OLD MANDURAH RD. - RAVENSWOOD

From: Gary Whisson (7/4/99)
To: Julie Tilleke
CC: Natalie Thorning,
Reply to:RE: Site inspection -Ravenswood
Thanks Julie,
I have discussed this briefly with Natalie and passed your Q-mail to her to follow up. We believe it is likely to be a property that we have visited with the owner and surveyed already. If it is this one it is quite significant and we can give you/Cameron information on its significance. Natalie will check and confirm. We would be opposed to it being rezoned to Urban Deferred. We probably do not need to visit the site again in order to get the necessary information to argue for its retention, but if it is important in terms of managing the situation then there may well be value in doing so.
I will be out on Thursday, in Friday pm and then on leave until the 27th, apart from the 15/16th, so you will need to arrange any site visits with Natalie or Bronwen. Bronwen will be back in on Monday 12th.
Cheers Gary
Julie Tilleke wrote:
>Garry,
>Cammeron Bulstrode (MfP) has been trying to contact you with regard to a
>24ha piece of land at Ravenswood - Lot 2 Old Mandurah Rd, just east of the
>Ravenswood raceway.
>
>This land has been identified by BBG as being of regional significance and
>has accordingly been earmarked for reservation in the draft Peel Region
>Scheme which is currently under review.
>
>As you can imagine the landowner strongly objects to the proposed
>reservation. The surrounding land is earmarked as Urban Deferred
>
>Cameron is arranging a site inspection after April 19th. He is looking for
>a botonist to attend to evaluate the vegetation. I suggested that DEP should
>be involved as it may be the only chance we get to look at the site.
>
>Cammeron is also interested in any data we may have to justify the
>reservation of this site (He is mindful of lifting the proposed
>reservation).
>
>Can someone from your branch attend. It would be good if we could get enough
>information on this site prior to close of the environmental review period.
>
>Can you call Cammeron at MfP Peel office on 9581 4471.
>Cheers Julie
==========

rang Cameron 8/4 left a message at Perth office.. Have visited 2 lots to the east. would like to attend site inspection

lot4_Old_mandurah_rd

by Cadastre.

by High

From: Natalie Thorning (8/4/99)
To: Julie Tilleke, Gary Whisson

Reply to:RE: Site inspection -Ravenswood
we have not visited that particular lot but the 2 west of it, it has been observed from nextdoor's fenceline however. It would therefore be worth one of us (Conservation Branch) going down, I have tried calling Cameron to let him know and have left him a message. Would you like to come too Julie, and I'll let you know when I hear from him??
Nat

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ENTERED ON GIS

Name: Peripheral Vegetation of Peel Inlet and Harvey Estuary, Western Australia
Date: 01/05/2006
Capture Author: Thomas Leong / Ian Steward

Comments:
Polygon
Created to match documented study area with high level of accuracy

Accuracy Levels:

- High = Document contained visual and or described spatial references easily copied, resulting in little or no polygon boundary errors
- Acceptable = Document contained visual references with complex boundaries, resulting in minor boundary errors
- Low = Document contained little or no visual references, resulting in polygon boundary errors

Attributes
Report Info – Captured without problems
Custodial/Contact – Captured without problems
Content – Captured without problems

Journal of the Royal Society of Western Australia, Vol. 4, Part 1, 1981, pp. 5-11.

Peripheral vegetation of Peel Inlet and Harvey Estuary, Western Australia

by D. J. Backshall and P. B. Bridgewater

School of Environmental and Life Sciences, Murdoch University, Murdoch, W.A. 6153

Manuscript received 25 July 1979; accepted 27 November 1979

Abstract

Fifteen vegetation units, distinguished by differences in the floristic composition of vascular plant species, have been recognised from the Peel Inlet-Harvey Estuary system, Western Australia. Analysis of the epontic diatom flora within units confirms their integrity. The spatial distribution of these vascular-plant communities around the estuarine system appears to be controlled by the substrate summer salinity values, together with the vertical distance from the high water mark. Evidence from aerial photographs extending back 23 years suggests that dynamic processes are less important than these spatial controls in determining community distribution. Exceptions to this occur only when sudden major geomorphic changes force concomitant vegetation changes.

Introduction

During 1977-78 an investigation was undertaken of the peripheral vegetation and associated diatom flora of the Peel Inlet-Harvey Estuary System, Western Australia. This estuarine system comprises two large shallow basins of 65 km² (Peel Inlet) and 50 km² (Harvey Estuary), joined to the sea by a 5 km inlet channel. The basins are connected to each other by a narrow channel, which cut through a broad, barely submerged marginal shelf. The sedimentology of the area has been described by Logan and Brown (1975). This survey was confined to the tidal marsh environment of both Peel Inlet and Harvey Estuary.

Ecological studies of Western Australian vegetation have shown considerable methodological variation, from empirical analysis of transects (e.g. Sauer 1964), classifications based on dominant strata using a range of criteria (Gardner 1942, Speck 1952, Beard and Webb 1974) to recent implementation of numerical methods utilising floristic information (Havel 1975). This paper outlines the application of the Zurich-Montpellier (Z-M) method as a practical technique utilising floristic attributes. Additionally, the paper evaluates the results from this technique with independently gathered environmental data and data obtained from diatom sampling.

Theoretical implications of Z-M phytosociology have been discussed by Bridgewater (1971), Westoff and van der Maarel (1973) and Muller-Dombois and Ellenberg (1974). These references contain the most detailed accounts of the techniques available in the English language, and it is not proposed to discuss them further in this paper.

Methods

At each of eighteen sites (Fig. 1) two or three transects were laid from the high water mark to the edge of the sandy beach ridge. These sites were considered to represent the least disturbed examples of a variety of soil and vegetational types. Soils of the estuary fringe are referrable to three soil systems—Bassendean and Spearwood Dune systems and Pinjarra Plain soil system (McArthur and Bettenay 1960). Site selection was made by field reconnaissance, coupled with use of colour aerial photography taken in 1976 by the Western Australian Lands Department. The transects comprised regularly spaced relevés (samples) one metre square and spaced 5 or 10 m apart, depending on the abruptness of vegetation change. A total of 747 relevés were collected from the estuaries. Species cover-abundance were recorded for each relevé using the Braun-Blanquet scale (Bridgewater 1971). A set of computer programs was used to print tables of species and relevés for each transect. These tables were then examined, and 'potential differential species' (PDS) noted. The initial choice of PDS is made from species having an apparently clumped distribution, with usually $< 60\%$ presence in the group of relevés forming the transect. Selection of PDS was facilitated using a computer program, which incorporates numerical methods as outlined by Ceska and Roemer (1971). Groups of relevés with similar PDS were then extracted from the transect raw tables and entered into a presence table (Table 1).

Each column in Table 1 represents thus the sum of a number of relevés from the estuary, with the frequency of species presence in these relevés recorded as a percentage class (I-V). Table 1 allows the structuring of a classification for the tidal marsh vegetation (Table 2). As only one locality was surveyed, it is inappropriate to utilise the standard Z-M system of nomenclature. Accordingly, the system [illegible] the vegetation units follows that of Bridge[illegible] specifi[illegible] (1974

PEEL-HARVEY CATCHMENT
NATURAL RESOURCE MANAGEMENT PLAN

SUMMARY

DRAFT FOR PUBLIC COMMENT

PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

March 2005

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

PEEL-HARVEY CATCHMENT NATURAL RESOURCE MANAGEMENT PLAN

EXECUTIVE SUMMARY

DRAFT FOR PUBLIC COMMENT

Prepared by

LAND ASSESSMENT PTY LTD

for

PEEL-HARVEY CATCHMENT COUNCIL (INC.)
P.O. Box 332
Mandurah WA 6210

March 2005

CONTENTS

1 INTRODUCTION

1.1 Background

The *Natural Resource Management Plan for Peel-Harvey Catchment* has been prepared by the Peel-Harvey Catchment Council (PHCC) to provide a framework for addressing natural resource management (NRM) issues across the whole of the catchment. It builds upon a considerable history of community involvement in landcare and natural resource management within the catchment, fostered by government agencies.

The nearly 1.15 million hectare catchment is geographically diverse with its western portion on the Swan Coastal Plain encompassing high quality coastal dune and lake environments, the largest estuarine system in the south west, and an extensive backplain and foothills area. The coastal plain portion of the catchment supports many relatively small sized farms and areas of irrigated horticulture. It also includes the rapidly growing City of Mandurah and southern parts of the Perth metropolitan region with the associated urban, peri-urban, and industrial land uses. Beyond the coastal plain, the central and eastern portions of the catchment within the Darling Plateau extend through a large expanse of State forest and conservation reserves centred around Dwellingup to the 'broad-acre' agricultural areas of the wheatbelt near Narrogin.

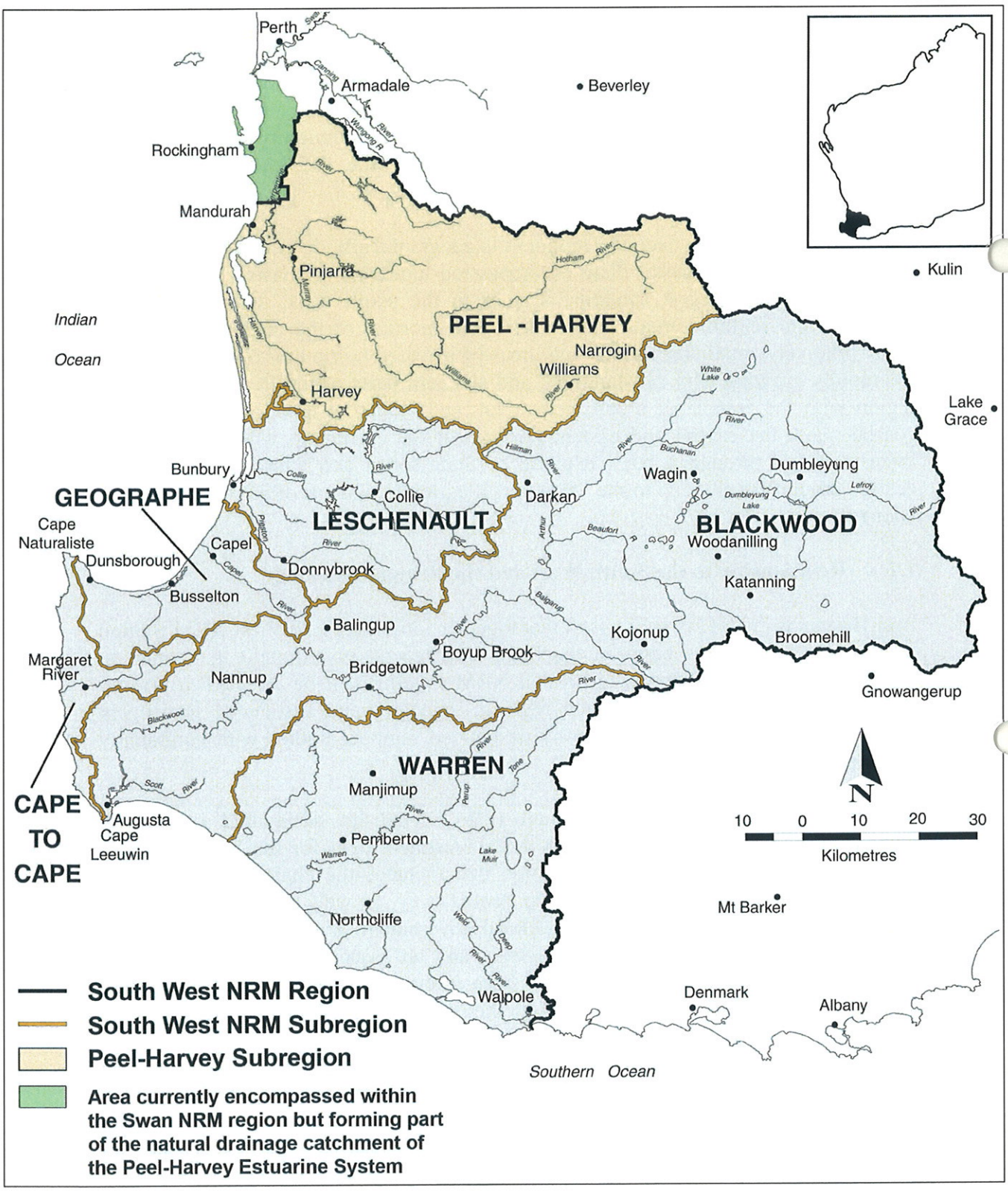
1.2 Relationship to the South West and the Regional Strategy

Peel-Harvey is one of six subregions that together form the South West NRM Region (Figure 1). Agreements between the State and Federal government in relation to natural resource management, mean that NRM funding will be directed to priority actions identified within accredited regional strategies and associated investment plans. These are being developed by designated regional bodies with community participation.

The South West Catchments Council (SWCC) is the designated body with responsibility for the regional strategy and investment plan for the South West of WA. SWCC is a partnership organisation that includes the chairpersons of NRM Groups in the six subregions, including Peel-Harvey, as well as representatives of relevant state government agencies and local government. The *South West Regional Strategy for Natural Resource Management* and an associated interim (one year) *Regional Investment Plan* have recently been prepared by SWCC with community input, facilitated in this catchment, through the Peel-Harvey Catchment Council.

The *Peel-Harvey Catchment Natural Resource Management Plan* is an integrating document between the South West Regional Strategy and the many previous and ongoing strategic NRM planning activities of local community groups and other stakeholders in the Peel-Harvey Catchment. It provides the results of a 'stocktake' of the catchment's natural resource assets, their current condition, and an overview of the current range of activities and future actions required to address the broad spectrum of threats and issues affecting those assets.

FIGURE 1. LOCATION OF PEEL-HARVEY WITHIN THE SOUTH WEST NRM* REGION



Note: Peel-Harvey, in common with all NRM regions or subregions encompasses not just a specific surface drainage catchment, but also coastal portions that are either internally drained or drain towards the ocean.

* Natural Resource Management

Source: Adapted from Hamilton (2002)

1.3 Catchment Boundary, the EPP, and the ERMP

The Peel-Harvey 'catchment area' for this Plan is shown in Figure 2. It is based on the nationally recognized hydrological boundaries of the Murray and Harvey drainage basins that include coastal portions with land that either drain internally or towards the ocean. It encompasses all, or the major portions, of twelve local government areas with lesser portions of five more. It is centred over the Peel Development Commission Region but also includes part of the South West and Wheatbelt Regions.

On the coastal plain, the catchment also encompasses the common administrative area for application of two major 'whole of government' policies addressing the important issue of water quality within the Peel-Harvey estuarine system. In 1992 an Environmental Protection Policy (EPP) and a Statement of Planning Policy (SPP) were put in place as part of the government's response to the formal environmental assessment and approval of the 1988 *Peel Inlet and Harvey Estuary Management Strategy; Environmental Review and Management Programme - Stage 2.*

The 1988 ERMP led to the completion in 1994 of the Dawesville Channel, a significant engineering achievement designed to allow a greater degree of interchange between marine and estuarine waters, and hence help 'flush' the Peel-Harvey system of its excess nutrients. However the 1988 ERMP also identified the need for this engineering measure to be accompanied by widespread changes in land use within the coastal plain portion of the catchment.

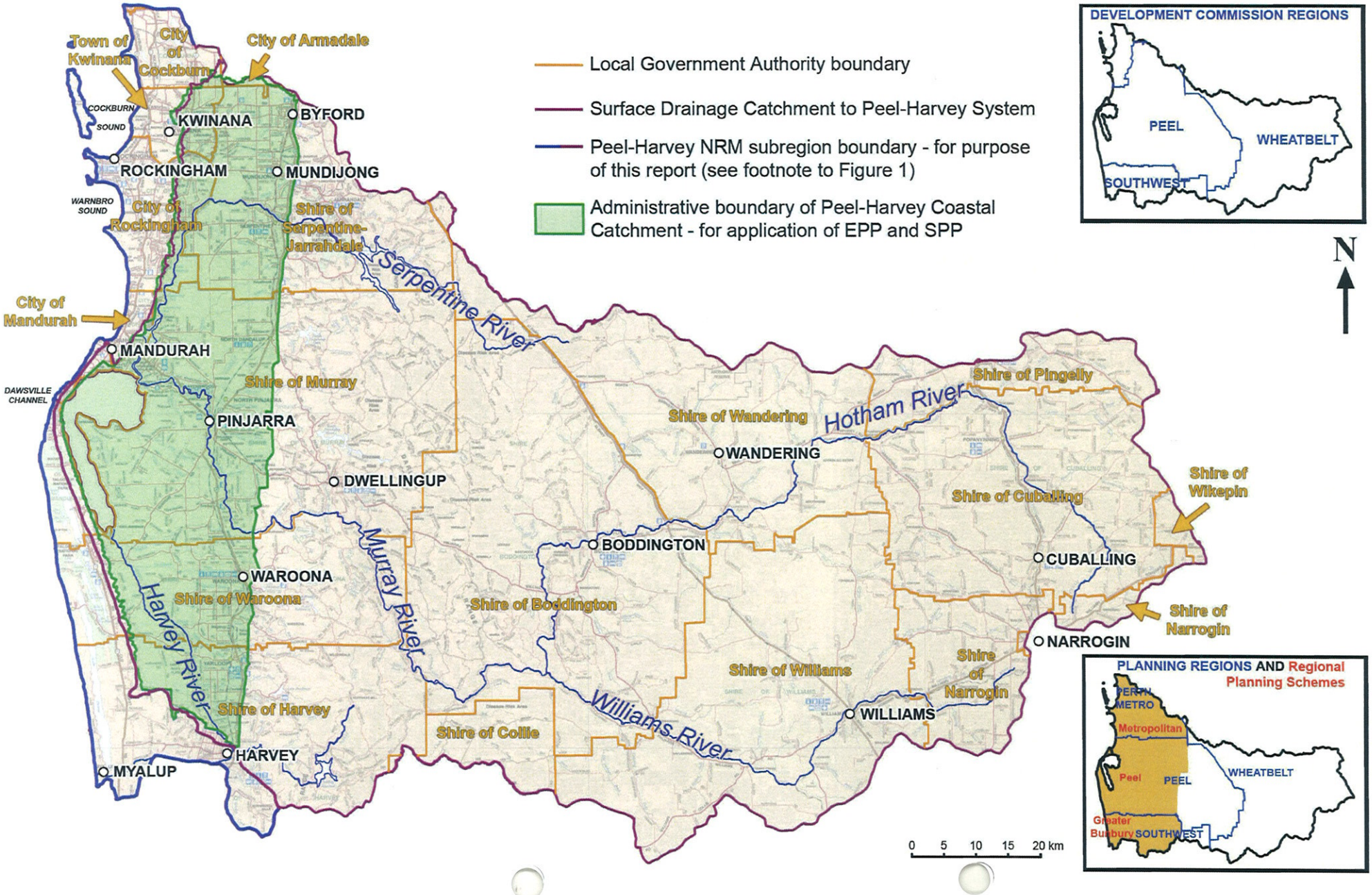
In approving the ERMP the Minister for Environment set a condition requiring the preparation of an "integrated catchment management plan" to meet specific nutrient input targets. That condition has yet to be met by government, and it is not the intent of the *Peel-Harvey Catchment Natural Resource Management Plan* to fulfill that requirement. However the Plan does provide a basis for consideration of appropriate policy and regulatory mechanisms to improve the condition of the catchment's natural resource assets, including water quality on the coastal plain portion.

2. NATURAL RESOURCE ASSETS AND VALUES

In common with the South West Regional Strategy, the PHCC have adopted an asset-based framework on which to develop an understanding of the strategically important issues to be addressed in future allocation of funds for NRM within the Peel-Harvey catchment. An 'asset' is an item of value, and the Plan presents a descriptive 'stocktake' under the following major categories; Land, Water, Biodiversity, Coastal environment, Marine environment, Air, Climate, and, People and Culture.

The primary asset categories of land, water and biodiversity were further divided to address topics such as soils and agricultural priority management areas, mineral resources and basic raw materials, river systems and drainage networks, wetlands and groundwater, bioregions and threatened ecological communities, vegetation flora and fauna.

FIGURE 2. ADMINISTRATIVE BOUNDARIES



Among many important Peel-Harvey catchment assets, the following are highlighted;

- The catchment's river systems provide significant sources of water for the State's integrated public water supply system

- The natural river systems have important inherent ecological values with twenty three rivers, streams, creeks, or portions thereof, identified as being of regional importance.

- There are three internationally recognised 'RAMSAR listed' wetlands within the catchment; the 21,000 ha Peel-Yalgorup wetland system being most significant, and more than 50 individual wetlands are listed as being of regional significance for ecosystem maintenance.

- The catchment is part of an internationally recognised South West biodiversity hotspot, and contains portions of two more focussed, and nationally recognised hotspots that are rich in plant and animal species but are also under a number of significant threats.

- Significant areas of the catchment are managed for conservation purposes, but also have recreational values. They include the Yalgorup and Serpentine National Parks, Land Poole Reserve, Dryandra State Forest, Tutanning Nature Reserve and the Shoalwater Islands Marine Park.

- There are thirty seven vegetation associations within the catchment and thirty nine recorded locations of threatened ecological communities, a notable example being the 'stromatolite–like' ancient life forms occurring within Lake Clifton and Lake Richmond.

- The coastal plain wetlands, particularly the Peel-Harvey estuarine system, are internationally significant feeding areas and habitat for large numbers of native and migratory birds.

- The Peel-Harvey estuary supports the largest professional and amateur estuarine fishery in Western Australia.

- In economic terms the catchment's mineral resources are of significantly greatest value followed then by agriculture, tourism, fishing and forestry.

- There are nine agricultural priority management areas recognised as part of a Statement of Planning Policy for their co-incidence of good quality land and water resources to support a variety of irrigated agricultural opportunities.

- There are significant areas of locally recognised 'prime' grazing land within the central to eastern portions of the catchment.

3 CURRENT CONDITION, THREATS AND ISSUES

3.1 Resource Condition

Methods to qualitatively and quantitatively assess the condition of specific natural resource assets are often complex and are continuing to evolve within the catchment. Nevertheless it is readily apparent to government and the community that continuing, and in many cases significantly increased, investment in natural resource management is required to prevent further deterioration in resource condition. Fundamental to the Australian Government's approach to NRM is the development of Resource Condition Targets (RCT). These will be developed by SWCC for the Southwest NRM region. The question remains whether specific RCTs should be developed for the Peel-Harvey system.

A key role of the National Land and Water Audit is to collate information that is being collected against indicators of resource condition across Australia. Using a methodology which is shortly to be updated, the Audit provides an overall assessment rating of the condition of all major catchments across Australia. For Peel-Harvey catchment, the overall condition rating is 'moderate to poor' based on a broad assessment of a number of indicators relating to the catchment's land, water and biota (biodiversity) resources. Factors responsible for the overall condition of the catchment are complex but include the extent of clearing, modifications to natural hydrology, reduced rainfall and stream flows, and land use impacts.

3.2 Regional Threats

At a regional level, SWCC (2004) lists the direct threats to NRM assets within the South West as;

1. Dryland Salinity
2. Loss of Productive Capacity of Agricultural Land Resource
3. Water Quality Decline (surface and groundwater, and including acid sulfate soils)
4. Disruption to Hydrology of Natural Water Systems
5. Terrestrial Habitat Degradation - loss of native species biodiversity
6. Coastal Processes – disturbance
7. Marine Habitat Degradation - loss of marine biodiversity
8. Climate Change

3.3 Locally Important Issues

At a sub-regional level, the major NRM issues within the Peel-Harvey catchment have been determined from community group workshops to be;

- control of drainage and water quality
- loss or fragmentation of biodiversity
- salinity (particularly within eastern portions of the catchment)
- adoption of best agricultural management practices
- allocation of water resources
- weeds and feral animals
- climate change (particularly rainfall)
- potential effects of acid sulfate soils
- support and funding for on-the-ground community-based NRM activities; and
- inappropriate land development arising from perceived inadequacies in land use planning and environmental impact assessment procedures.

4 OUR RESPONSE

4.1 An Integrated Structured Approach

An integrated response to the condition and threats to the catchment's natural resource assets is necessary to ensure current and future actions are most effective. It is also important, particularly within Peel-Harvey catchment, to understand and build upon the results of previous efforts to address degradation of the catchment's environment.

Existing and proposed responses to the NRM issues in the Peel-Harvey catchment have evolved from strategic planning studies and workshops conducted by or with local community groups, leading initially to the 2002 *Draft South West Regional Strategy,* and now the updated version (SWCC 2004). The structure of the 2002 draft Regional Strategy and the current 2004 Strategy differ. In the earlier Strategy the focus was on 'goal areas', while the latter responds to federal guidance and is more 'asset' focussed.

For the Peel-Harvey NRM Plan, the preferred structure for management responses is one based on major issues or threats, rather than assets. This allows a more integrated approach and represents a continuation of the structure used in the earlier *PHCC Draft Action Plan* (PHCC 2002).

Table 1 shows the relationship between the goal areas (from the 2002 Draft South West Regional Strategy), asset categories (from the 2004 SWCC Regional Strategy) and the categories that are used to address the major NRM issues or threats within the Peel-Harvey catchment.

TABLE 1. STRUCTURE AND EVOLUTION OF NRM RESPONSE CATEGORIES

GOAL AREAS *(from SWCC 2002)*	*ASSET CATEGORY (SWCC 2004)*	MAJOR ISSUE OR THREAT *(PHCC 2002)*
Core Objectives and Outputs		
A. CONSERVATION OF NATURAL RESOURCES and B. SUSTAINABLE RESOURCE USE	*LAND*	*1. Dryland Salinity*
		2. Loss of Productive Capacity of Land Resource
	WATER	*3. Water Quality Decline*
		4. Disruption to Hydrology of Natural Water Systems (allocation, use and protection)
	BIODIVERSITY	*5. Terrestrial Habitat Degradation*
	COASTAL	*6. Coastal Processes - disturbance*
	MARINE	*7. Marine Habitat Degradation – loss of biodiversity*
	AIR & CLIMATE	*8. Air and Climate change*
Enabling Mechanisms		
C. INTEGRATED PLANNING		*9. Strategic NRM Planning*
		10. Land Use Planning - and associated Environmental Impact Assessment
D. RESEARCH AND MONITORING		*11. Research and Resource Assessment*
		12. Monitoring and Evaluation
E. COMMUNITY DEVELOPMENT	PEOPLE AND CULTURE	*13. Communication and Awareness Raising*
		14. Support and Funding
		15. Indigenous Culture and Heritage

4.2 Current Programs

The Plan outlines a range of programs that are currently being undertaken by a range of stakeholders to address the condition and threats to the catchment's NRM assets. They include;

- Coastal Catchment Initiative Projects:

  Water Quality Improvement Plan

  Decision-Support System project

  Water Sensitive Design project

  Best Practice Agriculture project

  Assistance to Intensive Agricultural Industries project

  Licensing/Regulations Review project

  River Fencing / Stock Exclusion project

  Water Quality Monitoring and Infrastructure project

- Managing the Cockburn Sound Environment
- Supporting Community Landcare Centres
- Peel-Harvey Biodiversity Project
- The Peel-Harvey ICLEI Water Campaign™ Project
- River Restoration Projects
- Tuart Conservation and Protection Strategy

4.3 Future Actions

Importantly however, the Plan also lists 151 'future actions required' for better management of the Peel-Harvey catchment's natural resources. These actions are categorised in general accordance with the structure used in the PHCC Draft Action Plan (2002) and shown here in the right hand column of Table 1.

The future 'actions' have been identified primarily from community input through the PHCC, to the development of the South West Regional Strategy for NRM. That input has included collation and review of the results of earlier, and some concurrent, strategic planning exercises conducted at a sub-catchment level.

4.4 Priority Project Areas

Arising from the extensive list of future actions, the suggested priority project areas for further investment in NRM within Peel-Harvey catchment are listed below. It is anticipated that many of these priority projects will be implemented through the Regional Investment Plan for the South West NRM Region.

Project areas may respond to one or more of the major threats or issues within the catchment but are not 'fleshed out' within the Plan. It is envisaged that further expansion will be made by specific project proponents working in conjunction with PHCC to develop a submission to the South West Catchments Council's rolling *Regional Investment Plans*[*]

To assist the development of such submissions, the Plan (Appendix G) provides a cross reference between each of the priority project areas, the relevant future 'Actions' required, and the corresponding management action 'Targets' in the SW Regional Strategy.

Furthermore, to assist Land Conservation District Committees and other Peel-Harvey community groups to readily identify aspects of the Plan that are of local concern, it includes (Appendix A) a summary of key assets, issues and priority projects relevant to each of the 14 sub-catchment areas shown here in Figure 3.

The twenty nine priority project areas, in no inferred order of importance, are;

1. Better water management systems to address dryland salinity and sustainable agriculture.

2. Widespread modifications to the coastal plain arterial drainage network (to achieve water quality benefits).

3. Development of a management plan for the RAMSAR listed Peel-Yalgorup Wetland System.

4. Use of soil amendments / conditioners to reduce nutrient loss.

5. Expansion of Infill Sewerage programs.

6. Expansion of Peel-Harvey Rivercare Action programs to improve water quality and ecological function of waterways (including restoration training).

[*] The *South West Regional Natural Resource Management Strategy* (SWCC draft 2004) is currently supported by a one-year (Interim) *Regional Investment Plan* (2005/6). Once the SW Regional NRM Strategy is finalised and receives national accreditation, it will be supported by a three-year rolling Investment Plan (2006/07 – 2008/09 and onwards).

7. Implementation of major existing foreshore management plans for the protection and rehabilitation of Peel-Harvey waterways.

8. Expansion of ICLEI Water Campaign™ with Local Government to address water consumption and water quality issues.

9. Extension of Peel-Harvey and Local Government Biodiversity Projects (including decision support systems training).

10. Establishing ecological linkages in the landscape (Peel-Harvey Green Corridors).

11. Developing and implementing Coastal Management Plans.

12. Assisting the adoption of agricultural best management practices for nutrient and erosion control (including irrigation areas and animal industries).

13. Implementation of the Environmental Management Plan for Cockburn Sound.

14. Protecting priority remnant vegetation in the Avon Wheatbelt Bioregion (inland catchment).

15. Aligning strategic planning for NRM with Local Government planning processes.

16. Environmental planning for protection of natural resource assets on the eastern side of Peel-Harvey Estuary.

17. Peel-Harvey Biosphere pre-feasibility study.

18. Developing viable farming and land use options for saline areas.

19. Developing agricultural land use options for adaptation to climate change.

20. Acid Sulfate Soils research (identification and remediation).

21. Recreational use impact study of the Peel-Harvey estuary and waterways.

22. Research of land use and climate change impacts on stream runoff within the foothills and Darling Scarp.

23. Survey of nutrient impacts of peri-urban (rural-residential) development.

24. Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).

25. Peel-Harvey Catchment Council website development.

26. Establishment of Peel Waterways Institute.

27. Community capacity building and empowerment (including better access to information and input to planning processes).

28. Awareness raising and training for sustainable land management with small rural landholders.

29. Providing opportunities for engagement of indigenous stakeholders in NRM processes.

5 CONCLUSION

The Peel-Harvey Catchment Council welcomes feedback from the community on the catchment's Natural Resource Management Plan, and in particular on the suggested Priority Project Areas for future investment. All comments and feedback can be submitted to the Executive Officer, Peel-Harvey Catchment Council via P.O. Box 332 Mandurah WA 6210 or iwpickin@openaccess.com.au.

FIGURE 3. SUB-CATCHMENT AREAS

PEEL-HARVEY CATCHMENT

NATURAL RESOURCE MANAGEMENT PLAN

The Peel-Harvey Catchment Council is seeking your feedback and comments on the Draft Peel-Harvey Catchment Natural Resource Management (NRM) Plan.

The following versions of the NRM Plan are available as separate documents:

- An Executive Summary (this document)
  (A 13 page summary outlining the major background information, NRM assets and threats and a summary of the proposed management responses.)

- Sub-Catchment Summaries
  (Sub-catchment summaries provide a brief geographical based summary of the key NRM assets, issues and priorities for action for each of the 14 sub-catchment areas of the Peel-Harvey Catchment.)

- The full Peel-Harvey Catchment NRM Plan
  (This document describes in full detail the Peel Harvey Catchment, our assets, threats, issues, and the proposed management responses.)

- Peel-Harvey NRM Plan Appendices
  (The appendices contain the supporting documentation to the NRM plan including the 14 sub-catchment summaries, a list of the local NRM community groups, current NRM activities and projects, the policy and legislative framework for the catchment, the results of the community workshops undertaken to develop the NRM plan and the links to the South West NRM Regional Strategy.)

Copies of these documents will be available for download from the PHCC website:

www.peel-harvey.org.au

For further information or copies of these documents on CD, please contact your local Landcare Centre or the Executive Officer, Peel-Harvey Catchment Council, via P.O. Box 332 Mandurah WA 6210 or iwpickin@openaccess.com.au.

FEEDBACK FORM

DRAFT PEEL-HARVEY CATCHMENT NATURAL RESOURCE MANAGEMENT PLAN

Name: _____

Organisation (if applicable) _____

Address: _____ **Phone:** _____

Fax: _____

Email: _____

Permission is given for this submission to be made public if requested:

YES ☐ **NO** ☐

Please send (post, fax or email) the above details with your submission to:

Draft Peel-Harvey Catchment NRM Plan
Peel-Harvey Catchment Council
P.O. Box 332
MANDURAH WA 6210

Email: iwpickin@openaccess.com.au

Fax: (08) 9339 2742

Please include all possible referencing information such as document name, section titles, and page/paragraph numbers to assist in identifying the areas of the document to which your submission relates.

Submissions close Monday the 2nd of May 2005

cut here

Alex Thompson Steele : Riverine) (Murray? Murray?) Wetlands

(Support a lot of Riverine Restoration in the Murray Catchment)

(1) River Tech
Steer : Murray RAP - Payments Ordering Bags
Estuary : Peppermint Madness Murray

90 Dunelle Broush heat Using examples 25 Images

(2) Best Management Practices for Drainage of Dark Cracking Clays in Upper Murray

PIP NEWMAN 20 CRESCENT DR. BOUVARD pip.newman@bigpond.com.

Yarra Nat Package.

PEEL-HARVEY CATCHMENT
NATURAL RESOURCE MANAGEMENT PLAN

APPENDICES

DRAFT FOR PUBLIC COMMENT

PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

March 2005

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

PEEL-HARVEY CATCHMENT COUNCIL (Inc.)

APPENDICES

APPENDIX A.

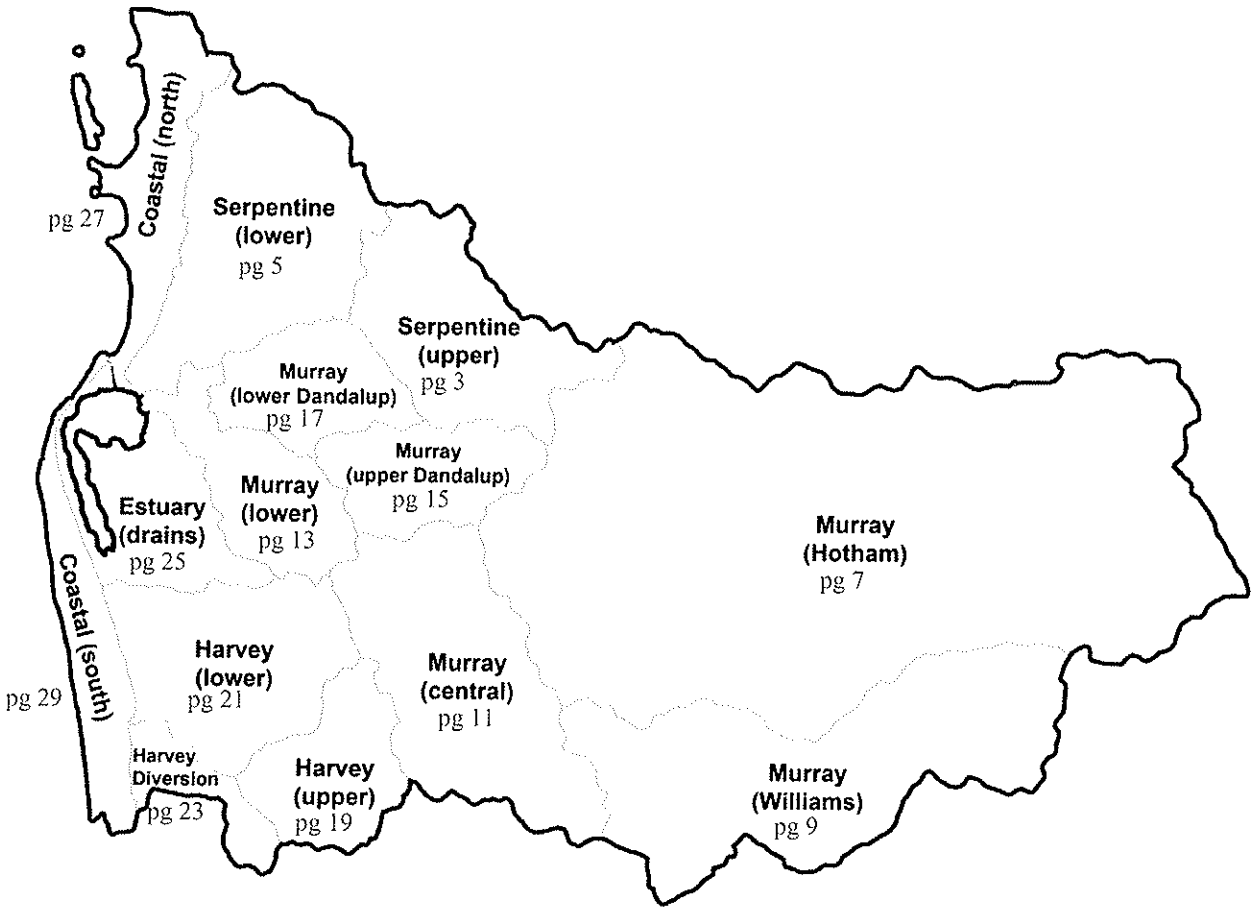
SUB-CATCHMENT SUMMARIES

SUB-CATCHMENT SUMMARIES

The following document provides a summary of the key NRM assets, issues and priority project needs for each of the 14 sub-catchment areas within Peel-Harvey catchment. These summaries have been compiled to assist Land Conservation District Committees and other Peel-Harvey community groups to readily identify aspects of the NRM Plan that are of local concern.

It should be noted that not all of the priority project areas will be shown within the sub-catchment summaries. This is because a number are 'whole of catchment' in nature, particularly those relating to capacity building. It should also be noted that these summaries are expected be updated every few years or so. This should occur as community groups and other NRM stakeholders in the Peel-Harvey catchment provide locally relevant input to the periodic updates to the Regional Investment Plan for the South West NRM region.

An index to the sub-catchment summaries is provided below.



SERPENTINE (UPPER) SUB-CATCHMENT

KEY ASSETS

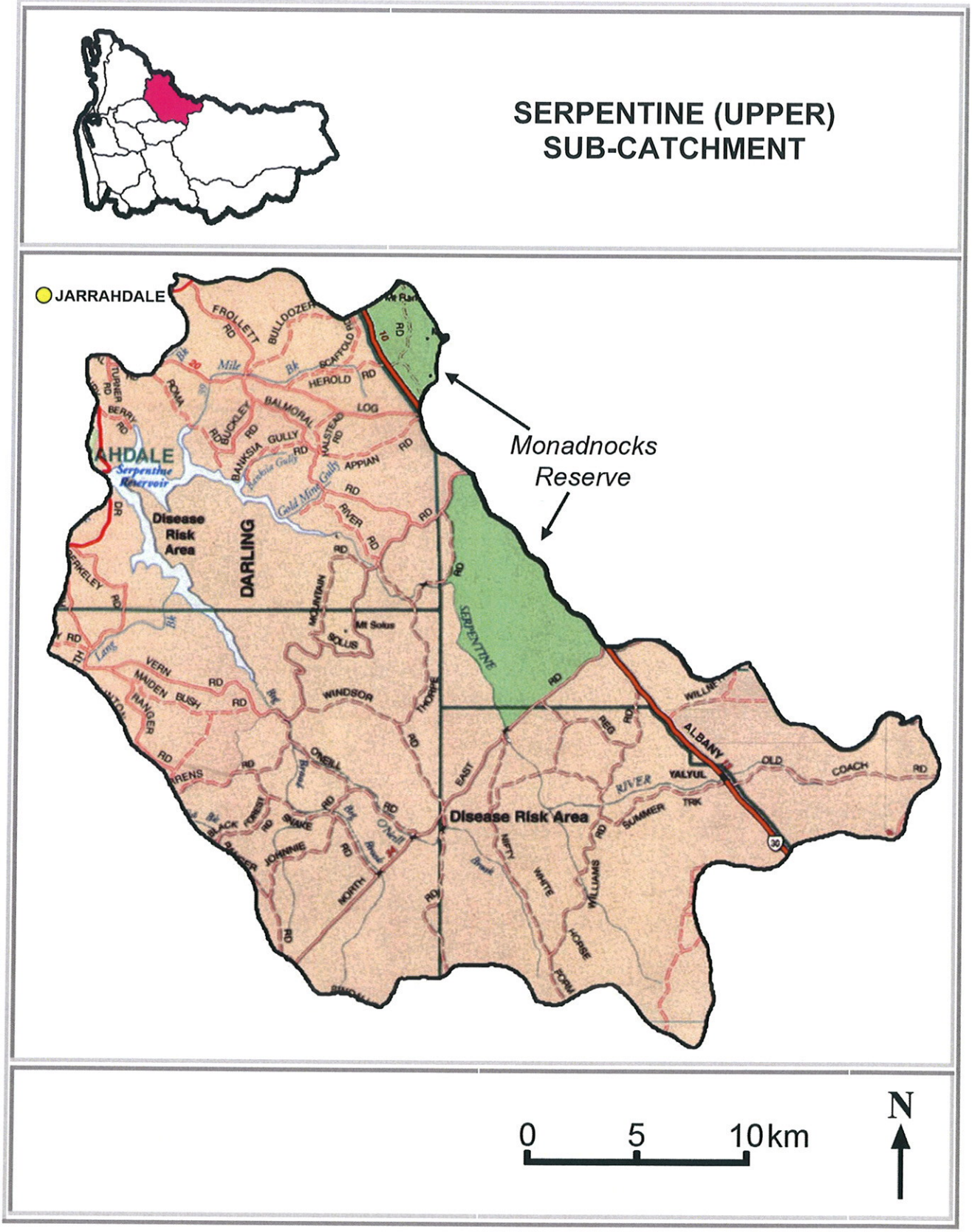
- Fresh quality surface water resources used for public water supply (Serpentine Dam)
- Bauxite and timber resources within State Forest
- Monadnocks Reserve
- Relatively limited extent of agriculture
- Community groups including Boddington Farm and Landcare group, and Wandering Productivity Group, and associated support bodies.

ISSUES

- Sustainability of forest management and mining practices
- Dieback

PRIORITY PROJECT NEEDS

- Extension of Peel-Harvey biodiversity project to better quantify assets
- Development of viable land use options for salt affected portions of farming land.


SERPENTINE (UPPER)
SUB-CATCHMENT
JARRAHDALE
Monadnocks
Reserve
Disease
Risk
Area
DARLING
Disease Risk Area
Serpentine
Reservoir
0
5
10km
N

SERPENTINE (LOWER) SUB-CATCHMENT

KEY ASSETS

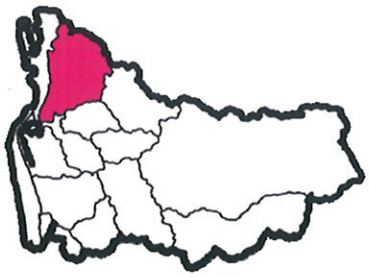
- Agricultural productivity of Pinjarra soil landscape zone (including foothills).
- Productive and potential horticultural (agriculture priority management) areas near Jarrahdale and within foothills
- Serpentine National Park (4367 ha)
- Lowlands and Riverlea Bushland
- Barragup Swamp – wetland of national significance
- Other wetlands of regional significance
- Jandakot, Darling Range and Beeliar Regional Parks
- Karnup-Dandalup UWPCA and part of Jandakot UWPCA.
- Numerous 'Bush Forever' sites
- Scattered occurrence of priority flora and fauna and threatened ecological communities.
- Community groups including Serpentine Jarrahdale and Dandalup Murray LCDCs and associated support bodies.

ISSUES

- Continuing algal blooms in the lower reaches of the Serpentine River
- Rapid transport of nutrients within artificial drainage network on coastal plain.
- Protection of groundwater resources within UWPCAs from land use impacts
- Loss and degradation of Swan Coastal Plain wetlands
- Adequacy of river flows to sustain riverine ecology
- Potential for exposure of acid sulfate soils particularly within areas of estuarine or lacustrine deposits (Vasse System), and subsequent effect on water quality and aquatic biodiversity.
- High risk of nutrient loss associated with horticulture on areas of Bassendean sands

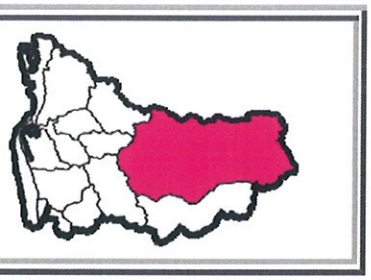
PRIORITY PROJECT NEEDS

- Drainage Reform on coastal plain (changes to management and widespread modifications to drains to achieve water quality benefits)
- Reinvigoration of programs for use of soil amendments / conditioners
- Expansion of Rivercare program
- Extension of Peel-Harvey Biodiversity Project
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Acid Sulfate Soils research
- Maintaining stream flows within first order streams
- Survey of nutrient impacts of peri-urban development
- Implementing existing foreshore management plans
- Assisting adoption of agricultural best management practices
- Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity)
- Awareness raising and training for sustainable land management with small rural landholders.



SERPENTINE (LOWER) SUB-CATCHMENT

MURRAY (HOTHAM) SUB-CATCHMENT



KEY ASSETS

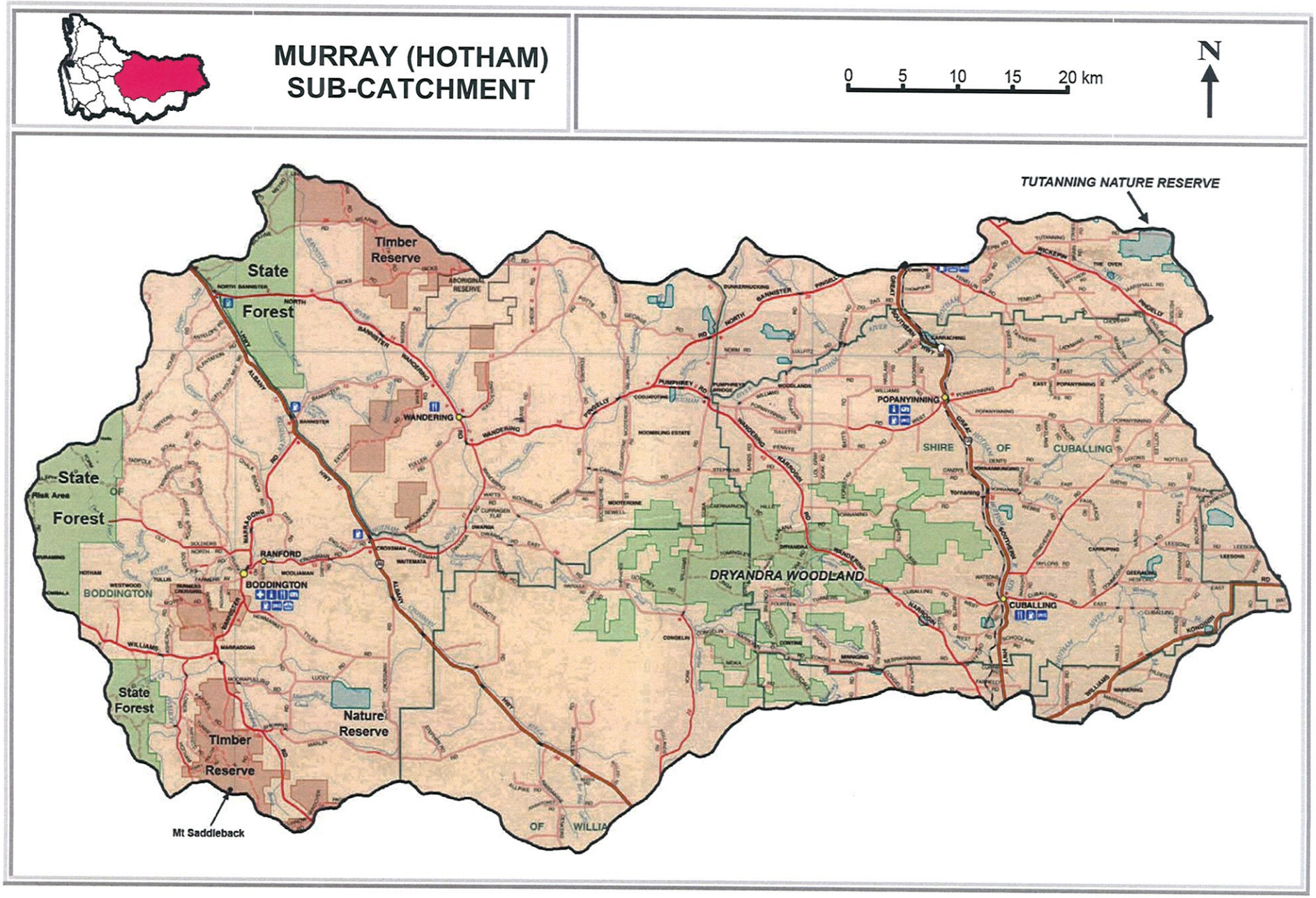
- Dryandra State Forest and part of Tutanning Nature Reserve (with potential linkages to other reserves such as Yornaning).
- Priority and Rare Flora, plus Priority and Threatened Fauna, particularly around Mt. Saddleback and Dryandra State Forest.
- Threatened ecological community (perched wetlands) towards Lake Toolibin (beyond catchment).
- Inland portions are part of the central eastern wheatbelt national 'biodiversity hotspot'.
- Gold resources north west of Boddington
- Bauxite and timber resources within timber reserves and some private land south west of Boddington
- General productivity of most of the soil landscape for grazing and cropping
- Developing horticultural (agricultural priority management) areas near Boddington and Wandering.
- Portions of Hotham River (west of Great Southern Highway and downstream from Boddington) are regionally important waterways
- Community groups including LCDCs (Cuballing, Pingelly, East Yornaning and Wickepin) as well as Wandering Productivity Group, Boddington Farm and Landcare Group and Williams Landcare Inc, and associated support bodies.

ISSUES

- Inland portions largely cleared with resulting loss of biodiversity.
- Climate change and resulting lower rainfall
- Availability, quality, and ability to store water for agriculture
- Widespread susceptibility of soils to salinity and acidification, and also to water erosion.
- Many upper tributary streams are in a degraded, weed dominated state.
- Gradual adaptation to changes required for agricultural best management.
- Restriction of agricultural development prospects in strategic mineral (bauxite) resource areas.
- Declining community NRM capacity.

PRIORITY PROJECT NEEDS

- Better water management systems to address dryland salinity and sustainable agriculture.
- Development of viable land use options for saline areas.
- Development of viable agricultural land use options responding to climate change.
- Expansion of Rivercare program.
- Peel-Harvey Green Corridors (linkages between biodiversity assets).
- Protecting priority remnant vegetation in the Avon Wheatbelt Bioregion (inland catchment).
- Assisting adoption of agricultural best management practices.


MURRAY (HOTHAM)
SUB-CATCHMENT
0 5 10 15 20 km
N
TUTANNING NATURE RESERVE
State Forest
Timber Reserve
ABORIGINAL RESERVE
WANDERING
POPANYINNING
SHIRE OF CUBALLING
State Forest
Risk Area
DRYANDRA WOODLAND
RANFORD
BODDINGTON
CUBALLING
State Forest
Nature Reserve
Timber Reserve
Mt Saddleback
OF WILLIA

MURRAY (WILLIAMS) SUB-CATCHMENT

KEY ASSETS

- General productivity of much of the soil landscape for grazing and cropping
- Inland portions are part of the central eastern wheatbelt national 'biodiversity hotspot'.
- Priority and Rare Flora, plus Priority and Threatened Fauna, around Mt. Saddleback.
- Community groups including Williams Landcare Inc and Narrogin LCDC and associated support bodies.

ISSUES

- Widespread susceptibility of soils to salinity, waterlogging and acidification.
- Inland portions substantially cleared with resulting loss of biodiversity.
- Climate change and resulting lower rainfall.
- Agricultural intensification and changes to farming systems.
- Gradual adaptation to changes required for agricultural best management.
- Widespread susceptibility of soils to water erosion within the Western Darling Range Zone.
- Many upper tributary streams are in a degraded, weed dominated state.
- Feral animals and noxious and invasive weeds.
- Declining community capacity to address NRM.

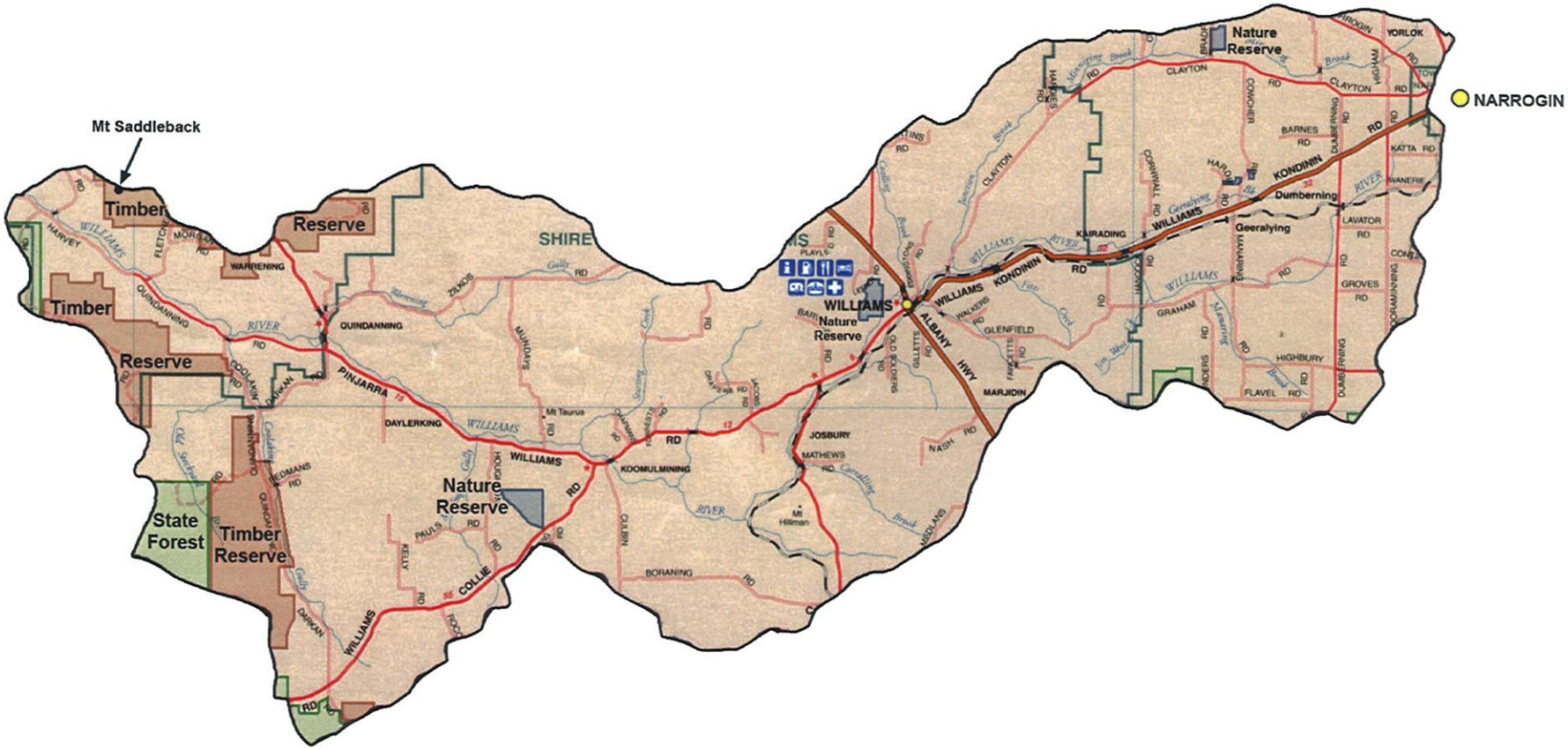
PRIORITY PROJECT NEEDS

- Better water management systems to address dryland salinity and sustainable agriculture.
- Development of viable land use options for saline areas.
- Development of viable agricultural land use options responding to climate change.
- Protecting priority remnant vegetation in the Avon Wheatbelt Bioregion (inland catchment).
- Assisting adoption of agricultural best management practices.

MURRAY (WILLIAMS) SUB-CATCHMENT

0 5 10 km

N



MURRAY (CENTRAL) SUB-CATCHMENT

KEY ASSETS

- Murray River system is a regional significant waterway devoid of dams for public water supply.
- Lane Pool Reserve (55,000 ha)
- Recreation and biodiversity values associated with relatively high quality sections of the Murray River.
- Bauxite and timber resources within State Forest
- Scattered priority fauna

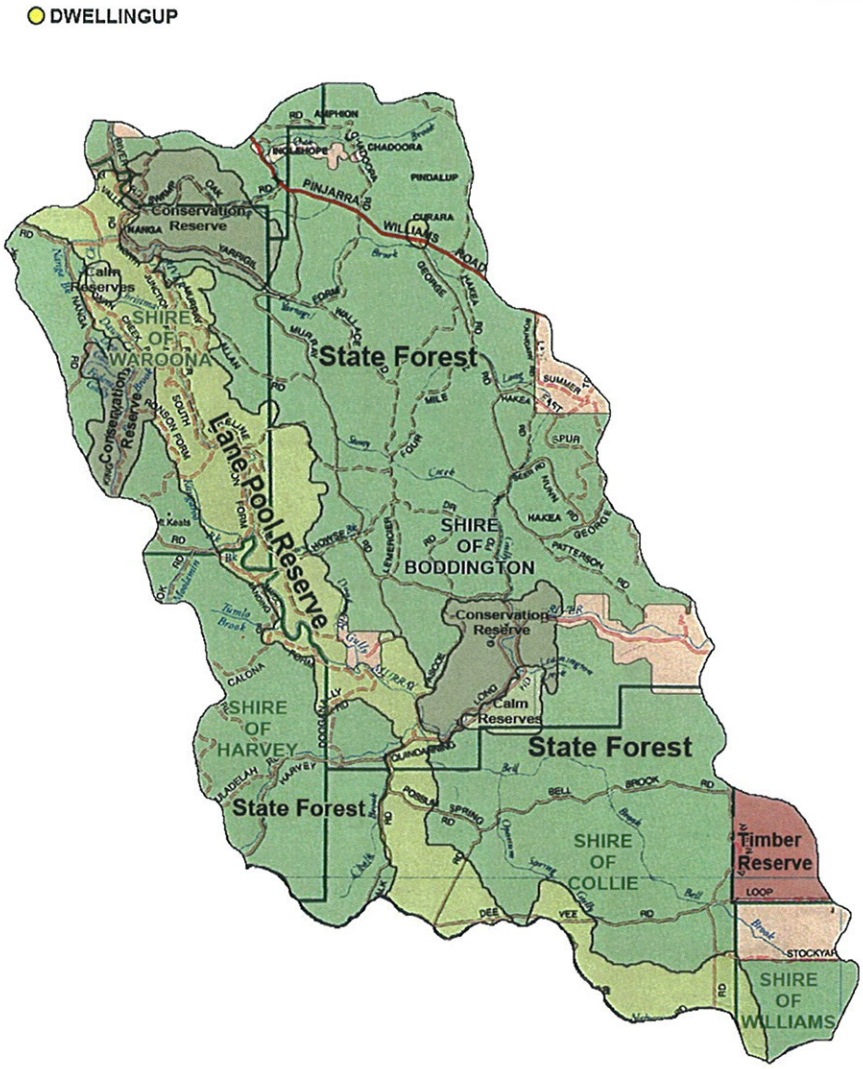
ISSUES

- Sustainability of forest management and mining practices.
- Dieback

PRIORITY PROJECT NEEDS

- Extension of Peel-Harvey biodiversity project to better quantify assets
- Development of viable land use options for salt affected portions of farming land.

MURRAY (CENTRAL) SUB-CATCHMENT



MURRAY (LOWER) SUB-CATCHMENT

KEY ASSETS

- Bauxite and timber resources near Dwellingup
- Agricultural productivity of Pinjarra soil landscapes zone (including foothills and alluvial terrace soils).
- Lower Murray is a waterway of regional significance
- Scattered occurrence of priority flora and fauna, and threatened ecological communities.
- Community groups such as the Dandalup Murray LCDC and associated support bodies.

ISSUES

- Continuing eutrophic condition in lower reaches of the river.
- Potential exposure of acid sulfate soils associated with dredging for canal developments within areas of Vasse estuarine or lacustrine deposits near Yunderup.
- Rapid transport of nutrients within artificial drainage network on coastal plain.
- Flood susceptibility of lower Murray

PRIORITY PROJECT NEEDS

- Drainage Reform on coastal plain (changes to management and widespread modifications to drains to achieve water quality benefits).
- Reinvigoration of programs for use of soil amendments / conditioners
- Expansion of Infill Sewerage programs for urbanised areas
- Expansion of Rivercare program
- Extension of Peel-Harvey Biodiversity Project
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Acid Sulfate Soils research
- Study of recreational uses of the lower river.
- Survey of nutrient impacts of peri-urban development
- Implementing existing foreshore management plans
- Assisting adoption of agricultural best management practices
- Awareness raising and training for sustainable land management with small rural landholders.
- Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).

MURRAY (LOWER) SUB-CATCHMENT

MURRAY (UPPER DANDALUP) SUB-CATCHMENT

KEY ASSETS

- Bauxite and timber resources with State Forest
- Productive orchard areas near Dwellingup
- Fresh quality water resources (South Dandalup dam) used for public water supply.

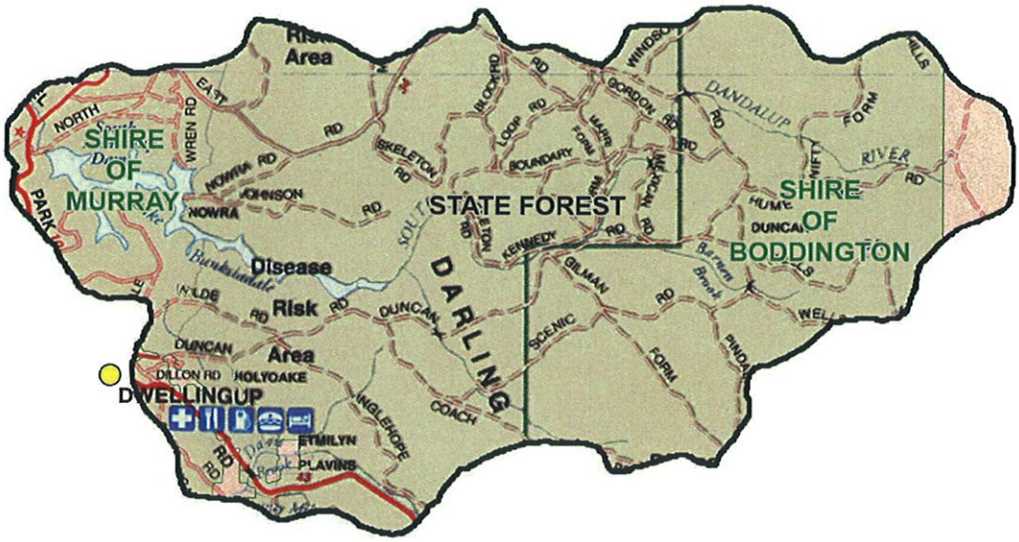
ISSUES

- Sustainability of forest management and mining practices.
- Dieback

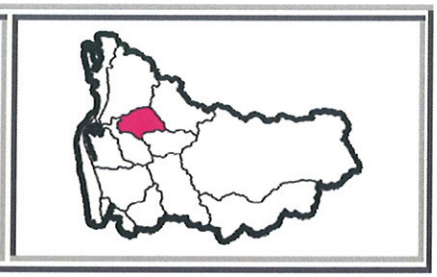
PRIORITY PROJECT NEEDS

- Extension of Peel-Harvey biodiversity project to better quantify assets

MURRAY (UPPER DANDALUP) SUB-CATCHMENT



MURRAY (LOWER DANDALUP) SUB-CATCHMENT



KEY ASSETS

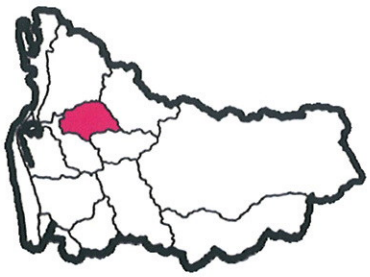
- Bauxite and timber resources within the Darling Plateau
- Agricultural productivity of Pinjarra soil landscape zone (including foothills).
- Fresh quality water resources (North Dandalup Dam) used for public water supplies.
- Karnup-Dandalup Water Reserve
- Scattered priority flora and fauna species.
- Community groups such as the Dandalup Murray LCDC and associated support bodies.

ISSUES

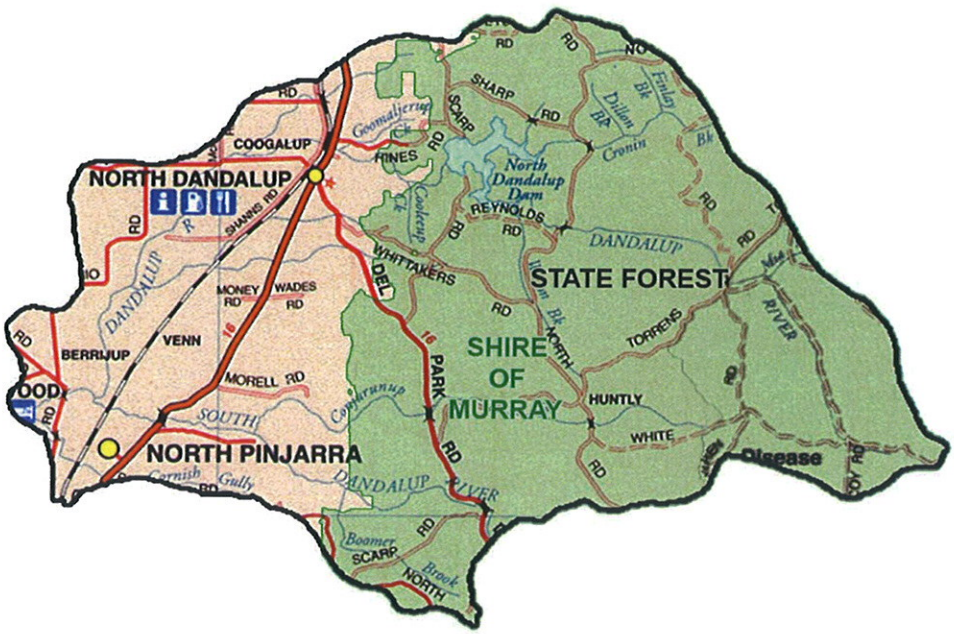
- Rapid transport of nutrients within artificial drainage network on coastal plain.
- Adequacy of river flows to sustain riverine ecology.
- High risk of nutrient loss associated with horticulture on areas of Bassendean sands

PRIORITY PROJECT NEEDS

- Drainage Reform on coastal plain (changes to management and widespread modifications to drains to achieve water quality benefits)
- Reinvigoration of programs for use of soil amendments / conditioners
- Expansion of Rivercare program
- Extension of Peel-Harvey Biodiversity Project to better quantify assets.
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Assisting adoption of agricultural best management practices
- Implementing existing foreshore management plans
- Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).



MURRAY (LOWER DANDALUP) SUB-CATCHMENT



0 5 10km

N

HARVEY (UPPER) SUB-CATCHMENT

KEY ASSETS

- Bauxite and timber resources within State Forest
- Fresh quality surface water resources (Harvey and Stirling Dams) used for public water supply and irrigated agriculture.
- Community and industry partnership efforts associated with Harvey River Restoration Trust and associated support bodies.

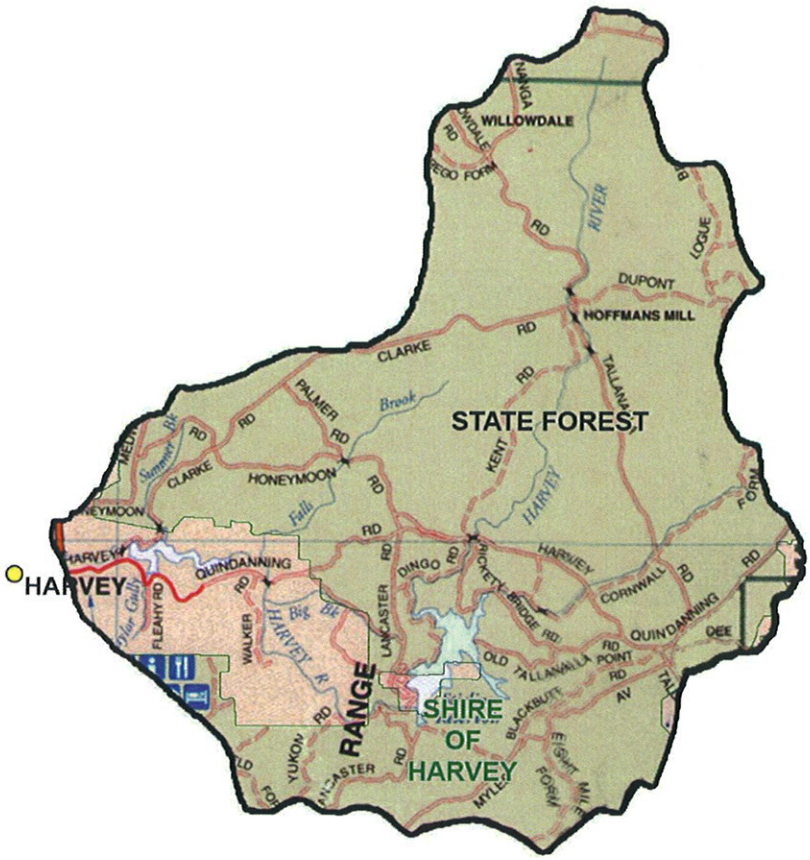
ISSUES

- Sustainability of forest management and mining practices.
- Dieback

PRIORITY PROJECT NEEDS

- Expansion of Rivercare program.
- Extension of Peel-Harvey Biodiversity Project to better quantify assets.
- Maintaining stream flow within first order streams.

HARVEY (UPPER) SUB-CATCHMENT



0 5 10km

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HARVEY (LOWER) SUB-CATCHMENT

KEY ASSETS

- South-West Irrigation Area infrastructure.
- Agricultural productivity of the Pinjarra soil landscape zone for grazing and horticulture, particularly within Harvey foothills and alluvial fans.
- Heavy mineral sand resources near Waroona
- Fresh quality water resources (within Darling Plateau portion) used for irrigated agriculture and recreational activities.
- Wetlands of regional significance including Hamden and Riverdale wetlands and the Harvey Flats nature reserve.
- Bauxite and timber resources with State Forest on Darling Plateau.
- Scattered occurrence of priority flora and fauna, and threatened ecological communities.
- Community groups including Harvey River LCDC and partnership agreements such as Harvey River Restoration Trust and associated support bodies.

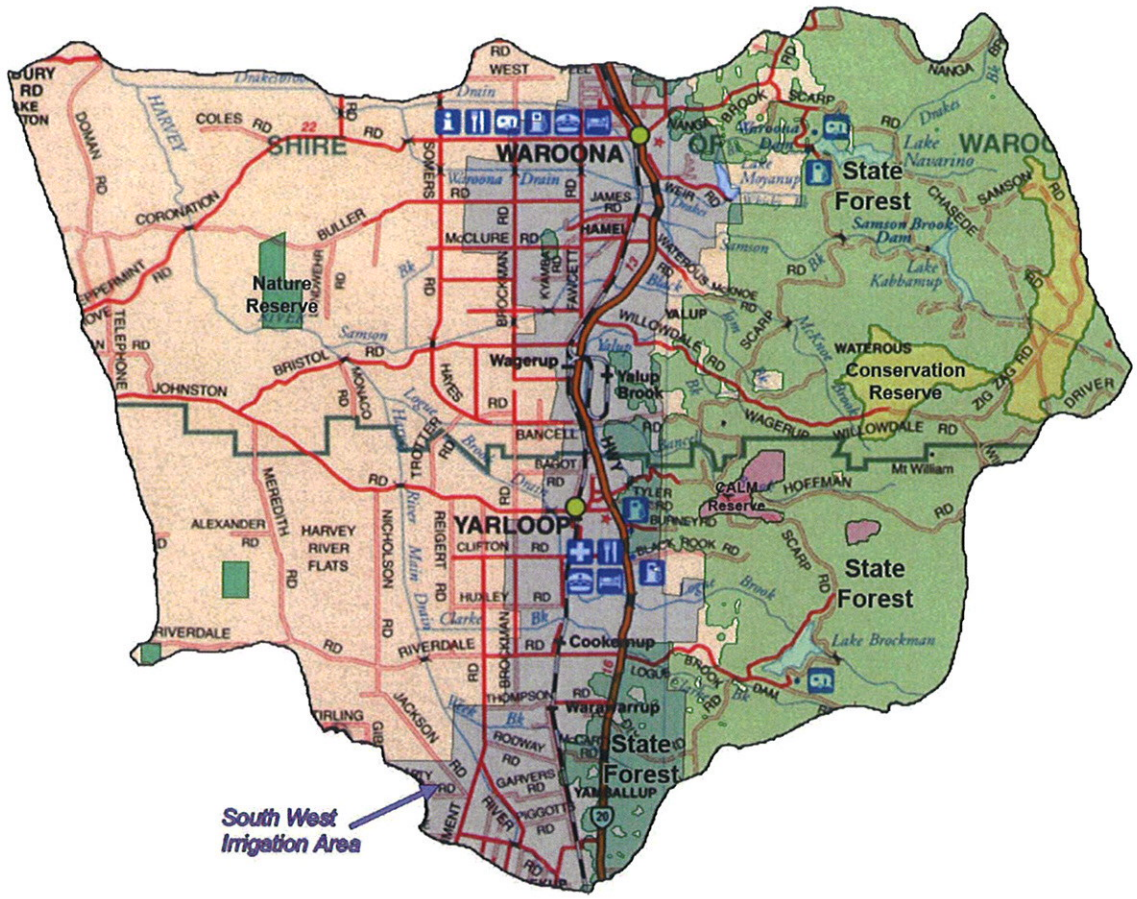
ISSUES

- Adequacy of river flows to sustain riverine ecology
- Rapid transport of nutrients within artificial drainage network
- Loss and degradation of Swan Coastal Plain wetlands.
- Rapid rate of nutrient loss associated with horticulture on areas of Bassendean soils

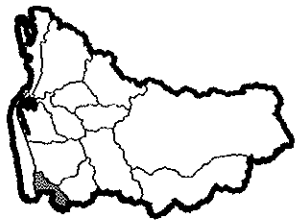
PRIORITY PROJECT NEEDS

- Expansion of Rivercare program
- Drainage Reform on coastal plain (changes to management and widespread modifications to drains to achieve water quality benefits).
- Reinvigoration of programs for use of soil amendments / conditioners
- Extension of Peel-Harvey Biodiversity Project
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Assisting adoption of agricultural best management practices
- Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).

HARVEY (LOWER) SUB-CATCHMENT



HARVEY (DIVERSION) SUB-CATCHMENT



KEY ASSETS

- General productivity of areas of Pinjarra soil landscape zone for grazing
- South-West Irrigation Area infrastructure.
- Scattered priority flora and fauna species
- Community groups including Harvey River LCDC and partnership agreements such as Harvey River Restoration Trust and associated support bodies.

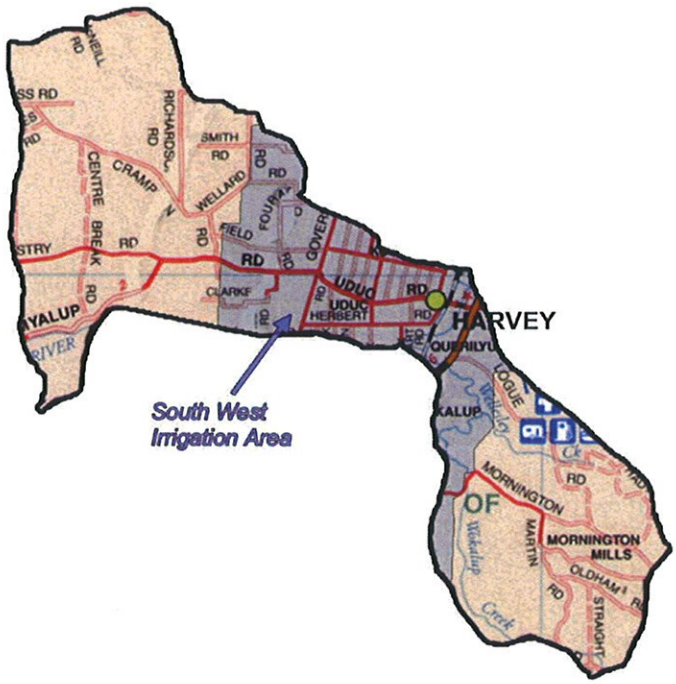
ISSUES

- Rapid transport of nutrients within artificial drainage network
- Much of natural drainage flow, of what was Harvey River, is now diverted to ocean at Myalup via diversion drain.
- High risk of nutrient loss associated with horticulture on areas of Bassendean sands
- Loss and degradation of Swan Coastal Plain wetlands

PRIORITY PROJECT NEEDS

- Expansion of Rivercare program
- Drainage Reform (changes to management and widespread modifications to drains to achieve water quality benefits)
- Reinvigoration of programs for use of soil amendments / conditioners
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Assisting adoption of agricultural best management practices
- Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).

HARVEY (DIVERSION) SUB-CATCHMENT



0 5 10km

N

HARVEY (ESTUARY DRAINS) SUB-CATCHMENT

KEY ASSETS

- Adjacent Peel-Harvey estuary is part of the internationally significant Ramsar listed Peel-Yalgorup system.
- Other wetlands of national (Lake McLarty) or regional (Lake Mealup) significance.
- Extensive nature reserves with salt-marsh fringing the estuary provide bird feeding or nesting grounds.
- General productivity of Pinjarra soil landscape zone for grazing
- Peel Regional Park (developing)
- Scattered threatened ecological communities, priority flora and fauna.
- Goodale Private Reserve
- Community groups including Coolup LCDC and associated support bodies.

ISSUES

- Continuing algal blooms particularly in lower part of Harvey Estuary.
- Rapid transport of nutrients within artificial drainage network.
- Eastern site of estuary is relatively little developed but likely to be subject to pressure following the construction of Peel Diversion (highway).
- Potential for exposure of acid sulfate soils within areas of Vasse estuarine or lacustrine deposits, and subsequent effect on water quality and aquatic biodiversity.
- Loss and degradation of Swan Coastal Plain wetlands

PRIORITY PROJECT NEEDS

- Environmental planning for protection of natural resource assets on the eastern side of Peel-Harvey Estuary.
- Drainage Reform (changes to management and widespread modifications to drains to achieve water quality benefits)
- Development of a management plan for the RAMSAR listed Peel-Yalgorup Wetland System.
- Reinvigoration of programs for use of soil amendments / conditioners
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Acid Sulfate Soils research
- Survey of recreational uses of the estuary
- Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).
- Assisting adoption of agricultural best management practices
- Implementing existing foreshore management plans

HARVEY (ESTUARY DRAINS) SUB-CATCHMENT

COASTAL (NORTH) SUB-CATCHMENT

KEY ASSETS

- Thomson's Lake and the Becher Point wetlands are internationally significant Ramsar wetlands
- 'Stromatolite-like' microbialite communities within Lake Richmond (a threatened ecological community
- A number of other wetlands of regional significance contained within Rockingham Lakes Regional Park.
- Port Kennedy Scientific Park
- Shoalwater Islands Marine Park
- Various 'Bush Forever' Sites
- Protected in-shore waters of Warnbro and Cockburn Sound – recreation, commercial fishing and shipping opportunities
- Scattered occurrence of priority flora and fauna and threatened ecological communities.
- Community groups including those involved with coast care and associated support bodies.

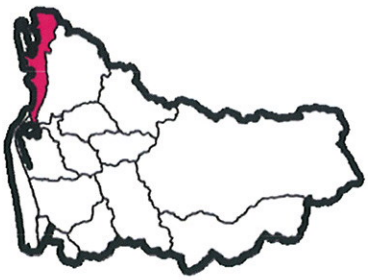
ISSUES

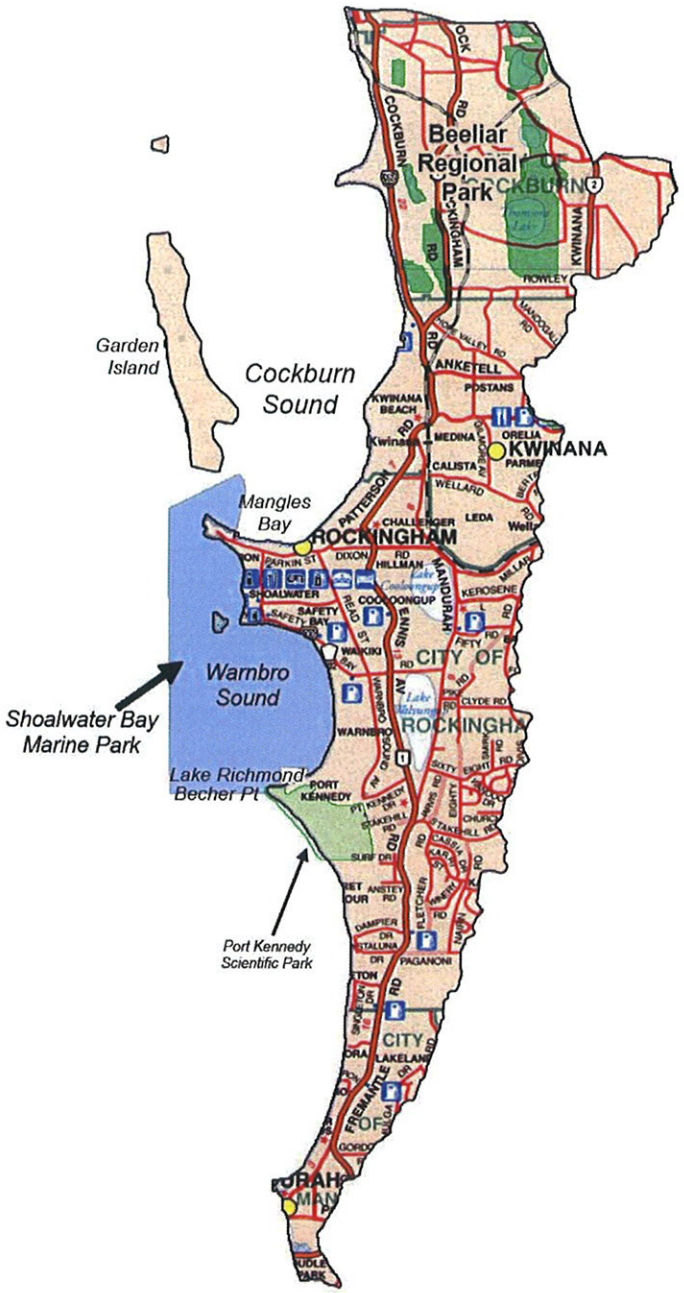
- Extent of urbanisation and industrial development and the effects on natural resources, particularly groundwater and remnant vegetation.
- Potential exposure of acid sulfate soils and resultant effects on water quality and aquatic biodiversity associated with dredging of Vasse estuarine system deposits for canal developments near Mandurah.
- Effects of nutrients and other pollutants on water quality and biodiversity within Cockburn and Warnbro Sounds (including stormwater and aquaculture sources).
- Ability of Sepia Depression within Cockburn Sound to continue to accept wastewater outfall from Woodman Point, and nutrient outflow from the Mandurah channel without detriment to marine ecology.
- Seagrass impacts associated with potential marine development in the Mangles Bay area (City of Rockingham)
- Protection of remaining wetlands from effects of groundwater abstraction and fertiliser use on nearby areas of irrigated horticulture
- Protection of remaining portions of agricultural priority management areas (horticulture)
- Effects of Mandurah channel on marine and coastal environments

PRIORITY PROJECT NEEDS

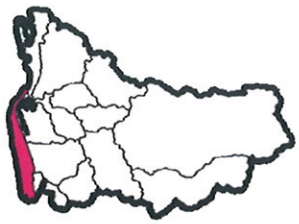
- Implementation of Cockburn Sound EMP
- Ramsar wetland management plans
- Expansion of Infill Sewerage program
- Peel-Harvey Green Corridors (linkages between biodiversity assets)
- Implementation of Coastal Management Plans
- Acid Sulfate Soils research
- Survey of recreational uses of the estuary and nutrient impacts of peri-urban development

COASTAL (NORTH) SUB-CATCHMENT





COASTAL (SOUTH) SUB-CATCHMENT



KEY ASSETS

- Peel-Yalgorup system is an internationally significant Ramsar listed wetland
- A number of other lakes and wetlands of regional significance
- Yalgorup National Park (12,888 ha)
- Tuarts (only eucalypt endemic to coastal plain)
- 'Stromatolite like' microbialites within Lake Clifton – a threatened ecological community
- Scattered occurrence of other threatened ecological communities including Pamelup Pond – microbial mat communities
- Considerable priority flora and fauna species
- Dawesville Channel – increased flushing of estuary
- Lime sand resources on Old Coast Road
- Existing productive horticultural (agricultural priority management) areas near Old Coast Road from Myalup to the northern part of Lake Clifton
- Recreational fishing from beaches
- Community groups including those involved with coast care and associated support bodies.

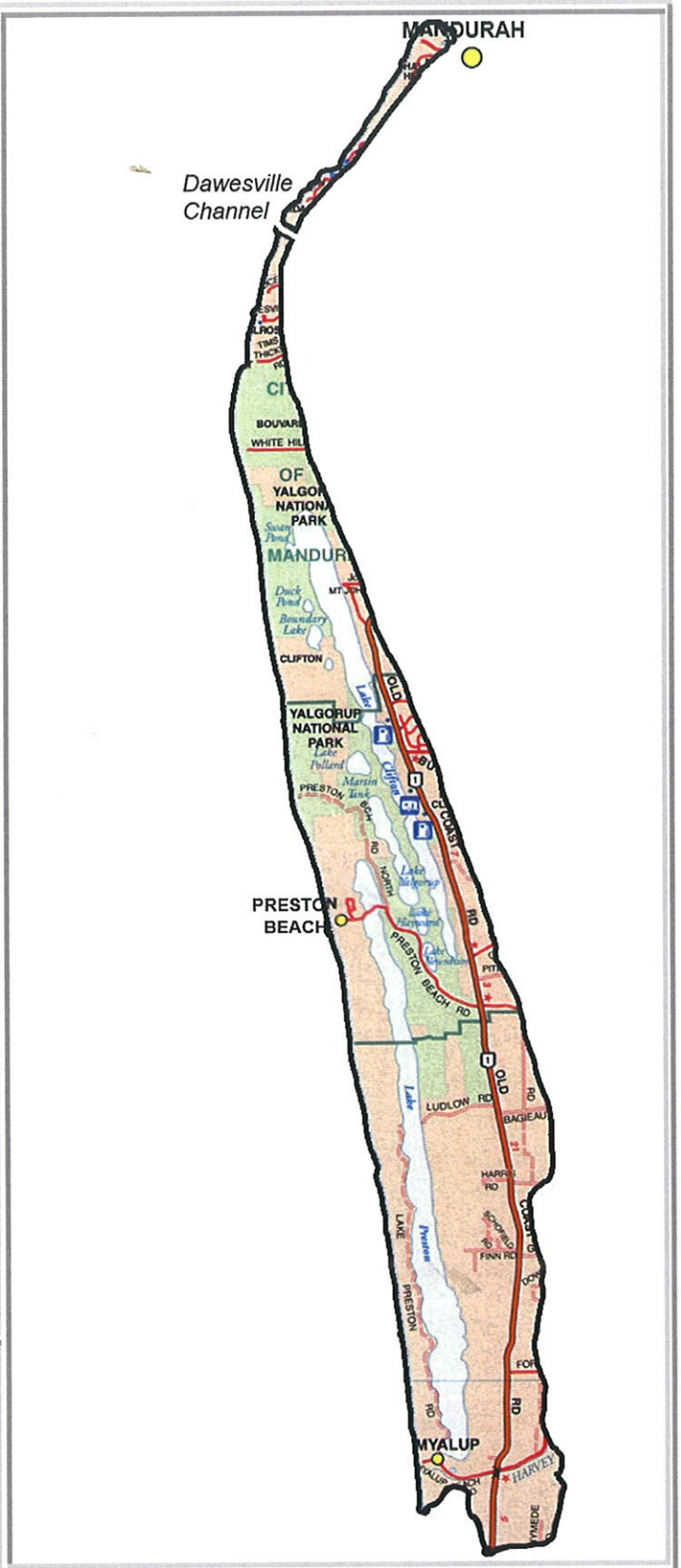
ISSUES

- Spread of urban development south of Mandurah and its affect on natural resources, particularly degradation of remnant vegetation and coastal dunes.
- Tuart decline, particularly along Old Coast Road.
- Protection of coastal lakes (Preston and Clifton) from the effects of groundwater abstraction and fertilizer use within nearby irrigated horticulture or residential development.
- Potential exposure of acid sulfate soils and resultant effects on water quality and aquatic biodiversity associated with dredging of Vasse estuarine system deposits for canal developments near Mandurah
- Effects of northerly flowing nutrient outflows from Dawesville channel on coastal and marine assets.

PRIORITY PROJECT NEEDS

- Development of a management plan for the RAMSAR listed Peel-Yalgorup Wetland System.
- Expansion of Infill Sewerage programs
- Extension of Peel-Harvey Biodiversity Project including implementation of Tuart Conservation Strategy.
- Development/Implementation of Coastal Management Plans
- Acid Sulfate Soils research
- Survey of nutrient impacts of peri-urban development
- Peel-Harvey Green Corridors (linkages between biodiversity assets)

COASTAL (SOUTH) SUB-CATCHMENT



APPENDIX B.

LOCAL COMMUNITY GROUPS ADDRESSING NRM ISSUES

APPENDIX B. LOCAL COMMUNITY GROUPS ADDRESSING NRM ISSUES

Bandicoot Brook LCG[1]
Barragup Swamp Management Committee
Beenyup Brook Reserve Residents Group[4]
Bob's Plain LCG (Landcare Group)[1]
Boddington Farm and LCG
Boddington Friends of Reserves
Boddington River Action Group
Boolgana Brook LCG[1]
Boomer Lakes LCG[1]
Boomerang Creek LCG
Bouvard Coastcare Group
Burrumbuttock West LCG
Byford Progress Association[4]
Calcoran Brook Catchment Group
Cardup Brook Group[4]
Coalling LCG
CoastSwap (formerly South West and Peel Coastal Management Group Inc.)
Comet Central Coastcare Group
Comet North Coastcare Group
Commodine Creek Catchment Group
Coolup LCDC
Corio LCG[3]
Cuballing LCG
Dandalup-Murray LCDC
Darling Downs Management Committee
Darling Downs Organic Weeders Group[4]
Dirk Brook Group[4]
Dirk Brook Group[4]
Drakesbrook Flats LCG[2]
Dumberning LCG
Falcon Coastcare Group
Falcon to Halls Head Protection Society
Farmers Carbon International
Fourteen Mile Brook Catchment Group
Friends of Peters Way Reserve
Friends of the Rivers (FOR PEEL)
Friends of Waroona Waterways
Geogrup Lakes and Serpentine Society
Green Stream Team[1]
Halls Head Coastcare Group
Harts Road West LCG[1]
Harvey River LCDC
Harvey River Restoration Trust
Hotham Catchment Management Committee
Jarrahdale Community Association[4]
Jarrahdale Heritage Society[4]
Junior community conservation groups
Kangaroo Creek LCG[1]
Keysbrook Environmental Group[4]
Korribinjal Brook Group[4]
Lake Clifton LCG
Lake Mealup Preservation Society
Little Harvey River LCG[2]
Logue Brook LCG[2]
Lower Hotham Catchment Group
Lowlands Conservation Association
Lowlands Road Group[4]
Mandurah Bird Watchers Club
Mandurah Coastcare Co-ordinating Committee
Mandurah Wildflower Group
Marjidan LCG
Mayfield Flats LCG[1]
Mealup LCG[1]
Medulla Creek Dwellers[4]
Men of the Trees (Peel Branch)
Meredith/Uduc LCG[2]
Minnigin Brook LCG
Murray River LCG[1]
Murray River Working Group
Myalup Community Association Inc
North Dandalup LCG[3]
Oakford Catchment Group
Oakley Brook LCG[1]
Peel LCG
Peel Preservation Group
Peel Region Fish Stocking and Management Association
Permaculture Group
Preston Beach Coast Care Committee
Quindanning LCG
Riverside Residents Community Group
Roadside Care Volunteers Committee
Rockingham Naragebup Regional Environment Centre
Rockingham/Kwinana Small Property Advisory Group
Seascapes Coastcare Group
Serpentine Bushland Group[4]
Serpentine Community Association[4]
Serpentine Golf Club[4]
Serpentine River Group[4]
Serpentine Sports Reserve[4]
Serpentine-Jarrahdale LCDC
South Coolup Main Drain LCG[1]
South Dandalup LCG[3]
South Pumphreys Catchment Group
Starting Creek LCG
Storey Road LCG[1]
Tuart Response Group
Upper Crossman LCG
Upper Hotham Catchment Group
Wandering Farm Productivity Group
Wandi LCG
Warrening LCG
Whitby Corridor Group
Wilgie Creek Restoration Group
Williams Landcare Inc
Winjan Aboriginal Corporation
Yangedi LCG
Yornaning Dam and Catchment Group

Superscript Notations
Group operates within part of:
1 = Coolup Land Conservation District
2 = Harvey River Land Conservation District
3 = Dandalup-Murray Land Conservation District
4 = Serpentine-Jarrahdale Land Conservation District

LCG = Land Care Group
LCDC = Land Conservation District Committee

APPENDIX C.

THREATS TO NRM ASSETS IN THE PEEL-HARVEY CATCHMENT

(Results of a PHCC Workshop held July 2003)

APPENDIX C. THREATS TO NRM ASSETS IN THE PEEL-HARVEY CATCHMENT (Results of a PHCC Workshop)

Asset Class	'High' Level Threats	'Moderate - High' Level Threats	'Moderate' Level Threats or 'Not Ranked'
LAND	**- Land Resources**		
	- Nutrient loss and eutrophication - Dryland salinity - Soil acidity - Water erosion - Failure to adopt or adhere to agricultural 'best management practices'	- Irrigation salinity - Soil fertility and structure decline - Wind erosion - Waterlogging	- Non wetting (water repellancy)
	- Use of Land for Agriculture		
	- Failure to adopt or adhere to agricultural 'best management practices' - Loss or export of agricultural chemicals and fertiliser nutrients (under dryland or irrigated agriculture) - Community Perceptions (that farming is an unviable landuse option and 'responsible' for many environmental problems)	- Loss of priority / prime rural land to urban and semi rural subdivisions - Loss of other productive rural land to same - Degradation of land or declining soil health. - Declining water quality for stock or irrigation - Land-use conflicts - Weed incursions - Introduced animal diseases - Climate change (lower rainfall - reducing ability to maintain viable farm water supplies)	- Inadequate support for diversification (technical and community support structures) - Inappropriate waste disposal and land contamination - Feral animals - Declining community input (absentee landowners / weekend farmers)
	- Rural Infrastructure		
		- Rising saline water tables	
	- Use of Land for Forestry		
			- Harvesting at unsustainable levels - Jarrah dieback - Inappropriate fire regimes

APPENDIX C. THREATS TO NRM ASSETS IN THE PEEL-HARVEY CATCHMENT (CONTINUED)

Asset Class	'High' Level Threats	'Moderate - High' Level Threats	'Moderate' Level Threats or 'Not Ranked'
WATER	**- Rivers and Streams**		
	- Nutrient enrichment from agricultural fertilisers (irrigated and dryland farming) - Nutrient enrichment from un-sewered areas (semi-urban) - Other pollution from urban/industrial areas - Inadequate or inappropriate management of drainage (agricultural, urban and peri urban) - Sedimentation - due to changed hydrological regimes - Riparian zone degradation (especially loss of vegetation and weed invasion) - Inefficient water use in irrigation areas - Unsustainable surface water extraction (including public supply).	- Salinity - due to changed hydrological regimes - Flow restriction and erosion (caused by dams, weirs, culverts, bridges and bridge abutments)	- Other pollution (agricultural chemicals) - Other pollution (waste disposal sites) - River training - altered hydrological regime. - Physical development on floodplains. - Introduced aquatic species. - Recreational uses (fishing, boating). - Exposure of acid sulphate soils. (*Note - potentially a major issue- but not currently ranked as such due to lack of knowledge of extent and severity.*)
	- Wetlands and the Estuary		
	- Nutrient enrichment (multiple sources) - Clearing of fringing buffer vegetation. - Livestock grazing fringing vegetation - Feral animals and weeds - Unsympathetic culture – lack of appreciation of wetland values - Aesthetic urban development pressures - to convert seasonal wetlands to lakes - Canal dewatering - Sedimentation	- Changing hydrology - Physical fragmentation or modifications to foreshores and fringing vegetation	- Use of wetlands for horticulture - Infilling of wetlands - Siltation and sedimentation - Frequent burning - Inappropriate disposal of saline drainage (particularly wheatbelt) - Recreational use pressures - Exposure of acid sulphate soils - Pollution (other than nutrients) - Excess extraction of groundwater

APPENDIX C. THREATS TO NRM ASSETS IN THE PEEL-HARVEY CATCHMENT (CONTINUED)

Asset Class	'High' Level Threats	'Moderate - High' Level Threats	'Moderate' Level Threats or 'Not Ranked'
WATER	**- Surface Water Infrastructure**		
		- Inefficient use of water - all users.	- Climate change (lower rainfall) - reducing ability to maintain viable water supplies for public drinking water and irrigation uses.
	- Groundwater		
	- Pollution caused by contaminants and nutrients from un-sewered areas - Waste disposal sites - poorly managed / inappropriately located	- Unsustainable groundwater extraction	- Pollution caused by loss of chemicals and nutrients from dryland farming or irrigated areas
BIODIVERSITY	**- Terrestrial Ecosystems / Communities and Species**		
	- Habitat loss / fragmentation through clearing of land for settlement - Habitat degradation (eg fires, grazing, trampling) - Hydrological changes - inappropriate drainage management resulting in salinity and waterlogging - Hydrological changes - to surface water quality and quantity - Riparian zone degradation - Nutrient enrichment of waterbodies - Introduced plants (weeds) - Inappropriate stock management - An unsympathetic culture (to water conservation values) - Lack of appropriate planning mechanisms / reporting procedures - Diseases affecting terrestrial or freshwater aquatic species	- Inappropriate drainage to wetlands - Introduced (feral) animals - Climate change (reduced rainfall and drought cycles) - Inappropriate fire regimes	- Habitat loss / fragmentation through; clearing of land for agriculture - Habitat loss / fragmentation through; pollution - Introduced plant or animal diseases - Harvesting bush - Inappropriate recreational uses of land or water assets - Aquatic pest or weed incursions - Firewood harvesting - Translocation of aquatic species

APPENDIX C. THREATS TO NRM ASSETS IN THE PEEL-HARVEY CATCHMENT (CONTINUED)

Asset Class	'High' Level Threats	'Moderate - High' Level Threats	'Moderate' Level Threats or 'Not Ranked'
BIODIVERSITY - Marine Ecosystems / Communities and Species			
	- Commercial or recreational fishing at unsustainable levels - Loss of habitat due to pollution and / or physical changes (eg dredging)	- Pollution from coastal land development	- Marine pest incursions - Pollution from point sources (eg oil spills) - Inadequate management of resources - Diseases affecting marine species
COASTAL			
	- Inherent fragility and dynamic nature of coastal dune systems - Disturbance to coastal processes and ecosystems through engineering structures	- Recreational use (particularly uncontrolled vehicular access) - Exposure to high energy wind and wave regimes - Fishing at unsustainable levels) - Habitat loss and fragmentation	- Exposure of acid sulphate soils following estuarine dredging - Loss of habitat due to pollution and / or physical changes - Installation of Dawesville Cut changing - Peel-Harvey Estuarine Ecosystem - Demand for land for caravan parks
MARINE			
	- Fishing at unsustainable levels (commercial and recreational) - Loss of habitat due to pollution and / or physical changes - Eutrophication - Ecosystem fragmentation - Alterations to hydrological regimes (additional outflow of sediment nutrients from Estuary via Dawesville Channel)	- Storm water runoff (from urban areas)	- Introduced marine pests (eg from discharge of ship ballast) - Pollution from point sources (eg oil spills) - Coastal development

APPENDIX D.

LIST OF STRATEGIC PLANNING STUDIES RELATING TO NRM WITHIN PEEL-HARVEY CATCHMENT

APPENDIX D. LIST OF STRATEGIC PLANNING STUDIES RELATING TO NRM WITHIN PEEL-HARVEY CATCHMENT

Strategic NRM Planning

Peel-Harvey Catchment Council (2003) - Draft Action Plan for Natural Resource Management 2002 - 2007

Peel-Harvey Catchment Council (2003) – Previous Strategic Planning Summary (2003) – unpublished report prepared by Land Assessment Pty Ltd as input to the development of the South West Regional Strategy for NRM

Peel Region Scheme and associated strategies and technical documents (WAPC 2000 and 1999, DPUD 1994)

Local Government Studies – various Planning or Local Rural Strategies, and State of Environment Reports

Cockburn Sound Management Council (2002) - Interim Environmental Management Plan for Cockburn Sound and its Catchment

Greening the Catchment Taskforce Inc (1994) Peel Regional Environment Plan

Peel Development Commission (2002) Peel Sustainable Development Strategy 2020

Peel Sustain (2002) Strategic Plan for the Future of Agriculture in the Peel Region of Western Australia

Water and Rivers Commission (2003) Peel Waterways - Economic Development and Recreation Management Plan

Peel Inlet Management Authority (1992) Peel Inlet Management Programme

Serpentine-Jarrahdale Land Conservation District Committee (1999 and in progress) Draft Serpentine-Jarrahdale Community Catchment Plan. March 1999 and current update

Harvey River LCDC (1999) Management Plan

Coolup LCDC (1999) Catchment Action Plan

Mandurah Coastal Strategy (1996)

Dandalup - Murray LCDC (2000) Dandalup - Murray Land Conservation District Committee Strategy

Harvey River Restoration Trust (2003) Strategic Directions Plan

Harvey River LCDC (1999) Harvey River LCDC Management Plan

Williams Landcare Inc (2003) Draft Five Year Plan

Narrogin LCDC (2003) Narrogin Strategic Five Year Plan

APPENDIX D. LIST OF STRATEGIC PLANNING STUDIES RELATING TO NRM WITHIN PEEL-HARVEY CATCHMENT (continued)

Land Use Planning

State Government

WAPC (2002) Peel Region Scheme

WAPC - Metropolitan Region Scheme

WAPC (2002) Greater Bunbury Region Scheme

WAPC (2000) Fremantle Rockingham Industrial Area Regional Strategy

WAPC (1999) Coastal and Lakelands Planning Strategy (Dawesville - Binninup)

WAPC (1994) Peel Regional Strategy

MfP (1995) Bunbury Wellington Region Plan

WAPC (1997) Inner Peel Region Structure Plan (Mandurah-Pinjarra - Point Grey)

WAPC (in progress) Peel Regional Park Management Plan

WAPC (in progress) Pinjarra-Brunswick Sustainability Study

Local Government Authorities (various years and subject to update)

Town Planning Schemes

Local Planning (or Local Rural) Strategies

Cockburn Sound Management Council *et al.* (2004) Local Planning Policy for the Cockburn Sound Catchment - CSMC, DoE, City of Cockburn, Town of Kwinana and City of Rockingham

City of Rockingham (2000) State of the Environment Report and Environmental Action Plan 2001-2002

City of Mandurah (1994) State of Environment Report

City of Mandurah Draft Coastal Management Strategy

Various LGAs – Numerous Coastal and other site-specific management plans

APPENDIX E.

KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
CONSERVATION AND SUSTAINABLE USE OF LAND RESOURCES				
1. Dryland Salinity	Hotham - Williams Greening Challenge	Landcare Centres	Completed 2003	Hotham, Williams
	Perennial pasture trials and demonstrations	DoA	Ongoing	Williams; Lower Dandalup; Estuary drains; Harvey (lower).
	Rapid Catchment Appraisal	DoA	Completed	Hotham (upper)
	Rural Towns Program	DoA	Ongoing	Murray (Hotham) - Boddington and Wandering townsites.
	Productive Use and Rehabilitation of Saline Land (PURSL) program	DoA	Completed	Hotham; Williams
	Sustainable Grazing (trials) on Saline Land (SGSL)	DoA	Ongoing	Hotham; Williams, Wandering
	Saline tolerant agroforestry trials (part of CALM's Search Project)	CALM	Ongoing	Harvey (lower), Hotham, Williams
	Mapping of soil salinity of coastal plain irrigation lands	DoA; Harvey Water	Completed	Swan Coastal Plain (Harvey lower and Harvey Diversion)
	Better Water Management Project	Soil and Land Conservation Council	Completed	Hotham; Williams

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
CONSERVATION AND SUSTAINABLE USE OF LAND RESOURCES				
2. Loss of Productive Capacity of Land Resource	Soil amendments - trials and applications - 'Alkaloam' (modified bauxite residue); 'ironman gypsum'; flyash. Also composting healthy soils	Alcoa et al.	Bauxite residue temp ceased; press disinformation. Others ongoing.	Swan Coastal Plain
a) Soil Condition / Soil Health	Development and testing of a range of low-phosphorus or slow-release fertilisers	Various industries	Cancelled - press disinformation.	Swan Coastal Plain
	Farm compost demonstrations - broadacre and vineyards	Various	Ongoing	Hotham, Serpentine (lower), Harvey (lower), Murray (Upper Dandalup).
	'Time to Lime' project	DoA	Ongoing	Whole of catchment
b) Adoption of Best Management Practices	Promotion of higher yielding production packages (eg. Prograze and Topcrop)	DoA	Ongoing?	Hotham; Williams
	Identification, evaluation and implementation of agricultural best management practices (CCI project)	DoA	Current	Swan Coastal Plain
	Targeted assistance to intensive agricultural activities (rural point source of pollution) (CCI project)	DoA	Current	Swan Coastal Plain
	Dairy Catch WA (dairy Best Management Practices)	DoA	Current	Swan Coastal Plain
	Wellard Rural Exports - nutrient management (addressing rural point source pollution)	SJ Landcare Centre	Current	Serpentine (lower)
	Small Block Manual - Land management on small rural blocks in the Shire of Serpentine-Jarrahdale	LGA	Completed	Serpentine (lower)
	Alcoa farmlands sustainable grazing demonstration	Alcoa Pinjarra Farmlands	Completed	Murray (lower)
	Rehabilitation compliance for Cable Sands at Yarloop	Landcare Centre	Ongoing	Harvey (lower)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
CONSERVATION AND SUSTAINABLE USE OF LAND RESOURCES				
c) Assessment, Planning and Diversification	Peel Agmaps - packaging land resource and management information on CDs	DoA	Current	Swan Coastal Plain and Darling Plateau (parts)
	Small Landholders Advisory Service	DoA	Current	Swan Coastal Plain
	Catchman - GIS property planning	Landcare Centres	Ongoing	Swan Coastal Plain (mainly)
	Strategic Plan for the Future of Agriculture in the Peel Region of Western Australia.	Peel Sustain	Completed 2002	Swan Coastal Plain
	Rural land use assessment	DoA	?	?
	High rainfall land use planning project	DoA	?	?
	Farm forestry trials and Infinitree program	FPC	Ongoing?	Whole of catchment?
	Search Project - identifying new tree species for farm forestry	CALM	Ongoing	Whole Catchment
	Oil Mallee Project	CALM	Ongoing	Hotham, Williams
	Fodder Shrubs Project	Dandalup Murray LCDC	Current	Murray (Lower Dandalup)
	Peel Olives Feasibility Study	Peel Olive Association Inc	Completed 1999	Swan Coastal Plain
	Heavenly Hectares / Sustainable Land Management Workshops and Courses for Small Landholders	Landcare Centres	Ongoing	Whole of Catchment
	Small Block Manual - Land management on small rural blocks in the Shire of Serpentine-Jarrahdale	LGA	Completed	Serpentine (lower)
	Alcoa farmlands sustainable grazing demonstration	Alcoa Pinjarra Farmlands	Completed	Murray (lower)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
CONSERVATION AND SUSTAINABLE USE OF WATER RESOURCES				
3. Water Quality Decline *a) Waterways*	**Coastal Catchment Initiative Projects**			
	Water Quality Improvement Plan	EPA	Current.- complete by 2005.	Swan Coastal Plain (apart from coastal dunes)
	Identification, evaluation and implementation of agricultural best management practices	DoA	Current.- complete by 2004	As above
	Targeted assistance to intensive agricultural activities (rural point source of pollution)	DoA	Current.- complete by 2004	As above
	Review of environmental protection regulations to protect the Peel-Harvey System	DoE	Current -complete by 2005	As above
	Evaluation of a statutory Decision-Support System for water quality improvement and protection	DoE	Current - complete by 2004.	Whole of catchment
	Stock exclusion from waterways	DoE	Current; complete by 2005; ongoing funded needed.	Swan Coastal Plain (apart from coastal dunes)
	Water quality monitoring program and infrastructure	DoE	Current; complete by 2005; then maintenance.	As above
	Water Sensitive Urban Design	PDC	Current; complete by 2005	As above
	Rivercare Action - for example; Coolup - Mayfield drains - streamlining Upper Harvey demonstration site Restoring the Lower Harvey River Buller Reserve Link	HRRT	Current; needs to continue.	Harvey (upper and lower)
	Peel Centre for Water Excellence (Establishment of) - including existing website	PDC, PHCC	Ongoing lobbying	Whole of Catchment

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
CONSERVATION AND SUSTAINABLE USE OF WATER RESOURCES				
3. Water Quality Decline (continued) *a) Waterways*	ICLEI Water Campaign - Catchment Module and Best Management Practices	PHCC	Current	Whole of catchment
	Drainage Reform White Paper - PHCC Case Study	Drainage Reform Group (multi-agency)	Completed but with ongoing lobbying	Swan Coastal Plain (apart from coastal dunes)
	Environmental Water Provisions (EWPs) on Harvey River, Samson Brook and Drakes Brook	WC	Ongoing	Harvey (lower)
	Dirk Brook Project – demonstration of drainage best management practices	SJ LCDC	Completed - ongoing demonstration	Serpentine (lower)
	Wilgie Creek Restoration	Wilgie Creek Restoration Group	Ongoing	Murray (lower)
	Furnisdale Stormwater drain project	Murray River Working Group	Proposed	Serpentine (lower)
	Streamlining projects for example; Project Black Swan - Wellard Rural Exports Peel Main Drain Mayfield Links	Landcare Centres	Ongoing	Swan Coastal Plain
	Reach Scale River Action Plan for the Murray River	DoE	Completed	Murray (lower)
	Ravenswood Sanctuary/ Murray Lakes Resort - Riparian Vegetation (Rivercare Action)	Landcare centres	Ongoing	Murray (lower)
	Upper Murray River Protection Project (Rivercare Action)	Landcare centres	Ongoing	Murray (Hotham) Murray (Williams)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF WATER RESOURCES			
3. Water Quality Decline (continued) *a) Waterways*	Pool Ripple Sequence Design and Construction, Revegetation and Fencing. (implementing Best Management Practice outcomes from the Dirk Brook project)	Landcare centres	Ongoing	Murray (lower), Serpentine (lower)
	Lower Harvey River Riparian Restoration (downstream from Bristol Rd) (sub-unit of Peel Regional Park Plan and a HRRT strategy).	Landcare centres	Ongoing	Harvey (lower); Estuary (drains)
	Culeenup Murray River Foreshore	FoR Peel	Ongoing	Murray (lower)
	Water sensitive urban design - demonstrations including retro fitting storm water drains at Byford and Mandurah (Riverside gardens reserve)	LGAs	Ongoing	Serpentine (lower); Murray (lower)
	Best Management Practices for operation and maintenance of rural drains (Drainage reform)	DoE; WC	Ongoing	Swan Coastal Plain (apart from coastal dunes)
	Acid Sulphate Soils Workshops	DoE	Ongoing	As above
	Ribbons of Blue	DoE	Ongoing	As above
	Marrinup Brook restoration (Rivercare Action Activity)	DoE	Ongoing ?	Murray (lower)
	Best Management Practices to reduce nutrient loss from Agriculture (Issue 2b: Adoption of Best Management Practices	DoA	Ongoing	Swan Coastal Plain (mainly)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF WATER RESOURCES			
3.Water Quality Decline (continued) ***3b) Wetlands - Restoration / Protection***	'Wetland watch' - brokering incentive packages for biodiversity conservation and awareness.	Worldwide Fund for Nature	?	Swan Coastal Plain
	Local initiatives to restore and protect wetland habitat on rural properties, for example; Project Black Swan Magenup Lake Public Open Space Bollard Bulrush Swamp	Landcare Centres	Ongoing	Serpentine (lower)
	Lake McLarty Management Plan	CALM	Ongoing	Estuary (drains)
	Lake McLarty fencing and revegetation project	PPG	Completed, but ongoing water monitoring and weed control	Estuary (drains)
	Lake Meelup Management Plan	Lake Meelup Preservation Group	Ongoing	Estuary (drains)
	Corio Wetland - water level monitoring	Corio LCG	Ongoing monitoring required	Murray (lower)
	The Spectacles Management Plan (part of Jandakot Regional Park)	Alcoa	Ongoing	Serpentine (lower)
	Draft Rockingham Lakes Regional Plan	CALM	Ongoing	Coastal Dunes (north)
	Proposed Port Kennedy and Rockingham Parks Management Framework	City of Rockingham	Out for public comment 1997	As above
	Draft management proposals for wetlands in various Local Authorities	Murdoch University	Completed 1992	Serpentine; Murray; Mandurah LGAs
	Wetland creation: Wellard Wetland and Mudijong Rd Wetland	Alcoa	Ongoing	Serpentine

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF WATER RESOURCES			
4. Disruption to Hydrology of Natural Water Systems ***a) For Agriculture***	Land and water management plan for the Irrigation areas	Harvey Water	?	Harvey (lower); Harvey Diversion
	Drought Strategy (Water demand management strategy for Serpentine River)	Serpentine River Group; Landcare Centre	Ongoing	Serpentine (lower)
b) for Public Water Supply	ICLEI Water Campaign – Corporate and community modules	PHCC; LGAs	Current, continuing co-ordination of implementation required.	Whole of catchment
	Management Plan for Karnup - Dandalup Underground Water Pollution Control Area (UWPCA) and Water Resource	DoE	to be prepared	Serpentine (lower) Murray (lower Dandalup)
	Environmental Water Provisions (EWPs) for Harvey, Samson, Drakesbrook and Serpentine Dams	WC	?	Harvey (upper and lower) Serpentine (upper and lower)
	CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY RESOURCES			
5. Terrestrial Biodiversity - Habitat Degradation and Species Loss	Peel-Harvey Biodiversity Project	PHCC	Current	Whole of catchment
	Perth Biodiversity Project – Biodiversity and Planning Guidelines	WALGA	Completed 2004	Perth Metro Region - LGAs
	Perth 'Bush Forever' Program	WAPC	Completed 2000 - ongoing implementation	Metropolitan Region LGAs
a) Focusing on vegetation (including riparian)	South West 'Bush Forever' Program	WAPC	Proposed	Swan Coastal Plain (south of Metro region)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY RESOURCES				
5. Terrestrial Biodiversity - Habitat Degradation and Species Loss *a) Focusing on vegetation (including riparian)*	A Strategic Plan for Perth's Greenways	MfP	Completed 1998	Metropolitan Region LGAs
	Tuart Conservation and Management Strategy; and Atlas (2003; 2004)	Tuart Response Group	Completed 2003; 2004 ongoing implementation	Coastal (south mainly)
	Peel-Harvey Landcare Landscapes (revegetation demonstration sites and publication)	PHCC	Completed 2002 and Ongoing	Swan Coastal Plain (apart from coastal dunes)
	Bush Protection Fencing	LCDCs	Ongoing	Whole of Catchment
	Peel-Harvey Landcare Landscapes	PHCC	Completed	Swan Coastal Plain (mainly)
	Shire of Serpentine-Jarrahdale Vegetation Strategy	Shire of SJ	Completed?	Serpentine (lower)
	Serpentine-Jarrahdale Conservation Zoning	Shire of SJ	Implemented?	As above
	Serpentine-Jarrahdale Parkcare Plan	Shire of SJ	Draft 2002	Serpentine (lower)
	Flora surveys or management plans for reserves and roadsides (eg Mundijong Road and Duck Pond Reserve)	LGAs	Ongoing	Swan Coastal Plain (mainly)
	Lake Clifton public open space - Tuart revegetation	Lancare Centre	Ongoing	Coastal (south)
	City of Rockingham Local Bushland Strategy	City of Rockingham	Completed	Coastal Dunes (north); Serpentine (lower)
	City of Rockingham Greening Plan	City of Rockingham	Completed	Coastal Dunes (north); Serpentine (lower)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY RESOURCES			
5. Terrestrial Biodiversity - Habitat Degradation and Species Loss (continued) ***a) Focusing on vegetation (including riparian)***	City of Rockingham Local Biodiversity Strategy	City of Rockingham	Completed 2001	Coastal Dunes (north); Serpentine (lower)
	City of Mandurah Bushland Protection Strategy	City of Mandurah	Completed 2003 Implementation ongoing	Coastal Dunes (north and south)
	Town of Kwinana Local Biodiversity Plan	Town of Kwinana	Yet to start	Coastal Dunes (north); Serpentine (lower)
	Survey of Bushland on Local Government Reserves Town of Kwinana	Town of Kwinana	Ongoing	Coastal Dunes (north); Serpentine (lower)
	Ravenswood Sanctuary/ Murray Lakes Resort - Riparian Vegetation (Rivercare Action)	PHCC	Ongoing	Murray (lower)
	Buller Link Project (and other Rivercare Action projects)	HRRT	Requires implementation	Harvey (lower)
	Remnant vegetation protection or revegetation projects on farms	LCDCs	Ongoing	Whole of catchment
	Corridor planning	PDC	?	Swan Coastal Plain (mainly)

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY RESOURCES			
5. Terrestrial Biodiversity - Habitat Degradation and Species Loss (continued)	Upper Murray Rivercare project	PHCC	Ongoing	Murray (Hotham and Williams)
	Boddington Fishway	BRAG	Ongoing monitoring of performance required.	Hotham
b) Focusing on Aquatic Biodiversity	Rivercare Action Projects - restoring ecological values Bancell Links Project	HRRT	Ongoing	Harvey (lower); Estuary (drains); Murray (Hotham)
	Upper Murray Rivercare project			
	Upper Harvey River demonstration site Restoring the Lower Harvey River Buller Reserve Link Project			
	South Dandalup Woody Debris Demonstration Project	DoE	Ongoing	Murray (Lower Dandalup)
	Baldivis wetlands (Rivers, wetlands and habitats Community Funding program)	Alcoa	Discontinued	Serpentine (lower)
	Frogwatch (and provision of 'frog-friendly garden' information)	Landcare Centres	Ongoing	Swan Coastal Plain (mainly)
c) Focusing on Pest plants and Animals	Western Shield and community fox or rabbit baiting programs	CALM	Ongoing	Whole of catchment?
	Serpentine-Jarrahdale pest plant and animal service	SJ Landcare Centre	Ongoing	Serpentine-Jarrahdale
	Roadside Conservation Surveys (including weed mapping and trial of control measures)	LGAs	Ongoing?	Swan Coastal Plain (mainly)
	Feral pig control program	CALM	Ongoing	Darling Range/Plateau
	Serpentine-Jarrahdale Integrated Weed Strategy	Shire of SJ	Completed?	As above

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF COASTAL RESOURCES			
6. Coastal Processes - Disturbance	Integrated Coastal Management Strategy for the City of Cockburn	City of Cockburn	Completed 1999	Coastal Dunes (north)
	Jervoise Bay (City of Cockburn) Conservation and Recreation Plan	Dept of Commerce and Trade	Completed 2001	As above
	City of Cockburn Coastal Works Plan	City of Cockburn	Completed 2001	As above
	Coogee Beach Power Road Structure Plan	City of Cockburn	?	As above
	Town of Kwinana Coastal Management Plan	Town of Kwinana	Completed 2002	As above
	Proposed Port Kennedy and Rockingham Parks Management Framework	City Rockingham	For public comment 1997	As above
	Rockingham Foreshore Strategy	City Rockingham	In progress?	As above
	Warnbro Dunes Foreshore Management Plan	City Rockingham	Completed 1990	As above
	St Clair Foreshore Management Plan	City Rockingham	Completed 1995	As above
	Secret Harbour Foreshore Management Plan	City Rockingham	Completed 1995	As above
	Bayshore Gardens Foreshore Management Plan	City Rockingham	Completed 1995	As above
	Cape Peron Study (City of Rockingham) - Site Management Plan	State Planning Commission	Completed 1992	As above

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF COASTAL RESOURCES			
6. Coastal Processes - Disturbance (continued)	Mandurah Coastal Strategy (1996; 2004)	City of Mandurah	Completed 1996; updated 2004	Coastal Dunes (north and south)
	Tims Thicket Reserve Management Plan	City of Mandurah	Completed 2000	Coastal Dunes (south)
	Seascapes Foreshore Management Plan	City of Mandurah	Completed?	As above
	Falcon Bushland Foreshore Management Plan	City of Mandurah	Completed 1999	As above
	Northport Foreshore Management Plan	City of Mandurah	Completed 1999	As above
	Southport Foreshore Management Plan	City of Mandurah	Completed 2002	As above
	Dawesville Channel-Estuary Foreshore and Channel Berm Management Plan	City of Mandurah	?	As above
	Madora Foreshore Management Plan	City of Mandurah	Completed 2000	As above
	Melrose Foreshore Reserve Rehabilitation Plan	City of Mandurah	Completed 1998	As above
	Florida Foreshore Management Plan	City of Mandurah	Completed 1999	As above
	Shire of Waroona Coastal Management Plan	Shire of Waroona	Completed 2002	As above
	Waroona Foreshore Management Plan	Shire; Prog Assoc	Completed 2002	As above
	Preston Beach Coastal Plan	Shire of Waroona	Completed 1989	As above

APPENDIX E KEY NRM PROJECTS AND ACTIVITIES RELATING TO THREATS

Major Issue or Threat	*Project or Activity*	*Primary Contact for Information*	*Status*	*Sub-catchment or Area*
	CONSERVATION AND SUSTAINABLE USE OF COASTAL RESOURCES			
6. Coastal Processes - Disturbance (continued)	Myalup Dune Rehabilitation Plan	Shire of Harvey	Completed 1992	As above
	Land Resources and their Management – Lake Preston Coastal Area	Lake Preston LCDC	Completed 1993	As above
	CONSERVATION AND SUSTAINABLE USE OF MARINE RESOURCES			
7. Marine Biodiversity - Degradation and Species Loss	Marine Habitat and Enhancement (Mandurah Canals) Project	Peel Region Fish Stocking and Management Association	Completed	Estuary
	Mandurah Canals Reef Balls project	Peel Region Fish Stocking and Management Association	Current	Estuary
	South Metropolitan Coastal Waters Study (1991 - 1994)	EPA	Completed	Offshore
	Establishment of Shoalwater Islands Marine Park	CALM	Completed when?	Offshore
	CONSERVATION AND SUSTAINABLE USE OF AIR AND CLIMATE RESOURCES			
8. Climate Change	No specific local projects apart from submission to Draft WA Greenhouse Strategy (2003).	PHCC	Ongoing	Whole of Catchment

APPENDIX F

Peel-Harvey Catchment

Summary of Results of Community Workshops

prepared by

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October 2003

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
WATER Waterways - water quality	Reduction in soil loss from areas susceptible to erosion (eg Darling Scarp) and subsequent improvement in quality of stream water runoff.	Increase coverage of deep-rooted vegetation Increased adoption of keylining (to prevent runoff into streams) and property planning.	SJ
	Greater incorporation of detention and treatment facilities for urban drainage.		SJ - High
	Put in place appropriate controls and management systems addressing runoff water quality for all new, and then progressively all existing, intensive agricultural land uses.	Progressively implement the results of relevant components of the Coastal Catchments Initiative CCI program Ensure adoption by Local Government Authorities of complimentary planning and regulatory mechanisms.	SJ - High SJ - Very High
	Increased adoption and understanding of the benefits and costs of water quality best management practices	Continued development and promotion of demonstration sites (such as Dirk Brook). Provision of incentives for involvement of all within a catchment/ subcatchment area. Promote and support the fact that water quality depends on soil / land use sustainability first.	SJ WL WL - High

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS* - continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
WATER Waterways - water quality (continued)	Reduce the potential for stream-bank erosion	Adopt and police permanent speed limits on power boats.	WA
		Control grazing animal access and use education of such as a management tool	WA
		Protect and enhance creekline (riparian) vegetation.	WA
	Improved management of drainage network	Increase legislative support for drainage management.	WA
	Reduce potential for build up of stream salinity	Enable release of saline water drainage into watercourses at appropriate times	WL - Very High
	Increased recognition that control of water (surface and groundwater) is the key to many land degradation issues.		WL
Water Resource Allocation	Increased adoption and understanding of the concept of environmental water requirements	Develop a policy for each waterway with respect to environmental water requirements.	SJ
		Instigate independent monitoring and assessment of the environmental requirements.	WA

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
WATER Water Resource Allocation (continued)	Ensure realistic environmental flows are established and maintained.	Water allocation process to take into account the long-term needs and access requirements of sustainable agricultural activities. Environmental flows to take into account scientific data AND community expectations. Establish realistic time frames for the collection of data so that seasonal variations in supply and use of water are accounted for.	WA - Very high WA - High WA - High
	Sustainable water allocation within the catchment and with long-term access to local users.	Promote the increase use of water within the catchment. Change allocation practices away from the current 'first come first served' and 'use it or lose it' procedures.	WA WA
Wetlands	Restore and create wetlands.		SJ
	Strengthen protection for remaining wetlands.	Strengthen and gazette the environmental policy on wetlands of the Swan Coastal Plain Ensure adequate buffer zones (eg 100 m) around wetlands.	WA - High WA
Recreational Use	Ensure continued access to Water Resource Protection Areas for public use		WA

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
BIODIVERSITY	Protection and enhancement of remnant vegetation.	Ensure Local Government conservation policies are adequately resourced. Develop management plans for Shire reserves	SJ SJ
		Develop processes whereby the whole community (through State or Commonwealth funding bodies) pay the rates on fenced remnant vegetation area OR fenced remnant vegetation is not rateable.	WL - Very high
	Seek multiple benefits from revegetation of land.	Enable some productive use of land re-established to native vegetation (eg grazing of understorey where salinity control rather than enhancement of biodiversity was the rationale for planting). Clarify goals for revegetation activities - biodiversity or sustainable agriculture?	CU WL
	Link significant areas of remnants.	Create vegetation corridors which link east-west, ie the way water runs through much of the landscape. Use planning processes and mechanisms relating to subdivisions and development to create links and buffers to remnant vegetation.	SJ, WL SJ
	Eradication and control of weeds and diseases	Continue using education and awareness as a major tool, including the threat of dieback to revegetation and biodiversity objectives.	SJ

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
BIODIVERSITY (continued)	Maintain local ecosystems and natural integrity of the vegetation when the land is developed.	Retain significant tracts of land to protect and encourage continued biodiversity.	WA - Very high
		Controlled access of people and vehicles to sensitive areas	WA
	Control development and minimise the impact on bush from urban clearing.	Develop and implement regulations to prevent total clearing in urban development areas.	WA - Very high
		Ensure higher density housing to be compensated by larger public open space.	WA
		Require EPA assessment of flora and fauna prior to development.	WA - Very high
		Address inequities in land clearing rules between urban and rural areas	WL
LAND Sustainable Use of Land for Agriculture	Use land within its capacity / capability.	Increase emphasis on research and development of farming systems based on greater use of perennial pastures, oil mallees, no-tillage and alternative commercial crops.	CU, WL
		Increase emphasis on research and development of EMS quality assurance systems for sustainable agriculture.	CU
		Develop funding support for commercial revegetation of degraded areas	WA

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
LAND Sustainable Use of Land for Agriculture (continued)	Use land within its capacity / capability. (continued)	Provide clarification to landholders on rural clearing and drainage moratorium (Coastal plain).	WA
		Develop processes whereby when land is up for sale consideration be given to purchase (for public benefit) of portions where agricultural use would be non-sustainable.	WL
		Provide more flexibility with regard to vegetation clearing on farms and consideration of 'compensation'.	WA
		Greater adaptation of 'best management practices' for agriculture.	WA
		Greater focus on intensive land use / agricultural systems based on ESD principles.	WA
		Integrate landcare into farming systems	WL - Very high
		Integrate commercial 'bush food' crops into farming systems.	WL
		Increase research into carbon fixation related to systems of agricultural land use	CU
		Identify point sources of land pollution and implement prompt action to reverse.	WL

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
LAND Salinity / Soil Condition	Reduce areas affected by soil salinisation and other forms of land degradation.	Increase use and careful management of water within farming systems through water harvesting, perennials and aquaculture.	WL - Very high
		Increase emphasis on implementation of earthworks and engineering solutions to address salinity and water management.	WL - Very high
		Increase emphasis on research and development of amelioration techniques for soil acidification, waterlogging and salinity	CU
		Increase emphasis on research and development of higher water-using crops that provide a commercial return to farmers.	WL
		Increase emphasis on research and development of profitable land-use alternatives for salt affected areas.	WL
		Ensure clear consideration is given to private good verses public good when intervention is required. (for private commercial benefit landholder pays,: for public benefit, government pays).	WL
		Provide incentives for landholders to address salinity and land degradation issues where benefits will be largely off-site.	WA - High
		Highlight and promote success stories	WL

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
NO SEPARATE THEME AREA	Increased recognition within planning of 'right to farm'.		WA
Land Use Planning / Integration	Stronger planning strategies and policies.	Introduce a new land use zoning category ('bush' or similar) to protect the remnant bushland from development and rural activities	WA - Very high
		Increase opportunities for meaningful local community involvement in strategic planning.	WA - Very high
		Fix a limit on extent of urban development (Perth - Mandurah) Infill and up - but not out.	WA - Very high
		Ensure implementation of management plans imposed through planning processes, and funding to cover monitoring.	WA
		Greater consideration be given to land purchase options (by government on behalf of community) for planning decisions based on 'public benefit.	WL High
	Land use planning to meet sustainability principles (ESD).	Improve land zoning process to ensure that land is used in accordance with its capacity/capability.	WA - Very high
		Greater focus on intensive land use / agricultural systems based on ESD principles.	WA - Very high

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
NO SEPARATE THEME AREA Land Use Planning / Integration (continued)	Adequate planning to cater for off-road recreational activities	Designate and manage appropriate areas to cater for demand. Improve consistency of legislation and enforcement of controls between inland areas and coast.	WA WA
Monitoring / Evaluation	Incorporation of clear monitoring and evaluation mechanisms in all projects.	Ensure for each project a monitoring and evaluation person is allocated to collate, analyse and present information.. Ensure the public and funding bodies, are provided with 'fair dinkum' baseline monitoring data. Provide feedback to communities on scientific value and benefits of tree planting programs . Promote greater use of simple mechanisms, such as before / after photographs for monitoring and communicating success / failure of actions. Develop better evaluation criteria, not just bland statistics re flow on effects - addressing all three environmental, social and economic benefits.	SJ WA WL - High WL WL

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
SOCIAL AND COMMUNITY Communications	Improve communications relating to the planning and implementation of natural resource management NRM.	Ensure contact with 'real' (on the ground) people in relation to NRM planning	CU
		Develop consistent approaches and policies between State and Local Government generally, and between individual local government authorities.	WA
		Enable greater community input into projects (development and implementation - eg appropriate tree species).	WL
		Increase data sharing	WL
Support / Funding	Increase whole of community support, and funding, for NRM.	Increase focus on taxation reform and longer term funding mechanisms for sustainable farming	CU
		Ensure landcare and agricultural sustainability are included in education systems.	WL

TABLE A. SUMMARY OF RESULTS FROM PEEL-HARVEY WORKSHOPS*- continued

THEME (Issues / Topics)	TARGETS (Objectives)	ACTIONS REQUIRED (Specific Things That Should Be Done)	SOURCE AND PRIORITY **
COASTAL / MARINE	Adequate protection of coastal assets	Support establishment of marine parks and 'no go' fishing areas.	WA
		Protect dunes from 4WD and ATVs with adequate fines.	WA
	Adequate planning to cater for off-road recreational activities	Designate and manage appropriate areas to cater for demand from 4WD and all terrain vehicles (ATVs).	WA
		Improve consistency of legislation and enforcement of controls between inland areas and coast.	WA

Footnotes

*Wording of targets and actions has been pa raphrased from workshop notes and only priority issues addressed here as participants aware that results from local strategic planning documents would be included separately (Table B).

** All targets ./ actions are of at least moderate priority by virtue of their identification at workshops. A 'red dot' prioritisation process was used at some, but not all, workshops. Where a target or action received greater than 10% of dots allocated per theme, the priority was considered 'high', and for greater than 20% it was considered 'very high'. SJ = Serpentine Jarrahdale (Mundijong). WA = Waroona, WL = Williams, CU = Cuballing,

APPENDIX G.

CORRELATING PEEL-HARVEY ACTIONS WITH REGIONAL NRM TARGETS*

**Source: 'Management Action Targets' from the South West Regional Strategy for Natural Resource Management as submitted by SWWC for State and Commonwealth accreditation – February 1, 2005*

TABLE G1: PRIORITY PROJECT AREAS AND ASSOCIATED PEEL-HARVEY 'ACTIONS' AND SOUTH WEST REGIONAL 'TARGETS'

Priority Project (no inferred order of importance)	Peel-Harvey 'Actions' (refer to Main Report)	Regional (South West) 'Targets' (refer to Tables G2 – G15)
1. Better water management systems to address dryland salinity and sustainable agriculture.	1.1, 1.2, 1.3, 1.5, 3.9, 11.1, 11.13, 13.7	WT9, WT18, WT29, WT31, LT31, LT32, LT36, LT48
2. Widespread modifications to the coastal plain arterial drainage network (to achieve water quality benefits).	3. 1, 3.2, 3.3, 11.12	WT9, WT18
3. Development of a management plan for the RAMSAR listed Peel-Yalgorup Wetland System.	3.19, 3.21, 14.3	WT6, WT20, WT25, BT7
4. Use of soil amendments / conditioners to reduce nutrient loss.	2.3, 11.4, 13.8	LT36, LT43, LT87
5. Expansion of Infill Sewerage programs.	11.9	
6. Expansion of Peel-Harvey Rivercare Action programs to improve water quality and ecological function of waterways (including restoration training).	3.4, 3.5, 3.6, 3.15, 4.1, 5.7, 9.9	WT8, WT14, WT36, WT38
7. Implementation of major existing foreshore management plans for the protection and rehabilitation of Peel-Harvey waterways.	3.5, 5.2, 6.1, 10.3	WT6
8. Expansion of ICLEI Water Campaign with Local Government to address water consumption and quality issues.	3.12, 13.3	WT27, WT34, WT54, WT62, PT22
9. Extension of Peel-Harvey and Local Government Biodiversity Projects (including decision support systems training).	5.1, 5.2, 5.5, 8.2, 8.3, 9.9, 9.10, 10.14, 11.17, 14.4	BT6, BT11, BT20
10. Establishing ecological linkages in the landscape (Peel-Harvey Green Corridors).	5.2, 5.4, 3.15, 8.2, 9.9, 9.10, 10.14	BT6, BT20

TABLE G1: PRIORITY PROJECT AREAS AND ASSOCIATED PEEL-HARVEY 'ACTIONS' AND SOUTH WEST REGIONAL 'TARGETS' continued

Priority Project (no inferred order of importance)	Peel-Harvey 'Actions' (refer to Main Report)	Regional (South West) 'Targets' (refer to Tables G2 – G15)
11. Developing and implementing Coastal Management Plans.	6.1, 6.2, 6.4, 6.5, 7.1, 10.3, 11.13, 11.15, 12.12, 14.3	MT5, CT2, CT4, CT&7, CT9, CT10, CT11, CT12, CT19
12. Assisting the adoption of agricultural best management practices for nutrient and erosion control (including irrigation areas and animal industries).	2.1, 2.2, 2.3, 3.7, 3.10, 3.11, 4.1, 9.3, 10.15, 11.9, 13.3, 13.7, 13.8	WT59, LT21, LT43, LT44
13. Implementation of the Environmental Management Plan for Cockburn Sound.	4.2, 6.3, 7.1, 7.2, 10.10, 10.15, 12.6, 12.11	MT1, MT5, MT14, MT24, MT26
14. Protecting priority remnant vegetation in the Avon Wheatbelt Bioregion (inland catchment).	5.1, 8.2, 8.3, 8.4	BT6, LT52, LT53, LT54, LT62,
15. Aligning strategic planning for NRM with Local Government planning processes.	5.1, 5.3, 5.8, 6.2, 9.2, 9.4, 10.2, 10.7, 10.8, 10.9, 10.11, 10.12, 10.14, 10.15, 10.18, 15.1	WT7, LT9, LT11, LT14, LT17, LT55, LT85, PT5, PT17
16. Environmental planning for protection of natural resource assets on the eastern side of Peel-Harvey Estuary.	10.2, 10.18	BT2, BT10, BT9, BT16, LT6, PT17, PT18
17. Peel-Harvey Biosphere pre-feasibility study.	11.5, 12.3, 13.9	BT4, LT79, LT89
18. Developing viable farming and land use options for saline areas.	11.4	BT19, LT23, LT31, LT32, LT36, LT60
19. Developing agricultural land use options for adaptation to climate change.	2.5, 2.6, 8.1, 8.4, 8.5, 9.3,11.1, 13.9	WT72, WT75, BT19, LT13, LT22, LT23, LT24, LT27
20. Acid Sulfate Soils research (identification and remediation).	1.4, 3.14, 4.3, 4.7, 10.11, 11.8	WT42, LT6
21. Recreational use impact study of the Peel-Harvey estuary and waterways.	3.16, 3.17, 3.18, 11.15	MT6, CT4
22. Research of land use and climate change impacts on stream runoff within the foothills and Darling Scarp.	4.1, 4.6, 9.5, 10.16, 11.11	WT61

TABLE G1: PRIORITY PROJECT AREAS AND ASSOCIATED PEEL-HARVEY 'ACTIONS' AND SOUTH WEST REGIONAL 'TARGETS' continued

Priority Project (no inferred order of importance)	**Peel-Harvey Actions' (refer to Main Report)**	**Regional (South West) Targets' (refer to Tables G2 -G15)**
23. Survey of nutrient impacts of peri-urban (rural-residential) development.	3.13, 11.9, 13.11	
24. Establishing and monitoring condition of soil health on the coastal plain (including soil acidity, fertility, and salinity).	11.3, 11.5, 12.1	WT74, LT4, LT6, LT15, LT37, LT49
25. Peel-Harvey Catchment Council website development.	13.3, 13.4, 13.9, 14.6	LT5, LT35, LT60, PT1, PT2, PT13
26. Establishment of Peel Waterways Institute.	11.4, 11.7, 13.5	WT55
27. Community capacity building and empowerment (including better access to information and input to planning processes).	9.1, 9.4, 10.6, 10.7, 13.1, 13.2, 13.6, 14.6	LT5, LT35, LT60, CT14, CT15, PT1, PT2, PT5, PT13
28. Awareness raising and training for sustainable land management with small rural landholders.	2.3, 3.13, 13.7, 13.9, 13.11, 14.5	LT21, LT29, LT47, LT51
29. Providing opportunities for engagement of indigenous stakeholders in NRM processes.	15.1, 15.2, 15.3	PT1, PT6, PT11

TABLE G2. REGIONAL TARGETS FOR - WATERWAYS, WETLANDS AND ESTUARIES (INCLUDING AQUATIC BIODIVERSITY)

Resource Assessment
WT1: Standard water quality data set and resource inventory for waterways, wetlands and estuaries by 2008
WT2: Effective research and monitoring Strategy for waterways, wetlands and estuaries developed by 2006.
WT3: Water quality targets for nutrient levels are developed in priority waterways, wetlands and estuaries by 2008.
WT4: Waterways, wetlands and estuaries (including floodplain areas) identified, prioritised and mapped for condition, values and threats by 2006.
WT5: All flood-prone areas identified with best practice flood plain management plans and being implemented by 2010.
Planning
WT6: Increase protection through statutory and non-statutory mechanisms for all waterways, wetlands and estuaries within the region by 2006.
WT7: Develop complementary policies and guidelines between State and Local Governments to ensure consistent management and protection of waterways, wetlands and estuaries by 2006.
WT8: Ribbons of Blue programs linked to on-ground river action planning by 2006.
WT9: Revised and improved management mechanisms for drainage schemes by 2006
WT10: Revised and improved practices implemented to minimise flooding impacts by 2006.
WT11: State and Regional Algal Management Strategy developed and implementation commenced to improved on ground management by 2004
WT12: Water quality management aligned with National and State Water Quality Management Strategies by 2007.
WT13: Performance based licence conditions set by state regulatory authorities for point nutrient sources by 2006.
Capacity Building
WT14: Community training plan developed and implemented addressing technical advice and assistance for the planning, protection and restoration of all waterways, wetlands and estuaries by 2008.
WT15: Strategies prepared and implemented raising awareness of waterway, wetland and estuary values by 2006.
WT16: Regional cost sharing protocol developed by 2004 and program of financial support to stakeholders to protect priority waterways, wetlands and estuaries through on ground works operating by 2005
WT17: Awareness and incentive program for waterway, wetland and estuary degradation and contamination threats and best management practices developed by 2007.
On Ground Works
WT18: Research sites establishing best practice rural drainage management implemented by 2006.
WT19: Comprehensive Catchment plans updated or prepared addressing protection and management of waterways, wetlands and estuaries by 2006 and progress towards implementation by 2008.
WT20: 55% of priority waterways, wetlands and estuaries have comprehensive plans prepared and implemented addressing a range of issues including biodiversity, restoration, indigenous culture, instream health etc by 2008.
WT21: Implementation commenced of appropriate controls and management systems in priority areas to address water quality runoff for all new, and then progressively all existing, intensive agricultural land uses in the Region by 2006.
WT22: A Demonstration Catchment Management Plan prepared and implemented with defined water management targets prepared for one catchment by 2008.
WT23: A weed mapping protocol for waterways, wetlands and estuaries endorsed and implementation commenced by 2006.
WT24: Incentives for land managers to retain high value waterways amenity and habitat prepared and implemented in three trial areas by 2007.
WT25: The State Wetlands Conservation Policy and other key wetland programs implemented and evaluated by 2008.
WT26: Two demonstration areas that are particularly susceptible to erosion implemented , with subsequent improvement in quality of stream water runoff by 2008.
WT27: A plan to understand the benefits and costs of conserving water quality through best management practices prepared and implementation commenced by 2006.
WT28: Resource Condition Targets for salinity recovery for priority waterways developed and commence implementation of management options developed by 2008.
WT29: Management plans developed to incorporate engineering schemes for salt interception and commence implementation by 2008.
WT30: Comprehensive Catchment plans updated or prepared for priority waterways addressing hydrological change by 2006.
WT31: Water cycle & drainage plans in priority areas to assist land managers in sustainable land and water use and protection, and salinity management by 2006
WT32: Regional flood strategy developed and implementation progressed by 2006.
WT33: Increase in percentage of region utilising best practice storm water management by 2006.
WT34: 50% of new developments in the Region incorporating Urban Storm Water Management water sensitive design principles by 2006.
WT35: Nutrient, pollution and acidity risks are identified and addressed in catchment plans for waterways, wetlands and estuaries by 2006.
WT36: Fencing and nutrient strips along waterways and drains promoted and constructed to achieve increase in adoption by 10% on third order drainage and streamlines in priority catchments by 2008.
WT37: 55% of significant nutrient point sources utilising best practice waste water management and industry codes of practice by 2008.
WT38: A network of readily recognised demonstration sites established to promote waterways management best practice techniques, including drainage across the Region by 2006.

TABLE G3. REGIONAL TARGETS FOR - WATER RESOURCES

Resource Assessment
WT39: Regional Monitoring strategy to measure sustainability targets for ground and surface water developed by 2007
WT40: All water quality and level data from various sources stored on a central database and available to all stakeholders by 2008.
WT41: Program to carry out research into the impacts of farming practices on ground and surface water use documented by 2008.
WT42: Acid Sulphate Soils risk mapping priority areas of the Region by 2006.
WT43: 50% Public Water Supply Catchment have monitoring programs developed by 2006.
WT44: Programs provide updated technical advice to decision-making and management for Public Water Resources by 2008.
Planning
WT45: All priority ground water areas (70% or more allocated) allocation limits and management plans are reviewed and refined by 2008.
WT46: All priority Surface Water Catchments to be proclaimed under the Rights in Water and Irrigation Act 1914 by 2024.
WT47: All priority surface and ground water allocations based on environmental water provisions by 2020.
WT48: 25% of regional, subregional, catchment and local NRM plans addressing priority groundwater resources issues by 2008.
WT49: Develop and implement a regional, State and Commonwealth framework for Public Water Supply by 2008.
WT50: All farmers in the region have access to emergency water supplies by 2015.
WT51: Farm water grants scheme reviewed by 2006.
Capacity Building
WT52: 5 training courses to coordinate stakeholder involvement in water resources planning and decision making ensuring stakeholders have the capacity to undertake, evaluate and monitor groundwater resource management actions by 2006.
WT53: 10 training and developed programs implemented to raise public awareness on ground and surface water quality issues by 2008.
WT54: Increased adoption and understanding of the benefits and costs of water use and best management practices by 2006.
WT55: Program in place to increase community understanding & educational opportunities for Public Water Resource Management & decision making by 2008.
WT56: 5 training courses for landowners on farm water planning delivered by 2006.
On Ground Works
WT57: Implementation plan for Collie Salinity Recovery completed by 2004
WT58: Preferred management options for the recovery of the Warren River Salinity Recovery by 2005.
WT59: Best management practices introduced, documented and extended to ground and surface water areas to reduce impact or point and diffuse source pollution by 2008.
WT60: 60% of high resource competition ground and surface water resources have management plans addressing a broad range is issues including use, protection, biodiversity and pollution risks by 2006.
WT61: Environmental flows (EWR's and EWP's) for priority surface and groundwater resources are established and maintained by 2008.
WT62: Water efficiency and involvement programs extended in region by 2006
WT63: Local rules established under the Rights in Water and Irrigation Act (1914 amended) in priority surface and ground water areas of region by 2008
WT64: 75% of surface and ground water licences checked in priority areas for compliance by 2008.
WT65: Research and development program to improve knowledge and understanding of values, threats, status and appropriate management of Public Water Supply resources including identification of priority water supplies in the region prepared by 2007.
WT66: 75% of priority public water resources protected and or restored by 2008.
WT67: All surface and ground water drinking source areas protected in accordance with Priority Protection Areas.
WT68: Catchment plans for 30% of Public Water Supply Catchments developed by 2006.
WT69: 75% of the State Water Strategy recommendations implemented by 2010
WT70: Report prepared on the adequacy of farm water resources by 2006 and implementation of key priorities by 2008.
WT71: Five workshops, field days, demonstrations conducted in region by 2006 addressing water harvesting techniques.
WT72: Information package on integration of engineering options for farm water supply by 2006.
WT73: Assessment of impacts and trade offs for farmers water availability with the incorporation of deep rooted perennials and farm forestry into the farming system prepared by 2006.
WT74: Program identifying, mapping salinity impacts developed by 2006 and technical support to stakeholders progressing implementation by 2008.
WT75: Emergency Rural water supply sources identified and accessible by 2006

TABLE G4. REGIONAL TARGETS FOR - BIODIVERSITY

Resource Assessment
BT1: The conservation status of species, communities, habitats and ecosystems is re-evaluated every 5 years or less ongoing till June 2008.
BT2: An inventory of at-risk species, communities and ecosystems: developed by June 2008
BT3. A monitoring program for threatened and at-risk ecosystems, communities and species is developed and implemented by June 2008.
Planning
BT4: Representative examples of the SW NRM Region's natural biological and physical diversity at landscape scale are identified and managed for conservation by June 2008.
BT5: Management plans for regionally significant threats to biodiversity – eg. Salinity, *Phytophthora* disease, feral animals: prepare as required and commence implementation by 2008.
BT6: A Regional Vegetation Management Strategy: developed and distributed by 2008.
BT7: A Regional Wetlands and Waterways Management Strategy: developed and in operation by 2008.
BT8: Regional guidelines for the management of fire in selected remnant specific native vegetation types developed and in operation by June 2008
BT9: Identify gaps /deficiencies in planning mechanisms for biodiversity conservation by 2008.
Capacity Building
BT10: Increase by 10% on baseline levels, awareness for the conservation of the Region's highest value biodiversity assets by 2010
BT11: By 2008, develop a process for the distribution of information and data on biodiversity elements, processes and threats.
On Ground Works
BT12: Recovery Plans and Interim Recovery Plans developed endorsed and fully funded: for all Critically Endangered and Endangered taxa, within 1 year and 3 years and implementation commenced within 3 years and 4 years respectively
BT13: Recovery plans developed, endorsed and funded for all identified Natural Diversity Recovery Catchments and poorly conserved ecosystems by 2008
BT14: All existing biodiversity threat abatement plans (eg. State Salinity Strategy, Feral animals, Phytophthora dieback) relevant to the Region being implemented.
BT15: Significant invasive environmental weeds affecting native vegetation: weed species identified, prioritised and implementation of control strategies commenced by 2008.
BT16: All occurrences of ecological types with less than 10% remaining: are identified and management strategies developed and commenced by 2008.
BT17: Ecological types with less than 30% remaining: Increase by 20% the area managed for conservation within the SW NRM region of by June 2008
BT18: Develop criteria and processes to enable the prioritisation of biodiversity values of wetlands and waterways by 2006
BT19: Investigate potentially viable commercial native flora industries by 2009.
BT20: Commence Phase II of Bush Forever (the State government's policy for the protection of regionally significant bushland) by 2008.

TABLE G5. REGIONAL TARGETS FOR - AGRICULTURAL LAND

Resource Assessment
LT1: Resource Condition Target for land affected by salinity determined for priority catchments (Blackwood, Collie, Murray and Warren-Tone) by Dec 2005
LT2: Resource condition target for groundwater levels in priority catchments (Blackwood, Collie, Murray and Warren-Tone) determined by Dec 2005.
LT3: Monitoring network improved for regional trends (groundwater levels and salinity risks) endorsed by SWCC and information promoted to NRM groups in the Region by 2007.
LT4: A system of soil condition targets and indicators developed and published by March 2006
LT5: Land resource information and decision-making tools made available through NRM groups and agencies by 2006.
LT6: Extent of areas affected by, and susceptible to land degradation identified, mapped at a regional scale and documented by 2008.
LT7: Monitoring network established for regional pests and weeds and information accessible to NRM groups in the Region by 2007.
Planning
LT8: Agricultural effluent discharge sites implementing and evaluating effluent management plans according to industry Code of Practice (50% adoption) by 2008.
LT9: 20% of regional and local planning schemes, strategies and development plans include provisions, guidelines and/or zonings to address agricultural and rural sustainability by 2007.
LT10: Community values for rural landscapes identified for 30% of Local Government areas by 2007 and 90% by 2020.
LT11: Priority agricultural land (as per State Planning Policy No.2.5) identified and protected in land use planning strategies and LGA local planning strategies by 2008.
LT12: Priority water resources identified and protected for future growth in agricultural industries in water resource allocation plans by 2006.
LT13: Establishment of new farm forestry industries consisting of two plans developed for the implementation of commercial tree crops and one plan for a new biomass plant by 2008.
LT14: State policies and LGA Town Planning and District Schemes in the region support sustainable land management options, including tree farming, by 2008.
LT15: All catchment-based local NRM plans include soil condition actions and monitoring by 2008
LT16: Vegetation management plans prepared for at least two Local Government Reserves with more than 5 ha of remnant vegetation (or less when only 10% left), or vegetated reserves that provide links to other remnants, in 30% of Local Government Areas by 2007.
LT17: Land use planning and development strategies to include guidelines to address land degradation by 2005.
LT18: Three regional biosecurity plans prepared for priority ecologically significant invasive vertebrate and insect pests, weeds and diseases by 2008.
LT19: Regional biosecurity Plans prepared for priority plant and animal pests by 2006.
Capacity Building
LT20: EMS framework for major farming systems developed and published by 2008
LT21: A system of effective industry and community based incentives for improved land management developed, tested and implemented by 2008
LT22: Technical support for whole farm planning provided to 75% of farmers by 2008.
LT23: Extension program supporting implementation of agricultural diversification in the SW region developed by 2008.
LT24: Sustainable production practices identified and reviewed for priority production systems by 2007 and a program developed to promote options for new sustainable production practices by 2008.
LT25: Sustainable agriculture funding needs for community implementation of NRM identified and being addressed by 2005.
LT26: A working plan prepared for integrating and delivering farm forestry advice and support to landholders in the South West region by December 2006.
LT27: Viable farm forestry industry/market options for landholders researched and implemented -Two external "carbon investors" in the Region, and - Five research projects relevant to the Region completed by end 2008
LT28: 75% of landholders aware and confident in the role of commercial tree species in productive and sustainable farming systems by 2008 and 20% of landholders having planted commercial species by 2008.
LT29: Sustainable land management and compliance responsibilities of being a rural land-holder understood by 50% of small land holders by 2005
LT30: Property planning principles adopted by 10% of SLHs by 2008
LT31: Management options for salinity risk assessed and implemented in agricultural region by 2008.
LT32: New viable salinity management options developed, demonstrated and commenced by 2008.

TABLE G5. REGIONAL TARGETS FOR - AGRICULTURAL LAND continued

Capacity Building
LT33: One salinity mitigation demonstration catchment commenced by 2006.
LT34: A new drainage assessment and regulation process developed by 2005. and implemented by 2006.
LT35: Comprehensive communication and information sharing network for salinity related datasets established and accessible by all landholders by 2006.
LT36: New technologies and production systems for managing land susceptible to degradation (eg saline soils, sodic soils) developed by 2007.
LT37: Demonstration projects to improve soil health and condition conducted by 75% of community based NRM groups by 2007.
LT38: Effective control and eradication methods for ecologically significant pests, weeds and diseases developed and communicated to private landholders by 2007.
LT39: Technical support and information to address risks from ecologically significant invasive pests, weeds and diseases provided to 50% of local community groups by 2008.
LT40: Community workshop program on the control of ecologically significant pests, weeds and diseases developed by 2005, implemented in all LGA areas by 2007.
LT41: Information on biological and biosecurity risks included in a regional information network system by 2008.
On Ground Works
LT42: The principles of Environmental Management Systems (EMS) for agricultural production used on 10% of farmed area within the Region by 2008
LT43: Best Management Practices (BMPs developed and implemented for regionally identified priority agricultural systems and implemented by 25% of farmers within these agricultural systems by 2008.
LT44: Water Use Efficiency BMPs being implemented by 50% of commercial irrigation farmers by 2008, 80% by 2020. (Links to Water target WT57)
LT45: Farm forestry conducted on 10% of agricultural area of priority catchments and five demonstrations of farm forestry on saline land established by 2008.
LT46: Two large scale private external revegetation investors in the Region by 2008.
LT47: 10% of SLHs managers aware of and implementing BMPs in relation to biosecurity risks of weeds, pests and diseases by 2008
LT48: Best practice in drainage and conservation earthwork implemented by 35% of farmers, with 75% aware by 2008.
LT49: Regular soil test for pH and nutrients adopted by 75% of farmers in the Region by 2008
LT50: Implementation of State Weed Plan actions relevant to SW region by 2008
LT51: Farm biosecurity measures adopted by 50% of landowners (including 10% of SLHs) by 2008.

TABLE G6. REGIONAL TARGETS FOR - REMNANT VEGETATION

Resource Assessment
LT52: Resource condition target for percentage of area of native vegetation to be protected determined for region by Dec 2005.
LT53: A rapid farm bush assessment process developed and extended by 2007.
LT54: Size, distribution and protection status of remnant vegetation on farmland mapped and documented in the Avon-Wheatbelt, Mallee and Coastal Plain IBRA regions by 2006 (rest of region by 2015); priorities for protection established by 2007 and condition of high priority and blocks >20 ha assessed by 2008.
Planning
LT55: All LGA areas in the region to be involved in a coordinated approach to protection of remnant vegetation and control of ecologically significant invasive weeds by end 2006.
LT56: South West region position paper on the protection of native vegetation (including incentives, mechanisms to implement clearing legislation and taxation reform) submitted to state government by 2006.
LT57: Benefits and costs of representative remnant vegetation protection and rehabilitation projects in the region evaluated and documented by 2006.
LT58: Native seed requirements for the region determined by 2005.
Capacity Building
LT59: Improved practices for direct seeding for rehabilitation of remnant vegetation on land-climate types developed, published and extended by 2008
LT60: Comprehensive communication and information sharing network for vegetation and rehabilitation related datasets established and accessible by all landholders by 2006.
On-Ground Works
LT61: Use of regional and local provenance extended within the region, and implemented in 85% of rehabilitation projects by 2008.
LT62: Conservation protection and management of remnant vegetation on farmland planned and implemented by 50% of farmers by 2008.

TABLE G7. REGIONAL TARGETS FOR - PRODUCTIVE FORESTS

Resource Assessment
LT63: Sustainable yield (10 yr) of sawlogs and other timber from all native forest and timber reserve areas determined by 2008
LT64: Update datasets for use in estimating sustainable yields for logging and native forestry by 2008
LT65: Measure and report on all formal Key Performance indicators in the Forest Management Plan (FMP) as set out in the FMP timetable (WACC 2004).
Planning
LT66: Position paper on applying the principles of ecologically sustainable forest management to private native forests in the South West region prepared for public comment by December 2006.
LT67: In consultation with key interest groups, the area of State forest is maintained or increased over the life of the Forest Management Plan, 2013
LT68: The productive capacity of State forest is maintained through the Management Action Targets defined in the Forest Management Plan 2004 – 2004
LT69: In consultation with key interest groups, State forest available for the sustainable use of natural resources will be defined in relation to the formal and informal conservation reserve system in State forest by 2008.
LT70: Ecosystem health and vitality will be protected by managing weeds and pests, dieback hygiene, and appropriate fire regimes by 2013.
LT71: The ecological integrity and productive capacity of the forest will be preserved by protecting forest soils from unacceptable damage by disturbing activities by 2008.
LT72: Fauna and flora values in operational areas used for natural resource use will be managed sustainably by 2008.
LT73: In consultation with key interest groups, all State policies and legislation support sustainable approaches in relation to native forestry and value-added industries by 2008.
Capacity Building
LT74: Silvicultural guidelines are revised to accommodate all FMP requirements by 2005 and evaluated by 2008.
LT75: All native forest timber contracts support value-added industry opportunities by 2008.
LT76: All timber harvesting contractors and field staff to be aware of and trained in the revised guidelines for timber harvesting by 2008.
LT77: Provide an interactive and comprehensive community participation program in the major aspects of forest management and community interest by 2008.
LT78: Increase awareness and involvement of regional communities in the community forest inspection program by 2008.
On Ground Works
LT79: Public native forests (State forest) is managed according to ecologically sustainable forest management principles that ensure all natural values and ecological processes are maintained during the life of the Forest Management Plan 2004 (FMP)
LT80: Forest is managed to preserve water catchment conditions and water production criteria by 2013.
LT81: Rehabilitate and regenerate 50% of all areas of significant disturbance to native forest (used for timber harvesting, basic raw materials, mining and other commercial uses) by 2013.
LT82: Implement the 2004 forest management plan by 2008.
LT83: Implement the 'Protecting Our Old Growth Forests' policy by 2008.

TABLE G8. REGIONAL TARGETS FOR - MINERAL RESOURCES AND BASIC RAW MATERIALS

Planning
LT84: System of accreditation for mining sustainability of mining practices in the SW region developed and documented by 2008.
LT85: All local and regional planning strategies identify areas for access to minerals and BRM by 2008.
Capacity Building
LT86: Rehabilitation guidelines and BMPs prepared and published for mining and raw material extraction operations in the Region by 2008.
LT87: Benefits of mining by-products for use as soil ameliorants identified and extended to farmers and landholders (75% awareness in Peel-Harvey) by 2008.
LT88: Mining company and community project partnership framework developed, documented and implemented by 2008.
On-Ground Works
LT89: All mining operations in the South West Region have sustainability accreditation by 2015.

TABLE G9. REGIONAL TARGETS FOR - MARINE ENVIRONMENT (INCLUDING BIODIVERSITY)

Resource Assessment
MT1 Gaps in Marine knowledge to be identified, with priorities for gap filling, by 2006
MT2: The level of contaminants in estuarine and marine environments, with clear targets in key areas established by 2007
MT3: Clear contaminant reduction targets for key areas are to be established by 2010.
MT4: Critical marine ecosystem processes for the ongoing conservation of the most threatened biodiversity assets are identified and documented by 2008
MT5: Baseline information on the ecological condition of key coastal, estuarine and marine species and ecosystems is documented by 2007.
MT6: The impact of recreational and commercial activities on the marine environment within the South West is researched and reported by 2008.
MT7: 50% of marine and coastal habitats are surveyed and mapped by 2010.
MT8: An inventory of at-risk species, communities, habitats and ecosystems is prepared by 2009
MT9: A long-term monitoring program of at risk ecosystems, communities, habitats and species, is developed and implemented by 2009.
MT10: The conservation status of at- risk and special species, communities and ecosystems are evaluated by 2009.
MT11: A monitoring program for introduced marine pests is to be in operation by 2010.
Planning
MT12: A Comprehensive, Adequate and Representative (CAR) marine reserve system is developed within the SW NRM region,
MT13: Management plans to be developed for 5 at risk species, communities and ecosystems that are not listed in existing plans by 2010.
MT14: State marine biodiversity information is used to enhance planning and decision making within the SW region
MT15: A process to integrate conservation into the use and extraction of marine organisms/values is developed and implemented by 2009.
MT16: Ecologically sustainable development reports to be produced for 50% of fisheries by 2010.
MT17: Integrated fisheries management is developed and implemented by 2009.
Capacity Building
MT18: A program to increase awareness and support for the conservation of key marine species, communities and ecosystems, and to improve user behaviour in the marine environment, to be developed by 2007.
MT19: A local community participation program to increase the understanding of marine assets, threats and condition to be developed by 2007.
MT20: Community awareness of the region's marine biodiversity, habitat integrity and threats to be increased by 2010.
MT21: A program to encourage the south-west community participation in resource allocation decisions relating to the Region's fisheries is developed and implemented by 2007.
MT22: 25% of threatened species action plans are to be implemented by 2010.
MT23: 5 new threatened species action plans are to be developed by 2010.
MT24: Significant threats to marine conservation are identified and managed
MT25: 50% of current marine pest incursions to be managed by 2010.
MT26: No additional marine pest species to become established by 2010.

TABLE G10. REGIONAL TARGETS FOR - COASTS

Resource Assessment
CT1: Gaps in knowledge of Coasts to be identified, with priorities for gap filling, by 2006
CT2: Coasts habitat condition, extent & distribution to be assessed by 2006 (2 Years)
CT3: A monitoring and evaluation program for Coasts habitat condition, extent & distribution to commence by 2008
CT4: Impact of recreational and commercial activities on the coastal environment within the South West to be investigated by 2010
Planning
CT5: Coasts RCTs & MATs to be reviewed & quantified by 2006
CT6: Coasts habitat requirements for protection on private land &/or for inclusion in reserve system to be identified by 2007
CT7: Priority sites for improving Coasts habitat condition to be identified by 2007
CT8: All development proposals to be consistent with the State Planning Policy for Coastal planning by 2005
CT9: Suitable measures are to be in place to manage off-road recreational activities by 2008
CT10: 100% of Local Governments to have coastal management plans by 2010
CT11: All of the coast to be covered by a South West Regional Coastal Strategy, supported by local coastal management plans for each Local Government and Conservation Reserve, that complement the recommendations of the SW Regional NRM Strategy by 2008
CT12: 25% of planning documents for Coasts to be reviewed and updated by 2010
CT13: Options for the long-term management of shoreline movements at priority sites to be developed by 2010
Capacity Building
CT14: All community groups and volunteers involved in coastal management to be supported by NRM officers by 2006
CT15: Community capacity for management of Coasts to be improved by 2010
CT16: Community awareness of Coasts habitat integrity to be increased by 2010
CT17: Community engagement in Coasts planning decision-making to be increased by 2010
CT18: A program to encourage and support coastal rehabilitation on private land to be developed by 2007
On Ground Works
CT19: Coast habitat integrity to be improved at 10 priority sites by 2010
CT20: The extent and distribution of Coasts habitat in reserves to be increased by 2010
CT21: The extent and distribution of Coasts habitat protected on private land to be increased by 2010
CT22: All coastal rehabilitation to include weed management by 2008

TABLE G11. REGIONAL TARGETS FOR - AIR

Resource Assessment
AT1: Baseline ambient air quality monitoring program developed by 2006.
AT2: Best Practice Management Plans for air quality implemented by 2007.
AT3: Develop regional strategy for emergency response to industrial accidents by 2006.
AT4: Fire management plans addressing air quality issues by 2006.
Planning
AT5: Baseline survey of domestic heating methods implemented by 2007.
AT6: Investigate all Travel Smart initiatives by 2006.
AT7: Level of impact of small to medium sized enterprises on air quality in the SWCC region identified by 2006.
Capacity Building
AT8: Increase awareness and support by communities of air pollution risks and status in the Region by 2006.
On-Ground Works
AT9: Developers, community, industry, local government and rural landholders to adopt the objectives, strategies and actions contained in the South West Air Quality Management Plan by 2010.

TABLE G12. REGIONAL TARGETS FOR - CLIMATE

Resource Assessment
AT10: Strategy projecting impacts of global warming at a local and regional level developed by 2006.
AT11: Strategy to promote and support renewable energy projects in the SW developed by 2005.
AT12: Review of water resource allocation assessment tools by 2007.
Capacity Building
AT13: Program to educate the community and industries of the Region on how to reduce greenhouse gas emissions developed by 2006.
Planning
AT14: Strategy developed establishing regional links to implement the state, national and international climate initiatives by 2007.
AT15: Strategy to minimise GHG emissions developed by 2006.

TABLE G13. REGIONAL TARGETS FOR - NRM CAPACITY

Capacity Building
PT1. Increase community awareness of, and engagement in, NRM and regional processes in the South West by 2009
PT2: Numbers of Increased community members accessing information and knowledge of NRM issues increased by 50% by 2007.
PT3: Training and skills development opportunities being provided for community and support officers at 110% current level by end of 2005.
PT4: Regional strategy and Investment Plan finalised and core executive support, business management, administration and regional coordination network engaged to implement the Regional NRM strategy by 2005.
PT5 Protocols that strengthen: and extend partnerships for improving NRM developed by 2008.
PT6: A range of activities, incentives and initiatives available to increase participation of all South West stakeholders in NRM.

TABLE G14. REGIONAL TARGETS FOR - INDIGENOUS PEOPLE

Resource Assessment
PT7: Landscapes, cultural heritage and knowledge are recognised, recorded and conserved in a manner acceptable to the Indigenous community through specific management plans by 2008
PT8: A MOU between Traditional Owners and SWCC, for protection of knowledge rights recognised by SWALSC by 2006.
PT9: Policy on the protection of all Indigenous environmental knowledge supplied by Indigenous community by 2009.
Planning
PT10: 50% increase of culturally important areas for Indigenous community on privately owned land is identified in partnership with landowners through management plans by 2008
Capacity Building
PT11: Projects demonstrating protocols for engagement and addressing Nyungar NRM issues instigated by 2008
PT12: Indigenous representation on SWCC to be achieved by 2006.
PT13: All subregions have access to information resources about important issues relating to Indigenous traditional activities amongst non-indigenous SW resource managers 2008.
PT14: All CSO, Regional Coordinators and SWCC Members participate in cross cultural awareness-raising program June by 2005
PT15: All partners aware of the Native Title rights and interest in land and water with respect to the Native Title Act 1993 (Commonwealth) 2009

TABLE G15. REGIONAL TARGETS FOR - SUSTAINABLE SETTLEMENTS

Planning
PT16: Framework developed to ensure that environmental and planning assessment of projects includes the direct and cumulative environmental impact by 2008.
PT17: Strategies to protect natural areas of significance included in LPS and required provisions in Town Planning schemes by 2007.
PT18: Policy developed to ensure that new urban expansion areas are located appropriately to avoid regionally or locally significant natural features by 2007.
PT19: Implementation of the State Coastal Planning Policy and assessment of all coastal development to include cumulative impacts by 2007.
PT20: All coastal reserves to have adequate management plans development by 2015
PT21: All new urban development projects to adopt 'Liveable Neighbourhoods' design principles by 2008 and all development to be subject to sustainability assessment by 2010.
PT22: All development to be undertaken in accord with water sensitive urban design principles (new DOE policy framework), WAPC Planning Bulletin on acid sulfate soils by 2006.
PT23: All development subject to assessment and compliance with WAPC Planning Bulletin 64 by ???? (To be completed out of session).
PT24: Rural residential development is limited to existing designated areas or where particular circumstances exist that would provide a beneficial environmental outcome from such a form of development by 2007.
PT25: Townsite salinity plans prepared for the 9 towns in salinity risk areas by Dec 2005 and implementation commenced for 4 high priority towns by Dec 2006.

APPENDIX H.

PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS

ON-GROUND WORKS: Conservation and Sustainable Use of Nrm Assets	
Funding Support and Opportunities	**Policy Instruments and Guidelines**
1. Dryland Salinity	
National Action Plan for Salinity and Water Quality (NAPSWQ)	State Salinity Action Plan Salinity Investment Framework (DoE 2003) Environmental Protection Act (1986) Environmental Protection Amendment Act (2003)
2. Loss of Productive Capacity of Land Resource	
Natural Heritage Trust (NHT) - Landcare Program Farm Forests Program National Program for Sustainable Irrigation Farm Water Grant Scheme	Soil and Land Conservation Act (1945) Statement of Planning Policy No. 2.5 (formerly No 11) - Agricultural and Rural Land Use Planning Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Clearing Controls - through Soil and Land Conservation Notices (DoA) and new clearing and environmental harm provisions of EP Amendment Act Agriculture and Related Resources Protection Act (1976) Peel Region Scheme Policy - Strategic Agricultural Resource Areas (2003) Regional Forestry Agreement Forest Management Plans (CALM) Draft Forest Management Plan (Conservation Commission 2002) Code of Practice for Timber Harvesting in WA (CALM 1999) Code of Practice for Timber Plantations in WA (CALM 1997) Manual of Management Guidelines for Timber Harvesting in WA (CALM 1999) SPP No. 2.4 - Basic Raw Materials Policy State Lime Strategy (DRD 1991) Peel Region Scheme Policy - Minerals and Basic Raw Materials (2003)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

Funding Support and Opportunities	Policy Instruments and Guidelines
3. Water Quality Decline	
NAP for Salinity and Water Quality NHT - Landcare Program NHT - Coastal Catchments Initiative NHT – Rivercare Program Harvey River Restoration Trust (WC)	National Water Quality Management Strategy State Water Quality Management Strategy Waterways WA Strategy (in progress) Draft Waterways Management Policy (2000) State Salinity Action Plan (1996) State Algal Bloom Management Strategy (2003) Statement of Planning Policy SPP No 2.5 (formerly No.2) - *The Peel-Harvey Coastal Plain Catchment Policy* (requiring planning to take cognisance of effects of land use change on Estuary) Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Environmental Protection (*Peel Inlet - Harvey Estuary*) Policy (1992) (sets environmental quality objectives relating to reduction of nutrient inputs and drainage). Peel-Harvey Environmental Review and Management Program - Stage 1 1995, Stage 2 1998. State Environmental Protection (Coburn Sound; 2005) Development Requirements (DoE) - Foreshore management plans - Compensation basins Licensing of point sources (DoE) Land use controls in Underground Public Drinking Water Areas (DoE) Production of guidelines, protection notes and inter agency BMPs (DoE, DoA, and Shires) Jandakot Land Use & Water Management Strategy-'95 SPP No. 2.3 - Jandakot Groundwater Protection Policy Drinking Water Source Protection Assessment and Plans (DoE) Development of Water Quality Protection Notes (DoE)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

Funding Support and Opportunities	Policy Instruments and Guidelines
3. Water Quality Decline(continued)	
	Manual for Managing Urban Stormwater Quality (1998) River Restoration Training & Demo Program (DoE) International Convention on Wetlands (Ramsar 1971) Wetlands Conservation Policy for WA (1997) Environmental Protection (Swan Coastal Plain Lakes) Policy (1992) Environmental Protection (South West Agricultural Zone Wetlands) Policy (1998) Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations (2004) Review of System 6 wetlands
4. Disruption to Hydrology of Natural water Systems	
National Program for Sustainable Irrigation Farm Water Grant Scheme Community Water Supply Program	Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Draft Waterways Management Policy (2000) Environmental Water Provisions Policy for Western Australia (2000) Waterways WA Strategy (in progress) State Water Strategy (DoE 2003) Establishment of South West Irrigation Land and Water Management R&D Reference Group (DoA; SWI) Environmental Water Provision Policy (WRC 2000) Environmental water requirements and provisions (eg Harvey River) (DoE) Development of Water Allocation Plans (DoE) Allocation, licensing and monitoring of groundwater bores (DoE) Peel Region Scheme Policy - Floodplain Management (2003) State Water Strategy (DoE 2003) Jandakot Land Use & Water Management Strategy-'95 SPP No. 2.3 - Jandakot Groundwater Protection Policy SPP No. 2.7 - Public Drinking Water Source Policy

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

Funding Support and Opportunities	Policy Instruments and Guidelines
4. Disruption to Hydrology of Natural water Systems (continued)	
	Drinking Water Source Protection Assessment and Plans (DoE) Development of Water Quality Protection Notes (DoE) Environmental Water Provision Policy (WRC 2000) Development of Water Allocation Plans (DoE) Allocation, licensing and monitoring of groundwater bores (DoE) Management and distribution of potable water supplies (DoE; WC)
5. Terrestrial Habitat Degradation	
NHT – Endangered Species Program Harvey River Restoration Trust (WC) Worldwide Fund for Nature (WWF) Threatened Species Network (TSN)	Commonwealth Environment Protection and Biodiversity Conservation Act (1999) National Weed Strategy (1997) Endangered Species Protection Act (1992) Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Clearing Controls - through Soil and Land Conservation Notices (DoA) and the new clearing and environmental harm provisions of EP Amendment Act - through moratorium on clearing in Peel-Harvey Coastal Catchment (SPP 2.1) SW Regional Bushcare Strategy (CALM) Land for Wildlife Program (CALM) Bush Brokers Program Environmental Weed Strategy for Western Australia (1999) CALM Estate - Preparation of Management Plans eg - Waroona Dam; Lane-Poole Reserve; Serpentine National Park; Yalgorup National Park; Logue Brook Reservoir and Catchment. Regional Forestry Agreement Forest Management Plans (CALM) Draft Forest Management Plan (Conservation Commission 2002)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

Funding Support and Opportunities	Policy Instruments and Guidelines
5. Terrestrial Habitat Degradation (continued)	
	National Biodiversity and Climate Change Action Plan (2004-2007) Code of Practice for Timber Harvesting in WA (CALM 1999) Code of Practice for Timber Plantations in WA (CALM 1997) Manual of Management Guidelines for Timber Harvesting in WA (CALM 1999) Environmental Water Provisions Policy for Western Australia (2000) Waterways WA Strategy (in progress) Draft Waterways Management Policy (2000) River Restoration Training and Demonstration Program (DoE) International Convention on Wetlands (Ramsar 1971) Wetlands Conservation Policy for WA (1997) Environmental Protection (Swan Coastal Plain Lakes) Policy (1992) Environmental Protection (South West Agricultural Zone Wetlands) Policy (1998) Review of System 6 wetlands
6. Coastal Processes - Disturbance	
Coastcare Coastwest	Draft State Coastal Zone Management Policy for WA (2001) Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Statement of Planning Policy SPP 2.6 State Coastal Planning Policy Coastal and Lakelands Planning Strategy (1999) Coastal Planning Program - Status of Coastal Planning in Western Australia (WAPC 2003) Coastal Planning and Management Manual (WAPC 2003)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

7. Marine Habitat Degradation	
Australian Government's Ocean Policy Initiative	Fisheries Management Act (1991) Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Fish Resources Management Act (1994) State Marine Waters Policy - Draft Environmental Protection 1998 Perth's Coastal Waters - Environmental Values and Objectives - working document (EPA 2002) State Environmental Protection (Cockburn Sound) Policy (EPA 2005) Marine Conservation Reserves (Shoalwater Islands Marine Park) Environmental Management Plan for Cockburn Sound and its Catchment (CSMC 2005) Perth's Long Term Ocean Monitoring Program (PLOM) National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances (Australian Marine Safety Authority) West Coast Estuarine Fishery (Interim) Management Plan (2003)
8. Climate Change	
Indian Ocean Climate Initiative (2002) Greening Challenge Program (Australian Greenhouse Office)	National Biodiversity and Climate Change Action Plan (2004-2007) National Greenhouse Strategy (1999) National Carbon Accounting System Cities for Climate Protection Campaign (National) WA Draft Greenhouse Strategy (2003) Environmental Protection Act (1986) Environmental Protection Amendment Act (2003) Environmental Protection (*Kwinana - Atmospheric Waste*) Policy and Regulations (1999) Environmental Protection (*Ozone Protection*) Policy (2000)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

PLANNING	
Funding Support and Opportunities	**Policy Instruments, Programs and Guidelines**
9. Strategic Natural Resource Management Planning	
Natural Heritage Trust (NHT) - various programs National Action Plan for Salinity and Water Quality Envirofunds Coastcare	Natural Resource Strategy (1988) State Sustainability Strategy (2003) Environmental Protection Act (1986) and associated Environmental Protection Policies Environmental Protection Amendment Act (2003) Statement of Planning Policy SPP No.2 - Environment and Natural Resources Policy Draft South West Regional Strategy for Natural Resource Management (SWCC 2004) Local Agenda 21 (various LGAs) <u>Guidelines</u> Biodiversity Conservation Outcomes and Targets for NRM (Standards and Targets Working Group of the NRM Ministerial Council) Framework - Guide for Investment in NRM in WA National Guidelines for the accreditation of integrated catchment/regional working plans National Framework for NRM Standards and Targets
10. Land Use Planning (Strategic and Statutory)	
WAPC assistance to LGAs	Statement of Planning Process No.1 (formerly No. 8) - State Planning Framework Policy State Planning Strategy (WAPC 1996) <u>WAPC/DPI</u> - Peel Region Scheme (2003) - Perth Metropolitan Region Scheme - Greater Bunbury Region Scheme - Preparation of regional and subregional plans or strategies - Preparation of Structure Plans - Assessment of Planning Schemes, Amendments, and land use proposals (land rezoning and subdivision)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

Funding Support and Opportunities	Policy Instruments, Programs and Guidelines
10. Land Use Planning (Strategic and Statutory) (continued)	
	EPA/DoE - Assessment of Planning Schemes and Amendments Local Government - Preparation of Town Planning Schemes and Local Planning (or Local Rural) Strategies - Provision of advice on land use proposals (rezoning and subdivision) - Assessment of development applications
RESOURCE ASSESSMENT	
Funding Support and Opportunities	**Policy Instruments, Programs and Guidelines**
11 & 12. Research, Resource Assessment, Monitoring and Evaluation	
Natural Heritage Trust (NHT) National Action Plan for Salinity and Water Quality (NAP) Envirofunds	Perth's Long Term Ocean Monitoring Program (PLOM) Guidelines National Natural Resource Management Monitoring and Evaluation Framework Monitoring and Evaluation Implementation Plan for the 'National Action Plan for Salinity and Water Quality' and 'NHT Extension for WA' State Water Monitoring Programs (DoE)
CAPACITY BUILDING	
Funding Support and Opportunities	**Policy Instruments, Programs and Guidelines**
13 & 14. Communication, Education and NRM Capacity Building, Support and Funding	
Natural Heritage Trust (NHT) National Action Plan for Salinity and Water Quality (NAP) National Landcare Program - community support components Envirofunds Coastcare	Guidelines Community Support for Natural Resource Management - Future Frameworks: Future Needs (2000)
15. Indigenous Culture and Heritage	
Natural Heritage Trust (NHT) NHT - Indigenous Land Management Program	Aboriginal Heritage Act (1972) Native Title Act (1993)

APPENDIX H. - PRIMARY FUNDING OPPORTUNITIES AND POLICY INSTRUMENTS (continued)

Funding Support and Opportunities	Policy Instruments, Programs and Guidelines
15. Indigenous Culture and Heritage (continued)	
National Action Plan for Salinity and Water Quality National Landcare Program Environfunds Coastcare	Evolving Processes - Indigenous Land Use Agreements (ILUAs) - voluntary agreement about the use and management of an area of land or waters made between one or more native title groups (possibly through South West Aboriginal Land and See Council (SWALSC) and others (mining companies, government)) - Joint Management Strategies with CALM

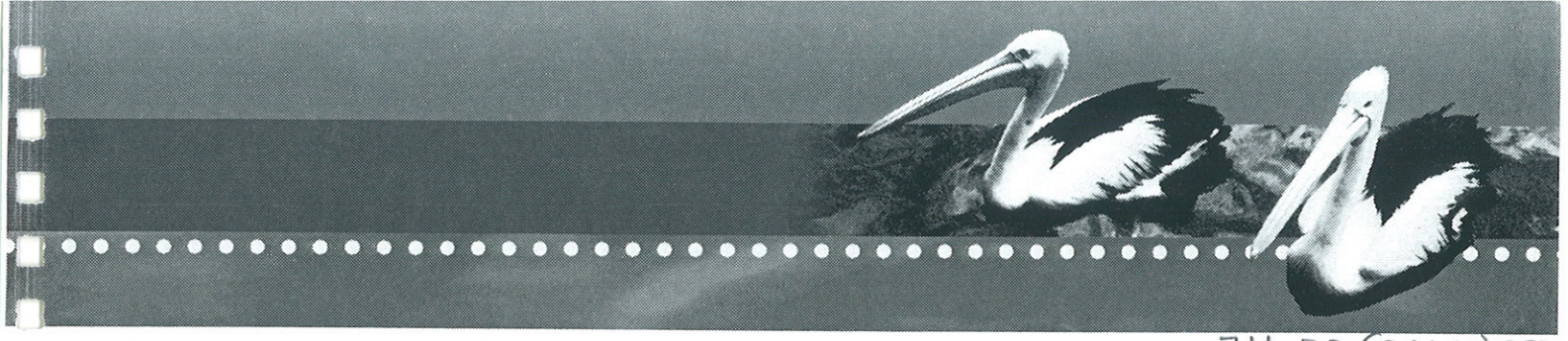
FOR PUBLIC COMMENT

MARCH 1999

Peel Region Scheme

Environmental Review

WESTERN AUSTRALIAN PLANNING COMMISSION



Peel Region Scheme

Environmental Review

Prepared for

WESTERN AUSTRALIAN
PLANNING COMMISSION

March 1999

Published by the
Western Australian Planning Commission
Albert Facey House
469 Wellington Street
Perth, Western Australia 6000

Published March 1999

ISBN 0 7309 9073 7

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Executive Summary

Introduction

The draft Peel Region Scheme ("the Scheme") has been prepared by the Western Australian Planning Commission (WAPC) as part of a program to provide greater certainty in the allocation of strategic land uses, conservation areas and transport infrastructure to key regions. Commitment to this program of region schemes is set out in the *State Planning Strategy* (WAPC, 1997).

The Peel Region Scheme is the first statutory region scheme to be prepared outside the Perth metropolitan region. A major purpose of the Scheme is to give statutory effect to the land use recommendations of the final *Inner Peel Region Structure Plan* (WAPC, 1997).

The Scheme covers the whole of the City of Mandurah and the Shires of Murray and Waroona. The draft Scheme map is shown on Figure 1.

Environmental Assessment of the Scheme

Environmental assessment of planning schemes is enabled by Division 3 of the *Environmental Protection Act, 1986*, as amended by the *Planning Legislation Amendment Act, 1996.*

The WAPC referred the proposed Peel Region Scheme to the Environmental Protection Authority in August 1996. The EPA determined that the Scheme should be formally assessed and in October 1996 issued instructions as to the scope and form of the assessment. The EPA Instructions are reproduced in Appendix A.

In accordance with the EPA Instructions, this Environmental Review focuses on those areas where the zonings proposed under the Region Scheme differ significantly (in environmental terms) from the existing zonings under the local government town planning schemes.

This Review is available for public comment until 2 July 1999 alongside the draft Scheme map and text. Following the receipt and consideration of public submissions and consultation with other government agencies by the EPA, the Minister for the Environment (in consultation with the Minister for Planning) will set conditions under which the Scheme may be implemented.

These conditions will consist of general and possibly specific provisions to ensure that land uses permitted under the Scheme (and subsidiary local government schemes) are carried out in an environmentally acceptable manner. The conditions will apply both to the Region Scheme and to the subsidiary local government schemes.

Environmental Impacts and Management

In considering the environmental implications of the Scheme, the EPA identified a number of environmental factors that were relevant to the assessment. These factors and their proposed management under the Scheme are described in detail in Chapter 3 of this Review.

In addition to these relevant factors, the EPA identified three environmental factors which, although significant, cannot be properly addressed at the regional level. These "deferred environmental factors" and their proposed management under the Scheme are discussed in Chapter 4 of this Review.

Table A1 presents a summary of the relevant and deferred environmental factors. For each factor, the table details the potential impacts of the Scheme, the EPA's stated management objectives, the management strategy adopted by the Scheme, relevant policies and regulations and, where appropriate, specific environmental management measures as set out in Chapter 5.

Table A1 Summary of Environmental Impacts and Management

Environmental Factor	*Site-Specific Factor(s)*	*EPA Objective(s)*	*Impact(s) of the Scheme*	*Proposed Management Strategy*	*Relevant Policies, Published Management Plans and Legislation*	*Relevant Specific Environmental Management Measure(s) (see Chapter 5)*
ENVIRONMENTAL FACTORS RELEVANT TO THE SCHEME						
Vegetation, Fauna and Habitat in the Existing and Proposed Conservation Estate.	Changes to the boundaries of System 6 Area M107.	Vegetation in the existing and proposed Conservation Estate should not be adversely affected.	88ha and 50ha of M107 to be rezoned from Rural to Urban Deferred respectively. 6ha reserved as Regional Open Space.	Small areas of M107 near the coast to be included within proposed ROS foreshore. Sand ridge north of Madora Beach Road to be retained within the Rural zone.	*Mandurah Coastal Strategy* (1996).	1
	Peel Regional Park.		Peel Regional Park proposals progressively implemented by the Scheme.	Areas vested and managed in accordance with *Inner Peel Region Structure Plan* (1997).	*Inner Peel Region Structure Plan* (1997). CALM and PIMA management plans.	1
	Fauna in the Existing and Proposed Conservation Estate.	Fauna and habitat in the existing Conservation Estate should not be adversely impacted.	Minimal – Scheme reserves all significant fauna habitat in the Conservation Estate as Regional Open Space.	ROS vested in and managed by relevant agencies in accordance with structure plans and government policies.	CALM management plans.	1
	Interface impacts/ Edge Effects.		New Urban areas abut System 6 areas at Madora and Yunderup.	Appropriate management of interface to be addressed in Environmental Management Plans to the satisfaction of the responsible authority.		1
Regionally Significant Vegetation.	Areas "Pinjarra 1" and "Clifton 1"	Ensure the abundance, diversity, geographical distribution and productivity of vegetation communities is maintained. Protect Declared Rare Flora (DRF) and Priority Flora consistent with the provisions of the *Wildlife Conservation Act, 1950.*	Western Pinjarra Bypass road encroaches on degraded part of Pinjarra 1. No impact on Clifton 1.	The portion of Pinjarra 1 that is reserved as for Public Recreation/ Conservation in the local scheme to be reserved as Regional Open Space. Edge effects on Pinjarra 1 managed as above.	*Urban Bushland Strategy* (1995).	1

Table A1 Summary of Environmental Impacts and Management

Environmental Factor	*Site-Specific Factor(s)*	*EPA Objective(s)*	*Impact(s) of the Scheme*	*Proposed Management Strategy*	*Relevant Policies, Published Management Plans and Legislation*	*Relevant Specific Environmental Management Measure(s) (see Chapter 5)*
	Riparian Vegetation.	Ensure riparian vegetation on substantial streamlines is adequately protected.	Minimal – New zonings do not impinge on riparian vegetation.	Riparian vegetation around Peel-Harvey Estuary and lower reaches of Serpentine, Murray and Harvey Rivers managed by PIMA as part of Peel Regional Park. Prior to any rezoning of land in the Region Scheme upon which there is riparian vegetation, a vegetation survey may be required. Upper reaches of rivers managed by local governments.	*Inner Peel Region Structure Plan* (1997).	1, 4
Regionally Significant Fauna and Habitat.	Migratory Waterbirds.	Biological diversity should be protected and essential ecological processes and life support systems maintained. Important habitat areas for waterbirds should be identified in accordance with international treaties and published advice from the Australian Nature Conservation Agency (ANCA), and be protected from adverse impacts.	Minimal direct impact – Little new Urban zoning proposed close to the Peel-Harvey Estuary. Indirect impacts from increased population in the region (eg boats, foot traffic, domestic animals).	Significant waterbird habitats are reserved in ROS and managed by PIMA, CALM or local governments. Management of impacts on wetlands and waterways due to stormwater drainage systems for proposed developments will be addressed through the preparation of Drainage and Nutrient Management Plans.	*Inner Peel Region Structure Plan* (1997). PIMA and CALM management plans.	1, 2
Regionally Significant Wetlands.	Lakes protected by the Lakes EPP 1992, *Wetlands of International Importance* and important wetlands identified by ANCA.	Key ecological functions of these wetlands should be protected and maintained through appropriate planning mechanisms.	Potential water balance and water quality changes caused by nearby Urban and Industrial development.	All regionally significant wetlands within or immediately adjacent to new Urban and Industry zonings are reserved in ROS. Development setbacks and/or other interface management measures determined on a site- specific basis by the responsible authority having due regard to advice from relevant government agencies.	CALM and local government management plans.	1

Table A1 Summary of Environmental Impacts and Management

Environmental Factor	*Site-Specific Factor(s)*	*EPA Objective(s)*	*Impact(s) of the Scheme*	*Proposed Management Strategy*	*Relevant Policies, Published Management Plans and Legislation*	*Relevant Specific Environmental Management Measure(s) (see Chapter 5)*
	Paganoni Swamps.	Key ecological functions of Paganoni Swamp should be protected and maintained through appropriate planning mechanisms, with a particular emphasis on water balance.	Minimal potential for water balance and water quality changes caused by nearby Urban development.	Hydrological assessment and Drainage and Nutrient Management Plans required before subdivision approval near Paganoni Swamp. All residential lots to be sewered. Water Sensitive Design employed for developments within the catchment.	*Planning & Management Guidelines for Water Sensitive Urban (Residential) Design* (Whelans *et al.*, 1993). *Urban Stormwater Quality Management Manual* (WRC).	1,2,3
Estuaries	Water Quality in the Peel-Harvey Estuary.	Environmental quality objectives for the Peel Inlet-Harvey Estuary specified in the *Peel-Harvey EPP 1992* and water quality guidelines specified in EPA Bulletin 711 for protection of aquatic ecosystems should be met.	Phosphorus exported in drainage from new Urban and Industry zones on palusplain.	Implement Water Sensitive Urban Design. Drainage and Nutrient Management Plans to be prepared prior to subdivision on palusplain. Generally lots in new Industry zones and residential lots in new Urban zones to be connected to reticulated sewerage as per the requirements of the Peel-Harvey SPP No.2.	Peel-Harvey EPP. SPP No. 2. EPA Bulletin 711.	2,3
Foreshore Stability and Dune Protection.		Coastal processes should be maintained to ensure that the physical stability and ecological integrity of the coastline are not affected.	New Urban zonings near the coast at Madora and San Remo. Increased population in coastal areas.	Foreshore reserved in Regional Open Space and managed by City of Mandurah generally in accordance with the *Mandurah Coastal Strategy*.	*Mandurah Coastal Strategy* (1996). WAPC Policy DC6.1. *Coastal Planning and Development in WA* (1996). *Coastal and Lakelands Planning Strategy* (1999).	1
Groundwater Quality in Future Public Water Supply Areas.		Groundwater quality and quantity in the proposed public water supply area at Karnup should be protected.	None – No new land uses proposed in Karnup-Dandalup Groundwater Scheme study area.	Provision in Scheme for declaration of Special Control Area over groundwater resource when boundaries are defined by WRC.	*Country Areas Water Supply Act, 1947.* Region Scheme provisions.	

Table A1 Summary of Environmental Impacts and Management

Environmental Factor	*Site-Specific Factor(s)*	*EPA Objective(s)*	*Impact(s) of the Scheme*	*Proposed Management Strategy*	*Relevant Policies, Published Management Plans and Legislation*	*Relevant Specific Environmental Management Measure(s) (see Chapter 5)*
Surface Water Quality – Existing Water Supply Catchment Areas.		Surface water quality and quantity in existing and proposed water supply catchment areas should be protected.	None – No new land uses proposed in public water supply catchments.	Areas proclaimed as Water Reserves by WRC will be declared Special Control Areas under the Scheme. Development applications assessed in consultation with WRC.	*Country Areas Water Supply Act, 1947.* Region Scheme provisions.	
Surface Water Quality – Cumulative Impacts.	Peel-Harvey Estuary.	The cumulative impact of diffuse sources of water quality contaminants should not result in pollution. Sedimentation should not occur beyond natural levels in waterways.	Increased population in catchment may contribute increased nutrient, sediment and other pollutant loads to estuary and rivers.	Implement Water Sensitive Design in new developments.	*Liveable Neighbourhoods: Community Design Code* (1997).	2
	Marine Waters.	Nutrient export (particularly nitrogen) from the Peel Region (including the Peel-Harvey catchment) into the nearshore waters should be minimised and reduced.	Estimated 300% increase by 2021 in volume of sewage requiring treatment and disposal.	Water Corporation to investigate options for effluent disposal including land irrigation, deep ocean outfall, effluent reuse and improved nitrogen reduction in Wastewater treatment plants (WWTPs).	Licensing provisions of the *Environmental Protection Act, 1986.*	
Odour	WWTPs, poultry farms and areas where Industrial zones are adjacent to or near residential zones.	Ensure that odours from new odour-producing land uses do not adversely affect the welfare and amenity of residents in nearby existing and proposed future residential areas. Ensure that, where there is an existing odour-producing land use, new residential areas are located so that the welfare and amenity of those new residents are not adversely affected.	None – no conflict between existing or proposed odour producers and rezonings proposed by the Scheme.	Apply existing EPA and WAPC policies and procedures regarding buffer zones.	EPA draft EIA Policy No. 3. SPP No. 4: *State Industrial Buffer Policy.* SPP No. 5: *Poultry Farms Policy.*	
Air Quality	Gaseous Emissions from the Industrial zone	Gaseous emissions from industrial zones should not adversely affect the health, welfare and amenity of nearby land users.	New Industrial zone south of Amarillo. Expanded industry zone at Pinjarra.	Implement existing policies and procedures regarding setting of air quality buffers.	EPA draft EIA Policy No. 3. SPP No. 4: *State Industrial Buffer Policy.*	

Table A1 Summary of Environmental Impacts and Management

Environmental Factor	*Site-Specific Factor(s)*	*EPA Objective(s)*	*Impact(s) of the Scheme*	*Proposed Management Strategy*	*Relevant Policies, Published Management Plans and Legislation*	*Relevant Specific Environmental Management Measure(s) (see Chapter 5)*
	Regional Air Quality – Smog and Haze.	Criteria in DEP Technical Series 86 should be met.	Increased population may produce more smog and haze from vehicles, industry, fires. Evidence suggests no significant problem by 2021.	Design urban areas to minimise vehicle travel.	*Liveable Neighbourhoods: Community Design Code* (1997). Proposed EPP based on final National Environmental Protection Measure.	
Solid Waste Disposal.		There should be a reduction of 50% [per capita] in waste going to landfills achieved by waste avoidance, reuse and recycling strategies. The remaining waste should be disposed of in an environmentally acceptable manner, including landfill.	Expected 120% increase in population by 2021 could lead to increase in waste requiring disposal.	Local governments to implement waste reduction and recycling schemes. The need for a regional landfill site in the Peel Region to be monitored.	State Waste Reduction and Recycling Policy (in preparation).	
Risk and Hazard.	Industrial Areas.	Risk levels should be as low as reasonably achievable and comply with acceptable standards.	New industrial zone south of Amarillo. Expanded industry zone at Pinjarra.	Implement existing policies and procedures regarding setting of buffers.	EPA draft EIA Policy No. 3. SPP No. 4: *State Industrial Buffer Policy.*	
Urban Bushland (Local).		Protect where possible through the planning system.	Bushland at Madora, Lakelands, Melros and Point Morfitt plus smaller remnants elsewhere rezoned to Urban and Industry, to be cleared for development.	Reserve bushland assessed as regionally significant in Regional Open Space. (Note: Other remnant vegetation areas over 1ha are to be assessed prior to future Region Scheme rezonings.)	*Urban Bushland Strategy* (1995).	
DEFERRED ENVIRONMENTAL FACTORS						
Noise and Vibration from the Rapid Transit Corridor.		Noise and vibration in residential areas near land uses generating significant levels of noise should meet statutory requirements and acceptable standards.	Noise and vibration impacts from trains in new and existing residential areas near the Railways Reserve.	Assess noise and vibration impacts at pre-development stage.	EPA EIA Guidance Note for road and rail noise (in preparation).	

Table A1 Summary of Environmental Impacts and Management

Environmental Factor	*Site-Specific Factor(s)*	*EPA Objective(s)*	*Impact(s) of the Scheme*	*Proposed Management Strategy*	*Relevant Policies, Published Management Plans and Legislation*	*Relevant Specific Environmental Management Measure(s) (see Chapter 5)*
Regionally Significant Vegetation in the Rural Zone.		Ensure the abundance, diversity, geographical distribution and productivity of vegetation communities is maintained. Protect DRF and Priority Flora consistent with the provisions of the *Wildlife Conservation Act, 1950.* Ensure riparian vegetation on substantial streamlines is adequately protected.	None. However, future agricultural clearing (not requiring rezoning) could affect significant vegetation.	All Rural zone clearing in excess of 1ha assessed through Memorandum of Understanding process under provisions of Soil and Land Conservation Act, 1945, with DEP input. Other remnant vegetation areas over 1ha are to be assessed prior to future Region Scheme rezonings. All activities requiring rezoning referred to EPA.	*Soil and Land Conservation Act, 1945.* *Memorandum of Understanding (1997).* *Environmental Protection Act, 1986.*	
Regionally Significant Wetlands in the Rural Zone.		Key ecological functions of these wetlands should be protected and maintained through appropriate planning mechanisms.	None. However, future rural activities including water abstraction, clearing, drainage and fertiliser use may affect wetlands.	Future rezonings and subsequent subdivision and development subject to measures 1,2,3,4. All bores (other than private domestic bores) require licensing by WRC. Clearing governed by *Soil and Land Conservation Act, 1945.* Drainage prevented by Drainage Moratorium imposed by Minister for the Environment. Nutrient-intensive land uses subject to planning approval by local governments. Gazetted wetlands protected by *Lakes EPP.*	*Rights in Water and Irrigation Act, 1914,* *Soil and Land Conservation Act, 1945.* Memorandum of Understanding (1997). Peel-Harvey catchment Drainage Moratorium (Minister for the Environment). Mandurah, Murray and Waroona local planning schemes.	1,2,3,4 (Future Region Scheme rezonings)
	Land Use in the Catchment of Lake Clifton.	Ensure protection of stromatolites in Lake Clifton by implementing planning mechanisms so developments meet the criteria outlined in EPA Bulletin 864.	None. However, Rural zone activities (special rural, horticulture) could affect water quality of the Lake.	Implement *Coastal and Lakelands Planning Strategy*, which reflects criteria for lot sizes, land uses, drainage etc. set out in EPA Bulletin 864.	EPA Bulletin 864. *Coastal and Lakelands Planning Strategy* (1999).	1,2

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(Note: Figures for the Report are contained in the accompanying folder)

1.0 Introduction

1.1 The Proposed Scheme

The draft Peel Region Scheme ("the Scheme") has been prepared by the Western Australian Planning Commission (WAPC) as part of a program to provide greater certainty in the allocation of strategic land uses, conservation areas and transport infrastructure to key regions. Commitment to this program of region schemes is set out in the *State Planning Strategy* (WAPC, 1997).

The Peel Region, comprising the City of Mandurah and the Shires of Murray, Boddington and Waroona, is Western Australia's fastest growing region. The Region is expected to experience considerable development pressure in the coming years, generated by continued expansion of Perth's population, growth in the regional population and a rise in the level of regional economic activity.

The Scheme covers the whole of the City of Mandurah and the Shires of Murray and Waroona. It does not cover the Shire of Boddington, which is not subject to the same development pressures as the local governments on the coastal plain. The draft Scheme map is shown on Figure 1.

The Scheme is considered necessary to:

- provide a mechanism for the reservation and protection of land identified as being of regional significance for transport, economic development, conservation, recreation and public use;
- provide a mechanism for the compensation of landowners in a fair and equitable manner where land is reserved for a public purpose;
- provide an opportunity for the formal environmental assessment of regional planning proposals and thereby create increased certainty for such proposals;
- provide a mechanism to enable certain classes of development of State or regional significance to be considered and determined by the WAPC;
- identify and protect land that has strategic importance for industrial and future urban uses; and
- ensure that local governments take account of the State Government's regional planning policies and statements in the preparation of local town planning schemes.

A major purpose of the Scheme is to give statutory effect to the land use recommendations of the *Inner Peel Region Structure Plan (WAPC, 1997).*

1.2 Responsible Authority

The responsible authority for the Scheme is the Western Australian Planning Commission. In relation to the implementation of any particular part of the Scheme, the responsible authority will be the WAPC or such other authority (generally local government) as the WAPC delegates under Section 20 of the *Western Australian Planning Commission Act, 1985.*

1.3 Background to the Scheme

Regional planning for the Peel Region commenced in 1974 with the preparation of a structure plan for the South-West Corridor extending to the Peel Inlet, known as the Martin Plan (Martin, 1974). After a lengthy process of consultation, a preferred strategy plan for the South-West Corridor was adopted in 1980 (Town Planning Department, 1980).

In 1984 the *Mandurah and Districts Planning Study* was released by the Town Planning Department, a predecessor of the Ministry for Planning. The Study covered the Shires of Mandurah (as it then was), Murray, Waroona and part of Harvey, and identified potential Future Urban, Conservation, Special Rural and Industrial areas and regional roads.

In 1994 the then State Planning Commission adopted the *Peel Regional Strategy*, which covered the City of Mandurah and the Shires of Murray, Waroona and Boddington.

The *South-West Corridor Structure Plan* for the Metropolitan Region, published by the then Department of Planning and Urban Development (DPUD) in 1994, covered the north-western corner of the Peel Region as far south as Silver Sands.

In 1996 the WAPC released the draft *Inner Peel Region Structure Plan* for public comment. The draft Structure Plan covered the coastal plain from Warnbro in the City of Rockingham south to Lake Clifton in the Shire of Waroona.

Following the receipt of submissions from government agencies, private organisations and the public, the final Structure Plan was published in December 1997. The land use recommendations of the Structure Plan will be progressively implemented in the Region Scheme and subsequent amendments. The Structure Plan provides detail on the purpose and management of particular areas, particularly Regional Open Space.

Further details regarding these and other previous planning studies relevant to the Peel Region are given in the draft and final *Inner Peel Region Structure Plan* (WAPC, 1996 & 1997).

1.4 The Role of Region Schemes in the Planning Process

Region schemes provide the highest level of planning control and certainty of purpose for the allocation of strategic land uses, conservation areas, transport and industrial infrastructure. They usually involve more than one local government area.

Recent legislation allows for the preparation of statutory region schemes outside Perth. This is intended to secure the effective and coordinated planning of land use and development, and to provide a statutory mechanism in planning for change. Figure 2 illustrates the place of region schemes in the statutory planning process.

The Peel Region Scheme is the first statutory region scheme to be prepared outside the Perth Metropolitan Region. The Scheme will provide an agreed framework between State and local governments and the community by which development and environmental management can be guided. It differs from previous regional planning initiatives for the Peel Region in having the force of law and thereby exercising legal control over the use of land.

1.5 The Division 3 Environmental Approval Process

Division 3 of the *Environmental Protection Act, 1986*, as amended by the *Planning Legislation Amendment Act, 1996*, is designed to enable the assessment of land uses at the stage of rezoning rather than development. Land uses permitted under a Scheme in accordance with a zoning that has been assessed under Division 3 and found acceptable for that use (for example, residential subdivision in an assessed Urban zone) are exempt from further assessment under the Environmental Protection Act unless the responsible authority determines that:

- the environmental issues raised by the proposal were not assessed during the assessment of the Scheme; or
- the proposal does not comply with the assessed Scheme and any conditions to which the Scheme is subject.

The WAPC referred the proposed Peel Region Scheme to the EPA in August 1996, in accordance with the requirements of the *Environmental Protection Act, 1986*. The EPA determined that the Scheme should be formally assessed and in October 1996 issued instructions as to the scope and focus of the assessment. The EPA Instructions are reproduced in Appendix A.

This document has been structured in accordance with the EPA Instructions and has the purpose of describing the existing environmental characteristics of the region, the rezonings proposed under the Scheme, the potential environmental impacts of developments permitted under the Scheme, and proposed environmental management measures to be implemented as part of those developments.

This Review is available for public comment until 2 July 1999, alongside the draft Scheme map and text. Submissions on environmental matters received by the WAPC from government agencies, private organisations and individuals during that period will be considered by the WAPC, which will prepare a response that may include:

- clarification of parts of the Review to resolve misunderstandings;
- modification of the Scheme as appropriate in response to environmental issues; or
- provision of additional information to support particular proposals.

The WAPC's response, together with the Review document and the Scheme itself, will then be assessed by the EPA, which will advise the Minister for the Environment under what conditions the Scheme should be approved. The EPA's advice will be published and will be open to public appeal for two weeks.

The Minister for the Environment will then consult with the Minister for Planning regarding the conditions of approval and any other relevant matters before the conditions are set and incorporated into the Scheme.

The parallel environmental and planning approval processes for the Scheme are illustrated on Figure 3.

1.6 Legislative and Regulatory Framework

1.6.1 Key Authorities Involved in the Decision-Making Process

A number of government authorities will be involved in the decision-making process with regard to the Scheme and subsequent developments. The key decision-making authorities will be the:

- Minister for the Environment;
- Minister for Planning;
- Western Australian Planning Commission;
- Environmental Protection Authority;
- City of Mandurah;
- Shire of Murray; and
- Shire of Waroona.

1.6.2 Existing Zonings

The Peel Region is currently covered by land use zonings and local reservations of the district zoning schemes for Mandurah, Murray and Waroona. Until the Region Scheme is gazetted, these local schemes are the only statutory planning schemes in the Peel Region.

The *Inner Peel Region Structure Plan (1997)* and its predecessor, the *Peel Regional Strategy (1994)*, provides a policy guide for new zones and reserves, but is not a legal document or a statutory plan.

Under the provisions of the *Western Australian Planning Commission Act, 1985*, once the Region Scheme is gazetted, the City of Mandurah, and the Shires of Murray and Waroona will be required, within three months, to initiate amendments to their district zoning schemes so that they are consistent with the Region Scheme.

It is important to note, however, that the Region Scheme does not replace the local schemes. The more detailed zonings such as residential areas, commercial areas and local parks will continue to be defined by the district zoning schemes within the overall framework established by the Region Scheme.

1.6.3 Proposed Zonings

All areas where the Region Scheme differs from the local schemes are shown on Figure 4. Only a small number of these differences represent real, environmentally significant land use changes. These are shown on Figure 5 and their environmental implications are examined in Chapter 3 of this Review.

The majority of differences are of no environmental significance for a variety of reasons. Many are artefacts of differences in nomenclature and scale – for instance, local public open space reserved for recreation under local schemes is included in the broad Urban zoning under the Region Scheme. This does not imply any change in land use and is therefore of no environmental significance.

A number of other small apparent "changes" visible on Figure 4 are due to cadastral mismatches between the local and region schemes. In these cases, neither the actual boundaries nor the intended use of the land will change.

1.6.4 Government Policies and Guidelines

1.6.4.1 Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992

The Peel-Harvey EPP sets guiding principles for the planning and management of land use and development within the Peel-Harvey catchment, and sets statutory limits on phosphorus export from the major catchments. The Scheme implements the principles of the EPP, as described in Section 3.5.

1.6.4.2 Statement of Planning Policy (SPP) No. 2 1992

SPP No. 2 is administered by the WAPC under the powers of the *Town Planning and Development Act, 1928* (as amended). It imposes requirements on local and regional planning within the catchment of the Peel-Harvey Estuary on matters concerning drainage and nutrient management, effluent disposal systems, development density, vegetation retention and the management of public open space. SPP No. 2 implements the phosphorus export limitation requirements of the Peel-Harvey EPP and is itself implemented by the Scheme.

1.6.4.3 Environmental Protection (Swan Coastal Plain Lakes) Policy 1992

The Lakes EPP confers statutory protection from mining, drainage, effluent disposal and filling on a defined set of wetlands gazetted by the Policy Approval Order. As a rule, lakes gazetted under the Policy are those that held at least 1,000m^2 of standing water on 1 December 1991. Management issues relating to EPP Lakes are discussed in Section 3.4.

1.6.4.4 Conservation Reserves for Western Australia – System 6 ("Red Book")

The Environmental Protection Authority's 1983 System 6 Study recommended a number of areas in the greater Perth area for reservation on the basis of their ecological and/or landscape attributes. Those areas identified in the Peel Region (excluding those located within State Forest) were:

- M107 Peelhurst, Singleton and Madora;
- M108 Goegrup Lakes;
- C47 Reserve C14629, North Dandalup;
- C48 Reserve C19413, North Dandalup;
- C49 Reserve C21038, North Dandalup;
- C50 Peel Inlet (south-east corner);
- C51 Harvey Estuary (southern end and other small foreshore areas);
- C52 Lakes McLarty and Mealup;
- C53 Coolup Reserves;
- C54 Yalgorup National Park;
- C58 Reserve A23172, Harvey River; and
- C59 Reserve C22199, Wagerup.

The Scheme will significantly advance the implementation of the EPA's management recommendations for these areas. Most will be reserved as Regional Open Space without significant modification.

The boundaries of M107 in the area between Singleton and San Remo will be substantially modified to form part of a wider system of Regional Open Space including a near-continuous coastal reserve and a large area around the Paganoni Swamps. This change is discussed in detail in Section 3.1.1.

1.6.4.5 System 6 Update

In recent years there has been criticism from both government agencies and the community concerning the System 6 Red Book and the rate of implementation of its recommendations. The EPA has acknowledged these concerns and, in response, has initiated an update and review of the System 6 recommendations through the DEP.

Under the overall umbrella of the update program, four major initiatives have developed:

(i) Updating of the System 6 recommendations for the Swan Coastal Plain portion of the Perth Metropolitan Region has been incorporated in the *Perth Bushplan* (Govt. of WA, 1998), which has identified natural areas of regional conservation significance through a coordinated program involving the Ministry for Planning, DEP, CALM and the Water and Rivers Commission (WRC).

(ii) CALM has recently completed Forest Management Plans for all State Forest areas on the Darling Plateau. The State Government has endorsed these plans as an update to the System 6 recommendations for State Forest.

(iii) The System 6 Update for the remainder of the Swan Coastal Plain, including the Peel Region, is progressing at a lower level of priority than the Perth Bushplan. The update program for the Peel Region is far from complete.

To date, investigations based on floristic survey work by Gibson *et al.* (1994) and others have identified a number of occurrences of DRF and threatened flora communities in the region. These are shown on Figure 13.

(iv) Threatened and Poorly Reserved Plant Communities identified by CALM have been recognised and incorporated in the updated System 6 recommendations.

The completion date for the System 6 Update in the Peel Region is unknown at present. However, as any new areas of regionally significant vegetation become apparent through the update, they will be considered in future amendments to the Region Scheme.

1.6.4.6 International Agreements

Australia is a signatory to the:

- *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (Ramsar Convention, 1971);
- *Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment* (JAMBA, 1981); and
- *Agreement Between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment* (CAMBA, 1988).

These agreements, which were ratified under the Commonwealth *National Parks and Wildlife Conservation Act, 1975*, place an obligation on Australia to preserve important waterbird habitats.

The Peel-Harvey Estuary and the Yalgorup Lakes are among forty Australian wetlands specified in the Ramsar Convention. Thirty-four species of waterbirds listed under the CAMBA and/or JAMBA treaties have been recorded from the Peel-Harvey Estuary (ANCA, 1993).

The implications of these agreements for developments permitted under the Scheme are described in Section 3.3.

1.6.4.7 Peel Regional Park Planning Study

The Peel Regional Park Planning Study and its report, the *Peel Regional Park Proposal* (DPUD, 1993), outlined a proposal for the establishment of a regional park through the coordinated management of a number of proposed parks and reserves centred on the Peel-Harvey Estuary. The currently proposed boundaries of the park, as modified in the light of public and agency submissions, are set out in the *Inner Peel Region Structure Plan* (WAPC, 1997).

The Scheme implements the recommendations of the Peel Regional Park Proposal by reserving almost all of the land within the proposed park boundaries as Regional Open Space. Vesting and management prescriptions for particular areas within the park are detailed in the Peel Regional Park Proposal and summarised in Section 3.1.3 of this Review.

1.6.4.8 Peel Inlet Management Programme

The *Peel Inlet Management Programme* (Waterways Commission, 1992) presented recommendations for the management of particular areas throughout the Peel-Harvey estuarine system. Of particular relevance to the Scheme are those recommendations dealing with protection of waterbird habitat, as discussed in Section 3.3.

1.6.4.9 PIMA Management Policies

The Peel Inlet Management Authority (PIMA) has produced a number of Policy Statements relating to the general principles to be applied to development that might affect the Peel-Harvey Estuary. These policies apply to such matters as vegetation clearing, foreshore management, water quality protection, dredging and dredge spoil disposal. The application of these policies will be essentially unchanged by the Scheme.

1.6.4.10 WAPC Development Control Policy No. DC 6.3

Policy No. DC 6.3 introduces planning considerations in the Metropolitan Region for sources of public water supply and sensitive water resource areas. This policy was adopted in order to conserve water resources for public and private water supplies and to protect the natural environment, particularly wetlands.

The policy applies to proposed Public Water Supply Areas and Underground Water Pollution Control Areas. One such area has been identified by the Water Corporation in the Peel Region north of Pinjarra. The implications of the Scheme for this area are discussed in Section 3.7.

The policy requires the WAPC, in assessing proposals for the rezoning or subdivision of land, to take account of the effects the development would have on:

- the quality and quantity of groundwater;
- any permanent or seasonal wetland or environmentally sensitive area; and
- any natural watercourse or drain,

and may require a Water Resource Management Plan to be prepared for that area.

1.7 Scope of the Environmental Review

In setting the Instructions for the Review, the EPA identified a number of environmental factors that were considered relevant to the Region Scheme and which should be addressed by the Review. The EPA also identified the specific aspects of the Scheme to which each factor applied. These specific aspects were set out in the EPA Instructions (Appendix A) and, in some cases, clarified through subsequent discussion with officers of the DEP. Where appropriate, the specific focus of each factor is described in Chapter 3 at the beginning of the Section dealing with that factor.

In addition to the Relevant Factors, the EPA also identified three Deferred Factors that it considered could not be adequately addressed at the regional level but for which a mechanism was required to ensure that they were properly addressed at a later stage. These deferred factors are discussed in Chapter 4.

As the Division 3 assessment process has not previously been applied to a Region Scheme, this Review represents a first attempt to create a model for the assessment of future Region Schemes and Scheme Amendments.

Based on the EPA Instructions and the general requirements of Division 3, the guiding principles for the Review have been:

1. The EPA Instructions specified that the Review should focus on areas where the zoning shown in the Region Scheme differs from that shown in the existing district zoning scheme and represents a real change in land use that has the potential for adverse environmental impacts. For example, a change from Rural to Urban is regarded as a significant change.

2. Rezonings that represent a shift to a less intensive land use or no effective change (e.g. Rural to Regional Open Space or Urban to Public Purposes) are not assessed unless the new zoning or intended use of the land has specific environmental implications not applicable to the previous zoning or use.

3. Rezoning or development proposals that have already been referred to the EPA under Division 3 or Division 4 are not considered in this Review. Examples include:

   - Harbour City Stage 2 (approved – Minister for the Environment's Statement No. 341, February 1994);
   - South Yunderup (assessed – EPA Bulletin 844; April 1997);
   - Point Grey Development (currently being assessed under Division 3);
   - Lot 22 Corio Road, Ravenswood (referred to the EPA in January 1993 – EPA advisory letters 7 May 1993 and 8 September 1993 refer); and

- Perth-Bunbury Highway – Peel Deviation (currently being assessed via Public Environmental Review under Division 4).

4. Existing district scheme zonings in the Scheme are not considered in the Review, except to the extent that they contribute to regional factors such as population. Proposed developments within these zones may therefore be subject to referral to the EPA under Division 4 if they have the potential to impact significantly on the environment.

1.8 Consultations with Relevant Agencies

During the preparation of the draft Scheme and this Review, extensive consultation has been undertaken with government departments, local governments and other interested parties. Further consultation will occur with these parties and with members of the public during the public review and finalisation of the Scheme.

Consultations undertaken to date specifically for the Environmental Review are summarised in Table 1.

Table 1 Consultations Undertaken for the Environmental Review

Organisation	*Consulted with*	*Main topic(s) discussed*
Ministry for Planning	C. Bulstrode, D. Nunn, R. Griffiths, M. Ward, I. McRae	Planning issues, overall structure of Review.
Department of Environmental Protection	G. Middle, B. Keighery, G. Whisson	EPA Instructions, focus of Review. System 6 Update.
City of Mandurah	B. Bunny K. Carman-Brown D. Shepherd J. Hofland	Coastal planning, remnant vegetation. Population distribution. Waste disposal. Planning approvals for horticulture.
Shire of Murray	B. Flugge R. Davies	Pinjarra industrial area. Planning approvals for horticulture.
Shire of Waroona	E. Gude	Planning approvals process.
Water and Rivers Commission	A. Tomlinson T. Rose L. Brouwer R. Sheridan S. Chase	Paganoni Swamps hydrology. Peel-Harvey Estuary water quality. Peel-Harvey Estuary water quality. Karnup-Dandalup Groundwater Scheme. Water resources.
Department of Transport (Maritime)	R. Mahoney	Peel-Harvey Estuary tides.
Main Roads WA (Bunbury)		Assessment of Perth-Bunbury Highway (Peel Deviation).
Water Corporation	G. Brown (Bunbury) M. Martin	Wastewater Treatment Plants. Karnup-Dandalup Groundwater Scheme.
Department of Conservation and Land Management (CALM)	M. Love (Mandurah) J. Lane (Bunbury)	Remnant vegetation, reserves. Waterbird habitats.

2.0 The Existing Environment of the Peel Region

The environmental characteristics of the Peel Region have been described in a number of previous planning documents including the *Mandurah and Districts Planning Study* (TPD, 1984), the *Peel Regional Strategy* (DPUD, 1994) and the draft and final *Inner Peel Region Structure Plan* (WAPC, 1996 & 1997). Particular aspects of the regional environment have also been described in the *Peel Inlet and Harvey Estuary Management Strategy* (Kinhill, 1988), the *Amarillo PER* (BBG, 1996) and the *Point Grey Section 48 Environmental Review* (BBG, 1997).

Much of the environmental information relevant to this Review has been captured in Geographic Information System (GIS) format by a number of government agencies and made available to the Ministry for Planning for use in preparing the Scheme and this Review.

A summary of the relevant environmental characteristics of the Region, drawn from these sources, is presented below.

2.1 Climate

The Peel Region has a temperate Mediterranean climate, with hot dry summers and mild wet winters.

During summer (November to April), high pressure systems create a typical cycle of light morning easterly land breezes and fresh afternoon south-westerly sea breezes. The average rainfall between September and April is 121mm in Mandurah and 136mm in Pinjarra.

In winter, low pressure systems and cold fronts bring south-westerly winds and rainfall to the region. The average winter rainfall (May to October) is 763mm in Mandurah and 820mm in Pinjarra. Rainfall reaches a peak of about 1200mm per annum at the top of the Darling Scarp, then diminishes rapidly further to the east.

The highest temperatures in Mandurah occur in February, with an average maximum of 29°C and an average minimum of 17.9°C. Maximum temperatures in Pinjarra are often up to 10°C hotter than those in Mandurah when the sea breeze fails to penetrate inland.

The coldest month is July, with Mandurah having an average July maximum of 17.5°C and an average minimum of 9.4°C. Winter minima decrease away from the coast, with occasional frosts occurring in inland areas.

2.2 Landforms and Soils

The physical make-up of the Peel Region has four distinct major elements, each with its own environmental characteristics. These are:

- the coastal dunes;
- the estuarine soils and waterways of the Peel-Harvey Estuary and the lower tidal reaches of its major tributaries the Serpentine, Murray and Harvey Rivers;
- the inland plains, consisting of flat, low-lying, heavily cleared and frequently saturated land; and
- the mostly forested hills, upland plains and valleys of the Darling Scarp and Darling Plateau.

The soil and landform units which make up these elements are mapped on Figure 6 and are discussed briefly below.

2.2.1 The Coastal Zone

The coastal zone comprises landforms, soils and vegetation of the coastline itself and the Quindalup and Spearwood Dune sequences.

(i) Coastline

The coastline of the Peel Region consists mostly of sandy beaches that are partly protected from ocean swells by fringing and offshore reefs. The coastline is dynamic, with significant erosion and accretion of sand occurring in different areas continually, seasonally or in response to severe short-term events such as cyclones (B. Bunny, City of Mandurah, pers. comm.). Hard (limestone) coast occurs only in a few isolated areas, such as at Dawesville and Halls Head.

(ii) Quindalup Dune System

The Quindalup Dunes are the most recent landforms on the Swan Coastal Plain and are formed of calcareous marine sand that has been deposited on the beaches and blown inland to form parallel beach ridges and nested parabolic dunes.

The soils of the Quindalup Dunes are loose, well drained and contain little organic matter. The older dunes generally have a core of limestone formed by *in situ* leaching of calcium carbonate.

(iii) Spearwood Dune System

The Spearwood Dunes consist of gently to moderately inclined parallel ridges of Tamala Limestone overlain by variable depths of well-drained, siliceous yellow-brown sands.

To the west, limestone is frequently exposed near the surface with shallow, yellow soils (Cottesloe Association). Further inland, the sands are deeper and browner with a more developed soil structure and overlie pinnacle limestone (Karrakatta Association). In some areas, particularly around the coastal lakes, gently undulating terrain overlies marine limestone terraces (Yoongarillup Association).

(iv) Herdsman Unit

The Herdsman Unit underlies the larger swamps within the Spearwood and Bassendean Dune Systems. The soils consist of black organic sands, peaty loams, black clays and peat.

2.2.2 The Peel-Harvey Estuary

(i) Vasse Estuarine and Lagoonal System

The Vasse System comprises low-lying, poorly-drained terraces, flats and beach ridges fringing Peel Inlet, Harvey Estuary, the coastal lake system and the major river mouths. The soils are extremely variable, being formed on unconsolidated Holocene estuarine alluvium and lagoonal deposits, and are often highly saline and subject to periodic inundation.

2.2.3 The Inland Plains

The inland plains include the low dunes and swales of the Bassendean Dune System, in addition to alluvial soils associated with the floodplain of the Murray River and the Pinjarra Plain. Over most of this area, the low relief and high groundwater tables cause widespread seasonal saturation and flooding.

(i) Bassendean Dune System

The Bassendean Dune System, comprising the Bassendean and Southern River Soil Associations, is located immediately east of the Spearwood system and features wide sandy flats and seasonal swamps interspersed with low dunes. The most common soils are highly leached, grey siliceous sands, often underlain by an iron-organic hardpan.

The Southern River unit occurs where Bassendean unit sands have been blown over alluvial silts of the Guildford unit.

(ii) Swan Association

The Murray River floodplain is made up of a complex series of alluvial soils transported from inland areas of the Darling Plateau and collectively known as the Swan Association. Prior to the damming of the Murray River, these soils were subject to regular flooding and deposition of additional silt.

(iii) Pinjarra Plain

The Pinjarra Plain comprises the Forrestfield, Guildford and Cannington Soil Associations. The undulating plain rises gently toward the east, from about 15m AHD at its junction with the Bassendean Dune System to 40m AHD at the edge of the Ridge Hill Shelf in the foothills of the Darling Scarp.

The plain consists of riverine soil deposits that have washed down from the Scarp. Duplex (sand over clay) soils are common. Drainage is generally poor, with frequent swamps and widespread seasonal waterlogging.

2.2.4 The Darling Scarp and Plateau

The Darling Scarp rises steeply from about 40m AHD at the Ridge Hill Shelf to over 250m AHD on the plateau. The face of the Scarp is deeply cut by major and minor valleys with local relief of up to 200m and slopes of up to 30. The slopes are covered by erosional soils with frequent granite outcrops.

The lower slopes and floors of the major valleys generally have well-developed, fertile soils consisting of red and yellow earths and loams.

The plateau surface is mantled by gravelly and sandy soils of the Dwellingup and Yalanbee units, mostly underlain by lateritic caprock over clay and granite. The lateritic rises are interspersed with silty clays in minor valleys and deep leached sands in swampy depressions.

2.3 Surface Water

The surface drainage of the region originates in the headwaters and tributaries of the Serpentine, Murray and Harvey Rivers east of the Darling Scarp. The Serpentine River has been dammed for public drinking water supply while the Harvey River has been dammed for irrigation water. The Murray River is the major drainage feature of the region.

Apart from being crossed by the three major rivers, the coastal plain has no significant, defined natural surface drainage. Instead, most drainage under natural conditions was by slow westward movement of shallow groundwater.

With the development of agriculture in the region, a comprehensive network of artificial drains was developed to reduce waterlogging. As a result, most of the coastal plain in the region is now drained either into one of the major rivers or, via trunk drains, directly into the Estuary.

The existing natural and artificial drainage of the Region is mapped on Figure 7.

2.4 Groundwater

An unconfined aquifer is developed in the sand and limestone that make up the superficial formations.

The Superficial aquifer is recharged directly by rainfall and also in places by upward leakage from the underlying Leederville Formation. Groundwater flow in the Superficial aquifer is generally westerly.

Groundwater contours for the Superficial aquifer are mapped on Figure 7.

Beneath the Superficial aquifer is a confined or semi-confined aquifer known as the Leederville Formation. The Leederville is an important

drinking and irrigation water source but has no bearing on the Region Scheme.

2.5 Wetlands

2.5.1 Wetland Occurrence

Wetlands of various types are a dominant feature of the coastal plain in the Peel Region, ranging from the major water bodies of the Peel-Harvey Estuary and pools on the Serpentine River to the seasonally-inundated palusplain that makes up much of the inland plains. Virtually the entire coastal plain east of the Serpentine River and Peel-Harvey Estuary consists of wetlands of one kind or another.

The wetlands of the Peel Region are mapped on Figure 8. For the remainder of this Review, the term "wetland" will be taken to exclude estuaries and rivers, as these are dealt with separately.

Much of the wetland area shown on Figure 8 has been so comprehensively altered by agricultural clearing over the years as to be scarcely recognisable as wetland, having little or none of its original wetland vegetation remaining. Most of the basin wetlands east of the Serpentine River and the Peel-Harvey Estuary appear as no more than shallow depressions in broadacre pasturelands, where the grass may stay slightly greener than their surroundings during summer.

Closer to the coast, Lakes Clifton and Preston and other wetlands of the Yalgorup Lakes chain remain well preserved and relatively undisturbed, although they are currently under pressure from adjacent intensive agriculture and Rural-Residential developments.

Many of the wetlands within the Peel Region are protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (the Lakes EPP). The wetlands protected under the Lakes EPP are shown on Figure 8. The implications of the Scheme for management of EPP lakes are discussed in Section 3.4.

2.5.2 Wetland Classification

EPA Bulletin 686 described a wetland evaluation and classification method by which specific wetlands may be classified into one of five management categories, based on the human and environmental values evident in their natural attributes. For each of the five management categories there were complementary management objectives.

The second volume of the WRC's *Wetlands of the Swan Coastal Plain* series (Hill *et al.*, 1996), commonly known as the Wetland Atlas, mapped all wetlands on the Swan Coastal Plain between Wedge Island and Pinjarra and assigned provisional management objectives to each, based on a simplified system of three management categories (Conservation, Resource Enhancement and Multiple Use), as summarised in Table 2.

The assignment of management categories to the wetlands within the Peel Region by the Wetland Atlas is shown on Figure 9. A future addition to the Atlas is planned to cover the area from Pinjarra south to Dunsborough.

The Wetland Atlas is used as a guide by the EPA and the WRC in assessing proposals that may affect wetlands protected by the Lakes EPP, as well as other wetlands potentially affected by developments.

Table 2 Preliminary Management Categories and Objectives as proposed by the Wetland Atlas (Hill et. al., 1996)

Management Category	*General Description*	*Management Objectives*
C Conservation	Wetlands which support high levels of natural attributes and functions.	To preserve wetland attributes and functions through reservation in national parks, crown reserves, state owned land and protection under environmental protection policies.
R Resource Enhancement	Wetlands which have been partly modified but still support substantial natural functions and attributes.	To restore wetlands through maintenance and enhancement of wetland functions and attributes by protection in crown reserves, state or local government owned land and by environmental protection policies, or in private property by sustainable management.
M Sustainable Use-Multiple Use	Wetlands with few attributes which still provide important natural wetland functions.	Use, development and management should be considered in the context of water (catchment/strategic drainage planning), town (land use) and environmental planning through landcare.

2.6 The Peel-Harvey Estuary

2.6.1 Introduction

The Peel-Harvey Estuary is a shallow coastal lagoon with an area of 133km^2. Since the 1960s the water quality of the estuary has become seriously degraded as a consequence of high nutrient inputs from agricultural land in its catchment and an inherently slow rate of flushing.

The estuary has suffered from severe algal blooms since the late 1970s, driven by excessive input of phosphorus from the catchments of the estuary's three main tributary rivers (Serpentine, Murray and Harvey) and agricultural drains, and by the release of phosphorus from the sediments to the water column during periods of anoxia. The algal bloom cycle in the estuary has been well described elsewhere (e.g. Gorham *et al.* 1988; Kinhill 1988; EPA 1985, 1988).

Management of land use in the catchment aimed at reducing phosphorus exports has been implemented during the last decade under both planning and environmental legislation. The Dawesville Channel, opened in April 1994, was designed to reduce eutrophication by flushing nutrient-rich water to the ocean and to preclude blooms of the dominant blue-green alga *Nodularia* by modifying the salinity regime in the estuary. The hydrodynamics and water quality of the estuary have changed significantly since the channel was opened.

2.6.2 Inflows and Outflows

Fresh water flows into the Peel-Harvey Estuary from the Harvey, Serpentine and Murray Rivers, several major agricultural drains and direct groundwater inflow. Large volumes of seawater flow into and out of the estuary via the Mandurah and Dawesville Channels. These inflows and

outflows exert the primary influence over the hydrodynamics and water quality of the estuary.

The Dawesville Channel has significantly improved tidal exchange between the estuary and the ocean, as predicted in Kinhill (1988) and discussed more recently by the Department of Transport with the benefit of more detailed data (Department of Marine and Harbours, 1993 & 1994).

The total tidal exchange between the estuary and the ocean is now estimated to be four times greater than it was prior to the opening of the Dawesville Channel. Annual tidal exchange is now ten times the annual average freshwater inflow and 56 times the estuary's total volume. This greatly improved flushing has mostly affected Harvey Estuary, with a lesser but still significant effect on Peel Inlet (Department of Marine and Harbours, 1993 & 1994).

2.6.3 Water Quality

2.6.3.1 Salinity

The salinity of the Peel-Harvey Estuary varies with river flow, oceanic inflow and evaporation.

The salinity regime of Harvey Estuary has changed substantially since the Dawesville Channel opened. Prior to the opening of the Channel, the Harvey Estuary salinity ranged from brackish (5 parts per thousand (‰) TDS) in late winter to hypersaline (50‰) in late summer. Since the opening of the channel, the surface salinity in the northern part of Harvey Estuary has generally remained within the range 10-40‰. Maximum salinities at the southern end of Harvey Estuary have continued to reach pre-Dawesville Channel levels.

Salinity in Peel Inlet always varied less than in Harvey Estuary, and the Dawesville Channel has had a much smaller impact there. The salinity of Peel Inlet now generally ranges between 10‰ in winter and 45‰ in late summer (Wilson and Latchford, 1995).

2.6.3.2 Dissolved Oxygen

Dissolved oxygen levels in the Peel-Harvey Estuary vary with the oxygen content of incoming waters, mixing of the water column and algal population dynamics. Prior to the opening of the Dawesville Channel, seasonal stratification of the water column and accumulation of decaying macrophytes on the bottom led to deoxygenation of the bottom waters, causing the release of phosphorus from the sediments.

Monitoring data since the opening of the Dawesville Channel have shown a very marked improvement in dissolved oxygen concentrations. Summer concentrations have remained at or above saturation throughout the water column. In winter, the bottom waters of Harvey Estuary continue to carry less oxygen than the surface waters but have generally remained more than 50% saturated (Wilson and Latchford, 1995). An episode of anoxia was recorded in bottom waters of the southern Harvey Estuary, but all other data indicate greatly improved water quality since the Dawesville Channel was opened (Wilson and Latchford, 1995).

2.6.3.3 Water Clarity

Water clarity in the Peel-Harvey Estuary is affected by phytoplankton blooms, tannin-stained river water and suspended sediments. Water clarity is generally highest in late summer, and lowest in late winter and early summer with the advent of algal blooms.

Following the opening of the Dawesville Channel, water clarity in Harvey Estuary increased immediately and has remained higher than before the channel, except during sediment resuspension events in summer (Wilson and Latchford, 1995). Phytoplankton concentrations in the estuary have not reached bloom conditions and are generally very low (Wilson and Latchford, 1995; Lavery *et al.*, 1995).

Water clarity strongly influences the growth of benthic macrophytes. Clear water entering

through the Dawesville Channel has been predicted to stimulate increased growth of benthic macroalgae (eg *Cladophora)* and seagrass (eg *Halophila)* due to increased light penetration. No data are yet available to ascertain whether this has occurred.

2.6.3.4 Nutrients

The Dawesville Channel and prior dredging in the Mandurah Channel have improved the nutrient status of the Peel-Harvey Estuary through enhanced export of nutrient-rich river water. This would be aided by the inhibition of *Nodularia* blooms by the increased salinity of Harvey Estuary, which would reduce phosphorus uptake and deposition in the sediments. The continued flushing of the estuary by the Dawesville Channel is likely to cause a progressive decrease in stored and available nutrients.

2.7 Vegetation and Flora

2.7.1 Vegetation

The natural vegetation of the Peel Region is closely associated with the dominant landforms and soils. Vegetation complexes mapped by Heddle *et al.* (1980) are shown on Figure 10.

From the beach, succulent herbs and spinifex grasses give way to low shrubs and coastal heath on the younger Quindalup Dunes. Behind the first dunes, a taller shrubland including Peppermint and Acacias is present. On the older, more inland Quindalup Dunes, the more fertile soils support Peppermint, Acacia and Tuart woodlands in addition to shrubs.

The vegetation of the Quindalup dunes is generally poorly reserved throughout the Swan Coastal Plain but is well reserved in the Peel Region, largely in Yalgorup National Park. About half of the original extent of the Quindalup Complex in the region remains, and about 21% is currently reserved for conservation (GIS data supplied by Agriculture WA and CALM).

The Spearwood Dunes support a range of woodlands and forests, with Banksias usually either making up the overstorey or forming a second storey beneath Tuart or Jarrah. The deeper soils of the Karrakatta Association generally support taller and more diverse vegetation than those of the Cottesloe Association. On the Yoongarillup Plain, Coastal Peppermint forests, with or without an overstorey of Tuart, occur above a shrub layer of Acacias and Melaleucas.

The Spearwood vegetation associations have been cleared over 50-70% of their original range within the Peel Region. Their current degree of reservation (in conservation reserves) ranges from 4% for the Karrakatta Complex-Central & South to 14% for the Yoongarillup Complex.

The Bassendean soils are dominated by Jarrah-Banksia-Sheoak woodlands on the dunes, with Melaleuca shrublands and sedgelands in the interdunal swales and swamps and a Flooded Gum-Swamp Banksia-Peppermint woodland along the streams.

The vegetation of the Bassendean system is heavily cleared and poorly reserved in the Peel Region and throughout the Swan Coastal Plain. Less than 14% of the original extent of the Bassendean Complex-Central & South and 22% of the Southern River Complex remain in the Peel Region, and the areas currently reserved within the region are only 3.5% for the Southern River Complex and less than 0.1% for the Bassendean Complex.

The Murray River valley supports a Flooded Gum-Swamp Paperbark forest of the Swan Complex. This vegetation has been heavily cleared since the commencement of settlement in the region so that less than 15% of its area remains, mostly as disturbed remnants. None is currently reserved for conservation in the region.

The Pinjarra Plain supports an open forest of Marri-Wandoo-Jarrah and Jarrah-Banksia woodland of the Guildford, Forrestfield and

Cannington Complexes. Being dominated by useful timber species and located on prized agricultural soils, these complexes have all been more than 90% cleared across the region since European settlement, and none is currently reserved for conservation in the region.

The Darling Scarp and Plateau are dominated by Jarrah-Marri forest and Wandoo woodland interspersed with shrublands and sedgelands on rock outcrops and in swampy depressions. As most of this area is State Forest, the vegetation complexes associated with the Scarp and plateau have suffered only minor clearing and, although little area is reserved specifically for conservation, the majority is managed for multiple uses including conservation within the framework of CALM's management plans for State Forests.

Figure 11 shows the distribution of remnant vegetation within the region, as mapped by the Department of Agriculture. Being compiled largely from aerial photography, the accuracy of the mapping varies, particularly in the distinction between the "remnant" (essentially undisturbed) and "modified" (moderately disturbed) categories. The map does, however, illustrate the varying degrees of clearing across the region.

2.7.2 Flora

CALM holds a large database of known occurrences of DRF and Priority Flora in the Peel Region. The known DRF occurrences are shown on Figure 13.

A recent floristic analysis of existing reserves on the southern Swan Coastal Plain by Gibson *et al.* (1994) identified 43 floristic community types, of which 20 were judged to be threatened or poorly reserved.

Floristic analysis represents a different approach to the vegetation complexes described by Heddle *et al.* (1980), and can produce somewhat different assessments as to the status of different vegetation types.

Because floristic analysis is primarily a site-specific analysis method, its applicability to broad-scale mapping is limited. However, the DEP is currently reviewing floristic community data for the southern Swan Coastal Plain as part of the System 6 Update (Section 1.6.4.5) and has so far identified a number of specific sites within the Peel Region where threatened flora communities are known to occur. These are shown on Figure 13.

The System 6 Update in the Peel Region is still at an early stage. It is therefore likely that further sites will be identified where threatened flora communities or species are present. Environmental Management Measure No. 4 in Chapter 5 is proposed to ensure that vegetation surveys are carried out prior to any future rezoning in the Scheme, which could lead to the clearing of more than 1ha of native vegetation (clearing of rural land is governed by a separate process, as described in Section 4.3).

2.8 Fauna and Habitats

2.8.1 Terrestrial Fauna

A wide range of native terrestrial fauna would once have occupied the rich habitats of the Peel Region. In developed parts of the Region, the native fauna have mostly declined along with their habitat so that, in the most heavily cleared areas, only the most disturbance-tolerant species remain. Apart from clearing, the most serious impact on the smaller ground-dwelling native fauna has probably been predation by introduced species such as foxes and cats.

The larger areas of remnant vegetation still provide valuable habitat for a range of native species. The largest such areas on the coastal plain are Yalgorup National Park and the eastern margin of the Peel-Harvey Estuary.

The habitat value of smaller areas of remnant vegetation can be enhanced by maintaining or re-establishing vegetated links between bushland areas to create contiguous habitats.

The large expanse of State Forest east of the Scarp constitutes by far the largest area of relatively undisturbed habitat in the Region. The habitat values of the State Forest are managed as part of a multiple-use regime in accordance with CALM forest management plans.

2.8.2 Waterbirds

Peel Inlet is listed as the fourth most important area in Western Australia in terms of the number of shorebird species for which it is internationally and nationally important (Watkins, 1993), and is recognised as the most important habitat in south-western Australia for waterbirds. It is listed in the Ramsar Convention as a wetland of international significance.

The high usage of the Peel-Harvey Estuary by waterbirds is one of the highest conservation values of the Peel Region. The protection of waterbird habitats from conflicting uses is a primary aim of both the *Peel Inlet Management Programme* (Waterways Commission, 1992) and the *Peel Regional Park Proposal* (DPUD, 1993).

The Peel-Harvey Estuary normally supports more than 20,000 waterbirds, including 27 species cited in Japan/Australia (JAMBA) and China/Australia (CAMBA) Migratory Bird Agreements (Ninox, 1996). A significant portion of the estuary is contained within System 6 areas C50, C51 and C52, which are recommended for reservation for conservation, including waterbird protection.

Eighty four waterbird and water-associated species have been recorded at the estuary and its peripheral wetlands (Ninox, 1996). Surveys by the RAOU (Jaensch *et al.*, 1988) have recorded more than 100,000 individual waterbirds using the estuary during a single month. These waterfowl predominantly utilise the shallows of the eastern and southern shores of Peel Inlet and southern Harvey Estuary. Wading birds use these areas and the shallows at the northern shore of Peel Inlet as feeding grounds.

The estuary is also considered to be important as a drought refuge when inland wetlands dry out. Very high concentrations of wading birds, such as the banded stilt, have been recorded at the estuary during such conditions.

The most important waterfowl habitats in the estuary are salt marshes and intertidal and shallow subtidal areas, which are the critical habitats for migratory waterbirds recognised by the JAMBA and CAMBA agreements. These habitats are mapped on Figure 12.

3.0 Environmental Factors Relevant to the Scheme

3.1 Vegetation, Fauna and Habitat in the Existing and Proposed Conservation Estate

EPA Objective:
Vegetation, fauna and habitat in the existing and proposed Conservation Estate should not be adversely affected.

The aim of nature conservation planning is to ensure the conservation, in perpetuity, of the biological diversity of a region. To achieve this, it is essential to maintain the habitat and ecological and evolutionary processes that will maximise the long-term persistence of species and communities.

Conservation through reserves is one way of achieving this aim. Reserves are selected which broadly represent landforms, marine habitats, biogeographic districts and biota. Also included are special areas which include rare species or communities, geographic outliers and unique or spectacular landforms.

In 1992 CALM published the draft *Nature Conservation Strategy for Western Australia* which stated, among its objectives, to:

"Complete the conservation reserve system by selecting, reserving and managing viable protected areas broadly representative of the natural ecosystems and species of Western Australia and including areas with special landscape, cultural and educational values."

This is to be achieved by:

- continuing to support the implementation of the EPA Red Book and other existing recommendations for additional conservation reserves; and
- identifying and protecting the most threatened habitats by reservation of public land or, in the case of private land, by land purchase or by negotiation with landholders as necessary.

The existing Conservation Estate is managed by CALM and includes:

- Nature Reserves;
- National Parks;
- 5(g) Reserves; and
- Other areas managed for conservation by CALM.

The proposed conservation estate includes:

- areas recommended for conservation by the System 6 study; and
- areas recommended by WAPC (1997) for inclusion in the Peel Regional Park.

The Conservation Estate thus defined is shown on Figure 13.

The Regional Open Space (ROS) proposed by the Scheme effectively encompasses all of the existing Conservation Estate, almost all of the proposed Peel Regional Park and most System 6 areas. The ROS also includes additions to Yalgorup National Park proposed in the *Yalgorup National Park Management Plan* (CALM, 1995).

Figure 13 shows the ROS proposed in the Scheme in relation to the existing and proposed Conservation Estate. Impacts and management of the Scheme on particular aspects of the Conservation Estate, as identified by the EPA Instructions, are discussed below.

3.1.1 Changes to the Boundaries of System 6 Area M107

Background

M107 consists of a narrow (500m) north-south strip of Rural-zoned former grazing land west of Mandurah Road, with narrow east-west corridors extending to the coast as Peelhurst, Singleton, Madora and San Remo. About one third of M107 is within the Peel Region.

The landform of M107 consists of coastal dunes and swales of Holocene and Pleistocene ages, including a small part of the southern extremity of the Rockingham-Becher beach ridge plain, which is better represented and extensively reserved at the Port Kennedy Scientific Park (System 6 Area M106). The western edge of M107 corresponds approximately to a prominent north-south line of parabolic dunes, which also marks the boundary between the beach ridge plain and the inland plain that makes up most of M107.

The vegetation of M107 consists of coastal dune scrub that has been degraded by grazing, fire, vehicular traffic and other disturbances.

The System 6 Red Book stated in relation to M107 that:

"The area has extensive coastal dunes which are very valuable for their coastal vegetation and for recreational and aesthetic reasons. Buffer zones of uncleared land should be left to preserve some segments of the scenery and vegetation near the main Mandurah Road and between areas of housing. ... These buffer zones would restrict housing to west of the dune ridge, and provide east-

west links of vegetation between Mandurah Road and the coast. The present practice of excluding housing from a strip adjacent to the shore should be continued."

The Red Book's recommendations for M107 included:

"M107.3 ... ways and means of protecting the area's recreational and landscape values be sought through planning procedures."

In relation to the Red Book description, it is noted that there are in fact few coastal dunes in the part of M107 within the Peel Region, as the coastal dunes mostly occur further to the west.

In 1994 the Minister for the Environment, in determining appeals in relation to the EPA's recommendations on the South West Corridor Structure Plan (Bulletin 746), confirmed the primacy of the planning process as the appropriate vehicle for implementing the intentions of the System 6 recommendations for M107.

Impact of the Scheme

Parts of System 6 Area M107 totalling about 110ha between Singleton and San Remo, at the north-west corner of the Scheme Area (Figure 14), are proposed to be rezoned from Rural to Urban.

Of the 201ha of M107 that lies within the Peel Region, the following mix of zonings and reservations will apply following the implementation of the Scheme:

- Rezoned to Urban: 88ha
- Rezoned to Urban Deferred: 50ha
- Already developed for Urban: 5ha
- Reserved as Regional Open Space: 6ha
- Left as Rural: 52ha.

Proposed Management

Based on the EPA Red Book recommendations, the EPA's statements in Bulletin 746 and the Minister for Environment's statements (1994), the principal objectives for M107 are considered to be:

(a) representative reservation of landforms and vegetation in conservation reserves;

(b) preservation of the essential landscape features;

(c) maintaining a foreshore reserve to protect the vegetation and public amenity of the coastal dunes; and

(d) vesting and management of the reserve.

The approach taken by the Scheme to achieving these objectives is set out below.

(a) Representative Reservation of Coastal Landforms and Vegetation in Conservation Reserves

The landforms and vegetation (Quindalup and Cottesloe-Central & South complexes) present in M107 are extensively represented in Yalgorup National Park and in Regional Open Space at Port Kennedy.

Overall, 28% (1,519ha) of the original extent of the Quindalup vegetation complex in the Peel Region (not including Port Kennedy) is reserved as Regional Open Space in the Scheme.

A small area (about 60ha) of the Rockingham-Becher beach ridge plain occurs in M107 in the Peel Region. Most of this will be rezoned to Urban or Urban Deferred, with about 5ha being included within in Regional Open Space. However, more than 1,700ha of the Rockingham-Becher beach ridge plain is reserved in Regional Open Space within the Port Kennedy and Rockingham Lakes Regional Park (WAPC, 1997).

It is therefore concluded that the principal landforms and vegetation present in

M107 are well reserved nearby and will not be significantly affected by the Scheme.

(b) Preservation of the Essential Landscape Features

The essential landscape features of M107 are:

- the prominent sand dune ridge visible from Mandurah Road;
- the unbuilt strip between Mandurah Road and the dune ridge; and
- the coastal dunes (as seen from the beach).

These features will largely be preserved within Regional Open Space and Urban areas as follows:

- About half of the undeveloped strip west of Mandurah Road will be rezoned to Urban Deferred, with the rest remaining Rural. Lifting of Urban Deferment in this zone will be subject to resolution of outstanding planning issues including landscape.
- The dune ridge will remain, despite being partly subject to urban development. The western boundary of the proposed Urban zone immediately north of the existing Madora residential area has been modified from what was shown in the *Inner Peel Region Structure Plan* to exclude the dune ridge.
- The coastal dunes are protected by a new continuous foreshore reserve.

It is therefore concluded that the essential landscape features seen from the road and the coast will be retained under the Scheme.

(c) Maintaining a Foreshore Reserve to Protect the Vegetation and Amenity of the Coastal Dunes

The Mandurah district zoning scheme shows a narrow (<100m) strip of Public Open Space along the foreshore opposite Madora and San Remo.

The *South West Corridor Structure Plan* and subsequent draft *Inner Peel Region Structure Plan* followed the Mandurah model, reserving a relatively narrow strip of ROS along the coast and a narrow linkage from the coast to the Paganoni Swamps at the northern edge of the existing Madora townsite.

The final *Inner Peel Region Structure Plan* showed a substantial coastal foreshore reserve north of the existing Madora residential area, however, following further planning investigations and site inspections, the proposed reservation was redefined. The proposed coastal Regional Open Space reservation for north Madora now varies in width from about 120 metres to 200 metres, which is still considerably wider than the foreshore shown in the draft Structure Plan.

South of the existing Madora residential area, the proposed coastal Regional Open Space reservation is approximately 140 metres in width.

(d) Vesting and Management of the Reserve

All Regional Open Space in M107 within the region is shown in the final Structure Plan as "Open Space – Conservation" and will be managed for that purpose by the City of Mandurah.

The foreshore reserve will be managed by the City of Mandurah for a combination of conservation and

recreation in accordance with the *Mandurah Coastal Strategy* (City of Mandurah, 1996).

Conclusion

The Regional Open Space proposals for Singleton-San Remo are considered more appropriate than those shown in the previous planning studies for the area and are considered to meet the Minister for the Environment's requirements in terms of implementation of the Red Book recommendations for System 6 Area M107.

The management of the interface impacts where the proposed urban areas abut those areas of M107 to be reserved for Regional Open Space under the Scheme will be ensured by the provisions of Environmental Management Measure No. 1 in Chapter 5.

3.1.2 Dunkerton-Husband Road Crossing over System 6 Area M108

The Shire of Murray has advised the Ministry for Planning (B. Flugge, 1998 pers. comm.) that, in view of recent rezonings and subdivisions in the Barragup area, a connection between Dunkerton and Husband Roads over the Serpentine River (M108) is no longer possible or proposed. This factor is therefore no longer relevant to the Scheme.

3.1.3 Peel Regional Park

Background

The System 6 Red Book (DCE, 1983) recommended that a Regional Park be established over the area surrounding the Peel-Harvey Estuary and the adjacent Yalgorup Lakes.

Acting on the Red Book recommendations, the draft *Peel Regional Park Proposal* (DPUD, 1993) identified a number of areas associated with the Peel-Harvey Estuary, its major tributaries and associated wetlands as having priority for conservation, and made recommendations for their vesting and management.

The Peel Regional Park will be part of a regional network of national and regional parks that extends from the Beeliar Regional Park, through Leda Regional Open Space, Port Kennedy and Rockingham Parks, Anstey Swamp and Paganoni Wetlands in the Perth Metropolitan Region, to the proposed Serpentine and Peel Regional Parks and Yalgorup National Park in the Peel Region, and on to the South-West Region.

The draft *Peel Regional Park Proposal* mainly comprised those parts of the foreshores and fringing vegetation of the Peel-Harvey Estuary and the Murray, Serpentine and Harvey Rivers that were in public ownership. It also identified a number of privately-owned areas of foreshore that could be acquired for inclusion in the park during subdivision, rezoning or development.

The final *Inner Peel Region Structure Plan* (WAPC, 1997) incorporated and, in many cases, expanded the boundaries of the Peel Regional Park.

The Peel Regional Park as now proposed comprises about approximately 6,415 hectares and includes:

- areas along the Serpentine River and adjoining foreshore areas, including parts of the 100-year floodway as defined by the Water and Rivers Commission and some areas of good remnant vegetation;
- the Black Lake Reserve with some adjoining areas of remnant vegetation;
- the Murray River, together with a nominal minimum width of 50 metres from the High Water Mark on both sides of the river, with variations to include old river channels, EPP wetlands, significant remnant vegetation and river bends;
- the southern end of Harvey Estuary;
- foreshore reserves and other areas identified around the eastern side of the Peel-Harvey Estuary, including Lakes Mealup and McLarty and Point Grey;

- the Harvey River through the Shires of Murray and Waroona, together with foreshore buffers;
- the western foreshore of the Peel-Harvey Estuary, including the whole of Caddadup Reserve and a foreshore reserve both sides of the Dawesville Channel;
- the foreshores of the Mandurah Estuary Channel, including the Creery Wetlands; and
- all the waters of the rivers and estuary within the areas described above.

Impact of the Scheme

The Scheme will identify and enable the acquisition of land, where required, for the establishment of the Peel Regional Park, generally in accordance with the final *Inner Peel Region Structure Plan.*

Proposed Management

The Peel Regional Park includes areas that range from uncleared land and foreshores having high conservation value to cleared parkland with active recreation facilities. The differing vesting and management arrangements for these areas are described in the final *Inner Peel Region Structure Plan* (WAPC, 1997), and will include the following:

- The land proposed for inclusion in the Peel Regional Park, with the exception of the waterways and margins of the Murray River upstream (south) of Pinjarra, will be reserved as ROS in the Scheme. Special provisions for privately-owned land fringing the Murray River south of Pinjarra are discussed below.
- Following an announcement by the State Government on 8 June 1997, coordination of management of regional parks in Western Australia will be the responsibility of CALM.
- Areas identified as having a primary conservation purpose, including Yalgorup National Park, nature reserves and the foreshores of the Harvey Estuary and the Serpentine River, will be vested with the NPNCA and managed by CALM for conservation.
- Areas with a primary emphasis on recreational use rather than conservation will be vested with the relevant local government.
- Land along the Murray River north of Pinjarra will be vested with PIMA in view of its location within the PIMA management boundary, its primary landscape function and its requirement for substantial remediation to counteract bank erosion.

Privately owned land currently makes up about 35% of the proposed Peel Regional Park. As the *Inner Peel Region Structure Plan* and the Scheme are progressively implemented, opportunities for acquiring these areas will be identified. As land parcels are acquired, they will be vested with the appropriate agency for management in accordance with the principles described above.

The WAPC is the authority responsible for determining subdivision applications and will also be responsible for determining development applications on land reserved as Regional Open Space for the Peel Regional Park. When considering subdivision and development applications for freehold land within the proposed Peel Regional Park, the WAPC will have regard for any approved management plan for the Park and, when required, consider the most appropriate mechanism for securing land for the Park. Such mechanisms may include outright purchase by the WAPC, ceding as Public Open Space as part of a subdivision, or establishment of management agreements with the owners.

Ongoing management of interface impacts where proposed subdivisions and developments adjoin

the Peel Regional Park is provided for by Environmental Management Measure No. 1 in Chapter 5.

3.1.4 Fauna in the Existing and Proposed Conservation Estate

The most effective way to protect fauna is to preserve and manage its natural habitat (CALM, 1992). This is most effectively achieved by the management and protection of complete ecosystems.

The two main priorities of the Conservation Reserve System as set out in the A Nature Conservation Strategy for Western Australia (CALM, 1992) are:

- to reserve adequate representative areas to encompass the diversity of habitats and species; and
- to manage the Conservation Estate to protect ecological values including fauna habitats and populations.

The Scheme supports these priorities by reserving all of the existing Conservation Estate as Regional Open Space, with management of specific areas to be carried out in accordance with management plans prepared by the vesting agencies.

With CALM now having overall responsibility for management of all conservation areas including reserves, national parks and regional parks, management of the Conservation Estate in the Peel Region will be carried out in accordance with government-endorsed CALM management plans and policies.

Protection of regionally significant fauna habitats is further supported by Environmental Management Measure No. 1 in Chapter 5.

3.1.5 Interface Impacts

Background

When intensive land uses such as urban, industry, transportation or farming abut conservation areas, interface impacts caused by such influences as increased pedestrian traffic, weed invasion, straying pets and livestock may cause degradation at the edges of the conservation area. Narrow conservation areas with long boundaries (e.g. connecting corridors and roadside reserves) are the most susceptible to interface impacts.

Impact of the Scheme

The new Urban, Urban Deferred and Industry zonings and reservations for regional roads proposed under the Peel Region Scheme are generally well separated from the existing and proposed Conservation Estate. Only at Madora-San Remo and Yunderup do new Urban zones abut System 6 Areas M107 and C50 respectively, as shown on Figure 13.

Proposed Management

Measures that may be used to mitigate interface impacts include:

- minimising boundary-area ratios and making conservation areas sufficiently wide to withstand edge disturbances (by making connecting corridors at least 100m wide);
- providing building setbacks or buffer areas, such as passive recreation areas; and
- providing physical barriers such as fences.

The minimisation of boundary-area ratios has been addressed through the delineation of conservation Regional Open Space and connecting corridors in the Scheme.

The management of interface impacts between proposed development and Regional Open space, will be addressed through the preparation of Environmental Management Plans, as may be required by the WAPC or local government for particular subdivision or development applications.

The ongoing management of interface impacts with respect to conservation areas will be ensured

by Environmental Management Measures No. 1 (Chapter 5).

3.2 Regionally Significant Vegetation

EPA Objective:

(a) Ensure the abundance, diversity, geographic distribution and productivity of vegetation communities is maintained;

(b) Protect Declared Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act, 1950; and

(c) Ensure riparian vegetation on substantial streamlines is adequately protected.

This factor applies to areas of vegetation that are considered regionally significant but are not part of the existing or proposed Conservation Estate. The areas identified by the EPA Instructions in this category are:

- System 6 Area M107 (assessed in Section 3.1.1);
- Dunkerton-Husband Road link across M108 (not assessed, as discussed in Section 3.1.2);
- Peel Regional Park (assessed in Section 3.1.3); and
- Areas "Pinjarra 1" and "Clifton 1" (assessed below).

3.2.1 Areas "Pinjarra 1" and "Clifton 1"

"Pinjarra 1" and "Clifton 1" are areas identified by the EPA's System 6 Update that are known to contain occurrences of threatened flora communities. The two areas are shown on Figure 13.

Clifton 1 is currently zoned Rural and will remain so. It will not be affected by the Scheme and is therefore not assessable through this Review.

Management of potential impacts on the vegetation as a result of intensification of rural activities, such as future Special Rural subdivision, are discussed as a deferred factor in Section 4.3.

Pinjarra 1 is currently reserved for Public Recreation/Conservation under the Shire of Murray district zoning scheme except for its western extremity, which is zoned Industry. Under the Scheme, the Public Recreation/Conservation reserve will become Regional Open Space, to be managed for conservation. An area abutting the southern boundary of Pinjarra 1 will be rezoned from Rural to Industry.

The western portion that is currently zoned for Industry will be unchanged except for a 60m strip on its western boundary, which will be affected by the alignment of the proposed Western Pinjarra Bypass. Figure 15 shows the encroachment of the Bypass on the Pinjarra 1 area.

As Figure 15 shows, the western part of Pinjarra 1 contains a BMX track and is heavily degraded. The westernmost 60m, in particular, contains little vegetation of any kind. It is therefore concluded that the proposed bypass will have little or no direct impact on the conservation values of Pinjarra 1.

Interface impacts on Pinjarra 1 caused by development and use of the adjacent Industry zone will require management at the development stage. Measures to minimise interface impacts may include the provision of development setbacks or fencing of the Pinjarra 1 site from adjacent land uses. These measures were discussed in Section 3.1.5.

The ongoing management of interface impacts for areas such as Clifton 1 and Pinjarra 1 are provided by Environmental Management Measure No. 1 (Chapter 5).

3.2.2 Riparian Vegetation

Riparian (streamside) vegetation is crucial to maintaining the hydrology, stability and water

quality of watercourses. Vegetation reduces water velocity and binds and stabilises the banks and beds of rivers, reducing erosion and flood damage. Fringing vegetation also helps to remove suspended solids and nutrients from surface runoff and groundwater before they enter the watercourse. Fringing trees shade the watercourse, reducing water temperatures and light intensity, both of which favour native aquatic fauna and discourage algal growth.

Fringing vegetation in the Peel Region, in common with much of the South-West, has been significantly degraded by influences including clearing and cattle damage (e.g. Olsen and Skitmore, 1991).

In many rural areas, continual disturbance by cattle accessing the rivers has meant that the original understorey has been destroyed and mature trees are unable to be replaced when they die, leading to a gradual deterioration. Even where river frontages in rural areas are contained within stream reserves, a lack of effective management often means that the reserve is grazed along with the adjoining farm paddocks (Olsen and Skitmore, 1991).

Under the Scheme, fringing vegetation around the Peel-Harvey Estuary and along the middle to lower reaches of the Serpentine, Murray and Harvey Rivers will be protected by inclusion in the Peel Regional Park. Furthermore, under proposed Environmental Management Measure No. 4 (Chapter 5), prior to any future rezoning of land in the Scheme upon which there is riparian vegetation, a vegetation survey may be required.

The interface management measures discussed in Section 3.1.5 of this Review will also assist in improving the management of areas reserved for the Peel Regional Park.

Protection of vegetation on the upper reaches of the major rivers and on minor watercourses will be the responsibility of local governments in consultation with the DEP, WRC and landowners.

To conclude, mechanisms to ensure ongoing management of riparian vegetation are provided by Environmental Management Measures No.s 1 and 4 (Chapter 5).

3.3 Regionally Significant Fauna and Habitat

EPA Objective:

(a) Biological diversity should be protected and essential ecological processes and life support systems maintained; and

(b) Important habitat areas for waterbirds should be identified in accordance with international treaties and published advice from the Australian Nature Conservation Agency, and be protected from adverse impacts.

In accordance with the EPA Instructions (Appendix A), this factor refers specifically to the protection of migratory waterbirds and their habitats in the Peel-Harvey Estuary.

Background

The most important waterfowl habitat in the Peel-Harvey system is the intertidal zone. This is the critical habitat for migratory waterbirds recognised by the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA). The key waterbird habitats were described in Section 2.8.2 and are mapped on Figure 12.

Waterbird habitats in the Peel-Harvey Estuary have been subject to a number of pressures over previous years in connection with land uses such as farming, recreation, mosquito control and other influences. Impacts include:

- clearing, trampling and grazing of saltmarshes (the total area of saltmarshes surrounding the Estuary declined by 17% in the 37 years to 1994 (Lavery *et. al*, 1995);

- driving of vehicles and machinery over samphire marshes or exposed tidal mudflats, which can have direct effects by disturbing waterbird nesting sites or benthic communities upon which the birds feed, or indirect effects by creating channels that drain tidal pools; and
- eutrophication of the estuary, resulting in tidal flats being subject to covering by algal mats.

Previous Conservation Initiatives

The EPA's 1983 System 6 Red Book (DCE, 1983) identified three main areas of Peel Inlet (C50), Harvey Estuary (C51) and the adjacent Lake Mealup (C52) as having particularly high conservation significance for waterbirds and recommended that they be reserved and managed as part of a Regional Park. Figure 12 shows coverage of the EPA's recommendations C50, C51 and C52 in relation to the key waterbird habitat areas in the Estuary. The EPA's recommended reserves mainly comprised Crown reserves and other Crown land, but also included some areas of privately-owned, mostly rural land.

The *Peel Regional Strategy* (DPUD, 1994) turned the EPA recommendations into a proposal for a regional park and made recommendations for its vesting and management.

The *Peel Inlet Management Programme* (Waterways, 1992) supported the proposal for a Peel Regional Park and proposed a Waterways Protection Precinct covering all areas below the 100-year flood level, which included the waterbird habitats within the tidal margins and salt marshes of the Peel-Harvey Estuary and the margins of the Serpentine, Murray and Harvey Rivers and associated wetlands.

The habitat areas identified in the Peel Inlet Management Programme in turn formed part of the basis for recommendations for reservation in the *Peel Regional Park Proposal* (DPUD, 1993). The history, objectives and proposed management of the Peel Regional Park are described in Section 3.1.3.

Impact of the Scheme

As the Peel Region's population increases and land use near the Peel-Harvey Estuary becomes more intensive, the potential for human activities to adversely affect waterbird habitats in the estuary must also increase.

The Scheme proposes little intensification of land use in proximity to the major waterbird habitat areas in the Peel-Harvey Estuary. Isolated instances where new or extended Urban zones approach System 6 areas or waterbird habitats are located at Point Morfitt, Yunderup and Wilderness Estate. These are shown on Figure 12. None of these new Urban zones directly affects waterbird habitat areas.

A number of proposed urban developments have been previously approved near the key areas and are currently being assessed under separate processes of the *Environmental Protection Act*. These include Point Grey (being assessed under Division 3), South Yunderup (assessed by EPA Bulletin 844) and Harbour City Stage 2 (approved by Ministerial Statement No. 341, February 1994).

Although these and future development proposals will be designed and undertaken to avoid directly affecting valuable waterbird habitats, they will bring more people into close proximity to key habitats and have the potential to increase indirect impacts such as predation by domestic animals, waterbird disturbance by humans and boats, and damage to sensitive mudflats by pedestrians and small boats.

Management strategies therefore need to aim at managing the interaction of humans with the intertidal zone of the Estuary in a way that minimises damage while enabling the high recreational potential of the Estuary to be realised.

Proposed Management

The Scheme addresses the protection of waterbird habitats in the Peel-Harvey Estuary by

reserving the land for the Peel Regional Park as Regional Open Space, generally in accordance with the final *Inner Peel Region Structure Plan* (WAPC, 1997). This reservation is the culmination, in planning terms, of the process of identification and protection of key waterbird habitat areas that began in 1983 with the EPA's System 6 recommendations for the Peel-Harvey Estuary.

Within this reservation, individual areas will be vested and managed as described in the draft and final *Inner Peel Region Structure Plan* (WAPC, 1996 & 1997), in accordance with the principles set out in Section 3.1.3. In particular, areas identified as having high value as waterbird habitat will be managed primarily for conservation.

Overall management of the Regional Park will ultimately be handed over to CALM. It is expected that, in common with other regional parks, national parks and major reserves under its management, CALM will prepare a detailed management plan for the Peel Regional Park that will have the primary aim of protecting and managing the ecological values of the Park.

The management of interface impacts between proposed developments and significant waterbird habitats, will be addressed through the preparation of Environmental Management Plans, as may be required by the WAPC or local governments for particular subdivision or development applications.

Furthermore, management of impacts on wetlands and waterways due to stormwater drainage systems for proposed subdivisions or developments will be addressed through the preparation of Drainage and Nutrient Management Plans.

In conclusion, protection of waterbird habitats is further supported by Environmental Management Measures No. 1 and 2 (Chapter 5).

3.4 Regionally Significant Wetlands

The EPA Instructions for the Environmental Review define Regionally Significant Wetlands as:

(i) Listed Wetlands – gazetted by the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (Lakes EPP), listed for protection by international agreements including Ramsar, JAMBA, CAMBA, or listed in the Australian Nature Conservation Agency publication *A Directory of Important Wetlands in Australia* (ANCA, 1993);

(ii) Lake Clifton; and

(iii) the Paganoni Swamps.

Impacts and management related to new Urban and Industry zones close to listed wetlands and the Paganoni Swamps are discussed in Section 3.4.1 and 3.4.2 below.

No rezonings are proposed by the Scheme in the vicinity of Lake Clifton. The remainder of the land around the lake is and will remain zoned Rural. Issues relating to the impact of Rural zone activities such as Special Rural subdivision or horticulture near Lake Clifton are addressed as a deferred factor in Section 4.4.

3.4.1 Listed Wetlands

EPA Objective:

Key ecological functions of these wetlands should be protected and maintained through appropriate planning mechanisms.

EPP Lakes

The *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (Lakes EPP) confers statutory protection from mining, drainage, effluent disposal and filling on a defined set of wetlands gazetted by the Policy Approval Order (WA Government Gazette, 18 December 1992). As a rule, lakes

protected under the Policy are those that held at least 1,000m^2 of standing water on 1 December 1991.

The Peel Region contains around 200 lakes protected under the Lakes EPP. None of these will be directly affected by any rezonings proposed in the Scheme, apart from some which are to be included within Regional Open Space. Figure 8 shows the EPP lakes in relation to rezonings proposed by the Scheme.

Wetlands Subject to International Agreements

The Peel-Harvey Estuary and the Yalgorup Lakes are listed for protection under the 1971 Ramsar Convention, which is designed to protect the habitats of migratory waterbirds. They also support waterbird species listed in the Japan-Australia and China-Australia Migratory Bird Agreements (JAMBA and CAMBA). The protection of waterbird habitats in the Peel-Harvey Estuary was discussed in detail in Section 3.3.

Wetlands Identified as Important by ANCA (1993)

The Australian Nature Conservation Agency publication *A Directory of Important Wetlands in Australia* (ANCA, 1993) lists 51 wetlands in the South-West of Western Australia, including four in the Peel Region: Barragup Swamp, Lake McLarty, the Peel-Harvey Estuary and the Yalgorup Lakes. All of these except the Peel-Harvey Estuary are also gazetted by the Lakes EPP.

Impact of the Scheme

New Urban and Industry zones abut or approach regionally significant wetlands in several places. These instances are shown on Figure 8. The potential impacts of these land uses relate principally to changes in water levels and water quality.

Water Levels

The primary hydrological response to urbanisation on the Swan Coastal Plain is usually a rise in the average elevation of the water table. The three principal factors that generally contribute to this rise are:

- removal of vegetation and a reduction of water utilisation by plants, which results in increased groundwater recharge;
- importation and on-site use of scheme water that ultimately becomes aquifer recharge; and
- stormwater collection from impervious surfaces such as roads and concentrated discharge of this water using soakwells and infiltration basins.

Of these, clearance of vegetation generally contributes most to groundwater rise. Therefore, urban development in areas from which the vegetation has already been removed by clearing for agriculture may produce little or no further rise in the water table.

Because most Swan Coastal Plain wetlands are surface expressions of the shallow water table, persistently higher water table levels can affect wetland vegetation through changed distribution or loss of species (particularly mature trees intolerant to prolonged waterlogging).

Examination of changes in wetland vegetation with time by Froend *et al.* (1993) showed that emergent semi-aquatic wetland plant communities are very dynamic, responding rapidly to both increases and decreases in water levels. The rate and magnitude of a change in plant distribution depends on the rate and magnitude of change in water regime. Changes in species distribution in response to changes in the water regime reflect the dynamic and resilient nature of littoral communities and do not necessarily indicate degradation.

The ability of wetland communities to cope with raised water levels depends on the presence of sufficient area free of development around the wetland into which plants displaced by the higher water levels can colonise. In cases where

encroaching development or other influences restrict the outward colonisation of wetland species, the result of an increase in water levels may be a net reduction in the area of habitat available to the less flood-tolerant species.

Water Quality

Residential and industrial development can result in changes to the quality of underlying groundwater through the transport to the aquifer of contaminants including septic tank effluent (if unsewered), garden fertilisers, garden and household chemicals, hydrocarbons and heavy metals.

Davis and Appleyard (1996) presented numerous examples and case studies of groundwater contamination by substances including herbicides, petroleum, industrial chemicals beneath residential and industrial areas around Perth, most of which had been discovered accidentally (the implication being that many more, undiscovered cases may exist).

Barber *et al.* (1992) described contamination of groundwater in the Water Corporation's Gwelup wellfield by nitrate from unsewered urban areas and by volatile organic compounds from industrial areas.

Sharma *et al.* (1996) measured significant leaching of nitrogen beneath urban lawns, largely as a result of excessive watering. Little phosphorus leaching was detected, indicating that phosphorus was being adsorbed by the soils. This confirms research by Gerritse (1988). However, Gerritse (1992) noted that the phosphorus adsorption capacity of soils is finite (and, in the case of Bassendean Sands, low), and that continued application of phosphorus will eventually lead to breakthrough and significant phosphorus leaching to groundwater and lakes.

Groundwater contamination by phosphorus and, to a lesser extent, nitrogen from urban areas has been implicated in water quality deterioration and eutrophication in many wetlands on the Swan Coastal Plain. Higher nutrient (especially phosphorus) concentrations increase the bioproductivity of wetlands. This can eventually lead to algal blooms, odour and insect nuisances, outbreaks of botulism among waterbirds and disease risk to humans.

It follows that the wetlands most at risk from groundwater nutrient contamination are those located downstream of nutrient sources on areas of poorly retentive soils and high water tables (e.g. palusplain on Bassendean sands), while those least at risk are those in areas of highly adsorbent soils with a deep water table (e.g. Spearwood Dunes).

Another significant potential source of contamination in wetlands is surface flow, either via constructed drains or overland flow, which can carry suspended sediments, nutrients, organic matter and other contaminants into the wetland. Bayley *et al.* (1989) recorded short-term phosphorus concentrations ranging from less than .05mg/L up to 11mg/L in stormwater drainage from an urbanised catchment in Kardinya, WA.

Sharpin (1995) noted that urban stormwater runoff can be more polluted than secondary treated sewage effluent. However, high pollutant concentrations in stormwater are typically very short term and associated with the "first flush" effect of rainfall after extended dry periods. Sharpin (1995) found no consistent trend for runoff from sewered urban catchments to have higher nutrient concentrations than that from rural catchments.

Proposed Management

The management applied to each individual wetland potentially affected by new developments will depend upon the attributes and management objectives assigned to the wetland by a review in line with the procedures set out in EPA Bulletin 686 and the Wetland Atlas.

Bulletin 686 recommends that wetlands categorised as "Conservation" or "Resource Enhancement" should become part of the open

space system (ROS or POS) if they are likely to be affected by subdivision or development. Under the Peel Region Scheme, all regionally significant wetlands that are within or immediately adjacent to new development zones will be reserved in Regional Open Space.

Management strategies for these wetlands may include:

- provision of appropriate setbacks between the wetland and adjacent development;
- implementation of Water Sensitive Design principles in nearby urban areas; and
- sewering of urban and industrial developments near wetlands.

Wetland Buffer Areas

Buffer areas around wetlands are designed to minimise direct disturbance, impacts of nearby developments on water quality and water level. The functions of buffer areas include:

- Vegetation in the buffer area assists in the removal of nutrients from the groundwater and suspended solids from overland flow before they can enter the wetland.
- The provision of an area of dryland vegetation around the wetland allows the wetland to adapt to changing water levels by providing room for up-gradient colonisation of wetland-dependent species (Balla, 1994).
- Dense, undisturbed fringing vegetation discourages uncontrolled human access to the central wetland, which can disturb wetland fauna such as nesting birds (Balla, 1994).
- Dense, tall fringing vegetation helps to reduce dispersal of midges, reducing nuisance in nearby residential areas.

Vegetated buffers provide wildlife habitat to maintain species diversity and abundance of plants and animals associated with wetlands. In particular, they provide shelter, feed and breeding habitat for the terrestrial stages of aquatic insects, birds, frogs, reptiles and mammals.

The width of buffer required to fulfil these functions depends upon a number of factors including:

- the wetland values to be protected;
- the nature and potential impacts of the surrounding land use;
- the adsorptive capacity of the soils;
- the topography and groundwater gradient around the wetland; and
- the degree of hydrological (water level and water quality) change expected as a result of neighbouring developments.

For example, adsorption of phosphorus from groundwater between an urban area and a wetland may be achieved by a fairly small separation (<50m) where soils have a high phosphorus adsorption capacity, while to achieve the same adsorption on poor soils (e.g. quartz sands) with a high water table may require a setback of more than a hundred metres.

As another example, a rise in groundwater of one metre in an area with fairly steep topography may induce only a small increase in the area of inundation, thereby requiring only a small buffer area into which plants displaced by the rise can colonise. A similar rise in a flatter area may produce a substantial change in the area of inundation, thereby requiring a larger area of new habitat for displaced plants.

On the basis of these and other considerations, a number of agencies have proposed guidelines for determining generic buffer distances for Swan Coastal Plain wetlands. The EPA has previously had

a informal standard setback requirement of 50m horizontally or 1m vertically (whichever is the greater) around each wetland.

The Wetland Atlas (Hill *et al.*, 1996) mapped zones of critical (50m) and secondary (200m) influence around wetlands to provide guidelines for minimum interim wetland buffers.

The Australian Nature Conservation Agency (Davies and Lane, 1995) proposed a range of buffer distances ranging from 20m for the removal of organic matter from runoff to as much as 2km for protection of groundwater quality. Because the Davies & Lane (1995) recommendations were in some cases based on overseas examples and in other cases did not take account of differing soil and groundwater factors, they cannot be applied to Swan Coastal Plain wetlands without site-specific confirmation.

Because the above buffer recommendations provide, at best, general guidance, it is apparent that the setting of buffer widths for individual wetlands needs to be done on a case-by-case basis in the light of site-specific considerations concerning the key wetland attributes to be protected, the nature of the proposed land use, the soil types, topography and hydrological regime and the predicted impacts of development.

Notwithstanding the above, regionally significant wetlands in areas liable to be affected by new zonings are generally included within Regional Open Space under the Scheme. Management plans for wetlands in Regional Open Space will be developed by CALM or the local government, whichever has management of the open space containing the wetland.

A provision to enable interface impacts to be addressed through the preparation of Environmental Management Plans for proposed subdivisions or developments adjoining regionally significant wetlands is given by Environmental Measure No. 1 (Chapter 5).

3.4.2 Paganoni Swamps

EPA Objective:

Key ecological functions of Paganoni Swamps should be protected and maintained through appropriate planning mechanisms, with a particular emphasis on water balance.

Background

The Paganoni Swamps are a series of lakes and damplands extending from Paganoni Road in Karnup to Lakelands in the City of Mandurah. Within the swamp complex are a number of individual lakes protected under the Lakes EPP. Five of these lakes are situated at the northern end of the Scheme Area (Figure 16), where they are surrounded by a wide zone of dampland and wetland-dependent vegetation. The lakes and the surrounding damplands are assigned "C" (Conservation) status by the Wetland Atlas (Hill *et al.*, 1996).

Groundwater mapping supplied by the Water and Rivers Commission (Figure 16) shows that the lakes are located at the crest of a local groundwater mound, from which groundwater flows west to the ocean and east to the Serpentine River.

The wetlands occur in a swale between two linear dunes belonging to the Karrakatta unit of the Spearwood Dune System, running parallel to the coast. The surface catchment of the lakes totals about 275ha and is bounded to the east and west by the crests of the dunes, and to the north and south by other wetlands.

Surface runoff into the lakes would be minimal, occurring only under very heavy rainfall in winter and from the area immediately adjacent to the lakes. There are no constructed surface drains into or out of the lakes.

In winter, the lakes and swamps would act as groundwater recharge sources, with water which entered the lakes as rainfall and local runoff

contributing to groundwater flows outwards towards the coast and the Serpentine River.

In summer, high evaporation and evapotranspiration would cause the lakes and surrounding vegetation to act as groundwater "sinks" or discharge areas, with local groundwater flow occurring towards the lakes from the surrounding dunes. This inflow would probably only be drawn from as far as the dune ridges, with areas outside the ridge lines still contributing to outward groundwater flow towards the ocean and the Serpentine River.

Thus both the surface catchment and the groundwater capture zone of the lakes are likely to be bounded by the approximate lines of the dune ridges.

The land to the west and south of the lakes is largely cleared for grazing with a few scattered trees. To the east, a Jarrah-Banksia woodland persists. Three areas totalling about 20ha to the east of the lake and one area of about 12ha to the west have been cleared for quarrying.

The soils that make up the lakes' catchment are composed of yellow calcareous sands of the Karrakatta Association underlain by limestone. These soils have a very high capacity to adsorb many groundwater contaminants, particularly phosphorus.

Impact of the Scheme

The Scheme proposes to rezone two areas east and west of the Paganoni Swamps, totalling about 175ha, from Rural to Urban. A further 5ha will be rezoned to Railways Reservation. Approximately 50% (90ha) of this area is within the interdunal valley that contains the lakes, and therefore within the inferred catchment of the lakes.

This represents about 33% of the total mapped catchment of the lakes. Of the remainder, about 60ha is already zoned Urban and about 120ha is within the Regional Open Space that contains the lakes. As a result of these rezonings, about 55% of the 275ha catchment of the lakes will ultimately be urbanised.

Water Levels

The additional clearing implied by the new Urban zonings totals about 30ha, in comparison to the 120ha of the lakes' catchment that is already cleared. The effect of this additional clearing on rainfall recharge is likely to be minimal, so urban development is expected to cause little or no impact on local groundwater and wetland levels. The potential for groundwater rise will be further reduced by the peculiar local hydrological regime, under which groundwater is inferred to flow out of, rather than into, the lakes during the main winter recharge season.

The potential effects of urban development on the quality of underlying groundwater and downstream wetlands were discussed in Section 3.4.1. Because the land use permitted under an Urban zoning will be predominantly residential, the potential contaminants which might enter the groundwater include:

- nutrients from garden fertilisers;
- garden pesticides and herbicides; and
- hydrocarbons from service stations and illicit backyard disposal of oils.

The potential for these contaminants to significantly affect groundwater or wetlands will be minimised by the following:

- The urban areas will have a considerable clearance above groundwater, ranging from a minimum of 2m to more than 27m. Both soluble (e.g. nutrients) and insoluble (e.g. petroleum) contaminants would have to travel a considerable distance through the unsaturated soil profile before reaching the groundwater.
- The yellow calcareous sands and limestone that underlie the development areas and the lakes have a proven high capacity (e.g. McPharlin *et al.*, 1990) to adsorb a range of contaminants including phosphorus, pesticides and heavy metals.

McPharlin *et al.* (1990) measured phosphorus storage in the top 100cm of the soil profile in Spearwood sands at more than 1,000kg/ha. At this rate, the unsaturated soil profile in the catchment of the Paganoni Swamps (averaging about 7m deep) could retain in excess of 100 years' phosphorus input at the rates measured in medium density unsewered residential areas, and more than 600 years' input in sewered residential areas (Gerritse *et al.*, 1991).

The peculiar hydrological regime of the Paganoni Swamps means that groundwater flow occurs predominantly out of, rather than into, the lakes. As a result, nutrients and other groundwater contaminants originating from the urban areas would mostly be carried away from the lakes.

Surface Water Quality

The other, and perhaps more significant, potential source of contamination in the lakes is surface runoff from roads and other sealed surfaces in the urban areas. Urban stormwater can contain high levels of nutrients, organic matter, total suspended solids, hydrocarbons and other materials washed from paved areas by rainfall, as discussed in Section 3.4.1.

Bayley *et al.* (1989) estimated stormwater phosphorus loads from an urban catchment in Kardinya at 0.43kg P/ha/yr. At this rate, the 90ha of new Urban zone within the catchment of the Paganoni Swamps could contribute about 38kg/yr of phosphorus to the lakes if it were drained directly into the lakes.

The lakes have an open water area (as measured from December 1996 aerial photos) in the order of 0.35ha. An annual input of 38kg phosphorus would therefore equate to an areal phosphorus loading rate of about 110kg P/ha/yr, which would be sufficient to cause severe eutrophication of the lakes.

While this analysis employs a number of pessimistic assumptions that would tend to over-estimate the loading of phosphorus into the lakes, it is nevertheless clear that the drainage of untreated urban stormwater into the lakes would be undesirable.

Proposed Management

Environmental Management Measure No. 1 (Chapter 5) provides for Environmental Management Plans to be prepared for wetlands where the proposed subdivision or development is considered likely to have significant effects on the wetland. In the case of the Paganoni Swamps, such an EMP will incorporate the measures described below.

Water Levels

Developers wishing to subdivide land within the catchment of the lakes will be required to provide satisfactory evidence to the local government and WAPC, if necessary including the results of groundwater modelling, to demonstrate that the impacts of the development on the hydrological regime of the lakes will be so small and/or readily managed as to not significantly degrade the ecological or hydrological functions of the lakes.

Groundwater Quality

All conventional residential subdivisions will be sewered. Drainage and infiltration basins in the catchment will be designed to retain phosphorus, if necessary by including modified soils with high phosphorus retention capacity.

Stormwater Quality

Water Sensitive Design (as described in Whelans *et al.*, 1993) will be employed in all developments in the lakes' catchment. This will include:

- use of local recharge rather than collection and central disposal of stormwater where possible;
- use of porous, rough-surfaced drainage channels and swales in preference to lined drains;
- use of multi-purpose Public Open Space as recharge and retention basins;
- retention of all normal (up to 10-year) runoff in recharge basins designed to trap nutrients, sediments and other contaminants, with direct overflow to the lakes only under extreme storm conditions when a high degree of dilution is available and most pollutants will have been trapped by basins in the first flush; and
- preparation of Drainage and Nutrient Management Plans which demonstrate that the nutrient loads reaching the lakes from the development will be so low as to not cause eutrophication of the lakes.

3.5 Estuaries

EPA Objective:

The environmental quality objectives for the Peel Inlet-Harvey Estuary specified in the Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992 and the water quality guidelines specified in EPA Bulletin 711 for the protection of aquatic ecosystems should be met.

Background

The Peel-Harvey Estuary is eutrophic (nutrient-enriched) as a result of excessive phosphorus inputs from its catchment. The state of the estuary and the issue of phosphorus application to and export from the catchment have been thoroughly described elsewhere (e.g. Kinhill, 1988) and will not be revisited here.

The Peel-Harvey EPP established statutory targets for phosphorus input from each part of the coastal catchment of the estuary. These can be translated to annual loadings per unit area, as shown in Table 3.

Table 3 Peel-Harvey EPP Phosphorus Export Targets

Sub-Catchment	*EPP Target (tonnes P/yr)*	*Catchment Area (ha)*[1]	*Areal P loading (kg/ha/yr)*
Serpentine River	21	78,645	0.27
Murray River	16	32,366	0.49
Harvey River & Drains	38	91,404	0.42
Total	75	202,415	1.18

1. Source: Kinhill (1988).

The WAPC's *Statement of Planning Policy (SPP) No. 2: The Peel-Harvey Coastal Plain Catchment* gives effect to the objectives set out in the Peel-Harvey EPP by setting planning controls on new land developments designed to reduce phosphorus inputs to the estuary. These controls include sewerage requirements, drainage restrictions and a target for 50% coverage of deep-rooted vegetation across the catchment.

General water quality objectives for the Peel-Harvey Estuary and other surface waters in Western Australia are set out in EPA Bulletin 711: *Western Australian Water Quality Guidelines for Fresh and Marine Waters* (EPA, 1993). Bulletin 711 does not set water quality criteria for individual developments or discharges. Rather, it sets objectives for receiving waters designed to protect a range of defined beneficial uses, including ecosystem protection.

The water quality objectives for the protection of aquatic ecosystems that are of relevance to the Peel-Harvey Estuary in this context are listed in Table 4.

Table 4 Water Quality Objectives Set By EPA Bulletin 711

Parameter	*Objective*
Nuisance organisms (including algae)	Not excessive
Clarity	<10% change
pH	<0.2 pH unit change
Temperature	<2C increase
Dissolved Oxygen	80-90% saturation
Nutrients:	
Ortho-phosphate	5-15µg/L
Nitrate-nitrogen	10-100µg/L
Ammonia-nitrogen	<5µg/L
Chlorophyll-a	1-10µg/L
Toxic chemicals	Various, generally below drinking water levels

It is noted that the background water quality of the Peel-Harvey Estuary is already marginal or non-compliant in terms of some of the objectives of Bulletin 711, particularly those relating to nutrients. However, the construction of the Dawesville Channel and the progressive introduction of improved catchment management on the coastal plain are predicted to cause a substantial long-term improvement in the water quality of the estuary.

Preliminary indications (Wilson and Latchford, 1995) are that nutrient levels in the estuary have declined and salinities have risen since the Channel was constructed, while growth of microalgae has substantially declined. However, monitoring by the Water and Rivers Commission has shown no reduction in the loads of nutrients entering the estuary from the catchment and a continuing decline in the water quality of the major rivers (T. Rose, WRC, pers. comm).

Impact of the Scheme

The Scheme proposes about 345ha of new Urban and 200ha of new Industrial areas on palusplain within the Serpentine and Murray River catchments, as shown on Figure 8.

Previous studies (e.g. Schofield *et al.*, 1985) have identified palusplains (flat areas subject to seasonal saturation or flooding) as being of particular concern in regard to phosphorus exports. This is because:

- In rural areas, saturated ground generates very high rates of rainfall runoff. Phosphorus applied in fertiliser to these areas is subject to high leaching losses. Previous studies carried out in the Peel-Harvey catchment (Schofield *et al.*, 1985) showed that up to 40% of phosphorus applied as superphosphate to seasonally waterlogged soils may be lost to drainage (and hence the estuary) in the year of application.

- When rural areas on palusplain are converted to urban or industrial use, drainage and/or filling are generally necessary to provide the 1.2m minimum clearance above groundwater required for building. Phosphorus that has accumulated in the soil and groundwater due to past agricultural practices, in addition to that applied to urban lots in garden fertilisers, pet faeces and other forms, may be exported along with the drainage water.

Current WRC policy is that lowering of the groundwater table by drainage should not be used to provide clearance for building in the Peel-Harvey catchment. This policy seeks to avoid increasing the volume of groundwater (and hence phosphorus) exported to the estuary from palusplain areas.

Because the areas within the Peel-Harvey catchment proposed for urban and industrial development under the Scheme are already cleared, there will probably be little if any rise in the water table as a result of their development. However, because the average annual maximum groundwater level (AAMGL) in some areas is above the ground surface and because the water table in some areas has been lowered by agricultural drains, the importation of fill in these areas may cause the water table to rise even in the absence of any increase in recharge.

In order to comply with WRC policy, subsoil drains must be set at or above the pre-existing AAMGL, with fill applied above this level as necessary to provide the required 1.2m clearance.

The rise in groundwater following urbanisation, coupled with the use of subsoil drains, will result in an increase in the discharge of groundwater and hence phosphorus to drainage in some areas. Despite this, the Amarillo PER (BBG, 1996) demonstrated an overall reduction in phosphorus exports under urban land use on palusplain, as opposed to the former rural use.

Other Contaminant Exports

New industrial land uses permitted under the Scheme could, in the absence of proper drainage management, export a range of contaminants including hydrocarbons, organic matter, suspended sediments and heavy metals to the estuary. The potential for this to occur will depend upon the types of industry present and the measures put in place to control pollutant emissions.

Proposed Management

Sewerage

Proposed Environmental Management Measure No. 3 in Chapter 5 regarding the connection of new subdivisions and development to reticulated sewerage systems, makes reference to SPP No. 2, which states that:

> "5.1 ...land shall not be rezoned for urban purposes ... unless ... arrangements

have been made so that connection to an adequate sewerage service or alternative system satisfactory to the EPA and Health Department will be available to all lots [having lot sizes up to 4,000m^2] in the subdivision."

"6.5.1 Proposals to develop land for industry, where the industrial process would create liquid effluent, must include provision for connection to a reticulated sewerage system.

6.5.2 Works Approvals and Licences will be required from the EPA where the proposal has a wastewater discharge or falls within the list of scheduled premises under Part V of the Environmental Protection Act. Some types of industrial development may require an impact assessment under Part IV of the *Environmental Protection Act*."

Industries permitted in the Industry zones will be restricted to those whose wastewater (if any) is suitable for treatment and disposal via the sewerage system, as determined by the sewerage provider on advice from the WRC.

Drainage

As well as complying with the provisions of the Peel-Harvey EPP and Statement of Planning Policy No. 2, new Urban and Industrial areas on palusplain permitted under the Scheme will be required to incorporate management plans based on *Water Sensitive Urban Design Guidelines* (Whelans *et al.*, 1993), including:

- Subsoil drains to be set at a height no lower than the Average Annual Maximum Groundwater Level (AAMGL), as determined by on-site measurements, unless it can be demonstrated that the phosphorus content of the drainage water will be so low as to enable the EPP phosphorus export targets to be achieved.
- No increase in peak water discharge from the development area.
- Maximise on-site retention and infiltration of stormwater and subsoil drainage water in drainage control structures designed to retain phosphorus and other contaminants from the water.
- Annual average phosphorus export loads from the site to comply with export targets set for the relevant catchment in the Peel-Harvey EPP.

A major study of drainage management on palusplain in the Peel Region has recently been carried out in relation to Homeswest's proposed Amarillo Urban Development, located largely on palusplain east of the Serpentine River on the northern boundary of the Scheme Area (BBG, 1996). The drainage strategy proposed for Amarillo is based on channelling all stormwater runoff and drainage from the 3,300ha site through a series of multi-purpose public open space areas, drainage structures and constructed wetlands that will act as biological filters to remove excess nutrients.

In order to provide the required retention and treatment capacity, the multi-purpose public open space and drainage areas will comprise approximately 25% of the developable area of the Amarillo site. Other urban and industrial areas proposed by the Scheme on palusplain are likely to face a requirement to devote a similar proportion of their area to drainage management.

Because the drainage strategy proposed for Amarillo has not previously been demonstrated on the Swan Coastal Plain, its ability to achieve the EPA Performance Standard of <.225 kg P/ha/yr (83% of the EPP target for the Serpentine River catchment) has not been proven. Indeed, this limitation applies to Water Sensitive Urban Design in general, which is still largely an unproven concept in terms of meeting specific water quality targets. Nevertheless, the Water and Rivers Commission has expressed confidence, in relation

to Amarillo, that the implementation of Water Sensitive Urban Design principles will achieve the desired results in terms of water quality (Chapter 12 in BBG, 1996).

In order to provide greater certainty on drainage and phosphorus management, the Minister for the Environment has approved the development of 10% (330ha) of the palusplain within Amarillo as a pilot-scale trial (Ministerial Statement No. 473, Gazetted 15 April 1998). Approval of the remaining 90% will be contingent on satisfactory demonstration of the proposed phosphorus export management measures.

The Amarillo trial, if successful, will provide confidence in the effectiveness of the proposed measures and will be a model for nutrient management in future urban developments on palusplain.

A further trial implementation of the principles of Water Sensitive Urban Design and Best Practice Management is planned in the Byford-Mundijong area, based on a Stormwater Management Strategy prepared for the then Water Authority and DPUD (Evangelisti & Associates, 1994).

Given the still-conceptual nature and uncertain timing of the Amarillo proposal, it is considered unacceptable to formally tie other, smaller future urban and industrial developments on palusplain to the outcome of the Amarillo trial. Any such development proposal which precedes the Amarillo trial will therefore be required to independently demonstrate an effective drainage and phosphorus management strategy to the satisfaction of the WAPC on advice from the EPA and WRC.

In relation to the proposed new industrial zones on palusplain, it should be noted that the Scheme proposes to rezone only about 200ha of 1000ha of future industrial land on palusplain identified in the *Inner Peel Region Structure Plan*. Development of the Industrial zones proposed in the Scheme will provide the opportunity to test the effectiveness of the drainage management measures developed for these areas when considering any future applications for Industrial rezonings on palusplain.

Proposed management strategies for drainage in new urban and industrial areas on palusplain are set out in Environmental Management Measure No. 2 in Chapter 5. It is considered that this Measure, along with Environmental Management Measure No. 3, will ensure that the EPA's objectives for protection of the water quality of the Peel-Harvey Estuary can be achieved.

3.6 Foreshore Stability and Dune Protection

EPA Objective:

Coastal Processes should be maintained to ensure that the physical stability and ecological integrity of the coastline is not affected.

Background

The coastline of the Peel Region is a natural asset of great importance for residential development, recreation, tourism, commerce, education and conservation. There are currently heavy demands on the coast within Mandurah and elsewhere on the Swan Coastal Plain due to population increase and intensifying land use.

Shoreline movement plans prepared by the Department of Transport and quoted in the *Mandurah Coastal Strategy* (City of Mandurah, 1996) show that the sandy coastline of the Peel Region is a dynamic one, with significant erosion and deposition of sand occurring under normal conditions. Severe storms can greatly accelerate this process, producing severe shoreline erosion over very short periods.

Coastal dunes are a hostile environment for plants, with poor soils, little water-holding ability, strong winds and salt spray. The plants that can tolerate this environment perform a vital role in stabilising the loose sand of the dunes.

Coastal vegetation is slow to recover if disturbed and disturbed areas are susceptible to weed invasion. If the vegetation is disturbed over a large area or in critical locations, severe erosion and inland migration of the sand dunes can occur.

The principal tool for maintaining the stability of the coastline and dunes in urban areas is to provide suitable setbacks of roads and buildings from the shoreline and to manage activities within this coastal buffer.

Problems caused by inadequate coastal setbacks have previously arisen in a few parts of the Mandurah coastline. One of these was at San Remo, where storm damage caused erosion and slumping up to the pavement edge of Ormsby Terrace. This problem was partly rectified by constructing the second leg of Ormsby Terrace further inland, effectively widening the coastal buffer (B. Bunny, City of Mandurah, pers. comm.).

In assessing coastal developments, the City of Mandurah has historically specified a minimum setback of 50m from the seaward edge of the permanent dune vegetation (i.e. not including the beach and foredunes) (B. Bunny, pers. comm.). In particular areas where the coastline is considered to be susceptible to erosion or intense use, wider setbacks may be required.

Impact of the Scheme

Two coastal areas are proposed for rezoning from Rural to Urban under the Scheme (Figure 5) and are therefore subject to coastal setback requirements. The first of these is located north of Madora and is approximately one kilometre long, consisting of a broad beach backed by a low, relatively undisturbed foredune. Shoreline movement plans quoted in the *Mandurah Coastal Strategy* indicate that this sector of coastline is accreting (accumulating sand) at a rate of between 1.9 metres and 2.7 metres per year.

The second area is located north of San Remo and is approximately 0.6 kilometres long, with a relatively narrow beach backed by steep-faced dunes displaying considerable evidence of seasonal storm damage. Shoreline movement plans quoted in the *Mandurah Coastal Strategy* indicate that this sector of coast is stable overall, with minor erosion occurring at the southern end and minor accretion at the northern end. However, the evidence of periodic storm damage on the frontal dunes and the experience of the nearby Ormsby Terrace suggest that the apparent stability of this sector may be temporary or unreliable.

The coastal sector north of Madora is expected to become a regional beach and therefore to receive a high level of recreational use. The San Remo North sector is intended as a local beach, with the primary management purpose being dune conservation (City of Mandurah, 1996).

Proposed Management

The *Mandurah Coastal Strategy* deals with, among other things, the provision of adequate coastal setbacks and the management of the coastal reserve. The Strategy examines the coastal processes specific to each area and makes recommendations in relation to planning and management.

Although not a statutory document, the Strategy has been considered in the formulation of the City of Mandurah's upcoming new Town Planning Scheme No. 3. The Strategy is also used as a guide by Council officers when assessing development proposals in the coastal zone.

In addition to the *Mandurah Coastal Strategy*, a number of State Government policies guide and regulate coastal development in the Peel Region, including:

- WAPC *Country Coastal Planning Policy 1987* (Policy No. DC 6.1);
- *Coastal Planning and Development in Western Australia* (WAPC, 1996); and
- the *Coastal and Lakelands Planning Strategy* (WAPC, 1999).

With the adoption by Council of the Mandurah Coastal Strategy, the management strategies proposed for the areas north of San Remo and north of Madora are as follows:

San Remo North

Designation:	Local Beach (due to narrow beach and limited access).
Foreshore Reserve:	120 metres, to be managed as a Dune Conservation Zone. (Since reduced to 90m by agreement with the Water Corporation to coincide with the position of a new water main, although the Regional Open Space reservation in the Scheme is about 140m in width as the western boundary is taken from the mean annual high water mark.
Foreshore Development:	None within foreshore reserve except controlled beach access points.

Madora North

Designation:	Regional Beach.
Foreshore Reserve:	130m at the Regional Beach and 100m elsewhere, of which 70m should be managed as a Dune Protection Zone.
Foreshore Development:	In Dune Protection Zone: None except controlled beach access ways.
	In Dune Amenity Zone: Beach access and dual-use path.
	In Regional Beach Dune Amenity Zone: Grassed picnic, BBQ and playground areas and amenity blocks.

The Scheme addresses the protection of the foreshore and dunes by creating a foreshore reserve of Regional Open Space along the entire coastline of the Peel Region. The width of the coastal reserve varies in response to the width of the coastal dunes, the presence of existing developments and the intended use of each sector of coastline.

In the sector north of San Remo, the Scheme provides a minimum coastal setback of 90m from the permanent vegetation line, bounded on the inland side by the Water Corporation's water pipeline. This is consistent with setbacks immediately to the north (Madora) and south (San Remo), which have proved adequate to preserve the frontal dunes and avoid erosional damage to structures (Ormsby Terrace, which suffered storm damage, had a much narrower setback). It also accords with the City of Mandurah's revised setback recommendation for the area.

North of Madora, the Scheme provides a coastal setback of between 100 metres and 180 metres. This greater width recognises this sector's likely status as a regional beach and is intended to provide space for both public amenities and protection of the coastal dune vegetation. The width of this reserve exceeds that proposed by the Mandurah Coastal Strategy and WAPC Policy No. DC 6.1.

Future proposals for coastal development in the Region will be subject to the minimum setbacks required by the coastal Regional Open Space, in addition to any additional setback found by the City of Mandurah to be necessary in particular cases.

The management of coastal areas and the assessment of future coastal development proposals will be carried out under the framework established by the State and local government policies mentioned above. The foreshore reserve will be managed by the City of Mandurah for a combination of conservation and recreation in accordance with the *Mandurah Coastal Strategy* (City of Mandurah, 1996).

These measures will continue to ensure that the EPA's objectives regarding the preservation of the physical stability and ecological integrity of the coastline are achieved.

Ongoing management of coastal areas reserved under the Scheme is further supported by Environmental Management Measure No. 1 in Chapter 5.

3.7 Groundwater Quality in Future Public Water Supply Areas

EPA Objective:

Groundwater quality and quantity in the proposed public water supply area at Karnup should be protected.

The Water Corporation has identified an area between Karnup and Dandalup as having potential for future development of a public groundwater supply scheme. The southern half of the study area is within the Peel Region, as shown on Figure 17.

The Water Corporation is currently carrying out a pre-feasibility study to assess the viability of establishing a public water supply scheme in this area based on a network of bores drawing water from the Superficial (shallow) and/or Leederville (artesian) aquifers. The time scale for development of the groundwater scheme is in the order of 10 to 20 years (M. Martin, Water Corporation, pers. comm.).

If the outcome of the study is positive, the Water Corporation will consider requesting the WRC to declare the groundwater scheme area a Water Reserve under the provisions of the *Country Areas Water Supply Act, 1947*. The boundaries of the Water Reserve would be determined by further studies, with those shown on Figure 17 being indicative only (M. Martin, pers. comm.).

In the meantime, the WRC makes recommendations on land use zonings to local governments in the study area in recognition of the area's possible future use for water supply.

The Region Scheme provides for Special Control Areas to be declared over Water Reserves for the purpose of restricting land uses to those compatible with protection of the groundwater resource.

The current land use in the proposed groundwater scheme area is almost entirely rural, a use that is generally compatible with groundwater protection. Uses that would need to be excluded or restricted include intensive horticulture, animal husbandry (e.g. feedlots), urban, special rural, waste disposal and potentially polluting industry.

The area identified by the Water Corporation for the potential future Karnup-Dandalup Groundwater Scheme will be noted in the implementation of the Scheme. The WAPC will consult with the Water Corporation and WRC over the boundaries of the proposed groundwater supply area.

If and when a Water Reserve is declared by the WRC in the Karnup-Dandalup area, that area will be declared a Special Control Area under the Scheme. Land uses permitted within the Special Control Area will be limited to those that the WAPC, on advice from the WRC, is satisfied are compatible with the protection of the groundwater resource.

In the meantime, the existing zoning, development approval and environmental assessment processes are adequate to preserve the integrity of the

groundwater resource until a decision is made as to its use as a public water supply source.

The Karnup-Dandalup groundwater study area is identified as "Rural – Groundwater Protection" in the Inner Peel Region Structure Plan. In assessing rural land use proposals in the study area, the Shire of Murray will have regard to the Structure Plan. Land uses which require rezoning (e.g. Urban or Industry) would also be considered in light of the Structure Plan proposals as well as being subject to referral to the EPA.

3.8 Surface Water Quality – Existing Water Supply Catchment Areas

EPA Objective:

Surface water quality and quantity in existing and proposed water supply catchment areas should be protected.

Figure 17 shows the hills surface catchments that are currently developed or have the potential to be developed for public water supply. Almost all of the land within these catchments consists of State Forest. Within these areas, CALM manages the forest for the purposes of timber production, conservation and water resource protection in consultation with the WRC.

All of the catchments shown on Figure 17 have been proclaimed as Catchment Areas under the *Country Areas Water Supply Act, 1947* and the *Metropolitan Water Supply, Sewerage, and Drainage Act, 1909*. Preliminary Priority classifications have been assigned by the WRC to all of these catchments. Priority 1 areas have been assigned to all catchment land under Crown ownership and Priority 2 areas have been assigned to all catchment land in private ownership. Until such time that a Water Resource Protection Plan is prepared to establish the level of protection required for these catchments, they will be managed in accordance with these preliminary Priority classifications.

Priority 1 water source protection areas are defined to ensure that there is no degradation of the water source. Priority 1 areas are managed in accordance with the principle of risk avoidance and so development is generally not permitted.

Priority 2 water source protection areas are defined to ensure that there is no increased risk of pollution to the water source. Priority 2 areas are managed in accordance with the principle of risk minimisation and so some development is allowed under specific guidelines.

The Peel Region Scheme proposes Special Control Areas for Priority 1 and 2 surface catchments to prevent incompatible development. Within these areas, applications for development approval will be assessed in consultation with the WRC.

3.9 Surface Water Quality – Cumulative Impacts

3.9.1 Peel-Harvey Estuary

EPA Objective:

(a) The cumulative impact of diffuse sources of water quality contaminants should not result in pollution; and

(b) Sedimentation should not occur beyond natural levels in waterways.

Impact of the Scheme

Human activity in the Peel-Harvey catchment contributes a range of contaminants from a multitude of sources to the rivers, drains, groundwater and ultimately the estuary. These include:

- nutrients from farm paddocks, intensive agriculture, horticulture, garden fertilisers, domestic animals and dry fallout on sealed surfaces;
- pesticides and herbicides from domestic and commercial use;

- hydrocarbons from roads, leaking storage tanks and illegal backyard disposal;
- suspended sediments from roads, development sites, land clearing and erosion; and
- heavy metals from roads, industries and fertilisers.

Some of these sources of contamination, such as agricultural fertilisers, are associated with particular land uses and, as a result of catchment management measures, are unlikely to increase. A number of others are linked closely to population increase and residential design in the catchment. This applies especially to sources associated with residential areas and development sites.

Therefore, as the population of the region increases, there is potential for these land uses to contribute increased pollution loads to the Peel-Harvey Estuary. This impact can be minimised by careful design and management of new developments, particularly in terms of drainage, erosion control and chemical usage.

Table 5 shows estimated populations within the Peel-Harvey catchment for the years 1996 and 2021.

Table 5 Current and Projected Populations

		1996[1,2]	*2021*[3,4]	*Increase*
Mandurah:	Peel-Harvey	24,276 (60%)	37,600 (43%)	13,324 (55%)
	Coastal	16,184 (40%)	49,900 (57%)	33,716 (208%)
	Total	40,460	87,500	47,040 (116%)
Murray:	Peel-Harvey	9,510 (100%)	18,500 (100%)	8,990 (95%)
	Coastal	0	0	0
	Total	9,510	18,500	8,990 (95%)
Waroona:	Peel-Harvey	2,236 (70%)	4,015 (73%)	1,779 (80%)
	Coastal	958 (30%)	1,485 (27%)	527 (55%)
	Total	3,194	5,500	2,306 (72%)
Totals	Peel-Harvey	36,022	60,115 (54%)	24,093 (67%)
(estimated):	Coastal	17,142	51,385 (46%)	34,243 (200%)
	Total	53,164	111,500	58,336 (110%)

Sources:
1. Catchment populations estimated as proportions of total population based on area of existing residential land within catchments.
2. Total from ABS (1996)
3. Catchment populations estimated as proportions of projected total population based on areas of Urban zones within catchments.
4. Total from Ministry for Planning

The estimates shown in Table 5 suggest that most population increase within the region between 1996 and 2021 will occur outside the Peel-Harvey catchment in the coastal zone. The increase within the Peel-Harvey catchment is estimated at 67%, compared with 200% for the coastal zone and 110% for the region as a whole. This means that the potential for increased pollution of the Peel-Harvey Estuary will be significantly less than is indicated by the total population increase.

Nevertheless, the Table shows that around 24,000 extra people are likely to be living in the coastal plain catchment of the Peel-Harvey Estuary within the Peel Region by 2021.

Proposed Management

The primary tool for minimising the water quality impacts of future urban development in the region will be the implementation of best practice planning and management in Water Sensitive Design (WSD).

The principle objectives of Water Sensitive Design are to:

- Manage water balance
  - maintain appropriate aquifer levels, recharge and stream-flow characteristics in accordance with assigned beneficial uses;
  - prevent flood damage in developed areas; and
  - prevent excessive erosion of waterways, slopes and banks.
- Maintain and, where possible, enhance water quality
  - minimise waterborne sediment loading;
  - protect existing riparian or fringing vegetation;
  - minimise the export of pollutants to surface waters or groundwater; and
  - minimise the export and impact of pollution from sewage.
- Encourage water conservation
  - minimise the import and use of scheme water;
  - promote the reuse of stormwater;
  - promote the reuse and recycling of effluent;
  - reduce irrigation requirements; and
  - promote regulated self-supply.
- Maintain water-related environmental, recreational and cultural values.

The principles of Water Sensitive Design as they apply to Western Australia are set out in the *Planning and Management Guidelines for Water Sensitive Urban (Residential) Design* (Whelans, *et al.*, 1994) and are further developed in the WRC's *Manual for Managing Urban Stormwater Quality in Western Australia*, which was released in August 1998.

Specific recommendations of the WSD Guidelines include:

- Because pollutants such as phosphorus, pesticides, hydrocarbon metals and bacteria may be carried by soil particles, non-point-source pollution control should be achieved by detention/retention techniques which settle particulate matter and prevent erosion by maintaining the hydrological regime.
- New development projects should include a stormwater management system which ensures that the peak discharge rate, total volume and pollution load of stormwater leaving a site after development are no greater than pre-development.
- New developments should have a erosion and sediment control plan.

The principles of Water Sensitive Design are incorporated in the new Community Design Code for WA, as set out in *Liveable Neighbourhoods: Community Design Code* (WAPC, 1997).

When submitting Structure Plans or subdivision proposals for assessment under the Community Design Code, proponents will be required to provide the following specific information in relation to water management:

- an explanation of the proposed urban water management network;
- maintenance of natural drainage networks and groundwater systems;
- groundwater recharge;
- runoff water quality;
- environmental values and physical characteristics of receiving waters;
- protection of people and property from stormwater and flooding;
- developer cost contribution arrangements; and
- ongoing management arrangements and responsibilities.

The Community Design Code is currently presented as an alternative to current subdivision policies and will operate alongside existing policies. Proponents will have the choice to submit development plans for assessment under either the Community Design Code or existing policies.

The effectiveness of the Community Design Code will be reviewed after at least twelve months' operation. Following final review and amendment, it is anticipated that the Community Design Code will be adopted by Government as a Statement of Planning Policy.

The implementation of Water Sensitive Urban Design in new subdivisions and developments within the Peel-Harvey catchment can be implemented by Environmental Management Measure No. 2 in Chapter 5.

3.9.2 Marine Waters

EPA Objective:

Nutrient export (particularly nitrogen) from the Peel Region (including the Peel Inlet-Harvey Estuary catchment) into the nearshore marine waters should be minimised and reduced.

Background

The EPA Instructions for the Environmental Review define this factor to refer specifically to nitrogen exports to the ocean from Waste Water Treatment Plants (WWTPs). Nitrogen has been identified as a significant contaminant in the coastal waters near Perth through recent studies such as the *Southern Metropolitan Coastal Waters Study* (DEP, 1996), which estimated that between 450 and 900 tonnes of nitrogen are exported each year from the Peel-Harvey Estuary to the ocean (an estimated fivefold increase since the 1960s).

Existing WWTPs are located at Gordon Road, Halls Head, Caddadup, Pinjarra and Waroona. Future plants are planned at Tims Thicket and possibly near Ravenswood. The approximate volumes of effluent treated by the existing plants are:

Gordon Road	4,000 m^3/day	(20,000 persons)
Halls Head	1,400 m^3/day	(7,000 persons)
Caddadup	100 m^3/day	(500 persons)
Pinjarra	750 m^3/day	(3,750 persons)
Waroona	44 m^3/day	(220 persons)
Total	6,294 m^3/day	(31,470 persons).

Impact of the Scheme

The volume of effluent requiring treatment by WWTPs (and hence the volume of treated effluent produced) is a function of the population served by those WWTPs. The total population of the Peel Region is forecast to grow by about 58,000 people to a total of 111,500 by the year 2021 (Table 5). Given that this increase will mostly be in sewered urban areas near the coast, the volume of effluent treated by WWTPs can be expected to almost treble over that period.

Treated effluent from the existing plants is disposed of as follows (G. Brown, Water Corporation, pers. comm.):

Gordon Road: To on-site infiltration ponds. Bores located a short distance

	downgradient of the ponds abstract water to irrigate nearby schools and a golf course.
Halls Head:	To on-site infiltration ponds in coastal dunes. Possible future use for irrigation of Public Open Space.
Caddadup:	To on-site infiltration ponds.
Pinjarra:	To Alcoa tailing ponds for reuse as process water (from early 1998).

Investigations by the Water Corporation of the planned Tims Thicket plant site indicate that the site is suited to disposal of treated effluent by on-site infiltration ponds in the coastal dunes. The effluent disposal method for any future plant near Ravenswood has not been determined, but options include piping the effluent to infiltration ponds in the coastal dunes. Disposal within the Peel-Harvey catchment is considered undesirable and unlikely.

Effluent disposal by concentrated infiltration cannot be relied upon to achieve a substantial removal of nitrogen from the effluent by bacterial denitrification. Recent studies of the Gordon Road WWTP confirm that some decay of nitrogen can be expected in the groundwater (G. Brown, pers. comm.). However, the extent of this denitrification varies depending on site conditions including the oxygen status and organic carbon content of the groundwater.

Therefore, as a conservative measure until the rate of denitrification at each site can be determined, it is assumed here that all nitrogen contained in the treated effluent will pass into the groundwater and thence to the estuary or ocean.

The nitrogen load generated by WWTPs serving the current and projected population of the Peel Region can be estimated by assuming:

- effluent generation at the rate of 200 litres per person per day (M. French, WC, pers. comm.);
- a nitrogen content of 10mg/L in the treated effluent (as required by DEP Licences for existing plants); and
- all nitrogen in effluent reaches the groundwater and subsequently the ocean.

Using these assumptions, the worst-case nitrogen loading to the ocean from the existing and projected populations can be estimated as follows:

Current (population served: 31,500):
23 tonnes N per year

2021 (population served: 90,000):
65 tonnes N per year.

The estimated current nitrogen load represents between 2.5% and 5% of the total nitrogen load exported to the ocean from the Peel-Harvey Estuary. Assuming that the total load from the estuary did not change, by 2021 the load exported from WWTPs would have risen to between 7.3% and 15% of the total estuary export.

It is emphasised that the worst-case analysis presented here is likely to be a significant over-estimate of the true amount of nitrogen entering the ocean from sewage effluent, mainly because it takes no account of denitrification within the soil and groundwater.

Proposed Management

The Water Corporation is aware of the need to limit nitrogen exports to coastal waters. In 1996 the then Water Authority of Western Australia implemented the Wastewater 2040 Strategy to review effluent disposal options. Three main options are available to reduce nitrogen exports. These are discussed below.

Treated effluent reuse for irrigation to woodlots, golf courses or Public Open Space

This option is already being employed, indirectly, at the Gordon Road WWTP where groundwater is abstracted from directly downgradient of the treatment plant ponds to irrigate a golf course and school grounds. Gerritse *et al.* (1988) noted

research by Kolenbrander (1972), which found that nitrogen uptake in the root zone was very efficient and that possibly less than 10% of applied nitrogen would leach to the groundwater if tree loppings and grass clippings were removed.

In 1995, recreational facilities in 35 inland country towns in Western Australia were irrigated with treated effluent (WAWA, 1996). The total reuse through these schemes averages 8ML/day. Many of the towns store all or part of their winter effluent flows for summer reuse. This can require large areas to be set aside for storage ponds, as the maximum effluent production and maximum irrigation demand occur in opposite seasons.

Effluent can also be used to grow trees. However, large areas of land are required and, as with recreational facilities, care must be taken to ensure runoff to surface waters and infiltration to the groundwater does not compromise the local environment.

The first major effluent irrigation scheme in Western Australia is at Albany, where 575ha of land are used for growing eucalypts irrigated by treated wastewater (Kinhill, 1992). Nutrients are retained on the site, with nitrogen mainly taken up by the trees and phosphorus captured in the clay soils. A large dam stores excess winter flows to prevent surface runoff of the effluent. Twenty three monitoring bores surround the site to give early warning of possible groundwater pollution.

The most suitable areas for effluent irrigation on the Swan Coastal Plain are those with deep, dry soil profiles with high phosphorus retention capability such as the Spearwood Dunes. Areas of deep grey sands and shallow water tables would not generally be considered suitable due to their poor ability to remove nutrients and micro-organisms from the wastewater.

Effluent reuse as process water by industry

This option, while a desirable use for effluent, has limited application at present in the Peel Region as it depends on the availability nearby of a major industry whose water quantities and quality requirements are compatible with treated effluent. Nevertheless, opportunities for this type of reuse are actively explored and encouraged by the Water Corporation. Since early 1998, treated effluent from the Pinjarra WWTP has been used by Alcoa for process water at its Pinjarra refinery.

Effluent disposal via deep ocean outfall

Ocean disposal of treated effluent is used extensively in Western Australia. In 1995, 83.5% of all effluent was disposed to the ocean via outfalls at Beenyup, Point Peron and Woodman Point, all in the Perth Metropolitan Region.

The ocean has a significant capacity to dilute and further treat wastewater effluent. If an outlet is well designed there are few health or environmental problems. However, poor flushing of the ocean can limit the dilution of the effluent. This depends mainly on the depth of water in which the outlet is located and on the energy (waves and currents) of the ocean at the diffuser.

Some ocean waters may flush so poorly that a healthy marine system cannot be maintained with large-scale effluent disposal, even with additional treatment for nutrient removal. For example, the Water Authority stopped discharging treated wastewater effluent into the poorly-flushed Cockburn Sound south of Perth in 1984, due largely to the impact of nitrogen in the effluent which promoted algal growth and contributed to the large-scale decline of seagrasses in the Sound.

Given the configuration of the Peel Region coastline, the nearshore coastal waters are likely to vary from well-flushed to relatively poorly flushed. In order to avoid nitrogen enrichment of nearshore waters, detailed modelling and measurement of circulation patterns would be required to ensure that any ocean sewage outfall was located sufficiently far offshore to achieve effective dispersal and dilution of the effluent.

Improving nitrogen reduction technology of treatment plants

The DEP regulates the nutrient content of WWTP effluent through the licensing provisions of the *Environmental Protection Act, 1986*. The current EPA licence requirement for existing plants is for a nitrogen concentration of 10mg/L or less in the final effluent.

The technology exists to produce a final effluent nitrogen concentration of 5mg/l or less. As technology improves, even lower levels of nitrogen in the final effluent are likely to become technically and economically feasible.

It is therefore open to the EPA, through negotiation with sewerage providers such as the Water Corporation, to achieve substantial reductions in nitrogen export from new and existing and future WWTPs at a cost.

Summary

Of the three options outlined, it is not possible at present to say which, if any, will be implemented in the Peel Region. However, all government agencies involved in sewerage provision, effluent disposal and regulation (including local governments, the Water Corporation, the WRC and the DEP) have a role to play in minimising nitrogen exports to the ocean in the Peel Region and elsewhere.

3.10 Odour

EPA Objective:

(a) Ensure that odours from new odour-producing land uses do not adversely affect the welfare and amenity of residents in nearby existing and proposed future residential areas; and

(b) Ensure that, where there is an existing odour-producing land use, new residential areas are located so that the welfare and amenity of those new residents are not adversely affected.

Background

Certain land uses such as poultry farms, piggeries, cattle feedlots, mushroom farms, WWTPs, rubbish tips, waste transfer stations and some manufacturing industries generate odours that may at times exceed levels considered acceptable in residential areas.

Odour levels generally decrease with increasing distance from the source. Consequently, conflicts between odour-producing industries and residential areas can normally be avoided by the use of buffers to separate the two land uses. The area affected by odour can also be minimised by the adoption of best practice management at the source.

Existing Policies

Two State Government policies provide general guidance on buffer areas. The EPA's draft *Environmental Impact Assessment (EIA) Policy No. 3* sets out recommended buffer distances for a number of different types of industry, including 500m for poultry farms, 1km for mushroom farms and 2-3km for feedlots. Buffers for other facilities such as WWTPs and piggeries are referred by the policy to other relevant authorities such as the Department of Agriculture for piggeries and the Water Corporation for WWTPs.

The WAPC's *Statement of Planning Policy No. 4: State Industrial Buffer Policy* was gazetted in May 1997 to provide a consistent, Statewide approach to the provision and protection of buffer areas to ensure the long-term security of Industrial zones and other facilities requiring buffers, and the protection of adjacent sensitive land uses. SPP No. 4 refers to the generic buffer distances proposed by the EPA's draft EIA Policy No. 3.

The buffer distances recommended by EIA Policy No. 3 and other authorities are typically intended only as guidelines. The EPA has previously (e.g. BBG, 1996) established mechanisms by which buffer distances may be varied in individual cases, based on site-specific investigations. This flexibility is also built into SPP No. 4 by a provision for

buffer definition studies in relation to particular development proposals.

The *Statement of Planning Policy No. 5*, deals specifically with the avoidance of land use conflicts in relation to poultry farms. SPP No. 5 specifies buffers of 500m from poultry farms to existing or future Residential zones and 300m to existing or future Rural-Residential zones.

Existing Odour Sources

Three poultry farms and four piggeries are currently located within the Peel Region. No Residential zones exist within the nominal buffer areas of any of these sites.

Existing Urban zones surround or approach the existing WWTPs at Gordon Road and Halls Head. These and other WWTPs at Caddadup, Pinjarra and Waroona are surrounded by odour buffer areas in accordance with the Water Corporation's standard requirements. Planning decisions by local governments and the WAPC in areas near these facilities are made in recognition of these buffer areas on advice from the Water Corporation.

Impact of the Scheme

No new Urban or other Residential zones are proposed by the Scheme within the buffer area of any existing WWTP, refuse transfer station, poultry farm, piggery or other odour-producing industry. Likewise, the Scheme does not propose any new zones or reservations in which odour-producing facilities may be established in close proximity to any existing or proposed Urban or Urban Deferred zones. There is therefore no immediate requirement for management of odour in terms of the rezonings or reservations proposed by the Scheme.

Proposed Future Management

Future proposals for Residential, Rural-Residential or odour-generating developments within the Region will be subject to the requirements of the *State Industrial Buffer Policy* (SPP No. 4), which provides the means to prevent conflicts over odour.

New WWTPs planned at Tims Thicket and possibly Ravenswood will incorporate odour buffers sized in accordance with Water Corporation recommendations and implemented through the provisions of SPP No. 4.

The EPA's objectives in terms of odour will therefore be achieved by the application of existing EPA and WAPC policies.

3.11 Air Quality

3.11.1 Gaseous Emissions from the Industrial Zone

EPA Objective:

Gaseous emissions from Industrial zones should not adversely affect the health, welfare and amenity of nearby land users.

Background

As with odour, some industries may produce gaseous emissions which could create a nuisance or health risk to nearby residents. As with odours, conflicts between industrial and other land uses over air quality may be dealt with by a combination of best practice management and provision of buffer zones.

Industries that produce noxious or polluting atmospheric emissions require an Operating Licence from the DEP. In assessing the licence application, the DEP takes into account the availability and security of an adequate buffer area. Either retention of all emissions within the industrial area or provision of adequate external buffers from residential areas is generally required.

SPP No. 4 and EPA EIA Policy No. 3 provide a mechanism for determining and implementing air quality buffer areas around industry. EIA Policy No. 3 makes generic buffer distance recommendations for a wide range of industry types. SPP No. 4 requires any new industry with buffer requirements or air quality impacts to be the subject of a Buffer Definition Study at the planning

approval stage, with EIA Policy No. 3 to be used as a guide to appropriate buffer distances.

Impact of the Scheme

Two new or extended Industrial zones are proposed in the Scheme. These are a large new zone south of Amarillo and extensions to an existing industrial area west of Pinjarra. Both are intended to house light and general industry and are therefore unlikely to generate any significant emissions of noxious gases. However, there is a possibility that some industries in these zones may emit low levels of gases or particulates from furnaces, generators or incinerators.

The buffers currently available at the proposed Industrial zones are determined by the proximity of existing or proposed Residential zones and rural-residential areas. The proposed Industry zone south of Amarillo has a maximum internal buffer of about 400m available at the widest part of the zone. Therefore, any industry that required a buffer width of 400m or less could be located at the centre of this zone without requiring its buffer to encroach outside the zone. A larger, partly external buffer is available to some parts of this zone. The size of the external buffer in this case is limited by the presence of the nearby Nambeelup Kennels subdivision to the north-east and a Special Rural subdivision to the south-west.

The Pinjarra Industrial zone is too small to incorporate any significant internal buffer. Its external buffer is similarly limited by the presence of existing and planned urban areas immediately to the north and east.

Proposed Management

Individual gas-emitting industries wishing to begin operating in new or existing Industrial zones will be required to meet air quality standards compatible with surrounding existing and proposed land uses, in accordance with the provisions of SPP No. 4 and EPA EIA Policy No. 3.

The acceptability of particular industries with gaseous emissions in these zones will depend upon the availability of a site within the zone that has sufficient separation from other land uses. The size and availability of a suitable buffer in each case will be determined in accordance with the requirements of the SPP No. 4, either by the carrying out of a buffer definition study or by reference to the general buffer recommendations in EPA EIA Policy No. 3. Therefore, the EPA's objectives for gaseous emissions can be achieved by the application of existing EPA and WAPC policies.

3.11.2 Regional Air Quality – Smog and Haze

EPA Objective:

Criteria outlined in Department of Environmental Protection Technical Series 86 should be met.

Background

With the exception of ambient air quality standards for sulphur dioxide and total suspended particulates at Kwinana, and for sulphur dioxide at Kalgoorlie, Western Australia has no statutory standards for air quality.

In 1996, the DEP published interim air quality criteria for a range of pollutants in Technical Series 86: *Ambient Air Quality Data Summary, Western Australia* (DEP, 1996). The criteria of relevance to this Review are those for oxides of nitrogen (NOx), ozone (O_3), total suspended particulates and visibility, as listed in Table 6.

In June 1996, the National Environmental Protection Council agreed to develop a National Environmental Protection Measure (NEPM) for ambient air quality. A discussion paper published in 1997 (NEPC, 1997) proposed draft standards for the pollutants of relevance to the Scheme. These are shown in Table 6. The EPA and DEP will implement the final NEPM within Western Australia through an Environmental Protection Policy under the *Environmental Protection Act, 1986*. In the meantime, the DEP applies the interim criteria set out in Technical Series 86.

Table 6 EPA Technical Series 86 Interim Air Quality Criteria

Pollutant	*EPA Technical Series 86 Interim Criterion*	*NEPC (1997) Draft Criterion*
NOx	160ppb (1-hr av)	125ppb (1-hr av)
O_3	80ppb (1-hr av)	100ppb (1-hr av)
Total Particulates	90µg/m³ (24-hr av)	50µg/m³ (24-hr av)
Visibility	2.35×10^{-4} Bsp[1] (1-hr av)	No criterion

Note: 1 Coefficient of backscatter due to the presence of particles.

Monitoring by the DEP at a number of sites around Perth (DEP, 1996) showed that the interim air quality criterion for ozone had been regularly exceeded, mostly in summer. The criterion for particulates was rarely exceeded, while that for NOx had never been exceeded since monitoring began in 1993.

The interim criterion for visibility was frequently exceeded, with the seasonality of exceedences varying between monitoring sites and possibly reflecting the influence of different sources of haze (e.g. wood-fired heaters, burn-offs, dust). Overall, however, the haze problems experienced in Perth are minor compared to cities in other countries.

Photochemical Smog

Photochemical smog is produced by the action of sunlight on oxides of nitrogen and volatile organic compounds in the atmosphere to form ozone. Photochemical smog may be visible as a brownish or greyish haze. Ozone can have health effects, including respiratory problems and eye irritation, on sensitive individuals.

Smog was the subject of a separate study carried out for the Environmental Review. The main conclusions of that study were as follows:

- The Peel Region may occasionally experience summertime smog events caused by the transport of pollutants from Perth. Results of air quality modelling suggest that ozone levels within the Peel Region on these smog days are comparable to current ozone guidelines adopted by DEP. The ozone concentrations estimated for the single meteorological event modelled, however, were found to be lower than the draft ozone guidelines that have been proposed by the National Environmental Protection Council (NEPC).
- The model results indicated that smog emissions from the Peel Region did not significantly affect Perth in terms of peak ozone concentrations. There is, however, potential for Peel emissions to have an incremental effect on ozone levels in Perth, leading to an increase in the number of people exposed to ozone levels exceeding the current guidelines.
- The model results indicated that changes in motor vehicle emission control technology (and resultant emissions) caused only small differences in ozone levels. These results show that the formation of smog is a complex and non-linear process, and that effective control

strategies are not straightforward and require consideration of a number of inter-related factors.

- The study findings support the view that air pollution is a regional rather than a local problem, which requires a cooperative effort between a number of groups including the WAPC, the EPA and local governments.

Haze

Haze is caused by the presence of minute airborne particles in concentrations large enough to impede vision, making the air appear brownish in colour (DEP 1996). These airborne particles are very diverse in their chemical composition and physical properties.

Haze-forming particles are emitted from motor vehicles, domestic wood fires, burning-off of vegetation litter on development sites, forest fires (both wildfires and planned burns), power plants, industrial processes and incinerators. Secondary particles, which can also contribute significantly to haze levels, include:

- sulphates, derived primarily from sulphur dioxide emissions;
- nitrates, derived primarily from nitrogen oxide emissions; and
- organic aerosols, derived primarily from volatile organic compound emissions.

Particles that can be inhaled deeply into the lungs have been associated with a wide range of respiratory disorders. Long and short-term exposures to such particles have been linked to increased deaths from heart and lung disease and respiratory problems such as pneumonia, loss of lung function and asthma. Particles can also carry carcinogens into the lungs (NEPC, 1997).

In Perth, haze levels are highest in winter due to increased emissions from wood heaters and the frequent occurrence of atmospheric inversions accompanied by light winds, which restrict dispersion (DEP, 1996). Some areas experience greater haze problems due to being located in depressions in which cooler, denser air carrying particulates collects (Gras, 1996).

Impact of the Scheme

The NEPC (1997) identified the major capital cities as the only parts of Australia where photochemical smog is currently or is likely to be a significant issue.

The Peel Region's projected population of about 111,500 in the year 2021 will be less than 10% of Perth's current population. As many of the principal sources of atmospheric pollutants (including motor vehicles, industry, land development and wood fires) are strongly linked to population, it is logically unlikely that the population increase envisaged for the Peel Region in that period would lead to a significant level of smog or haze.

It is not possible to calculate current or likely future smog or particulate levels in the Peel Region without comprehensive modelling (J. Gras, pers. comm.). This modelling would require detailed information on topography, meteorology and pollutant sources in the region. Modelling would be both time consuming and expensive and, in the absence of any information to suggest that haze is a potential problem in the Peel Region, does not appear to be warranted at this stage.

Proposed Management

The two largest contributors to smog and haze in Perth (and probably the Peel Region) are motor vehicles and open fires. Therefore, any management measures that aim to minimise the occurrence of smog and haze must focus primarily on these two sources.

The DEP (1996) and the NEPC (1997) have recommended a number of possible measures to minimise haze. Those which may have relevance to the Peel Region include:

- Restrict the use of wood heaters in areas where dispersion is poor or there are topographical features which cause high haze concentrations.
- Stringent emission standards for wood heaters in line with AS4013.
- Community education about the impacts of using wood heaters.
- Avoid burning vegetation litter on development sites.
- Prior to fuel reduction burns, responsible authorities to liaise with the Department of Environmental Protection to determine the best conditions for burning and particle dispersion.

The Western Australian Government Select Committee on Perth's Air Quality (Legislative Assembly, 1997) canvassed a number of educational, technical and regulatory strategies that could be used to reduce the contribution of open burning to both photochemical smog and haze in Perth. These strategies included those listed above.

The planning process has limited influence over the generation of atmospheric pollutants, beyond ensuring that major emitters (such as some industries) are located where their particulate emissions will not affect residential areas, and designing road networks so that travelling distances are minimised.

The future development of a passenger railway linking Mandurah and Perth will play an important part in promoting the use of public transport over private vehicles. The Scheme recognises this potential by reserving a conceptual alignment for the railway.

The recently-released *Liveable Neighbourhoods: Community Design Code* (WAPC, 1997) sets out principles for design of new residential subdivisions. An important objective of the Code is the design of neighbourhoods and transport systems (including road and rail) so that private vehicle use is reduced, public transport is utilised to its maximum and travelling distances between home, work and other facilities are minimised. By reducing the use of private vehicles, the Community Code will help to reduce a major source of photochemical smog precursors and atmospheric haze.

The control of smog emissions from open fires is outside the scope of the regional planning process.

3.12 Solid Waste Disposal

EPA Objective:

There be a 50% reduction in waste [per capita] going to landfills achieved by waste avoidance, reuse and recycling strategies and that the remaining waste is disposed of in an environmentally acceptable manner, including landfill.

Background

A study by the Peel Regional Council in 1995-96 reviewed a number of possible future regional landfill sites within the Peel Region. The Peel Regional Council adopted a site on the edge of the Darling Scarp in Del Park Road as its preferred site. This site had the advantage of being located on suitable soils outside existing or potential public water supply catchments, but was constrained by the presence of residences a little more than one kilometre away. The lifetime of the site was estimated at more than fifty years at projected rates of population increase without any waste reduction.

When the agreement of all the local governments to the Del Park Road site could not be achieved, the Peel Regional Council was disbanded.

More recently the City of Mandurah opened a waste transfer station on Gordon Road, which receives about 30,000 tonnes of municipal waste per year. This facility incorporates a number of waste reduction strategies including waste

segregation, marketing of useful components, composting and mulching of green waste. The remaining portion of the waste stream, which represents about 75%, is transported to the regional landfill site on Millar Road, Baldivis. It is estimated that the Baldivis landfill facility, even with joint use by the Cities and Rockingham and Mandurah, will have a lifespan of about 20 to 30 years.

The Shire of Waroona currently operates a landfill in Buller Road. This site receives 1,000 to 1,500 tonnes of waste per annum (Shire of Waroona, pers. comm.).

The recent closure of the Corio Road landfill facility, has prompted the proposal by Shires of Murray and Waroona to jointly upgrade and use the landfill facility on Buller Road. It is anticipated that the upgraded landfill facility will be operational by 1999. It is expected that this facility will accommodate the needs of the two Shires for the foreseeable future.

Impact of the Scheme

The population of the Peel Region Scheme area is forecast to grow by about 110% by the year 2021 (Table 5). In the absence of other factors, this could be expected to bring about a similar increase in the volume of municipal waste produced in the region. Even if the rate of waste generation per capita were reduced by 50% in line with the EPA objective, the total volume generated each year would be expected to increase over its current level. However, the current and proposed municipal waste arrangements for the City of Mandurah and the Shires of Murray and Waroona should be adequate for the next 20 to 30 years.

Proposed Management

The EPA objective of a 50% reduction in waste going to landfill is based on a State Government objective of a 50% reduction *per capita* in landfill, as stated in the *1998 State of the Environment Report* (DEP, 1998). Possible strategies for achieving a reduction in waste include:

- introduction of kerbside recycling services;
- providing exclusive-use bins of limited size;
- reducing the frequency of kerbside rubbish collection;
- community education campaigns;
- introduction of variable disposal fees based on volume; and
- providing or subsidising recycling tools such as compost bins.

At the State level, work is well advanced on the development of a State Waste Reduction and Recycling Policy. Many local governments have also adopted waste reduction policies and kerbside recycling programs, with mixed results. Impetus is given to these initiatives by the high cost to local governments of developing and managing new landfills in accordance with current EPA licensing requirements.

The City of Mandurah has a formal objective of achieving a 50% reduction in waste disposal per capita to landfill by the year 2000. Mandurah also has a kerbside recycling service, which is operated under contract by a private company. It is intended that this service will be upgraded when the contract is renewed in the year 2000.

Kerbside recycling and other waste reduction measures are seldom economically viable for private contractors without government subsidies. In recognition of this, the State Government introduced a differential levy on landfill received within Perth in July 1998. Some of the revenue generated by this levy will be directed to supporting and subsidising kerbside recycling and other waste reduction programs in country areas.

The success of these and other measures in achieving the State Government's objective of a 50% reduction in waste disposal per capita to landfill will depend on continued support from the State Government, local governments and the public.

3.13 Risk and Hazard

EPA Objective:

Risk levels should be as low as reasonably achievable and comply with acceptable standards.

Background

Public risk may arise from industries that use or produce toxic, explosive or otherwise hazardous materials or processes. The risk of fatality to a particular person at a particular time depends on his or her proximity to the source of the risk and the magnitude of the source. Management of risk is therefore approached by provision of buffer areas and/or implementation of best practice management at the source.

Impact of the Scheme

The new or expanded Industrial zones proposed by the Scheme (south of Amarillo and west of Pinjarra) are intended for light and general industry, and as such are unlikely to house hazardous industries. However, some light and general industries may give rise to localised risk through the storage or use of hazardous materials such as chlorine gas and petroleum products.

Of the Industrial zones, the one south of Amarillo has a maximum internal buffer of 400m and an additional external buffer of about 500m to the nearest residence. The one west of Pinjarra also has a maximum internal buffer of about 400m but, due to the proximity of existing and proposed residential areas, little external buffer.

Proposed Management

As is the case for odour and gaseous emissions, EPA Draft EIA Policy No. 3 and SPP No. 4 provide a mechanism by which industries requiring risk buffers can be assessed for approval in Industrial zones. As a general rule, industries that have risk factors could be permitted within the Industrial zones provided that their risk buffer (as defined by a Buffer Definition Study based on EIA Policy No. 3 and SPP No. 4) can be accommodated entirely within their own site or, in some cases, the industrial estate.

Industries whose risk buffer extended past the boundaries of the Industry zone could be considered for approval provided that no nearby residences or public recreation areas were within the buffer distance and that neighbouring land holders did not object to the buffer area impinging on their property.

WAPC Policy No. DC 4.2: *Planning for Hazards and Safety* sets out development control guidelines for local governments in the assessment and approval of hazardous industries, including the provision of buffer areas and possible assessment by the EPA.

Industrial proposals whose risk factors are considered by the responsible authority to warrant specific environmental assessment will be referred to the EPA for assessment under Division 4 of the *Environmental Protection Act, 1986.*

Industries with risk implications, or which involve the handling or storage of dangerous goods, will also be subject to licensing and regulation under the *Environmental Protection Act* and/or the *Explosives and Dangerous Goods Act, 1991* (administered by the Department of Minerals and Energy).

Management of risk from existing and proposed industry in the region is therefore adequately addressed by existing government legislation and policies, without the need for specific provisions in the Scheme.

3.14 Local Urban Bushland

EPA Objective:

Protect where possible through the planning system.

Background

For the purposes of this Review, urban bushland is defined as remnant vegetation in proposed urban areas that is not within the existing or proposed Conservation Estate (relevant System 6 areas, Crown Conservation Reserves and lands managed by CALM for conservation).

Local Urban bushland may have a range of environmental and social values and functions including:

- representation of a local vegetation type and biodiversity maintenance;
- fauna habitat;
- provision of habitat linkages between other remnants;
- control of groundwater rise;
- landscape enhancement;
- education;
- passive recreation; and
- heritage.

The importance of conserving Urban bushland at the regional and local level has been recognised by the State Government's *Urban Bushland Strategy* (Govt of WA, 1995), which sets out the government's objectives in terms of urban bushland protection and provides a framework for identifying and assessing areas of bushland that should be protected where possible in the development of Western Australian cities.

The criteria for assessment of regional and local significance, as established by the *Urban Bushland Strategy*, are listed in Table 7.

Table 7 Assessment of Regional and Local Significance of Urban Bushland

Regionally Significant	*Locally Significant*
*Example of a regional vegetation type which is threatened or poorly reserved or a site with special value for flora or fauna conservation.	One of the better examples of a local vegetation type.
*Has considerable biodiversity or supports a population of Declared Rare Flora, priority listed flora, or threatened flora.	Has biodiversity value but unlikely to include Declared Rare Flora. May include geographically significant species at the limit of their range.
*Vegetation in good condition or better.	Threatened vegetation types may be regionally significant even if in poor condition.
Vegetation may be in poor condition but if poor, capable of regeneration.	Usually greater than 20 hectares but may be smaller in the case of threatened or poorly reserved vegetation types, or areas with special significance for other purposes.
Ideally greater than 4 hectares but smaller areas may be of significance depending on how much remains in the locality.	Suitable for passive recreation by people from both within and beyond the locality. Suitable for passive recreation by the local community.
Region wide use or potential for scientific or educational study.	Use or potential use by local schools.
Having cultural heritage values of a regional or greater significance.	Having local heritage value.
Regular shape is desirable unless the area functions as a significant corridor linking other remnants.	Shape not critical but remnant should be capable of ongoing management.

Source: Urban Bushland Strategy (Govt of WA, 1995).

* Essential criteria for bushland to be regarded as regionally significant.

The above criteria should also be judged alongside other social and economic opportunities and constraints in order to select areas to be protected at the regional and local level.

Impact of the Scheme

Four sizeable parcels of remnant bushland are proposed to be rezoned to Urban or Urban Deferred under the Scheme. These are shown on Figures 18 and 19 and described below.

Madora-San Remo – Coastal dune scrub totalling about 153ha (mostly degraded by grazing), including about 110ha of System 6 Area M107; proposed to be rezoned from Rural to Urban and Urban Deferred.

Lakelands – About 90ha of Jarrah-Banksia woodland east of the southern extension of the Paganoni Swamps; rezoned from Rural to Urban.

Melros – About 45ha of coastal scrub, Tuart and Jarrah-Banksia woodland; rezoned from Rural to Urban.

Point Morfitt – About 70ha of Jarrah/Banksia/Peppermint woodland; rezoned from Rural to Urban and proposed for subdivision into a variety of lot sizes (BBG, 1997).

For this Review, the four bushland areas listed above were examined in terms of the regional criteria in Table 7, as follows:

- Vegetation mapping by Heddle *et al.* (1980) was combined with GIS-based remnant vegetation mapping by Agriculture Western Australia to identify the vegetation complexes (as defined by Heddle *et al.*, 1980) present and the remaining and reserved areas of those complexes in the Peel Region.

  An objective of the Urban Bushland Strategy, in accordance with guidelines set by the World Conservation Union, is that "...not less than 10 per cent of each vegetation complex ... [based on the Heddle classification] should be regionally reserved in not less than five separate areas." Where it is not possible to achieve this target within a particular region, opportunities will exist outside the region for the 10% target to be achieved.

- Size, shape and connectivity of the parcels were assessed by examination of December 1996 aerial photographs.

- Vegetation condition was assessed by field inspection by an environmental scientist and rated on a scale from Excellent (near-pristine) to Poor (severely degraded).

- The presence of DRF, Priority Flora and Gazetted Rare Fauna has not been assessed except in the case of Point Morfitt, which had previously been the subject of DRF searches by botanist Dr Arthur Weston (BBG, 1997).

  The presence of rare and priority flora can only be determined by detailed site-specific searches by an experienced botanist.

The findings as to the environmental attributes and significance of the areas examined are summarised in Table 8.

The following conclusions and recommendations can be drawn from Table 8:

- All sites examined contain vegetation complexes that meet the minimum requirement for reservation in the Peel

Region and/or the Swan Coastal Plain by virtue of having more than 10% of their original extent reserved in Regional Open Space. While the quality of the vegetation in these areas is in some cases high, their value in terms of the other criteria is generally low. They may therefore be considered for local, rather than regional, significance. Local governments could address retention of parts of any of these areas during the preparation of Local Structure Plans or Outline Development Plans.

- A search for DRF, threatened flora and Gazetted Rare Fauna has been carried out for the Point Morfitt site. The site is known to contain several Aboriginal heritage sites, with Morfitt's Cave (BBG, 1997) being the most significant, which is to be included within Regional Open Space. The City of Mandurah has also recently adopted an Outline Development Plan for Point Morfitt.

- It is understood that no vegetation surveys have been carried out for the other sites, however, in most cases rare flora occur in localised areas and can be protected by a relatively small local reservation. All of these sites are subject to Residential rezoning proposals under the City of Mandurah's proposed Town Planning Scheme No.3, which is anticipated to be finalised in early 1999.

Proposed Management

The analyses carried out as part of this Review have shown that all known regionally significant vegetation in areas subject to rezoning under the Scheme has been proposed for incorporation in Regional Open Space.

The assessment of whether there is a need to protect any small parcels of remnant bushland of local significance within existing or proposed urban zones, is more appropriately addressed at the local planning level through the preparation of local structure plans and at the subdivision stage.

Local governments may also consider the significance of local bushland areas through local conservation or local urban bushland strategies. For example, the City of Mandurah has adopted a Bushland Policy that sets out Council's requirements for protecting local bushland at the subdivision stage. The City is also in the process of finalising a Concept Vegetation Plan, which identifies (on the basis of vegetation quality, ecological linkages and other factors) areas of bushland with priority for retention within subdivisions, and sets out principles for their management.

Notwithstanding the above, the identification and appropriate protection of other areas of remnant vegetation affected by future rezonings under the Peel Region Scheme will be further supported by proposed Environmental Management Measure No.4 in Chapter 5. The provisions of which, will generally require a vegetation survey to be carried out prior to the rezoning of land in the Scheme where there is riparian vegetation or more than 1 ha of native vegetation.

4.0 Deferred Environmental Factors

4.1 Introduction

Deferred environmental factors are those factors which are identified as significant by the EPA but which, for reasons of timing or scale, cannot be properly addressed at the Region Scheme level. The EPA has identified three deferred environmental factors for the draft Peel Region Scheme. These are:

- noise and vibration from the Perth-Mandurah passenger railway;

- regionally significant vegetation in the Rural zone; and

Table 8 Remnant Bushland Attributes

Site	Vegetation Type, Size and Condition	Complex(es) (after Heddle et al., 1980) Area	Remaining in Peel Region (% of original)	Area in Peel Regional Open Space (% of original)	Presence of DRF/Priority Flora or Gazetted Rare Fauna	Shape and Connectivity	Social/ Cultural Values	Assessment Against Criteria in Table 7	
								Local Significance	Regional Significance
Madora-San Remo	Coastal dune scrub totalling about 158ha, mostly degraded by grazing.	Quindalup (88ha) Cottesloe – Central & South (70ha)	Quindalup – 2397ha (44%) Cottesloe – 7323ha (35%)	Quindalup – 1519ha (28%) Cottesloe – 3794ha (18%)	Unknown	Elongated and isolated by cleared rural land, existing & future urban areas and major highway.	Suitable for local passive recreation. Significant local landscape element.	Low	Moderate
Lakelands	Predominantly Jarrah-Banksia woodland (86ha) in moderate to good condition.	Cottesloe – Central & South (8ha) Yoongarillup (77ha) Karrakatta – Central & South (1ha)	Karrakatta – 2883ha (53%)	Karrakatta – 680ha (13%)	Unknown	Directly adjacent to Paganoni Swamps ROS.	Suitable for local and regional passive recreation.	Low-Moderate	Low
Melros	About 45ha of coastal scrub, Tuart and Jarrah-Banksia woodland in good to excellent condition.	Yoongarillup (27ha) Cottesloe – Central & South (18ha)	Yoongarillup – 4587ha (36%) Cottesloe – 7323ha (35%)	Yoongarillup – 3610ha (28%) Cottesloe – 3794ha (18%)	Unknown	Poor – isolated by future urban development.	Local landscape feature.	Low	Low
Point Morfitt	About 70ha of Tuart/Jarrah/Marri tall forest and Banksia/Peppermint low forest in poor to very good condition.	Karrakatta – Central & South (70ha)	2883ha (53%)	680ha (13%)	No DRF found. One Priority 4 Species: *Conostylis pauciflora* ssp. *pauciflora*.	Good connection to Yalgorup NP (across highway).	Regionally significant Aboriginal heritage site (Morfitt's Cave). Suitable for local and regional passive recreation.	Moderate	High in part around Morfitt's Cave which is to be included within ROS. Low – Moderate elsewhere.

- regionally significant wetlands in the Rural zone.

The general requirement for deferred factors is that a mechanism should be identified by which these factors will be addressed at an appropriate stage in the planning process. This may be by way of either:

- referral of schemes and amendments, subdivision and development applications to the EPA for assessment of the relevant factor(s); or
- implementation of other suitable planning, regulatory or policy provisions to consider and manage the factors.

The deferred environmental factors for the Scheme are discussed below.

4.2 Noise and Vibration from the Rapid Transit Corridor

EPA Objective:

Noise and vibration in residential areas near land uses generating significant levels of noise should meet statutory requirements and acceptable standards.

A possible route for the proposed future Perth-Mandurah passenger railway line is shown on the Scheme as a Railways Reservation. The time scale for construction of the railway is in the order of 15 to 30 years.

The physical impact of the development of a railway line within the reserve would be minimal, as the proposed rail route and station sites are located largely on cleared or parkland-cleared land. Neither the rail route nor the proposed station sites impinge on any regional environmental features.

Noise emitted by the railway may have impacts on nearby residents, and therefore requires detailed assessment before a railway can be approved on the route shown. This assessment is not appropriate at this stage because:

- the design, construction, operating regime and noise characteristics of the railway are unknown; and
- the pattern of residential occupation along the railway route may change substantially in the time before the railway is constructed.

There are currently no formal criteria in Western Australia for acceptable noise or vibration impacts from railways on residences. The mobile and distributed nature of the source means that it is difficult to control through regulations. The *Environmental Protection (Noise) Regulations 1997* specifically exclude road and rail noise. As a result, there is a need for consistent noise criteria for transportation noise which can be used as the basis for planning decisions and environmental impact assessments.

The DEP is currently undertaking preliminary investigations with a view to preparing an EIA Guidance Note to set criteria for rail and road noise. Related issues such as ground vibration from road and rail transport may be included at a later stage. The draft note outlines criteria for:

- proposed noise-sensitive developments (residences, hospitals and the like) near existing transportation routes;
- new road and railway lines near existing noise-sensitive premises; and
- traffic expansion on existing roads and railways.

Given the probable 15 – 30 year timeframe for construction of the railway, it is likely that formal policies and criteria for rail noise and vibration will be in existence to guide both the planning and environmental assessment processes.

Unless the environmental assessment process is amended to provide an alternative assessment pathway for railway proposals, the Perth-Mandurah passenger railway will be referred to the EPA before construction for assessment of its potential noise and vibration impacts under Division 1 of the *Environmental Protection Act, 1986.*

No formal condition is considered necessary to facilitate this process.

4.3 Regionally Significant Vegetation in the Rural Zone

EPA Objectives:

(a) Ensure the abundance, diversity, geographic distribution and productivity of vegetation communities is maintained;

(b) Protect Declared Rare and Priority Flora consistent with the provisions of the Wildlife Conservation Act, 1950; and

(c) Ensure riparian vegetation on substantial streamlines is adequately protected.

The potential impacts of new land uses on regionally significant vegetation in areas rezoned by the Scheme were discussed in Section 3.2. That discussion did not include any areas where no change in zoning or land use was proposed by the Scheme.

The Rural zone shown in the Scheme encompasses a broad range of rural land uses including broadacre farming, special rural, rural-residential and intensive agriculture/horticulture. These land uses have varying degrees of impact on remnant vegetation, and a change from one use to another may have significant impacts on vegetation.

The System 6 study (DCE, 1983) identified a number of areas of vegetation in rural parts of the Peel Region that were and are considered regionally significant. In addition, the current System 6 Update (see Section 1.6.4.5) has identified a number of areas in the Rural zone that contain rare or threatened plant communities. The regionally significant vegetation identified by these studies is shown on Figure 13. As the System 6 Update proceeds, it is possible that further areas of remnant vegetation in the Rural zone may be identified as regionally significant.

Three scenarios exist under which clearing of vegetation in the Rural zone may be proposed under the Scheme. These are discussed below.

1. *Change in land use requiring a rezoning at the Region Scheme level (e.g. Rural to Urban)*

A proposal of this type would automatically trigger a referral to the EPA by the WAPC under Division 3 of the *Environmental Protection Act, 1986*. However, with proposed Environmental Management Measure No. 4, there would be a mechanism in place to require a vegetation survey to be carried out prior to any future rezoning of land in the Peel Region Scheme upon which there is riparian vegetation or more than 1ha of remnant vegetation.

2. *Change in land use requiring a rezoning under the local Scheme but not the Region Scheme (e.g. Rural to Special Rural).*

Given that the Rural zone in the Region Scheme has not been assessed as part of this Review (in accordance with the EPA Instructions), local government town planning schemes and amendments within this zone will be referable to the EPA under Division 3 of the *Environmental Protection Act, 1986* for assessment of remnant vegetation and other relevant factors.

3. *Clearing carried out as part of rural activities (e.g. for establishment of pasture, vineyards or tree farms) which does not require rezoning at either local or regional level.*

Agricultural clearing is not referable under Division 3 of the Environmental Protection Act, 1986 as it does not involve any rezoning. It is, however, referable under Division 1 (Section 38) of the Act via an interdepartmental procedure known as the Memorandum of Understanding.

Under the Soil and Land Conservation Act, 1945, any proposal to clear more than 1ha of native vegetation in agricultural areas must be referred to the Commissioner for Soil and Land Conservation for approval. A Memorandum of Understanding signed in 1997 between the Commissioner for Soil and Land Conservation, the EPA, DEP, Agriculture WA, CALM and WRC established a process for assessing clearing proposals. Briefly, the process is as follows:

- In shires where less than 20% of the original vegetation remains in the main agricultural area, applications to clear land are subject to individual assessment by the EPA.
- In shires where more than 20% of the original vegetation remains in the main agriculture area (including the City of Mandurah and the Shires of Murray and Waroona), proposals to clear more than 1ha are subject to a four-step assessment process which comprises:

1. initial screening by Agriculture Western Australia;
2. site inspection by Agriculture Western Australia and other agencies as appropriate;
3. consideration by an inter-agency working group which includes a DEP representative; and, if the working group considers it necessary;
4. formal EPA assessment at the level of Consultative Environmental Review (CER).

In Step 3, the inter-agency working group may recommend approval of the clearing proposal if it is judged acceptable against a set of agreed criteria including:

- no deterioration in surface and groundwater catchments leading to increased salinity and eutrophication;
- no contribution to soil erosion, waterlogging and flooding;
- the land does not provide a corridor or important stepping stone between conservation areas and is not an inlier to conservation areas;
- the land has no high physiographic, landscape or heritage values;
- the land has no high ecological values (rare or threatened flora and fauna, biological diversity, significant wetlands, representation in reserves, habitats, viability of existing bushland, pests and weeds).

If these criteria are not judged to be met, the working group may recommend that the Commission for Soil and Land Conservation refer the proposal to the EPA for formal public assessment at CER level.

In addition to the *Memorandum of Understanding* process, proposals for agricultural clearing may also be called in for assessment by the EPA or the Minister for the Environment, or may be referred to the EPA by the proponent or any other person.

The combined effect of the *Soil and Land Conservation Act*, the *Environmental Protection Act* and the *Memorandum of Understanding* will be that all proposals to clear more than 1 ha of vegetation in the Rural zone will be subject to review and assessment by all relevant authorities including the DEP and/or EPA. No formal environmental condition in the Scheme is considered necessary to facilitate this process.

4.4 Regionally Significant Wetlands in the Rural Zone

4.4.1 General

EPA Objective:

Key ecological functions of these wetlands should be protected and maintained through appropriate planning mechanisms.

Rural-zoned areas of the Peel Region contain a number of wetlands that are considered regionally significant by virtue of being gazetted under the Lakes EPP or named in international treaties. These wetlands are shown on Figure 8.

Similarly to vegetation (Section 4.3), regionally significant wetlands in the Rural zone could be affected by land uses under three scenarios, as described below.

1. *New land uses requiring rezoning at the Region Scheme level (e.g. Rural to Urban or Industry).*

The first of these scenarios would trigger referral of the proposed rezonings to the EPA under Division 3 of the *Environmental Protection Act, 1986*, which would enable the implications of the proposed rezonings for regionally significant wetlands to be assessed. However, proposed

Environmental Management Measures No.s 1,2,3 and 4 would provide various mechanisms to ensure the protection of regionally significant wetlands affected by future rezonings under the Peel Region Scheme and subsequent subdivision and development.

2. *New land uses requiring rezoning under the local scheme but not the Region Scheme (e.g. Rural to Special Rural).*

Given that the Rural zone in the Region Scheme has not been assessed as part of this Review (in accordance with the EPA Instructions), local town planning schemes and amendments within this zone will be referable to the EPA under Division 3 of the *Environmental Protection Act, 1986* for assessment of wetlands and other relevant factors.

3. *New land uses carried out under the existing Rural zoning (e.g. clearing of vegetation, water abstraction or intensive horticulture).*

A number of agricultural activities within the existing Rural zoning may have impacts on wetlands. These include:

- abstraction of groundwater;
- clearing of wetland vegetation;
- drainage into or out of wetlands; and
- fertiliser-intensive land uses such as horticulture in the capture zone of the wetland.

In each of these cases, an appropriate mechanism exists to ensure that the impacts of the land use are assessed. These are briefly described below.

Groundwater Abstraction

The whole of the coastal plain within the Peel Region is covered by the Murray and South-West Coastal Groundwater Areas. Within these control areas, under the provisions of the *Rights in Water and Irrigation Act, 1914*, all bores (other than those used for private domestic purposes on residential lots smaller than 2,000m^2) are subject to licensing by the WRC (C. Treloar, WRC, pers. comm.).

The impact of an isolated private domestic bore on groundwater and wetland levels would be negligible. For all larger bores, the possible impacts on wetlands will be considered by the WRC as part of the licensing process. If the proposed bore appears likely to have significant impacts on a regionally significant wetland, the proposal may be referred to the EPA for assessment.

Clearing of Wetland Vegetation

Under the *Memorandum of Understanding*, all proposals to clear more than 1ha of vegetation of any kind in agricultural areas are subject to assessment and approval by an interdepartmental committee comprising the Commissioner for Soil and Land Conservation, the DEP, the Department of Agriculture, CALM and the Water and Rivers Commission. This process was described in Section 4.3.

Drainage

Most, if not all, of the land in the Peel Region that would be likely to require drainage for agriculture purposes is within the coastal plain catchment of the Peel-Harvey Estuary.

A moratorium on drainage within the Peel-Harvey Coastal Plain Catchment was imposed by the Minister for Environment following EPA review of the *Peel Inlet – Harvey Estuary Environmental Review and Management Programme Stage 2* (Kinhill, 1988). The intent of the drainage moratorium in terms of new developments was subsequently incorporated in State Planning Policy No. 2, which required new subdivisions within the Peel-Harvey catchment to have drainage systems that minimised nutrient exports.

Drainage proposals in the Rural zone are subject to assessment and approval under the provisions of the *Soil and Land Conservation Act, 1945*. Approval generally depends on the proponent

demonstrating that nutrient exports will not be increased and that land degradation on the subject land or downstream will not result.

Fertilisers

Proposals for new horticulture operations and other nutrient-intensive land uses are subject to planning approval under the district zoning schemes of Mandurah, Murray and Waroona.

In Mandurah, horticulture is a "P" (Permitted) use in the Rural zone, meaning that it would normally be approved provided that it complied with all relevant local scheme standards and requirements, and any specific conditions placed on the approval. Council may consult with other relevant authorities such as the DEP and WRC in making its decision on the planning application.

In Murray and Waroona, horticulture is an "AA" (Discretionary) use in the Rural zone. Approval may be granted at the discretion of Council, provided that the proposal meets overall planning objectives for the area and does not conflict with other priorities. Council would normally consult with other agencies such as the DEP and WRC in makings its decision on the planning application.

Conclusion

In addition to the measures discussed above, the *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992* (the "Lakes EPP") requires that all activities that may result in "filling, excavation, pollution or drainage" of any lake gazetted under the Lakes EPP be referred to the EPA.

The above discussion demonstrates that procedures exist by which all developments in the Rural zone that have the potential to affect regionally significant wetlands will be assessed in terms of their environmental impacts.

No formal environmental condition in the Scheme is considered necessary.

4.4.2 Land Use in the Catchment of Lake Clifton

EPA Objective:

Ensure protection of stromatolites in Lake Clifton by implementing planning mechanisms so developments meet the criteria outlined in EPA Bulletin 864.

Lake Clifton is part of the Yalgorup Lakes, a chain of eleven wetlands of international environmental importance that is partly contained within Yalgorup National Park. The Yalgorup Lakes are named in a number of policy documents including the Lakes EPP, the Ramsar Convention and ANCA (1993).

Lake Clifton contains the largest known occurrence of microbialites (specifically thrombolites, although they have historically been referred to as stromatolites) in the southern hemisphere. The continued survival of the microbialites depends upon protection of the water regime of the lake. Of main concern are water quality issues relating to the use of the freehold rural land that adjoins most of the eastern margin of the lake. This area consists largely of small (mostly 2 – 10ha) rural lots and is subject to development pressures ranging from Rural-Residential subdivision to intensive agriculture and horticulture.

In September 1997 the EPA released Bulletin No. 864: *Final Criteria of Environmental Acceptability for Land Use Proposals Within the Catchment of Lake Clifton.* The Bulletin set out criteria for water use, fertiliser application, stocking densities and other matters relating to horticultural, residential and tourist developments near the lake. The stated intention of Bulletin 864 is that developments which comply with the criteria set out in the Bulletin will normally not require formal assessment by the EPA.

The *Coastal and Lakelands Planning Strategy* (WAPC, 1999) responds to the Bulletin 864 criteria by making the following recommendations for the Lake Clifton catchment:

Rural-Residential (Zone)

- Classify as Rural-Residential those areas that are:
  - already zoned for that use; or
  - proposed by local rural strategies (excluding areas within the perimeter of Yalgorup National Park or abutting Lake Clifton).
- Except where approved subdivisions exist, adopt a minimum average lot size of 5ha with a minimum of 2ha.
- Where appropriate, vary site densities and lot sizes within subdivisions (subject to the 5ha minimum average lot size requirement) to achieve development that is responsive to landform, landscape and other site criteria.
- Exercise controls on the abstraction of water.

Rural 1 – General Farming (Zone)

- Zoning to remain as General Farming, with the main land uses being grazing and plantation forestry.

Rural 2 – Multiple Use, Grazing, Horticulture (Zone)

- Appropriate uses in this zone are horticulture, plantation forestry, limestone extraction and grazing.
- Land uses apart from general farming and grazing should be subject to planning consent and site controls under local government district zoning schemes.
- Subdivision for small-lot rural-residential use should not be permitted.
- Limited subdivision for specialised commercial and tourist activity may be permitted for a use approved by the local government and the WAPC.
- Landscape protection measures recommended by the Strategy will be applied.
- Setback for horticultural activity to be 100m from the lake fringe, including at least 20m of Spearwood soils.

Rural 3 – Highway Environs (Zone)

- Minimum lot size of 5ha.
- Smaller lot sizes for specialised tourist/commercial purposes may be permitted for a use approved by the local government and the WAPC.
- Development for building and horticulture to be set back from Lake Clifton by a minimum of 150m, including at least 20m of Spearwood soils and 2m vertical clearance from groundwater.
- No direct drainage into Lake Clifton.

As Lake Clifton is also a regionally significant wetland as defined in the EPA Instructions (Appendix A), land use proposals in the catchment will be subject to the controls and assessment processes described in Section 4.4.1.

Assessment of Rezoning, Subdivision and Development Proposals

The subdivision and development criteria outlined in EPA Bulletin 864 are reflected in the *Coastal and Lakelands Planning Strategy*, which is incorporated by reference into the Peel Region Scheme. Therefore, the WAPC will have to have due regard to the criteria in the Strategy when considering Scheme amendments, and subdivision and development (where required under the Region Scheme) applications. Given the relevant local governments' involvement in the preparation of the Strategy, it is expected that they will also have regard to the criteria when preparing or considering town planning schemes, amendments and development applications. Furthermore,

development proposals that are not consistent with the criteria, will most likely be referred to the EPA for assessment.

In concluding, it is considered that no formal environmental condition in the Scheme is necessary.

5.0 Implementation of Management Proposals

5.1 Introduction

The environmental management measures discussed in Chapter 4 fall into three main categories on the basis of how they will be applied to specific land uses. These are:

- management that will be applied through existing legislation, policies and procedures (e.g. Industry buffers, regionally significant vegetation in the Rural zone;);
- management that will be achieved through the implementation of Best Practice Management (e.g. drainage, smog and haze); and
- management that will be implemented by specific conditions that legally bind the Region Scheme and, through the provisions of Section 18(1c) of the *Western Australian Planning Commission Act, 1985*, the local government town planning schemes.

The first of these types of management requires no formal commitment in this Review, as implementation will be through either statutory process or stated government policy.

The second category of management will continue to evolve as advances in technology and understanding improve the performance of Best Practice Management. It is not considered appropriate to set specific conditions for this management category as to do so could impede the implementation of Best Practice Management.

The third category represents management requirements that are not covered by either existing policy or best practice management. The proposed environmental management measures for this category of management are presented in Section 5.2 and are intended to apply to the whole Scheme area. It is expected that the conditions imposed on the implementation of the Scheme by the Minister for the Environment with the agreement of the Minister for Planning will incorporate these specific environmental management measures.

5.2 Proposed Environmental Management Measures

1. Prior to the subdivision or development of land, the responsible authority may require an Environmental Management Plan to assess the possible impacts of the proposed subdivision or development on any adjoining land with conservation values as listed below:

   i) land which is reserved as Regional Open Space in the Scheme;

   ii) a Crown conservation or nature reserve;

   iii) a National Park; or

   iv) wetland or lake which is identified in an approved Environmental Protection Authority Policy to be protected for conservation.

   An Environmental Management Plan, if required, shall be prepared to the satisfaction of the responsible authority having due regard to advice from relevant government agencies and shall be implemented in accordance with a program defined in the Environmental Management Plan.

2. Prior to the subdivision or development of land in areas where the Average Maximum Groundwater Level is less than 1.2 metres below the natural ground surface, or where any proposed off-site drainage could lead to degradation of wetlands or waterways, the responsible authority may require a Drainage and Nutrient Management Plan (DNMP).

   The DNMP, if required, shall be prepared to the satisfaction of the responsible authority having due regard to advice from relevant government agencies and shall be implemented in accordance with a program defined in the DNMP.

   The DNMP may include, but is not limited to, the following:

   (i) a numerical model or other suitable analysis and forecasting techniques developed to determine the drainage management requirements of the site following development;

   (ii) an estimate of the existing nutrient mass balance of the site based on detailed on-site measurements;

   (iii) predicted post-development nutrient mass balance of the site based on the monitoring results of existing nutrient-stripping ponds on other sites and other nutrient management measures proposed;

   (iv) establishing water quality performance criteria consistent with targets established for the catchment;

   (v) a comparison of the results of the predicted mass and water balances with water quality performance criteria for the development; and

   (vi) the design and management planning (including mosquito control measures in the drainage system), monitoring to demonstrate compliance with water quality performance criteria, and reporting.

3. In considering any proposal for the subdivision or development of land for residential, special residential, commercial, industrial and tourist purposes the responsible authority may require connection of the land to reticulated sewerage where the land is:

   i) within the Peel-Harvey Coastal Catchment Area and therefore subject to provisions of the Statement of Planning Policy No. 2 for the Peel-Harvey Coastal Plain Catchment; and

   ii) outside the Peel-Harvey Coastal Plain Catchment Area and has an Average Annual Maximum Groundwater Level of less than 1.2 metres below the natural ground surface or where subsoil drainage is proposed or will be required as a part of subdivision or development.

4. Prior to any rezoning of land in the Scheme upon which there is riparian vegetation or more than 1 ha of native vegetation, the responsible authority may require a Vegetation Survey, including a search for DRF, Priority Flora, Threatened Flora Communities and Threatened Fauna, to be undertaken.

   The Vegetation Survey, if required, shall be prepared to the satisfaction of the responsible authority having due regard to advice from relevant government agencies, and shall be taken into account in considering the rezoning, subdivision and development proposal.

5.3 Application of Environmental Management Measures to Local Schemes

Because the Region Scheme has a regional and strategic focus, many of the environmental management principles upon which it is based are also regional in focus.

In contrast, many of the potential environmental impacts of land uses permitted under the Scheme will be local and site-specific. Environmental controls are therefore required at the local government town planning scheme level to manage these impacts.

The regional environmental conditions of the Region Scheme will be transferred to the local level by a three-tiered legislative process:

- Under the provisions of 18(1a) of the *Western Australian Planning Commission Act, 1985* (as read with section 33H of the *Metropolitan Region Town Planning Scheme Act, 1959*), environmental conditions imposed by the Minister for the Environment on the Peel Region Scheme are incorporated into and regarded as parts of the Scheme.
- Section 18(1c)(b) of the *Western Australian Planning Commission Act, 1985* requires that, within 90 days of the Region Scheme being gazetted, local governments must initiate amendments to their district zoning schemes in order to make them consistent with the Region Scheme (including environmental conditions).
- Subdivisions and developments approved under local government schemes are subject to the general and specific environmental conditions incorporated in those schemes. These will include local application of the conditions applying to the Region Scheme.

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PEEL REGION SCHEME

ENVIRONMENTAL ASSESSMENT OF A PLANNING SCHEME

ENVIRONMENTAL REVIEW INSTRUCTIONS

1. Introduction

The Environmental Protection Act sets out that where a planning Scheme, or an amendment to a Scheme, is judged to have a significant environmental impact it will be subject to an assessment by the Environmental Protection Authority (EPA) under Section 48A of the Act. These Schemes/amendments are being assessed because they raise significant environmental factors.

Where a Scheme/amendment is subject to an assessment by the EPA, the responsible authority is required to produce an Environmental Review addressing the environmental factors relevant to the Scheme/amendment. The EPA is required to issue Instructions for the scope and content of the Environmental Review. Below are the Instructions for the above Scheme/amendment.

The Environmental Review is then made publicly available with the Scheme/amendment document to enable members of the public and relevant agencies to comment on the possible environmental impacts of the Scheme/amendment. Additional information on the purpose and functions of environmental assessment of a Scheme/amendment is given in Attachment 1.

The Scheme the subject of this assessment is called *The Peel Region Scheme*, within the Local Authorities of Mandurah, Murray and Waroona.

A map showing the location of the Scheme is shown as Attachment 2.

2. Instructions

2.1 Status of the instructions

The EPA, in its formulation of the Instructions, endeavours to come to an agreement with the Responsible Authority and any other involved agency about the scope and content of the Environmental Review document, with the Department of Environmental Protection (DEP) acting for the EPA in most discussions.

Other parties may also have a view about the contents of the Instructions. To accommodate this additional input the Instructions are subject to appeal to the Minister for the Environment.

Where an appeal is lodged and upheld the Chief Executive Officer will issue the final instructions, consistent with the appeal decision. Where no appeals are received or all appeals are dismissed, this document is the final instructions for the preparation of the Environmental Review.

The date of issue of this set of Instructions by the EPA is Friday 25 October 1996. Appeals must be received by the Minister for the Environment by Friday 8 November 1996.

2.2 General information

The fundamental requirements of the Environmental Review document are to:

(a) describe the state of the environment affected by the Scheme, indicating at least the Scheme area and its immediate surroundings;

(b) describe the purpose of any zoning or reservation;

(c) identify those environmental factors which should be considered in relation not only to the Scheme being assessed but also to later levels of planning, such as subdivision and development;

(d) from those environmental factors identified in (c) identify those environmental factors which relate to later levels of planning ("deferred" factors) and require alternative procedures or processes to address any requirements for on-going long-term management. For these factors the Environmental Review should describe the process (approvals and the like) necessary to address those factors later, including likely referral to the EPA; and

(e) for those factors relevant to the Scheme being assessed and which can be addressed at this level of planning, describe the extent to which the environment could be protected from both direct and indirect impacts, including:

- identifying the portions of the environment of highest conservation value and describing how the Scheme plans to protect them;
- listing those land-uses that will be permitted without further environmental approval being required under proposed zoning;
- predicting the potential environmental impacts of these land uses;
- describing the Scheme provisions which will allow management of those impacts to ensure the environment is protected to an acceptable level in the best manner possible; and
- identifying potential conflicts of land uses having environmental implications and how the environmental impacts are to be managed.

2.3 Environmental factors relevant to this Scheme and deferred environmental factors

The EPA, following consideration of the factors related to the Scheme, is likely to identify some key factors which need to be given special attention and which should form the principal basis of the EPA assessment report to the Minister for the Environment. These key factors are termed the "environmental factors relevant to the Scheme".

The EPA has also identified other environmental factors which it considers to be relevant to the scheme but are likely to be best addressed at a later level of planning. These factors are considered to be significant enough to warrant attention as part of the environmental review of this scheme to the extent that the Responsible Authority should show how these factors could be addressed at a later level of planning. These factors are called "deferred environmental factors".

The EPA, through the DEP and in consultation with the Responsible Authority and the relevant agencies, has identified a list of factors likely to be found to be the "environmental factors relevant to the Scheme" and those likely to be found to be "deferred environmental factors". This list is provided to assist with the preparation of the Environmental Review document, but during the course of the preparation of the document other factors may be found also to be relevant, and they should be included in the detailed discussion.

A copy of the form used to identify the environmental factors (the "filtering form") is included as Attachment 3.

Environmental factors identified by the EPA as being relevant to the Scheme are shown in the tables which follow Section 2.4.

2.4 General scope of the Environmental Review - Limit of the Environmental Review

The Peel Region Scheme is a new Scheme which, for the most part, reflects existing zoning at the Town Planning Scheme (TPS) level. It is likely to be formulated using the Peel Inner Structure Plan as a guide. The Environmental Review should focus on those areas which will require new zoning changes at the TPS level. Further, zoning changes which reflect proposals already being assessed by the EPA through Part IV of the Act are not included in this review.

The EPA has, however, identified some environmental factors which are relevant to the whole scheme area and should be addressed in the Environmental Review document.

1. Environmental factors relevant to the Scheme

CONTENT		SCOPE OF WORK	
Factors	**Site specific factor**	**Work required for the environmental review**	**Additional comments**
BIO-PHYSICAL IMPACTS			
Terrestrial vegetation			
Vegetation in existing and proposed conservation estate		The existing and proposed conservation estate should be identified and appropriate protection measures relevant to the region scheme identified. For proposed zones adjacent to the conservation estate, new land uses which could indirectly affect the conservation estate should be identified. Management strategies to prevent or minimise indirect impacts should be discussed.	Applies to whole of scheme area. Applies to those zonings which reflect new zoning changes at the TPS level.
Regionally significant vegetation	M107 Dunkerton - Husband Rd across M108 Peel Regional Park Areas " Pinjarra 1 and Clifton 1" - DEP identified areas	Any land uses or boundaries which are inconsistent with the System 6 recommendations should be identified and justified. Direct and indirect impacts should be considered	This factors relates to regional significant vegetation not included in the existing or proposed conservation estate
Terrestrial Fauna			
Fauna and habitat in existing conservation estate			Could be dealt with in the Environmental Review under "Vegetation in existing conservation estate"

CONTENT		SCOPE OF WORK	
Factors	**Site specific factor**	**Work required for the environmental review**	**Additional comments**
Regionally significant fauna and habitat	Migratory waterbirds	For Wetlands of International Importance (Peel-Harvey Estuary) waterbird habitats should be identified. Management strategies to prevent or minimise indirect impacts should be discussed.	Could be dealt with in the Environmental Review under "Regionally significant vegetation".
Wetlands			
Regionally significant wetlands	Refers to lakes protected by the Environmental Protection (Swan Coastal Plain Lakes) Policy 1992, Wetlands of International Importance and important wetlands identified by the Australian Nature Conservation Agency.	Regionally significant wetlands should be identified. For those zonings which reflect new zoning changes at the TPS level which include or are adjacent to regionally significant wetlands appropriate protection measures should be identified, including the provision of adequate buffers. Appropriate buffer zones for regionally significant wetlands should be identified by reference to "Guidelines for design of effective buffers for wetlands of the Swan Coastal Plain" (Australian Nature Conservation Agency 1995), existing EPA minimum buffer requirements (ie 50m or 1 m AHD higher than maximum water level whichever is greater), and liaison with Department of Conservation and Land Management	Applies to whole of scheme area. Applies to those zonings which reflect new zoning changes at the TPS level.
	Lake Clifton	Criteria agreed by the EPA and Western Australian Planning Commission should be reflected in the scheme as it relates to Lake Clifton Catchment.	
	Paganoni Swamp	The impacts of the new urban zone should be discussed including indirect impacts on water balance and any resulting loss of ecological function.	

CONTENT		SCOPE OF WORK	
Factors	**Site specific factor**	**Work required for the environmental review**	**Additional comments**
Estuaries	Water quality in the Peel - Harvey Estuary	Proposed new urban, industrial or commercial zones on land subject to seasonal waterlogging (ie palusplains) or high water table would likely be required to meet drainage water quality objectives set through the assessment of the proposed Amarillo development. The Environmental Review should discus these new zones in this context. The new industrial zones should also consider other possible contaminants - hydrocarbons, heavy metals etc.	Applies to those zonings which reflect new zoning changes at the TPS level.
Coastal areas			
Foreshore stability and Dune protection		Consistent with the appropriate Western Australian Planning Commission Policy identify areas of coastal instability due to active coastal processes. Mechanisms to ensure coastal processes are not adversely affects by new developments should be identified.	Applies to those zonings which reflect new zoning changes at the TPS level.
POLLUTION MANAGE-MENT			
Water quality			
Groundwater quality for future public water supply area		A possible future public water supply area exists in the scheme area (Karnup). The Environmental Review should discuss how this area is to be zoned so as not to compromise future options to manage the area for public water supply purposes.	
Surface water quality existing water supply catchment areas		Existing water supply catchment areas should be identified and appropriate protection measures proposed.	

CONTENT		SCOPE OF WORK	
Factors	**Site specific factor**	**Work required for the environmental review**	**Additional comments**
Surface water quality - cumulative impacts	Peel Harvey Estuary	The total proposed growth allowed for in the Peel Region by this scheme (including Amarillo) could add to water quality problems in the Estuary. The Environmental Review should estimate the possible changes to water quality in the estuary because of the growth (including the industrial area)	Applies to whole of scheme level
	Marine waters	The total proposed growth allowed for in the Peel Region by the scheme could lead to additional contaminants from human effluent from wastewater treatment plants being disposed of in the marine environment. The Environmental Review should estimate the nature of the problem and the possible impact on marine water quality.	Applies to whole of scheme level
Air quality			
Odour	Wastewater Treatment plants and poultry farms including waste water treatment plants at Gordon Road and Halls Head, existing poultry farms at Furnisdale/Barragup and areas where industrial zones are adjacent to or near residential zones (eg Pinjarra Road near Pinjarra, Gordon Road, Amarillo).	The Environmental Review should identify existing land uses which produce odours in relation to those zoning which reflects changes of zoning under the TPS. Planning mechanism including possible buffers requirements should be identified which would protect these residents from noxious odours. Planning mechanism including possible buffers requirements should be identified which would protect new and existing residents from noxious odours from new odour producing land areas.	Applies to those zonings which reflect new zoning changes at the TPS level. Applies to whole of scheme area where there are new odour producing land uses proposed.

CONTENT		SCOPE OF WORK	
Factors	**Site specific factor**	**Work required for the environmental review**	**Additional comments**
Gaseous emissions	Gaseous emissions from industrial zone	The likelihood of noxious emissions from the proposed new industrial areas should be discussed. Mechanisms to either retain all noxious emission within the zone or the provision of adequate buffers should be discussed.	
	Regional air quality - smog and haze	The total proposed growth in the Peel region allowed for by the scheme (including Amarillo) could add to regional air quality problems. The Environmental Review should estimate the possible change to air quality to the greater Perth region through the additional growth.	Applies to whole of scheme area
Solid waste disposal		The total proposed growth allowed for in the Peel Region by the scheme (including Amarillo) could pose significant problem for waste disposal. The Environmental Review should estimate the nature of the problem and discuss how the waste could be managed.	
SOCIAL SURROUND-INGS			
Risk and hazard	Industrial areas	Industries which could generate high levels of risk or hazards may be located in new industrial areas. The Environmental Review should discuss: a) whether the inclusion of these industries could be allowed; and b) if allowed, how these industries could be managed to ensure risk levels are acceptable at existing and new residential areas.	
Urban bushland		This is a significant local environmental issue of interest to the public. The Environmental Review should discuss how this matter would be addressed.	Refers to vegetation other than in existing or proposed conservation areas and other regionally significant vegetation

2. Deferred environmental factors

CONTENT		SCOPE OF WORK	
Factors	**Site specific factor**	**Work required for the environmental review**	**Additional comments**
Noise and vibration	Noise and vibration from the rapid transit corridor	The operation of the transport mode in this corridor could impact on the existing and future residents. The Environmental Review should discuss the range of mechanisms which could be used to manage this problem, including at which level of planning to assess this factor.	
Regionally significant vegetation	Regionally significant vegetation in the rural zone	The Rural zone could contain remnant bushland considered to be of regional significance. Areas known to be of regional significance should be identified. Developments could be allowed under rural zone which could impact (directly or indirectly) on these areas. Processes and procedures should be identified which would allow such developments to be assessed for their environmental impacts on those areas of remnant bushland.	
Regionally significant wetlands	where they exist in the rural zone	The Rural zone could contain regional significant wetlands considered to be of regional significance. Areas known to be of regional significance should be identified. Developments could be allowed under rural zone which could impact (directly or indirectly) on these areas. Processes and procedures should be identified which would allow such developments to be assessed for their environmental impacts on these regional significant wetlands.	

Attachment 1 - Information on the purposes and functions of the environmental assessment of Schemes and their amendments

Purpose of the environmental assessment

The purpose of an environmental assessment is to ensure that the Scheme takes proper account of the relevant environmental factors. To do this the EPA reports to the Minister for the Environment on the environmental factors relevant to the Scheme, recommends environmental conditions under which the Scheme may operate and provides other recommendations as it sees fit.

Functions of an Environmental Review

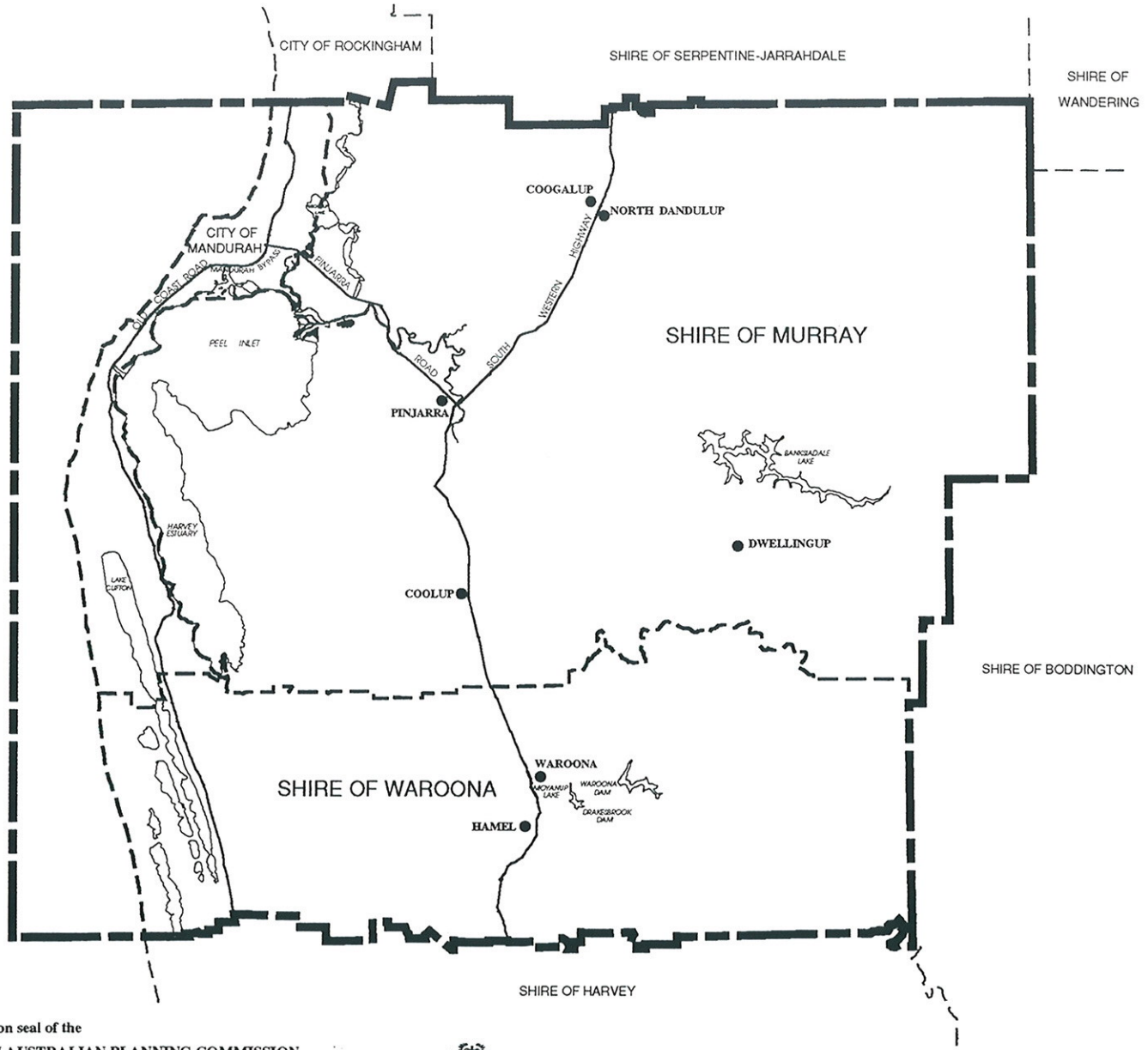
The primary function of the Environmental Review is to provide information about the environmental factors related to the proposed Scheme to the EPA to enable it to evaluate the environmental acceptability of the Scheme and provide independent environmental advice to Government.

An additional function of the document is to clearly communicate details of the proposed Scheme and it's future implications to the public so that the EPA can obtain informed public comment on relevant environmental factors. Effective public information and involvement is an essential part of environmental impact assessment.

These instructions are issued to assist in identifying matters that should be addressed within the Environmental Review document. However other relevant matters may arise during the preparation of the environmental review document and these should also be included.

The Environmental Review document will be made publicly available during the advertised period for the Scheme and submissions from other agencies and the public will be sought. The Responsible Authority is required to forward submissions relating to the Environmental Review to the EPA and respond to the EPA on environmental factors raised in those submissions. Based on the information in the Environmental Review document, the response to submissions and its own investigations the EPA will then report to the Minister for the Environment.

Attachment 2 - Location Map



The common seal of the
WESTERN AUSTRALIAN PLANNING COMMISSION
was here onto affixed by resolution of the COMMISSION
in the presence of :

CHAIRMAN

MEMBER

28/8/96
DATE

WESTERN AUSTRALIAN PLANNING COMMISSION
COMMON SEAL

SCHEME AREA BOUNDARY

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SCALE 1:400 000

9000 6000 3000 0 12
metres kilometres

PEEL REGION SCHEME AREA

WESTERN AUSTRALIAN PLANNING COMMISSION

AUTHORISED: C.BULSTRODE
DRAFTSPERSON: D.CLIFFORD
EXAMINED:
REVISED:
DATE: 30th July 1996

FILE REF: 801/14/1/2
PLAN REF:

PLAN No **4.1460**

BAR CODE