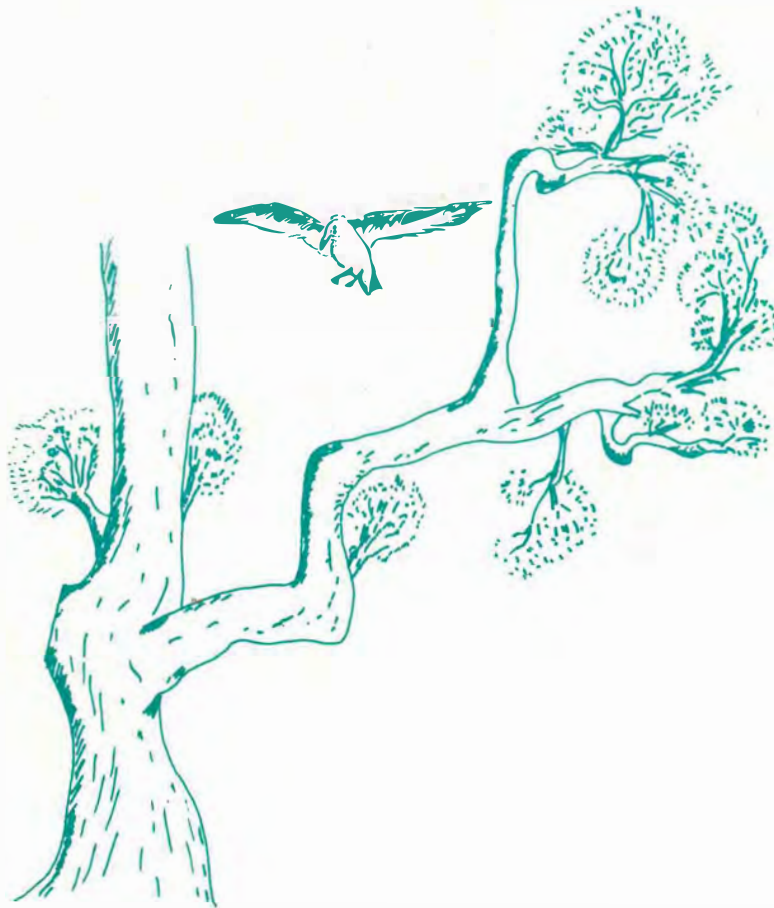


**LESCHENAULT INLET  
MANAGEMENT  
AUTHORITY**

**Collie and Brunswick  
Rivers Foreshore  
Reserves Study  
Draft Report**



**Waterways Commission  
Report 39  
June 1993**



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# **Collie and Brunswick Rivers Foreshore Reserves Study**

**Draft Report**

**Prepared for the Leschenault Inlet Management  
Authority by the Waterways Commission**

**Compiled by Scott Woodcock**

**Waterways Commission  
216 St Georges Tce  
Perth**

**Report No. 39  
June 1993**

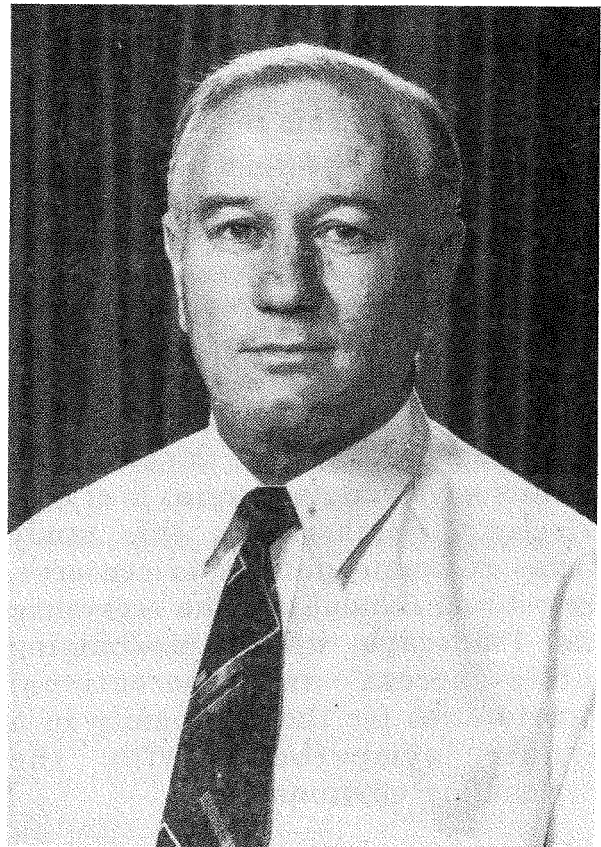
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## MINISTER'S FOREWORD

The Collie and Brunswick Rivers are significant natural resources as they provide a habitat for many varied plants and animals, carry essential nutrients to the estuary, act as corridors for wildlife and recreation areas for people, and impart a unique landscape value to the Bunbury region. This importance is reflected in the Leschenault Waterways Management Programme 1992 and the Bunbury - Wellington Region Plan 1993.

This study details recommendations for the adequate provision of foreshore reserves based on detailed environmental assessment. The aims and recommendations of the study will facilitate considerable improvements in the planning and management of the rivers' foreshore, shifting the focus of development approvals toward proactive assessment. Landowners, local and State government and developers will all have a keener understanding of what is required to protect and enhance the rivers and foreshores. Accordingly, a development proposal can be constructed to address the Leschenault Inlet Management Authority's concerns, expediting development applications whilst minimising the impact on the environment. In effect, the study suggests a vision of how the rivers will be in the future, a vision which takes into account existing ecosystem and community needs but provides flexibility and opportunity into the next century.



The community is invited to consider this draft report and make appropriate comments to aid the Leschenault Inlet Management Authority in preparing the final plan. I urge you to read the study and if you need more information, feel free to approach the Leschenault Inlet Management Authority and Waterways Commission staff for assistance.

A handwritten signature in dark ink, which appears to read "K. J. Minson". The signature is written in a cursive style with a large, sweeping initial "K".

Kevin Minson MLA  
Minister for the Environment

## CHAIRMAN'S FOREWORD

In 1992 the Leschenault Waterways Management Programme was released. The management programme identifies a range of issues of concern to people with an interest in the waterway and makes recommendations to deal with them.

Of particular concern are the Collie and Brunswick Rivers which are under increasing pressure from urban expansion. Traditionally, urban estates are separated from the waterways by thin strips of foreshore reserves whilst private land commonly abuts the river. This report challenges that notion by examining the provision of foreshore reserves based on a detailed environmental assessment of both the rivers and foreshores. To assist LIMA in providing concise and consistent advice to decision making authorities, developers and landowners, this document focuses attention on areas where the protection of waterways and its margins is of high priority. Furthermore, this study makes recommendations to conserve, protect and rehabilitate the ecosystem and landscape whilst maximising public access and recreational opportunities for the community in a manner sympathetic with the surrounding environment.



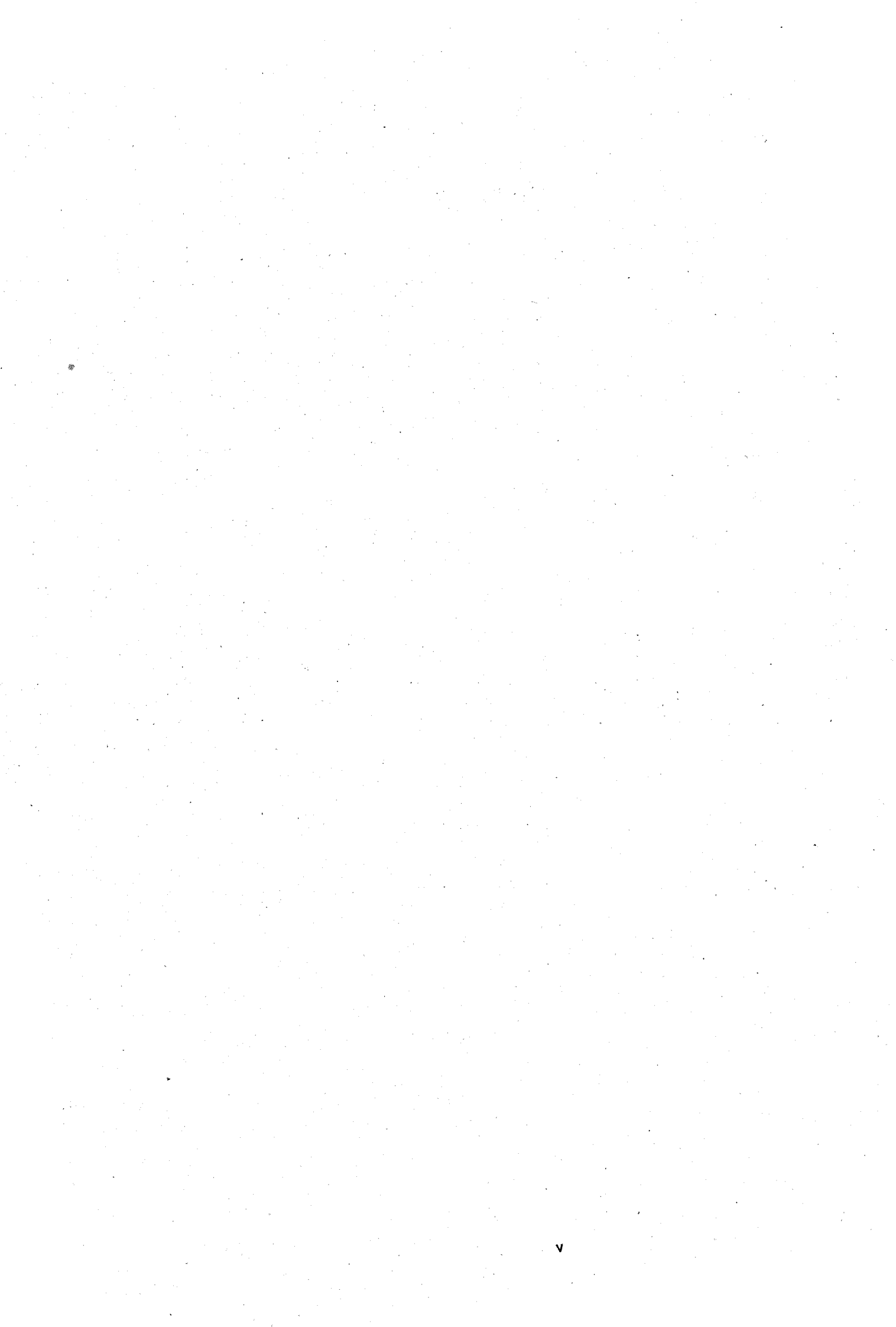
Public submissions are invited. I urge the community to work with the Authority and express their support and indeed their concerns as to how the waterways are to be managed in the years to come.

A handwritten signature in dark ink, appearing to read 'Donald Eckersley'. The signature is fluid and cursive, with a long horizontal stroke at the end.

Sir Donald Eckersley OBE

Chairman

Leschenault Inlet Management Authority



## **ACKNOWLEDGEMENTS**

Many people must be acknowledged for their assistance during the preparation of the report:

DOLA for providing the base maps, the Integrated Land Information Programme for the use of their GIS hardware plus their technical assistance and patience, as well as Pat George of the Water Authority of WA for his relevant flood data.

Luke Pen for his detailed research in the area and for extending his considerable specialised knowledge.

The committee members for their valued advice and challenging ideas and, Greg Baxter for the careful preparation of all the associated maps and figures.

Particular thanks must be extended to the staff of the Waterways Commission and the Leschenault Inlet Management Authority for their constant advice and support.

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Mr B. Chandler	Department of Conservation and Land Management
Dr R. George	Leschenault Inlet Management Authority
Mr C. Lockwood	Shire of Harvey
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Mr M. Smith	Shire of Harvey
Mr S. Woodcock	Waterways Commission
Mr E. Wright	Leschenault Inlet Management Authority



## **PUBLIC SUBMISSIONS**

This management plan was prepared by Waterways Commission for the Leschenault Inlet Management Authority.

Copies of the management plan will be available at the State Library and local government public libraries, also at:

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Public submissions on the draft management plan are invited. All public submissions received will be considered before the preparation of the final management plan.

A summary of public submissions will be contained in Appendix 1 in the final draft.



(Plate 1 : Willy wagtail)

Intact native understorey provides a habitat for songbirds such as the Willy wagtail.

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## SUMMARY

In recent years the Leschenault Inlet Management Authority's advice has been sought on an increasing number of development proposals around the Leschenault waterways. These proposals include large scale structure plans for Australind and Eaton, special rural subdivisions, individual residential properties, and tourism nodes on the mouth of the Collie River as well as the Draft Bunbury - Wellington Region Plan.

LIMA has attempted to provide consistent advice on such proposals to government, local government and individual developers. One issue has been the need for and size of foreshore reserves required around the waterways, particularly when an area is sought for conservation or recreation purposes. LIMA's advice however has not always been accepted possibly because much of it was based on general knowledge about waterways rather than the particular needs of the Leschenault system. Many agencies or individuals considered the proposed foreshore reserve boundaries to be arbitrary rather than based on sound ecological principles. This has highlighted the need for comprehensive planning for foreshore reserves.

In order to overcome this problem, the concept of a Waterways Protection Precinct has been employed. The precinct focuses attention on areas where the protection of waterways and adjacent foreshore margins is of high priority. The limit of the precinct is illustrated by a line. The depth of the Waterways Protection Precinct varies as it is based on a number of factors including the extent and quality of the vegetation, the floodway, the floodfringe, erosion, topography and landscape aesthetics. It also incorporates planning considerations such as existing reserves, public access, recreation needs and miscellaneous constraints and the results of strategic planning reports.

Accordingly, the Waterways Protection Precinct may be defined as **"a guide to limit the impact of environmental change"**. To further refine the role of the precinct, specific planning considerations and recommendations are listed adjacent to the maps to delineate suitable boundaries in terms of conservation and land use planning values.

Alternatives to foreshore acquisition are examined as well as strategies for the rehabilitation of the ecosystem, landscape and general environment of the Collie and Brunswick Rivers. Finally, guidelines for the establishment of bridges over waterways and for the provision of retention basins within proposed developments are outlined for the use of LIMA, decision making authorities and proponents.

Regional Map

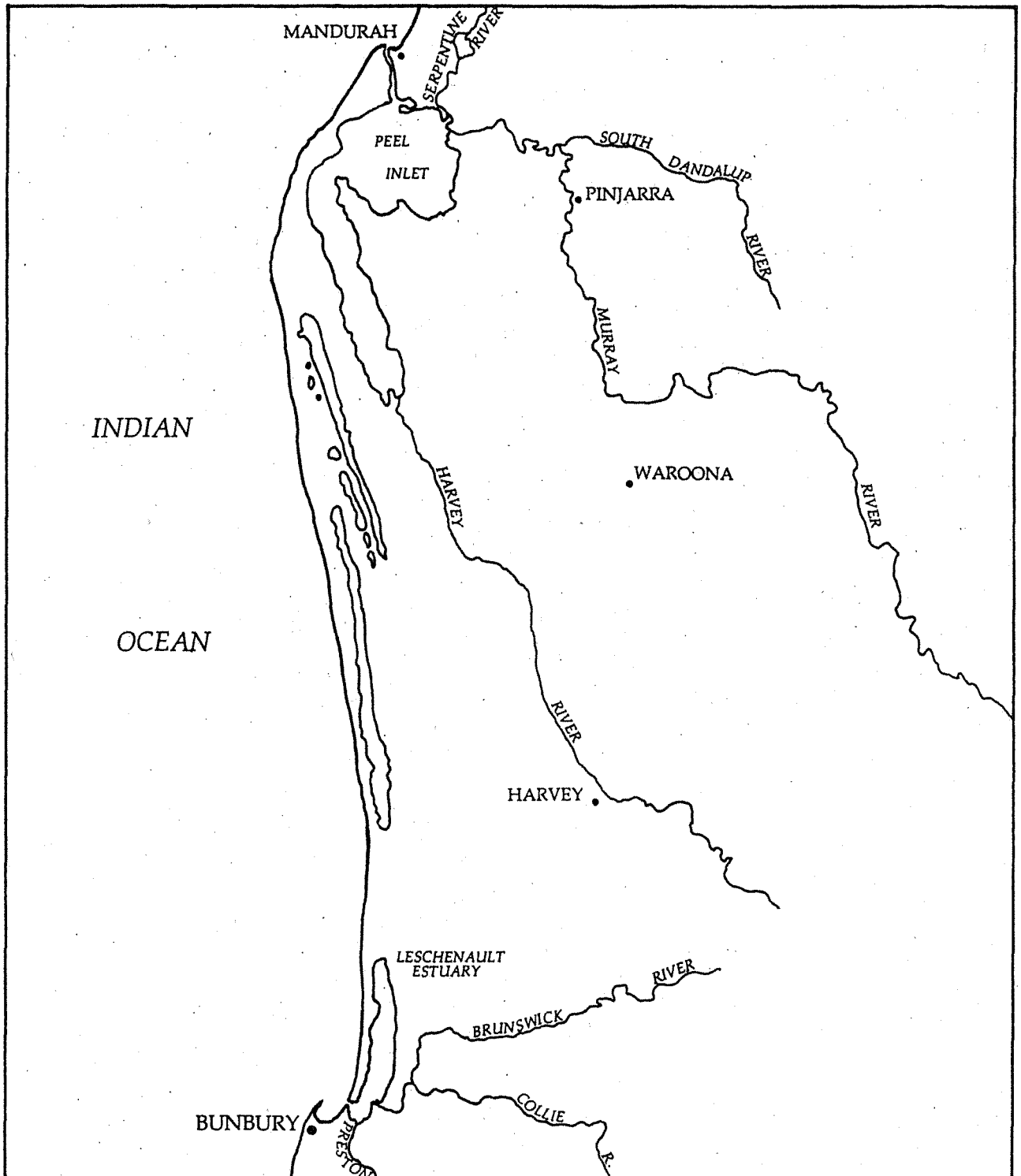


FIG. 1: Regional Map



# 1. Introduction

## 1.1 Background

The Leschenault Inlet Management Authority (LIMA) is responsible for the management of the Leschenault Inlet Management Area declared under the Waterways Conservation Act (Amended) 1976.

### 1.1.1 What LIMA Does

Its roles include :

- Preparation of a management programme for the Leschenault Inlet Management Area.
- The day-to-day management of the river including such aspects as beach cleaning, erosion control works, water quality sampling.
- Establishment of facilities such as jetties, boat ramps, change rooms, toilets, recreation areas and barbecue sites, normally in conjunction with local government.
- Advising the Department of Planning and Urban Development (DPUD), local government and the Department of Marine and Harbours (DMH) on the impact of developments on the foreshore and river.
- Making and enforcing by-laws pursuant to the Waterways Conservation Act.
- Control of pollution and licensing of industrial discharges under powers delegated by the Environmental Protection Authority (EPA).

### 1.1.2 Need for the Study

In recent years the Leschenault Inlet Management Authority's advice has been sought on an increasing number of development proposals around the Leschenault waterways. These proposals include large scale structure plans for Australind and Eaton, special rural subdivisions, individual residential properties, tourism nodes on the mouth of the Collie River as well as the Draft Bunbury - Wellington Region Plan.

LIMA has attempted to provide consistent advice on such proposals to government, local government and individual

developers. One issue has been the need for and size of foreshore reserves required around the waterways, particularly when an area is sought for conservation or recreation purposes. LIMA's advice however has not always been accepted possibly because much of it was based on general knowledge about waterways rather than the particular needs of the Leschenault system. Many agencies or individuals considered the proposed foreshore reserve boundaries to be arbitrary rather than based on sound ecological principles. This has highlighted the need for comprehensive planning for foreshore reserves.

In order to overcome this problem LIMA has sought to increase the knowledge of the Leschenault waterways to provide a basis for advice on development proposals adjacent to the waterways. Priorities have been set for a series of studies for waterways within LIMA's management area. These are:

- Lower Collie and Brunswick Rivers
- Wellesley River
- Preston and Ferguson Rivers
- Upper Collie and Brunswick Rivers

## 1.2 Aim of the Study

The aim of the study is to "delineate suitable boundaries in terms of conservation and land use planning values, for proposed conservation and recreational reserves within the study area".

The boundaries should provide for :

- (a) the long term health, conservation, recreation and management of the Collie and Brunswick Rivers,
- (b) the adequate provision of foreshore reserves within the Shires of Harvey, Dardanup and the City of Bunbury.

The report contains recommendations to maintain and enhance the public reserves and vacant crown land whilst providing public access where appropriate. Furthermore, the possibilities for future foreshore reserves are examined. In effect, the report will replace the previous ad hoc management planning with a consistent holistic approach to the reserves and the waterway by establishing a "Waterways Protection Precinct" for the study area (see Chapter 3 for further explanation of this concept).

### 1.3 Vision of the Future

The implementation of the aims and recommendations of the study will facilitate considerable improvements in the planning and management of the rivers' foreshore. It will shift the focus of development approvals toward proactive assessment where both the developer and council will have a keener understanding of the rivers' and foreshores' needs. A development proposal which addresses LIMA's concerns will expedite the approval process and minimise the impact on the environment.

THE STUDY SHOULD SHIFT THE FOCUS OF RELEVANT DEVELOPMENT APPROVALS TOWARD PROACTIVE ASSESSMENT WHERE BOTH THE DEVELOPER AND COUNCIL HAVE A KEENER UNDERSTANDING OF THE RIVERS' AND FORESHORES' NEEDS.

The implementation of the recommendations should allow for the adequate provision of vegetation, wildlife corridors, fauna habitats, protection of floodplains, control of erosion, maintenance of ecosystem function and a continuation of species diversity. Furthermore, the recommendations provide for a linear system of foreshore reserves containing recreation nodes linked by a network of dual use paths. They maintain public access to the foreshore consistent with protection of river environment whilst preserving the unique landscape character of the waterways.

In summary, the study suggests an overall vision of how the rivers will be in the future, a vision which takes into account existing ecosystem and community needs but provides flexibility and opportunity for the future.

### 1.4 The Committee

A committee was convened to consider a variety of options, provide technical advice and review the direction of the study. Complete agreement, particularly at the draft stage, was not essential but the discussion was useful in highlighting the various concerns of the particular agencies. The Collie and Brunswick Rivers Foreshore Reserves Study Committee consisted of representatives from the

- Department of Conservation and Land Management
- Department of Planning and Urban Development
- Leschenault Inlet Management Authority
- Shire of Dardanup
- Shire of Harvey
- Waterways Commission

Table 1 outlines the primary concerns raised by each of the agencies.

Table 1. Committee Members' Primary Concerns

AGENCY	ISSUES
CALM	Conservation of Vegetation and Fauna / Wellesley River
DPUD	Draft Bunbury - Wellington Region Plan / Landscape Protection / Implementation
LIMA	Minimum Water Flows To Support Waterway Dependent Ecosystems / Compensating Basin Guidelines / Recreation Nodes / Public Access
Shire of Dardanup	Guidelines for Establishment of Bridges over Waterways.
Shire of Harvey	Vesting / Funding of Management
Waterways Commission	Report Structure/ Content / Implementation

The report and recommendations developed by the committee are now available for public comment.

## 1.5 Land and Waterways Planning

The Leschenault Inlet Management Authority is only one of a number of other agencies involved with land and waterways planning. Numerous other major land and waterway planning documents provide an overview of the study.

### 1.5.1 Leschenault Waterways Management Programme 1992

In 1992 the **Leschenault Waterways Management Programme** was prepared by the Waterways Commission. The purpose of the programme is to develop a strategy for the management of the entire Leschenault waterways management area.

This study will represent the first step in implementing general recommendations 2, 4, 10, 13, 37 and 42 of the Leschenault Waterways Management Programme 1992 (WWC, 1992a).

### 1.5.2 Draft Bunbury - Wellington Region Plan

The Department of Planning and Urban Development released the **Draft Bunbury-Wellington Region Plan; Regional Open Space Working Paper**, in 1992. The document presents the Department's current vision of the future in terms of

- (a) the existing and possible CALM estates,
- (b) existing parks and recreation,
- (c) possible foreshore reserves and
- (d) proposed rural landscape amenity areas.

This information is presented in the context of the present infrastructure, development and natural resources.

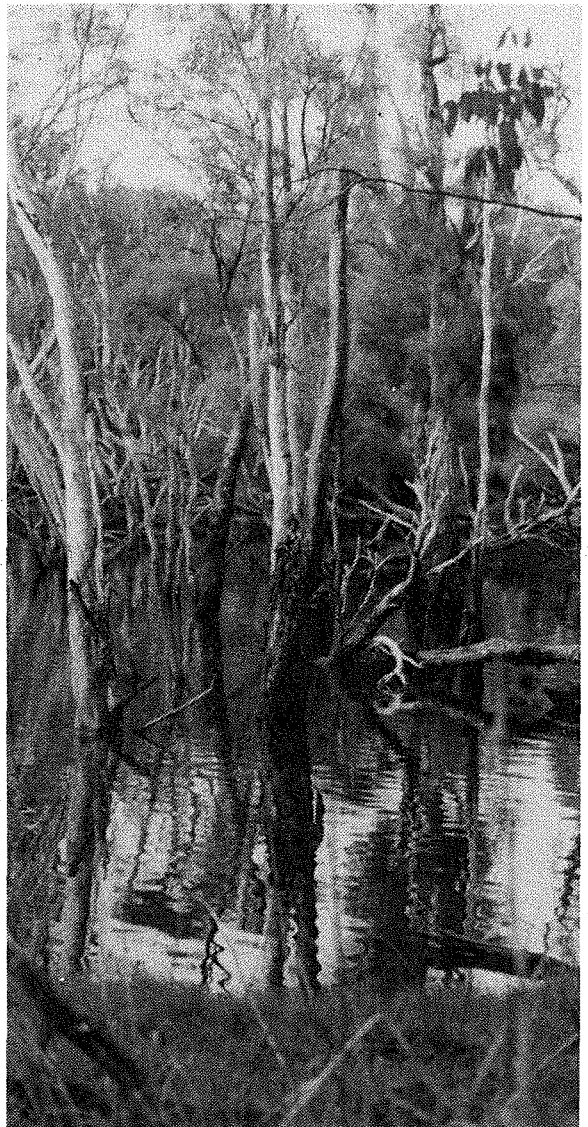
Because of the size of the study area, the plan is only a broad scale planning guide. The results are illustrated as a map drawn at 1:100 000.

With reference to the Regional Open Space Working Paper, it is apparent that the majority of the Collie and Brunswick Rivers' study area is designated as Parks and Recreation (up to the Australind Bypass) with the remainder being proposed for a Rural Landscape Amenity Area.

### 1.5.3 This Study's Role

LIMA's Waterways Management Programme 1992 and the Department of Planning and Urban Development Draft Bunbury Wellington Region Plan therefore provide a framework in which this study can examine the issues in a local perspective, incorporating both planning and environmental concerns.

It is the role of this study to provide recommendations for adequate provision of foreshore reserves based on a detailed environmental assessment of the rivers and foreshores rather than the reactive approach previously encountered.



(Plate 2 : Wetland)

Wetlands provide valuable nesting sites for colonies of Darters

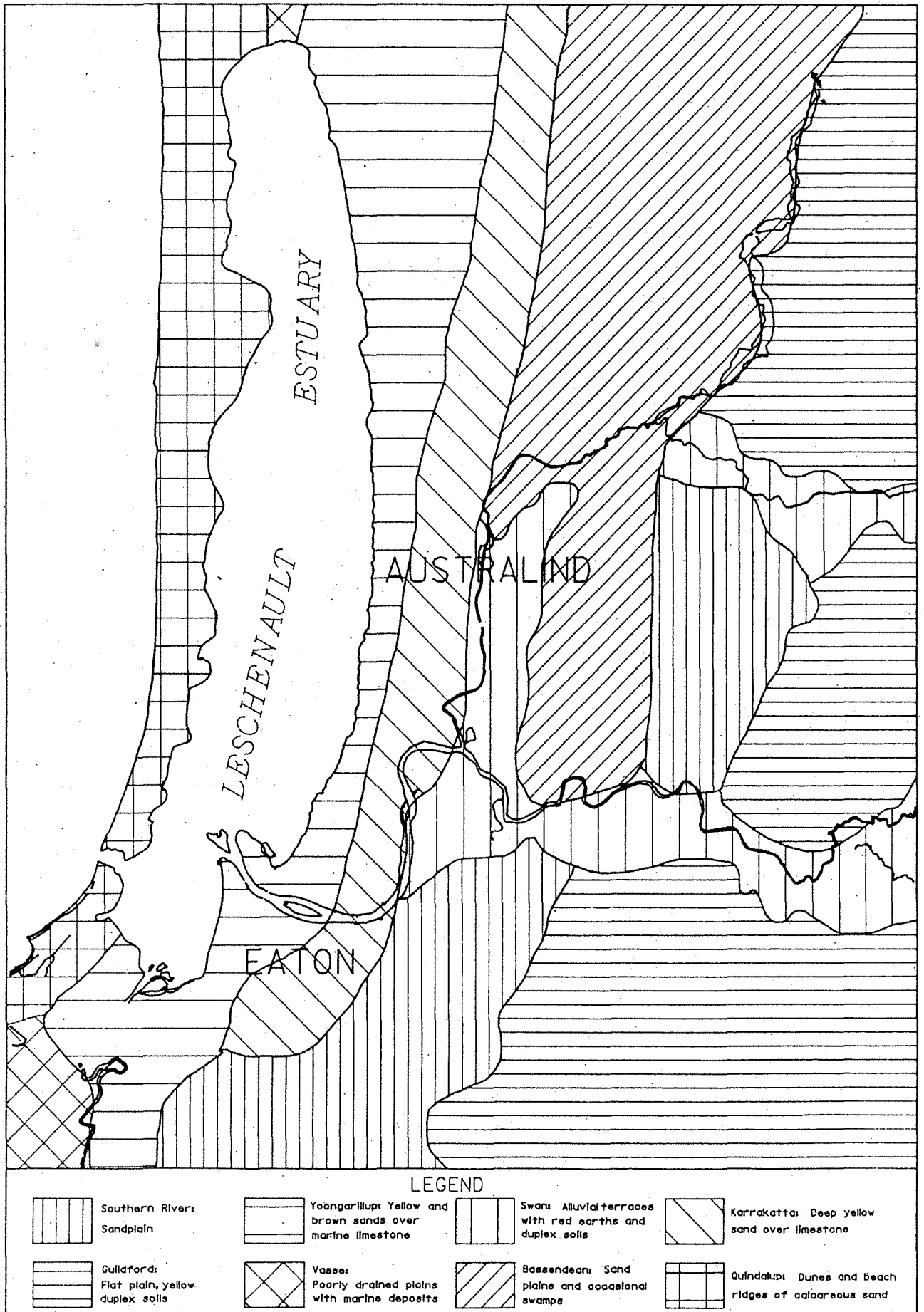


FIG. 2: Landforms and Soils Map (Churchward and McArthur, 1980)

## 2. Study Area

### 2.1 Location

The study area is defined by the

- (a) Collie River west of the bypass road (115°44'15"E, 33°18'00"S) through to the Collie River mouth (115°41'30"E, 33°18'00"S).
- (b) Brunswick River west of the Wellesley River confluence (115°41'30"E, 33°18'00"S). (See Figure 1)

The study area was limited to focus on the issues of current concern, to maximise detail, and due to the lack of resources available. The boundary was chosen by analysing proposed residential expansion (through current literature) and identifying major landmarks to clearly define the extent of the project.

The width of the foreshore under examination is variable (see Chapter 5), depending upon the vegetation complexes present, the topography and the extent of the floodway. For the purposes of this study the maximum width of the study area does not exceed 1 kilometre from the centre line of the river.

### 2.2 Geology

The soil associations of the region are described in detail by Churchward and McArthur (1980) in the "Atlas of Natural Resources Darling System Western Australia". Eight formations are illustrated in Figure 2 of which five relate directly to the river's landform. The five soils are :

- (1) Yoongarillup
- (2) Karrakatta
- (3) Swan
- (4) Bassendean, and
- (5) Southern River

The Yoongarillup and Karrakatta formations are derived from the limestone which they overlay. These shallow soils are synonymous with the geographically restricted Tuart (*Eucalyptus gomphocephala*). The Bassendean and Southern River soils are commonly known as the "gutless grey sands" due to their poor

phosphorus retention and the general lack of nutrients available to plants grown in them. Finally the Swan formation is typical of a terrace structure with its red earths and duplex soils. The Swan soil tends to be well drained.

### 2.3 Climate

#### 2.3.1 Rainfall

The climate experienced in the vicinity of Bunbury is described as Mediterranean which implies cool, wet winters and hot, dry summers. Rainfall is moderate and falls mainly between May and August. Rainfall is considered moderate at 1000 mm per year (LeProvost Env. Con. 1991).

#### 2.3.2 Winds

The winds during summer are dominated by the easterlies originating from the anti-cyclonic belt (high pressure systems) to the south of Australia and by the south-westerly sea breezes coming in over the hot land. Inland temperatures tend to be hotter during the day as the cool sea breeze often cannot penetrate far in from the coast.

In winter, the westerlies and southerlies predominate as the cyclonic belt (low pressure systems) re-establishes itself over the southern section of Australia.

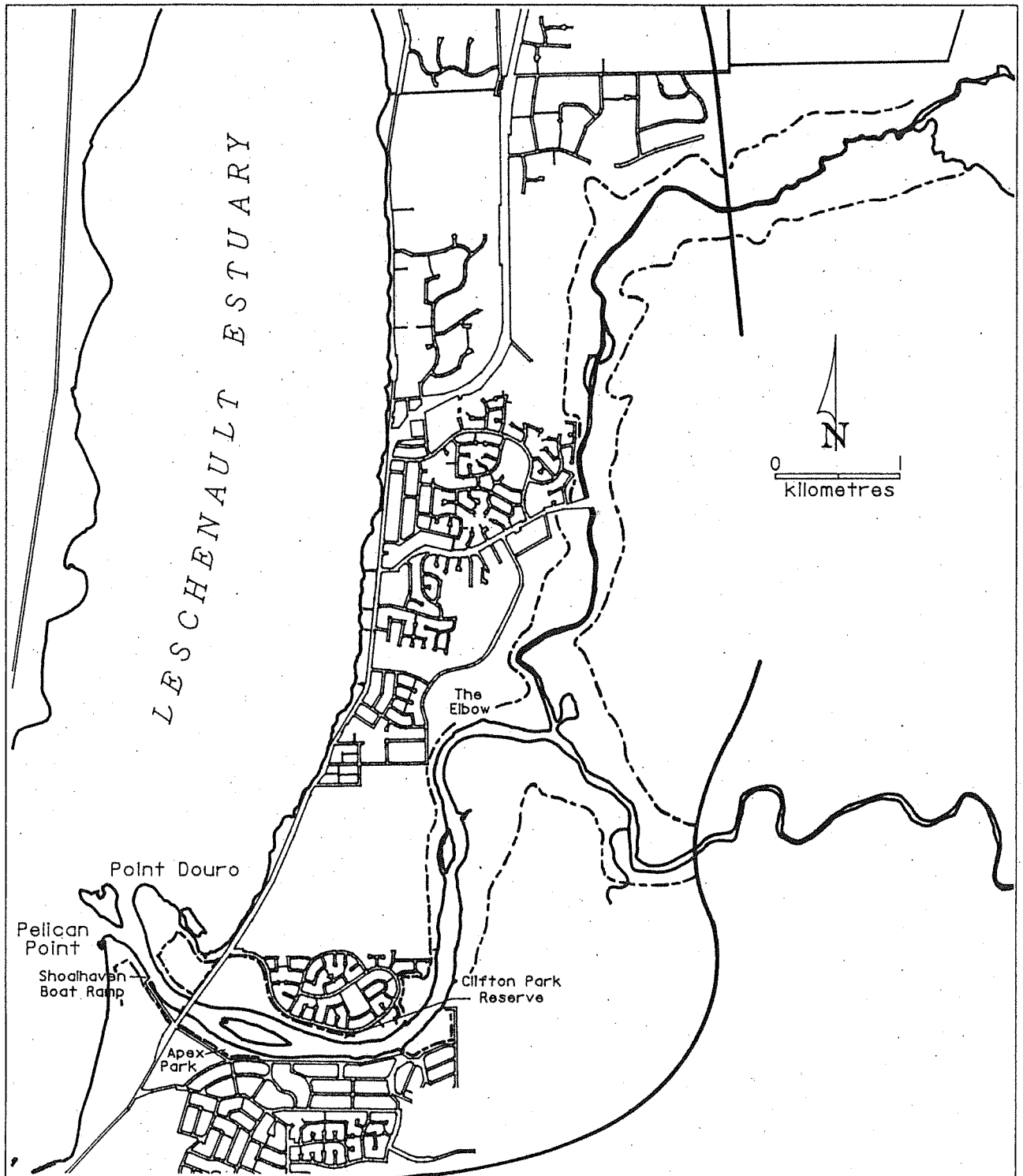


FIG. 3: Waterways Protection Precinct Locality Map

### 3. Methodology

To achieve the aforementioned aim a series of objectives has been developed. The objectives provide a framework in which the various recommendations of the study have been formulated.

#### 3.1 Objectives

The study makes recommendations to facilitate the following objectives:

- conservation, protection and rehabilitation of the ecosystem, landscape, character and general environment of the abovementioned rivers,
- maximisation of public access and recreational opportunities along the foreshores of the abovementioned rivers in a manner which is sympathetic to the river landscape,
- conservation and protection of rare/or endangered species of flora and fauna within the study area,
- prevention of development or filling which inhibits flood flow,
- implementation of regional and local strategic town planning objectives,
- formulation of alternatives to the acquisition of land adjacent to the waterway within rural areas,
- protection and preservation of sites or buildings of heritage value,
- participation of local government and the community in the landscape planning and management process.

#### 3.2 Waterways Protection Precinct

In order to achieve the preceding objectives, the concept of a "Waterways Protection Precinct" has been developed. A considerable proportion of the land abutting the waterways is in private ownership and is zoned for rural purposes. As the population grows there is increasing pressure to rezone this land. LIMA provides advice to decision making authorities about these changes after considering their likely impact on the waterway. The precinct focuses attention on areas where the protection of waterways and

adjacent foreshore margins is of high priority.

Management techniques required to protect fringing vegetation are known, particularly in terms of erosion control. However, it is a function of the precinct to identify areas of waterway at risk from degradation and establish a bank and foreshore revegetation strategy to ameliorate the effects of conflicting land use.

**THE WATERWAYS PROTECTION  
PRECINCT MAY BE DEFINED AS A  
GUIDE TO LIMIT THE IMPACT OF  
ENVIRONMENTAL CHANGE**

The provision of public access to the foreshore is of major concern in waterways planning; as the population increases there will be a greater demand for foreshore access. To ensure that physical and visual alienation does not occur the precinct can be utilised to identify suitable recreational nodes, connected by linear access corridors (e.g. dual use paths).

Similarly, it will be employed to describe environmentally sensitive wetlands and areas of conservation significance so that public access can be appropriately managed. Accordingly, the "Waterways Protection Precinct" may be defined as a guide to limit the impact of environmental change.

The limit of the precinct is illustrated by a line. The depth of the Waterways Protection Precinct varies as it is based on a number of factors including the extent and quality of the vegetation, the floodway, the floodfringe, erosion, topography and landscape aesthetics. It also incorporates planning considerations such as existing reserves, public access, recreation needs and miscellaneous constraints and the results of strategic planning reports.

#### 3.3 Criteria for Determining the Waterways Protection Precinct

Outlined below are the criteria that were examined to determine the Waterways Protection Precinct. The component issues that comprise a riverine and estuarine landscape are detailed to provide the reasoning for the consequent positioning of the line. The

Waterways Protection Precinct is a tool to address the problems encountered along a waterway environment and to preserve the landscape features important in maintaining the character and integrity of the river.

### 3.3.1 Importance of Riverine and Estuarine Vegetation

Fringing vegetation is of critical importance to the riverine system for a number of reasons. Saltmarsh or samphire is a highly productive ecosystem valuable in controlling erosion, providing an organic nutrient source for the detrital estuarine food chains and as a habitat for birds and insects.

It also provides a buffer between nutrient sources such as septic tanks and domestic gardens and the waterway (Adam 1981).

**SALTMARSH IS A HIGHLY PRODUCTIVE ECOSYSTEM VALUABLE IN CONTROLLING EROSION, PROVIDING AN ORGANIC NUTRIENT SOURCE FOR DETRITAL ESTUARINE FOOD CHAINS AND AS A HABITAT FOR BIRDS AND INSECTS.**

Fringing vegetation acts to minimise erosion and impede floodwaters and it provides fauna corridors. Of exceptional importance are the stands of fringing vegetation (including forest) that contain an intact native understorey. These are often relict communities of vegetation that were once established all along these waterways. Furthermore, the understorey is of primary importance to songbirds including the willy wagtail, to small mammals and reptiles.

High sandy rise vegetation is significant in preventing mass wasting such as landslides and it fulfils a landscape aesthetic function for the waterway environment.

**WOODLAND AREAS OVER PASTURE IMPART A UNIQUE LANDSCAPE VALUE AND ADD CHARACTER TO THE AREA.**

Similarly, the woodland areas over pasture impart a unique landscape value and add character to the study area. Pastured areas

with aged stands of trees within the floodplain are a highly valuable resource to egrets, ibis and kangaroos. The same open floodplains can be utilised by the public as low impact recreational areas.

### 3.3.2 Tree Regeneration

In many areas of the country old growth trees are not being replaced once they are cleared, succumb to disease or perish of old age. Consequently, a reduction in the numbers and diversity of the trees and the animals that depend on them is observed. Tree regeneration is therefore important as it indicates the establishment of new growth and an attempt by the ecosystem to regain the previous balance.

The Waterways Protection Precinct provides for areas of tree regeneration, to afford some measure of protection to the maturing stands.

### 3.3.3 Erosion

Erosion of a riverbank is not necessarily a negative condition. Often it is part of the natural process of a waterway whereby the river alters its meander over the years. However, when erosion occurs too rapidly then it may be a problem.

Erosion may be divided into four broad categories :

#### (a) Erosion at the Water Line

Occurs primarily due to alterations in drainage patterns or land surface contours, weed and noxious animal invasion, fire, clearing and as a result of various forms of development. The use of the waterway as a de facto cattle fence has also resulted in the degradation of the fringing vegetation and trampling of the banks by livestock.

Erosion at the water line generally causes the most public concern and attracts the most attention. Techniques exist to manage this form of degradation such as revegetation, log walling and rock walling.

#### (b) Erosion Below the Water Line

Is most prevalent outside the bends. As it occurs out of sight, it does not draw public comment until it causes a major collapse of the bank above. This is generally the most damaging area of erosion and the most expensive to deal with.



(c) Erosion Above the Water Line

This form of erosion is exacerbated by heavy rains and during floods but is principally caused by human trampling, clearing, trailbikes, four wheel drive vehicles, livestock, frequent fires and wave action.

(d) Mechanical Erosion

Occurs at sites, particularly on estuaries where algae is blown onto beaches and removed by front end loaders. The FELs push rotting weed into heaps and load it onto trucks which take it away to designated tip sites. Each time this operation occurs on a beach, some sand is removed, resulting in beach erosion over a long period.

The Waterways Protection Precinct identifies sites of significant erosion and recommends appropriate action.

USE OF THE WATERWAY AS A DE FACTO CATTLE FENCE RESULTS IN THE DEGRADATION OF FRINGING VEGETATION AND THE TRAMPLING OF BANKS.

3.3.4 Fauna

Fringing vegetation is important in sustaining wildlife by providing shelter and the basis for the food chain. Alternatively, the fauna present contribute to the maintenance of the vegetation by undertaking functions including pollinating flowering plants, transferring seeds, limiting the spread of competing species through browsing and consuming pests. There is a direct relationship between the abundance and diversity of flora to the fauna. This is particularly relevant in regard to fringing vegetation whereby the ecosystem is often defined as a comparatively narrow strip adjacent to the waterway. Geographic constraints often result in specialised niches and complex species interactions.

For example, paperbark stands provide roosting sites for Sacred Ibis and Staw-necked Ibis. These species feed on moist grasslands (damplands) such as paddocks and on flooded areas including floodplains.

Similarly, mammals such as marsupials utilise the hollows of old trees including flooded gums for shelter. They feed on

grassed areas, shrubs or other wildlife. Furthermore, any fruit ingested contains seeds which are spread through the depositing of faeces. Transitory animals spread seeds over a larger area resulting in a greater diversity of vegetation.

VARIED VEGETATION PRODUCES DIFFERENT HABITATS AND RESULTS IN A GREATER DIVERSITY OF ANIMALS.

Accordingly, varied vegetation produces different habitats and results in a greater diversity of animals. The Waterways Protection Precinct addresses this issue by identifying and protecting the vegetation to conserve and maintain the ecosystem in its entirety.

3.3.4.1 Feral Animals

Feral animals are often observed along the foreshores of waterways as they are attracted by the abundance of water, food and shelter. Of particular concern are the introduced cat (*Felis catus*) and the fox (*Vulpes vulpes*). The former becomes predominant with the establishment of residential areas. Many species of native mammals have had their populations severely reduced by such predators. "Competition between native and introduced species for food and / or territory often leads to drastic reductions, and sometimes complete exhaustion of the native species population" (Cavana 1986).

Accordingly, preservation of native habitats would assist in sheltering the endemic fauna from feral predation. The maintenance of natural barriers such as brooks and the establishment of buffers on developments may minimise feral animal encroachment.

3.3.5 Wildlife Corridors

Wildlife corridors aid in preventing species in-breeding which results in genetic abnormalities and the eventual deterioration of the community through environmental factors like disease. Fauna corridors enable populations to interact which facilitates genetic diversity. The corridors are also useful in times of drought and bushfire so that wildlife can move to similar habitats without being exposed to predators.

### 3.3.6 Mosquitoes

Mosquitoes create considerable nuisance to visitors and residents in the vicinity of rivers and estuaries. In addition, they are known to be the primary carrier (vector) of the Ross River Virus. The issue of mosquitoes therefore assumes a particular relevance in relation to the provision of foreshore reserves and their associated designated use.

Generally, there is a high correlation between the level of disturbance (low conservation value) and the intensity of mosquito breeding (Chester & Klemm 1990). For example, unrestricted trailbike and 4WD access to a wetland would tend to result in a high incidence of mosquito breeding.

**MAXIMISING ADEQUATELY  
VEGETATED BUFFERS ON  
DEVELOPMENTS ABUTTING  
WATERWAYS REDUCES MOSQUITO  
NUISANCE.**

Research suggests that public access to saltmarshes should be restricted. These wetlands are easily degraded by human interference, which would exacerbate the mosquito problem. The saltmarsh's high conservation value would therefore be more appropriately served by reserving the area for conservation purposes.

The remaining fringing vegetation complexes have similar management requirements. The Waterways Protection Precinct is positioned to assist in maintaining the environmental integrity of the foreshore vegetation, as degradation of the ecosystem will surely increase mosquito breeding.

Most importantly, the maximisation of adequately vegetated buffers on developments abutting waterways reduces mosquito nuisance by:

- (a) retaining the habitat for fauna such as birds which prey on the mosquitoes reducing their numbers and
- (b) screening and filtering adult mosquitoes from leaving their breeding sites (Klemm 1992).

### 3.3.7 Floodplain

The floodplain may be defined as a relatively smooth portion of a river valley, adjacent to the river channel, built of sediments carried by the river and covered when the river overflows its banks (Gilpin 1990). The extent of the floodplain is generally described according to the frequency that the area floods. The Water Authority of Western Australia utilises the concept of a 100 year floodplain, which describes land known to flood once in a 100 years (George 1992).

#### 3.3.7.1 Floodplain vs Floodway vs Floodfringe

The floodplain is divided up into the floodway and floodfringe which are defined according to the severity of flooding experienced. The floodway is the channel and the lands immediately adjacent which carry the fast moving flood waters. (Gilpin 1990). The floodfringe is the remainder of the floodplain outside the floodway. These concepts are particularly useful as a guide to the limit of development along the river.

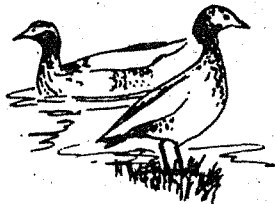
For structural engineering purposes the limit of the floodway described in Chapter 5 may be interpreted as a limit of development. If fill were to be introduced into the floodway it would alter the pattern of flow of the flood waters causing areas previously outside the floodway to be inundated. Also, by nature of the definition of a floodway, this land acts to channel the fast moving flood waters. The power contained in them would eventually erode the fill, such as a house pad, and in effect wash away the development.

The chances are about one in four that a home built on the 100 year floodplain will be flooded before a thirty year mortgage is paid off (Gilpin 1990). This includes land located in the floodfringe. However, authorities may permit development in the floodfringe so long as the fill is raised above the level of the 100 year floodline, as waters in this part of the floodplain do not possess the amount of energy experienced in the floodway. Such development must not increase the extent of the 100 year flood levels upstream by more than a stipulated amount. The permissible amount of increase is usually set at 0.5 metres (George 1981).

**FLOODPLAINS AND THEIR  
ASSOCIATED VEGETATION ARE USED  
EXTENSIVELY AS FAUNA CORRIDORS.**

Furthermore, floodplains have high water tables even in terms of normal river flow which will increase the risk of an on-site sewerage system failure. Development in many instances removes vegetation cover and increases the rate of stormwater discharge leading to accelerated erosion (Gilpin 1990). The floodplain and its associated vegetation are also used extensively as fauna corridors between similar habitats, particularly in times of drought and bushfires.

No development should be permitted within the limit of the floodway and any encroachment into the floodfringe must be assessed on environmental grounds.



### 3.3.8 Greenhouse Implications

Future climatic changes have been forecast from the impact of the Greenhouse Effect. It is predicted that the average annual temperatures in southern Australia may be 4-5°C higher than at present and the south will probably have less rainfall.

In terms of foreshore management, the implications for vegetation must be taken into consideration, with more salt tolerant varieties becoming predominant and possibly a movement toward more drought tolerant species. Furthermore, the foreshore should be wide enough to account for predicted sea level rises and higher rates of erosion from increased storm frequency. Sea level rises would not only reduce foreshore width by inundation but the associated rise in groundwater would affect drainage and effluent disposal by reducing the depth of the soil to filter nutrients and pathogens (WWC 1992b).

### 3.3.9 Ecosystem Water Requirements

#### 3.3.9.1 Dams

For a river to maintain its current level of ecosystem function it requires a minimum amount of water. The construction of dams alters the flow regime and accordingly may have an impact on the river's hydrological and biological characteristics. Although quite a number of dams have been established in Western Australia, insufficient research exists to provide any understanding of their effects downstream (Arrowsmith 1992).

The issues involved in determining the impacts are complex. The main concerns involved are listed below :

- the proposed discharge regime,
- the relative position of the next major tributary,
- the climate,
- the current extent of riverine vegetation,
- groundwater versus surface run-off and
- the extent of catchment clearing.

However, before a major dam could be constructed along a waterway considerable environmental assessment of the proposed impacts would have to be addressed by the proponent.

The Waterways Protection Precinct is based on current water regimes and requirements and would require modification if there were changes to the hydrological systems.

#### 3.3.9.2 Groundwater

Groundwater drawdown from excessive bore use may have an effect on the fringing vegetation adjacent to estuarine waters. A reduction in the fresh groundwater would result in a shift to more salt tolerant communities in those parts of the rivers subject to tidal fluctuation. In riverine parts the effect may be negligible (Pen 1992).

However, groundwater use would have to be quite marked to produce any significant changes. The increase in groundwater flows resulting from the past considerable clearing of the catchment would compensate

for a substantial amount of bore extraction (Pen 1992).

### 3.3.9.3 Water Quality

A number of waterways now experience annual moderate to intense phytoplankton blooms. The peak in biomass of the phytoplankton is commonly associated with the strong stratification of the water column which develops as river flow decreases and the salt wedge moves upstream. The leading edge of a saltwedge is often oxygen deficient resulting in anaerobic conditions on the river bottom. This causes the release of nutrients from the sediments to the water column which in turn feeds phytoplankton blooms.

**ADEQUATE, WELL VEGETATED  
FORESHORE RESERVES FILTER  
NUTRIENTS BEFORE THEY ENTER  
THE SYSTEM.**

Water quality data highlights the need for adequate, well vegetated foreshore reserves to filter nutrients from the system before they enter the river. Furthermore, deterioration in water quality often has an adverse effect on recreation. The Department of Conservation and Environment Bulletin 103 (1981) contains water quality criteria for marine and estuarine recreation. Before swimming, people should ensure that the water quality is adequate. A secchi disc should be visible to a depth of 2 metres. Also the water should be free from materials which will produce odour, colour or turbidity.

In conclusion, estuaries and rivers are quite suitable for direct contact recreation except in the presence of phytoplankton blooms. Correct catchment management practice and adequate, well vegetated foreshore reserves would ensure that suitable water quality is maintained. Consequently the ecosystem would remain in balance and the associated recreational and conservation value of the waterway would not decline.

## 3.3.10 Heritage and Cultural Sites

### 3.3.10.1 Aboriginal, Archaeological and Ethnological Sites

Archaeological and ethnographic sites are protected under the provisions of the Western Australian Heritage Act 1972-80. Planning for foreshore reserves must therefore account for such sites to prevent any adverse impact.

### 3.3.10.2 European Historic Sites

Historic sites are an important cultural component in the character of the waterway environment. As early settlements often were founded on rivers and estuaries they represent a significant link with the past.

## 3.3.11 Surrounding Land Use Pressure

Urban estates are often separated from the waterways by thin strips of foreshore reserves whilst privately owned rural land commonly abuts the river (See Chapter 4).

The urban cells are rapidly expanding, resulting in increased pressure on the highly valued waterway. Views and location are at a premium in real estate terms, therefore the waterway must be considered an asset to the development it enhances. To minimise foreshore reserves is to compromise not only your asset but that of the community.

The Waterways Protection Precinct is targeted at maintaining the integrity of the river and in turn preserving a valued natural and community asset.

## 3.3.12 Existing Reserves

Most of the existing reserves have been created as a condition of subdivision. The Waterways Protection Precinct follows the boundary of urban reserves where appropriate as the extent of the natural environment has been artificially defined. However, this does not create a precedent for future foreshore reserves which will be negotiated through the implementation of the Waterways Protection Precinct according to their natural and community value as detailed in this study.

### 3.4 Research

This chapter listed the criteria used to develop a Waterways Protection Precinct. In order to draw the WPP around the study area specific studies and investigations were undertaken and information collected. This research is presented in Chapter 4.



(Plate 3 : Landscape amenity)

The fringing vegetation imparts a unique landscape amenity to the river environment.

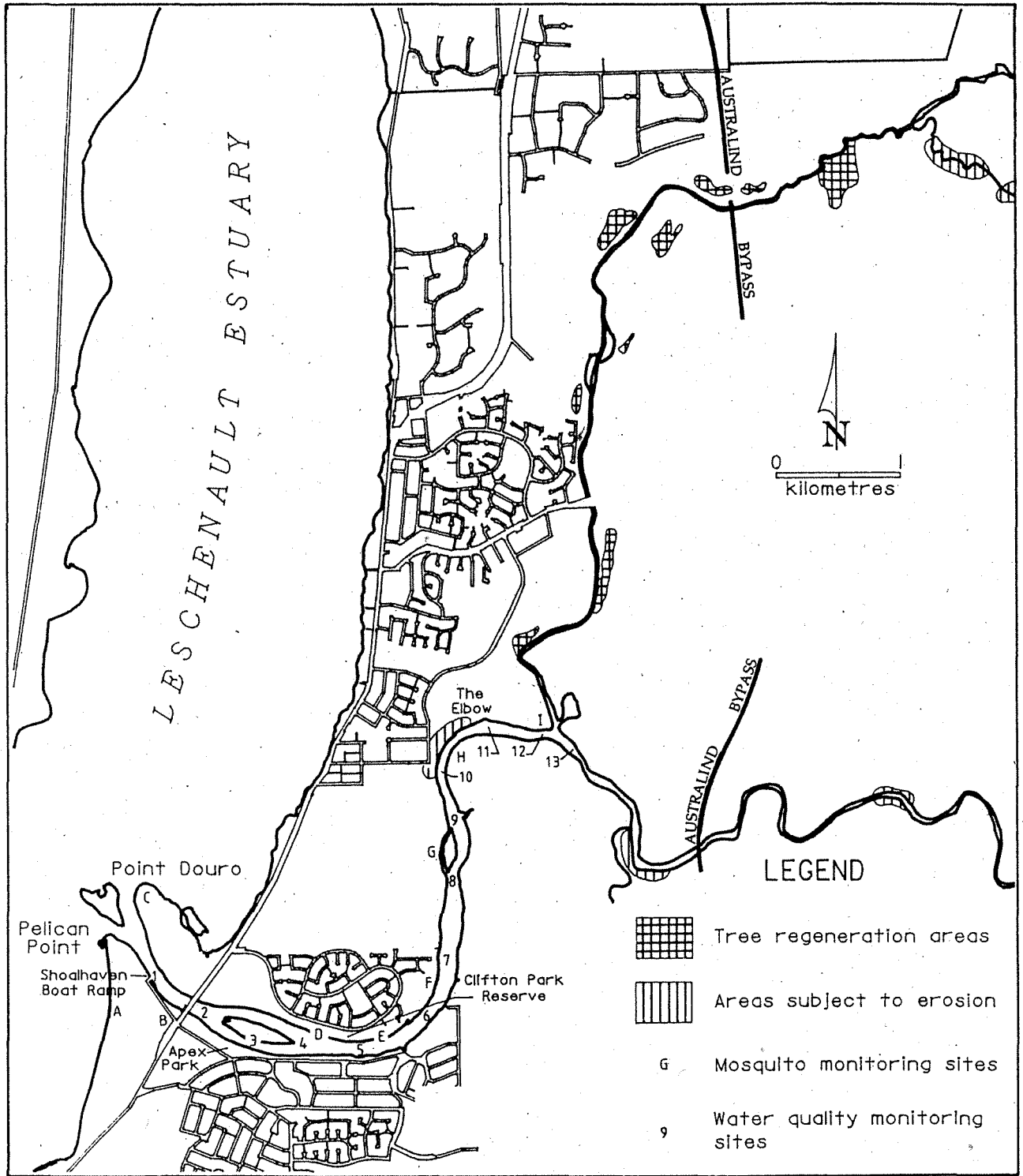


FIG. 4: Monitoring Map

## 4. Specific Studies

This chapter details the research used to develop the Waterways Protection Precinct for the Collie and Brunswick Rivers. This information was obtained from a variety of sources:

- (a) specific studies undertaken as part of the project
- (b) existing reports
- (c) on-site investigations

Chapter 5 depicts this information on maps, lists area specific planning considerations and makes recommendations for LIMA when planning, managing and advising on the area.

### 4.1 Vegetation

In 1992 a comprehensive vegetation survey of the study area was undertaken by Pen (1993). Pen's report describes six major categories of fringing estuarine vegetation. These include:

- (1) Saltmarsh
- (2) Fringing vegetation
- (3) Estuarine vegetation forest
- (4) Freshwater (riverine) fringing forest and sandy rise vegetation
- (5) Sandy rise vegetation
- (6) Other plant communities and vegetation types

These groups are further classified into their constituent complexes and ultimately the particular species in each are defined.

The Waterways Protection Precinct has been drawn to include the fringing vegetation within the study area ensuring that all components are included. For this study a simplified version of Pen's categories has been adopted. Five plant complexes are illustrated on the maps in Chapter 5 and listed below:

- (1) Saltmarsh
- (2) Fringing vegetation
- (3) Fringing vegetation (including forest) with intact native understorey
- (4) High sandy rise
- (5) Woodlands

### 4.2 Tree Regeneration

Tree regeneration is occurring within the study area and is detailed in Pen (1993). The most marked regrowth has been noted along the Brunswick River where seedlings and saplings have been observed. The species primarily recovering in numbers are *Melaleuca raphiophylla* (Swamp Paperbark) on boggy pasture and *Eucalyptus rudis* (Flooded Gums) within the floodplain. The latter is displaying considerable regeneration where large numbers of seedlings have established dense stands of young trees (Pen 1993).

### 4.3 Erosion

The Waterways Protection Precinct has been drawn to account for these areas, which are illustrated in Figure 4. Sites of severe erosion within the study area are to be found between Point Latour and Snake Island, where four wheel drive vehicles, trailbikes, human trampling and frequent fires have thinned out the vegetation (Pen 1993). The steep slopes combined with the location on the power curve of the river have resulted in considerable loss of soil along the foreshore.

Another site is located 500 metres west of the Australind Bypass on the Collie River where extensive clearing and the use of the waterway as a de facto cattle fence has resulted in the degradation of the fringing vegetation and the trampling of the banks by livestock. Undermining of the remaining trees by the fast flowing waters in the power curve of the river has eroded and undercut the exposed foreshore (Pen 1993).

The Waterways Protection Precinct has been drawn to allow for natural erosion processes. Recommendations for erosion control are included in Chapter 5.

### 4.4 Revegetation

Revegetation is critical in restoring waterway buffers on areas previously cleared for farming. A guide outlining suitable species for replanting is contained within (Pen 1993).

Particular care should be taken when revegetating the floodway to avoid replanting with small trees and shrubs. Dense undergrowth would inhibit the fast flowing floodwaters of the floodway in much the same manner as artificial structures do. Establishing trees of a minimum height of 3 metres would negate such problems.

The Waterways Protection Precinct recognises that considerable revegetation of the foreshore is required at particular sites, therefore the WPP line has been drawn to allow for future enrichment planting of foreshore reserves.

## 4.5 Fauna

There have been no recognised fauna surveys of the study area. In order to achieve some understanding of the species which may be present and consequently attribute a conservation value to the foreshore habitat based on its significance to the existing fauna, a comparison has been made with the Kemerton area.

A number of fauna surveys of the Kemerton region were made for the environmental assessment of the proposed industrial development. This study compared the vegetation complexes at Kemerton and within the Collie and Brunswick Rivers study area to derive determine the types of species possibly found along the foreshore and in the associated wetlands.

### 4.5.1 Birds

In 1985, Ninnox Wildlife Consultants undertook a vertebrate fauna survey of Kemerton. Of the six quadrats observed, the site most similar to that of the Collie and Brunswick River environments was FQ 6. The site, classified as a drainage line, contained open woodland of *Eucalyptus rudis* to dense low forest of *Melaleuca priessiana* (Moonah Paperbark) and *Acacia saligna* (Coojong).

As a result FQ 6 supports a preponderance of species adapted to deeper water including *Pelicanus conspicillatus* (Australian Pelican), *Phalacrocorax sulcirostris* (Little Black Cormorant), *P. varius* (Pied Cormorant) and *Biziura lobata* (Musk Duck). *Anhinga melanogaster* (Darter) and *Cygnus atratus* (Black Swan) were observed breeding (Ninnox Wildlife Consulting 1985).

*A. melanogaster* are commonly associated with estuaries and rivers where they mainly feed on fish such as yellow-eyed mullet, whiting and cobbler. They are known to utilise the lower reaches of the Collie and Preston Rivers for foraging (Bamford & Watkins 1983).

*Melaleuca* swamp is known to provide roosting sites for *Threskiornis aethiopicus*

(Sacred Ibis) and *T. spinicollis* (Straw-necked Ibis). A number of such swamps are located adjacent to the Collie and Brunswick Rivers. These species tend to feed on moist grasslands (damplands) such as paddocks and on flooded areas including floodplains (Bamford & Watkins 1983).

Similarly, *Nycticorax caledonicus* (Rufous Night Heron), a nocturnal bird, forages on the edge of the swamps and favours roosting in trees lining the banks of rivers (Bamford & Watkins 1983).

Of the above species, none are gazetted as "rare, or otherwise in need of special protection" (Ninnox 1985). However, bird populations that nest in a limited number of colonies such as the *A. melanogaster* (Darter), *Threskiornis* spp. (Ibis) and *Egretta alba* (Egret) are those most susceptible to changes in land use. The *Melaleuca* and *Eucalyptus* lined banks of the Collie, Brunswick and Wellesley Rivers provide breeding habitat for a limited variety of waterbirds such as tree nesting ducks and Herons (Bamford & Watkins 1983).

The maintenance of the current variety of habitats is therefore essential to prevent significant changes in the bird populations that are reliant on the Collie and Brunswick rivers.

The Waterways Protection Precinct has been drawn to protect the habitats of the above birds, particularly to prevent the loss of *Melaleuca priessiana* and *Eucalyptus rudis* communities.

### 4.5.2 Amphibians and Reptiles

Amphibians are often good indicators of an ecosystem's health. They exist partly on land and partly in water and therefore are very susceptible to changes in their environment. Again, there have been no direct studies undertaken along the Collie and Brunswick Rivers and therefore inference has to be made from the relevant Kemerton surveys.

Seven species of frogs were identified in the Kemerton region. The two tree frogs (*Littoria*) are the most aquatic species present, *L. adelaidensis* usually occurring in reeds growing in water. *L. moorei* is more common in the reeds and grasses of the swamp regions, such as the wetland areas adjacent to the Collie and Brunswick Rivers (Bamford & Watkins 1983).



All seven species identified are widely distributed on the coastal plain except *Ranidella glauerti* which favours dense grass areas with scattered clumps of reeds and no trees (Bamford & Watkins 1983).

Sixteen species of reptiles were recorded by the Bamford and Watkins (1983) at Kemerton. The skinks (family Scincidae), *Egernia luctuosa* and *Ctenotus labillardieri* were significant as examples of species commonly associated with the Darling Scarp of which populations exist on the coastal plain, probably as a relict of a wetter climatic period. Such populations are scattered and may be associated with Collie and Brunswick river system.

It is the intention of the Waterways Protection Precinct to highlight and conserve these habitats, to maintain species diversity and preserve the amphibians' and reptiles' ecological niches in the wetland ecosystem.

#### 4.5.3 Mammals

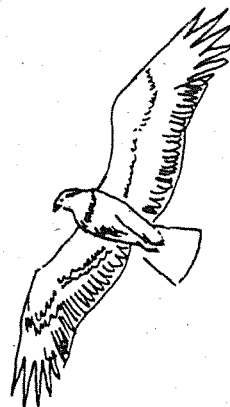
The majority of the mammals identified at the Kemerton site are commonly found along the coastal plain such as *Trichosurus vulpecula* (Brush Tail Possum) and *Isoodon obesulus* (Quenda). However, a number of species of bat have been observed which have a particular association with wetlands and river systems.

Five bat species were described by Bamford & Watkins (1983). These include :

<i>Chalinolobus gouldii</i>	Gould's Wattled Bat
<i>Eptesicus regulus</i>	King River Eptesicus
<i>Nyctophilus geoffroyi</i>	Lesser Long - eared Bat
<i>N. major</i>	Greater Long - eared Bat
<i>Pipestrellis tasmaniensis</i>	Great Pipestrelle

All of the above shelter in tree hollows in species such as *Melaleuca priessiana* and *Eucalyptus rudis*. These readily are common along the fringes of the Collie and Brunswick Rivers and may support populations of the above bat species. The Waterways Protection Precinct identifies these habitats and recommends rehabilitation if they are in a degraded condition.

Bat species of the genus *Nyctophilus* may be considered rare, but not enough is known to determine how rare particular species of the genus are (Nichols 1980).



#### 4.5.4 Mosquitoes

In 1984 the Mosquito Control Review Committee was established by the Waterways Commission to respond to nuisance and potential health problems caused by mosquitoes (Chester & Klemm 1990). A survey of mosquitoes in the Bunbury region was undertaken by Wright (1986) which detailed larval breeding and adult biting activities in the Leschenault area. The report concluded that the mosquito nuisance problem in the Bunbury region is mainly caused by *Aedes camptorhynchus* and *Aedes vigilax* which are both carriers of the Ross River Virus. The study identified the saltmarsh habitats such as those found at the Collie River mouth as the most significant breeding sites for these species (Wright 1986).

An epidemic of polyarthritis (Ross River Virus) was experienced in the summer of 1988-89 leading to a considerable injection of funds into the research programme to control mosquito breeding in the Peel and Leschenault regions. The results are described in the Draft Integrated Mosquito Control Strategy for the Leschenault Estuary Region, Western Australia (Chester & Klemm 1990). For the purposes of this study the major breeding sites have been identified and are illustrated in Figure 4. They are listed with their associated breeding intensity rank and prescribed control options in Table 2.

Table 2. Mosquito Monitoring Sites

Wetland Name	Breeding Intensity Rank	Current and/or proposed mosquito control options
Point Douro	High	Spinner channels
Pelican Point	High	Modify tidal flushing. To be viewed as part of development. Current aerial larviciding
West of the Collie Bridge	High	Formalise outlet to Collie River
Clifton Park Collie River	Low	Chemicals as required
East of WAWA pipe	Limited	Low priority
West of Harding St	Low	Investigate top dressing while preserving <i>Melaleuca</i> spp. stand.
SCM Backwater	Medium	Limited to backpack spraying
West of Collie/ Brunswick Rivers Confluence	Limited	Low priority

(Chester & Klemm, 1990)

In conclusion, the research suggests that public access to the saltmarshes should be restricted. These wetlands are easily degraded by human interference, which would exacerbate the mosquito problem. The saltmarsh's high conservation value would therefore be more appropriately served by reserving the area for conservation purposes.

The Waterways Protection Precinct was drawn to maximise buffer vegetation to screen adult mosquitoes and to provide a habitat for their predators. It also aims to

separate development from known high intensity mosquito breeding areas in an effort to reduce the incidence of mosquito nuisance.

The remainder of breeding sites along the Collie River assigned a low breeding rank do not have many implications for the planning aspects of this study, but the sites must retain their environmental integrity as degradation of the ecosystem may increase mosquito breeding. The Waterways Protection Precinct would limit environmental change, particularly any modification of the areas hydrological regime, to control mosquito breeding

#### 4.6 Water Quality

The nutrient condition of the Collie River is considered to be between mesotrophic and eutrophic (Hosja 1992). The Leschenault Inlet Management Authority has monitored a number of moderate to intense phytoplankton blooms in the Collie River. These have been observed during the summer-autumn period. The monitoring sites are illustrated in Figure 4 (WWC 1990).

The peak in biomass of the phytoplankton is commonly associated with the strong stratification of the water column which develops as river flow decreases and the salt wedge moves upstream. The leading edge of a salt wedge is often oxygen deficient resulting in anaerobic conditions on the river bottom. This causes the release of nutrients from the sediments to the water column which in turn feeds phytoplankton blooms.

The cell concentrations are commonly a reddish brown colour which indicates the presence of dinoflagellates. The pattern and intensity are similar to those blooms experienced in the Swan and Murray Rivers (WWC 1990).

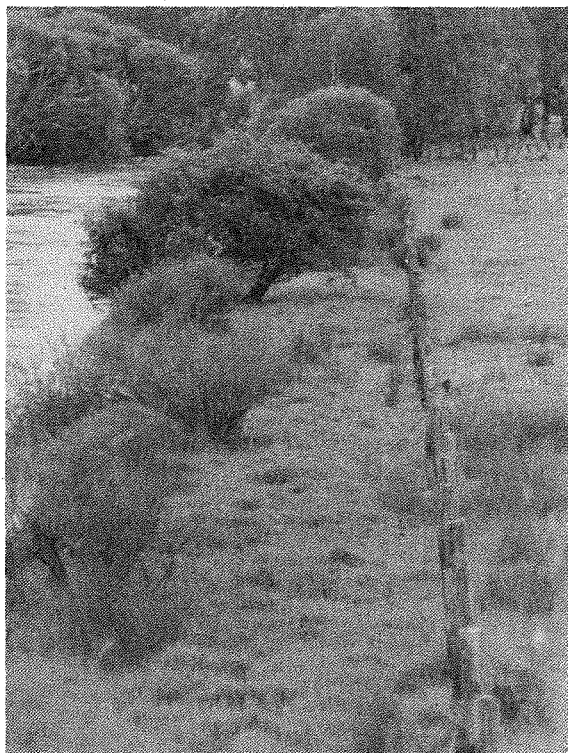
Water quality data highlight the need for adequate, well vegetated foreshore reserves to filter nutrients from the system before they enter the river. Furthermore, deterioration in water quality often has an adverse effect on recreation. The Department of Conservation and Environment Bulletin 103 (1981) contains water quality criteria for marine and estuarine recreation. Before swimming, people should ensure that the water quality is adequate. A secchi disc should be visible to a depth of 2 metres; which in terms of the

Collie River generally means that the bottom should be seen. Also the water should be free from materials which will produce odour, colour or turbidity.

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In conclusion, the Collie River is quite suitable for direct contact recreation except in the presence of phytoplankton blooms. Correct catchment management practice and adequate, well vegetated foreshore reserves would ensure that suitable water quality is maintained, consequently the ecosystem would remain in balance and the associated recreational and conservation value of the river would not decline.

The Waterways Protection Precinct was drawn to conserve the buffer vegetation as a filter system for nutrients and sediments. It also emphasises an area where any proposed changes to the hydrological regime must undergo special consideration.



(Plate 4 : Land use pressure)

Privately owned rural land commonly abuts the river.

## 4.7 Existing Reserves

A number of foreshore reserves currently exist along the Collie and Brunswick Rivers. Most of these are vested in the local authorities for recreation purposes. The remainder (except 8118) are unvested. Currently, no reserves are vested for conservation purposes. Table 3 outlines the existing reserves, their purpose and vesting.

Table 3. Existing Reserves, Purpose and Vesting

RESERVE	PURPOSE	VESTING
26858	recreation	Harvey
32868	recreation	N.V.
24359	recreation	Dardanup
25417	recreation	Dardanup
31576	recreation	Harvey
31166	-	-
33247	recreation	N.V.
32214	recreation	N.V.
32213	-	-
8025	recreation	Harvey
8118	stopping place	Harvey
39922	recreation	Harvey
40020	recreation	Harvey
39864	recreation	Harvey

(WWC 1988)

Vacant Crown land also exists along the foreshore and is illustrated on the relevant maps.

## 4.8 Foreshore Reserve Demarcation

The line of demarcation between reserves and freehold land should be clearly defined to avoid confusion over the location of property boundaries and the extent of management responsibilities. This is most effectively achieved through the appropriate positioning of a minor road and/or by the construction of a dual use path abutting the reserve.

The imposition of a road and/or a dual use path along the reserve boundary assists in :

- (a) facilitating public access where it is considered suitable,
- (b) precluding boundary disputes,
- (c) deterring unauthorised clearing of foreshore reserves,
- (c) preventing the establishment of structures and boat launching areas on public land, and
- (d) clearly defining the limit of government and landowners' management responsibilities.

The Waterways Protection Precinct therefore includes sufficient room for such a demarcation.

#### 4.9 Existing Recreational Nodes

The Collie and Brunswick Rivers and their associated foreshores form an integral part of the recreational and tourist resources of the Bunbury region. This importance is reflected in a study by Thurlow (1990) which identifies uses of the area and their recreational pursuits, and outlines the public's attitudes towards current and future management.

The major recreation nodes relevant to this document:

- (1) Shoalhaven Boat Ramp
- (2) Apex Park (24359) and
- (3) The Elbow (Eastwell St Boat Ramp) (33247)

The position of the above sites is illustrated in Figure 4. Other sites which are currently under increasing recreational pressure are the Clifton Park foreshore (Reserve 31576) and Reserve 25417, off Pratt Road.

A management plan has been produced for the Clifton Park Foreshore Reserve, the recommendations from which are detailed in Appendix 2 (WWC 1989).

Apex Park and Shoalhaven Boat Ramp appear to be the most popular recreational nodes. Both contain a toilet block, barbecues and a launching ramp. Apex Park contains further facilities, including a swimming jetty and formalised car and trailer parking. Access to the Collie River bridge can also be gained from Apex Park allowing for crabbing and fishing from the platform beneath the structure (Thurlow 1990).

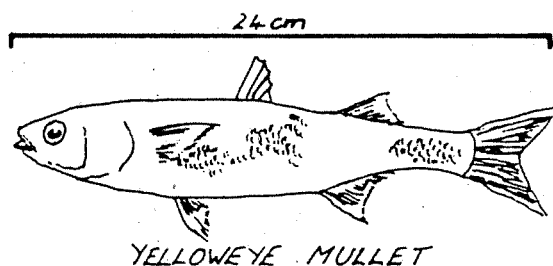
The Elbow has a launching ramp, toilets, barbecues and formalised parking, yet the secluded nature of the reserve means that it is primarily utilised by local residents. Clifton Park is also principally used by the surrounding residents (Thurlow 1990).

The existing recreational nodes may be considered adequate in terms of their respective area. However, considerable concern has been expressed by visitors regarding the provision of further facilities. Comments and observations suggest that upgrading of the boat ramps may be required as well as installation of more barbecues, picnic facilities and formalised car and trailer parking (Thurlow 1990).

Most of these issues have been addressed in the Pelican Point Public Environmental Review which proposes to replace Shoalhaven Boat Ramp with a new ramp, considerably improved parking and changerooms. This is presently only defined in terms of a concept plan, yet if the project were to proceed then the appropriate location of public access and facilities would be formalised by a foreshore management plan for the reserves to be developed and implemented by the proponent (LeProvost Env. Con. 1990).

The Leschenault Inlet Management Authority's vision of an ideal recreation node would be similar to that presently found at The Elbow. The launching ramp and parking facilities would be proportional to the projected use but the reserve would remain aesthetically pleasing. However, additional improvements would include an increased capacity for picnicking and a jetty for mooring and fishing where considered appropriate.

The Waterways Protection Precinct as drawn addresses the need for future recreational nodes by defining adequate space on foreshore land that has limited conservation significance and is adjacent to areas designated by DPUD as urban deferred.



## 4.10 Heritage and Cultural Sites

### 4.10.1 Aboriginal, Archaeological and Ethnographic Sites

An archaeological and ethnographic site survey was commissioned by LeProvost Environmental Consultants for the Pelican Point, Bunbury Public Environmental Review. It concluded that there were six archaeological sites located within the area but each was considered to be of minor archaeological importance (LeProvost Env. Con. 1990). Other surface artefact scatters have been located in the region of the Collie River defined in the study area but these also are of minor significance (LeProvost Env. Con. 1990).

The major archaeological and ethnological sites identified along the Collie River are found above the Wellington Dam and have no direct relevance to this study (Bodney, O'Connor and Quartermaine 1989). However, if a site is discovered, then all development must comply with the provisions of the Western Australian Heritage Act 1972-80.

The Waterways Protection Precinct line is based on current sites but could be expanded to cover new listings as information becomes available.

### 4.10.2 European Historic Sites

There are no historic sites within the study area listed or registered with the National Trust (Macey 1992).

## 4.11 Floodplain

The Water Authority of Western Australia has developed maps which delineate the extent of the floodplain. Data exists for the Brunswick River from the Australind Bypass to its confluence with the Collie River. Similarly maps exist for the Collie River from its confluence with the Brunswick to its mouth at the Leschenault Estuary (George 1992). The floodplain, floodway and floodfringe are described in section 3.3.7.1.

The Waterways Protection Precinct accounts for the floodfringe as lands consistently subject to inundation tend to have high water tables even in terms of normal river flow, which increases the risk of on-site sewerage system failure. Development in many instances removes vegetation cover and increases the rate of stormwater discharge

leading to accelerated erosion (Gilpin 1990). The floodplain and its associated vegetation are also used extensively as fauna corridors between similar habitats, particularly in times of drought and bushfires. Foreshore areas subject to inundation contain the most productive ecosystems (see sections 4.1, 4.2 and 4.5).

## 4.12 Ecosystem Water Requirements

It is important that some understanding be developed in relation to the processes involved in maintaining an adequate water supply to support natural ecosystems. Insufficient research exists to provide any understanding of the effects of dams on downstream ecosystems and their water requirements (Arrowsmith 1992).

The factors involved in determining the impacts are complex and include :

- the proposed discharge regime,
- the relative position of the next major tributary,
- the climate,
- the current extent of riverine vegetation,
- groundwater versus surface runoff and
- the extent of catchment clearing.

The Waterways Protection Precinct is based on current water regimes and requirements. Any proposal to dam a river should provide evidence that it will not adversely affect the hydrological regime of the ecosystems located downstream of the development.

## 4.13 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 (DPUD 1992).

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 (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. (DPUD 1992)

The Waterways Protection Precinct reflects the findings of the DPUD report and the line drawn generally conforms to the areas of Regional Open Space depicted in the Bunbury - Wellington Planning Study. Specifically, it is consistent with the extent of the Possible Reserves zone and Rural Landscape Amenity Area designated in the DPUD study.

The Waterways Protection Precinct also plans for urban expansion and its associated problems of increased public usage of local resources. The WPP line has been drawn to account for the needs of an increased population and associated infrastructure such as bridge/utility crossings, drainage and public open space for community recreation rather than conservation purposes (see Appendices 3 and 4)

#### 4.14 Alternatives to Foreshore Acquisition

Currently, foreshore reserves can only be established outside the metropolitan region through

- (a) the ceding of a foreshore reserve to the Crown free of cost as a condition of subdivision and
- (b) the Crown purchasing the land at its market price.

The first process depends upon a landowner subdividing. This presents problems for the management of foreshore areas in commercially viable rural areas, particularly in respect to controlling river bank erosion, undertaking enrichment planting and maintaining wildlife corridors. The second option also presents problems as the funds are frequently not available to purchase freehold title for public purposes.

A solution has been established in the Perth metropolitan area through the formation of a Metropolitan Region Scheme Improvement Fund which contains money for the appropriation of reserves for public purposes.

To acquire foreshore land outside the metropolitan area three alternatives are available :

- (1.) Establish a fund similar to the MRS Improvement Fund, for rural areas.

- (2.) The Waterways Commission or a Management Authority may enter into agreements with the owner, lessee or licensee of any area of land (including land from time to time or at all times covered by water) for the control or management of that land under the provisions of the Waterways Conservation Act.
- (3.) Incorporate a fee into the price of residential blocks to finance the acquisition of foreshore land.

The second option is in accordance with section 31 of the Waterways Conservation Act 1976. The final option refers to Scheme 3, previously implemented by the Shire of Harvey to fund the acquisition of foreshore land for public open space.



(Plate 5 : Floodplain)

A considerable amount of land adjacent to the Collie and Brunswick Rivers lies within the floodplain.





## 5. Waterways Protection Precinct Maps

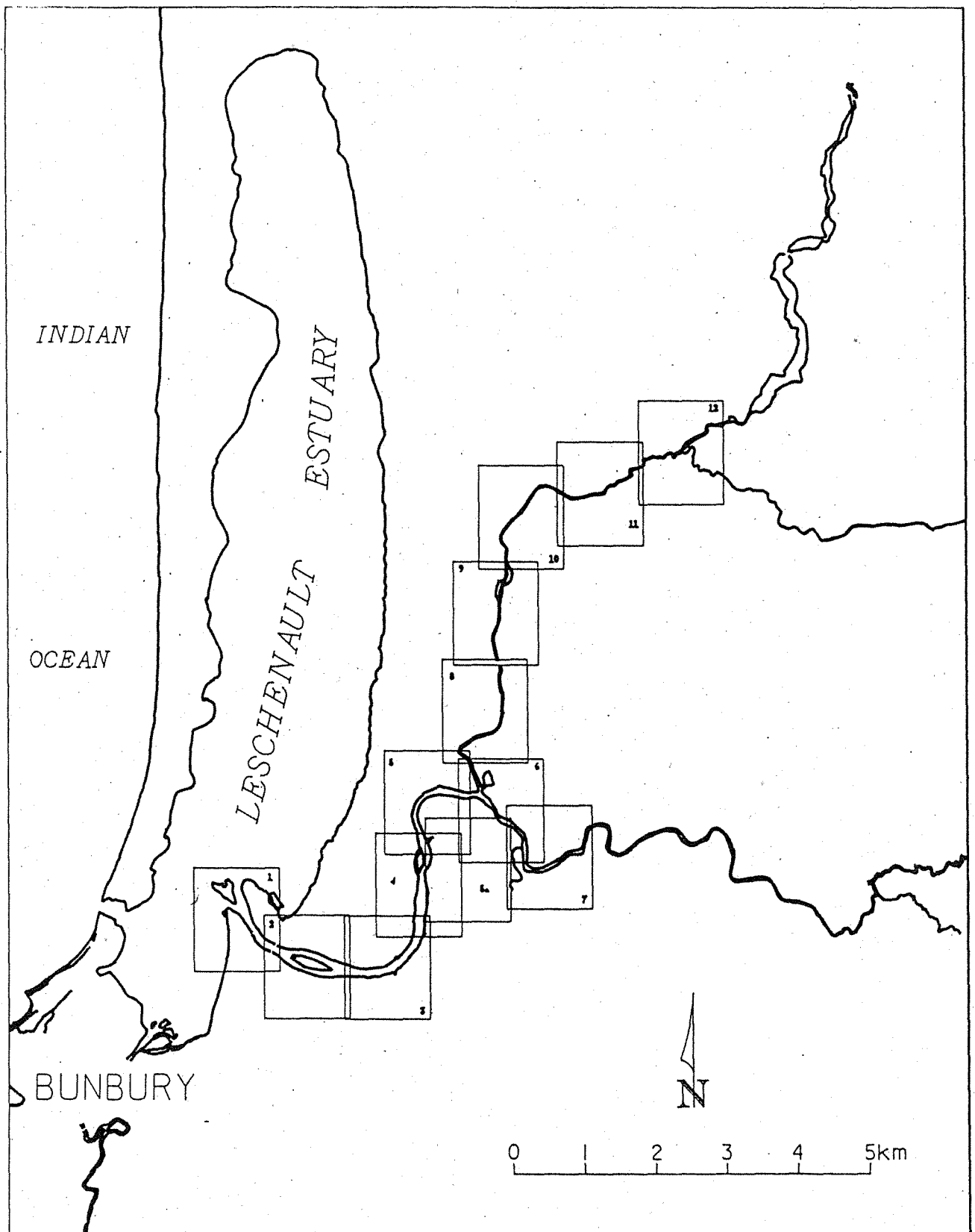


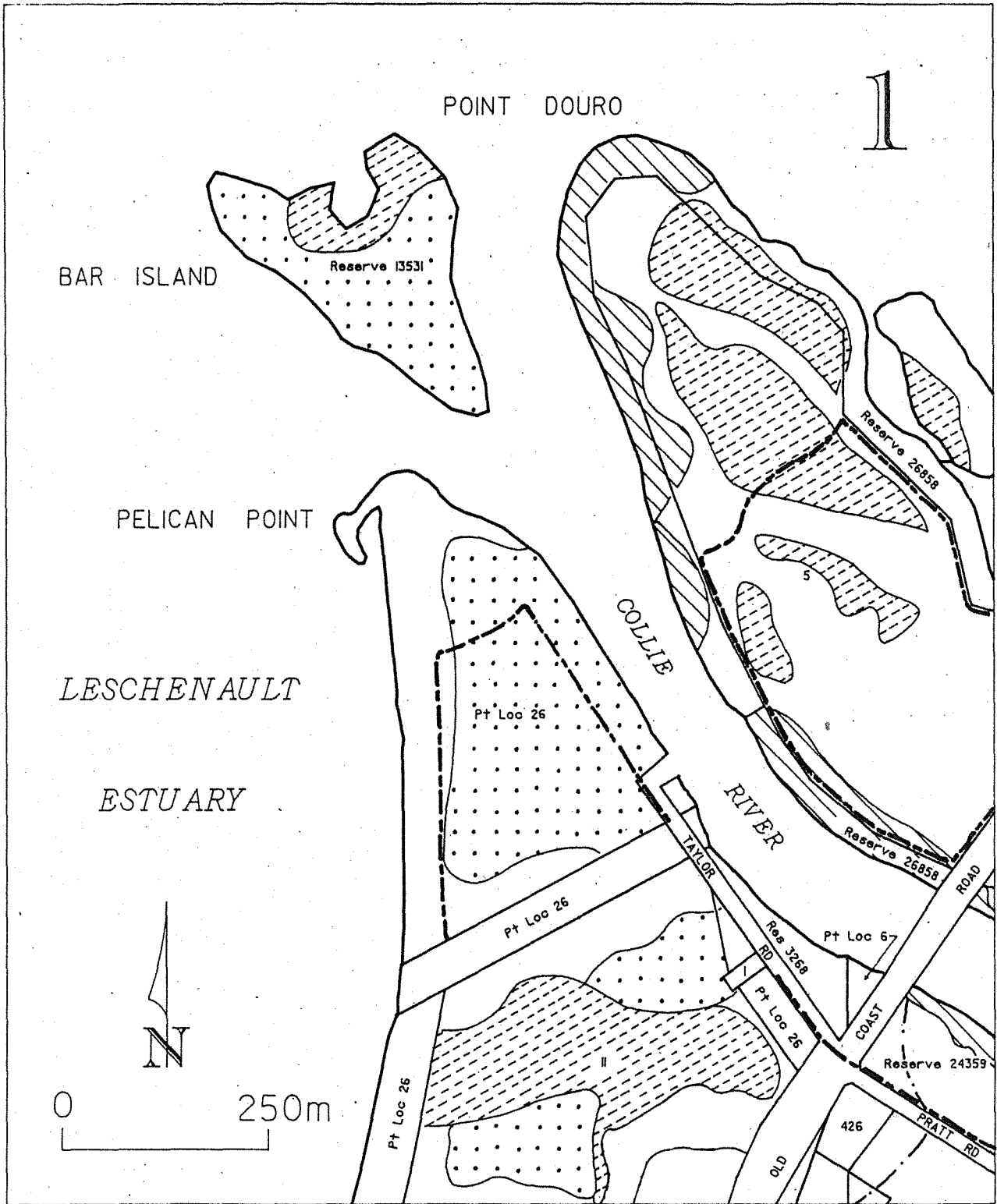
FIG. 5: Index Map

## **Planning considerations for Map 1**

- the Waterways Protection Precinct at Point Douro is in accordance with the development plan approved by the Minister for the Environment, dated 14 September 1989. The illustrated line is subject to the adherence of the developer to the stated Ministerial conditions pursuant to the provisions of the Environmental Protection Act 1986 and the implementation of the Point Douro Management Plan.
- the Waterways Protection Precinct at Pelican Point is in accordance with the development plan approved by the Minister for the Environment, dated 8 September 1992. The illustrated line is subject to the adherence of the developer to the stated Ministerial conditions pursuant to the provisions of the Environmental Protection Act 1986 and the preparation and implementation of a Pelican Point Management Plan.
- saltmarsh
- floodway / floodplain
- reserve 32868 and 26858
- high recreational potential of the area
- valuable conservation area for waterbirds and associated wetland habitat

## **Recommendations**

1. Support the continued implementation of the Integrated Mosquito Control Strategy for Point Douro and Pelican Point.
2. Create additional public access and recreation areas at Pelican Point, if an alternative development is proposed.

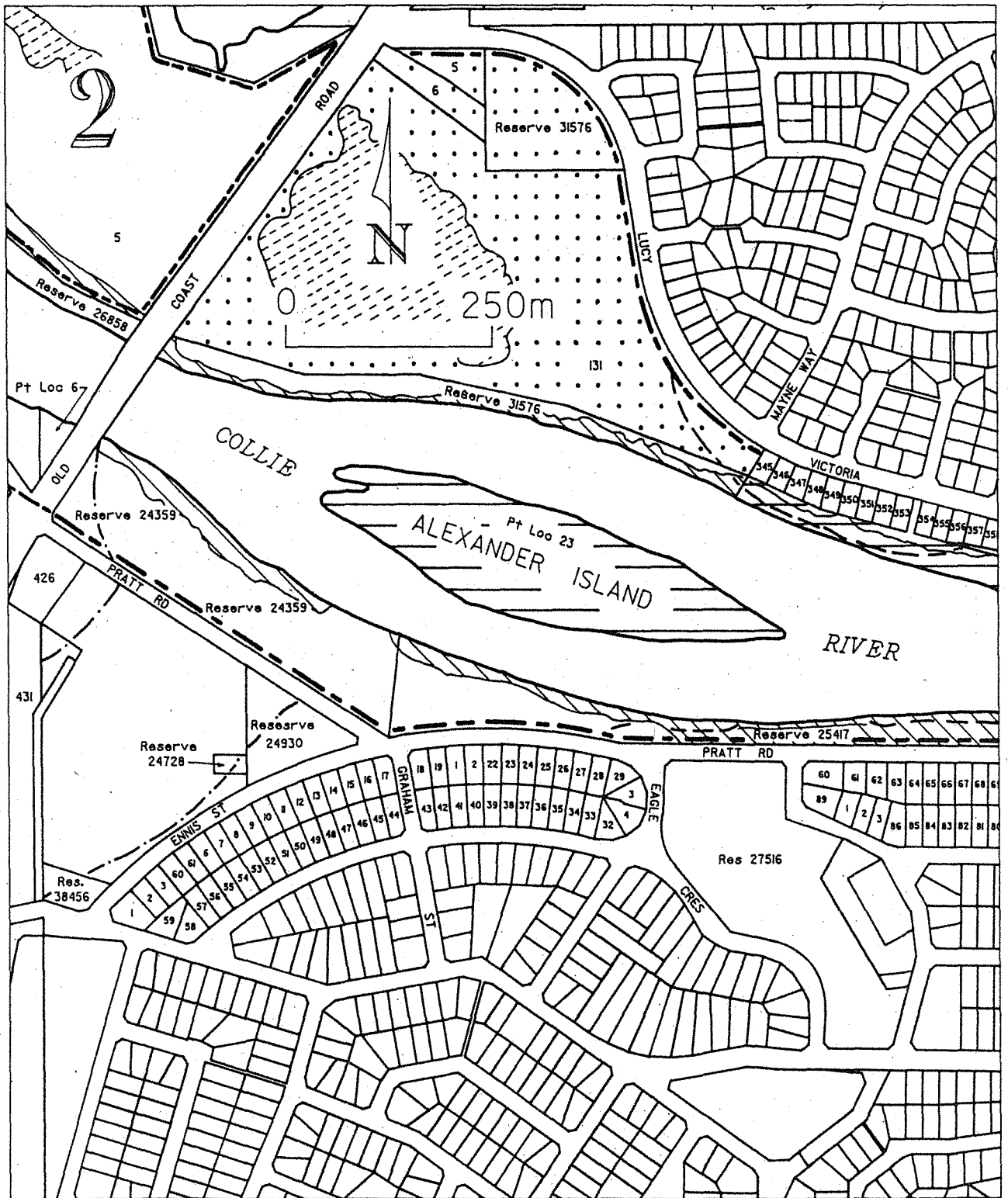


## **Planning considerations for Map 2**

- existing reserves
- floodway / floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- Clifton Park Reserve as a high use recreation area
- Apex Park as a high impact recreation area and boat launching site
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation

## **Recommendations**

3. Continue implementation of the Clifton Park Management Plan.
4. Endorse appropriation of lot 131 by the South West Development Authority and the establishment of the relevant Joint Management Committee.
5. Rehabilitate wetland on lot 131 as a waterbird habitat and recognise the conservation importance of the area through the development of interpretation facilities and the formalisation of limited public access.

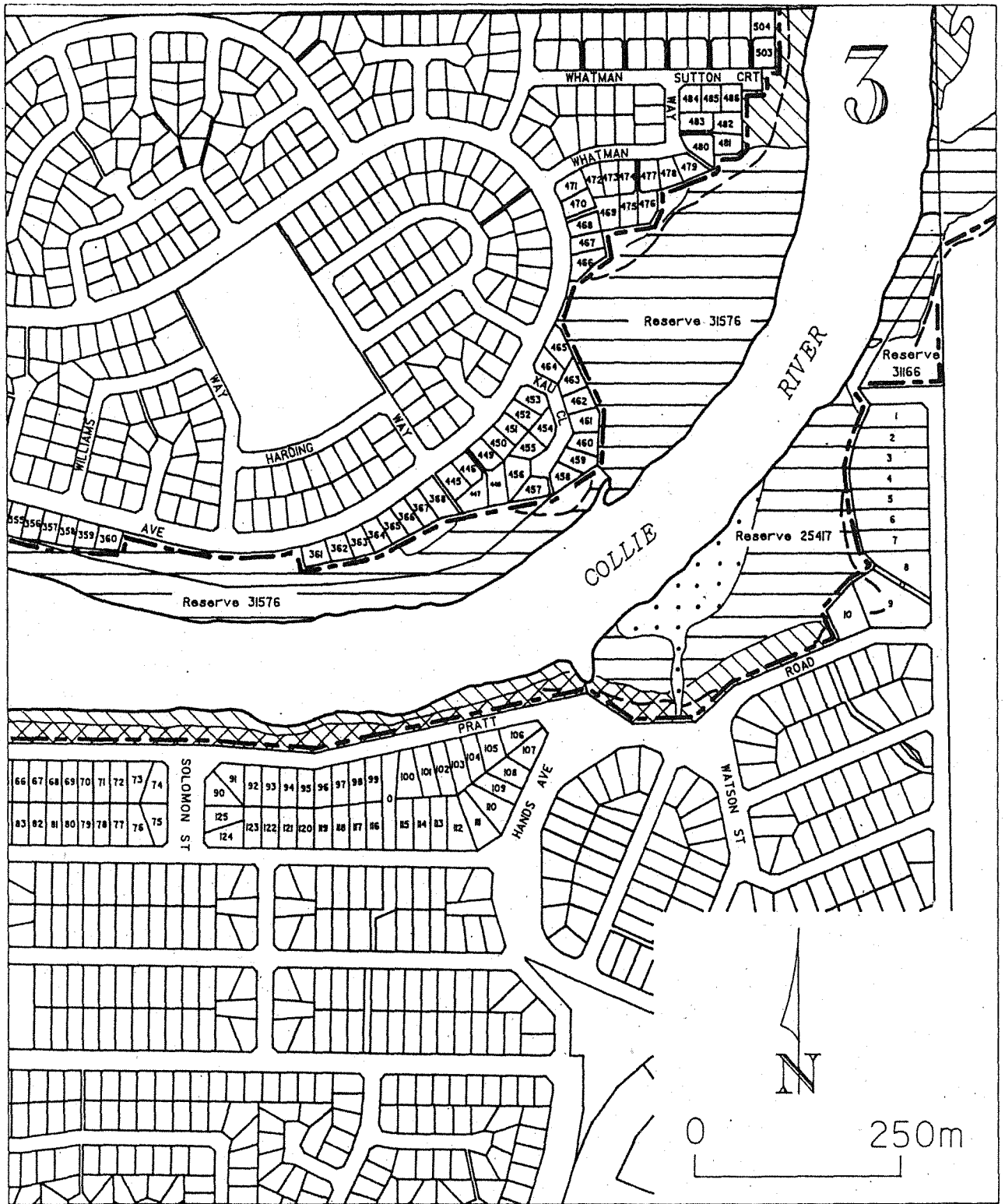


### **Planning considerations for Map 3**

- wildlife corridors
- existing reserves
- floodway / floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- Clifton Park Reserve as a high use recreation area
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation

### **Recommendation**

6. Develop a management plan for Pratt Road Reserve (reserve 25417) to formalise the recreational potential of the woodland area whilst recognising the conservation significance of the peripheral vegetation.



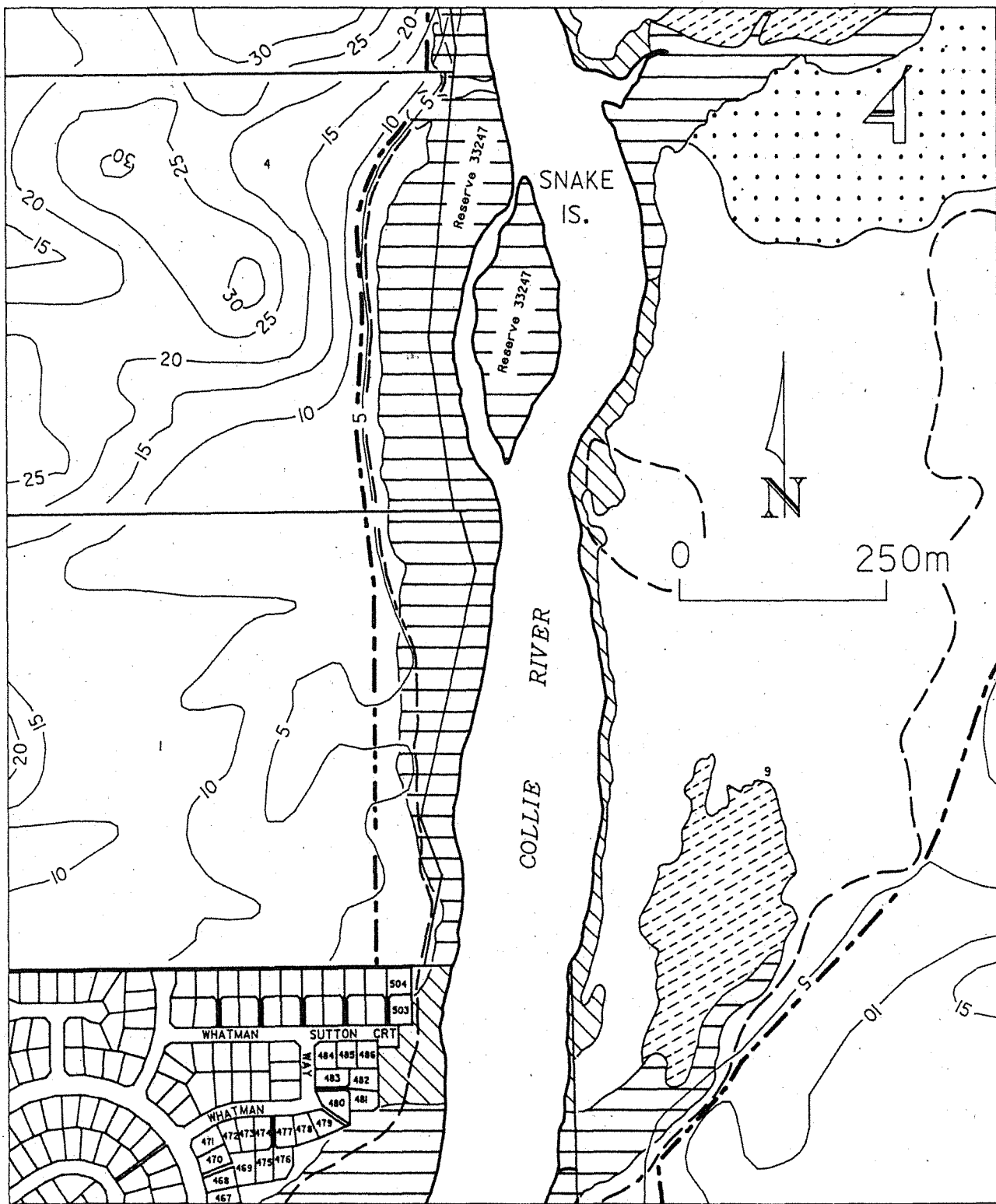
## **Planning considerations for Map 4**

- medium intensity mosquito breeding
- reserve 33247
- 5 metre contour
- 50 metre buffer on fringing vegetation on the west bank
- associated wetlands
- 50 metre buffer on associated wetland on the east bank
- Eaton Structure Plan
- floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- Clifton Park Reserve as a high use recreation area
- wildlife corridors
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation

## **Recommendations**

7. Rehabilitate and enhance fringing vegetation and associated wetlands.
8. Develop a management plan to control the demand for public access, created by the expansion of the Eaton urban area. Area suitable for low impact recreation and conservation of associated wetlands.
9. Support the continued implementation of the Integrated Mosquito Control Strategy.



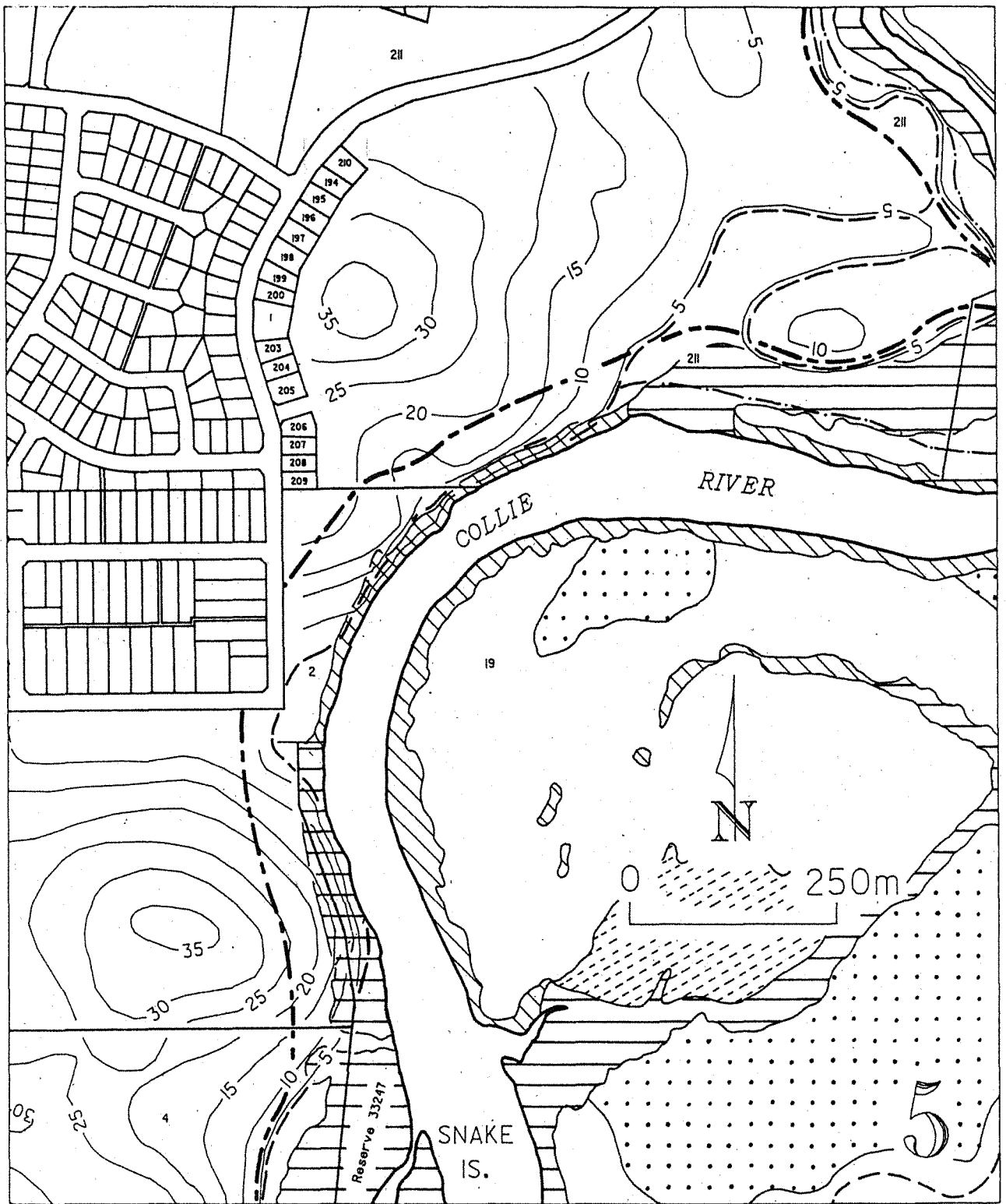


## **Planning considerations for Map 5**

- The Elbow as an important local recreation area
- reserve 33247
- 5 metre / 10 metre contour
- 50 metre buffer on fringing vegetation on the west bank
- associated wetlands
- Eaton Structure Plan
- floodplain
- steep slopes
- peripheral vegetation (incl. forest) with intact understorey
- feeding and roosting area for waterbirds
- landscape amenity provided by the combination of the gorge, river and overhanging vegetation
- wildlife corridors
- eastern foreshore requires enrichment planting
- the western bank of the Elbow is suffering from severe erosion

## **Recommendations**

10. Undertake remedial works to control erosion along the Collie River.
11. Rehabilitate and enhance fringing vegetation and associated wetlands.
12. Develop a management plan to control the demand for public access, created by the expansion of the Eaton urban area. Area suitable for low impact recreation and conservation of associated wetlands.
13. Limit foreshore access to within the Elbow recreational reserve to minimise erosion of the surrounding steep western slopes.

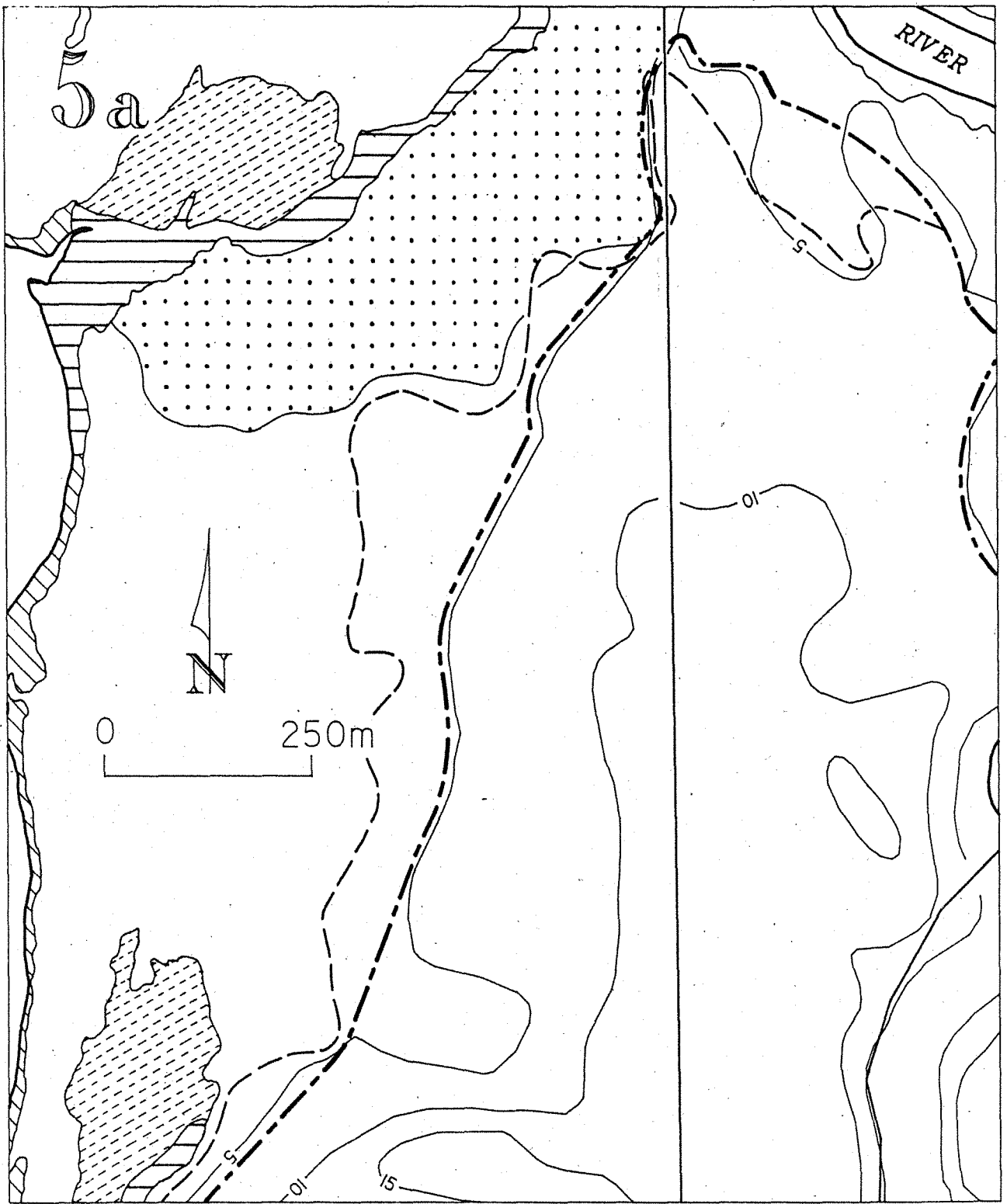


### **Planning considerations for Map 5a**

- 50 metre buffer on associated wetlands
- feeding and roosting area for waterbirds
- extensive woodlands
- associated wetlands
- Eaton Structure Plan
- lack of public access
- floodplain
- 5 metre contour
- wildlife corridors
- peripheral vegetation (incl. forest) with intact understorey

### **Recommendation**

14. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.

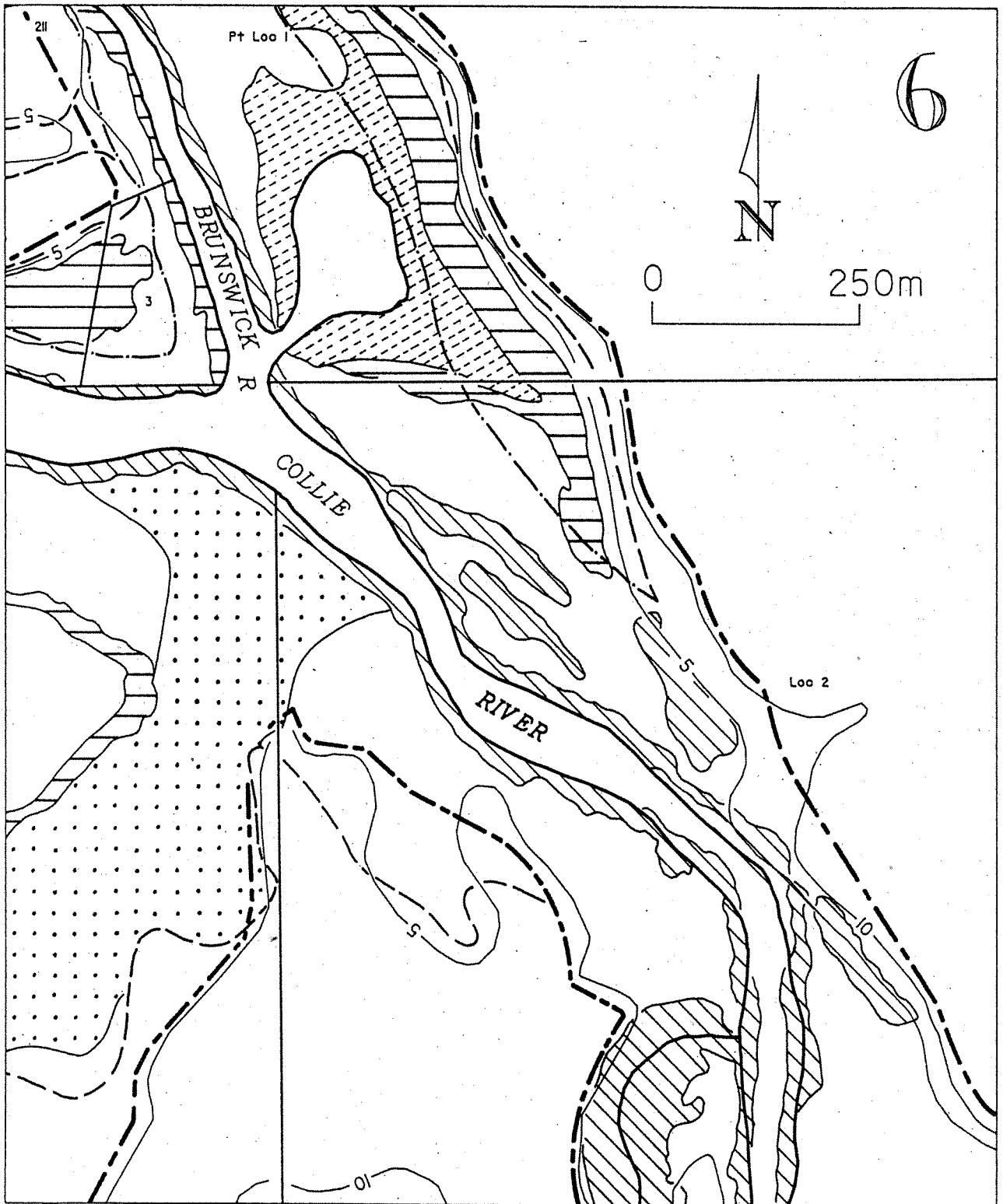


## **Planning considerations for Map 6**

- 50 metre buffer on peripheral vegetation
- feeding and roosting area for waterbirds
- extensive woodlands
- associated wetlands
- Eaton Structure Plan
- floodplain / floodway
- 5 metre / 10 metre contour
- peripheral vegetation (incl. forest) with intact understorey
- confluence of the Brunswick and Collie Rivers
- wildlife corridors
- stream entering Collie River from the south

## **Recommendations**

15. Develop a management plan to control the demand for public access, created by the expansion of the Eaton urban area. Area suitable for low impact recreation and conservation of associated wetlands.
16. Recognise the importance of the foreshore surrounding the confluence of the Collie and Brunswick Rivers as a high quality conservation area.



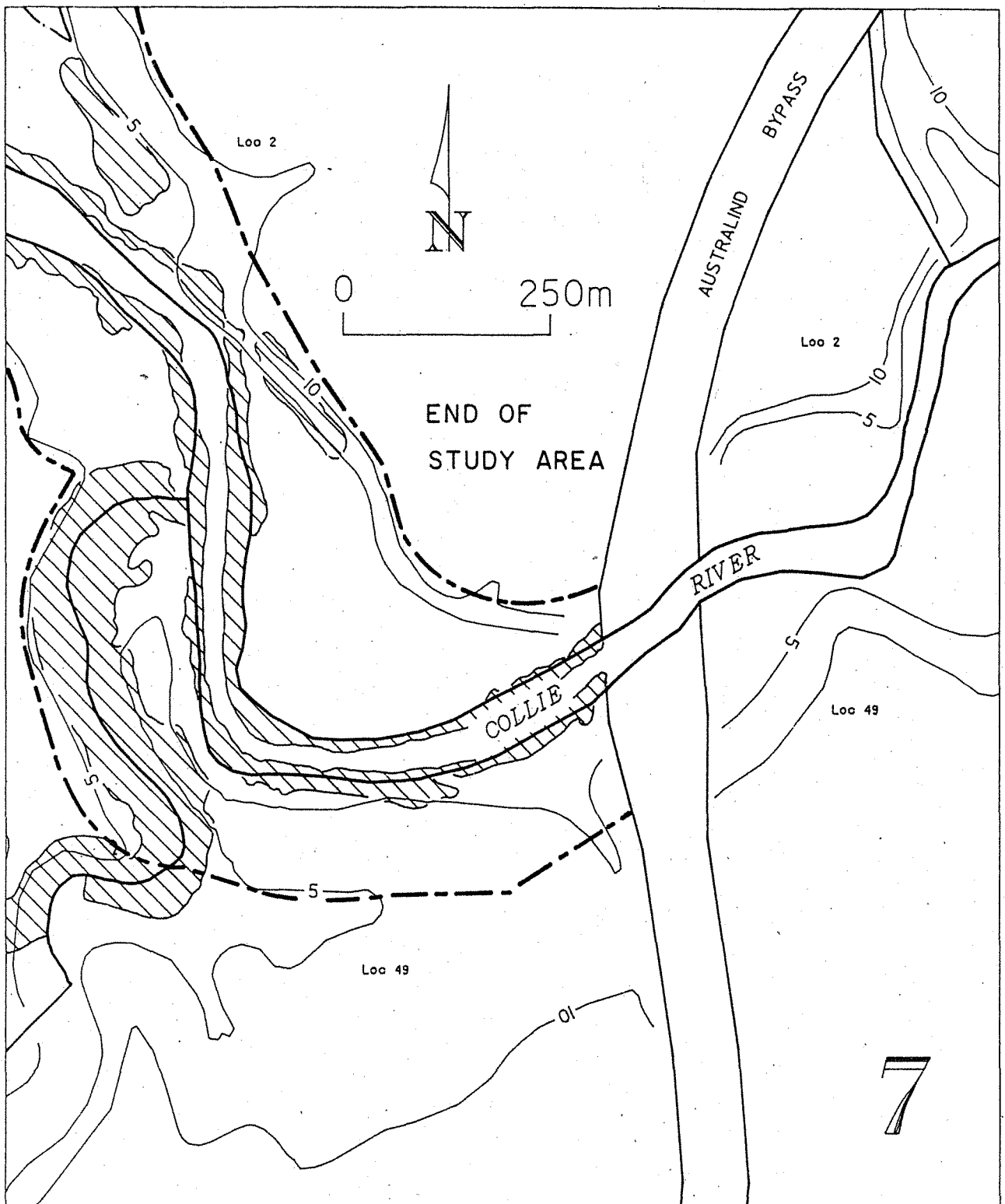
### **Planning considerations for Map 7**

- 50 metre buffer on peripheral vegetation
- feeding and roosting area for waterbirds
- associated wetlands
- Eaton Structure Plan
- floodplain / floodway
- 5 metre / 10 metre contour
- Australind Bypass
- confluence of the Brunswick and Collie Rivers
- wildlife corridors
- stream entering Collie River from the south
- the southern bank of the Collie River is suffering from severe erosion

### **Recommendation**

17. Preserve stream vegetation as a valued wildlife corridor through the development of linear public open space.



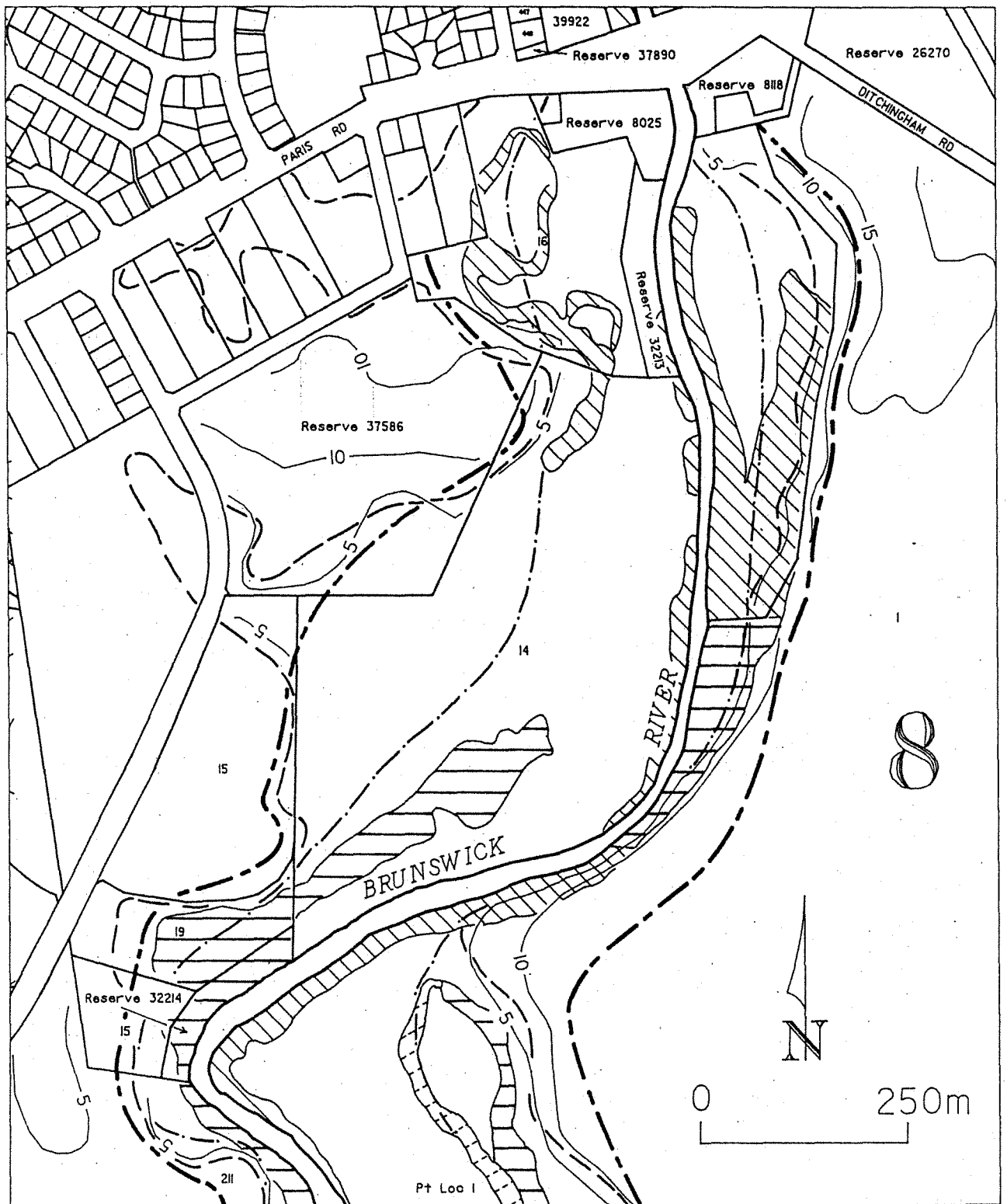


## **Planning considerations for Map 8**

- area exhibiting tree regeneration
- narrowness of the river
- peripheral vegetation (incl. forest) with intact understorey
- East Australind Structure Plan Stage 2
- Paris Road Bridge
- reserves 32214, 32213, 8118 and 8025
- 50 metre buffer on peripheral vegetation
- feeding and roosting area for waterbirds
- associated wetlands
- floodplain / floodway
- 5 metre / 10 metre contour

## **Recommendations**

18. Encourage landowners to restrict stock access to areas exhibiting tree regeneration.
19. Rehabilitate and enhance fringing vegetation and associated wetlands.
20. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area suitable for low impact recreation and conservation of associated wetlands.
21. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.

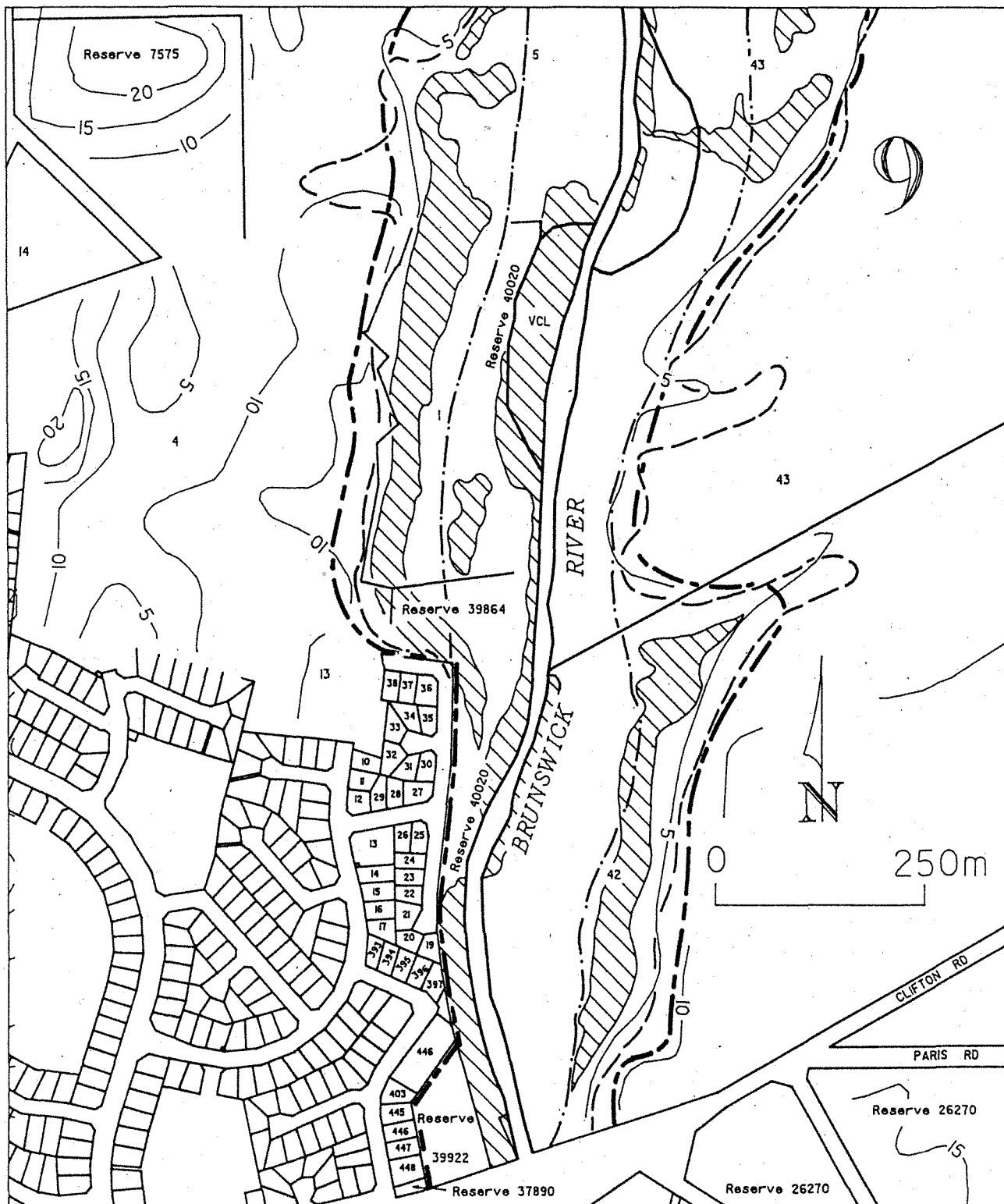


## Planning considerations for Map 9

- area exhibiting tree regeneration
- narrowness of the river
- peripheral vegetation (incl. forest) with intact understorey
- East Australind Structure Plan Stage 1
- currently predominant rural land use with special rural/ residential pressure
- Paris Road Bridge
- reserves 39922, 40020, 39864 and vacant Crown land
- 50 metre buffer on peripheral vegetation
- landscape amenity provided by the combination of the river, woodland over pasture and riverine vegetation
- wildlife corridors
- eastern foreshore requires enrichment planting
- feeding and roosting area for waterbirds
- associated wetlands
- floodplain / floodway
- 5 metre / 10 metre contour

## Recommendations

22. Rehabilitate and enhance fringing vegetation and associated wetlands.
23. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area suitable as a low impact recreational node incorporating the conservation of the associated wetlands.
24. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.
25. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Western foreshore suitable for conservation purposes.

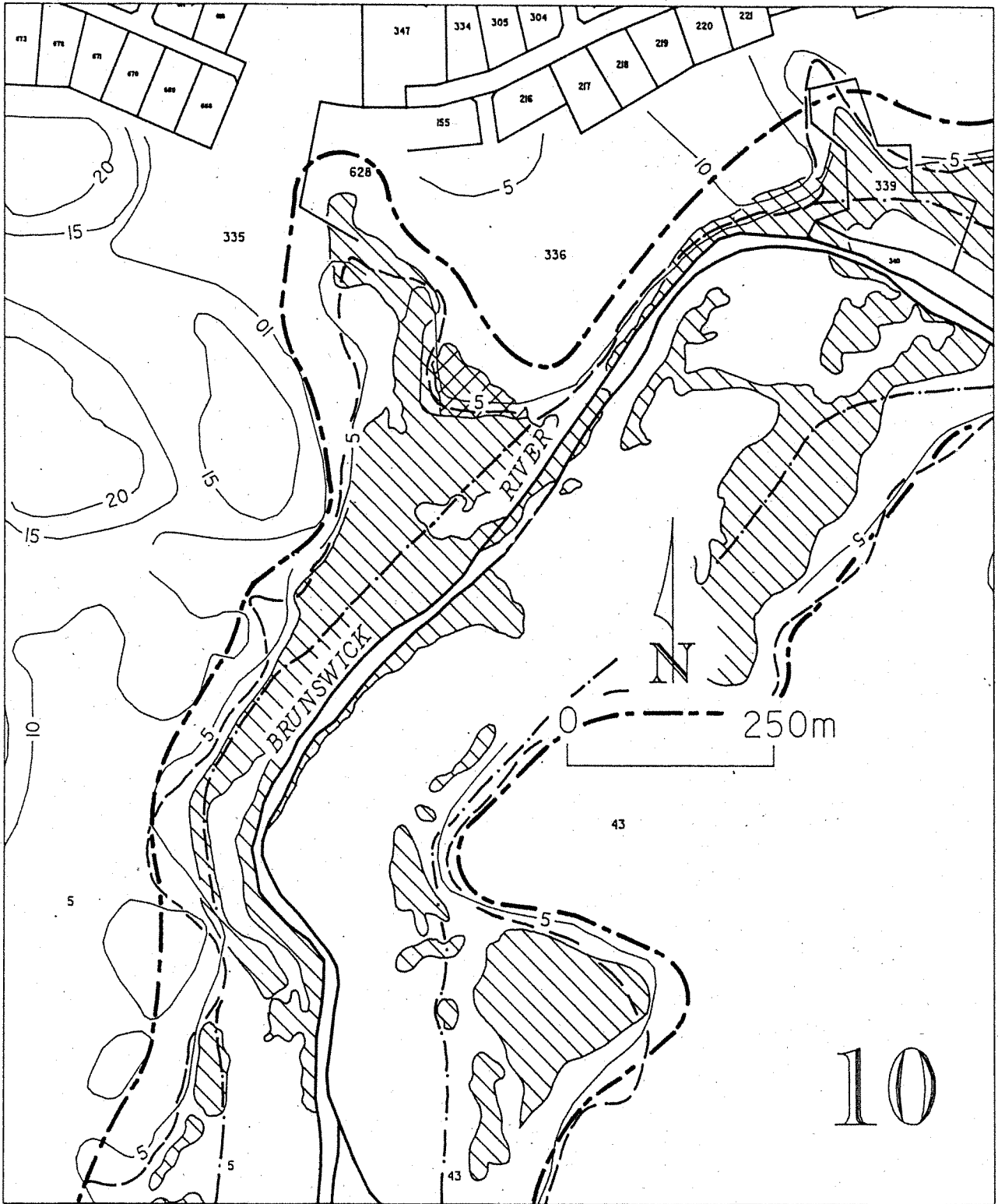


## **Planning considerations for Map 10**

- area exhibiting major tree regeneration
- narrowness of the river
- East Australind Structure Plan Stage 1
- currently predominant rural land use with special rural/ residential pressure
- no existing foreshore reserves
- lack of public access
- 50 metre buffer on peripheral vegetation
- landscape amenity provided by the combination of the river, woodland over pasture and riverine vegetation
- wildlife corridors
- eastern foreshore requires enrichment planting
- feeding and roosting area for waterbirds
- associated wetlands
- floodplain / floodway
- 5 metre / 10 metre contour

## **Recommendations**

26. Rehabilitate and enhance fringing vegetation and associated wetlands.
27. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area suitable as a low impact recreational node incorporating the conservation of the associated wetlands.
28. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.
29. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Western foreshore suitable for conservation purposes.



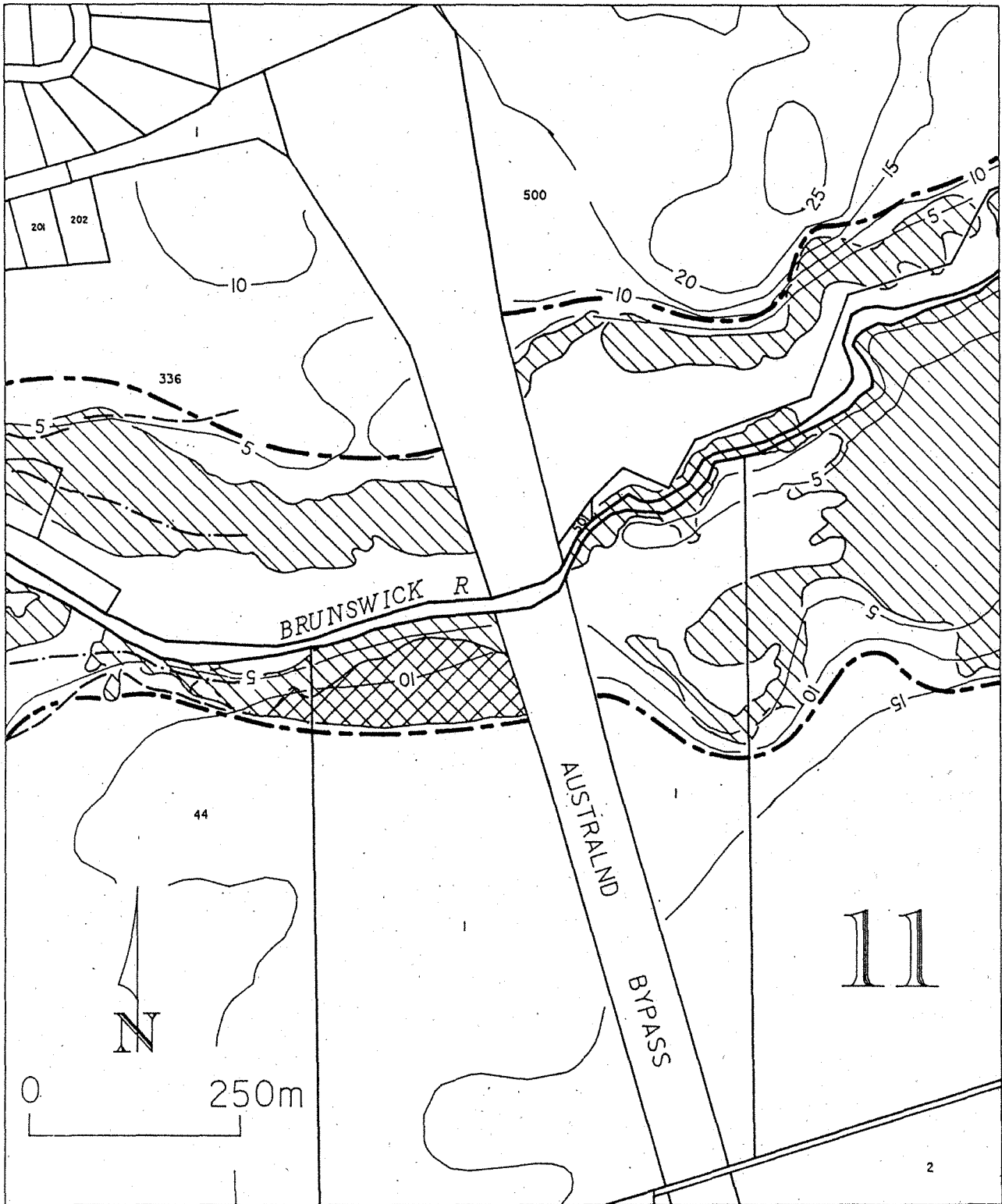
## Planning considerations for Map 11

- area exhibiting major tree regeneration
- narrowness of the river
- East Australind Structure Plan Stage 1
- currently predominant rural land use with special rural/ residential pressure
- Australind Bypass
- no existing foreshore reserves
- lack of public access
- 50 metre buffer on peripheral vegetation
- steep banks
- high sandy rise vegetation preventing erosion
- associated wetlands
- floodplain
- 5 metre / 10 metre contour

## Recommendations

30. Rehabilitate and enhance fringing vegetation and associated wetlands.
31. Develop a management plan to control the demand for public access, created by the establishment of the East Australind urban area. Area important as a wildlife corridor, for its value in minimising erosion and its associated aesthetic qualities. Direct public use to surrounding areas.
32. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.
33. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Northern foreshore suitable for conservation purposes.



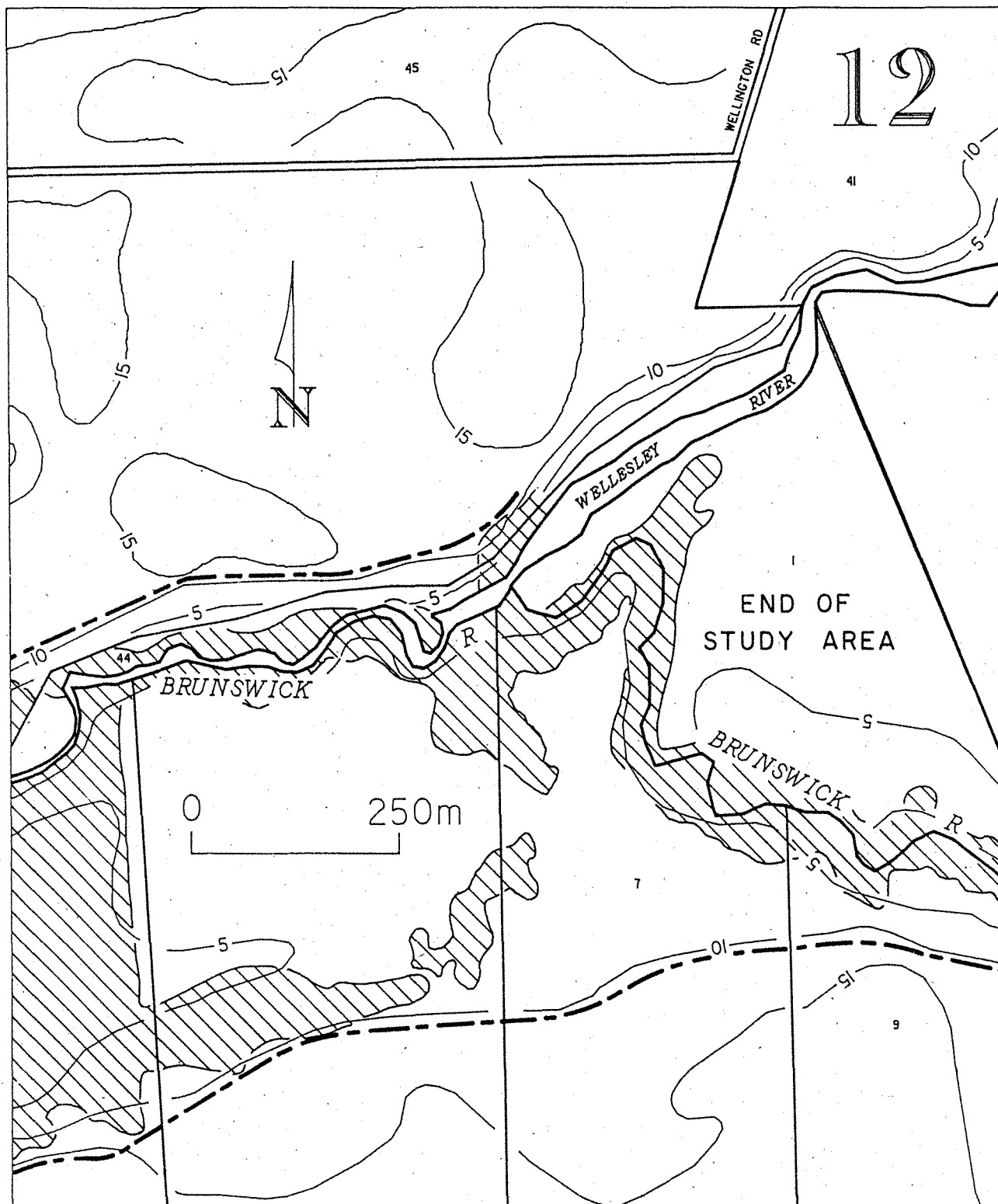


## **Planning considerations for Map 12**

- area exhibiting major tree regeneration
- 50 metre buffer on peripheral vegetation
- landscape amenity provided by the combination of the meandering river and overhanging vegetation
- wildlife corridors
- associated wetlands
- consistency with map 11
- 5 metre / 10 metre contour
- feeding and roosting area for waterbirds
- confluence of the Wellesley and Brunswick Rivers
- Brunswick River becomes very narrow

## **Recommendations**

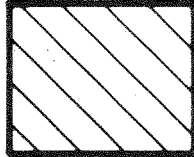
34. Encourage landowners to restrict stock access to areas exhibiting tree regeneration. Northern foreshore suitable for conservation purposes.
35. Recognise the importance of the foreshore surrounding the confluence of the Brunswick and Wellesley Rivers as a high quality conservation area.
36. Rehabilitate and enhance fringing vegetation and associated wetlands.
37. Preserve and enhance wildlife corridors through the development of continuous linear reserves and via strategic enrichment planting.



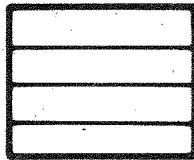


# LEGEND

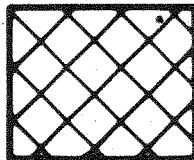
## VEGETATION CLASSIFICATIONS



Fringing vegetation



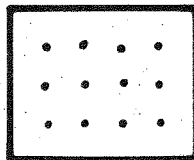
Fringing vegetation (incl. forest) with intact native understorey



High sandy rise vegetation



Saltmarsh



Woodlands



100 year floodline



W.A.W.A. limit of floodway



Waterways Protection Precinct

## 6. Glossary of Terms and Abbreviations

CALM	Department of Conservation and Land Management
community	a natural group of organisms of different species that live together and interact as a relatively self-contained unit.
Crown	Local, State or Commonwealth Government
DCE	Department of Conservation and Environment
development	(a) the erection, construction, demolition, alteration or carrying out of any building excavation, or other works in, on, over or under land or waters  (b) a material change in the use of land or waters; and  (c) any other act or activity in relation to land or waters declared by regulation to constitute development.
DMH	Department of Marine and Harbours
DOLA	Department of Land Administration
DPUD	Department of Planning and Urban Development
ecosystem	an ecological system that includes all living things and the environment in which they naturally occur.
EPA	Environmental Protection Authority
estuary	the tidal mouth of a river, or partially enclosed body of water having variable salinity due to its connection with river(s) and sea.
eutrophic	having a very high nutrient content.
eutrophication	nutrient enrichment usually due to accumulation of nutrients from agricultural lands. May bring about rapid growth of algae, causing unpleasant odours and death of aquatic life.
floodfringe	the remainder of the floodplain outside the floodway.
floodway	the channel and the lands immediately adjacent which carry the fast moving flood waters.
LIMA	Leschenault Inlet Management Authority
low impact recreation	forms of recreation that have minimal impact on the environment - e.g. walking, birdwatching.
MRS	Metropolitan Region Scheme
nutrient	material taken in by living things for growth and maintenance.
phytoplankton	plant plankton or single-celled algae in water.
saltmarsh	a coastal marsh, inundated by only the high tides.
substrate	the object or material on which or within which an organism lives.
Waterways Protection Precinct (WPP)	a guide to limit the impact of environmental change.
WWC	Waterways Commission

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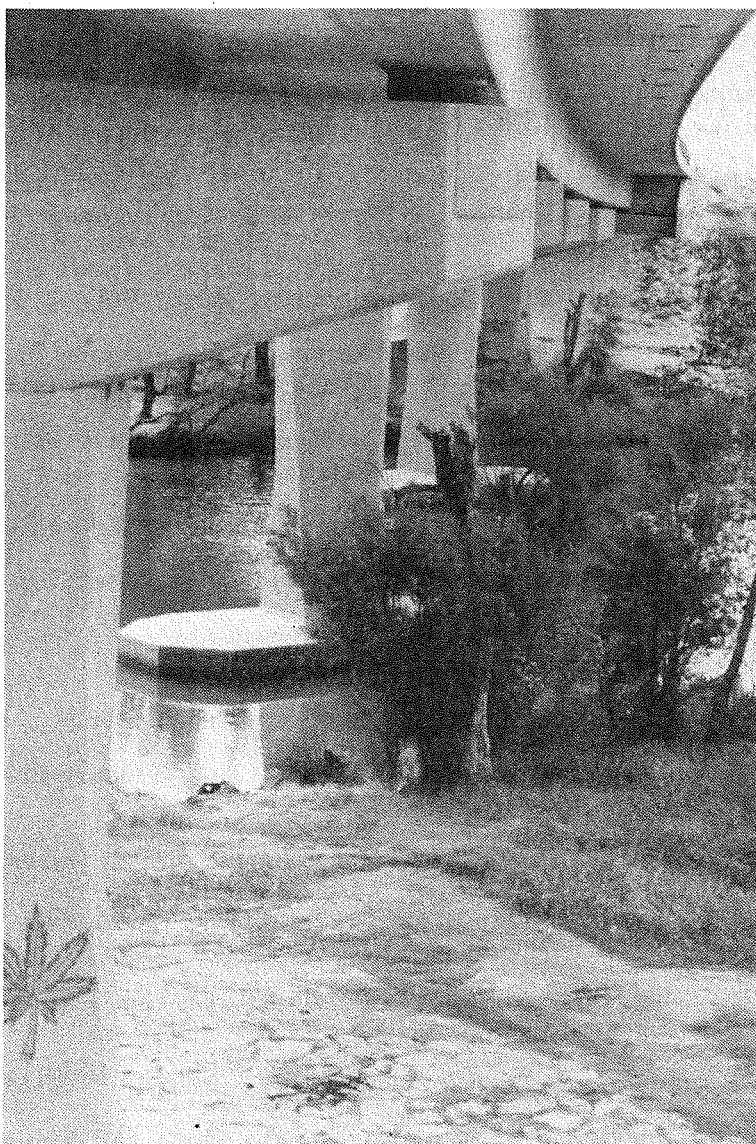
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WWC (1992b) Peel Inlet Management Programme 1992. Waterways Commission, Perth, WA.



(Plate 6 : Collie River bridge)

Foreshore land adjacent to bridges is often under utilised and left in a degraded condition.



## **Appendix 1 : Public Submissions**

## Appendix 2 : Clifton Park Recommendations

The recommendations were divided up into two categories, General Recommendations and Area Recommendations. The following are the General Recommendations :

- 1) Maintain vegetation to protect landscape views from the river. Consider the views of residents in the landscaping of the area. No existing vegetation to be removed to enhance residents' views.
- 2) Keep grassed and parkland areas informal to minimise on-going maintenance costs.
- 3) Monitor erosion of the bank to determine need for future works.
- 4) Provide for hand launching of dinghies, sailboards and canoes in Areas A, B and D.
- 5) Ensure that any proposals for filling the area are in accordance with Water Authority recommendations on floodways and floodplains.
- 6) Ensure that drainage from lots, car parks and roadways does not alter the hydrology of the area.
- 7) Ensure catch traps are placed on road and car park sinks.
- 8) Establish bollards or post and rail fencing at strategic locations to delineate the reserve and restrict vehicle and bike access.
- 9) Monitor problems of vandalism and determine a joint strategy between Council and LIMA for controlling such problems.
- 10) Ensure that fertilising of grassed areas occurs during spring and minimal applications are used.
- 11) Control mosquito problem in accordance with the established mosquito strategy.
- 12) Construct a walk trail along the reserve, following the present firebreak. The walk trail to connect to access points at Sutton Court, Lucy Victoria Avenue adjacent Area C conservation area, the access way opposite Duigan Place, the swimming area opposite Mayne Way, and the Old Coast Road at the Collie River Bridge.  
  
A raised boardwalk to be developed in the vicinity of the Area C to minimise hydrological changes to the conservation area.
- 13) The need for a dual use path to be reviewed and reassessed after 3 to 5 years.
- 14) Maintain a firebreak along the existing alignment. When the walk trail is constructed, this should act as the firebreak.
- 15) Establish a fire management programme according to the established policy of Council and LIMA. Provide vehicle access for emergencies and maintenance along firebreaks. Inform local residents of the programme and encourage resident participation in fire control measures.
- 16) Develop a joint funding programme between Council and LIMA.
- 17) Implement the plan over 5 years.

Most of the above recommendations have already been implemented but are included as a useful guide to the preparation of management plans by highlighting a number of key issues. For further reference, the area recommendations are detailed in the Clifton Park Foreshore Reserve Management Plan (WWC 1989).

## **Appendix 3 : Guidelines for the Establishment of Bridges Over Waterways**

The establishment of bridges over waterways can alter the hydrological characteristics of a river and affect the natural ecosystems if they are not designed and constructed carefully. Potential changes in flooding patterns, vegetation loss, weed invasion, silting and lack of foreshore access are issues which must be considered when assessing linear developments over waterways.

The following guidelines may be used by decision making authorities and the Leschenault Inlet Management Authority when assessing such proposals.

### **Siting**

- 1) Bridges should be located to avoid :
  - (a) quality riverine vegetation (particularly with intact native understorey)
  - (b) associated wetlands
  - (c) banks of streams and larger waterways with remnant native vegetation.
- 2) Bridges should be located and designed to minimise the need to fill the floodplain.
- 3) Positioning of the bridge should account for areas of archaeological and ethnographic significance. If sites are discovered during construction the developer should comply with the provisions of the Western Australian Heritage Act 1972-80.
- 4) Streamlining of crossing points for utilities and other facilities to be encouraged.

### **Timing**

- 5) Construction and maintenance activities should be timed to minimise their effect on migratory bird colonies and breeding times of waterfowl. Proponents should liaise with the Department of Conservation and Land Management (CALM) and the Royal Australasian Ornithologists Union (RAOU).

### **Hydrology**

- 6) Proponents should liaise with Water Authority of Western Australia before designing any bridge. Bridge design should conform to WAWA's criteria in regard to flooding. Structures placed within the floodway may alter the flooding patterns.
- 7) During construction, water flow should be maintained to support ecosystem function. Water flow can be critical to the survival of fish and freshwater crustaceans (eg. yabbies).

### **Erosion**

- 8) Damage to river banks should be minimised by limiting the size of the construction site and ensuring that all activity is limited to that site. Vegetation should not be removed.
- 9) All batters and slopes should be stabilised as rapidly as possible. Direct seeding with indigenous species and the use of original topsoil is recommended.

### **Preservation of Vegetation and Fauna**

The floodplain may contain productive ecosystems. Secondly, the vegetation along the foreshore functions to minimise erosion and trap nutrients before they enter the waterway. These properties combined with the aesthetic value of foreshore environments clearly suggest

that all intrusion into the floodplain should be kept to a minimum. Guidelines to ensure that the establishment of bridges conform to such criteria are outlined below :

10) Filling of the floodplain should be discouraged and effectively minimised. Floodplain vegetation minimises erosion by binding soil and slowing runoff. It provides a diverse habitat for fauna and a productive nutrient source for estuarine food chains. Floodplains are frequently utilised as fauna corridors which enable animals to move to and from various habitats in times of drought or bushfire and the corridors ensure genetic diversity through interbreeding populations. Furthermore, the vegetation acts as a nutrient trap and fulfills a landscape aesthetic function.

11) Clearing of vegetation to be kept to a minimum. Existing cleared areas to be utilised where possible. The topsoil should be stockpiled from areas that require clearing to facilitate bridge construction. When construction is completed, cleared areas should be ripped and the topsoil replaced as soon as possible.

12) All noxious weeds should be sprayed and removed prior to construction. Liaise with the Waterways Commission on appropriate chemical treatments and physical removal methods.

13) Lighting fires to be discouraged on-site. Prefer removal of waste from area for appropriate disposal as the risk to riverine vegetation is considerable from wind driven embers which may ignite the undergrowth. Frequent fires alter the composition of the complexes toward exotic annuals. If it is necessary to incinerate the waste on-site, obtain a permit from the Fire Brigade to ensure that neighbouring properties are not threatened.

14) All litter to be removed from site and disposed of appropriately.

15) Parking areas should be clearly defined to minimise the area disturbed and should be located away from the river bank. Existing cleared areas should be utilised where possible.

16) The proponent should consult with the Department of Conservation and Land Management regarding dieback control measures.

17) Monitoring of weed invasion from fill and disturbance to be undertaken after 12 months and treated accordingly.

### **Construction Impacts**

18) All drainage to be contained on-site. Construction activity should not cause river waters to become muddy. Suspended solids reduce light penetration and affect aquatic vegetation and fish.

19) Dust and noise should be minimised during development, to the satisfaction of the local authority.

20) All fill should be clean and free of pollutants.

21) The disposal of oil and building rubble should be organised to ensure that they are disposed of appropriately.

22) Construction site toilets should be self-contained and not discharge waste into the environment.

### **Revegetation/Aesthetics**

23) Replanting of the construction site should occur in accordance with a plan approved by the Leschenault Inlet Management Authority.

24) Enrichment planting of the foreshore and rehabilitation of the riverbed with native species should be undertaken to the satisfaction of the Leschenault Inlet Management Authority.

25) Bridge to be designed and constructed to minimise landscape intrusion. Advice from a landscape consultant should be sought on this subject.

## **Public Access**

- 26) Fishing platforms, pedestrians and cycle paths are to be incorporated into the bridge's design where practicable.
- 27) Provision for public access along the foreshore beneath the bridge should be created and maintained.

## **Design Standards**

- 28) The design of the bridge should be approved by the Manager Engineer, Department of Marine and Harbours, and the Commissioner for Main Roads.
- 29) The specifications of the bridge's span should minimise the necessary fill required and accordingly reduce the vegetation disturbance as well as maximising fauna corridors.
- 30) The structure should not interfere with boating activities on the waterway.

## Appendix 4 : Draft Guidelines for Stormwater Use

The traditional method of urban stormwater management has been through the direction of the flow via feeder drains to a trunk channel which continues on into the nearest river. This technique is now considered unacceptable, as the nature of the stormwater results in the degradation of the receiving natural watercourse. Consequently, the use of compensating basins has been employed to check the velocity of the flow and to provide a limited pollution control function. It is the purpose of these guidelines to progress the idea of stormwater disposal, by presenting the concept of stormwater use, by which the water can be utilised to establish wetlands. Within these constructed wetlands, pollutants can be stripped and a wetland ecology sustained for the benefit of the urban area and the surrounding natural environment.

The key concept in stormwater use is to view the water as a resource rather than a waste product that requires disposal. There has been an estimated 80 per cent loss of wetlands within the Perth Metropolitan Area through infill and drainage from the expansion of the urban area. The loss of such valuable and productive habitats can be compensated to some extent by establishing artificial wetlands that can fulfill an urban stormwater management function, create a natural habitat for flora and fauna and an asset for urban recreational areas.

Please note that the guidelines have not been compiled at this stage as it has been resolved that further preparation is required before they can be adopted as Waterways Commission policy. This will involve considerable consultation with WAWA, Health Department and the Environmental Protection Authority to refine the design specifications.

If you require more information on retention basins please do not hesitate to contact the Waterways Commission.