revegetation of open areas was also suggested. Revegetation could be designed to act as fauna habitats, increase the variety of flora in the area and to act as a nutrient stripping buffer. Such a plan would need to take into consideration protection of important views and give landowners the opportunity to replant their land in their own way but in keeping with the character of the area. Revegetation plans would also have to consider the impact on the floodway.

6.5.3 Fire Management

Maintaining the vegetation or rural zoning may increase the problem of fire management. Rural land that is not cropped and/or grazed because it is unviable can create a fire hazard. Similarly revegetating an area can also exacerbate fire problems. Annual burning however also creates a problem encouraging weed grass species to grow and so introducing a continuing cycle of burning and weed growth. Stock grazing will assist in keeping grasses under control.

7. SOLUTIONS

The issues outlined in Section 6 were examined by the Working Group. Outlined below are potential solutions to the concerns raised.

7.1 Catchment Management

As mentioned in Sections 3 and 4 the Leschenault Catchment Coordinating Group (LCCG) is developing a draft catchment plan covering the issue of water quality including the development of fertiliser and soil management practices. If land within and abutting the study area is to remain in rural use then guidelines must be developed by the Working Group and the LCCG covering issues such as stocking rates, types of rural use, nutrient export from the site. While the development of such guidelines for land use outside the study area are outside the scope of the Working Group it is essential that the LCCG is aware of the practical problems that Council and LIMA experience in managing land use. Zoning an area is no longer sufficient to ensure the health of the estuary.

7.2 Change in Zonings

Increasing the density of zoning would increase septic tank numbers which in turn could increase nutrient loading to the estuary (See Section 6 for more details). Only by reducing lot sizes to less than 4000 m2 could sewerage be connected to the area. Such dense development would introduce problems of loss of 'rural' character and loss of flora and fauna.

It is understood that the rural land is currently not used to its full agricultural potential because the lots are too small to be viable. It is possible that landowners could wish to increase stocking rates or use the land for other agricultural purposes. If this was to occur it could lead to potential water quality problems. Protective measures could be taken under the Soil Conservation Act or the Environmental Protection Act. This is however a slow and tedious process and would be a reactive measure. The development of guidelines on fertiliser and soil management practices for landowners is favoured, encouraging a co-operative approach rather than a 'control' approach.

Changing to Residential or Special residential zonings may lead to an increase in fertiliser use for household gardens. Education of householders and restrictions on building envelopes and garden envelopes may be necessary.

7.3 Alternative Effluent Disposal

In recent years alternative effluent disposal techniques have been developed. All of these have been approved for use by the Health Department of Western Australia. Techniques to remove and reduce nutrients are red mud soil amendment, a sealed tank which is pumped out and disposed of off-site, or an air-vac (dry toilet system).

A recent CER proposed the use of the red mud soil amendment system. This technique increases the phosphorus retention index of the soil surrounding the septic tank. Estimates are that it will bind phosphorus leaching from septic tanks for up to 50-100 years. Unfortunately it does not bind nitrogen and this can still leach into groundwater. The system was approved by the Environmental Protection Authority and has now been cleared by the Health Department . A large development near Busselton has a red mud amendment system. Feedback on how effectively it is functioning is required.

A sealed tank system is also suitable but may be prohibitively costly for landowners to operate. Landowners may therefore not operate it properly. This could possibly lead to health, as well as nutrient leaching problems.

The air-vac or dry toilet system stops nutrients from toilet systems entering the groundwater system. It doesn't however account for waste disposal from sink and shower sources. These sources generally account for 70% of phosphorus used per person/year.

The red mud system appears the best option if nitrogen leaching could also be reduced by another method.

7.4 Vegetation Buffers and Biological Filter Systems

One system of removing nutrients from ground and surface water is via uptake of nutrient laden waters by vegetation. The nutrients are then bound in the vegetation. If the vegetation dies and decomposes on site the nutrients can again be released into the system. However if the vegetation is 'harvested' and removed off-site the nutrients are also relocated.

It is possible to develop a lake system as part of the drainage network. This would increase the retention time of waters in the lake system before discharge to the estuary allowing greater nutrient uptake by vegetation. Problems associated with artificial lake systems as nutrient filter systems are:

- mosquito and midge breeding
- algal blooms
- introduction of weeds
- harvesting of vegetation is required
- periodical dredging of nutrient laden sediments
- fire hazards depending on species used as filtering agent
- management body and ongoing management costs
- large water area necessary to be effective.

Advantages of such systems are:

- creation of wetland habitats
- increased fauna habitats
- reduces nutrient loading to estuary
- can be a landscape and recreation feature
- can intercept other toxins and rubbish before they enter the estuary.

Vegetation buffers need not be associated with a lake or drainage network. A vegetation buffer which draws on the water table will do a similar but not as effective job. Both these mechanisms would reduce the nitrogen as well as phosphorus leaching from septic tank systems and animal wastes.

7.5 Stormwater Networks

Stormwater networks are generally designed to remove stormwater off-site. On-site disposal will enable nutrients to become bound to soil particles as stormwater infiltrates through the ground. On-site disposal will only be possible if the water table is low enough.

7.6 Rehabilitation

Weed invasion of the Juncus kraussii closed sedgeland can best be controlled by planting those species which once occupied the situations now favouring the weed invasion. These include *Baumea juncea, Isolepis nodosa, Melaleuca rhaphiophylla, Agonis flexuosa, Viminaria juncea* and *Eucalyptus rudis*. Most important is the planting of trees which will preclude the establishment of many weeds through shade, while still enabling the native species to survive. Short term weed control can be used to encourage the native species.

Clearing of drains of obstructions such as aquatic weeds or sediment will ensure that stormwater is discharged directly to the estuary. While this will largely prevent the flushing of saline foreshore zones supporting saltmarsh or saline fringing forest and thus prevent weed invasions, it will also have the effect of maximising the nutrient loss from the pastured areas of the estuary flats which may contribute towards problematic algae growth. The establishment of native plant species along the peripheries of the drains and the creation of nutrient traps of

aquatic plant species in pastured areas will cause a proportion of the nutrients to be taken up in plant growth and then, through death of the plant, held for a time as peat or detritus.

Further more, the presence of native species will stabilise the peripheries of the drains and create wetland habitats.

Reservation of large areas in one region of the estuary only will not serve to conserve all the components of the system. Conservation should therefore aim to maintain representative stands of the various elements of the fringing vegetation.

Replacement of plant communities through environmental change can also threaten the loss of components of the estuarine fringing vegetation. Care needs to be taken that fresh water from drains does not drain across salt marshes. Conversely fresh water should not be channelled through freshwater wetlands but rather should be allowed to disperse and flush the freshwater vegetation.

A list of vegetation species for rehabilitation is included in Pen (1992).

7.7 Compensating Basins

See Section 7.4

7.8 Reservations

Reserved land generally lies between Cathedral Avenue and the estuary. This is a very thin strip. Options are to make this a continuous foreshore reserve and to widen it. All unvested Crown land in this area should be vested in an appropriate agency. Given the importance of the remaining remnant vegetation it is considered that it should be jointly vested for conservation as well as recreation. This will ensure that the vegetation is rehabilitated and does not become mown grass.

One option is the relocation of Cathedral Avenue to the east allowing the width of the reserve to be increased. This however is an expensive option that no doubt is unrealistic. The alternative is to establish a reserved area along the eastern edge of Cathedral Avenue. This was something that was supported by the EPA in the CER for Part Location 1. The reservation should be wide enough to provide a buffer to the estuary, establish a viable vegetation belt and act as a filter to ground and surface waters entering the estuary. It is also considered that there should be a continuous reservation running from the estuary to the escarpment. This could be through a subdivision if the area was to be rezoned or alternatively the road reserves could be widened in this area and revegetated. This latter suggestion would be visually in keeping with Cathedral Avenue.

The Regional Park concept would be likely to gain EPA support. However legislation and financing arrangements are unlikely to be available in the short term (5-10 years). The alternative is for Council and LIMA to establish guidelines, policies and regulations under their existing legislation that would be in keeping with protection of flora and fauna, landscape and water quality.

7.9 By-laws and Regulations

The provision of guidelines for landowners in the area and a clear development (concept) plan rather than the use of by-laws and regulations is favoured in the first instance. This plan should be endorsed by agencies such as DPUD and EPA, as well as adopted by Council and incorporated in its TPS. In this way they can be proactive in their decision making rather than just reacting to an individual subdivision or rezoning and only addressing a few issues. Council has the option of endorsing the plan and incorporating it into its TPS and Rural Strategy. This would give it some statutory basis.

7.10 Mosquito Control

The Draft Mosquito Control Strategy (Chester and Klemm, 1990) clearly sets out the procedure for mosquito control in the area. Unfortunately mosquito control will always be an issue because of the distance they can fly. Dense housing development within the study area should

not occur as it will only create the expectation of a mosquito free environment. Any further housing development in the area must recognise and accept the current mosquito control strategy emphasis on control not eradication.

It is possible to ensure that the situation is not aggravated by further development or even vegetation rehabilitation. All wheel ruts and artificial depressions should be filled in. If a biological filter or compensating basin is established to strip nutrients from the water table then it should be designed to minimise mosquito breeding. There should also be a buffer around it and housing should be located as far away as is practical.

If birds are to be encouraged into the area then it is not desirable to eliminate mosquito breeding.

7.11 Restriction of Access to Northern 3 km of the Estuary

In order to protect the fringing vegetation and provide a large area for fauna and conservation, the restriction of power boat use in the northern estuary is the obvious choice. Accordingly, the launching of such craft should be confined to the formalised boat ramps in the southern reaches of the estuary. To maintain equality a boat facility for powered craft at Waterloo Head by CALM should not be supported.

Closure of the estuary should apply equally to professional and amateur fishermen. Currently 10 professional fishermen hold licences to fish the estuary, however only two do so on a regular basis. It may be possible to have a season, as for marron, when the area could be open for use. The impact would need to be monitored. If the abutting eastern foreshore was closed it would signal a clear intention to future landowners that if they want to use power boats they will have to travel further south on the estuary.

7.12 Increasing Size of Foreshore Reserves

Increasing the size and extent of the foreshore reserves would provide greater opportunities to:

- provide public access to the foreshore;
- provide pedestrian/cyclist access separated from vehicle traffic;
- increase flora and fauna habitat;
- provide recreation nodes with appropriate facilities if the reserve is wide enough; and
- provide a vegetation and nutrient stripping buffer between development and the estuary.

An increase in foreshore reserves would however require additional funds for management. In some cases it would require relocation of Cathedral Avenue.

Most foreshore reserves are obtained as a condition of subdivision or in some cases a condition of development, being ceded to the Crown free of cost. If no further subdivision is to be permitted then foreshore reserves could be obtained by:

- purchase of the area at current market value by State government. In the current economic climate this is extremely unlikely;
- conditions on any development of the land restricting its use;
- developing an agreement between Council and the landowner as a condition of development.

7.13 Integration of Reserves on the Escarpment

There is opportunity to link reserves on the escarpment with the foreshore area. This would provide:

- a wildlife movement corridor;
- a continuous landscape link between the two areas; and

- designated pedestrian access between the two areas.

It may not be necessary to create a reserve but there could be a road reserve wider than the norm which has no kerbing, has grass swales to aid drainage and is planted with vegetation. Visually it could be designed to look similar to Cathedral Avenue.

7.14 Zoning General Farming

The market value of land zoned General Farming within the study area is far greater than any financial returns that could be achieved through agricultural use. Greater use of these areas for agricultural practice could lead to increased nutrient export or land degradation due to increased stocking rates unless environmental controls were exercised. It would be necessary to remove some current land uses which are environmentally unacceptable from the TPS list such as horticulture, piggeries etc. No foreshore reserves could be obtained free of charge as no subdivision would occur. Sewerage would not be possible. Currently a maximum of two dwellings per lot are permitted with Council approval. Therefore, the number of dwellings would only increase marginally. The problem of nutrient leaching from septic systems would accordingly not be exacerbated. Conditions would need to be applied to future developments or planning applications to ensure that any further vegetation is not removed or that new vegetation is planted. Existing developments and uses would be permitted to operate as they do now as 'non conforming uses'.

7.15 Zoning Special Rural

Special Rural usually applies to lots of 2-4 hectares. Lots of 1 hectare may be considered by DPUD if additional services such as sewerage and water are available. Zoning to this classification would enable subdivision of most lots that have not already been subdivided. It would also allow the rural scenic character to be retained. Conditions could be applied to lots for vegetation buffers and building envelopes, as well as limits on the types and numbers of animals that could be kept. Given the size of lots such conditions would not be as onerous as they would on smaller lots zoned Special Residential. It would not be possible to connect sewerage to these lots and alternative methods would have to be used to reduce nutrient leaching to the estuary. With some subdivision occurring some foreshore reserves could be obtained. Lots could be divided perpendicular to the estuary so that a building envelope is possible on the high land of the escarpment away from the flood plain line and in amongst existing vegetation in most cases.

7.16 Zoning Special Residential

Lots in this category are usually between 4000 to 10000 m^2. Zoning to this classification would enable subdivision of most lots that have not already been subdivided. It would allow some of the scenic character to be retained. Conditions could be applied to lots for vegetation buffers and building envelopes, as well as limits on the types and numbers of animals that could be kept. Given the size of lots such conditions may be considered onerous. It would not be possible to connect sewerage to these lots and alternative methods would have to be used to reduce nutrient leaching to the estuary. With some subdivision occurring some foreshore reserves could be obtained. Lots may not always be able to be divided perpendicular to the estuary. This would mean that a building envelope may not always be possible on the high land of the escarpment away from the flood plain line. It could also mean extra roads are necessary to service these lots. This could increase traffic on Cathedral Avenue and other service roads.

7.17 Zoning Residential

Zoning to Residential would result in lots of a maximum of 4000 m^2. While this would have advantages in allowing sewerage to be connected and enabling land to be given up as regional open space (foreshore reserve) it would also result in a loss of the rural scenic character and a lifestyle that some people appear to like.

7.18 Building Envelopes

Designation of building envelopes within lots should occur. This will ensure that any buildings are located to protect views and vegetation. They should be of sufficient size to act as a fire break as well. Where buildings already exist on lots and the envelope is unsuitable a new envelope should be defined and any new developments proposed on that lot should be within the new envelope.

7.19 Stock Control

Where stock are permitted stocking rates should be controlled to ensure that land does not become degraded and sufficient groundcover is on the area at all times. Where vegetation buffers are planted stock access should be restricted. It may be necessary to inspect the area to ensure that landowners are keeping to stock limits. Self regulation amongst other landowners may be a way of undertaking this.

7.20 Rehabilitation Plan

A landscape and rehabilitation plan will protect and enhance the area and its character. It would need to be undertaken in consultation with landowners so they still retain views of the estuary although perhaps more restricted. There would need to be some type of overall plan which landowners adhered to, but which they were able to individualise for their properties.

(Plate 4 : Cathedral Avenue highlights the current inadequate provision of foreshore reserves abutting the estuary.)

8. IMPLEMENTATION

A number of tools may be employed to effect the solutions outlined in Section 7. Subsequent to the adoption of this management plan, the primary planning mechanisms that may be utilised would be :

(a) the Shire of Harvey Proposed Town Planning Scheme No 1 with an appropriate consistent zoning;

(b) State Planning Policy (5AA) to be implemented by the Department of Planning and Urban Development;

(c) a Leschenault Estuary Regional Park to be managed jointly by State and local government.

Each of the above instruments would contain provisions to implement a majority of the above solutions. Presently, option (a) is favoured as it can be readily implemented and it focuses on direct local government involvement. Option (b) is more of a long term approach which has been employed in the Peel-Harvey catchment to control development. It also implies greater State government involvement and less Council control. The final option (c) for the Regional Park requires substantial funding and is possibly dependent on the success of the Peel Regional Park.

Accordingly, it is preferable that the solutions be implemented as a consistent zoning for inclusion in the Shire of Harvey's Town Planning Scheme No 1. The development of the State Planning Policy (5AA) by DPUD and the creation of the Leschenault Estuary Regional Park are viewed as equally effective are long term management options.

(Plate 5 : The focus is toward conservation rather than recreation in the northern reaches of the estuary.)

9. ZONING AND DEVELOPMENT OPTIONS

Eight alternatives were selected by the Working Group for consideration. From these five have been selected for inclusion in the report. These are:

- Option 1 'Do Nothing' Current Zoning (General Farming and Special Residential)
- Option 2 Special Rural
- Option 3 Special Residential
- Option 4 Leschenault Estuary Regional Park
- Option 5 Special Use (Special Rural and Landscape Protection Zone)

The three that were rejected are:

- Option 6 General Farming as in Draft Town Planning Scheme No 1 and proposed Rural Strategy with a policy statement that would restrict particular land uses.
- Option 7 General Farming as in Draft Town Planning Scheme No 1 and proposed Rural Strategy with current land uses.
- Option 8 Current Zoning (General Farming and Special Residential) with special conditions and a policy statement that would restrict particular land uses within each zone.

Options 2 - 5 also have environmental criteria attached to them. These are grouped together wherever possible.

9.1 Option 1 'Do Nothing' Current Zoning (General Farming and Special Residential)

Under the General Farming zoning and Special Residential zoning the following uses are permitted as a right (ie. no specific Council approval is required):

rural pursuit, dwelling, viticulture, horticulture, market gardening, commercial stables, rural industry, public recreation, veterinary clinic, private stables, plant nursery, and art and craft studio.

Uses that need special Council approval and/or advertising :

caravan park, chalet park, camping area, radio/TV installation, service station/roadhouse, dog kennels, health farm, public utility, stock holding and saleyards, motel, consulting rooms, forestry, private recreation, extractive industry, private zoo, institutional home/building, piggery, wayside stall, duplex, residential building.

Uses permitted under the current Town Planning Scheme are quite extensive and rezonings would not be required.

To do nothing would only exacerbate existing problems and leave both LIMA and Harvey Shire Council with inadequate control over development and environmental problems. To have undertaken the study and resolved not to change anything would gain little support from other decision making bodies.

It is noted that the moratorium on development that was imposed by Council at the start of this study has been lifted. However under the current policies of DPUD and Council's Special Residential subdivision guide plans for the area no further subdivision is possible without rezoning. DPUD's policy is that no subdivision of rural land can occur on lots smaller than 80 hectares. Subdivision guide plans for the area specify that no further subdivision of Special Residential lots is permitted.

(Plate 6 : General farming is the current predominant land use toward the north of Cathedral Avenue.)

9.2 Option 2 'Special Rural'

Special rural usually applies to lots of 2-4 hectares. Zoning to this classification would enable subdivision of most lots in the study area except those occurring in the southern area. It would also allow the rural scenic character to be retained. Conditions could be applied to lots for vegetation buffers and building envelopes, as well as limits on the types and numbers of animals that could be kept. Given the size of lots such conditions would not be as onerous as they would on smaller lots zoned Special Residential. It would not be possible to connect sewerage to these lots and alternative methods would have to be used to reduce nutrient leaching to the estuary. With some subdivision occurring some foreshore reserves could be obtained. Lots could be divided perpendicular to the estuary so that a building envelope is possible on the high land of the escarpment away from the flood plain line.

Land uses that would be permitted within the zone are:

- dwelling (one dwelling per lot and associated out buildings)
- forestry
- viticulture/horticulture
- private stables
- commercial stables
- dog kennel
- art and craft studio
- home occupation
- plant nursery

Possible uses after special approval by Council:

- private recreation
- public recreation

In addition the following land use would be permitted.

- caravan park / chalet park/ camping area only on existing site and at the same density.

A new land use should also be added to the list of permitted land uses:

- wildlife habitat - environmental protection. This has been added to allow for landowners who wish to develop their property as a wildlife habitat but not on a commercial basis ie. the lake system which occurs on Pt Lot 1 and Rosamel Swamp would be within this category.

Council will consult with the Department of Agriculture on all applications for stocking and/or horticulture/agriculture and shall approve or refuse the application or specify conditions based on the advice. Lots less than 2 ha shall be used for rural living only.

Where reticulated scheme water is provided to all lots the Council may approve a minimum lot size of 1 hectare provided the natural vegetation at the time of subdivision is dense enough to screen houses from each other and from outside the subdivision.

Land use policy

A number of the above land uses are considered inappropriate for environmental and aesthetic reasons and it will be at Council's discretion to assess what is appropriate.

Land uses should not:

- increase the nutrient load to the estuary
- cause land degradation, dust and erosion

- result in clearing of existing native vegetation or replanting of significant areas with non indigenous species
- encourage buildings within the floodplain
- cause excessive noise or disturbance to the existing lifestyle of the area
- result in increased traffic on Cathedral Avenue
- increase power boating use of the northern estuary.

While not exhaustive the following list is indicative of land uses that do not meet these criteria:

- forestry
- viticulture and horticulture
- commercial stables
- plant nursery

Criteria

In addition a number of other criteria would need to be applied to the area. These include:

Setbacks	The Waterways Protection Precinct.
Building Envelopes	Determine a building envelope for the site which will be large enough for house and outhouses. Determine the building envelope to give views of the estuary but to minimise views of developments from the estuary and road. Determine building envelopes for existing lots already with developments. Ensure that any future developments on these lots occur on the new envelope.
Stock Control	The keeping of horses will not be permitted The keeping of grazing animals shall be subject to the prior approval of the Council. Animal stocking rates shall not exceed the stocking rates recommended by the Department of Agriculture for the pasture type for the policy area. (See other sections regarding effluent control and vegetation protection)
Utility Services	Further overhead powerlines will not be supported on the estuary flats.
Building Structures and Materials	Discourage developments which through their height, bulk, colour and/or texture or material used are considered to be out of character with the estuary and bushland environment.
Landscape and Rehabilitation Plan	Develop a landscape plan in consultation with landowners. (This should be done as part of this study and put out for public comment.) Trees used are to be at least 3 metres in height. Encourage landowners to develop part of their property as wildlife habitat. Restrict stock access to revegetated areas.

	Encourage landowners to develop an undergrowth of native vegetation which will not require annual burning.
	Restrict clearing of the escarpment to other than building envelopes.
	Control public access to POS on the escarpment to protect fragile slopes.
	Establish the area as a landscape protection precinct in the TPS.
Reserves	Link reserves on the foreshore to the escarpment:
	visually - through the landscape plan
	physically - through a roadway network but not for through traffic.
	Increase foreshore reserves (west of Cathedral Avenue) through subdivisions. Vest with LIMA for the purpose of Waterways and Foreshore Protection.
	Encourage buffer zones on the eastern side of Cathedral Avenue which will be treated like reserves but still be private property under agreement with the landowner.
	Encourage landowners and reserve vestees to remove weed species in accordance with the landscape plan. Use of pesticides should be in accordance with guidelines.
	Encourage community groups to assist with revegetation of public areas in accordance with the landscape plan.
Subdivision	If possible subdivide properties perpendicular to the estuary so that building envelopes are on the eastern end of the block, not the estuary flats.
	The minimum lot size for new subdivided lots will be 3 hectares. Lots currently below this will not be permitted to be subdivided. Although, there is a diversity of opinions on the minimum lot size this requirement will remain until the public review period is completed.
Recreation	Establish recreation nodes to the west of Cathedral Avenue for low key recreation use. No random power boat launching permitted other than in authorised areas.
	Discourage power boating access in the northern 3 kilometres of the estuary. Develop a brochure explaining why boating access in the northern 3 kilometres should be limited.
	Restrict the establishment of further camping areas on the basis that sufficient areas will be established in the future on Leschenault Peninsula.
Cathedral Avenue	Improve traffic management in Cathedral Avenue by providing traffic calming devices, landscaping, widening of the road reserve (eastwards only) for separate carriageways, pedestrian and cycling facilities and carparking, in accordance with Council plans.
Water Quality and Nutrient Control	Encourage establishment of vegetation buffers on the eastern side of Cathedral Avenue in association with the landscape plan.

	Advise landowners on recommended fertiliser and pesticide use.
	Maintain vegetation on lots at all times to reduce runoff from these areas into the estuary.
	Restrict the storage of toxic chemicals and fuels on properties on the estuary flats.
	Require landowners on the estuary flats to dispose of rubbish in accordance with Council guidelines. No personal tip sites and no burying of rubbish or animal effluent on site.
	Council supports the use of alternative wastewater treatment and effluent disposal systems. The onus of proof will rest with the subdivider to provide sufficient technical and engineering evidence that alternative systems or site modifications remove any adverse effects on public health, water resources or the environment while not detrimentally impacting on the character of the area.
	Existing properties will be permitted to operate conventional on-site effluent disposal systems provided they are operating effectively. If any existing systems are to be replaced in the future, Council will encourage the use of an alternative wastewater treatment and effluent system.
	New commercial development or extensions must incorporate effluent management systems approved by the Health Department , the EPA and the Water Authority of Western Australia, or connect to reticulated sewerage if available.
	Encourage the development of nutrient and irrigation management programmes for the northern catchment.
	Encourage the development of wetland wildlife habitats as nutrient stripping devices.
	Encourage the use of compensating basins as nutrient and pollution stripping devices.
Rates	Develop a system whereby people not wishing to be rezoned from General Farming get a discounted rate especially if they establish a portion of their property as wildlife habitat. Some sort of retrospective system must be in place if they wish to come under the new zoning practice, ie. they must pay rates for the new zoning at least two years before subdividing in accordance with subdivision plan.
Flora and Fauna	Establish strategies for the control of exotic species in association with the Agricultural Protection Board and the Mosquito Control Advisory Committee.

9.3 Option 3 'Special Residential'

Lots in this category are usually between 4000 to 10000 m2. This zoning would enable subdivision of most lots that have not already been subdivided. It would allow some of the scenic character to be retained. Conditions could be applied to lots for vegetation buffers and building envelopes, as well as limits on the types and numbers of animals that could be kept. Given the size of lots such conditions may be considered onerous. It would not be possible to connect sewerage to these lots and alternative methods would have to be used to reduce nutrient leaching to the estuary. With some subdivision occurring some foreshore reserves could be obtained. Lots may not always be able to be divided perpendicular to the estuary. This would mean that a building envelope may not always be possible on the high land of the escarpment away from the flood plain line.

Land uses that would be permitted within the zone are:

- dwelling (one dwelling per lot and associated out buildings)
- grouped dwelling
- attached dwelling
- home occupation
- residential building
- professional office
- club premises

Possible uses after special approval by Council:

- public recreation areas - not used at night

In addition the following land use would be permitted:

- caravan park / chalet park/ camping area only on existing site and at the same density.

In addition Pt Loc 22 and Pt Lot 1 west of Cathedral Avenue will remain General Farming with restricted land uses outlined in Option 2.

A new land use should also be added to the list of permitted land use:

- wildlife habitat - environmental protection. This has been added to allow for landowners who wish to develop their property as a wildlife habitat but not on a commercial basis ie. the lake system which occurs on Pt Lot 1 and Rosamel Swamp would be within this category.

Land use policy

A number of the above land uses are considered inappropriate for environmental and aesthetic reasons and it will be at Council's discretion to assess what is appropriate.

Land uses should not:

- increase the nutrient load to the estuary
- cause land degradation, dust and erosion
- result in clearing of existing native vegetation or replanting of significant areas with non indigenous species
- encourage buildings within the flood plain
- cause excessive noise or disturbance to the existing lifestyle of the area
- result in increased traffic on Cathedral Avenue
- increase power boating use of the northern estuary.

While not exhaustive the following list is indicative of land uses that do not meet these criteria:

- professional office
- club premises
- veterinary clinic for large animals and agistment

Criteria

In addition a number of other criteria would need to be applied to the area. These include:

Setbacks	The Waterways Protection Precinct
Building Envelopes	Determine a building envelope for the site which will be large enough for house and outhouses.
	Determine the building envelope to give views of the estuary but to minimise views of developments from the estuary and road.
	Determine building envelopes for existing lots already with developments. Ensure that any future developments on these lots occur on the new envelope.
Utility Services	Further overhead powerlines will not be supported on the estuary flats.
Building Structures and Materials	Discourage developments which through their height, bulk, colour and/or texture or material used are considered to be out of character with the estuary and bushland environment.
Landscape and Rehabilitation Plan	Develop a landscape plan in consultation with landowners.
	Trees used are to be at least 3 metres in height.
	Encourage landowners to develop part of their property as wildlife habitat.
	Restrict stock access to revegetated areas.
	Encourage landowners to develop an undergrowth of native vegetation which will not require annual burning.
	Restrict clearing of the escarpment to other than building envelopes.
	Control public access to POS on the escarpment to protect fragile slopes.
	Establish the area as a landscape protection precinct in the TPS.
Reserves	Link reserves on the foreshore to the escarpment:
	visually - through the landscape plan
	physically - through a roadway network but not for through traffic.
	Increase foreshore reserves (west of Cathedral Avenue) through subdivisions. Vest with LIMA for the purpose of Waterways and Foreshore Protection'.

	Establish buffer zones on the eastern side of Cathedral Avenue which will be treated like reserves but still be private property under agreement with the landowner.
	Encourage landowners and reserve vestees to remove exotic species in accordance with the landscape plan. Use of pesticides should be in accordance with guidelines.
	Encourage community groups to assist with revegetation of public areas in accordance with the landscape plan.
Subdivision	Subdivide properties perpendicular to the estuary so that building envelopes are on the escarpment, not the estuary flats.
	A minimum lot size of 4000 m2 to be permitted. Lots below this not to be subdivided.
Recreation	Establish recreation nodes to the west of Cathedral Avenue for low key recreation use. No random power boat launching permitted other than at authorised launching areas.
	Discourage power boating access in the northern 3 kilometres of the estuary. Develop a brochure explaining why boating access should be limited.
	Develop a small research project to examine the effects of boating access over a summer period.
	Restrict the establishment of further camping areas on the basis that sufficient areas will be established in the future on Leschenault Peninsula.
Cathedral Avenue	Improve traffic management in Cathedral Avenue by providing traffic calming devices, landscaping, widening of the road reserve (eastwards only) for separate carriageways, pedestrian and cycling facilities and carparking, in accordance with Council's plans.
	Implement regulations in association with Main Road Department to get a lower speed limit in the area.
Water Quality and Nutrient Control	Establish vegetation buffers on the eastern side of Cathedral Avenue in association with the landscape plan.
	Advise landowners on recommended fertiliser and pesticide use.
	Maintain vegetation on lots at all times to reduce runoff from these areas into the estuary.
	Restrict the storage of toxic chemicals and fuels on properties on the estuary flats (for personal use only).
	Require landowners on the estuary flats to dispose of rubbish in accordance with Council guidelines. No personal tip sites and no burying of rubbish or animal effluent on site.
	Require the use of alternative wastewater treatment and effluent disposal systems. The onus of proof will rest with the subdivider to provide sufficient technical and engineering evidence that alternative systems or site

	modifications remove any adverse effects on public health, water resources or the environment while not detrimentally impacting on the character of the area. (For special residential and tourist only)
	New commercial development or extensions must incorporate effluent management systems approved by the Health Department , the EPA and the Water Authority of Western Australia, or connect to reticulated sewerage if available.
	Encourage the development of nutrient and irrigation management programmes for the northern catchment.
	Encourage the development of wetland wildlife habitats as nutrient stripping devices.
	Encourage the use of compensating basins as nutrient and pollution stripping devices.
Rates	Develop a system whereby people not wishing to be rezoned from General Farming get a discounted rate especially if they establish a portion of their property as wildlife habitat. Some sought of retrospective system must be in place if they wish to come under the new zoning practice, ie. they must pay rates for the new zoning at least two years before subdividing in accordance with subdivision plan.
Flora and Fauna	Establish strategies for the control of exotic species in association with the Agricultural Protection Board and the Mosquito Control Advisory Committee.

9.4 Option 4 Leschenault Estuary Regional Park

This option was suggested in the System 6 report. A number of Regional Parks have been established in the metropolitan area and work is underway to determine the feasibility of implementing the Peel Regional Park. Funding for such 'park systems' is restricted in today's economic climate and while it is unlikely that this option would be funded in the short term it is possible that it may be considered in the future.

It is also unlikely that a proposal for the Leschenault Regional Park would include only the Cathedral Avenue area. However it is likely that the Cathedral Avenue Management Plan would form the basis of a more detailed study into the feasibility of this option at a later date.

Zoning within the park would still be necessary and so would guidelines for landowners. Only end management for the area would change. Other Regional Parks appear to be managed by a committee composed of local government, government agencies and community members. Funding is jointly undertaken by the State government and local government.

It is envisaged that the park would encompass both the water and the land making it easier to deal with the problem of boating and recreational use of the northern estuary.

It is recommended that if the Leschenault Estuary Regional Park option is to be pursued that the Preferred Option in Section 7.8 form the basis for land use in the Cathedral Avenue area.

Plate 7 : Samphire marsh functions as an effective nutrient trap and organic recycler.

9.5 Option 5 Special Use (Special Rural and Landscape Protection Zone)

Land use policy

This zone has been designed to ensure that land uses do not:

- increase the nutrient load to the estuary
- cause land degradation, dust and erosion
- result in clearing of existing native vegetation or replanting of significant areas with non indigenous species
- encourage buildings within the flood plain
- cause excessive noise or disturbance to the existing lifestyle of the area
- increase power boating use of the northern estuary.

The following criteria are attached to development in this zone:

- All developments must go to Council for consideration, no uses will be permitted as a right.
- Existing land use practices can be continued as non conforming uses.
- This zone allows for one residential property per lot, except with special Council approval.
- The minimum lot size is 2 hectares south of Crimp Crescent and a minimum of 5 hectares north of Crimp Crescent. This will allow for subdivision of lots of 4 hectares or greater to the south of Crimp Crescent and of lots 10 hectares or greater to the north of Crimp Crescent. Although there is a diversity of opinions on the minimum lot size this requirement will remain until the public review period is completed.
- Under the current Town Planning Scheme, a minimum of four chalets must be built for a chalet park. It is proposed this be carried through to the new TPS No 1. Developers will be required to prepare a special policy to ensure that chalets do not become de facto residential properties but are only used for short stay accommodation.
- Where practicable individual building envelopes for chalet developments would be outside the 1:100 year floodline, within the vegetation line and back along the escarpment.
- A restaurant is not included within this zoning and would require a further rezoning application. This applies to both on and over water developments.
- A Waterways Protection Precinct line has been drawn on the attached maps. This line has been determined using the following criteria wherever practicable:
- a setback of 200 metres from mean high water mark,
- development outside the 1:100 floodline
- landscape aesthetics
- topography
- existing vegetation and
- miscellaneous planning constraints.
- No development is to be permitted west of the Waterways Protection Precinct along the Cathedral Avenue side of the estuary, as illustrated on the relevant maps.

Land uses that could be permitted within the zone after Council consideration are:

- dwelling (one dwelling per 2 ha lot south of Crimp crescent and one dwelling per 5 hectare lot north of Crimp Crescent plus associated out buildings)
- home occupation
- art and craft studio
- keeping of livestock
- wayside stall
- consulting rooms
- caretaker's house

Land uses that could be permitted after advertising:

- chalet development in accordance with the criteria listed above
- lodging house/residential building
- residential hotel/motel
- school
- church
- health farm
- caravan park
- plant nursery

In addition the following land use would be permitted as a non conforming use.

- caravan park / chalet park/ camping area only on existing site and at the same density.

A new land use should also be added to the list of permitted land use:

- wildlife habitat - environmental protection. This has been added to allow for landowners who wish to develop their property as a wildlife habitat but not on a commercial basis ie. the lake system which occurs on Pt Lot 1 and Rosamel Swamp would be within this category.

Criteria

In addition a number of other criteria would need to be applied to the area. These include:

Setbacks	The Waterways Protection Precinct
Building Envelopes	Determine a building envelope for the site which will be large enough for house and outhouses.
	Determine the building envelope to give views of the estuary but to minimise views of developments from the estuary and road.
	Determine building envelopes for existing lots already with developments. Ensure that any future developments on these lots occur on the new envelope.
Stock Control	The keeping of horses will not be permitted
	The keeping of grazing animals shall be subject to the prior approval of the Council. Animal stocking rates shall not exceed the stocking rates recommended by the

	Department of Agriculture for the pasture type for the policy area. (See other sections regarding effluent control and vegetation protection)
Utility Services	Further overhead powerlines will not be supported on the estuary flats.
Building Structures and Materials	Discourage developments which through their height, bulk, colour and/or texture or material used are considered to be out of character with the estuary and bushland environment.
Landscape and Rehabilitation Plan	Develop a landscape plan in consultation with landowners. Trees used are to be at least 3 metres in height. Encourage landowners to develop part of their property as wildlife habitat. Restrict stock access to revegetated areas. Encourage landowners to develop an undergrowth of native vegetation which will not require annual burning. Restrict clearing of the escarpment to other than building envelopes. Control public access to POS on the escarpment to protect fragile slopes. Establish the area as a landscape protection precinct in the TPS.
Reserves	Link reserves on the foreshore to the escarpment: visually - through the landscape plan physically - through a roadway network but not for through traffic. Increase foreshore reserves (west of Cathedral Avenue) through subdivisions. Vest with LIMA for the purpose of Waterways and Foreshore Protection. Encourage buffer zones on the eastern side of Cathedral Avenue which will be treated like reserves but still be private property under agreement with the landowner. Encourage landowners and reserve vestees to remove weed species in accordance with the landscape plan. Use of pesticides should be in accordance with guidelines. Encourage community groups to assist with revegetation of public areas in accordance with landscape plan.
Subdivision	If possible subdivide properties perpendicular to the estuary so that building envelopes are on the eastern end of the block, not the estuary flats. The minimum lot size for new subdivided lots will be 2 hectares south of Crimp Crescent and 5 hectares north of Crimp Crescent. Lots currently below this will not be permitted to be subdivided. Although there is a diversity

	of opinions on the minimum lot size this requirement will remain until the public review period is completed.
Recreation	Establish recreation nodes to the west of Cathedral Avenue for low key recreation use. No random power boat launching permitted other than in authorised areas.
	Discourage power boating access in the northern 3 kilometres of the estuary. Develop a brochure explaining why boating access in the northern 3 kilometres should be limited.
	Restrict the establishment of further camping areas on the basis that sufficient areas will be established in the future on Leschenault Peninsula.
Cathedral Avenue	Improve traffic management in Cathedral Avenue by providing traffic calming devices, landscaping, widening of the road reserve (eastwards only) for separate carriageways, pedestrian and cycling facilities and carparking, in accordance with Council plans.
Water Quality and Nutrient Control	Encourage establishment of vegetation buffers on the eastern side of Cathedral Avenue in association with the landscape plan.
	Advise landowners on recommended fertiliser and pesticide use.
	Maintain vegetation on lots at all times to reduce runoff from these areas into the estuary.
	Restrict the storage of toxic chemicals and fuels on properties on the estuary flats.
	Require landowners on the estuary flats to dispose of rubbish in accordance with Council guidelines. No personal tip sites and no burying of rubbish or animal effluent on site.
	Council supports the use of alternative wastewater treatment and effluent disposal systems. The onus of proof will rest with the subdivider to provide sufficient technical and engineering evidence that alternative systems or site modifications remove any adverse effects on public health, water resources or the environment while not detrimentally impacting on the character of the area.
	Existing properties will be permitted to operate conventional on-site effluent disposal systems provided they are operating effectively. If any existing systems are to be replaced in the future, Council will encourage the use of an alternative wastewater treatment and effluent system.
	New commercial development or extensions must incorporate effluent management systems approved by the Health Department , the EPA and the Water Authority of Western Australia, or connect to reticulated sewerage if available.
	Encourage the development of nutrient and irrigation management programmes for the northern catchment.

	Encourage the development of wetland wildlife habitats as nutrient stripping devices.
	Encourage the use of compensating basins as nutrient and pollution stripping devices.
Rates	Develop a system whereby people not wishing to be rezoned from 'General Farming' get a discounted rate especially if they establish a portion of their property as wildlife habitat. Some sort of retrospective system must be in place if they wish to fall into the new zoning practice ie. must pay rates for the new zoning at least two years before subdividing in accordance with subdivision plan.
Flora and Fauna	Establish strategies for the control of exotic species in association with the Agricultural Protection Board and the Mosquito Control Advisory Committee.

9.6 The Preferred Option

The option preferred by the committee is Option 5 Special Use (Special Rural and Landscape Protection Zone).

This was chosen by the Working Group because :

1) The term Special Use (Special Rural and Landscape Protection Zone) by definition implies that special conditions apply to the subject land.

2) The zoning would retain the scenic rural character and a lifestyle that people value.

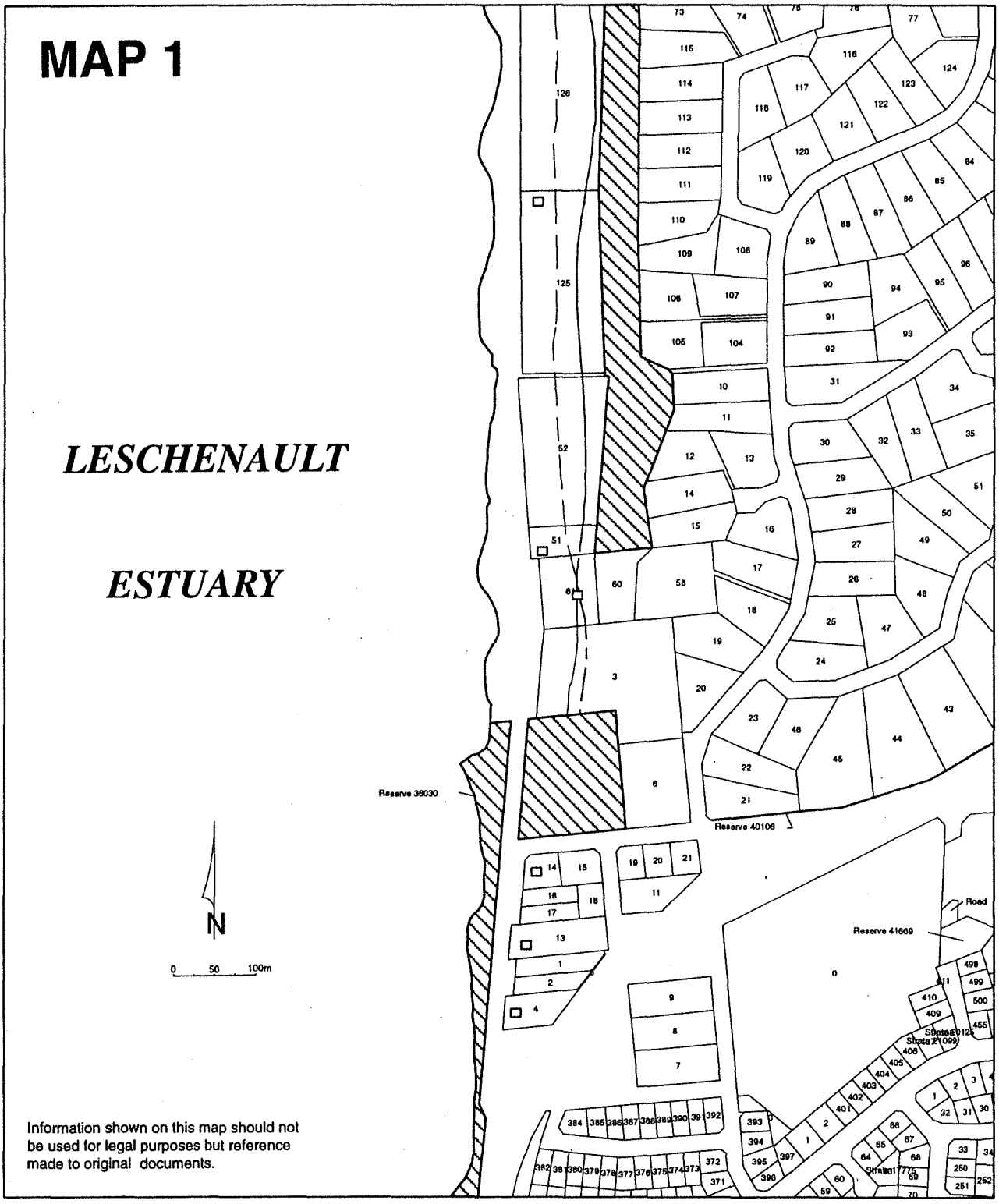
3) Specific criteria can be attached to the zoning to control development in a manner which accomplishes the objectives of the study. In effect, the criteria have been designed to retain the scenic quality of the area and provide for regulated development whilst enhancing the environment. The design criteria contain the best qualities of the existing Special Rural and the Special Residential zonings.

4) Foreshore reserves can be excised from developments as a condition of subdivision at no cost to the Crown.

5) A majority of the blocks may be subdivided perpendicular to the estuary to enable building envelopes to be situated outside the Waterways Protection Precinct.

6) Density of subdivision is strictly regulated to minimise service infrastructure, nutrient runoff and vegetation loss and to maintain landscape amenity.

10. RESOURCE MAPS



PLANNING CONSIDERATIONS

- Existing reserves
- Comparatively small lot sizes
- Floodplain
- Proximity of escarpment to the shoreline
- Caravan park

MAP 2

LESCHENAULT

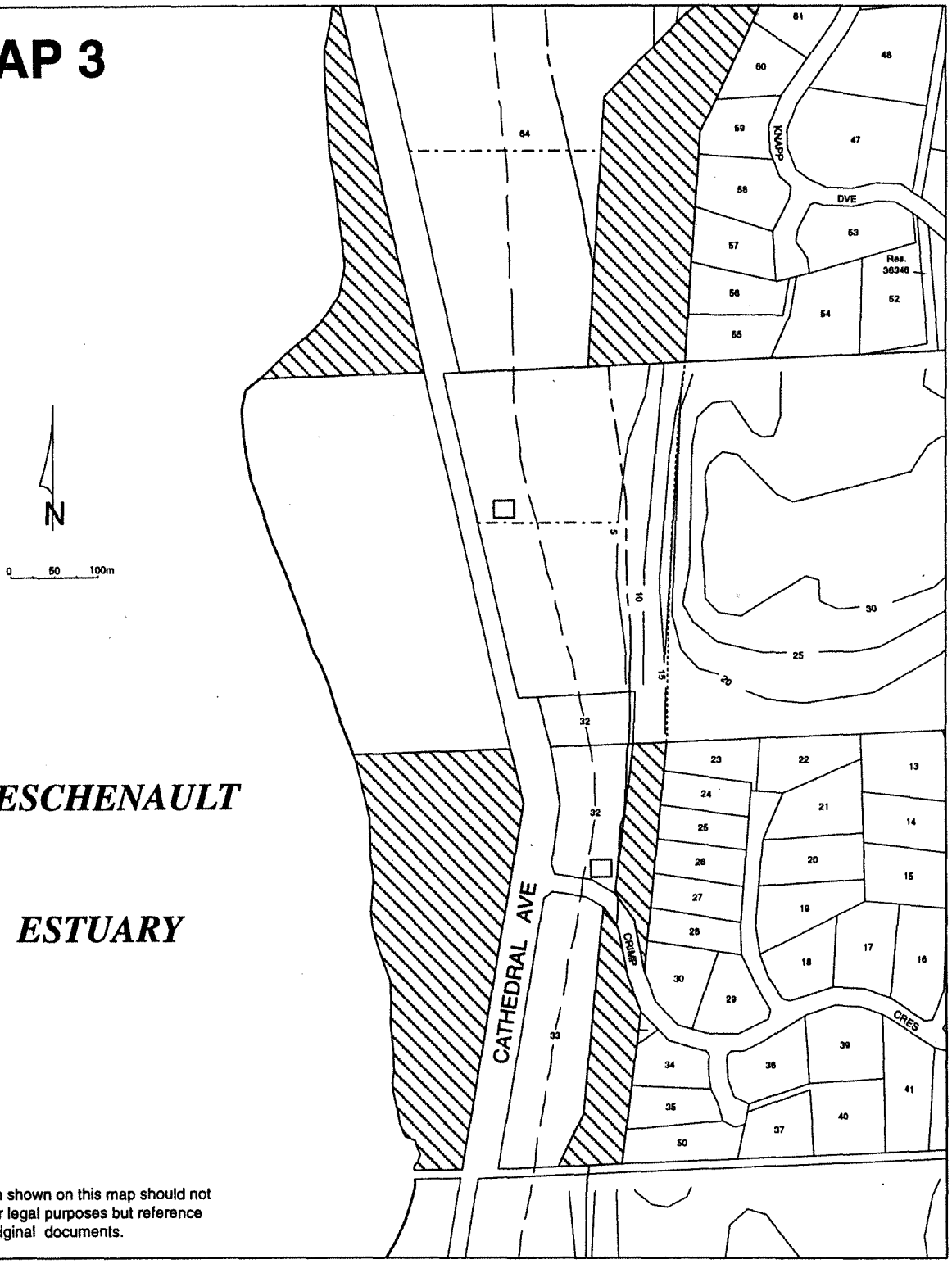
ESTUARY

Information shown on this map should not be used for legal purposes but reference made to original documents.

PLANNING CONSIDERATIONS

- Existing reserves
- Floodplain
- Good stands of rushes
- Road reserve adjacent to foreshore very narrow
- Pedestrian link from foreshore to escarpment
- Landscape aesthetics

MAP 3



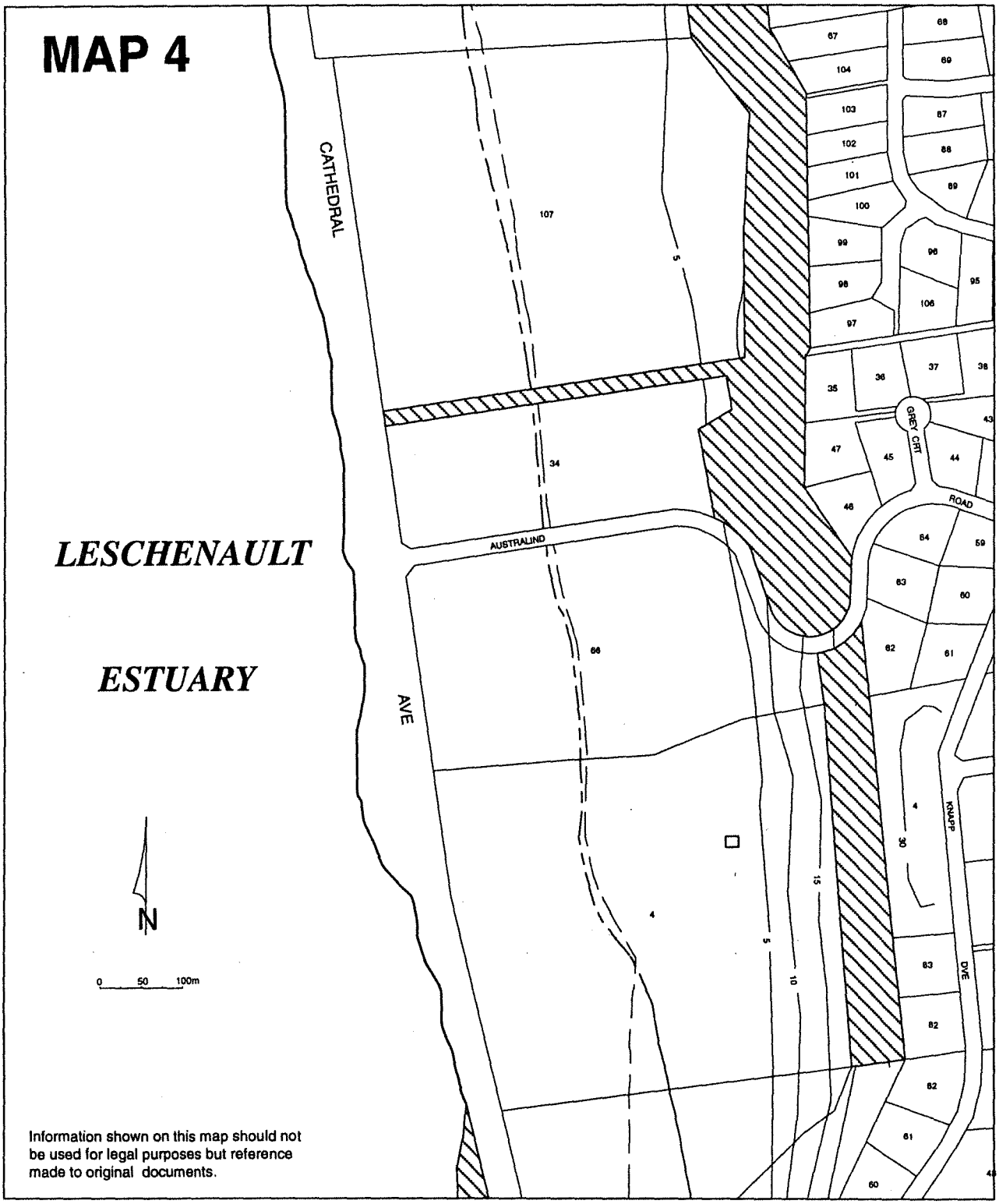
LESCHENAULT

ESTUARY

Information shown on this map should not be used for legal purposes but reference made to original documents.

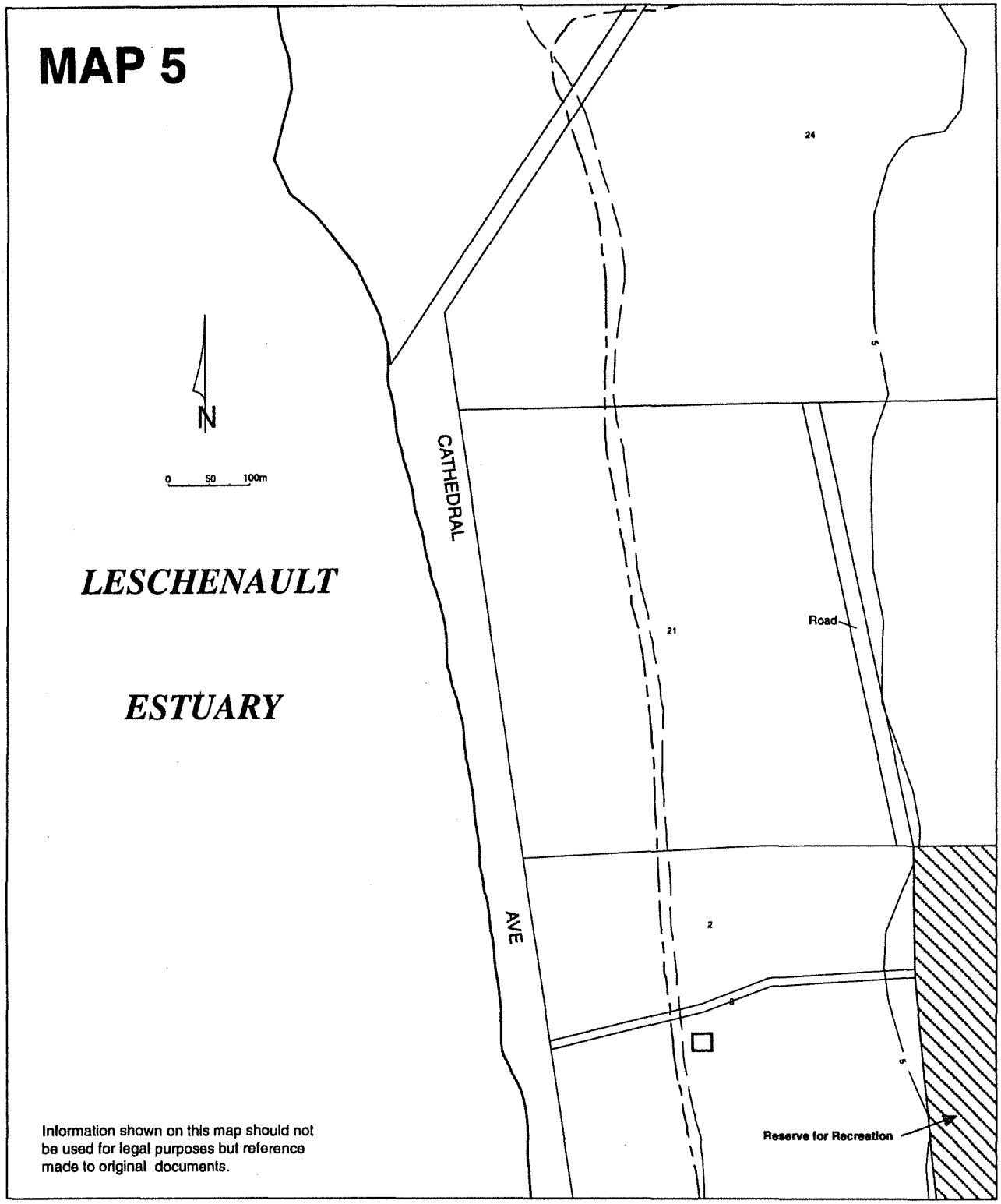
PLANNING CONSIDERATIONS

- Existing reserves
- Road width
- Floodplain
- Landscape aesthetics
- Sand spit


MAP 4
LESCHENAULT
ESTUARY
CATHEDRAL
AVE
AUSTRALIND
GREY CRT
ROAD
KNAPP
DVE
N
0 50 100m
Information shown on this map should not be used for legal purposes but reference made to original documents.

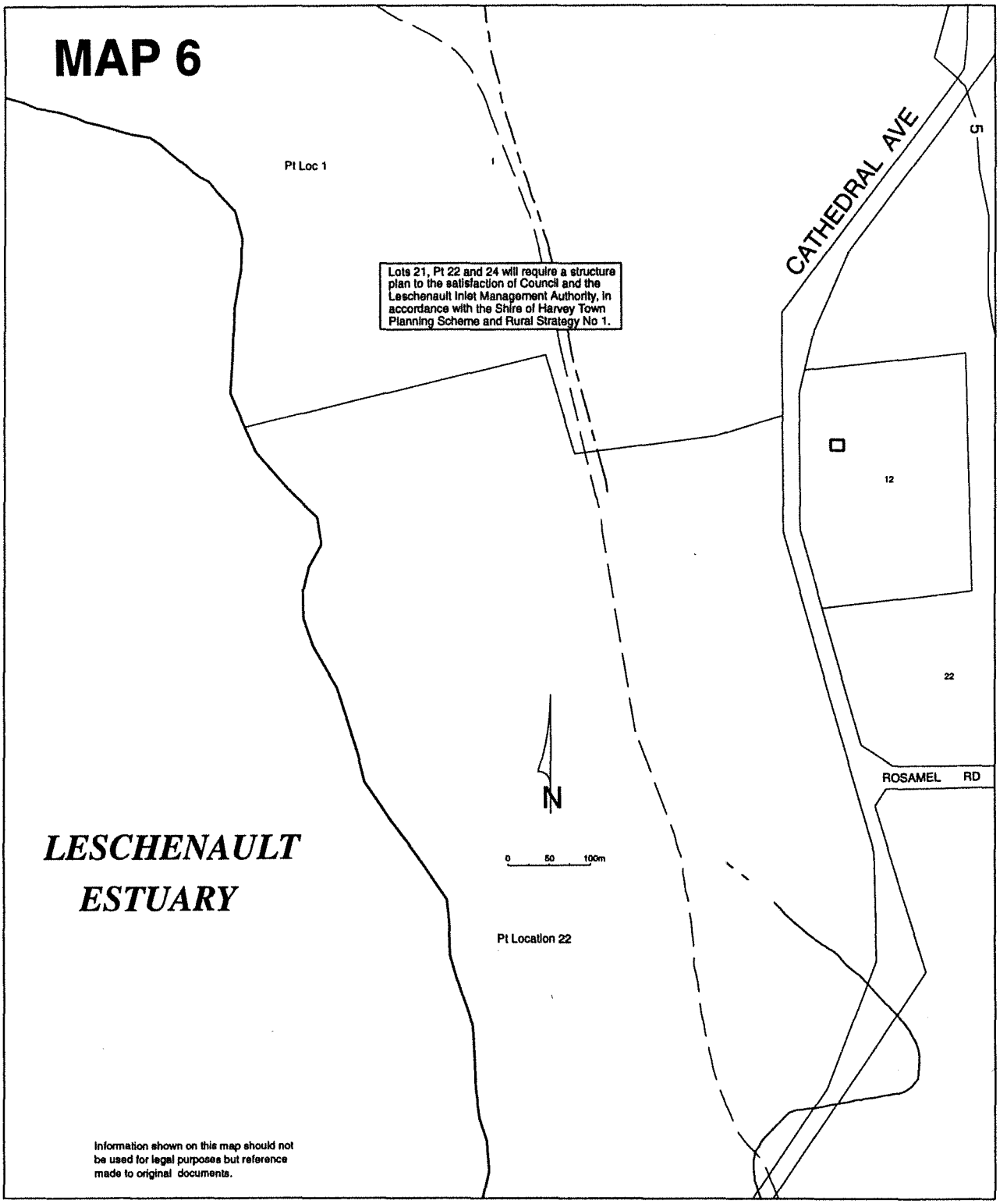
PLANNING CONSIDERATIONS

- Existing reserve along escarpment
- Comparatively large lot sizes
- Floodplain
- Landscape aesthetics
- Good stands of mature paperbarks
- Good stands of rushes
- Informal boat launching facilities
- Pedestrian link from foreshore to escarpment
- Inadequate width of foreshore reserve
- Road reserve adjacent to the foreshore is very narrow


MAP 5
N
0 50 100m
LESCHENAULT
ESTUARY
CATHEDRAL
AVE
24
21
2
Road
Reserve for Recreation
Information shown on this map should not be used for legal purposes but reference made to original documents.

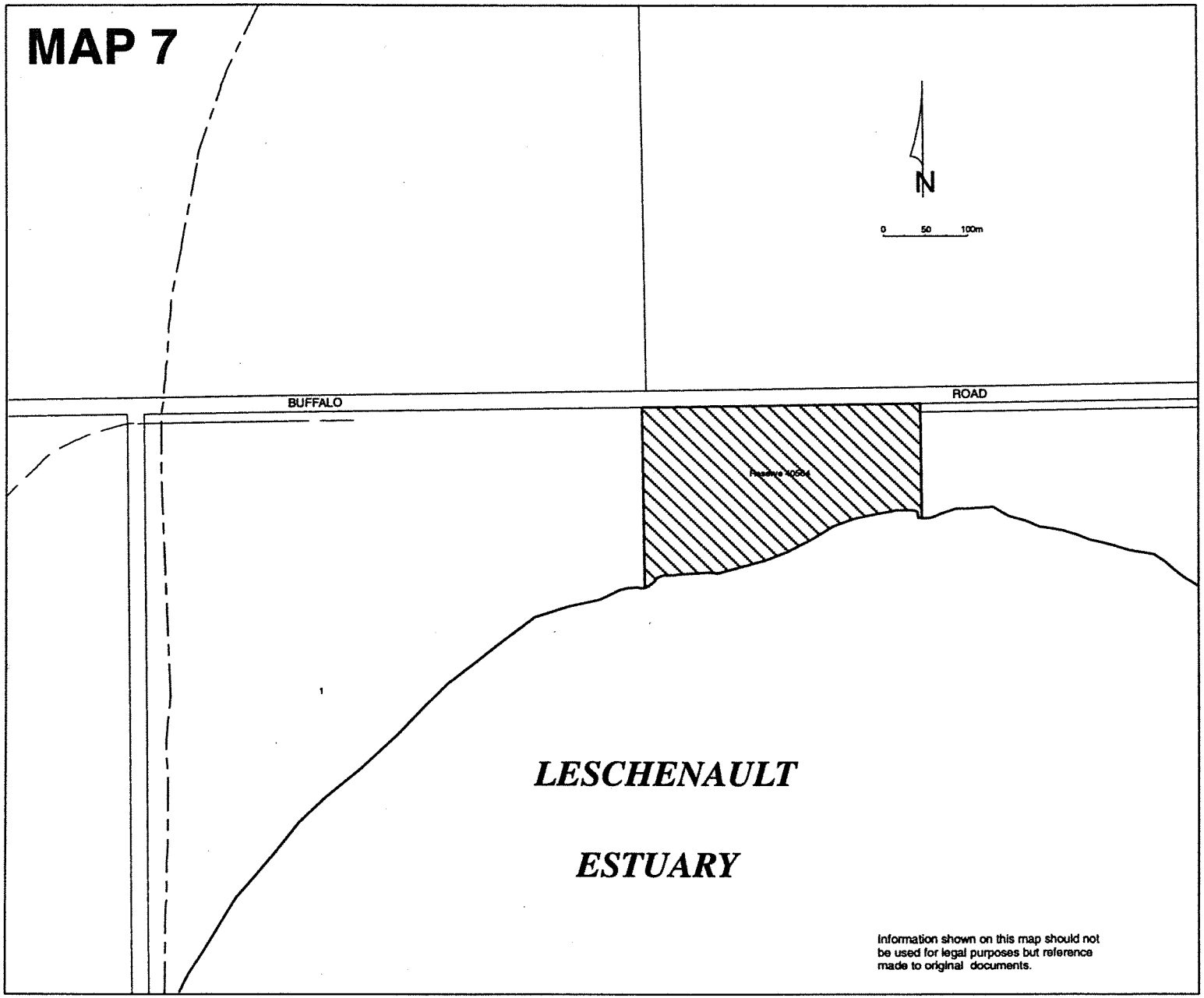
PLANNING CONSIDERATIONS

- Existing reserves
- Comparatively large lot sizes
- Floodplain
- Good stands of rushes
- Mature paperbarks
- Road width
- Existing land uses
- Pedestrian link from foreshore to escarpment
- Inadequate width of foreshore reserve
- Landscape aesthetics
- Road reserve adjacent to the foreshore is very narrow


MAP 6
Pt Loc 1
Lots 21, Pt 22 and 24 will require a structure plan to the satisfaction of Council and the Leschenault Inlet Management Authority, in accordance with the Shire of Harvey Town Planning Scheme and Rural Strategy No 1.
CATHEDRAL AVE
5
12
22
ROSAMEL RD
N
0 50 100m
LESCHENAULT ESTUARY
Pt Location 22
Information shown on this map should not be used for legal purposes but reference made to original documents.

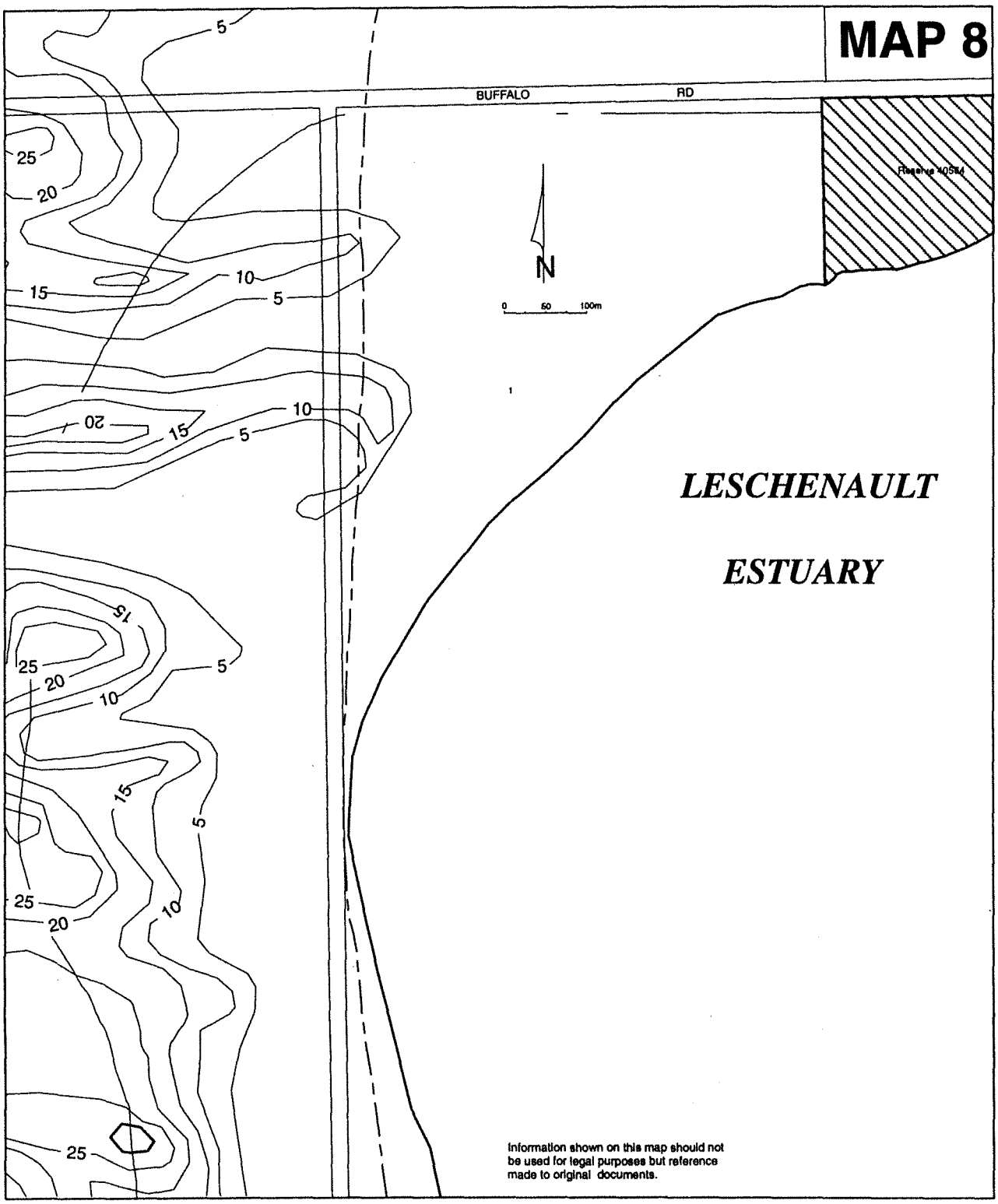
PLANNING CONSIDERATIONS

- Comparatively large lot sizes
- Extensive wetland network
- Samphire march adjacent to the estuary
- Existing land uses
- Floodplain
- No foreshore reserve
- Landscape aesthetics


MAP 7
N
0 50 100m
BUFFALO ROAD
Reserve 40564
LESCHENAULT
ESTUARY
Information shown on this map should not be used for legal purposes but reference made to original documents.

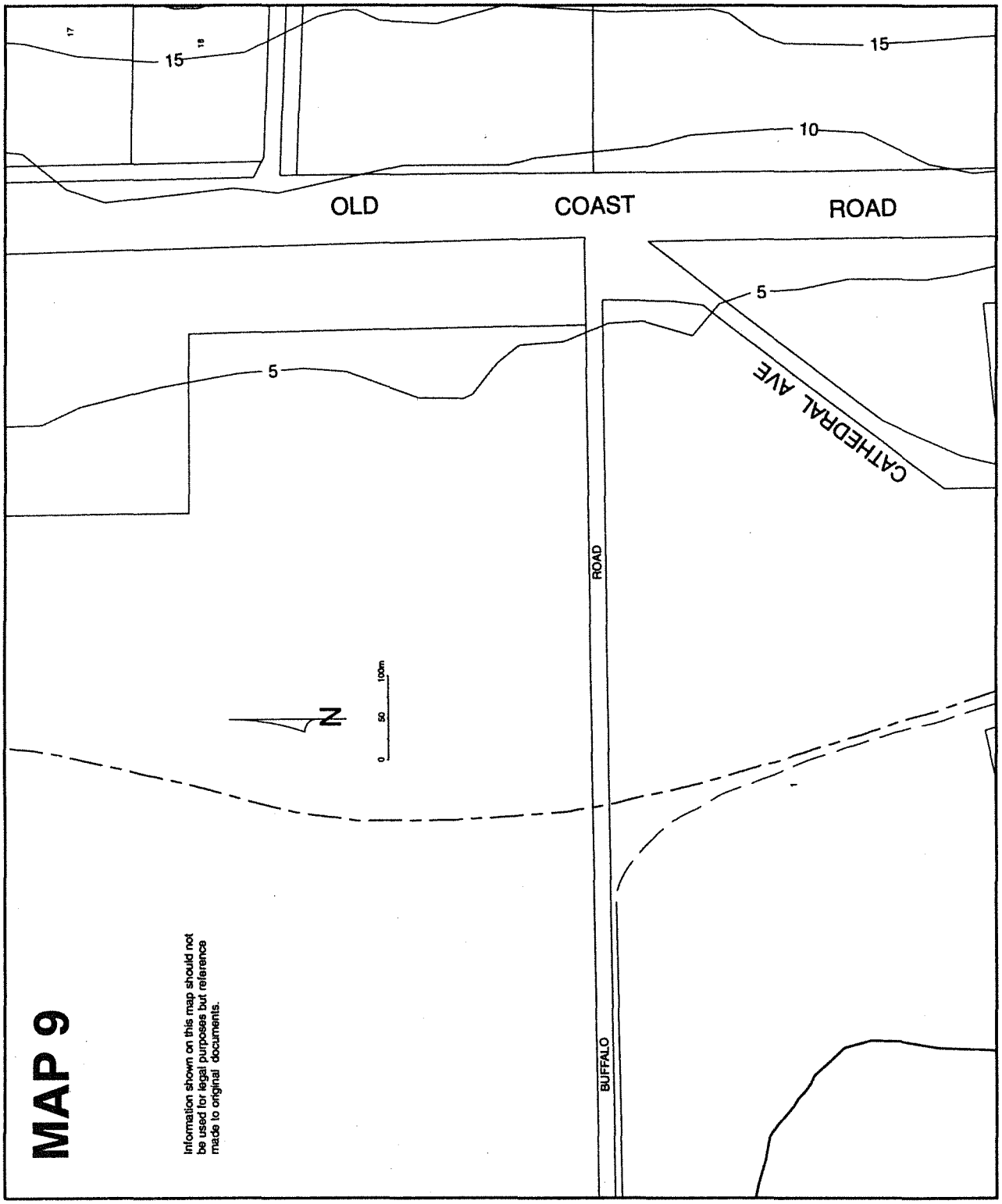
PLANNING CONSIDERATIONS

- Existing reserves
- Floodplain
- Buffalo Road divides the area
- Samphire wetlands
- Dune system
- Leschenault Peninsula Management Plan


MAP 8
BUFFALO RD
Reserve 40584
N
0 50 100m
LESCHENAULT
ESTUARY
Information shown on this map should not be used for legal purposes but reference made to original documents.

PLANNING CONSIDERATIONS

- Existing reserves
- Floodplain
- Buffalo Road divides the area
- Samphire wetlands
- Dune system
- Leschenault Peninsula Management Plan


MAP 9
Information shown on this map should not be used for legal purposes but reference made to original documents.
OLD COAST ROAD
CATHEDRAL AVE
BUFFALO ROAD
15
15
10
5
5
N
0
50
100m

PLANNING CONSIDERATIONS

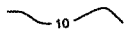
- Floodplain
- Existing land uses
- Extensive wetlands network
- Good stands of mature tuart trees
- Landscape aesthetics
- No foreshore reserve

LEGEND

Waterways Protection Precint

1 in 100 Years Floodline

Escarpment



Contours

Cadastral Boundaries

Possible Subdivision Boundary

Existing Dwellings

Public Open Space

11. REFERENCES

Appleyard, SJ (1992) Estimated Groundwater Nitrogen Influx into Leschenault Inlet. Hydrogeology Report No 1992/4, Geological Survey of WA.

Chester, ET and Klemm VV (1990) Draft Integrated Mosquito Control Strategy for the Leschenault Estuary Region. Waterways Commission, Perth, WA.

DCE (1983) Conservation Reserves for Western Australia as recommended by the Environmental Protection Authority. EPA, Perth, WA.

DPUD (1992) Bunbury-Wellington Regional Planning Study, Working Paper No 8 Regional Open Space an Integrated System. Perth, WA.

DPUD (1992) Greater Bunbury Structure Plan. (in prep)

Halse, SA, Pearson, GB and Pinder, AM (1989) Invertebrate Fauna and Waterbird Diet at Mosquito Breeding Areas of the Leschenault Inlet, Bunbury, Western Australia. Preliminary Report to MCAC (unpublished).

Klemm, VV (1989) Report on Mosquito Control in the Leschenault Estuary Region. Mosquito Control Review Committee (MCRC)/ Government of WA, Perth, WA.

Klemm, VV, Lukatelich, RJ and Atkins, RP (1987) Leschenault Inlet. A Comparison with the Peel-Harvey System. A paper presented at the Peel-Harvey colloquium. Perth, WA.

LeProvost Environmental Consultants (1990) The Sanctuary Pelican Point Public Environmental Review, Perth, WA.

Lukatelich, R (1989) Leschenault Inlet - Macrophyte Abundance and Distribution. Report to the Waterways Commission, Perth, WA.

Marshall, AJ and Williams, JD (Eds)(1972) Textbook of Zoology. Invertebrates. 7th ed. McMillan Press. London.

Meagher, TD (1971) The biology of the Blue Manna Crab (Portunus pelagicus) in South Western Australia. PhD Thesis, University of Western Australia (Unpublished).

Ninox Wildlife Consulting (1989) The Significance of Mosquito Breeding Areas to the Waterbirds of the Leschenault Estuary. Prepared for the Mosquito Control Review Committee, Waterways Commission, Perth, WA.

Pen, LJ (1992) Fringing Estuarine Vegetation of the Leschenault Estuary 1941-1991. Waterways Commission, Perth, WA.

Schwinghammer, T (1982) Leschenault Inlet Management Authority - Fact Finding Study. Waterways Commission, Perth, WA.

Seminiuk, V and Meagher, TD (1981) The geomorphology and surface processes of the Australind - Leschenault Inlet coastal area. J. Roy. Soc. West. Aust. 645 (2) : 71 - 83.

Shire of Harvey (1983) Report on the Coastal Lakelands Study. Harvey, WA.

SPC (1987) Bunbury Region Plan, Policy Statement of the State Planning Commission. Perth, WA.

SWDA (1991) South West Strategy - A People's Plan. South West Development Authority, WA.

Taylor and Burrell (1985) Bunbury Region Plan (Final Draft) Report For The State Planning Commission. Perth, WA.

Thurlow, B (1989) Leschenault Recreation Study, January 1988. Waterways Commission Technical Report No 2, Perth, WA.

Van Der Wiele H (1988) A Study of Recreational Boating and Aquatic Vegetation of the Leschenault Estuary. Department of Conservation and Environment, Perth, WA.

Wurm, PAS (1987) Molluscs of Leschenault Inlet - A Study of Habitats, Distribution, Abundance and Population Age Structures.

APPENDIX 1 - PUBLIC SUBMISSIONS

Twenty two public submissions were received on the Notice of Intent for the Cathedral Avenue and Northern Estuary Management Plan. A summary of these is provided below. Some of the comments are actually suggestions for the final management plan and were considered as the study progressed.

Generally the submissions supported the aim and objectives put forward with a few changes to clarify the intent. There were a number of concerns regarding the study area. It was considered that it was an artificial boundary and if the study was limited to this area it would be impossible to address the issue of nutrient input to the estuary.

The issues have been groups into the following categories.

1.0 Residential use and effluent disposal

Impact of existing and potentially increased numbers of on-site effluent disposal systems on the estuary flats area, and in the Leschenault escarpment area.

With new technology effluent leachate from septic tanks can be reduced. Similarly garden run off can also be controlled.

Smaller subdivisions, controlled septic systems, a drainage system which would use man-made wetlands as a biological filter and the associated dense planting of native trees around the wetlands.

2.0 Land use and nutrient leaching

Nutrient loadings to the northern Leschenault Estuary through a variety of sources including fertiliser application to pasture, intensive horticulture, surface runoff from land used for grazing, and groundwater seepage from on-site effluent disposal systems.

Contain nutrient loading to levels that will not cause undesirable algal blooms.

No quantitative information on eutrophication of waterways due to farming practices and housing development

Data show that livestock create much more effluent that humans therefore removing the livestock could allow human development on a controlled scale

Impacts of general land use on the estuary waters, including the development of horticulture to the north of Buffalo Road.

Review fertiliser practices on farmland and special residential areas, with possible controls, at least a public education programme.

3.0 Water quality monitoring

3.1 Environmental monitoring groundwater, estuary water quality

Identify sites which have the potential to contribute pollutants to the estuary Eg excess nutrients via groundwater.

Monitor water quality and identify potential and existing pollution entry points.

Set criteria for unacceptable levels of pollution

Water quality on eastern shore in and near boat channels needs examining re disposal of dredge spoil.

3.2 Other pollutants

Prevent pollution from pesticides and hydrocarbons.

4.0 Catchment management

View the study area in the context of the overall catchment and manage it accordingly

Extend study area to include area north to Binningup and south to Collie River.

Extend study area to include catchment of Parkfield Drain.

5.0 Suggested solutions

Any runoff along Cathedral Avenue should be directed into swamplands before seeping into the estuary. This could be achieved by developing current low lying areas in land immediately east of the road, by digging out to deepen and planting edges with paperbarks and rushes. It may also be possible to develop artificial wetlands for this purpose.

Consider restricting existing developments that are having a significant impact on the estuary eg horticultural practices.

Formation of EPP that would include guideline's for all landowners (rural and urban) on fertiliser practices.

Nutrient and irrigation management programmes for northern catchment.

Suggest the planting of trees on small holdings as a means of reducing the impact of such subdivisions on the estuary.

Suggestion of alternative septic disposal mechanisms as a means of reducing nutrients input to the estuary eg. red mud.

Minimum block size to be 4 ha or as near as possible.

Each new land owner agree to plant trees either in groups or total parkland.

Each new house to have an envirocycle septic system.

Landowners to mix red mud with the land before any subdivision occurs. This will reduce the amount of nutrients leaching from the land.

Undertake deep sewering of wider Australind area to reduce nutrient input to the estuary.

The perceived demand is for a rural outlook along Cathedral Avenue. Dense planting in wetlands on the east side of the road will achieve this, while filtering any nitrogen or phosphorus which may run onto them.

6.0 Fire management

Fire control and management of vegetation.

Prepare burning policy

7.0 Wetlands protection and rehabilitation

Remove feral species where practicable (rabbits and aggressive weeds)

Regeneration and preservation of wetland areas

We probably don't know enough about the ecosystem to know how best to protect and manage it, although in many cases it seems to be true that the more we modify the environment the greater the costs of managing it.

Preservation of waterbird habitats in the northern end of the Leschenault Estuary, including significant and valuable habitats o the foreshore areas surrounding the estuary.

Maintain shore vegetation (reeds etc) and terrestrial habitat for ducks etc.

South of Buffalo Road the land between the estuary and Old Coast Road be considered a conservation area to the estuary and buffer area to the Goodchild's abattoir, which is located just east of Old Coast Road, and as far as the south boundary of Lot 24. a piggery is located to the north east of this area.

Wetlands in the study area affected by the "Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy 1991".

Natural swamp area adjacent to Old Coast Road north of Dunn Road needs protection.

Maintenance and restoration of the area between the escarpment and the estuary should be given priority.

Revegetation should include public and private land.

Nature Reserve 40564 vested with NPNCA.

Consideration of Marine reserve issue of the northern estuary is desirable.

Biological sand deposition flora and fauna.

Shire and State resources for rehabilitation and protection of the area.

Need replanting of trees as existing trees are dying and there is no regrowth to provide bird habitats. Also use of nest boxes.

Provision of shrub layer to provide further bird habitat and increase types of birds.

Regrowth along Cathedral Avenue is required if the area is to be a scenic attraction.

8.0 Flora

Environmental monitoring of flora

9.0 Fauna

Environmental monitoring fauna

Protection of sites essential to the maintenance of fauna Eg feeding grounds for birds, fish, crustaceans, native flora to provide a habitat.

Breeding areas for fish and dolphins dependent on estuary fish for a food source.

Impact of pleasure craft on dolphins.

Consider wildlife corridors, connecting public open space to allow fauna to exist in the area when housing takes over the land east of the escarpment.

Priorities for abate program.

Ensure mosquito spraying is not harmful to fauna.

The 1983 System 6 Recommendations indicate that the whole area should become a Regional Park. What is the current status of this recommendation and how are regional parks being developed elsewhere.

This area has been recognised in many studies and reports, including the System 6 report as being of regional importance for conservation. Many species of waterbirds utilise the northern estuary and foreshore area, including migratory wading birds, and other local species that use the estuary as a feeding area, and a sanctuary when inland wetlands dry out. In addition, the northern estuary has significant importance as a nursery for juvenile fish.

Size and capability of reserves to cater for demands is critical

More demand will be placed on the eastern foreshore as the western foreshore is established as a conservation park and the wetlands are protected and development and provision of recreation facilities is limited.

Combining public open space with wildlife corridors.

The high summertime recreational use of the foreshore area, and the increasing amount of public land necessitate appropriate management of foreshore vegetation to prevent damage to nearby properties, and to prevent damage to foreshore vegetation.

10. Solutions

Preservation of vegetation on the northern estuary foreshore, the estuary flats and the Leschenault escarpment.

Rehabilitation of vegetation on the northern estuary foreshore and estuary flats area.

Maintain bush on scarp to minimise erosion, screen buildings from estuary users, minimise fire hazard and maximise wildlife value

Maintain and/or replant native species on flood-plain

Link bush areas to provide corridors for wildlife

No more filling of swamps

Land between the escarpment and the estuary should be re-planted with suitable trees to create a wildlife /bird area similar to Kemerton.

Protection of shallow emphemeral wetland in the area and fencing from stock.

Police the maintenance of the natural environment and prohibit the burning of foreshore reeds.

Keep area free of weed species.

Regional Park for the Bunbury Australind area so that the estuary is considered as a whole unit. It should cover land use controls, purchase of private land by State Government to allow increased public use. Should include Brunswick and Collie River systems.

Community participation - tree planting etc. The cost of rehabilitation and developing habitat and essential recreation facilities can be minimised by use of community labour. This will encourage greater respect for the area by some sections of the community.

Give local residents some responsibility for management

Recreational uses of the estuary and its perimeter can be controlled to confine activity and can be successfully managed.

11. Management and control of recreation use of foreshores.

Ensure that recreational use does not compromise the central aim of the plan.

Manage recreation activities - keep them to areas that can withstand the impacts, encourage non-destructive pursuits.

Recreational qualities people like are quite, fresh air, intimate contact with the natural environment, space, walking, birdwatching, access to recreational fishing, crabbing, prawning.

The foreshore of this area supports intensive use by crabbers and prawners over the summer periods, an has considerable recreational value to both locals and tourists.

Recreational uses of the estuary and its perimeter should be controlled to confine activity to specific areas on the perimeter of the estuary which can sustain such activity and be properly managed.

Need for public recreation and access but not to all areas.

Public access for boating, fishing, crabbing and bird watching rather than hotels, resorts etc.

Consider the restriction of uses to an area, closing of areas temporarily, seasonally or permanently, monitoring use, minimising visual impact, appropriate use.

Access to deeper water for boating and crabbing.

Programme of education, encouragement and enforcement to restrict boat movement in northern estuary.

Designation of recreation areas for particular activities.

Concern about area of waterway to be closed to fishing.

Belvedere should be a tourist resort with walking tracks further south. Vehicle access through to the coast for fishing.

Boat channels need reviewing.

11.1 Solutions

Limit power-boat access to prevent destruction of estuary vegetation.

Over water restaurant at Ridley Place.

Outdoor education and research, low-key interpretive centres, walk tails may be cycle trails.

The 1:100 year flood line includes nearly all of the estuary flats area. Will development in the area be affected?

12.0 Administration

Clarification of the approval/control process regarding land use in the area eg. responsibility of HSC, EPA, LIMA, WAWA in approving/rejecting applications to be clarified and agreed to.

Co-ordination of existing plans in preparation by other agencies.

13.0 Demand

The estuary foreshore is an attractive location and there is some demand from landowners to develop this land.

Pressure to confine the use of the land immediately adjacent to the estuary, including the estuary flats area below the escarpment, to conservation, controlled recreation and low intensity rural uses.

What are the appropriate uses for the larger rural lots adjacent to the estuary to the north of Australind Road.

Need a set of broad planning objectives for the next 20 to 30 years and more specific management objectives for the next 10 years.

Some owners wish to maintain the rural use they currently enjoy without any change to either their own land use or the rates that they pay.

Some believe the land they own is unviable as a rural use and wish to subdivide and sill. It has been generally agreed between the owners that the land should not be subdivided to a size less than two hectares (five acres).

Some wish to develop other uses which should be of low density, low impact .

Some people believe that the current zoning is inappropriate for the area. However if there is to be a change in land use zoning it should not effect those owners who wish to continue with the current use.

Pressure for development applications for subdivision of properties along Cathedral Avenue.

13.1 Solutions

13.1.1 Possible uses:

- Nursery wholesale, retail tree farm
- Camping park
- Caravan Park
- Chalets

- Tourist farm
- Tourist park
- Aquaculture
- Mini golf course
- Riding school
- Hydroponics
- Health farm
- Education camp
- veterinary surgeon

13.1.2 Preferred development

Land owners in the area east of Cathedral Avenue should be permitted to engage in activities which are compatible wit the objectives of preservation of the estuary and foreshore areas.

Farming of a general nature and some selective tourist industries such as chalets could be perceived to be compatible with the estuary. Caravan parks are not perceived as suitable.

Caravan park and private dwellings have already intruded on the area.

No further development should be permitted which will intensity the current land uses, and approval from Council should be obtained in all cases.

Other developments should be low key, environmentally sensitive, visually unobtrusive and not create undue traffic.

Intensive land use to west of the escarpment should be avoided.

No intensive horticulture, no high density residential development, no tourist development.

Moratorium on development until plan has been developed which is consistent with System 6 Recommendations.

Existing policy statement in the Town Planning Scheme and Rural Strategy Review detailing no further subdivision for intensification of residential development being permitted in the policy area.

Consideration of the environment and the expansion of Australind as a major tourist attraction.

Much of the area is already zoned 'Special Residential' and the few remaining blocks which are zoned General Farming, should be rezoned for development - as their owners wish to apply.

No permanent or short stay tourist accommodation as it will make people management impossible.

Maintain low intensity land use between the estuary and the scarp (first row of dune to the east)

this requires a halt to further subdivision of all land along the flats

if necessary, compensate the few landowners whose property rights have to be withdrawn, or whose land must be acquired.

The areas west of Cathedral Avenue should be preserved and improved from an environmental view point. Public access to these areas should be limited to current entry points . Further tree and general Vegetation planting in any suitable areas should be a priority.

Cathedral Avenue should be extended to Buffalo Road as a dual carriage way, though at all times protecting existing vegetation. Further tree and vegetation planting should be carried out on the road reserve.

Subdivision of land east of Cathedral Avenue should be permitted down to areas of 1 to 5 acres. Scientific evidence suggests that people produce less effluent than animals, however, strict criteria should be applied to any subdivision application, such as preservation of existing vegetation, further planting of suitable vegetation and building envelopes.

Reduce speed limits on Cathedral Avenue.

Northern Estuary should have a buffer zone of 1 km to prevent invasion of development.

Buffalo Road should remain the only access without small feeder roads from development to the north.

Restrictions on owners of land along Cathedral Avenue.

Maintenance and improvement of the aesthetics of the Cathedral Avenue area, including retention of vegetation along the Leschenault escarpment.

Maintain rural character of floodplain by curtailing conventional development (buildings, roads, poles) - restriction of use through appropriate zoning.

Aspects people like - wetlands, paperbarks, tuarts, peppermints, rural vista on Cathedral Avenue, landscape is not dominated by straight lines and harsh colour of buildings.

The estuary foreshore area is an integral part of the estuary environment and the maintenance of appropriate vegetation on the foreshore and Leschenault escarpment is necessary to ensure the continuing estuarine landscape and aesthetics. Many waterways in Western Australia and around the world have had their foreshores developed to the extent that they no longer provide a natural estuarine outlook and setting, and these values should be preserved for the northern estuary area.

Development of a landscape plan and development guidelines to ensure protection of the landscape desirable for planing purposes and to illustrate concepts to the public.

Should not be a tailored landscape plan.

Mandurah to Dawesville is a good example of development not intruding on the natural surroundings.

Strictly limit all industrial development.

Solutions

The scenic value of the area should be protected, and building envelopes would need to be allocated to lots fronting Cathedral Avenue, based on the following criteria:

- A 200 m setback is required for non-residential zoned land from shores or coasts.
- A 50 m setback is required from Scenic Drive (Cathedral Avenue) to protect the scenic value of the road.
- The 1:100 year floodline as determined by WAWA.
- The amount of vegetation cover on-site.

To protect the scenic value of the area the following aspects should also be taken into account. Any development on lots within this area will be subject to revegetation proposals, and a second carriageway is to be constructed to protect the existing vegetation within the road reserve.

No more houses within the 100 year flood line on the flats.

Submissions received

1 Environmental Protection Authority
2 Robertson DG and AF
3 Bunbury Dolphin Trust
4 Roach H
5 Roach I
6 Roach C
7 Conservation and Land Management
8 Leschenault Environmental Study Group
9 Landuse Australia Pty Ltd
10 Bartle P
11 Cooper GJ
12 Triplet M
13 Cooper H
14 Daws J and A
15 Bicknell G
16 Eckersley M
17 Smith M G
18 Thompson J
19 Shannon TDG Dr.
20 Williams H
21 Williams S
22 Mardon G

ABBREVIATIONS

AGC :	Australian Groundwater Consultants
CAL :	Cathedral Avenue Landowners
CALM :	Department of Conservation and Land Management
CAMBA :	China Australia Migratory Bird Agreement
CANEPS :	Cathedral Avenue and Northern Estuary Planning Study
DCE :	Department of Conservation and Environment
DOLA :	Department of Land Administration
DOT :	Department of Transport
DPUD :	Department of Planning and Urban Development
EPA :	Environmental Protection Authority
HSC :	Harvey Shire Council
JAMBA :	Japan Australia Migratory Bird Agreement
LCCG	Leschenault Catchment Coordinating Group
LESG :	Leschenault Environmental Study Group
LICMSC :	Leschenault Integrated Catchment Management Steering Committee
LIMA :	Leschenault Inlet Management Authority
MCAC :	Mosquito Control Advisory Committee
MRD :	Main Roads Department
RAMSAR :	A City in Iran where the convention was held
SPC :	State Planning Commission
SWDA :	South West Development Authority
TPS	Town Planning Scheme
WAWA :	Water Authority of Western Australia
WPP	Waterways Protection Precinct