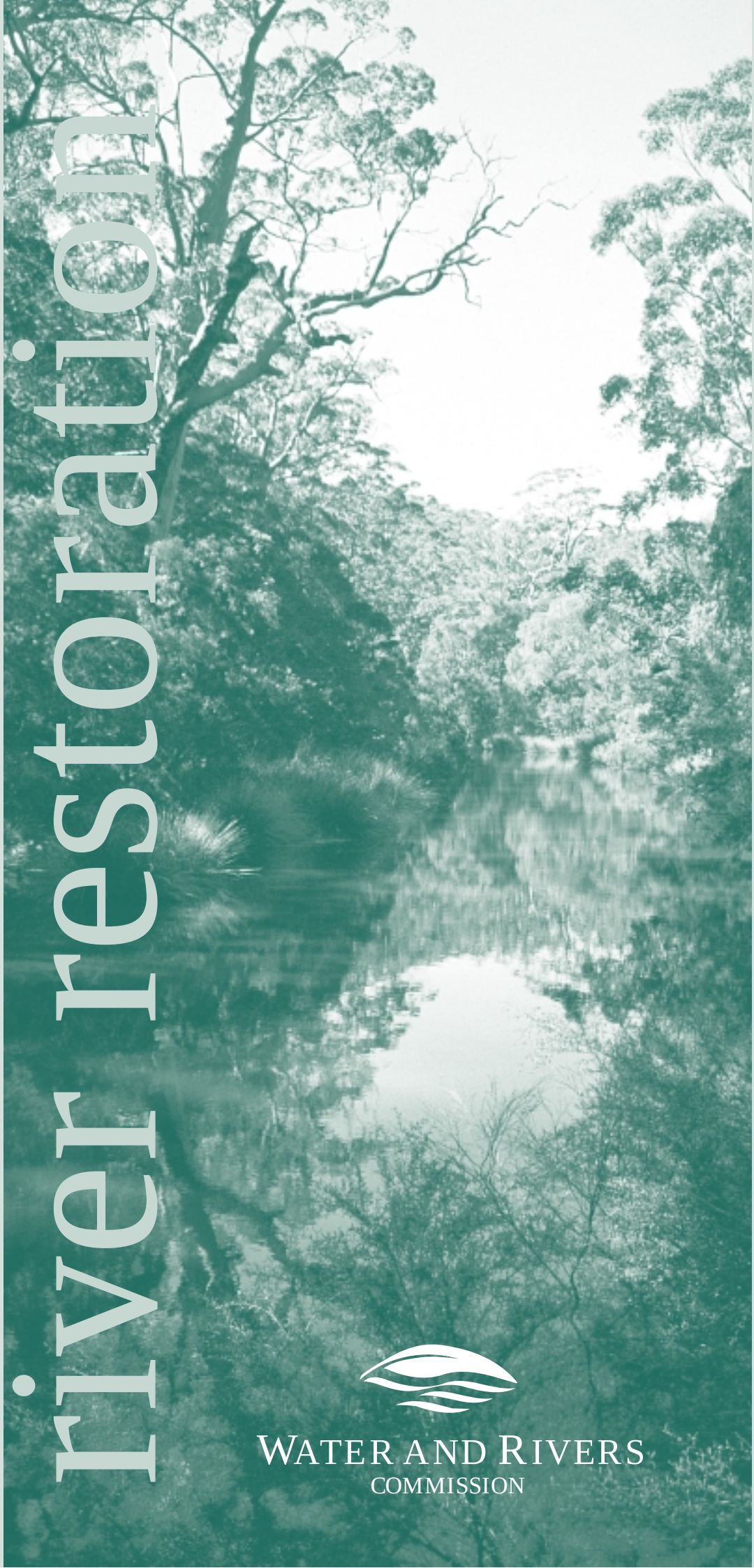

river restoration

Introduction

WATER AND RIVERS COMMISSION

September 2002
Report No. RR1

WATER & RIVERS COMMISSION
Hyatt Centre
3 Plain Street
East Perth
Western Australia 6004
Telephone (08) 9278 0300
Facsimile (08) 9278 0301

We welcome your feedback

A publication feedback form
can be found at the back of this publication,
or online at http://www.wrc.wa.gov.au/public/feedback

INTRODUCTION

Prepared by
Beth Hughes and Verity Klemm

This Manual is dedicated to Dr Luke Pen

jointly funded by

Natural Heritage Trust

WATER AND RIVERS COMMISSION

Hydromys chrysogaster, Water Rat
Symbolising river restoration work in Western Australia

WATER & RIVERS COMMISSION
REPORT NO. RR1
SEPTEMBER 2002

Acknowledgments

This document was prepared by Beth Hughes and Verity Klemm, with much of the text derived from Dr Luke Pen's writings. Acknowledgments to Dr Luke Pen, Antonietta Torre, Bill Till, Dr Clare Taylor and Dr Marnie Leybourne. Publication coordinated by Beth Hughes. This document has been jointly funded by the Natural Heritage Trust and the Water and Rivers Commission.

Reference Details

The recommended reference for this publication is: Water and Rivers Commission 2002, *Introduction*. Water and Rivers Commission, River Restoration Report No. RR 1

ISBN 1-9-209-4702-7 [PDF]
ISSN 1449-5147 [PDF]

Text printed on recycled stock,
September 2002

Foreword

Many Western Australian rivers are becoming degraded as a result of human activity within and along waterways and through the off-site impacts from inappropriate catchment land uses. The erosion of foreshores and invasion of weeds and feral animals are some of the more pressing problems. Water quality in our rivers is declining through excessive loads of nutrients and sediment and in some cases contamination by synthetic chemicals and other pollutants. Salinity levels in many rivers in the south-west region are also increasing.

The Water and Rivers Commission is responsible for coordinating the management of the State's waterways. Given that Western Australia has some 208 major rivers with a combined length of over 25 000 km, management can only be achieved through the development of partnerships between business, landowners, community groups, local governments and the Western Australian and Commonwealth Governments.

The Water and Rivers Commission is the lead agency for the Waterways WA Program, which is aimed at the protection and enhancement of Western Australia's waterways through support for on-ground action. One of these support functions is the development of river restoration literature that will assist local government, community groups and landholders to restore, protect and manage waterways.

This document provides an overview of the *River Restoration Manual, a guide to the nature, protection, rehabilitation and long-term management of waterways in Western Australia*. The Manual is part of an ongoing series of river restoration literature aimed at providing a guide to the nature, rehabilitation and long-term management of waterways in Western Australia. It is intended that the series will undergo continuous development and review. As part of this process, any feedback on the series is welcomed and may be directed to the Catchment Management Branch of the Water and Rivers Commission.

Contents

Background

This River Restoration Manual describes the basic principles of how rivers in south-west Western Australia work and the techniques that can be used to manage and rehabilitate them. Knowing something about the nature of our river systems is essential for their wise management and the conservation of the natural resources that they hold. Ideally, we should prevent degradation of our waterways in the first place, since it is more sensible and cheaper to protect something valuable from excess wear and tear than to try and fix it once it stops working properly. Unfortunately many of our rivers and streams have not been protected and urgently need management and rehabilitation.

Management decisions that do not consider the nature of rivers are fraught with unexpected and often disastrous consequences. This has been most dramatically demonstrated with the 'training' of the Avon River from the late 1950s to the early 1970s. At the time, it was believed that flooding could be reduced by straightening the channel, ripping the river bed and removing woody debris. The result was faster flows and extensive erosion and sedimentation. Deep permanent river pools that were once important habitats and sites for recreation are either filling with sediment or are completely filled. Erosion is continuing as the river is attempting to reassert its natural form of braids, meanders and pools.

Therefore, understanding the way rivers work is the first step in their management, protection and restoration. There are many elements to consider, including understanding catchment hydrology, stream ecology and processes that shape the channel. For example, the condition of a catchment directly affects the shape and function of stream systems. A cleared catchment will contribute greater runoff to a stream system following rain than one that is well vegetated. Greater runoff can cause channel erosion and hence affects channel size, shape and the density of streams across a landscape. Also, the loss of fringing vegetation through overgrazing and resultant erosion of unprotected banks has a direct impact on river processes.

The idea of gaining an understanding of these processes may seem daunting at first, but this Manual provides an explanation of these processes in bite size pieces. In addition, support and advice on restoration activities is always available from the Water and Rivers Commission (currently combining with the Department of Environmental Protection to form the Department of Environment, Water and Catchment Protection).

We will now look at the intention, contents and use of the Manual before going into a brief history of the rivers of south-west WA, some of their problems and the need to understand and rehabilitate them.

Dandalup River, Pinjarra - typical river bank degradation, bank erosion and slumping due to lack of vegetation and cattle trampling.

Who should use the Manual?

People who are actively involved in planning or implementing the rehabilitation and management of a surface water channel, be it a river[1], stream, brook or artificial drain should use this Manual. It is intended to guide community support officers, local government agencies, consultants and other community members in the restoration and management of our rivers and streams. Not all the manual chapters will hold the same relevance to each individual. For instance, some of the waterways planning chapters may only be of interest to local government or consultants involved in management planning for waterways.

The aim of the Manual is to equip readers with the information to:

- understand how rivers function,
- understand how to assess the condition of a river, and
- plan and implement a rehabilitation program which results in a healthier river.

[1] In this Manual the word river refers to surface water channels of any size, whether natural or artificially constructed.

Although this Manual contains information necessary to assist in rehabilitation works, it is also important to contact a Water and Rivers Commission officer in your region for advice. You will find a list of regional offices in Appendix 1.

Contents of the Manual

Most of the current literature on the nature of rivers and their restoration and management is written for rivers in the northern hemisphere or the Eastern States. These rivers behave differently to those in the south-west of Western Australia and therefore have different needs for rehabilitation and management (see page 5 for more information on the unique nature of south-west rivers). This Manual has been written for, and about, the rivers of south-west Western Australia by reviewing existing approaches and developing techniques that suit Western Australian rivers.

River restoration in Western Australia is also relatively recent and an evolving process. With this in mind, the Manual has been produced in a file format, with the chapters arranged under nine sections that can be updated or replaced as necessary. A range of Water Notes complements the Manual and are available from the Water and Rivers Commission. These provide an introduction and general guide to river and wetland ecology, restoration and management.

An overview of the nine sections and the contents of each section is provided in Figure 1. Remember this list is not static and may be amended or expanded in the future. A summary of the contents of each chapter is provided in Appendix 2.

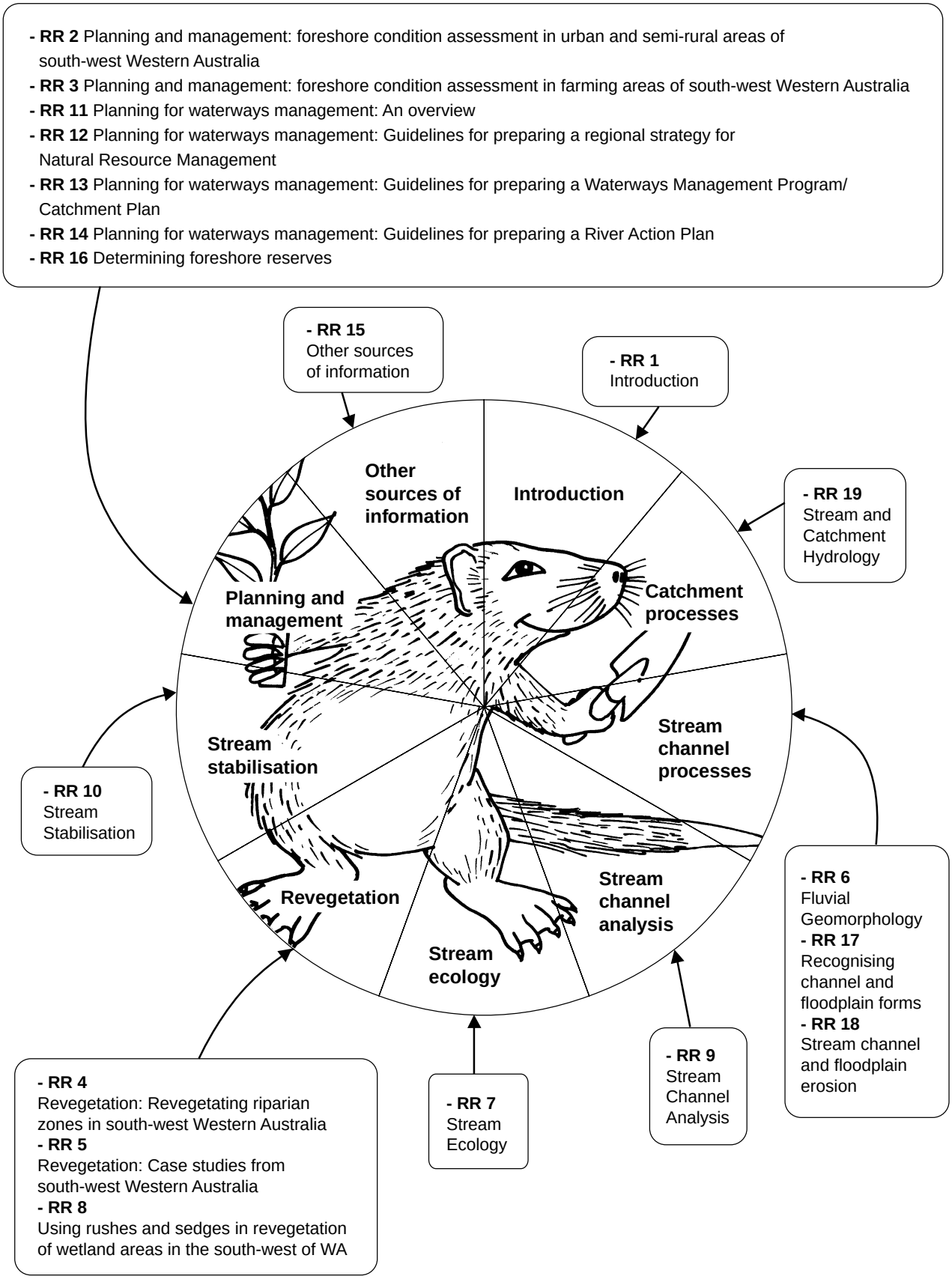

Figure 1. Structure and contents of the River Restoration Manual.

How to use this Manual

This Manual contains three main areas of information: *planning and assessment* at various scales, *processes* associated with the way rivers and catchments function, and *implementation* of restoration works. The stage your project is at will determine the best place for you to start using the Manual. The main thing to remember is that waterways cannot and should not be managed in isolation. Planning and implementing river restoration works need to be undertaken in a catchment context, and planning and assessment need to occur prior to implementation.

Planning and assessment

To learn more about, or to plan your restoration works at the 'big picture', or regional/catchment scale, read the following chapters from the Planning and Management section of the Manual:

- *RR 11 Planning for waterways management: An Overview*

  Provides an outline of the principles by which planning for waterways management should occur and is the background to more detailed documents.

- *RR 12 Planning for waterways management: Guidelines for preparing a Regional Strategy for Natural Resource Management*

  Discusses regional planning, integrated catchment management, natural resource management, development of regional strategies, components of regional strategies and the incorporation of waterways management issues.

- *RR 13 Planning for waterways management: Guidelines for preparing a waterways management program / catchment plan*

  Recommends a planning process, content and structure for waterways planning documents that focus at the catchment scale. Relevant to the development of catchment management plans.

- *RR 16 Determining foreshore reserves*

  Describes how to determine the extent of a foreshore reserve using biophysical criteria and the step by step process that will define and protect it. Also provides two case studies of the Hill River and the Collie and Brunswick Rivers.

At a local river section, reach or branch scale, the following Manual chapters from the Planning and Management and Stream Channel Analysis sections will enable you to assess the condition of waterways in your catchment, and to plan and prioritise onground works:

- *RR 2 Planning and management: Foreshore condition assessment in urban and semi-rural areas of south-west Western Australia*

  Simple method for assessment of instream habitat, health of foreshore vegetation, channel stability, areas suffering or prone to bank erosion and disturbance to the riparian zone as a result of the surrounding intensive landuse.

- *RR 3 Planning and management: Foreshore condition assessment in farming areas of south-west Western Australia*

  Simple method to assess overall rural foreshore health and grades the foreshore from pristine (with good vegetation), to a ditch or drain (with weed infestation or no vegetation).

- *RR 14 Planning for waterways management: Guidelines for preparing a river action plan*

  Assists the process of planning river restoration activities at the local level by outlining the major steps and actions required to develop a River Action Plan.

- *RR 9 Stream channel analysis*

  Discusses surveying, collection of data and assessment of river channels, calculation of flow velocity and discharge and stream power to understand the form of a stream channel and the force of the water that shapes it.

Processes

The Manual chapters in the sections Catchment Processes, Stream Channel Processes and Stream Ecology will help you understand the forces of nature at work in your river system. Combined with the planning and assessment activities, they will help you decide the best course of onground action:

- *RR 19 Stream and catchment hydrology*

  Describes and explains climate, the water cycle, how water runs off a catchment and how this can be measured.

- *RR 6 Fluvial geomorphology*

  Explains the basic physics and mathematics of water movement in a stream channel and how water shapes a channel - how banks erode, how meanders form and the influences of the stream bed and its vegetation.

- *RR 17 Recognising channel and floodplain forms*

  Describes channel and floodplain shapes, types and characteristics and the factors that influence them, how to recognise these forms in your river, and how to apply this knowledge to improve river health.

- *RR 18 Stream channel and floodplain erosion*

  Discusses bed, bank and floodplain erosion. Explains the characteristics of bends in streams and how erosion and sedimentation play a natural part in their development.

- *RR 7 Stream ecology*

  Provides an introduction to some of the important ecosystem processes that 'drive' the structure of stream communities and highlights some of the pressures that threaten stream ecosystems in WA.

Implementation

Once you are ready to undertake some onground river restoration activities, the chapters in the Revegetation and Stream Stabilisation sections will help:

- *RR 4 Revegetation: Revegetating riparian zones in south-west Western Australia*

  Explains site planning, weed control, species selection, plant establishment and monitoring and maintenance of the riparian zone.

- *RR 5 Revegetation: Case studies from south-west Western Australia*

  Provides examples of previous projects. Outlines the processes, management, cost and general success of previous revegetation projects.

- *RR 8 Using rushes and sedges in revegetation of wetland areas in the south-west of WA*

  Describes the common species of rushes, sedges, bulrushes and submergents of the south-west of WA, the aim of revegetation, revegetation techniques and weed control.

- *RR 10 Stream stabilisation*

  Outlines techniques to control the riverbed, stabilise channel alignment, protect stream banks and rebuild habitat. Provides techniques to integrate engineering with ecological restoration.

The rivers of south-west Western Australia – a brief history

The natural streamlines of south-west Western Australia are different. They typically carry intermittent or ephemeral flow, and are for the most part dry during the summer and autumn, though some may have a low base flow. In most river systems, only the river pools retain tannin stained water over the entire year. In winter, rains can flood the previously dry creeks, floodways and floodplains and create a diverse range of aquatic habitats. South-west rivers mostly transport sand or clay and their riffle zones generally consist of vegetation and woody debris. Figure 2 shows the distribution of the major rivers of south-west Western Australia.

We must learn more about the different features of our south-west rivers in order to manage them properly. The form of our larger south-west rivers is also jokingly referred to as being 'backwards'. Under an early 19th century northern hemisphere view of erosion processes, rivers ran from a steep, youthful stage where they began as minor streams cutting into mountain sides, to a moderately sloped mature stage where they passed through a hilly landscape, and then to a low gradient old age stage, where the river passed over a plain of deposited sediment. In Western Australia this is reversed or 'backward'; the youngest parts of our larger rivers lie near the coast while the older parts are at the inland, upstream end.

A curious fact about south-west rivers is that a good number of them have two names. The most obvious example is the Swan-Avon, but there is also the Southern-Wungong, the Murray-Hotham and the Blackwood-Arthur (or Blackwood-Beaufort, depending on which branch you consider to be the longest arm of the river system). There is also the Warren-Tone and the Frankland-Gordon. Whatever the reason for the dual naming of these rivers, it is strangely appropriate. This is because some rivers on the younger coastal plains have cut back through the ranges behind the plains to capture the older drainage systems that have existed for millions of years. The best example of this is the Frankland-Gordon, the younger Frankland having cut a valley back into the hinterland to capture the older, flat, sediment filled valley of the Gordon River.

Figure 2. Major rivers of south-west Western Australia.

Changing the landscape

European settlement in the south-west heralded great changes for our streams. Approaches to making land suitable for agricultural and urban development often involved removal of water from low-lying land. An extensive artificial drainage network was constructed on the Swan Coastal Plain and in other parts of the south-west. Natural creeks and rivers were altered to increase their flow capacities. This involved clearing natural debris, such as logs and branches, straightening watercourses and even the replacement of creeks with concrete channels and pipes.

Unrestricted grazing, clearing, altered surface and groundwater flows and urban, industrial and rural landuses further degraded water quality. Many of our south-west streams have become saltier. Most now carry excessive quantities of plant nutrients and sediment and, in some cases, pesticides and other pollutants. These streams carry their pollutant loads downstream to estuaries and inshore oceanic water, triggering environmental problems in those areas as well.

One of the continuing major impacts on stream environments is the loss of fringing vegetation. Past and present clearing, accompanied by stock or human activity, is causing erosion, undermining of trees and the loss of the rivers' scenic, recreational and habitat values. The loss of riparian vegetation also results in higher water temperatures because there is less shade, disruption of the food chain due to less leaf litter and less filtering of sediment and runoff from farmland.

In residential areas, old creek lines and open drains represent a very common form of wetland. Unfortunately they are primarily valued for their drainage function and are typically weed infested and polluted. Many urban streams, both in the country and metropolitan areas, have become open drains carrying polluted water, excessive algae and sediment along a narrow strip of disused land behind an ugly fence.

In the past, little consideration was given to other values of rivers such as wildlife habitat, ecological corridors, erosion control, biofiltering of pollutants, landscape and recreational amenity. However, in recent years, due to advances in water resources planning and recognition of the biofiltering or nutrient stripping function of well vegetated streams, stream revegetation has received some attention as part of an effort to reduce the amount of pollutants being carried to downstream waterways. In the Peel-Harvey catchment and Perth metropolitan region, this has led to the establishment of fringing vegetation along some old and new drainage lines, in a process known as streamlining, and the promotion of Water Sensitive Urban Design. Further information about Water Sensitive Urban Design and guidelines to reduce pollution of urban waterways are provided in the Water and Rivers Commission's *A Manual for Managing Urban Stormwater Quality in Western Australia* (1998) [being updated in 2002/3].

Creating living streams through river restoration

The ultimate aim of restoring our rivers is to generate healthy, living streams with a diversity of habitats which incorporate the essential elements of shade, hard leaves and tannin stained water. These 'ingredients' can be used to develop, as far as possible, a natural stream ecosystem and to keep the stream channel free of choking aquatic vegetation and algae. This concept can be applied at a simple scale, ie establishing fringing native vegetation along streamlines, through to the complex scale, where channel form, bank stability, in-stream habitats and catchment management are all incorporated.

The benefits of managing streamlines in this way include:

- Erosion control.
- Biological filtration.
- Energy dissipation.
- Creation of habitats, food webs and ecological corridors.
- Conserving our natural resources and retaining landscape value.
- Catchment management.
- Education.
- Recreation.

A living stream is a complex ecosystem supporting a wide range of plants and animals. It may be a narrow creek which runs only in winter, a permanent creek, a large river, or the lower estuarine reach of a mighty river system which drains a huge area of land. Whatever its size, a living stream has characteristics that distinguish it from a simple flow of water. It has stable vegetated banks with many plant species that act as biofilters, and it provides habitat for animals such as freshwater crayfish, fish, frogs and waterbirds. It is also a beautiful feature of the landscape for people to enjoy and a refuge for bush birds and other native animals. Incorporating this 'living stream' objective in drainage management may result in a living feature of the town environment, rather than just an essential, often unattractive, part of its infrastructure.

In rural areas, degradation is often caused by cattle trampling the river banks, causing physical erosion with their hooves, but also exposing the banks to water and wind erosion by grazing the riparian vegetation that holds the banks together. Multiple benefits arise by using river restoration techniques to address the problems associated with degraded streamlines. Not only can a rapidly eroding bank be stabilised through fencing, matting, riprap or revegetation, and a paddock saved, the longer term benefits include shaded waterways and habitat improvement.

Farmers, landcare groups, community and catchment groups are increasingly recognising the value of fencing and replanting degraded streamlines to improve the local environment and to meet the wider aims of integrated catchment management. Each section of rehabilitated streamline will contribute less sediment to its river system and help to reduce nutrient loss. Furthermore, linking stream rehabilitation projects throughout a catchment may produce wider benefits to the ecology of a region.

There are a range of river restoration demonstration sites throughout rural and metropolitan south-west WA, including the site depicted in Figure 3, where an urban drain was transformed to a living stream. For more information on the locations of these sites, please refer to Water Note 27 *Demonstration sites of waterways restoration in WA* – available from the Water and Rivers Commission.

Figure 3. An example of a living stream - Bannister Creek, Perth - An urban stormwater drain (L) was streamlined using river restoration techniques (R). Large volumes of soil were removed from the site to 'meander' the creek and reshape the steep banks to a gentler slope, suitable for planting. Riffles were built to aerate flows and create habitat. Erosion control matting was used to stabilise sections of the stream banks and the area was revegetated.

The decision to rehabilitate a degraded stream, be it natural or artificial, is not the end. There are certain aspects that need to be considered to ensure the rehabilitation works do not fail or create a worse problem. Planning and prioritising stream rehabilitation need to be undertaken in a catchment context. There may be underlying catchment-wide processes causing the stream degradation feature. The design process needs to take into account, at the very least:

- what is causing the stream degradation;
- what is the stable channel form;
- how to re-establish this form;
- appropriate channel and bank repair techniques, including foreshore revegetation;
- Aboriginal heritage;
- community support; and
- long term management.

In this way the restored river will be stable and supported by the natural functions of the stream.

IMPORTANT!

Before implementing stream works:

- **Read and understand this Manual.**
- **Contact a Water and Rivers Commission Rivercare officer.**

References and further reading

Pen L. J (1999) *Managing Our Rivers: a guide to the nature and management of the streams of south-west Western Australia*. Water and Rivers Commission, Perth.

Pen L. J (undated) *River Restoration Workshop speakers notes – course overview*. Water and Rivers Commission, Perth [unpublished].

Pen L. J. and Scott M. (1995) S*tream foreshore assessment in farming areas*. Blackwood Catchment Coordinating Group.

Morrissy, N. .M. (1974) 'Reversed longitudinal salinity profile of a major river in the south-west of Western Australia', *Australian Journal of Marine and Freshwater Research* vol. 25.

Water and Rivers Commission (1997) *Native vegetation of estuaries and saline waterways in south Western Australia*. Water and Rivers Commission, Perth.

Water and Rivers Commission (1997) *Native vegetation of freshwater rivers and creeks in south Western Australia*. Water and Rivers Commission, Perth.

Water and Rivers Commission (1998) *A Manual for Managing Urban Stormwater Quality in Western Australia*. Water and Rivers Commission, Perth.

Water and Rivers Commission River Restoration Manual Chapters – see Appendix 2 for details. Also available on the Internet: www.wrc.wa.gov.au/public/restoration.htm

Water and Rivers Commission Water Notes:

WN1 *Wetlands and weeds.*

WN2 *Wetlands and fire.*

WN3 *Wetland vegetation.*

WN4 *Wetland buffers.*

WN5 *Wetlands as waterbird habitat.*

WN6 *Livestock management: Construction of livestock crossings.*

WN7 *Livestock management: Watering points and pumps.*

WN8 *Habitat of rivers and creeks.*

WN9 *The value of Large Woody Debris (Snags).*

WN10 *Protecting riparian vegetation.*

WN11 *Identifying the riparian zone.*

WN12 *The values of the riparian zone.*

WN13 *The management and replacement of large woody debris in waterways.*

WN14 *Lamprey guides.*

WN15 *Weeds in waterways.*

WN16 *River and estuary landscape appreciation and protection.*

WN17 *Sediment in streams.*

WN18 *Livestock management: Fence location and grazing control.*

WN19 *Flood proofing fencing for waterways.*

WN20 *Rushes and sedges.*

WN21 *Importance of Large Woody Debris in sandy bed streams.*

WN22 *Herbicide use in wetlands.*

WN23 *Determining foreshore reserves.*

WN24 *Riparian zone revegetation in the Avon catchment.*

WN25 *The effects and management of deciduous trees on waterways.*

WN26 *Simple fishways.*

WN27 *Demonstration sites of waterways restoration in WA.*

WN28 *Monitoring and evaluating river restoration works.*

WN29 *Long-term management of riparian vegetation*

WN30 *Significance of rivers and wetlands to Aboriginal people and the need for consultation to protect Aboriginal heritage.*

Water Notes are also available on the Internet:
www.wrc.wa.gov.au/public/water_notes.htm

Appendix 1: Water and Rivers Commission Offices for further advice

Regional Office	Address	Phone	Fax
South West - Bunbury **- Busselton (Geocatch)**	U2 Leschenault Quays, Austral Parade Bunbury WA Unit 2 Palm Court Arcade, 62 Kent Street Busselton WA 6280	9721 0666 9754 4331	9721 0600 9754 4335
Kwinana Peel - Mandurah	"Sholl House" Unit 8, 21 Sholl St Mandurah WA 6210	9535 3411	9581 4560
South Coast - Albany	5 Bevan St Albany WA 6330	9842 5760	9842 1204
Swan Goldfields **- Welshpool** **- Northam**	 105 Kew Street Welshpool WA 6106 254 Fitzgerald St Northam WA 6401	 9231 8334 9622 7055	 9361 9311 9622 7155
Midwest Gascoyne **- Geraldton**	 Pass Street Geraldton 6530	 9964 5978	 9964 598
North West - Karratha **- Kununurra**	Cherratta Rd Karratha Lot 225 Bandicoot Dr Kununurra	9144 2000 9168 1082	9144 2610 9168 3174

Appendix 2: Contents of the Manual chapters

Section	Chapter Title	Brief Description
Introduction	*RR 1 Introduction*	Provides an introduction to the contents of the Manual, how to use it and why. It also provides a brief account of the nature of the rivers of south-west WA, typical problems and the need for restoration.
Catchment Processes	*RR 19 Stream and Catchment Hydrology*	Describes and explains climate, the water cycle, how water runs off a catchment and how we can measure this.
Stream Channel Processes	*RR 6 Fluvial Geomorphology*	Discusses how the forces in flowing water shape a stream channel - how banks erode, how meanders form and the influences of the stream bed and its vegetation. Explains the basic physics and mathematics of water movement in a stream channel.
	RR 17 Recognising Channel and Floodplain Forms	Describes local to sub-catchment scale channel and floodplain forms, identifies the factors that influence these forms, and comments on why forms change over time. It provides suggestions on how to recognise sedimentary forms in your river, any changes in form, and how to apply this knowledge to improve river health.
	RR 18 Stream Channel and Floodplain Erosion	Discusses the connection between the power of flowing water, its natural tendency to follow a winding path, and some of the specific erosion features we see along our rivers. It covers bed, bank and floodplain erosion and explains the characteristics of bends in streams and how erosion plays a natural part in their development. Understanding erosion and sedimentation processes helps us manage rivers better.
Stream Channel Analysis	*RR 9 Stream Channel Analysis*	Discusses surveying, collection of data and assessment of river channels, calculation of flow velocity and discharge and stream power to understand the form of a stream channel and the force of the water that shapes it.
Stream Ecology	*RR 7 Stream Ecology*	Provides an introduction to some of the important ecosystem processes that 'drive' the structure of stream communities and highlights some of the pressures that threaten stream ecosystems in WA.
Revegetation	*RR 4 Revegetation: Revegetating riparian zones in south-west Western Australia*	Outlines the riparian zone and the process involved to revegetate it with native species. It gives a brief background of the general structure and importance of the riparian zone before moving onto site planning, weed control, species selection, plant establishment then finally monitoring and maintenance of the site.
	RR 5 Revegetation: Case studies from south-west Western Australia	The case studies outline the processes, management, cost and general success of previous revegetation projects.
	RR 8 Using rushes and sedges in revegetation of wetland areas in the south-west of WA	Describes the common species of rushes, sedges, bulrushes and submergents of the south-west of WA, the aim of revegetation, revegetation techniques and weed control.

Section	Chapter Title	Brief Description
Stream Stabilisation	*RR 10 Stream Stabilisation*	Outlines techniques to control the riverbed, stabilise channel alignment, protect stream banks and rebuild habitat. Provides guidelines on managing erosion and sedimentation problems and practical techniques to integrate channel stabilisation engineering and ecological restoration.
Planning and Management	*RR 2 Planning and Management: Foreshore condition assessment in urban and semi-rural areas of south-west Western Australia*	Outlines a simple stream assessment method (modified from Pen and Scott 1995) for use in semi-rural and urban areas. It includes the assessment of instream habitat, foreshore vegetation, presence of dominant species (native plants and weed species), channel stability, areas suffering or prone to bank erosion and disturbance to the riparian zone as a result of the surrounding intensive landuse.
	RR 3 Planning and Management: Foreshore condition assessment in farming areas of south-west Western Australia	Outlines a simple stream assessment method (modified from Pen and Scott 1995) for use in farming areas of south-west Australia. The methodology looks at the overall foreshore health and grades the foreshore at various stages from pristine with good vegetation to a ditch or drain with weed infestation or no vegetation.
	RR 11 Planning for Waterways Management: An overview	Provides an outline of the principles by which planning for waterways management should occur and is the background to more detailed documents.
	RR 12 Planning for Waterways Management: Guidelines for preparing a regional strategy for Natural Resource Management	Discusses regional planning, integrated catchment management, natural resource management, development of regional strategies, components of regional strategies and the incorporation of waterways management issues.
	RR 13 Planning for Waterways Management: Guidelines for preparing a Waterways Management Program/Catchment Plan	Recommends a planning process, content and structure for waterways planning documents that focus at the catchment scale. Principally aimed at Waterways Management Authorities developing Waterways Management Programs, but the approaches and structures that are recommended are equally relevant to the development of catchment management plans.
	RR 14 Planning for Waterways Management: Guidelines for preparing a River Action Plan	A guide to preparing a River Action Plan for community groups and people involved in on-ground river restoration activities. It assists the process of planning river restoration activities at the local level by outlining the major steps and actions required to develop a River Action Plan.
	RR 16 Determining foreshore reserves	Describes how to determine the extent of a foreshore reserve using biophysical criteria and the step by step process that will define and protect it. Also provides two case studies of the Hill River and the lower Collie and Brunswick Rivers.
Other Sources of Information	*RR 15 Other sources of information*	Provides a listing of agencies and other organisations, as possible sources of information and funding for river restoration activities. **Information from this Manual chapter, due to its dynamic nature, will now be available on the Water and Rivers Commission website only: www.wrc.wa.gov.au/protect/waterways/index.htm**