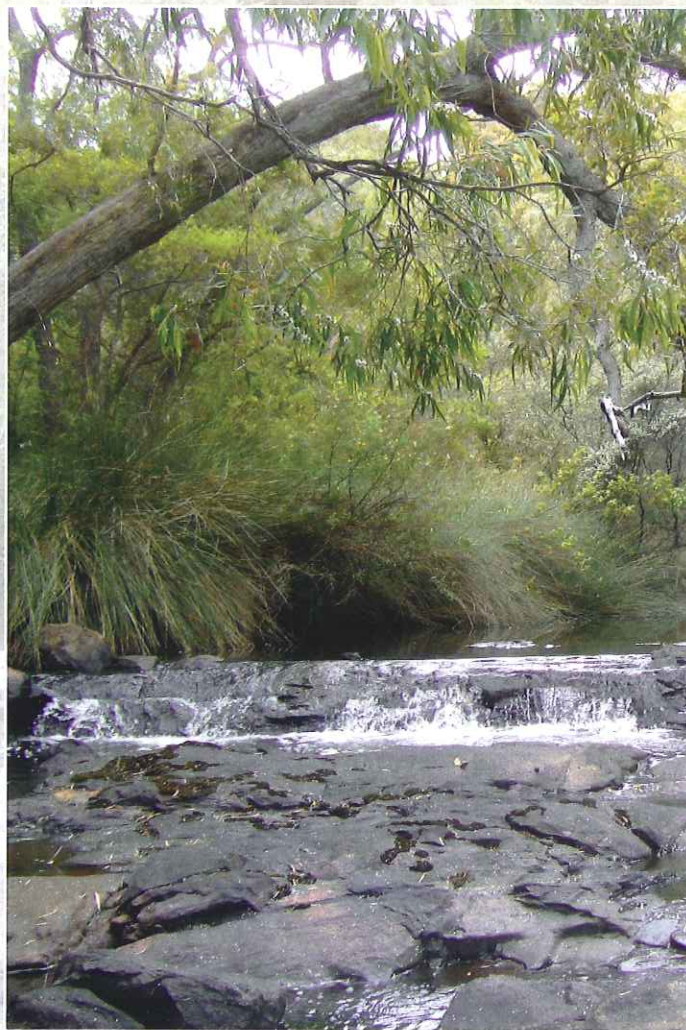


Wilyabrup Brook Action Plan



2006



*Cape to Cape
Catchments Group*



Australian Government



Wilyabrup Brook River Action

Prepared for the Cape to Cape Catchments Group (CCG)

by

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How to use this river action plan

This river action plan (RAP) was prepared for the Cape to Cape Catchments Group and landholders within the Wilyabrup Brook catchment. It contains a detailed description of the current health of the waterway in terms of the condition of the fringing vegetation, weeds and erosion. It provides information on current management issues, and recommends strategies to address these issues.

The report can be used to assist in prioritising actions in the catchment to protect and enhance the brook. It provides background information to aid decision making for landholders, land managers and the community.

Sections 1 and 2 provide an introduction to the report and describe the study area. Section 3 discusses ecology of the brook. Section 4 outlines the methodology used in developing this action plan. Sections 5 and 6 detail the management issues identified and actions which can be taken to address these issues. Section 7 contains maps of the study area showing foreshore condition rating, fencing status, weeds, erosion and other features. Specific management recommendations are detailed for each map in this section. This section may be a good starting point for landholders to identify management issues on their property. Section 8 summarises the key actions and recommendations in the report.

Four appendices provide further information that may be useful to landholders, land managers and community groups.

- List of local native plants species suitable for revegetation.
- List of local native plant species identified in the study area.
- Common weeds in the study area.
- Useful contacts for further information and assistance.

Acronyms

RAP	river action plan
CCG	Cape to Cape Catchments Group
GeoCatch	Geographic Catchment Council
NHT	Natural Heritage Trust
CALM	Department of Conservation and Land Management (now DEC)
WRC	Water and Rivers Commission (now DoW)
DoE	Department of Environment (now DEC)
DoW	Department of Water
DAFWA	Department of Agriculture and Food WA
AMRSC	Augusta-Margaret River Shire Council
SoB	Shire of Busselton
LBLCDC	Lower Blackwood Land Conservation District Committee

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Merryn Delaney from the Shire of Augusta-Margaret River and John McKinney from the Shire of Busselton provided information on land tenure, vesting and property owners. Judit Bonisch and Aidan Power of the Regional Support Branch of the Department of Water prepared the maps. June Hutchison edited the action plan.

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Reference details

The recommended reference for this publication is: Cape to Cape Catchments Group, 2006, *Wilyabrup Brook Action Plan*.

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Summary

Wilyabrup Brook is located in the Cape to Cape subregion. It has a catchment area of 89 km² (Hunt et al., 2002) and stream length of approximately 100 km. The brook starts in cleared farmland in the form of broad indistinct channels. The middle reaches of the main channel and tributaries are distinct channels running through predominantly cleared viticultural and grazing land. West of Caves Road the distinct channel runs primarily through bushland.

The Wilyabrup Brook catchment is experiencing significant population growth and land use changes, including agricultural intensification and diversification. The demand on water resources has increased with these land use changes, leading to the construction of a number of large in-stream dams. Community concern about the health of the waterway and a desire to protect and improve its health led to the development of this river action plan (RAP).

The aim of this RAP is to provide information to land managers, the community and the CCG on the health and current state of Wilyabrup Brook and formulate recommendations on priority actions which can be taken to protect and enhance the condition of the brook.

Assessments were primarily carried out in September, October and November 2005 using a slightly modified version of the foreshore condition assessment method (see p.14) developed by Dr Luke Pen and Margaret Scott for rivers in the south-west of Western Australia (Pen & Scott, 1995). Many landholders assisted with the foreshore surveys.

Key issues identified

The key issues of concern identified during the foreshore assessments and community consultation were:

- Loss of native fringing vegetation through degradation or clearing;
- Weed invasion and management of weeds;
- Altered hydrology including the quantity and timing of flows;
- Water quality issues, including nutrients and chemical pollutants;
- Barriers to migration of native fish by in-stream dams;
- Erosion and sedimentation; and
- Level of information and assistance provided to landholders.

General recommendations to improve the health of the Wilyabrup Brook

It is recommended that landholders consider the following:

- Retain and protect the remaining riparian vegetation of Wilyabrup Brook, including along drains, dams and tributaries.
- Revegetate waterways and dams with local native species to provide habitat and enhance ecological function.
- Fence the brook to control stock access.
- Use available funding to contribute towards the costs of fencing and rehabilitation projects by contacting the CCG on 9757 2202.
- Where there are bypass valves on dam walls, open them as soon as the creek upstream of the dam begins to flow. Where there are no bypass valves, install a siphon system to allow environmental flows.
- Plant vegetation corridors that support the movement of wildlife and re-create their habitat. This includes working with neighbours to provide more continuous habitat for native fauna.
- Control weeds, particularly invasive and declared species in the riparian zone.
- Implement management techniques that minimise soil erosion and nutrient loss and chemical pollution to waterways, such as buffer strips, soil testing and maximising vegetation cover on the soil.

It is recommended that the Cape to Cape Catchments Group consider the following:

- Encourage and support community efforts to fence the brook to restrict stock access.
- Apply for further funding to continue to subsidise the cost of rivercare projects.
- Encourage, as a priority, the protection of areas retaining native fringing vegetation. It is more cost effective to protect these areas now than to restore them later after further degradation has occurred.
- Provide encouragement and support to landholders to undertake revegetation using a diverse suite of local native species (including trees, shrubs, sedges, rushes, herbs and native grasses).
- Expand and continue to support weed and feral animal control projects in the catchment.
- Promote management techniques that minimise soil erosion and nutrient and other pollution loss to waterways, such as buffer strips, soil testing and fertiliser management plans, and maximise vegetation cover on the soil.
- Seek funding opportunities and encourage DoW to monitor water quality in the brook on an ongoing basis.
- Work with Ribbons of Blue and other community organisations to increase community awareness and knowledge of the Wilyabrup Brook catchment, focussing on natural assets, values, and threats.
- Continue to work with the wine industry and other stakeholders to develop and implement best management practices (BMPs) including winery wastewater and vineyard practices.

Priority actions are listed in Section 8. They provide a useful starting point for the implementation of this RAP. They include specific priority actions along with some more general short and long-term activities such as community education and strategic planning activities.

A summary of the foreshore condition rating of the Brook is presented in Table 1. Table 2 indicates the current length of brook which requires fencing to exclude stock.

Condition	Total Length	Total %
A (pristine)	6 km	6%
B (weedy)	17 km	17%
C (erosion prone)	22 km	22%
D (ditch)	44 km	44%
E (dams)	11 km	11%

Table 1: Summary of foreshore condition rating of Wilyabrup Brook.

	Required Fencing	% Of Length
Required for A grade	0 km	0%
Required for B grade	7 km	3.5%
Required for C grade	30 km	15%
Required for D and E grade	60km	30%

Table 2: Approximate length of Wilyabrup Brook requiring fencing for protection of riparian vegetation by excluding stock (Note this is the length of fencing required therefore includes both sides of the brook where necessary).

1. Introduction

Background

Many waterways in Western Australia are becoming degraded as a result of land use in the catchments. Issues of concern include the loss of native fringing vegetation, weed invasion, and erosion. This is allowing excess nutrients and sediment into our waterways which has led to a decline in water quality. It has also impacted on biodiversity, threatening flora and fauna species.

In recognition of the pressures on Wilyabrup Brook, the Cape to Cape Catchments Group, in partnership with GeoCatch, secured funding from the State and federally funded National Action Plan for Salinity and Water Quality (NAP) and the Natural Heritage Trust (NHT) to develop and implement the Wilyabrup Brook Action Plan.

A number of action plans have been developed for waterways in the Cape to Cape subregion with the assistance of GeoCatch. These include the Margaret River, Cowaramup, Yallingup, Ellen and Gunyulgup Brooks. This project continues the series of action plans. It also reflects community concern about the health of Wilyabrup Brook.

The Cape to Cape Catchments Group (CCG) is a community organisation that works in partnership with all land managers (public and private) to undertake on-ground environmental work and other natural resource management activities. The group works from Cape

Naturaliste to Cape Leeuwin extending inland to include the Margaret River catchment. The group was formed in November 2000 with the aim of *working with the community and management agencies to ensure that natural systems, people and their activities coexist in a healthy, productive and sustainable way.*

Study aims

The primary aims of this river action plan are to:

- Provide a description of the current state of Wilyabrup Brook and identify priority actions to improve and protect the health of the brook;
- Engage landholders and the community in waterway management and increase awareness of the importance of healthy waterways and riparian vegetation;
- Set a benchmark against which the local community's future work to protect and rehabilitate the brook can be gauged;
- Guide the use of funding and assistance available for fencing, weed and erosion control, and the planting and rehabilitation of native vegetation, and provide a sound technical basis for future funding or project submissions; and
- Protect and enhance water quality and the ecology of the brook.

2. Study area

For this study, Wilyabrup Brook was considered to include the main channel and all its tributaries (Bigbrook, Red Gully, Forest Spring and others). The location of the study area is shown in Figure 1.

Wilyabrup Brook and its catchment

Wilyabrup Brook has the second largest annual flow in the Cape to Cape subregion after the Margaret River. The main channel and the extensive network of tributaries total approximately 100 km with a catchment area of 89 km². The main land use in the catchment is agriculture (84%), including viticulture (40%), grazing and pasture (29%), dairies (10%) and other (5%). Only 4 % of the catchment is residential. Native remnant vegetation covers the remaining 12% of the catchment (Hunt *et al.*, 2002).

The headwaters of Wilyabrup Brook begin as low-lying, poorly drained, and primarily cleared grazing areas. As the brook drains west the channels become more defined. There are few areas where the vegetation remains intact. Viticulture dominates the middle portion of the catchment. West of Caves Road is primarily native bushland which in some areas has never been grazed due to the steep rock gorges.

Like many of the waterways within the Cape to Cape catchments, Wilyabrup Brook has been extensively modified as a result of agriculture in the area. Large sections of the brook have been cleared of vegetation or the vegetation has been degraded by grazing. The dominant land use is viticulture which has increased the demand on surface water. There are approximately 100 gully-wall dams that alter the quantity and timing of flow in the brook and are a barrier to native fish movement. The impact of these structures on water flow and fauna movement is discussed in Section 5 (see p.22).

Landform and soils

The Wilyabrup Brook catchment lies in the Leeuwin Block geomorphic zone. The Leeuwin Block is a narrow area along the west coast extending between Cape Naturaliste and Cape Leeuwin, dominated by a gently undulating laterite plateau lying 20-80 metres above sea level. Soils on the plateau include loamy gravels and grey deep sandy duplex soils. Some pockets of friable red-brown loamy earths occur in the valleys. Yellow sands overlay the limestone ridge and calcareous sands are found on the coastal dunes.

The information below comes from the Department of Agriculture *AgMaps Land Profiler* CDROM.

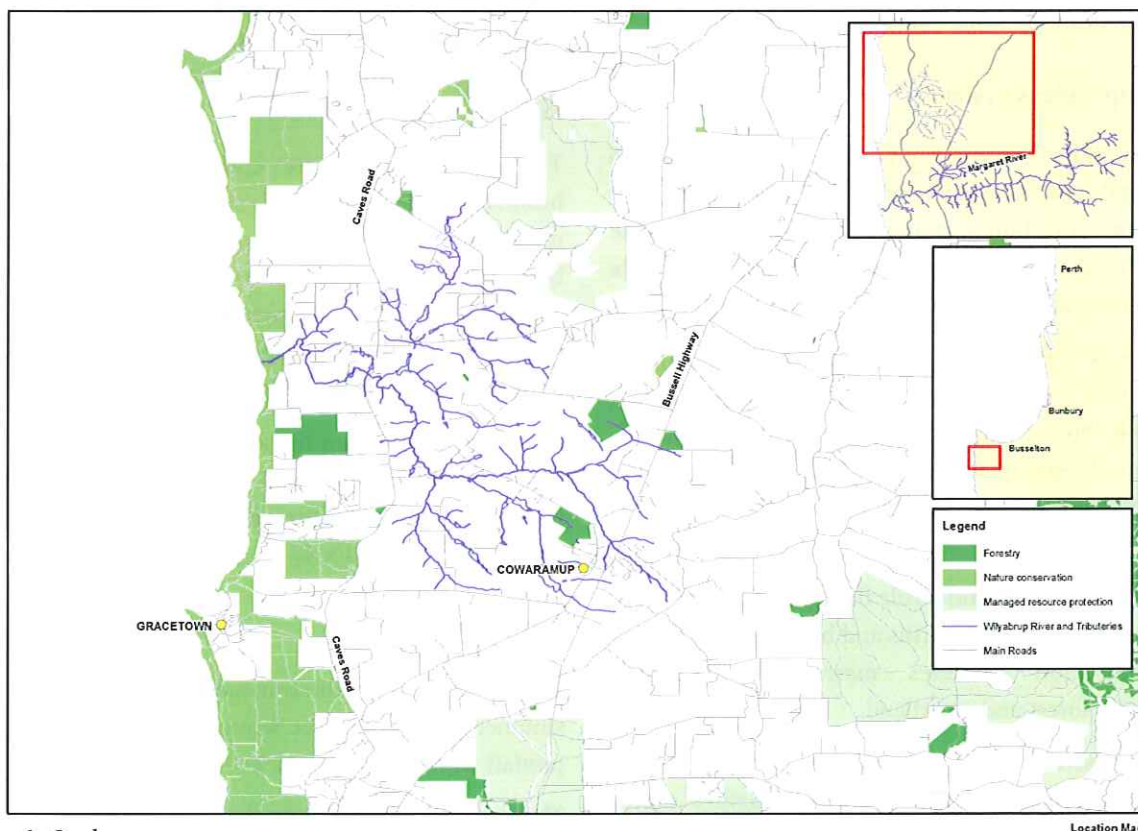


Figure 1: Study area.

Within the Leeuwin Block zone, there are three distinct land systems. They are:

1. Wilyabrup Valleys system: Comprises the major valleys in the Margaret River district from Dunsborough to Witchcliffe. Main soils are loamy gravels, duplex sandy gravels and loamy earths. Principal vegetation is jarrah-marri-karri forest.
2. Cowaramup Uplands system: A laterite plateau with broad swampy depressions. Main soils are loamy gravels, duplex sandy gravels, semi-wet and wet soils. Principal vegetation is jarrah-marri forest.
3. Gracetown Ridge system: Located along the coast between Cape Naturaliste and Cape Leeuwin and consists of dunes and rocky coast. Main soils are yellow and red deep sands, calcareous deep sands and calcareous stony soils. Principal vegetation is mixed coastal scrub, peppermint woodland and jarrah-marri-karri forest.

Within each of these land systems, there are a number of subsystems in the Wilyabrup Brook catchment. Broad definitions and characteristic vegetation communities of these subsystems along the brook and tributaries are outlined below. Bear in mind that these are broad generalisations only and that soil type and vegetation communities will vary considerably from one location to another, within the same soil subsystem.

Wilyabrup Valleys system

There are three dominant and four minor Wilyabrup Valleys soil type subsystems on Wilyabrup Brook. They are narrow valley floors, swampy valley floors and fertile flats with minor occurrences of rocky outcrops, gentle slopes, moderate slopes and deep sands.

The narrow valleys and gentle to moderate slopes commonly have loamy gravels, duplex sandy gravels, stony soils, brown deep loamy duplexes and friable red-brown and brown loamy earths. Marri-jarrah forest and woodland with some pockets of karri are associated with system.

Swampy valley floors and fertile flats generally consist of friable red-brown loamy earths and brown loamy earths. Key vegetation includes marri-jarrah-blackbutt-peppermint forest and woodland.

The deep sands system commonly includes sandy slopes, pale deep sands with some pale shallow sands, gravely pale deep sands and sandy gravels with jarrah-

marri-banksia-sheoak woodland. Rock outcrops include areas of bare rock with some stony soils and shallow sands and loams. They are mostly unvegetated or have low heath vegetation.

Cowaramup Uplands system

The two main subsystems are Cowaramup wet vales and wet flats. These are primarily located in the upper catchment. There are also smaller pockets of rocky gentle slopes and undifferentiated upland areas.

Wet vales and wet flats are commonly broad, swampy floored drainage depressions. The soil types include wet and semi-wet, grey deep sandy duplexes, loamy gravels and duplex sandy gravels. Marri-jarrah-paperbark-tea tree woodland and forest is associated with this subsystem.

The rocky gentle slopes include minor v-shaped valleys with loamy gravels and duplex sandy gravels. Undifferentiated upland areas have lateritic flats and low rises with loamy gravels, duplex sandy gravels, semi-wet soils and grey deep sandy duplexes. Marri-jarrah forest and woodland occurs on both subsystems.

Gracetown Ridge Uplands system

There are two Gracetown Ridge subsystems found on Wilyabrup Brook. They are located in the westernmost (coastal) part of the catchment near the mouth. They are rock outcrops and blowouts.

The rock outcrops are commonly exposed rocky headlands of bare rock with some stony soils. They are mostly unvegetated with some pockets of coastal heath. Blowouts are steep dunes (sheltered from prevailing winds) of calcareous deep sands (with topsoils stained dark by organic matter). Coastal heath and scrub occurs once areas have stabilised.

For more information on soil-landscape mapping, land use capabilities and soil types, please contact the Department of Agriculture and Food. Contact details are provided in Appendix 4.

Climate

The area has a Mediterranean climate with hot, dry summers and mild, wet winters. The average median rainfall was approximately 1100 mm (Pen, 1999).

There is data that supports the anecdotal evidence from landholders of decreased rainfall. It shows a 10-25 %

decline in annual rainfall in the south-west of Western Australia from the long-term climate mean (Hennessy, 2002). This is due to a reduction in the mean number of raindays, and the mean number of heavy raindays in winter. According to the *State Water Strategy* (Government of Western Australia, 2003) 'Climate change has contributed to a 10-20 percent reduction in rainfall in the south-west of the State over the last 28 years, a subsequent 40-50 percent reduction in run-off into our dams and reduced recharge of groundwater'.

Flora

The south-west has high species diversity with a large number of endemic species. The area is one of 34 international biodiversity hotspots (the only international hotspot in Australia). The flora in the Wilyabrup catchment is part of the Menzies and Warren subdistricts of the Darling District of the South-west Botanical Province (Beard, 1990). The forests of these subdistricts comprise of karri and jarrah-marri.

Most vegetation in the catchment has been cleared or degraded through grazing. Large areas of natural remnant vegetation occur west of Caves Road. East of Caves Road good remnant vegetation can be found in Wilyabrup Reserve on Puzey Rd, near Cowaramup in Parkwater Estate, along the Rails to Trails Reserve and in Reserve 9110 on Caves Rd.

Vegetation communities

Generally the main vegetation communities along the brook are:

- Marri-jarrah-blackbutt-peppermint forest or woodland on well drained loamy gravels throughout the catchment.
- Marri-peppermint-tea tree woodland on poorly drained flats and depressions throughout the catchment.
- Karri forest over peppermint on loamy gravels near Cowaramup
- Jarrah-marri-banksia woodland on sandy soils near Caves Rd and Fifty One Rd.
- Heathland with *Kunzea* spp. and *Darwinia citriodora* on rocky soils and rock outcrops primarily west of Caves Rd.
- Melaleuca woodland and coastal heath near the mouth.

Within each community the species composition varies according to soil and landform.

Threatened species

Two species of declared rare flora *Caladenia excelsa* and *C. huegii* and sixteen priority species including *Eucalyptus marginata x megacarpa*, *Gahnia scleriodes* and *Thysanotus glaucus* are known to occur in the Wilyabrup catchment. These are recorded species only, others are likely to occur.

Appendix 2 contains a full species list for the Wilyabrup catchment and should be referred to if undertaking a revegetation project. The first step in developing a species list for a revegetation project should be to look at what is currently growing in your area. The species list in this action plan is a guide for species selection.

Fauna

Riparian (creepline) vegetation provides a rich habitat for a variety of native fauna. The species below were noted during foreshore assessments and in studies, or have been observed by landholders or the community.

Large numbers of frogs, birds and reptiles are present in the area. During foreshore assessments many frog and bird calls were noted and occasionally the species were sighted. Landholders also noted the presence of a range of fauna.

Brush-tail possums (*Trichosurus vulpecular*), brush-tailed phascogale (*Phascogale tapoatafa*), chuditch (*Dasyurus geoffroil*), water rat (*Hydromys chrysogaster*), western grey kangaroo (*Macropus fuliginosus*) and pygmy possums (*Cercartetus concinnu*) are known to inhabit the Wilyabrup Brook catchment. The 'vulnerable' ringtail possum has also been sighted in the catchment. Any rehabilitation of creepline vegetation will help to enhance the suitability of all sites for native fauna habitat.

A recently completed fish and freshwater crustacean survey on the Wilyabrup Brook (Morgan, Beatty, Jury and Mitchell, 2006) found four species of fish and three species of crayfish at six sites from the mouth upstream to Miamup Rd. The fish species found are endemic to south-western Australia. They are the freshwater western pygmy perch (*Edelia vittata*), the western minnow (*Galaxias occidentalis*), and the marine-estuarine Swan River goby (*Pseudogobius olorum*). The great news was no introduced mosquito fish (*Gambusia*

holbrooki) were found at the sample sites. The three freshwater crayfish species found were the smooth marron (*Cherax cainii*), the common gilgie (*C. quinquecarinatus*) and the introduced yabbie (*C. destructor*).

The introduced yabbie is of serious concern in the Wilyabrup Brook. It is an aggressive species which is known to prey on juvenile fish and crayfish. At the site where the yabbie was found there were no gilgies. This was the only site sampled with an absence of gilgies.

In general, Wilyabrup Brook offers good habitat for native fish and crustaceans, such as shade, deep pools and riffles and in-stream habitat such as large woody debris and in-stream vegetation. There is a correlation between in-stream habitat and fish and crayfish populations. Therefore, any revegetation works such as erosion control using large woody debris, or planting of emergent vegetation such as rushes and sedges, will increase the habitat values of Wilyabrup Brook.

Heritage

Aboriginal people have occupied the south-west of Western Australia for at least 50,000 years.

Prior to European contact, the Aborigines of the South-west Region formed a distinctive socio-cultural group collectively known as Nyungar (O'Connor *et al.*, 1995). The group of Nyungar people that occupied the Cape to Cape Catchments area were known as the Wardandi people, 'the people that lived by the ocean and followed the forest paths' ('Wardan' meaning 'ocean') (Collard, 1994). The land as a whole, but especially waterways, are spiritually important to Aboriginal people, because of the 'Dreaming' (Berndt & Berndt, 1996).

The seasonal movement of Aboriginal groups related to the exploitation of various resources available in the different environmental situations. It was noted by early settlers that various water bodies on the coastal plain such as creeks, rivers and wetlands were an important source of food in summer, providing plentiful fish, waterbirds, turtles and frogs, as well as vegetable foods. In winter, Aboriginal groups generally moved inland, as there were abundant kangaroo, emu and roots and tubers, and the seasonal inundation of the coastal plain would have made travelling and camping in and through these areas difficult and unpleasant. It is likely that migration patterns also reflected social, cultural, and economic factors (O'Connor *et al.*, 1995).

Wilyabrup means place of red ochre (B.Webb, pers. comm., 2006). One site has been registered with the Department of Indigenous Affairs (DIA) in the Wilyabrup Brook catchment. It is located at the mouth and has been registered as an artefacts/scatter site. It is very likely that there are many more sites of Aboriginal significance in the catchment that have not been registered as this area and waterways are particularly important to Aboriginal people.

Consultation with the local Indigenous community is required before works are undertaken that may disturb the bed or banks of the brook.

Europeans arrived in the area in the late 1800s undertaking logging and receiving grazing leases. Permanent pools such as 'Top Pool' located at Howard Park at the confluence of two streams and 'Bottom Pool' near Vasse Felix were used as camping sites and stock watering points by fallers (Kinsella, 1990).

In the 1920s the Group Settlement Scheme developed four sites along the Wilyabrup Brook. The settlements were located at Cowaramup, just north of the townsite, on Harmans Mill Road and Fifty One Road. The early settlers found conditions difficult and many left their farms. Pasture and crop development was poor making dairy farming very difficult. Beef cattle farming and sheep grazing did not take off until the 1950s (Blond, 1988).

History of viticulture in the area

Sam Moleri was the first wine producer in the area. His vineyard was located north-west of Wilyabrup and was established in the 1920s. In 1965 Dr John Gladstone wrote a journal article suggesting the soil and climate of the west coastal area south of Busselton could be ideal for the production of high quality table wines. In 1967 Dr Tom Cullity established a small vineyard at Vasse Felix on the banks of the Wilyabrup Brook. Many other small vineyards were established in the 1970s and 80s. By 1987 there were 30 vineyards in the region and now in 2006 there are 57 landholders with vineyards along the Wilyabrup Brook itself. The Wilyabrup catchment is renowned for its high quality wines with many of the well known names including Vasse Felix, Moss Wood, Brookland Valley, Sandalford, Cullens, Woodlands, Howard Park, and the list goes on.

Places on Wilyabrup Brook (Kinsella, 1990)

Kelly's Farewell - Named by A. Bussell where his bullock driver, Kelly, refused to travel further south on the pioneer move and returned from here to Vasse. This spot appears to be located near Metricup Rd.

Forrest's Spring - Named after Gavin Forrest, a bullock teamster. Now Wilyabrup Reserve on Puzey Rd.

Gavvy's Get Down - A pinch (short, steep incline) on the hauling route named as above. Located on headwaters of a branch of Bigbrook.

Coutts's Hill - Another pinch named after a teamster hauling out for Yelverton. Also located on the headwaters of a branch of Bigbrook.

Sheep Wash Hollow - A locality deriving its name from a bullocky's swamper (assistant to the teamster) nicknamed 'Sheep Wash'. It is the last tributary on the eastern bank of Red Gully before it joins Bigbrook (near Sandalford).

Nandicap - The swamp at the head of the creek running south-east into Bigbrook was known to the Aborigines by this name. It is located on Moss Wood vineyard.

Tilly's Swamp - A swamp at the head of a tributary to Wilyabrup Brook west of Caves Rd. Named after a young girl 'Tilly' Adams who was lost for 5 days in the area and was found by a young Aboriginal under a tea tree.

Population growth

The Shires of Busselton and Augusta-Margaret River are growing rapidly, with average growth rates for 2004-2005 being 6.4% and 2.9% respectively. This compares

to the WA average for the same period of 1.6% per annum (ABS, Regional population growth 2004-2005). This population growth across the Shires increases the pressure on the environment.

Tourism

The Margaret River region is an international tourism destination with many attractions, including the Cape to Cape coastline, wineries and forests. It currently receives over 1.5 million visitors annually (AMRSC, undated) which places further pressures on the environment. The Leeuwin-Naturaliste National Park is the most visited national park in the State. The increase in tourists to this area is reflected by diversification in the Wilyabrup catchment, including cheese, wine, beer and chocolate businesses.

The catchment has a spectacular coastline with long beaches, sheltered bays, rocky headlands and dramatic coastal cliffs. Surfing, swimming, fishing and other water activities are popular. There has been an increasing demand for land for tourist developments and a need to preserve the natural features which are one of the area's main attractions.

Land tenure

The majority of the lots adjoining Wilyabrup Brook are privately owned, and corresponding lot and location numbers are shown on the maps in Section 7. The brook flows through a number of reserves, and the corresponding map number, the reserve number, classification, vesting and purpose is listed below (except constructed road reserves).

Map	Reserve No.	Classification	Vesting	Purpose
1	Reserve	A	Unvested	Leeuwin-Naturaliste NP
3 & 4	Reserve 22996	C	SoB	Recreation and Community purposes
10	Reserve 48251	C	SoB	Pedestrian Access Way
11	Reserve 9110	C	Unvested	Waterway
12, 13 & 15	Reserve 43215	C	AMRSC	Pedestrian Access Way
13	Reserve 22636	C	AMRSC	Pioneer Park

Table 3: Reserves on Wilyabrup Brook.

3. Stream ecology

The following information comes from the *Margaret River Action Plan* and *Managing Our Rivers* by Luke Pen (Pen, 1999). It provides details on waterway habitats which are found in the Wilyabrup Brook and the important function they perform. There is a list of references at the end of this section which provide more information on the ecology of our waterways.

Habitats

There are a great diversity of habitat zones and elements in a natural stream. This variety of habitats supports a diverse array of plants and animals. Fauna of the south-west waterways is shown in Figure 2. Flora of Wilyabrup Brook is listed in Appendix 2.

Habitat zones

Permanent pools

Over the summer season most of the water in the brook is in deep permanent pools. The pools provide an essential summer drought refuge for many stream animals, including waterbirds, turtles, water rats, fish, crayfish, shrimp and mussels, and are integral to the survival of many aquatic animal populations. Undisturbed pools are usually surrounded by dense fringing vegetation and are well shaded and provided with snags and woody debris along their edges.

Riffles, rapids and cascades

These habitats occur where water flows swiftly over an irregular stream bed, over and between rocks and from one rocky terrace to another. As well as providing habitat for particular macroinvertebrates they have two very important functions. They help to oxygenate the water and the sound they make enables some species to find their preferred habitat.

Runs and low flow channels

Long reaches of unobstructed stream flow, where the flowing water has a flat surface, are often called runs. In the south-west they are the low flow channels that wind their way across the floodway between pools. The low flow channels are often well supported and overhung by fringing and in-stream native vegetation.

Floodplains and backwaters

In terms of habitat, floodplains are generally broad areas of low flat land adjacent to the main floodway of the stream. Each year floodplains are inundated to some

degree by floodwaters, creating a seasonal habitat which may be used for feeding and breeding by a variety of animals such as tiny crustaceans, burrowing crayfish, birds, frogs and fish. Floodplains may also be part of broader wetland systems which in winter become very swampy through groundwater rise or the build up of rainwater over a clay layer. Floodplains are an integral part of the stream ecosystem. There is an exchange of water, nutrients, and living creatures between the stream and its floodplain, which is essential to the proper functioning of a healthy stream ecosystem. When secondary channels become disused and form pools they are referred to as backwaters. The still or slow flowing water in the backwaters is often the preferred habitat of species that are unable to cope with fast flow.

Habitat elements

Habitat elements are found within the zones outlined above in differing combinations to provide a large variety of habitats.

Riparian (fringing) vegetation

Riparian vegetation has a number of important functions as discussed in Section 5 of this report. In regard to habitat, native fringing vegetation is important as it contributes hard oily tannin rich leaves to fuel the food web, and provides shade throughout the year helping to keep water temperature low.

Snags and woody debris

Snags are fallen trees and large branches lying in the stream channel. They are important to the ecology of streams. Apart from generally helping to slow the flow of water, woody debris alters its flow, creating eddies and small isolated zones of turbulence or still water which provide 'microhabitats' for a range of tiny animals and plants. Furthermore, tree trunks and branches add a huge surface area to a stream environment, creating a woody habitat for certain species to use for all or part of their life cycle. Tree trunks lying close to or on the stream bed provide cover or a sturdy roof for burrowing animals, such as marron or gilgies.

Shade

Shade provides an essential refuge for aquatic animals to escape the heat of the sun, as well as generally keeping water temperature down.

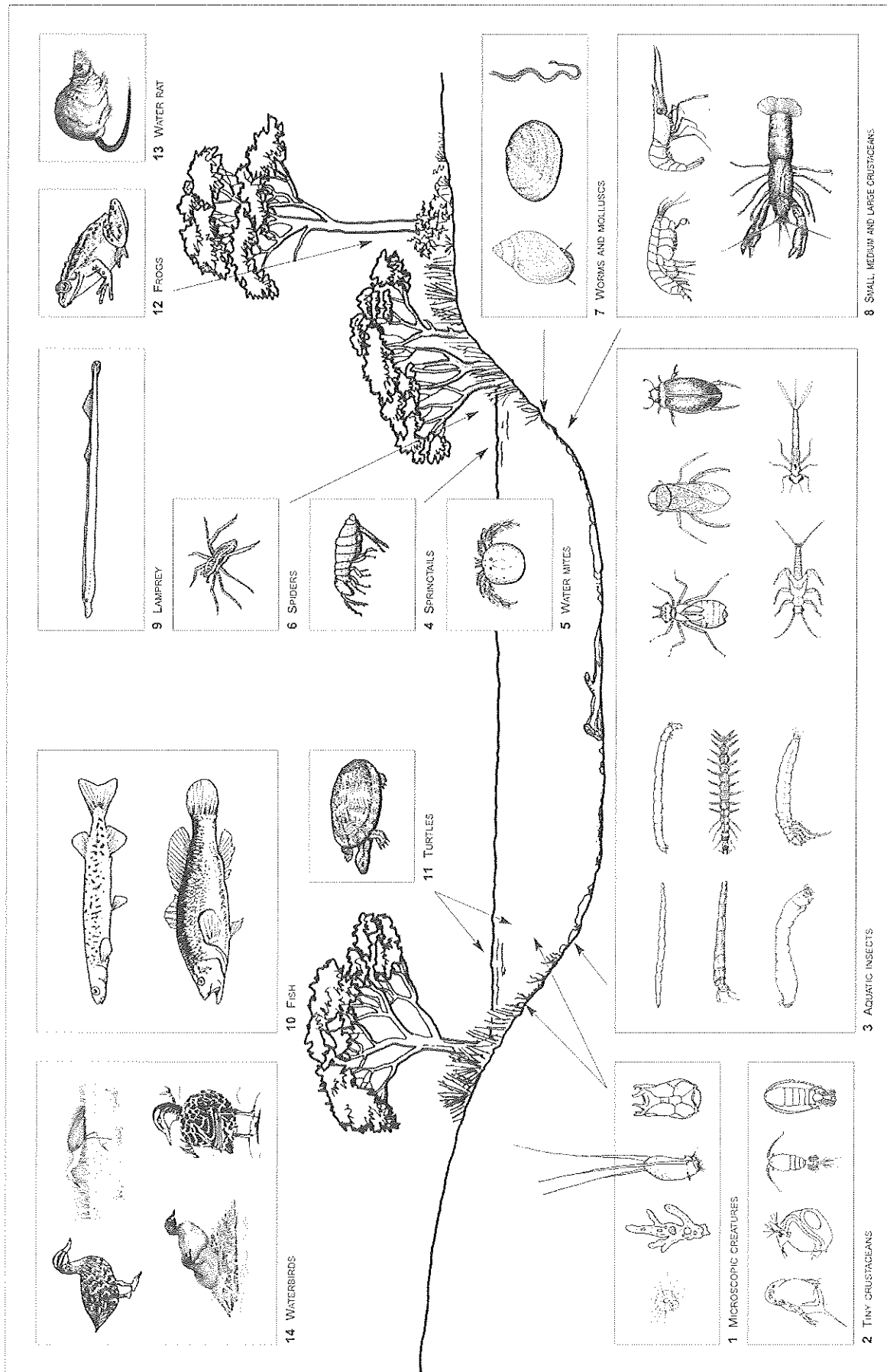


Figure 2: River fauna of south-western Western Australia.

Aquatic vegetation

Aquatic vegetation includes plants that are found submerged in, floating on or emerging from water. It provides a specialist habitat for certain animal species, such as fish and hunting spiders, as well as cover for fish, shrimps and crayfish and valuable breeding and nursery habitat for fish during spring.

Leaf litter

Leaves and twigs collect in pools or in areas of still or slightly flowing water and form an important microhabitat for a large range of aquatic organisms, from large crayfish to microscopic bacteria and fungi which break down the organic material and initiate the natural food web. Piles of leaves and twigs can also provide cover for certain fish species, aquatic insect larvae and juvenile crayfish, but only if there is a slight flow of water through the material to maintain well oxygenated conditions.

Rocks and stones

Although vegetation dominates waterway habitats in the south-west, rock and stone are important habitat elements. Rocks create a myriad of microhabitats in which a broad range of animals and plants can find a home. Rock also limits the growth of trees and shrubs over water and creates sunlit habitat. For example, the smooth rocky bed of the rapids in the area west of Caves Rd on Wilyabrup Brook supports the growth of algae in the shallow swiftly flowing sunlit waters. Finally, the

water flow over rocky stream beds helps to oxygenate the water, improving the quality of habitats downstream.

The catchment

The riparian ecosystem is determined not only by climate, habitats and the living creatures within it, but also by the nature of the much larger catchment beyond, as wind and water carry vegetable matter, inorganic sediment, dissolved organic material, salt and nutrients into the stream system (Pen, 1999).

The habitat value for riverine animals is also affected by the nature of the catchment. Many riverine animals make use of the broader stream system, such as seasonal creeks, and floodwaters and adjacent riparian lands, at some stage in their life cycle.

Useful references on river ecology

Pen, L.J. (1999) *Managing Our Rivers*. Water and Rivers Commission, Perth.

Water and Rivers Commission (2000) River Restoration Report No. RR7. *Stream Ecology*.

Water and Rivers Commission Water Note 8, *Habitat of Rivers and Creeks*.

Water and Rivers Commission Water Note 9, *The Value of Large Woody Debris (Snags)*.

Water and Rivers Commission Water Note 12, *The Values of Riparian Zones*.

4. Study methodology

Stakeholder involvement

The involvement of the community in the development of this project was a priority. Landholders, members of the community, local Indigenous people, and other stakeholders including local and State government agencies were involved in the project, assisting with collecting information and developing management recommendations.

Foreshore assessments were conducted with the landholders or after a discussion with the landholder. They provided invaluable information about their concerns and the catchment including observations of flow timing and fauna. Once the foreshore assessments were completed, a well attended community meeting was held to present initial findings and to seek feedback about the project and management recommendations.

Foreshore condition assessment

A slightly modified version of the Pen-Scott method of riparian zone assessment was used. This system provides a graded description of the river foreshore from pristine (A grade) through to ditch (D grade). A summary of the grades of the Pen-Scott system follows (Pen & Scott, 1995; Water and Rivers Commission, 1999a). These are illustrated in Figure 3 and photos on the following pages. This method allows comparisons of waterway health across the south-west of Western Australia, and can be used to prioritise actions.

A grade foreshore

A1: Pristine

The river embankments and/or channel are entirely vegetated with native species and there is no evidence of human presence or livestock damage. This category, if it exists at all, would be found only in the middle of large conservation reserves where the impact of human activities has been negligible.

A2: Near pristine

Native vegetation dominates but introduced weeds are occasionally present in the understorey, though not to the extent that they displace native species. Otherwise there is no human impact. A river valley in this condition is about as good as can be found today.

A3: Slightly disturbed

Here there are areas of localised human disturbance where the soil may be exposed and weed density is relatively heavy, such as along walking or vehicle tracks. Otherwise, native plants dominate and would quickly regenerate in disturbed areas should human activity decline.

B grade foreshore

B1: Degraded

Weed infested In this stage, weeds have become a significant component of the understorey vegetation. Although native species remain dominant, a few have probably been replaced or are being replaced by weeds.

B2: Degraded

Heavily weed infested In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined.

B3: Degraded

Weed dominated Weeds dominate the understorey, but many native species remain. Some tree and large shrub species may have declined or have disappeared.

C grade foreshore

C1: Erosion prone

While trees remain, possibly with some large shrubs or grass trees, the understorey consists entirely of weeds, mainly annual grasses. Most of the trees will be of only a few resilient or long-lived species and their regeneration will be almost negligible. In this state, where short-lived weeds support the soil, a small increase in physical disturbance will expose the soil and render the river valley vulnerable to serious erosion.

C2: Soil exposed

Here, the annual grasses and weeds have been removed through heavy livestock damage and grazing, or other impacts such as a result of recreational activities. Low level soil erosion has begun, by the action of either wind or water.

C3: Eroded

Soil is being washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.

D grade foreshore

D1: Ditch - eroding

Fringing vegetation no longer acts to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots, but all are doomed to be undermined eventually.

D2: Ditch - freely eroding

No significant fringing vegetation remains, and erosion is completely out of control. Undermined and subsided embankments are common, as are large sediment plumes along the river channel.

D3: Drain - weed dominated

The highly eroded river valley may have been fenced off enabling colonisation by perennial weeds. The river has become a simple drain, similar if not identical to the typical major urban drain.

Where there is complete kikuyu or some other perennial grass cover and the stream was not eroding, it was ranked D3. It should be noted that, in this catchment, a foreshore that is assessed to be D3 may require less management than a D1/D2 or C2/C3 foreshore. This is because the weeds, predominantly kikuyu, hold the bank together. This is only the case in smaller streams where low flows do not have the erosive capacity of larger streams and tributaries. This is discussed more fully in Section 6.

Variation: The Pen-Scott method is not ideally suited to smaller waterways like the tributaries of Wilyabrup Brook and to assessment of dams. Outlined is the variation made to the method:

Assessment of dams

The Pen-Scott method was not designed to assess dam foreshores. A new grade (E grade) has therefore been added to the foreshore assessment methodology to allow for dam assessment. The following grades were used:

E1: Vegetated dam-Well vegetated with native riparian vegetation.

E2: Partially vegetated dam- Partially vegetated with native vegetation or stabilised by grasses.

E3: Bare eroding dam- Soil completely exposed and evidence of erosion.

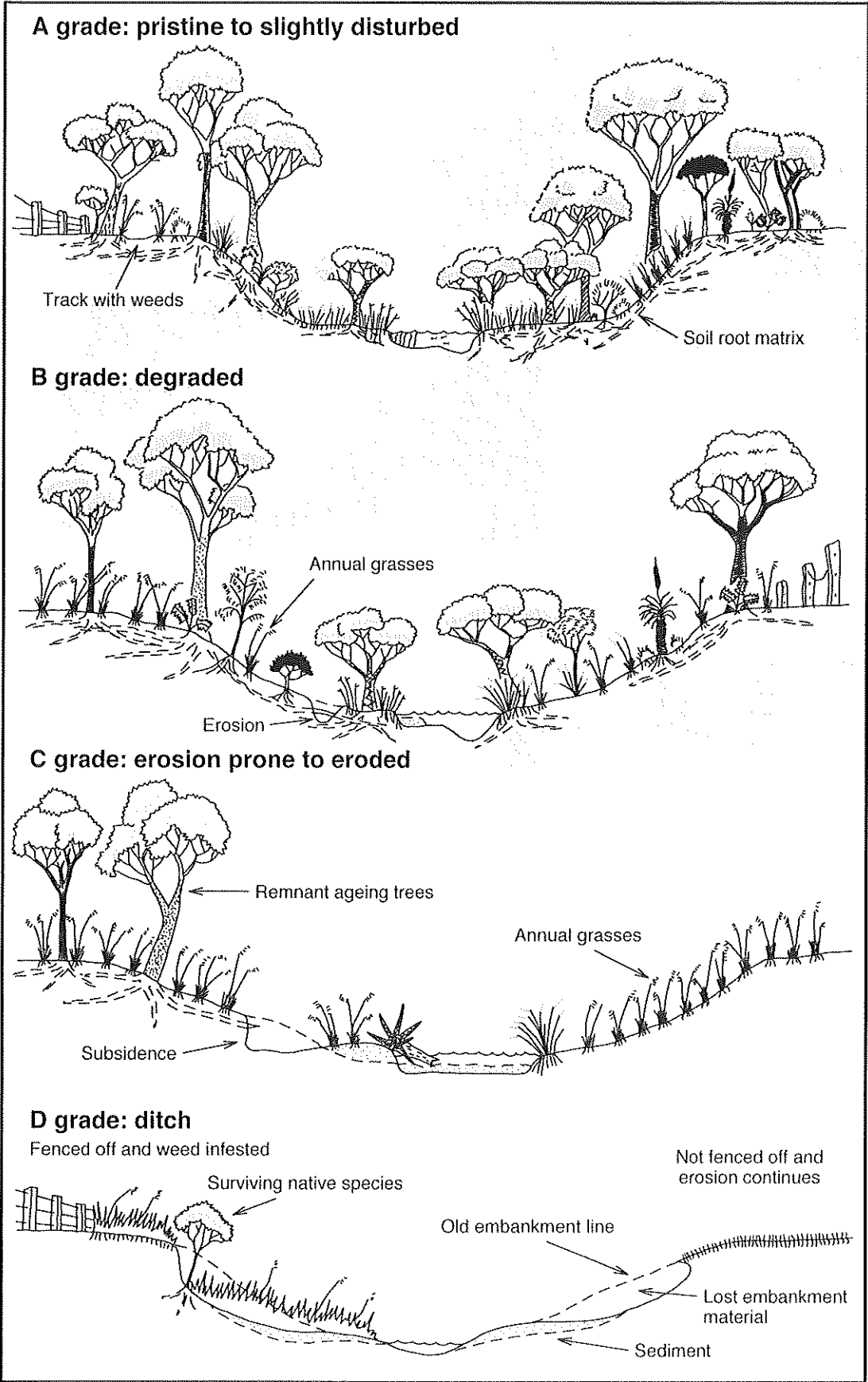


Figure 3: The four grades of river foreshore condition - (A) pristine to ditch (D).



A grade foreshore: This riffle-pool sequence with intact overhanging native vegetation provides important habitat for aquatic organisms.



A grade foreshore: Native fringing vegetation protects the banks from erosion and traps contaminants before they reach the brook.



B1-B2 grade foreshore: Native vegetation is still dominant on the banks but arum lily has started to replace understorey species. Weeds will out-compete native species and provide limited habitat and food resources for native fauna.



B1 grade foreshore: Once again native vegetation is dominant although blackberry is starting to smother areas restricting native plant growth. Blackberry not only threatens our bushland it also makes area inaccessible to people.



C2 grade foreshore: Stock have removed all understorey vegetation including grasses, exposing the soil to low level erosion.



C1-C2 grade foreshore: Cattle have removed the grass and pugged the soil, allowing minor erosion.



D2 grade foreshore: Stock have created a track on one side of the channel. The channel is freely eroding.



D3 grade foreshore: This low flow channel has complete perennial grass cover acting to prevent erosion.



E1 grade foreshore: This dam has excellent native fringing vegetation which provides habitat for fauna and will trap pollutants before they enter the dam.



E2 grade foreshore: The banks of this dam are eroding in the absence of native fringing vegetation.



Scald near a dam in the Wilyabrup catchment, as described on p.23.



Unfenced vs Fenced: The picture above is unfenced and immediately downstream of the picture left which has been fenced for approximately 12 months. You can see the regeneration of rushes and sedges.

5. Management issues

The Wilyabrup Brook catchment is highly altered resulting in a number of issues which threaten the brook and the life and agriculture which depend on it. Management issues vary according to landform and soils, and past and current land use and management practice. These interrelated issues are summarised below.

Stock access

Most of Wilyabrup Brook is unfenced with stock accessing approximately 50% of its length. Stock access to riparian vegetation and the brook is resulting in a number of problems including:

- degradation and loss of native fringing vegetation;
- weed invasion;
- soil compaction;
- nutrient enrichment;
- destabilising banks and erosion; and
- poor water quality.

Although there are a large number of vineyards in the catchment there is still a need for fencing on many properties to restrict stock access to the brook. Grazing remains a dominant land use in the catchment and cattle often graze in areas where vines are not grown. Also there are some vineyards which stock sheep for under vine weed control. If this practice increases fencing will be required to protect the riparian vegetation. Table 2 in the Summary details the length of fencing required which equated to over 45% of the brook.

Stock exclusion through fencing can cause other concerns such as weed invasion and associated fire risk if the area is not actively managed.

Loss of native fringing vegetation

Very little of the Wilyabrup Brook riparian (foreshore) zone has a healthy and complete vegetation structure. Most of the vegetation is degraded to some degree through weed invasion, clearing, stock access or erosion. In many areas on the main channel, there is an overstorey of mature trees, mainly peppermint and marri trees, but little else. In many areas on tributaries, particularly at the headwaters, there is no native vegetation remaining. It is important to retain and enhance riparian vegetation as it has many values and vital functions as discussed below:

Erosion control

The roots of trees and large shrubs anchor the river banks in place and prevent them from slumping and subsiding into the channel. The finer roots of shrubs, sedges and rushes hold the banks together, preventing soil from being washed away and protecting trees and shrubs from being undermined.

Dissipating flow

Riparian vegetation increases the roughness of the river banks, which serves to dissipate the energy of running water thereby reducing the erosive capacity of the flow. The type of vegetation determines the extent to which water velocity is decreased. Widely spaced trees are not as effective in reducing velocity as rushes and sedges.

Sediment and nutrient retention

Riparian vegetation slows overland movement of water resulting in sediments and nutrients being deposited on land prior to reaching the river channel. This effect is known as buffering. Grasses, rushes, sedges and shrubs are most effective in achieving this buffering effect. Many species of rushes and sedges can strip nutrients from soil and water, storing significant amounts in stems and rhizomes. They also support bacterial and invertebrate communities that help to break down nutrients and other pollutants. The wider the buffer zone, the more effective it will be at retaining nutrients and sediment.

Ecological values

Native fringing vegetation provides a range of habitats for many species of flora and fauna, particularly species that are restricted to moist or aquatic environments. Aquatic plants and animals rely on the leaf litter, insects and organic debris provided by riparian vegetation. Branches and fallen trees create habitat for aquatic fauna. The shade from fringing vegetation is important in keeping water temperatures low. Many native aquatic plants and animals cannot tolerate high water temperatures. Lower temperatures also reduce the risk of algal blooms.

Vegetation along stream systems provides a corridor along which fauna can move and may link areas of remnant vegetation.

Economic benefits

There are a number of direct and indirect economic benefits of native vegetation such as increased aesthetic appeal and resale value and increased productivity through provision of windbreaks.

The protection of the remaining native vegetation and the strategic revegetation of cleared land are considered to be the best ways of achieving the twin goals of sustainable agricultural production and biodiversity conservation (Hussey and Wallace, 1993, cited in Connell *et al.*, 2000a).

Weed invasion

Numerous weeds were identified during the foreshore assessments. Many of these are shown on the maps in Section 7 and a complete list can be found in Appendix 3. Disturbance through clearing, grazing, erosion and modification of the channel provides ideal conditions for weed growth and spread. The main weeds of concern in the study area were declared and environmental weeds such as blackberry, arum lily and apple of Sodom, wavy gladiolus, watsonia, bridal creeper, nightshade and pennyroyal. Grapevines and fig trees are also found along brook. Grasses such as kikuyu and Yorkshire fog, and rushes and sedges such as *Isolepis prolifera* and *Juncus microcephalus* are found throughout the catchment.

Grasses and bulbous weeds such as watsonia and chasmanthe (African cornflag) are a particular problem along the brook in vineyards and many lifestyle properties where they are not grazed. These weeds have the potential to impact on productivity if they spread into the vines and also on the health of surrounding bushland.

Weeds compete with native vegetation and restrict natural regeneration. They are a significant factor in the degradation of remnant vegetation and are a major threat to biodiversity. In addition, they are a major economic cost to society. According to a recent study (Sinden *et al.*, 2004) the economic cost of weeds in Australia is approximately \$4,000 million annually. This includes the costs of control and losses in output in agricultural land (\$3,927 million), the cost of control in the natural and built environment (\$104 million) and the amount spent on research and development (\$8

million). It does not include the considerable amount of time and labour community groups and landholders spend controlling weeds.

Deciduous plants

Deciduous species are widely planted in many parts of Australia for their appearance. Commonly planted deciduous trees in the Wilyabrup catchment include jacarandas, plane trees, poplars, robinias and willows. Unfortunately, deciduous plants are not suited to the Australian environment in many ways.

Nutrient enrichment

Deciduous plants drop all their leaves over a short period at the end of autumn, unlike Eucalypts, which tend to lose their leaves all year, though more so in the summer. The leaves of deciduous trees are also 'soft' and decompose very readily, far more quickly than our aquatic macrofauna can process. The large load of organic material, coupled with rapid breakdown by microbes, results in an excessive release of nutrients into water systems, causing deterioration in water quality (Carter, 1993). Even deciduous species planted a long way from the nearest water body can deliver large amounts of organic matter.

Effects on flora and fauna

Deciduous plants lack suitable habitat and prevent undergrowth which may result in a greatly reduced diversity of native flora and fauna. Research has shown that native fish and many invertebrates such as beetles and dragonflies are greatly reduced in numbers beneath willow trees. Woody debris and leaves from deciduous trees decay quickly, without producing the long-term shelter and food for aquatic animals. Deciduous trees spread rapidly into natural areas through seed or vegetative means (for example they can reproduce from twigs which break off and lodge in the soil and produce suckers).

'Sense of place'

Part of what attracts so many people to this area is the natural beauty, much of this is our native vegetation. Through using deciduous plants the unique character of this region is under threat.

Non-local plant species

Non-local native plant species, particularly Eastern States Eucalypts and Acacias have been planted throughout the catchment. A non-local native plant is one which is native to Australia but does not naturally occur in the local area. Some of these have the potential to become weedy in the south-west as they thrive in our ideal conditions and include: *Acacia melanoxylon* (blackwood), *A.baileyana* (Cootamundra wattle), *Eucalyptus camaldulensis* (river red gum) and *E. globulus* (blue gum). These species and many others threaten the character and biodiversity of this area.

Many of the species that are now weed problems in this area were introduced as garden plants for example arum lily, bridal creeper and watsonia. These garden plants are often referred to as 'garden escapees' and are threatening our native bushland. Plants such as agapanthus, vinca, freesias and lavender are spreading in areas along the brook near old settlements and houses, and are known to be weedy in the Cape to Cape area.

Contact CCG for more information on non-local plants and garden escapees. The CCG have developed two brochures, 'Weed It Out' and 'Plant this Instead'. They provide information on controlling weeds in the catchment and suggest local native plants which look great in gardens. Appendix 1 provides a list of plant species local to the Wilyabrup catchment which are available for landscaping and revegetation.

Dams and environmental flows

Throughout the foreshore surveys and community consultation concern was raised regarding the quantity and timing of flows in the Wilyabrup Brook. The potential impact of dams and declining rainfall on stream flows was of particular concern. There are approximately 100 gully-wall dams on the Wilyabrup Brook and tributaries, varying in size from small soaks up to 5 ha dams. Not all dams have bypass valves and some use boards to maintain water levels at the end of winter flows.

A gully-wall dam on an ephemeral (seasonal) stream can have significant impacts on the timing and amount of flow downstream. If a dam doesn't have an underwall bypass valve or it is not operated correctly, the dam must fill to overflowing before the creek immediately downstream receives flows. It is very important for riparian vegetation to receive these early flows,

especially in dry years, as they come at a time (end of summer/spring) when the vegetation is suffering most from water stress. This is becoming increasingly significant in light of our decreasing and more unreliable rainfall.

Several gully wall dams in the catchment leak which in some areas is resulting in year round flow in what would have been a seasonal creek. The impacts of the altered timing of flows is unknown.

The Shires of Augusta-Margaret River and Busselton have adopted Dams Policies to clarify the regulations regarding dam approval and construction. Most dams (on-stream and off-stream) require Council approval, and are required not to 'sensibly diminish' flow. A dam will not generally be approved unless it is required for agricultural purposes. Gully-wall dams will only be approved where it is demonstrated that no other option exists. All new dams are required to have a bypass valve to assist in the preservation of downstream vegetation and ecological systems. Revegetation of the dam banks is required on all new dams. These regulations also apply to the enlargement, deepening, and 'cleaning up' of existing dams. Landholders who do not comply with the policy can be required by the Shire to remove the offending dam and restore the creek to its previous state. For more information on this policy, please contact the relevant Shire.

Stream and environmental flows

As mentioned above there is community concern regarding decreased stream flows in the Wilyabrup Brook catchment. The Department of Water (DoW) are currently undertaking a Environmental Water Requirements (EWR) study of the Wilyabrup which will determine the amount of water the environment requires to maintain ecological function.

According to a recent report (WWRMC & DoE, 2004) the Wilyabrup Brook catchment, along with some other catchments in the Whicher Water Resource Region, will be proclaimed to ensure sustainable use of water resources. This involves licensing all water users and ensuring there are sufficient and sustainable environmental flows. The Wilyabrup Brook catchment has been given a high priority for proclamation.

For more information on proclamation and environmental flows, contact the Water Allocation Branch of the DoW in Busselton.

Changes in hydrology

Gully wall dams alter the quantity and timing of flows in the brook as discussed earlier. They also can lead to a localised rise in the water table which has result in waterlogging and the appearance of scalds or bare areas near dams. See photo under E grade foreshore.

Water quality

Issues such as nutrient levels and pesticide/herbicide levels in the waterway were raised during the foreshore surveys and community consultation.

Wilyabrup Brook was monitored by the Department of Water until 2005 for a variety of water quality parameters and flow levels and in 2004 a snapshot of the status of Wilyabrup Brook was undertaken. The brook has been the subject of two other water quality studies. In 2002, as part of a wider Cape to Cape stream condition monitoring project, snapshots were taken from three sites on the brook in June, August and October. In 2001 the AMRSC, WRC and LBLCDC initiated a catchment water quality project which took samples from four sites on the Wilyabrup over a six month period. The following information draws on data collected in these studies.

The results are compared with the ANZECC Guidelines (2000) which have been set for south-west Australian rivers. The guideline sets trigger values which if exceeded could negatively impact on the environmental values of the waterway.

Nutrients

Total nitrogen is generally well below the ANZECC trigger value apart from spikes in upper reaches of the brook. Total phosphorous levels have consistently been within the guidelines apart from occasional peaks. Ammonia levels at many sites regularly exceeded trigger values.

Sediments

The only data available measuring sediment transport in the brook is turbidity levels. Turbidity may be high after rainfall events, in response to bank erosion or ground disturbance. All sites monitored were within guidelines rarely exceeding 30NTU.

Dissolved oxygen

Dissolves oxygen levels are generally below acceptable limits. They decline over summer in some instances reaching 20%.

Salinity

The amount of dissolved salt in water is measured by conductivity. The Wilyabrup Brook is fresh apart from close to the inlet.

pH

pH is a measure of acidity or alkalinity. In general the sites tested were alkaline. Natural pH in limestone areas is high and as the Wilyabrup Brook is located on a limestone ridge the results are not surprising.

Parameter	Wilyabrup Values (range)	ANZECC Trigger Value
Total Nitrogen	0.25 to 1 mg/L	1.2 mg/L
Total Phosphorous	0.04 to 0.1 mg/L	0.065 mg/L
Ammonia	0.04 to 0.12 mg/L	0.08 mg/L
Turbidity (NTU)	5 to 25	10-20
Dissolved oxygen (DO)	40 to 80%	80 to 100%
Conductivity (salinity)	0.5 to 2 mS/cm	1.2 to 3 mS/cm
pH	7.5	6.5 to 8

Table 4: Water quality parameter values

Temperature

Water temperature is a function of depth, season, shade and several other factors. It affects the levels of plant growth and macroinvertebrate diversity. Water temperatures in Wilyabrup Brook were generally acceptable.

In conclusion the water quality in Wilyabrup Brook is fair. Of concern are peaks in total nitrogen and low levels of dissolved oxygen over summer months. Due to funding constraints ongoing monitoring of the brook by DoW has ceased therefore clear trends can not be established. DoW have recommended additional water quality testing for organophosphates (OP) and organochlorides (OC) at times when most herbicides and pesticides are applied.

Erosion and siltation

Some level of erosion and deposition is natural in any waterway. The acceleration of these processes through widespread clearing in the catchment, stock access to stream banks and human disturbance can cause management problems. Incision and bank erosion is

most evident where the brook has been channelised, increasing the velocity of the water, or where banks have been denuded of vegetation by clearing or stock damage. Erosion was also of concern on dam spillways or where the spillways re-enter the brook.

Issues associated with erosion problems include:

- loss of valuable soil;
- loss of fences as the watercourse deviates;
- poor water quality resulting from increased turbidity and nutrients;
- increased flood potential due to the silting up of the channel;
- filling of summer pools;
- increased channel width and loss of agricultural land;
- reduced visual amenity and recreational sites associated with the waterways; and
- further loss of native riparian vegetation as severe erosion problems cause subsidence.

6. Management advice

Much of the information in this section is taken from previous river action plans.

Where to start

The main principles for stream foreshore (riparian) management are:

- conserve the best areas first;
- move on to those areas showing signs of recovery; and
- then treat the more degraded parts of the system.

This advice applies to both individual properties and the system as a whole.

It is cost effective to protect areas still retaining native fringing vegetation. These areas are the most stable and the most likely to regenerate naturally. Continued stock access will result in degradation of the fringing vegetation and the need for revegetation. Assisting natural regeneration is a lot cheaper and easier than restoring degraded areas.

Work on the more degraded parts will be easier if upstream areas are in good condition. Erosion and weed infestations impact on areas downstream.

The *Cape to Cape Landcare Companion* (Cape to Cape Catchments Group, 2004) contains excellent advice on planning a restoration and revegetation project. This manual is available free from CCG. This advice and the lessons learnt from the implementation of other river action plans should be applied during the planning and prioritisation of individual on-ground activities. The CCG have staff who can provide individual technical advice.

Stock control

The control of livestock access is the most important management tool in the protection and restoration of waterways and vegetation. Fencing is the best method to achieve this. It can also reduce nutrient input to waterways from manure and urine.

APACE Green Skills & Pen (1997) provide good advice on the placement of fences alongside waterways:

'Ideally, fences should be placed above the river valley (Figure 4). Depending on the steepness of the embankment, the fence should be placed 5 m to 20 m back from the edge of the river valley (Figure 4 A). Five metres is sufficient for a shallow valley a couple of metres deep but a broader zone, greater than ten metres, is required for valleys deeper than five metres. The purpose of fencing off the shoulders of the river is to enable trees on the upper part of the embankment and those above the river valley to anchor the adjacent land, and thereby prevent subsidence.

In the case of shallow river valleys, there is little chance that embankments will subside. Nevertheless, fence-lines should be located above the river valley (Figure 4 B). This is because fences and firebreaks located within the river valley will be damaged and eroded by floodwaters. When they occur, firebreak washouts can be severe and contribute large quantities of sediment to the river system.

If the river valley is particularly broad and floodplains have been cleared for grazing, fencing them off may mean sacrificing good farmland. In this case it is necessary that only those areas that are prone to water erosion or stock damage, such as embankments and secondary river channels which only flow strongly at times of flood, need to be fenced off (Figure 4 C). Some of these fence-lines will be prone to flood damage, but this can be minimised if fences run, as much as possible, parallel to the direction of floodwaters.

In the flatter and broader valleys it may be acceptable to use fences to control the level of grazing rather than to exclude it altogether. A careful watch would need to be kept to ensure that the grazing is sustainable and is not so heavy as to prevent the regeneration of native trees, shrubs and sedges.'

Weed control is vital after excluding stock from a waterway with weeds particularly grasses such as kikuyu and watsonia. A long-term weed management and revegetation plan needs to be developed prior to fencing off riparian land.

Alternative stock watering points and stock crossings may need to be constructed. Information on the design and construction of these can be found in the references below, available from CCG.

Further advice and financial assistance is also available from the CCG.

Useful references on stock control

- Land and Water Australia, *Stock and Waterways: a Managers Guide*.
- Price, P. and Lovett, S. (2002) *Managing Stock*, Fact Sheet 6, Land and Water Australia.
- Water and Rivers Commission Water Note 18, *Livestock Management: Fence Location and Grazing Control*.
- Water and Rivers Commission Water Note 6, *Livestock Management: Construction of Livestock Crossings*.
- Water and Rivers Commission Water Note 7, *Livestock Management: Watering Points and Pumps*.
- Water and Rivers Commission Water Note 19, *Flood Proofing Fencing for Waterways*.

Regeneration and revegetation

In areas that still retain native trees and understorey, natural regeneration is the cheapest and easiest management option. Control of stock access and invasive weeds is essential to achieve this. Natural regeneration can be assisted by making small piles of branches and burning to promote germination through smoke and heat. Smoke water can also be applied to encourage germination. Another technique to assist regeneration involves laying the seed-bearing parts of native plants directly onto the ground, allowing seeds to fall from them. This is called brushing, and works best after weed control measures such as spraying to reduce competition.

Sections of the brook that have been heavily grazed and cleared generally contain more weeds and have a diminished native seed bank. Options for these areas

include: direct seeding; brushing with woody natives that contain seed; pre-seeded matting; and planting of tube stock. The riparian zone should be planted in a wide band with a diverse range of species including trees, shrubs, sedges, rushes, herbs and native grasses. This not only improves the habitat value of the foreshore, but also provides a matrix of different root structures that will improve bank stability and assist in erosion control. Where possible, seed should be collected from nearby as this will ensure that the species used are suitable, local and part of the existing ecological web. Appendix 2 provides a full list of species that were found in the area and Appendix 1 provides a list of species available for revegetation projects. It is recommended that species for revegetation projects in the catchment be selected from this list, choosing plants that are represented in nearby communities. CCG can assist with species selection.

Revegetation techniques

Good site preparation is crucial to successful revegetation. Elements that need to be considered are weed removal; soil amelioration; and preparation of the soil surface for direct seeding or planting. Ongoing pest and weed control will need to be part of the project. Planting and sowing at the right time of year and at the appropriate depth will influence the success of the revegetation effort. Different revegetation techniques are outlined below.

Direct seeding

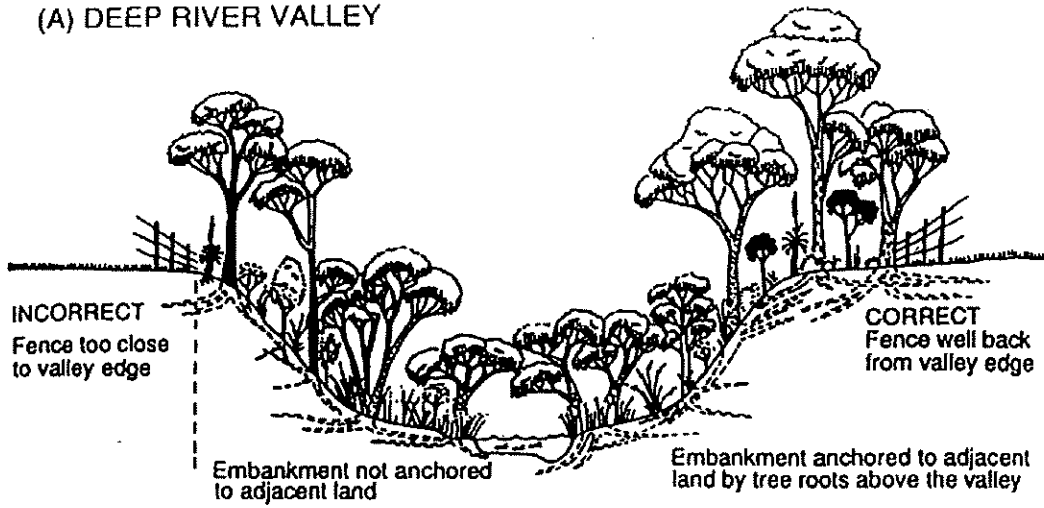
Direct seeding involves placing seeds directly on or into the soil on the site, either by hand or with machinery. For individual farm sized projects a mix of local seeds can be prepared in clean (weed free) sand and sown into lightly cultivated or raked soil. There are some areas on the brook that have potential for the collection of local provenance¹ seed. For more information on direct seeding contact CCG.

Direct seeding has a few distinct advantages over other revegetation methods:

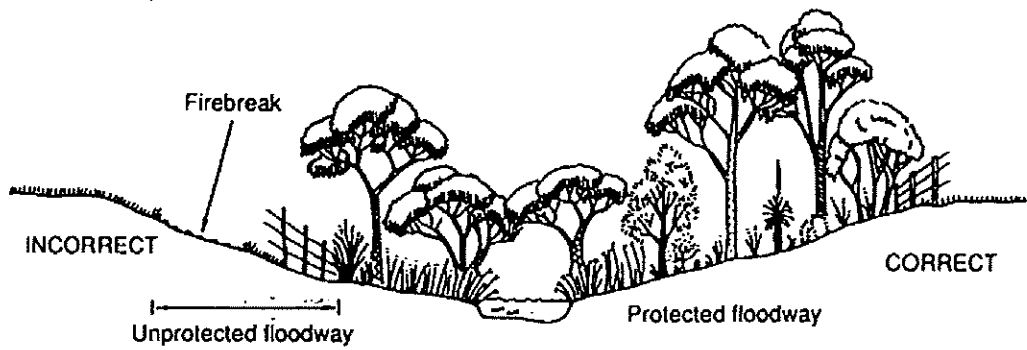
- it is less time consuming and requires less labour than planting tube stock;

¹The term provenance is used to identify the geographic origin of seeds or parent plants. Often genetically distinct local forms or varieties of a plant have evolved to suit a specific range of conditions, including soil, climate and water regimes. Direct seeding with local provenance seed ensures that the resulting plants will be suited to the localised environmental conditions and maintain ecological integrity of existing native plant communities (GeoCatch, 1999).

(A) DEEP RIVER VALLEY



(B) SHALLOW RIVER VALLEY



(C) BROAD RIVER VALLEY

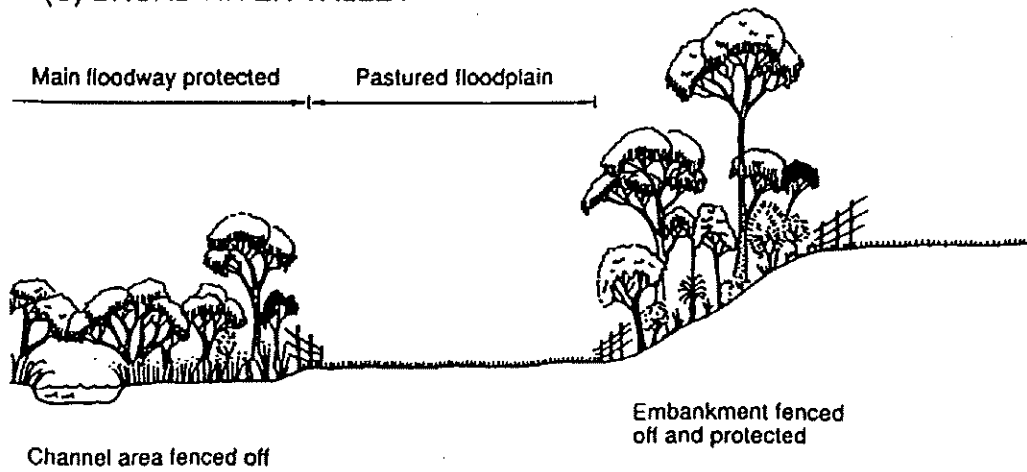


Figure 4: The correct placement of fences in relation to the river valley: (A) the deep river valley, (B) the shallow river valley and (C) the broad river valley with broad floodplain (APACE Green Skills & Pen, 1995).

- a mixture of trees, shrubs, sedges and groundcovers can be planted at the same time, resulting in a plant community with a more natural look, and better resilience due to increased diversity and synergy;
- seeds will germinate over several years, giving a range of ages and growth forms, resulting in a more natural look;
- it is less expensive than using tube stock; and
- the natural root development of seedlings grown from seed usually results in plants developing deeper taproots, requiring less follow-up care.

However, direct seeding can be less reliable than planting, due to predation, specific germination requirements not being met, and poor conditions for direct seeding. Direct seeding may not be possible when high winds or strong water flows are present.

Planting

Planting is an appropriate technique for embankment and in-stream revegetation, and where direct seeding is difficult due to insufficient seed, excessive weed competition, or other factors. In these cases, nursery tube stock is ideally supplied from local provenance seed. A rule of thumb guide for planting densities is 5-6 rushes per 1 m², 1 shrub per 1 m², and 1 tree every 3 m². When selecting plants and designing the revegetation of an area, it is also important to take into account the budget for follow-up management; the availability of water over summer; the range of species available; existing vegetation cover such as tree canopy; soil types; and the intended weed management approach.

Rushes and sedges should be planted in spring, when the water table is beginning to fall and the soil is still moist. Other seedlings should be planted when the surrounding soil is moist and follow-up rain is likely (usually May to July). Care should be taken to ensure that specimens are not root bound, and that minimal damage to the roots occurs when removing from pots. Planting requires significant prior planning, as it is best to collect local seed and contract a nursery to raise them in time for planting in the following wet season. See Appendix 1 for a list of nurseries that grow local native plants for revegetation purposes.

Brushing

Brushing is an excellent technique for all zones apart from the channel bed. This technique can be used to

spread seed and assist with erosion control simultaneously. Brush should be harvested from plants at seed maturity and laid immediately on the revegetation site. Brush along the embankment should be secured in place. Species suitable for this technique are those that retain seed on the plant, but shed it when the plant dries out. This includes many of the myrtaceous species (peppermints, tea trees, Melaleucas, and Eucalypts such as marri, jarrah and blackbutt). Brushing is easy to combine with other revegetation activities such as direct seeding and planting of tube stock, and provides shelter to seedlings, increasing seedling survival rates.

Pre-seeded matting

Pre-seeded matting involves sowing seeds onto appropriate fibre mulch, and laying the mat on-site in early winter after germination. This technique is excellent for steep embankments, since it provides erosion control and revegetation in a single step. It is generally only suitable for seeding with rushes and sedges, since matting usually requires rolling for transport to the site. It can be difficult to source matting with seeds of local provenance.

Division and transplanting of rushes and sedges

Many rushes and sedges propagate very well by vegetative division – plants can be easily split into individual plants (ramets) every two months or so under good conditions. With planning the prior year and a small initial outlay, a large number of these difficult to propagate (from seed) species can be raised by division. Plant salvaging from development sites or other areas where local native plants are to be removed is a great use of these plants.

Useful references on natural regeneration and revegetation

- Bradley, J. (1988) *Bringing Back the Bush: The Bradley Method of Bush Regeneration*. Lansdowne Press, Sydney.
- Buchanan, R.A. (1989) *Bush Regeneration: Recovering Australian Landscapes*. TAFE Open Training and Education Network, Strathfield, NSW.
- Ralph, M. (1994) *Seed Collection of Australian Native Plants*. Murray Ralph, Fitzroy.
- Scheltema, M. (1993) *Direct Seeding of Trees and Shrubs*. Greening Western Australia, Perth.

- Water and Rivers Commission (1999) *Revegetation: Revegetating Riparian Zones in South-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR4.
- Water and Rivers Commission (1999) *Revegetation: Case Studies from South-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR5.
- Water and Rivers Commission (1999) *Using Rushes and Sedges in Revegetation of Wetland Areas in the South-west of WA*. Water and Rivers Commission River Restoration Report No. RR8.
- Water and Rivers Commission (2000) Water Note 20, *Rushes and Sedges*.
- Geographe Catchment Council (2004) *Geographe Catchment Companion*.
- Cape to Cape Catchments Group (2004) *Cape to Cape Landcare Companion*.

Weed control

Weed invasion is a major threat to native vegetation along Wilyabrup Brook, and in the catchment as a whole. Fencing the brook and restricting stock access will result in the need for extra weed control. This is also evident in vineyards and lifestyle properties where stock are not present. Bulbous weeds and grasses in particular should be controlled in ungrazed situations as they will spread into bushland and potentially vineyards.

Control of declared and environmental weeds should be a priority in the Wilyabrup catchment and will need to be undertaken in a coordinated way and involving a range of techniques.

In foreshore areas, removal or control of weeds must take account of the erosive power of water. Clearing weeds in an unplanned manner could result in erosion in the stream channel. To stabilise areas where weeds have been removed, techniques such as laying jute matting and brushing can be used.

Weed control principles to keep in mind include:

- Weeds thrive in disturbed areas and on bare ground.
- If weed control is carried out, revegetate to prevent further weed invasion in the bare soil.
- Fire promotes weeds. Burning remnant bushland that is weed infested can make the weeds worse, unless there is follow-up weed control and revegetation. Native plants cannot compete with the

rapid regrowth of weeds, which then become a greater fire hazard.

- Aggressive perennial weeds that spread readily along riparian corridors should be a priority for eradication, for example, arum lily, bridal creeper, blackberry, and watsonia.
- Some native plants look and act like weeds. Do not begin weed control until you are sure a plant is a weed.

Chemical control of weeds on waterways requires careful consideration. It is vital to consider the effects of the herbicides on native flora and fauna, and on water quality. If you decide to use a herbicide, choose one that has a modified surfactant to reduce impact in waterways and wetlands, such as Roundup® Biactive or equivalent.

Specific notes on certain weeds

A number of declared and environmental weeds were found in the study area. According to legislation, declared plants need to be controlled or contained depending on their status, and reported to the local Agricultural Protection Officer. More information on the requirements for control and treatment is available from the DAFWA.

Information on the key declared (DP) and environmental weeds in the catchment is provided below. This is sourced from *Southern Weeds and Their Control* (Moore & Wheeler, 2002), *Bushland Weeds: A Practical Guide to their Management* (Brown & Brooks, 2002), and *Declared Plants Handbook: Recommendations for the Control of Declared Plants in Western Australia* (Department of Agriculture, 2002).

Southern Weeds is a useful guide to landholders in the south-west and provides information on weed identification and control. Many recommended control methods in this guide should not harm native vegetation. It is available from Department of Agriculture offices. Also useful for weed identification is *Western Weeds* (Hussey *et al.*, 1997).

Apple of Sodom *Solanum linnaenum* DP

An erect perennial shrub with deeply lobed prickly leaves, and prickly stems and branches. It has purple star shaped flowers often throughout the year and the fruits are bright yellow when mature. Introduced from South Africa, it is a serious problem in parts of the

south-west, especially in grazed paddocks and creeklines. Small plants may be grubbed out, however all root fragments must be removed. Chemical control using a 1:80 solution of Amitrole plus wetting agent is most effective.

Arum lily *Zantedeschia aethiopica* DP

A tufting perennial with dark green, shiny leaves arising from a tuberous root. Easily recognised by large white 'flower' with a central yellow column of minute male and female flowers. Toxic to stock. Berries are spread by birds and along watercourses. A serious threat to riparian vegetation. Slashing, if undertaken regularly (at least three times per season) over a long period, may be effective but is very time and labour intensive. Chemical control with low rates (0.4 grams per 10 L of water) of Chlorsulfuron as flowers emerge is most effective. Little effect will be noticeable immediately, however the following year very few plants will come up. Glyphosate is not an effective control. Blanket or hockey stick wipers should be used near waterways to prevent spray drift or runoff. In areas with very dense infestations, multiple applications will be required to ensure any new seedlings are controlled.

Blackberry *Rubus* spp. DP

A perennial plant with arching prickly stems (canes) that was introduced from Europe as a fruit crop. Highly invasive, especially along creeklines. Mechanical control is difficult except for small infestations. Care must be taken to ensure that all root material is removed. Herbicide control is most effective, with mixtures of metsulfuron and glyphosate in summer. In areas where there is good native vegetation use only metsulfuron. It can take up to 12 months for the chemical to take full effect. Further research is currently underway to develop effective biological controls.

Bridal creeper *Asparagus asparagoides*

A perennial climber with wiry stems that was introduced from South Africa as a garden plant. It is extremely invasive and spreads very rapidly, eventually smothering native vegetation. A variety of new bio-control methods seem to be having good results in the area. The 'rust' (fungus) is very effective and is available for release. Contact CCG for more information and release locations. Due to the nature of biological controls, the

rust will never eradicate bridal creeper, it will just make it manageable. Once manageable, herbicide can be used to eradicate it such as wiping individual stems with a 1:2 glyphosate solution as they emerge or very low rates of metsulphuron with wetting agent.

Weedy or non-local rushes including budding club rush (*Isolepis prolifera*), *Juncus microcephalus* and *Cyperus* spp.

These are introduced rushes from South Africa. *Isolepis prolifera* is a pale green fleshy short (to 50 cm) perennial that often reproduces by forming new plants (budding) at the end of a stem. *Juncus microcephalus* is a robust rush growing to 1.2 m with flowers in dense upright clusters and leaves divided by traverse (horizontal) partitions. *Cyperus* spp. form grass-like clumps and have triangular stems bearing umbrella-like inflorescences. They all thrive in disturbed damp areas and can become a problem, restricting flow and accumulating sediment. Manual control (removal) is best. Herbicides are not generally suitable unless the plants grow in areas that dry up in summer. In this case glyphosate is recommended.

Typha Typha orientalis

A perennial emergent aquatic plant, native to the Eastern States and Asia, up to 4 metres tall. Manual control through slashing in late summer and then drowning can be very effective, as can cutting the stem 15 cm below the waterline 2-3 times a year, including at flowering. Chemical control needs to be very carefully executed as the potential for runoff or drift into the water is very high. Glyphosate with a modified surfactant could be used in late spring to summer. Treating new growth after slashing is a good option.

Edible fig *Ficus carica*

A large tree with distinctive lobed leaves and fleshy fruit. A garden escapee that tolerates damp conditions. Takes root readily from cuttings and root fragments, with birds and animals also dispersing seeds. Hand pull seedlings or inject larger specimens with 50-100% glyphosate in summer. Can be treated with the cut and paint method, however all branches, twigs and fruit must be removed and burnt.

Kikuyu (*Pennisetum clandestinum*), buffalo grass (*Stenotaphrum secundatum*) and couch (*Cynodon dactylon*)

These perennial introduced grasses all spread from runners or rhizomes and are very invasive. Manual control (except large scale scalping) is not effective. A spray-burn-spray regime using glyphosate appears to work well. In areas where water levels recede (allowing herbicide and fire use) it is best to spray in late spring or early summer when the grass is actively growing and respray when new shoots emerge. Where native vegetation is present it is best to use a grass selective herbicide for example Fusilade®.

Deciduous trees and other woody weeds

Woody weeds and deciduous species like willows and poplars can be controlled using stem injection or cut and paint with undiluted glyphosate. To stem inject, holes should be drilled around the trunk and spaced no more than 5 cm apart into the sapwood (just beyond the bark, but not into the heartwood) and herbicide injected immediately. The tree may take up to 3 months to die and can then be felled or left as habitat. To cut and paint, the tree should be felled with a chainsaw as close to the ground as possible and painted immediately with undiluted herbicide. All material must be removed and monitoring for suckers should continue for at least 2 years.

Watsonia (*Watsonia* sp.), gladioli (*Gladiolus* sp.) and African cornflag (*Chasmanthe floribunda*)

These have been grouped together as growth form and control methods are similar. All are tufted bulbous species from South Africa with erect sword shaped leaves, and tall spike-like white, pink, yellow or orange flowering stems. Manual control (digging out) of African cornflag and watsonia can be effective in small areas but is very labour intensive and requires many years of follow-up. Manual control of wavy gladioli should not be attempted as numerous cormels will break off and cause a more severe problem than before. Spraying with glyphosate or 2,2-DPA just prior to flowering gives best results. In sensitive areas, using a sponge glove or a hockey stick wiper is best.

Pennyroyal *Mentha pulegium*

A slightly succulent rhizomatous perennial that favours damp conditions such as along paddock drains and

creeklines. Has a strong mint-like smell when crushed. Chemical control using high rates of glyphosate when actively growing is effective. Caution should be used when applying glyphosate near waterways. Spray when flows have receded or stopped.

More information on weed control is available from the Department of Agriculture and Food or CCG.

Useful references for weed identification and methods of control

Brown, K. & Brooks, K. (2002) *Bushland Weeds: A Practical Guide to their Management with Case Studies from the Swan Coastal Plain and Beyond*. Environmental Weeds Action Network, Greenwood, Western Australia.

Department of Agriculture (1999) *Wetlands not Weedlands*. Weed Note No. 1/99, Department of Agriculture, Perth, Western Australia.

Department of Agriculture (2002). *Declared Plants Handbook: Recommendations for the Control of Declared Plants in Western Australia*.

Dixon, B. & Keighery, G. (1995) 'Suggested methods to control weeds'. In: *Managing Perth's Bushlands*, Scheltema, M. & Harris, J. (eds). Greening Western Australia, Perth, WA.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. & Lloyd, S.G. (1997) *Western Weeds: A Guide to the Weeds of Western Australia*. Plant Protection Society of Western Australia, Victoria Park, Western Australia.

Hussey, B.M.J. & Wallace, K.J. (1993) *Managing Your Bushland*. Department of Conservation and Land Management, Como, Western Australia.

Moore, J. and Wheeler, J. (2002) *Southern Weeds and Their Control*. Department of Agriculture, Bulletin No. 4558. Perth, Western Australia.

Water and Rivers Commission River Restoration Report No. RR4, *Revegetation: Revegetating Riparian Zones in South-west Western Australia*.

Water and Rivers Commission Water Note 22, *Herbicide Use in Wetlands*.

Water and Rivers Commission Water Note 15, *Weeds in Waterways*.

Water and Rivers Commission Water Note 25, *Effects and Management of Deciduous Trees on Waterways*.

Dam management and environmental flows

Good dam management can reduce the potential impacts of gully-wall dams on seasonal streams and protect water quality in dams. Some good dam management practices include:

- The correct use of low-flow or bypass valve. The valve should be opened at the start of the season (as soon as water is flowing into the dam). The dam will still fill over the winter months, and once it is full to overflowing, the bypass valve can be closed. This ensures that the riparian ecosystem downstream of the dam receives water when it is meant to. Any salt or sediment that has built up in the dam over summer will safely be diluted by the rest of the flows.
- Setting up a siphon system if an existing dam does not have a bypass valve installed. A length of piping can be laid over the top of the dam wall extending into the deepest part of the dam (secured via a weight) and down the dam wall past the level of lowest water depth. A tap can be placed at the end of the pipe and it can be turned on and off as required. If the tap is turned off (but the pipe left in place) once the dam has overflowed, water will be retained in the pipe and there will be no need to prime the siphon in subsequent years.
- Revegetation of dam banks to create a healthy and diverse ecosystem. Not only will fringing vegetation around a dam clean the water and provide habitat to aquatic organisms such as marron and native fish, it may add considerable value to the property as vegetated dams are aesthetically pleasing. Dam walls should not be planted with trees as their roots may undermine the structural integrity. They can be safely planted however with a variety of rushes, sedges, groundcovers and shrubs. The same species should be planted on the edges and dam entry point, with the addition of local native trees.
- Fencing if stock is present on the property to protect water quality and prevent stock damaging vegetation. A corner of the dam can be left unfenced for stock access to water.
- Use only local native fish and crustacean species if stocking dams. Local fish and crustacean species are

mentioned in Section 2. Avoid stocking dams with introduced species such as yabbie, red-fin perch, trout and gambusia (mosquito fish). These introduced species out-compete local fish and crustaceans as they prey on them and reproduce more vigorously.

- When constructing new gully-wall dams consider a spillway design that allows fish passage. Most gully-wall dams and weirs are barriers to fish movement and migration.

Further work is required to determine the extent of barriers to fish passage in the catchment and the feasibility of constructing fishways. Restocking areas where native fish are no longer present may be an option.

Investigation is required to determine the ecological impacts of altered timing and quantity of flows and water table changes. The EWR study will enhance knowledge of flows in the brook. The DoW should work closely with the Shires in the assessment of dam applications as the cumulative impact of dams on small tributaries is currently not addressed.

Water quality

Waterways in rural areas receive a range of contaminants. These include soil particles, nutrients such as nitrogen and phosphorous, plant material and chemicals. Many contaminants such as manure and deciduous leaves enter waterways by surface runoff. Dissolved nutrients and other materials can move through the soil in underground flows and enter waterways.

The Wilyabrup Brook community expressed concern about possible chemical pollution in the brook due the spraying of herbicides, pesticides and fungicides in vineyards. Further water quality monitoring is required to determine if chemical levels in the brook are of concern. Testing should be carried out when spraying is occurring in the catchment. Specific management advice for chemical use can be found in the next section.

Ongoing monitoring is also required to monitor trends in all water quality parameters.

Outlined below are a number of ways protect water quality.

Vegetative buffers

Vegetated buffers alongside waterways can intercept and slow runoff and thereby trap suspended sediment, including organic material and chemicals attached to soil particles. Research has shown that vegetative buffers 10-50 m wide can achieve phosphorus and nitrogen filtration rates in the order of 50-100% (Pen, 1999). A vegetative buffer need not be of native vegetation and can be a simple grassy strip that is fenced off to control grazing if stock are present. The nutrients assimilated by the vegetation can be utilised by crash grazing or preferably in hay production since the latter does not involve livestock returning nutrients to the grassy border as urine and manure.

Vegetation within the waterway itself forms a longitudinal buffer which, similarly, slows the flow rate, reduces erosion and traps soil, sediment and organic matter.

Soil erosion

Erosion is a natural process but some land management practices can significantly increase the rate at which it occurs. To minimise soil erosion ensure some form of surface cover is retained and soil disturbance is minimal. This is especially important during times of high erosion risk and in particular places, for example wind prone areas. Some practices which aim to minimise soil erosion include:

- The use of crop and pasture rotations or cover crops in vineyards including perennial grasses and legumes;
- Planting of windbreaks. Windbreaks reduce the loss of topsoil, increase productivity of pastures and vineyards and offer shelter for stock.
- Appropriate stocking rates and stock rotations; and
- Cultivation along the contours, rather than at right angles to them. This will slow the rate at which water flows across the land, reducing soil erosion by as much as 50% (Pen, 1999).

Fertiliser management

After a number of years of fertiliser application, many soils are rich in nutrients but may be deficient in a few trace elements (Pen, 1999). Soil testing and tissue sampling should be undertaken to determine fertiliser requirements and avoid excess application of nutrients.

A portion of excess fertiliser will find its way into waterways and dams and can cause algal growth. For information on fertiliser management programs please contact CCG.

The timing and application of fertiliser also impact on the level of nutrients reaching waterways. Where possible fertiliser should not be applied when high runoff is expected.

A number of properties, particularly vineyards, in the catchment and the region are using organic and biodynamic practices to improve soil health, with an ultimate goal of reducing fertiliser, herbicide and pesticide use whilst maintaining or improving yields. For more information contact the Department of Agriculture.

Managing stock access

Uncontrolled stock access to riparian areas contributes significantly to the amount of sediment and nutrients entering waterways. Stock bare the soil, create tracks and destabilise banks, increasing erosion. They also directly input nutrients into waterways through urine and manure. Please refer to the management advice on stock control earlier in this section.

Useful references for protecting water quality through farming practices

- Price, P. and Lovett, S. (2002) *Improving Water Quality*. Land and Water Australia, Canberra.
- Prosser, I., Karssies, L., Ogden, R. & Hairsine, P. (1999) 'Using buffers to reduce sediment and nutrient delivery to streams'. In: *Riparian Land Management Technical Guidelines: Volume Two: On-ground Management Tools and Techniques*, Price, P. & Lovett, S. (eds). LWRRDC, Canberra.
- Department of Agriculture, Farmnote 69/2002, *Soil Testing: a Guide to Fertiliser Use*.

Chemical use

As we do not know enough about the impact of chemicals on water quality and biodiversity it is best to take precautions when spraying. Chemical contamination can be caused by the off-target and off-site movement of agricultural chemicals. This can occur directly (e.g. via spray drift) or indirectly (e.g. via erosion or runoff).

Sensitive areas such as bushland, waterways or residential properties, should be buffered from chemical spray drift. The buffer zone can take the form of a vegetative barrier, which can capture and/or filter drifting spray droplets thereby protecting the sensitive area. To be effective the vegetative buffer needs to:

- be a row of trees, tall grass or bushes;
- be taller than the crop or the spray unit being used;
- have foliage thin enough to see through (50% porosity); and
- have long, thin, rough foliage.

Consideration should be given to the other potential benefits of planting native vegetation around vineyards or grazing properties. For example native vegetation can attract and harbour beneficial insects and birds.

Chemicals need to be applied with care to ensure the off-target impacts are avoided and to ensure that the pest is controlled effectively. The weather conditions must always be considered before applying any chemicals, as they can have an effect on not only the performance of the spray, but also on the potential for environmental contamination.

The following are some useful tips for reducing off target impacts:

- make sure that the correct rate of chemical is applied, to optimise the efficiency of each spray and to minimise the need for repeat sprays;
- near water bodies apply herbicides before water levels have risen or after they have receded;
- where possible, wipe or inject weeds with herbicide instead of spraying;
- avoid using surfactants near water bodies;
- if the chemical is being applied directly to the soil (e.g. for weed control) particular consideration needs to be given to the and the timing of the application, as these chemicals can be more susceptible to leaching;
- avoid using volatile chemicals in hot weather;
- take measures to prevent soil erosion and surface runoff (e.g. cover cropping); and
- where possible spray with a light crosswind working upwind towards the unsprayed area of the crop.

Useful references for chemical application best practice

- CRC for Australian weed management (2005) *Herbicides: guidelines for use in and around water.*
- Department of Primary Industries, Water and the Environment Tasmania *Guideline for safe and effective use of herbicide near water.*
- WRC *et al.* (2002) *Environmental Management Guidelines for Vineyards.*
- Water and Rivers Commission Water Note 22, *Herbicide Use in Wetlands.*

Erosion control

Erosion is not a major problem on the Wilyabrup Brook although incision, undercutting and bank slumpage is occurring some areas where native vegetation has been removed. The cohesive soils and presence of rock in the main channel has protected much of the brook from serious erosion.

It should be noted that planning is required to address eroding sites. A detailed river geometry survey and a variety of calculations are necessary for the correct design of engineering works. It is also important to remember that streams are part of a dynamic system, that is they are in a constant state of change. Care should therefore be taken when attempting to predict the outcome of alterations to channel form and capacity. Site-specific technical advice including detailed stream surveys should be completed prior to commencing any form of physical modification to the stream channel. The CCG and engineers from the DoW can provide technical support.

A number of approaches to erosion control as outlined in the Capel River Action Plan by Kirrily White and Sarah Comer (GeoCatch, 1999) are discussed below.

Point bars

Once a river bank becomes disturbed to the point where it is actively eroding, there is large potential for this to create further erosion downstream through the formation of point bars. Currents remove material from the outside banks of meanders and deposit it on the inside banks where water moves more slowly, forming a point bar (Raine & Gardiner, 1995). Over time these sand bars trap more sediment and continue to accumulate, to a point where they may even start to support in-channel vegetation growth. Some point bars

are located and shaped in such a way that they actually divert the stream flow onto the opposite bank further downstream, thus creating a new erosion point on the next outside bend. This cycle of erosion and deposition often continues downstream, and is a classic sign of a stream in which the hydrological balance has been disturbed (Figure 5).

Removal of point bars may sometimes be needed in order to halt the progression of the erosion downstream. Generally, this should be undertaken in conjunction with other forms of restoration and care must be taken not to exacerbate the disturbance to the stream channel. As discussed previously, detailed stream surveys of the problem areas is essential before this type of restoration procedure should be contemplated.

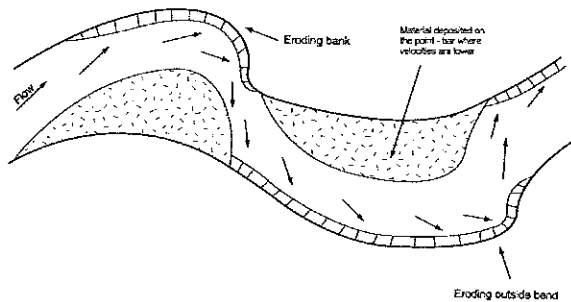


Figure 5: Outside bend bank erosion – Arrows mark the direction of flow showing that outside bends have the greatest erosion potential, so the meanders migrate downstream (Raine & Gardiner, 1995).

Undercutting

Undercutting often occurs in conjunction with the formation of point bars. Material is scoured from the toe of the bank, resulting in loss of bank support; this often results in subsidence as illustrated in Figure 6 (Raine & Gardiner, 1995). Previous experience has shown that supporting and protecting the toe of the bank can

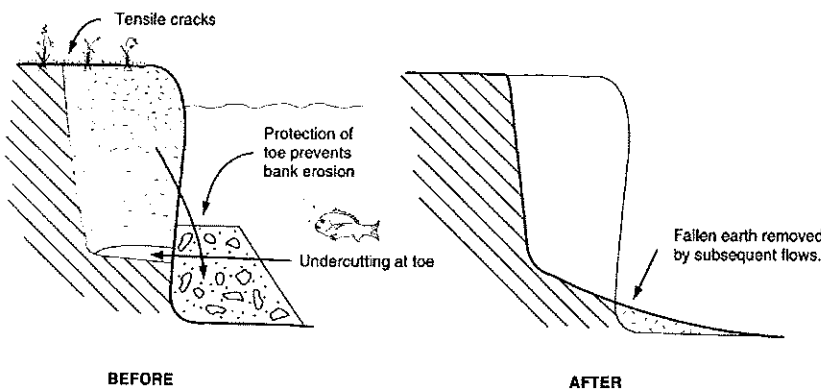


Figure 6: The use of structural works, such as a rock toe, will prevent the process of undercutting (adapted from Raine & Gardiner, 1995).

prevent undercutting. Generally undercutting will occur where there is a meander. If this is the case, only the outside bends need to be supported as the flow velocity on the inside bend is much lower. Once an outside bend is stabilised, the corresponding inside bend will usually adjust its width to cater for the change in flow.

Bank slumping

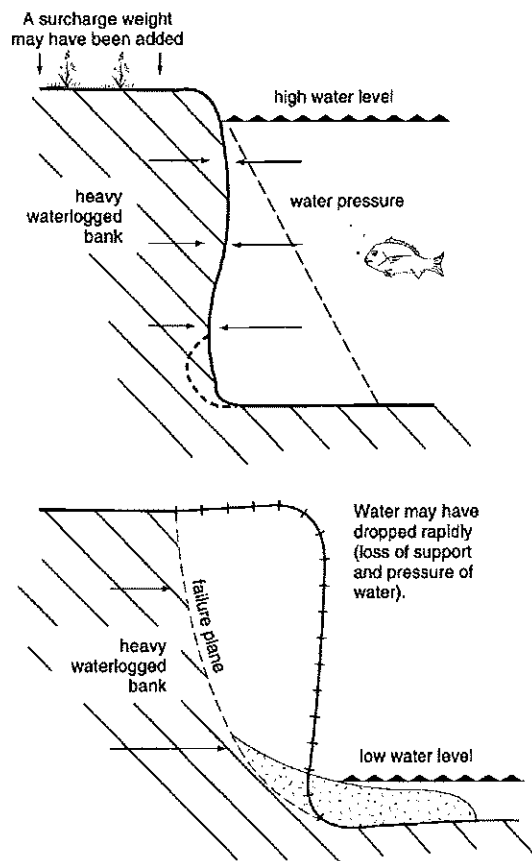


Figure 7: The process of bank slumping caused by excessive weight and lack of support (adapted from Raine & Gardiner, 1995).

Bank slumping can occur when poorly drained material within the bank becomes heavy with saturation and collapses into the stream channel (Figure 7). This can occur with or without prior undercutting. It will often occur in response to the loss of native deep-rooted riparian vegetation which is critical to bank stability. The best ways to manage this problem are to exclude stock with fencing set well back from the

stream channel, and revegetate the foreshore with suitable species. Raine and Gardiner (1995) provide the following advice on this process:

- replant the toe with species that can withstand high flow velocities (e.g. native sedges). This replanting should be dense with spaces between plantings of less than 1 metre;
- replant the middle to upper bank areas with fast growing, deep-rooted trees and large shrubs. These will hold the bank together, enhance drainage and remove excess moisture through transpiration;
- vary the species that are planted to ensure differing root structures; and
- extend plantings from the toe to the floodplain. If a narrow band of trees is planted, this may serve only to add to the weight of the bank without providing the necessary network of root support.

Large woody debris

Snags, or large woody debris, are natural components of the stream system. They play an important role in stream ecology by providing a range of flow conditions within the channel and habitat for aquatic life forms. Occasionally snags can divert the flow onto the bank and subsequently cause erosion in areas lacking support from native vegetation. While de-snagging rivers has been a common practice in the past, the current management emphasis is to leave as much woody debris as possible. Rather than removing large woody debris from the channel, it should be repositioned at an angle of 20° to 40° to the stream bank (Figure 8). This action will minimise the effect of the snag on flow levels and direction, whilst maintaining the habitat available for plants and animals that benefit from low flow conditions. Large woody debris can also be added to deflect flows from unstable areas.

Repositioning LWD

The capacity of a river channel can be improved by rotating the LWD at an angle of 20° – 40° to the streambank.

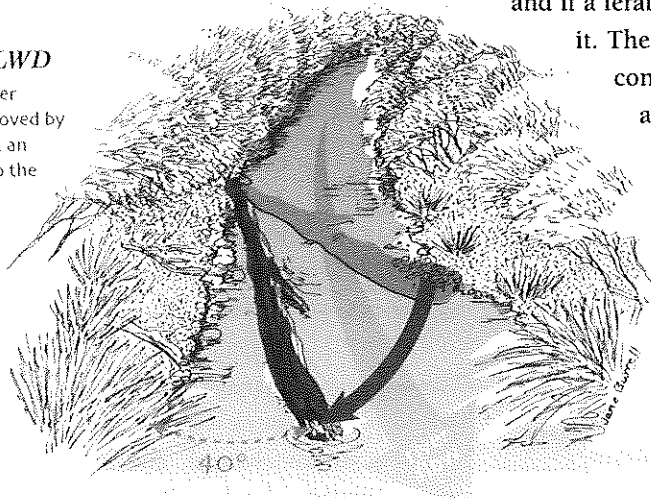


Figure 8: Repositioning large woody debris (Gippel et al., 1998).

Useful references on erosion control

- Pen, L.J. (1999) *Managing Our Rivers*. Water and Rivers Commission, Perth.
- Price, P. and Lovett, S. (2002), *Streambank Stability*, Fact Sheet 2, Land and Water Australia.
- Rutherford, Marsh, Price and Lovett, (2002) *Managing Woody Debris in Rivers*, Fact Sheet 7, Land and Water Australia.
- Water and Rivers Commission (2001) *Stream Stabilisation*. River Restoration Report No. RR 10.

Feral animal control

Rabbits were evident in the catchment and in some areas near the brook. Rabbits severely damage native vegetation, hindering regeneration and revegetation, and can cause localised erosion. Landholders and managers are encouraged to control rabbits through baiting, shooting, fumigation and destruction of warrens.

The value to native fauna of vegetated corridors along the brook is undermined by the presence of foxes and feral cats. Landholders were concerned that foxes and feral cats preyed on native fauna which has limited habitat options in the area. Baiting and shooting can control foxes. Feral cats are more difficult to control, although some success has been had with wire traps baited with sardines, and shooting. The effectiveness of fox and feral cat control is greatly improved if undertaken on a large scale, involving as many landholders as possible.

The Shire of Busselton has cat traps available for loan and if a feral cat is captured the Shire can dispose of it. The AMRSC has an ongoing Shire-wide fox control program for local landholders. For advice and assistance on feral animal control contact DAFWA, CCG, SoB or AMRSC.

7. River foreshore condition and recommendations for management

Using the maps

The following page provides an index for the individual maps, and an overview of the condition of Wilyabrup Brook. For a summary of the condition rating and percentage of Wilyabrup Brook that needs to be fenced to exclude stock, please see Table 1 and Table 2 in Summary.

Maps 1 to 16 show the entire Wilyabrup Brook catchment, the main channel and tributaries, and adjoining land titles.

The maps show the foreshore condition of the brook as assessed using the Pen-Scott method (see Section 4 for details of the method of assessment). Fencing status, weeds and management issues are also shown. A foldout legend is provided.

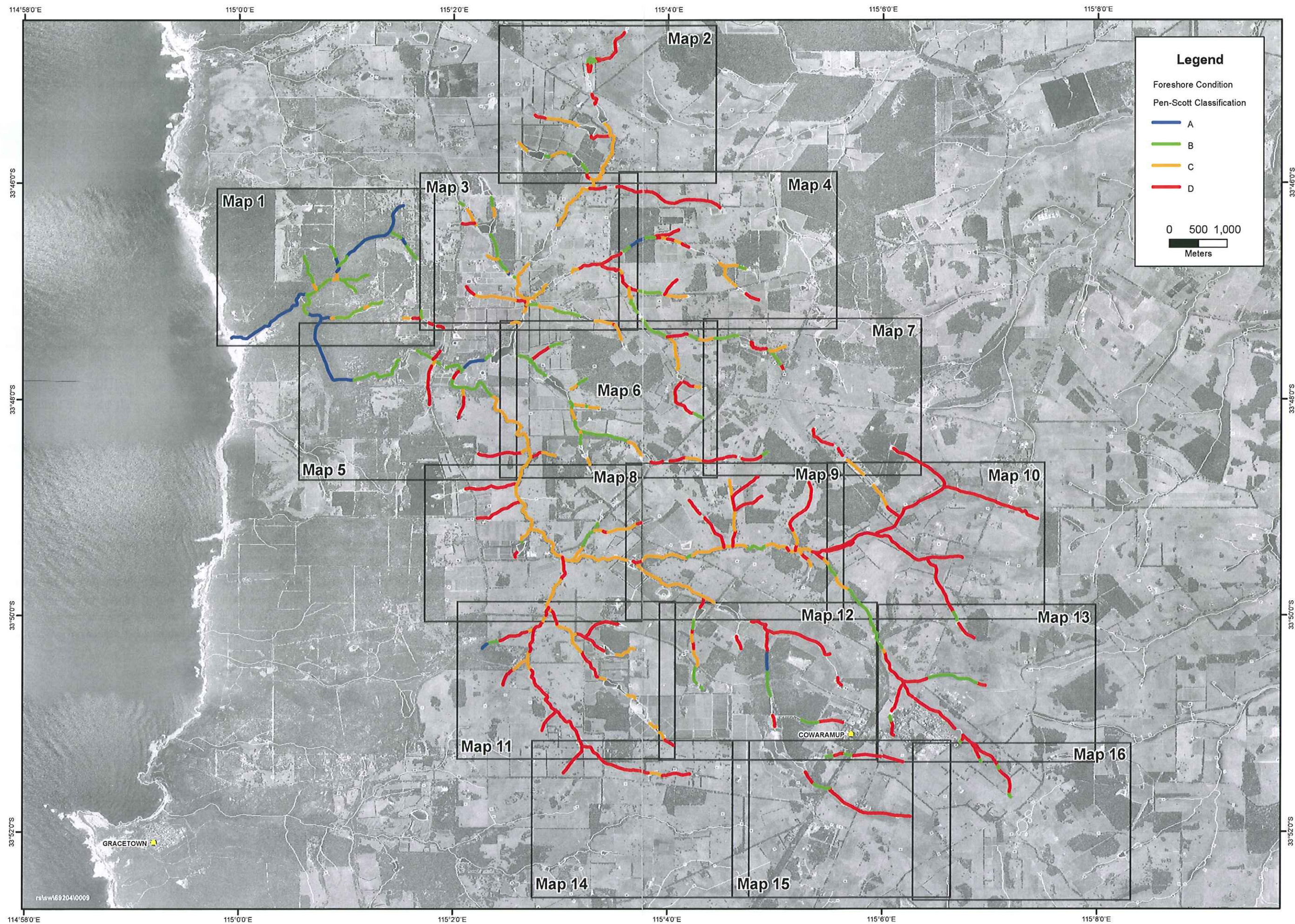
The background aerial photos of the maps were taken in 2003.

Management recommendations

The notes accompanying each map contain background information and management recommendations.

A set of catchment-wide priority actions is provided in Section 8.

These priority actions should be considered alongside the specific recommendations listed for each map. Prior to actions being undertaken, consultation should occur with stakeholders and relevant agencies, such as CCG, the Department of Environment and Conservation, Department of Water, the Shires of Busselton and Augusta-Margaret River and Department of Indigenous Affairs, the South West Aboriginal Land and Sea Council (SWALSC) and local elders.



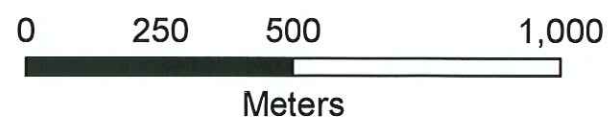
Wilyabrup Brook Index Map

Legend

Foreshore Condition

Pen-Scott (LBDS) Classification

- A1
- A2
- A3
- B1
- B2
- B3
- C1
- C2
- C3
- D1
- D2
- D3
- Dam
- Fencing linework
- Bridge
- Crossing



Map 1

Map 1 shows Wilyabrup Brook flowing west and entering the ocean, through predominantly private land, and a small section of national park.

Issues	Comments
Land use and fencing	No locations on this map have stock, and no sections of the brook are fenced. The main land use is conservation and lifestyle with viticulture starting in the south-east corner of the map.
Landform, soils and erosion	The main channel in this area is very rocky with steep rock gorges. The valley is quite steep, especially the right (northern) bank. The tributaries are also steep but the soil type is dominated by grey and white sands with patches of granite outcrops.
Native vegetation	The estuary consists of low Melaleuca heath, <i>Juncus kraussii</i> , <i>Baumea</i> and <i>Lepidosperma</i> spp. Upstream is generally marri, peppermint, wonnich forest with a mix of rushes and sedges. On the steep rock gorges a heathland of <i>Darwinia citriodora</i> is dominant. There is excellent native vegetation in this area. The tributaries have lost some understorey diversity due to past grazing.
Weeds	The key weeds in this section include arum lily, cyperus, wavy gladiolus, cape tulip and grasses. There are small areas heavily infested with arum. Arum lily has been controlled on Loc 346 for a number of years.
Other comments, special features	Arum lily is starting to appear in pristine areas in this section of the brook. It has also started to appear in the coastal dunes.

Map 1: Management recommendations and advice

- Weed control programs need to be developed and continued. Arum lily is a priority on most locations to protect the excellent remnant vegetation. Infestations of arum lily are light on Loc 350 and Lots 41, 42, 43, 12 and 2. Heavier infestations are found on Loc 346 and Lot 7.
- Assist regeneration of native vegetation and expand the riparian zone through minimising weed invasion. In areas where regeneration has not occurred for many years such as areas of Lot 42 and 43 consider planting a variety of understorey species, including rushes and sedges, or actively promote regeneration through brushing or making small heaps of leaves and twigs and burning. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information.
- Development on private land should be sensitive to the pristine nature of this area.

Map 2

Map 2 shows a number of tributaries running south, primarily through viticultural land.

Issues	Comments
Land use and fencing	The primary land use is viticulture. Most locations have a gully-wall dam. Loc 2883, 11 and 1 are not fenced and are grazed by cattle.
Landform, soils, and erosion	The area has been highly modified through clearing and gully-wall dams. This is the northern headwaters of the brook. The tributaries begin as broad poorly drained wet flats then become loamy gravel vales. This is part of the Cowaramup Uplands system. There is minor erosion on the channel on Lot 1 and Lot 30. Lot 1 also has an eroded spillway.
Native vegetation	The native riparian vegetation has primarily been cleared or degraded by stock. Dominant remaining species include peppermint (<i>Agonis flexuosa</i>), marri (<i>Corymbia calophylla</i>) and tea tree (<i>Taxandria linearfolia</i>).
Weeds	The main weeds of concern in this section are blackberry, arum lily, apple of sodom, and tagasaste. Other weeds include giant reed, typha, dolichos pea, pennyroyal, bridal creeper, <i>Isolepis prolifera</i> and <i>Juncus microcephalus</i> . There are severe blackberry infestations in Lot 61 and 2 and minor infestations on Lot 2878, 3, 11, 12, 1 and 60. The infestations were sprayed on all locations this year apart from Lot 2.
Other comments, special features	Lot 2, 11, 12 and Loc 2883 were not assessed, they were rated from neighbouring properties and aerial photos. The SoB currently considering a development application for Loc 2883 for two gully-wall dams and chalets.

Map 2: Management recommendations and advice

- Where stock are present, fence off the creek to restrict stock access, and provide water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry, arum and apple of sodom as a priority. Bridal creeper on Loc 1670 and Lot 3 should also be controlled as a priority.
- Assist regeneration of native vegetation and expand the riparian zone on the stream and dams through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, planting a variety of understorey species, including rushes and sedges, is a priority in degraded areas and around dams. This will assist in protecting water quality, preventing erosion and providing habitat.
- Implement erosion control measures on the dam spillway on Lot 1.
- The SoB is encouraged to ensure new dams comply with revegetation conditions.
- The cumulative impact of gully-wall dams on tributaries needs further investigation and consideration when approving dam applications.

Map 3

Map 3 shows a number of tributaries coming together from the north, east and west.

Issues	Comments
Land use and fencing	The primary land uses are viticulture and grazing. Loc 1670 is a dairy property. Loc 1677 and 1671 are beef grazing properties and Loc 2680 has a small number of sheep grazing. All stocked properties are unfenced. The remainder of the locations are vineyards.
Landform, soils and erosion	In this section the tributaries move from Cowaramup Uplands system in the north to the Wilyabrup Valleys system. The northern parts of the tributaries are generally loamy gravel. As the tributaries approach Metricup Rd, the valley becomes much steeper with exposed rock in the valley and bed. The spillway on Loc 1127 appeared to have eroded. The tributary running through Loc 1677 is eroding through a section of Wilyabrup fertile flats exposing the red-brown loam soil.
Native vegetation	The vegetation has been degraded on most locations from clearing and grazing. There is still a peppermint overstorey on most locations. Where vegetation is intact it is mainly marri, blackbutt, jarrah and peppermint over tea tree and <i>Lepidosperma tetraquetrem</i> , <i>Baumea</i> spp. and <i>Juncus pallidus</i> .
Weeds	The main weeds of concern in this section are fig trees, arum lily, grapevines, watsonia, typha and wavy gladiolus. Loc 1670 has a heavy blackberry infestation and bridal creeper. Bamboo spp. were removed from Lot 1 this year and will be monitored. <i>Kikuyu</i> , <i>Isolepis prolifera</i> and <i>Juncus microcephalus</i> occur on most locations. Arum lily infestations are light in this area therefore should be a priority for control.
Other comments, special features	Loc 341 is a good example of creek revegetation. This section would have been classified D two years ago and is now B3-C1 due to extensive plantings of local native species and rock placement in eroding areas. The stream running through the Loc 1127 was not assessed. From neighbouring properties and aerial assessments, it is considered to be predominantly C1-C2. A scald was noted in this section on Lot 125 upstream of the dam. Scalds occurred near other dams in the area.

Map 3: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive species such as blackberry and arum lily as a priority. Eradication of bridal creeper on Loc 1670 is also a priority.
- Consider erosion control measures on Loc 1677 taking into account the cost and benefits.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. Planting a variety of understorey species, including rushes and sedges, is encouraged.
- Revegetate dams to protect water quality, prevent erosion and provide habitat.
- Investigation into the scald on Lot 125 should be undertaken to determine the cause.

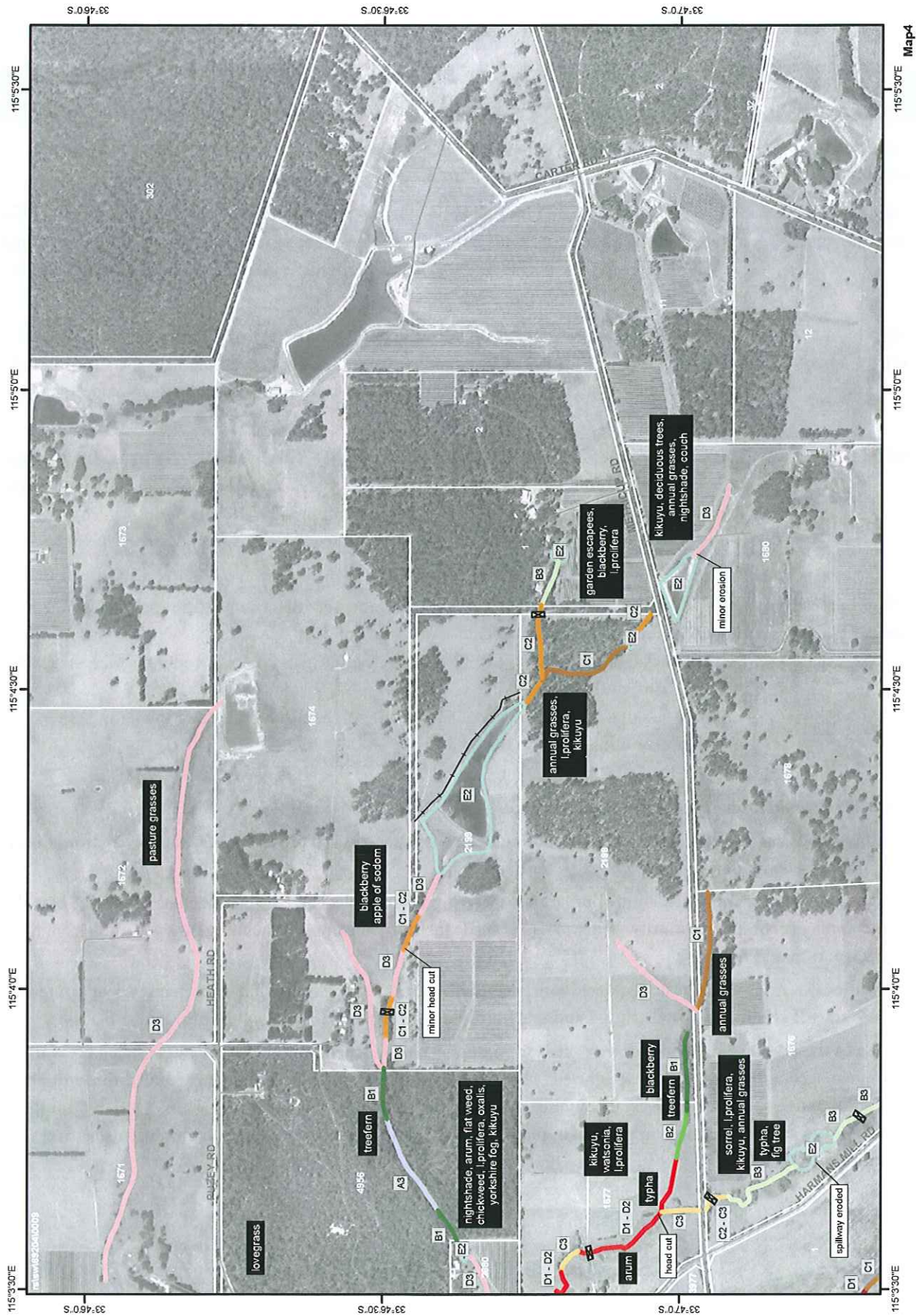
Map 4

Map 4 shows two tributaries flowing in a westerly direction through grazing and viticultural land.

Issues	Comments
Land use and fencing	Loc 2198, 1677 and 1672 are grazed and unfenced. Loc 1676, 1671 and 2199 have areas of vines along with grazing and are not fenced. All other locations do not currently have stock and are vineyards.
Landform, soils and erosion	This section is generally loamy sands with gentle slopes and poorly drained wet sandy flats. On Loc 1677 significant incision has exposed red/brown loamy soil of the Wilyabrup fertile flats. The brook on Loc 2199 is also incised and has minor headcutting.
Native vegetation	There is very little riparian vegetation remaining in this section. Location 4956 (Wilyabrup Reserve) has good vegetation consisting of marri, blackbutt, peppermint and wonnich over karri hazel and <i>Lepidosperma tetraquetrum</i> . There are walk trails in the reserve for those wanting to see what the area would have been like prior to clearing.
Weeds	The main weeds of concern include blackberry, arum lily, fig trees, typha, nightshade, apple of sodom, lovegrass and watsonia. Annual and perennial grasses, <i>Isolepis prolifera</i> and <i>Juncus microcephalus</i> are present throughout this area. Minor infestations of blackberry occur on Lot 1 and Loc 2198 and 2199.
Other comments, special features	The SoB is currently assessing a subdivision and gully-wall dam application for Loc 2198.

Map 4: Management recommendations and advice

- Where stock are present, fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality. The B1 and C1 section of Loc 2198 should be fenced as a priority due the quality of vegetation and its ability to regenerate.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry, apple of sodom and arum lily as a priority. The lovegrass around Wilyabrup Reserve should be eradicated before it moves into the reserve.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, planting a variety of understorey species, including rushes and sedges, is a priority in areas degraded by weed invasion or past stock access.
- Consider erosion control measures on Loc 1677, 1676 and 2199 taking into account the cost and benefit of the works.
- The cumulative impact of gully-wall dams on tributaries needs further investigation and consideration when approving dam applications.



Wilyabrup Brook Map 4

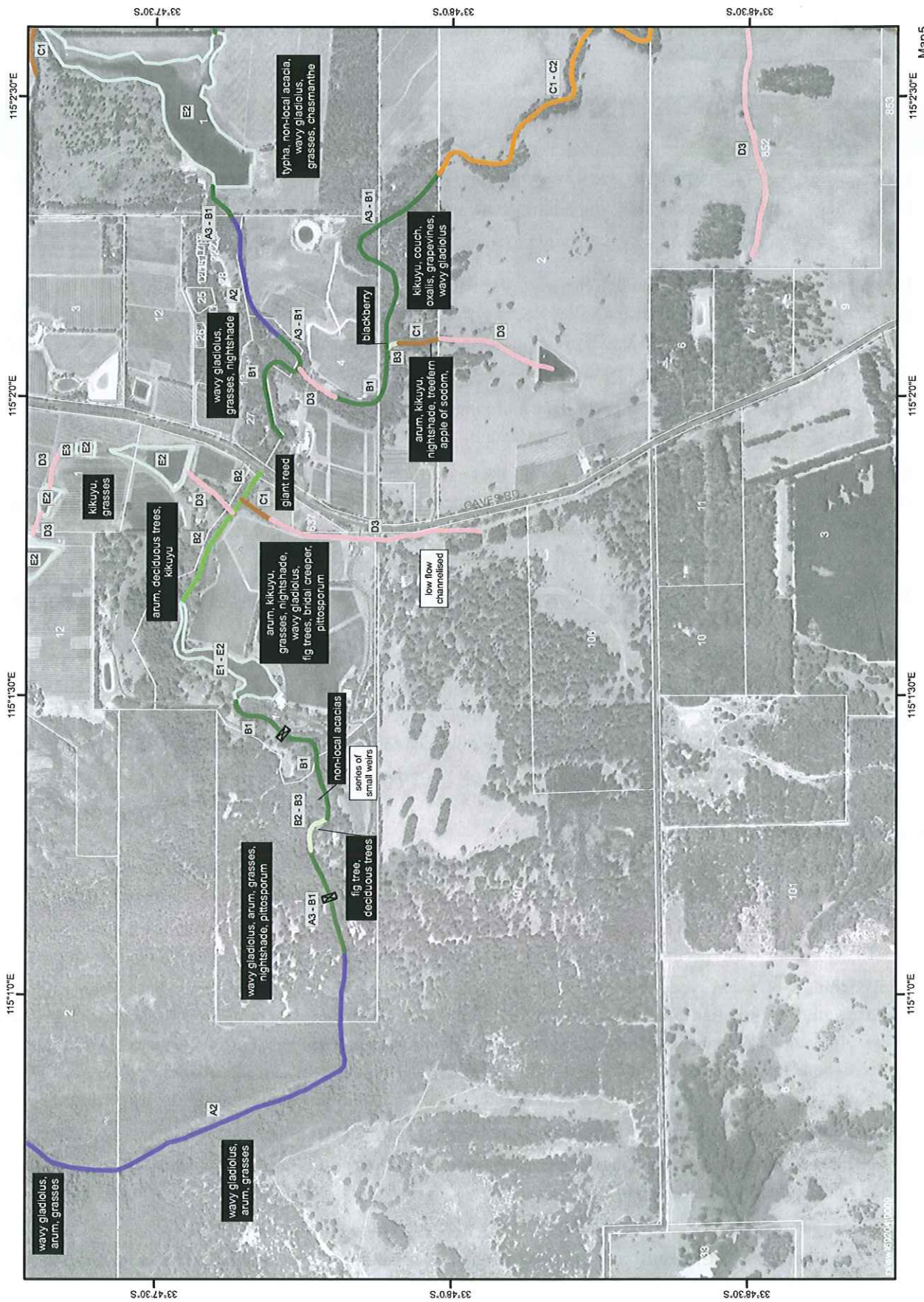
Map 5

Map 5 shows the main channel flowing west and a tributary joining it from the north.

Issues	Comments
Land use and fencing	The dominant land use is viticulture and lifestyle. Loc 2 (east of Caves Rd) and 852 are stocked and unfenced. The remaining locations are not stocked.
Landform, soils and erosion	This section is dominated by Wilyabrup narrow valley floors system. The main channel has a rock bed and a series of rapids and riffle pool sequences. The western section of Lot 1 and Loc 107 has steep rock gorges. Loc 107 has a particularly narrow v-shaped channel which runs NNW
Native vegetation	The vegetation in this section of the catchment is primarily marri/jarrah, peppermint and heartleaf poison with heath of <i>Darwinia citriodora</i> , <i>Kunzea</i> , and <i>Hakea</i> on the shallow rock outcrops. There is a range of rushes and sedges including <i>Lepidosperma</i> spp. and <i>Baumea</i> spp.
Weeds	The main weeds of concern in this area are arum lily, wavy gladiolus, fig trees, pittosporum and non-local acacias. Perennial and annual grasses are also present in areas of near pristine vegetation. Deciduous trees have been planted in a number of locations. Grapevines were noted in riparian vegetation and require management as they have the potential to become a weed in this region.
Other comments, special features	Lot 4, 2 and Loc 852 were not surveyed. Ratings were determined from neighbouring properties and aerial assessments. DoW has a gauging station on Lot 1 (west of Caves Rd) and there is a series of weir structures in this section of the channel. A scald was noted on Lot 1 (east of Caves Rd) on the northern side of the dam. Scalds occurred near other dams in the area.

Map 5: Management recommendations and advice

- Where stock are present, fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive declared species such as arum lily, blackberry and apple of sodom as a priority. Other priority weeds include watsonia, chasmanthe, wavy gladiolus, giant reed, pittosporum and fig trees.
- Non-local acacias and eucalypts, deciduous trees and 'escapee' grapevines should be removed or contained as they are self seeding and suckering. Landholders could consider replacement with local native plants.
- Due to the presence of good native vegetation in this section regeneration will occur in degraded areas if weeds are managed and locations are not grazed. The riparian zone around dams could be expanded through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, planting a variety of understory species, including rushes and sedges, is a priority.



Wilyabrup Brook Map 5

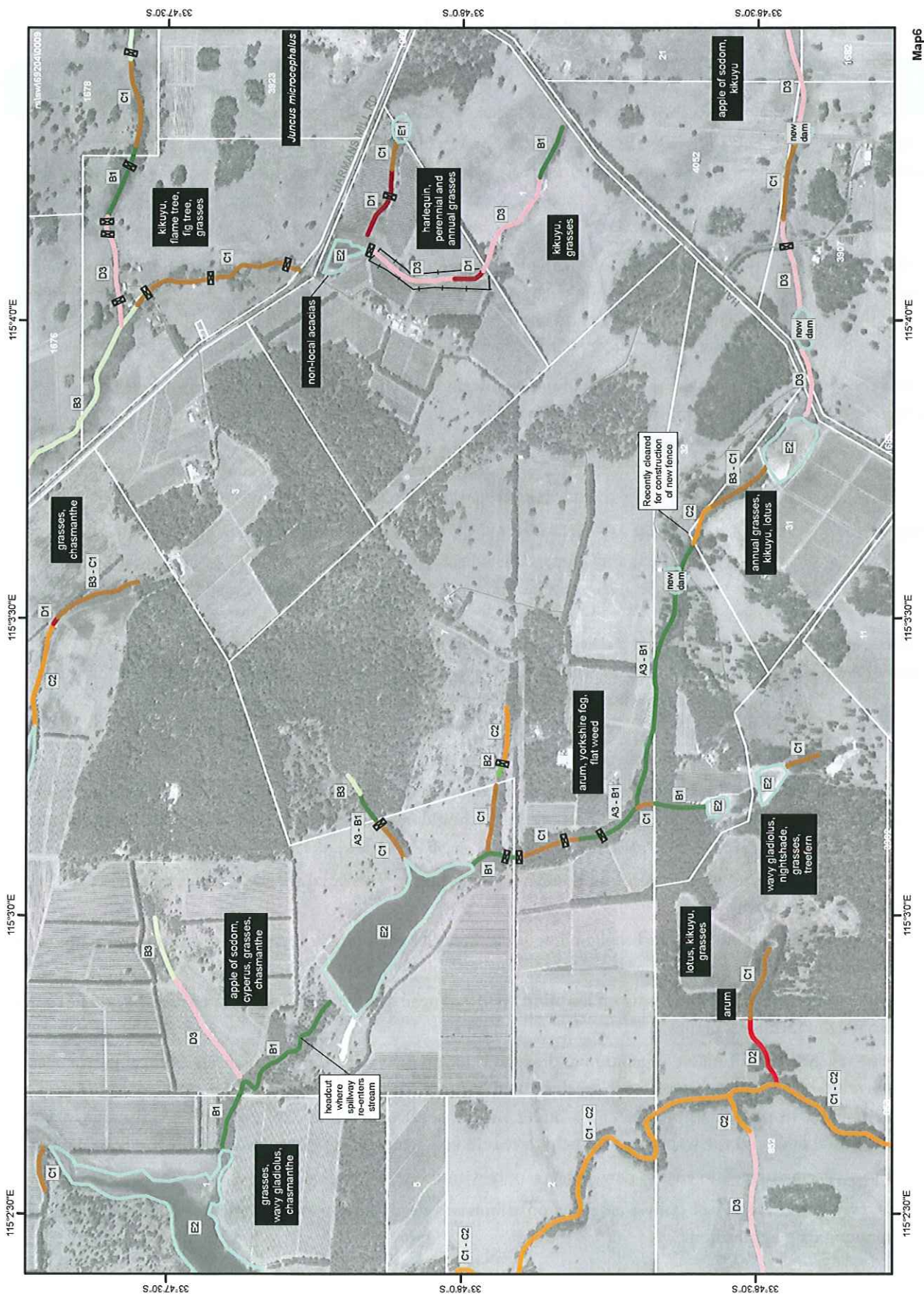
Map 6

This map shows the main channel and a number of tributaries flowing north-west through primarily viticultural land.

Issues	Comments
Land use and fencing	Locations 1679, 1678, 3907 and 852 and Lot 1 and 2 are grazed and not fenced. Lot 7 and 30 are vineyards which have some areas fenced and some grazing. The remaining locations are vineyards without stock.
Landform, soils and erosion	The two streams in the west of this section including the main channel are part of the Wilyabrup narrow valley floors system dominated by loamy gravels. The stream in the east of this section are Cowaramup vales and wet vales consisting of loamy and sandy gravels and areas of broad poorly drained wet flats. Location 852 appears to be suffering from gully erosion near the boundary of Lot 30. The spillway design on the large dam on Lot 1 is also causing gully erosion.
Native vegetation	Native riparian vegetation in this section has been cleared or degraded by stock on most locations on this map. Where stock have been excluded vegetation has regenerated well. The dominant vegetation is marri, jarrah, blackbutt and peppermint over <i>Lepidosperma tetraquetrum</i> , <i>Juncus pallidus</i> and <i>Baumea</i> spp.
Weeds	The main weeds of concern in this area are arum lily, wavy gladiolus, chasmanthe, apple of sodom and annual and perennial grasses. Ungrazed locations have greater problems with grass and bulb weeds.
Other comments, special features	Location 852 and Lot 2 Caves Rd were not assessed. Grades were allocated from neighbouring properties and aerial photos. Loc 3907 has recently been given approval for subdivision into 3 lots and construction of 3 in-stream dams.

Map 6: Management recommendations and advice

- Where stock are present fence off the creek to restrict stock access to minimise bank damage and protect water quality. Priorities for the protection of good native vegetation include a section on Loc 1678 and 1679.
- Continue and expand weed control programs. Arum lily infestations are light and should be a priority on Lot 30 and 7. Other invasive species such as apple of sodom and chasmanthe should also be a priority for control.
- Regeneration of native vegetation is occurring naturally in many areas where stock have been excluded. Expansion of the riparian zone through planting of local native species is recommended for dams and degraded sites. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the water bodies.
- The spillway on Lot 1 Metricup Rd requires alteration to prevent further erosion.
- The gully erosion occurring on Location 852 needs to be controlled as it is headcutting back into Lot 30 and will soon undermine the boundary fence.
- The SoB is encouraged to ensure new dams comply with revegetation conditions.
- The cumulative impact of gully-wall dams on tributaries needs further investigation and consideration when approving dam applications.



Wilyabrup Brook Map 6

Map 7

This map shows the beginning of a number of tributaries which generally begin as broad wet areas.

Issues	Comments
Land use and fencing	Loc 1678 and 4130 and Lots 303 and 22 have stock and are not fenced. Loc 1680 is a vineyard. Lot 21 is food tourism venture along with some grazing along the brook. Lot 301 is currently a lifestyle property. Lot 304 will have a mix of nut and other trees and a food tourism venture. Lot 4 has olives and blue gums.
Landform, soils and erosion	This section is dominated by Cowaramup wet flats and wet vales system consisting of sandy loams and gravels. The channel is broad and indistinct in most locations. Erosion is not an issue as the tributaries do not carry high velocity flows and they spread out as broad channels.
Native vegetation	Very little native vegetation remains on the two southern tributaries, with isolated peppermint trees in parts. Previously, jarrah, marri and peppermint over tea tree would have been dominant. The northern tributary has areas of good remnant riparian vegetation with marri blackbutt, peppermint and wonnich over <i>Lepidosperma tetraquetrum</i> and <i>L. effusum</i> .
Weeds	The main weeds of concern are blackberry, apple of sodom, fig tree, deciduous trees and annual and perennial grasses. Blackberry on the boundary of Lot 304 and 1 was controlled this year. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on all locations in this section.
Other comments, special features	The soak on Lot 4 dried up after blue gums were planted. A gully-wall dam application for the irrigation of vines has been approved for Lot 22 and Lot 303. The approximate size and location is represented on the map.

Map 7: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality. Location 4130 should exclude stock as a priority due to good quality vegetation.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry and apple of sodom as a priority.
- The water lily in a pond near the brook on Loc 1680 should be monitored or removed to ensure it does not escape into the waterway.
- Robinias and willows are suckering on Location 1680 and need careful management to ensure they do not spread onto neighbouring properties.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.
- The SoB is encouraged to ensure new dams comply with revegetation conditions.
- The cumulative impact of gully-wall dams on tributaries needs further investigation and consideration when approving dam applications.



Map 7

Wilyabrup Brook Map 7

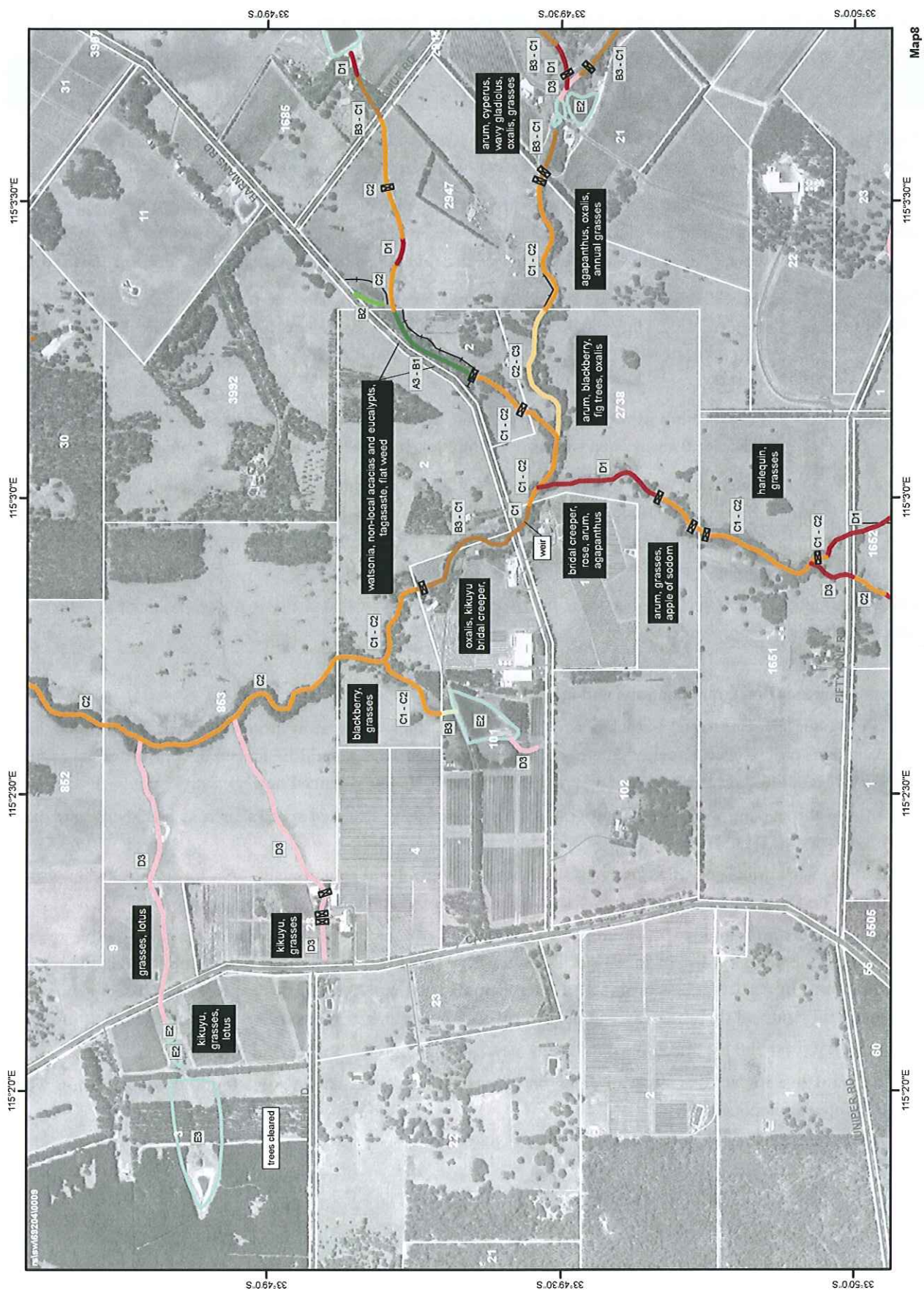
Map 8

This map shows the main channel and tributaries flowing north-west through a mixture of grazing and viticultural land.

Issues	Comments
Land use and fencing	Loc 852, 853, 2738, 2947, 1651, Lot 9 and 2 on northern side of Harmans South Rd have stock and are not fenced. Lot 2 on the southern side of Harmans South Rd has stock and is partially fenced as marked on the map. Lot 3, 23, 101, 21, and Location 1685 are viticultural properties.
Landform, soils and erosion	Wilyabrup narrow valley floors and Wilyabrup fertile flats are the dominant landform systems in the riparian area of this section. The soil is loamy gravel and well drained red/brown loams with exposed rock in the bed of the channel. There is evidence of bank erosion on locations where stock access the brook, denuding the banks of vegetation and grasses and destabilising and pugging the soil.
Native vegetation	Stock have access to the brook on most locations in this section resulting in little to no understorey. The remaining native vegetation in these areas consists of marri, blackbutt and peppermint with patches of tea tree. This section would have had a diverse understorey of grass trees, tea tree, hibbertias, karri hazel and rushes and sedges including <i>Baumea</i> and <i>Lepidosperma</i> spp.
Weeds	The main weeds of concern are blackberry, apple of sodom, arum lily, fig trees, bridal creeper, agapanthus and annual and perennial grasses. Blackberry on Lot 2 was controlled this year. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on most locations in this section. <i>Watsonia</i> is a problem along Miamup and Harman South Rd and is starting to invade Lot 2 and Loc 2947. Non-local acacias and eucalypts have been planted on a few locations.
Other comments, special features	The main channel in this section has riffle, pool sequences and areas of rapids and cascades. There are permanent pools which offer summer refuge for aquatic fauna and waterbirds. These pools also have historical significance as they were used as water points by early settlers. Sedimentation from bank erosion is threatening these pools.

Map 8: Management recommendations and advice

- Fencing of the brook to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry, arum lily and apple of sodom as a priority.
- Ensure bridal creeper on Lot 1 and Lot 101 is infected with rust or controlled with herbicide.
- *Watsonia*, agapanthus and other bulbous weeds require control and containment. Non-local acacia and eucalypt planting should be contained or removed and replaced with local native plants.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook.



Map 9

This map shows the main channel and a tributary flowing west through a mix of grazing and viticultural land.

Issues	Comments
Land use and fencing	Loc 1683, 3175, 3907, 1689, 1682, 4029, 1692, 1690 and 2949 have stock and are not fenced. Loc 1685, 2950, 1687, 2917 and Lot 21 are vineyards.
Landform, soils and erosion	This section is primarily Wilyabrup narrow valley floors system dominated by loamy gravel soils. The bed of the main channel of the brook has sections of rock. Erosion is present where stock have exposed soil and where the stream has been channelised on location 1690.
Native vegetation	Stock have access to the brook on most locations in this section resulting in little understorey. The remaining native vegetation in these areas consists of marri, blackbutt and peppermint with patches of dense tea tree. From Loc 1690 east vegetation changes to karri forest. This section would have had a diverse understorey of grass trees, tea tree, hibbertias, karri hazel and rushes and sedges including <i>Juncus pallidus</i> , <i>Baumea</i> and <i>Lepidosperma</i> spp.
Weeds	The main weeds of concern are blackberry, arum lily and annual and perennial grasses. Blackberry on Loc 4029, 1683, 1689 and 1690 was controlled this year. Grapevines, fig trees and deciduous trees were also present in this section. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on all locations in this section.
Other comments, special features	Subdivision of Loc 3907 into 3 lots and the construction of 3 gully-wall dams has been approved.

Map 9: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality. The eastern section of Loc 1690 should be fenced as a priority due to good quality vegetation. Loc 1689, 3175, 1683 and 2949 may regenerate if fenced now.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry and arum lily as a priority.
- *Watsonia*, *agapanthus* and other bulbous weeds require control and containment. Non-local acacia and eucalypt planting, deciduous trees and grapevines should be monitored and controlled if spreading.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce any sediment and nutrients entering the brook or dams.
- The AMRSC and SoB are encouraged to ensure new dams comply with revegetation conditions.
- The cumulative impact of gully-wall dams on tributaries needs further investigation and consideration when approving dam applications.



Wilyabrup Brook Map 9

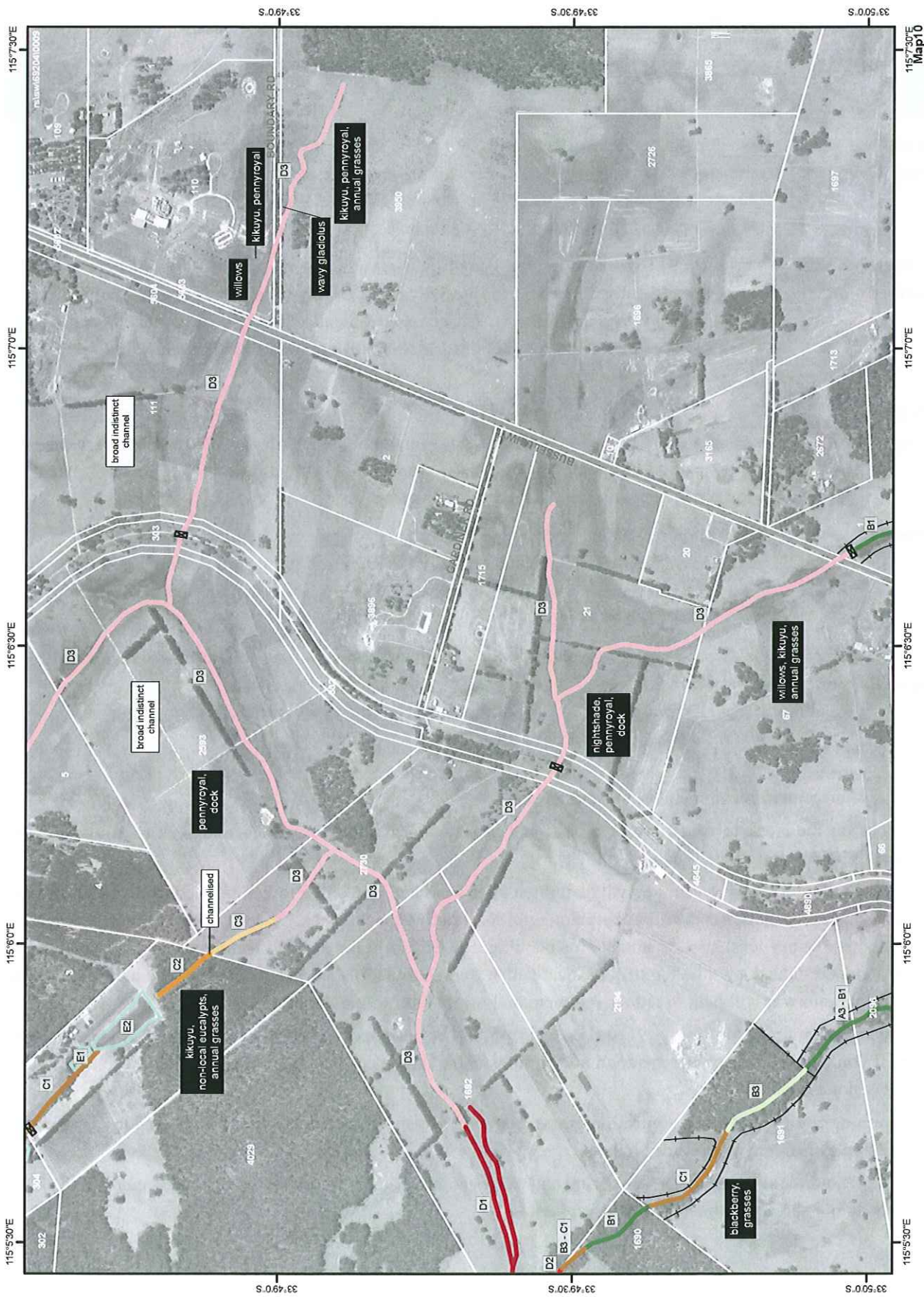
Map 10

This map shows the main channel in the bottom left corner of the map flowing north-west and a number of low flow tributaries starting as broad flat wet areas.

Issues	Comments
Land use and fencing	Loc 1692, 2194, 2730, 2593, 111, 21, 67 and 3950 have stock and are not fenced. Loc 2194 also has a dairy. Loc 110 is a winery and Lot 1 is a vineyard. Loc 1691 has stock and was partly fenced when assessed and will be completely fenced soon. This location is a great example of the benefits of fencing and the regeneration which can be achieved in a short time.
Landform, soil and erosion	This section consists of Cowaramup wet flats and wet vales system including sandy loams and gravels. The channel of the tributaries is broad and indistinct in most locations. The main channel is well defined with exposed rock in the bed and pool riffle sequences. There is minor erosion where the tributaries have been channelised and where stock has removed all grass.
Native vegetation	Very little native vegetation remains on the tributaries, with isolated trees in parts. Previously, jarrah/marri, blackbutt, paperbark and tea tree woodland. The main channel has areas of good remnant riparian vegetation dominated by karri, peppermint and wonnich over <i>Lepidosperma</i> and <i>Baumea</i> spp.
Weeds	The main weed of concern is blackberry. Due to clearing and prevalence of grazing, annual and perennial grasses dominant the tributaries. Willows have been planted on 2 locations and there are non-local eucalypts self seeding on Lot 1. Blackberry on boundary of Lot 304 and 1 was controlled this year. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on all locations in this section.
Other comments, special features	Winery effluent ponds are located close to the tributary on Lot 110 Bussell Highway.

Map 10: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality. Excluding stock from Loc 1690 is a priority due to good quality vegetation and its ability to regenerate.
- Regeneration of native vegetation will be limited once areas are fenced due to limited seed bank, weed invasion and soil compaction. Revegetation will need to be undertaken by planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry as a priority.
- Willows and non-local eucalypts should be monitored or removed to ensure they do not spread onto neighbouring properties.



Wilyabrup Brook Map 10

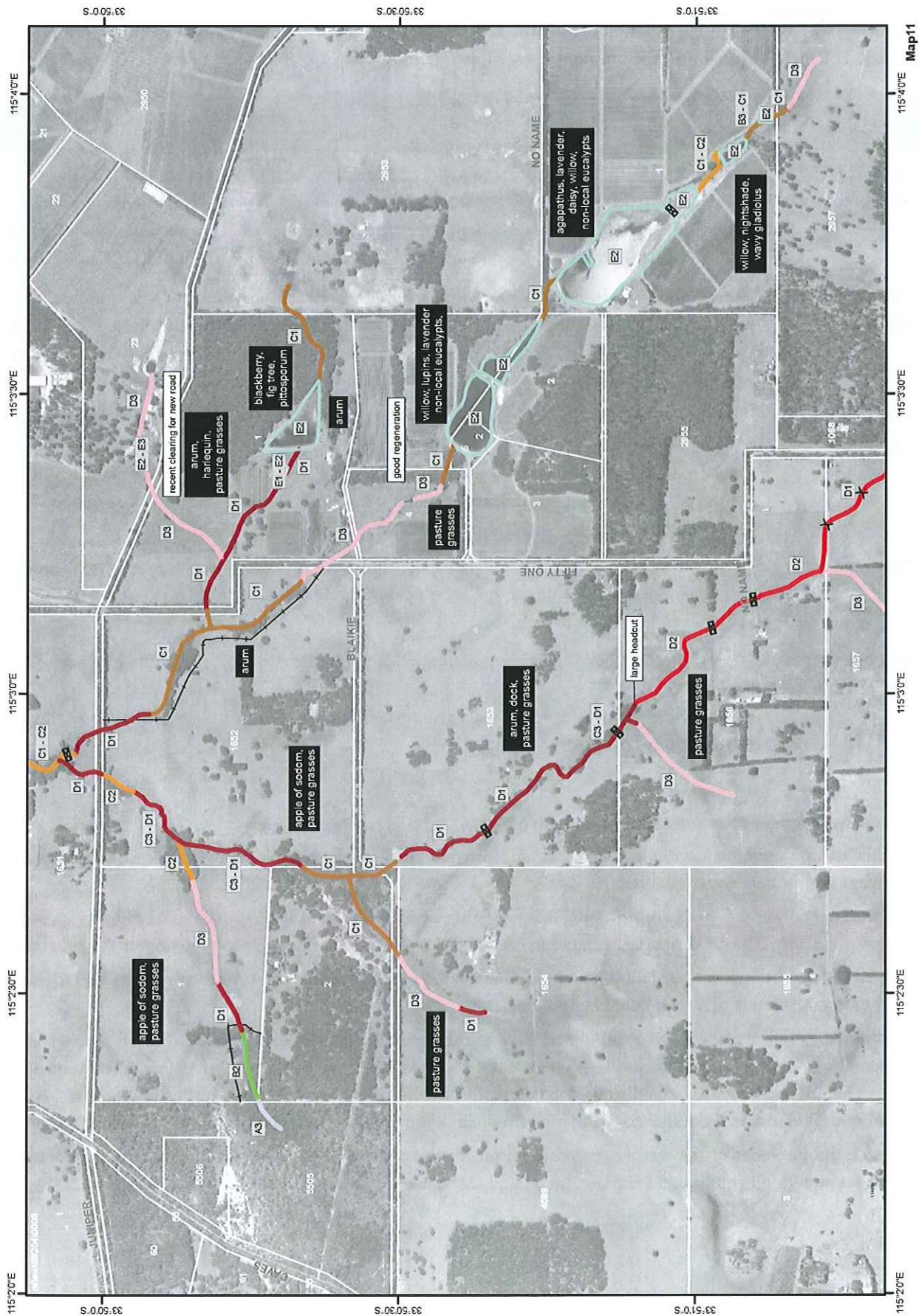
Map 11

This map show tributaries flowing north through a mixture of grazing and viticultural land.

Issues	Comments
Land use and fencing	Loc 2957, 1656, 1653, 1654 and 1651 have stock and are not fenced. Loc 1652 and Lot 1 have stock and are partly fenced. Loc 5505 is a reserve. Lot 5 is an organic vineyard with sheep grazing and is not fenced. The remaining locations are vineyards. One of the tributaries starts as a series of gully-wall dams.
Landform, soils and erosion	This section starts as Cowaramup vales and wet vales system consisting of sandy gravels and loamy gravels. It then flows north into Wilyabrup narrow valley floors and fertile flats dominated by well drained loams. The channel is broad and indistinct in most locations. There are areas of erosion caused by stock destabilising the banks. The creek on Location 1656 has a large headcut.
Native vegetation	Very little native vegetation remains on the tributaries, with isolated marri and peppermint trees and tea tree in parts. Previously, a diversity of understorey would have been present. Where sandy soils are dominant banksia woodlands occurred. Loc 5505 Reserve 9110 has good vegetation although dieback may be present.
Weeds	The main weeds of concern are blackberry, apple of sodom, arum lily, willows, wavy gladiolus and annual and perennial grasses. Lavender and pittosporum are self seeding. Non-local eucalypts have been planted on a few locations. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on most locations in this section.
Other comments, special features	Lot 2 was not assessed and a grading was determined from neighbouring properties and aerial photos. Loc 5505 (Reserve 9110) has been used as a car dump and there are visible signs of motorbike use and other access.

Map 11: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Regeneration of native vegetation will be limited once areas are fenced due to limited seed bank, weed invasion and soil compaction. Revegetation by planting of local native species is encouraged in these areas. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.
- A management plan for Reserve 9110 (Loc 5505) should be developed which will encourage active management as it contains a diversity of vegetation and is an example of banksia woodland which would have occurred in areas along the brook.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry, arum lily and apple of sodom as a priority.
- Willows, non-local eucalypts, pittosporum and other garden escapees should be contained or removed to ensure they do not spread onto neighbouring properties.



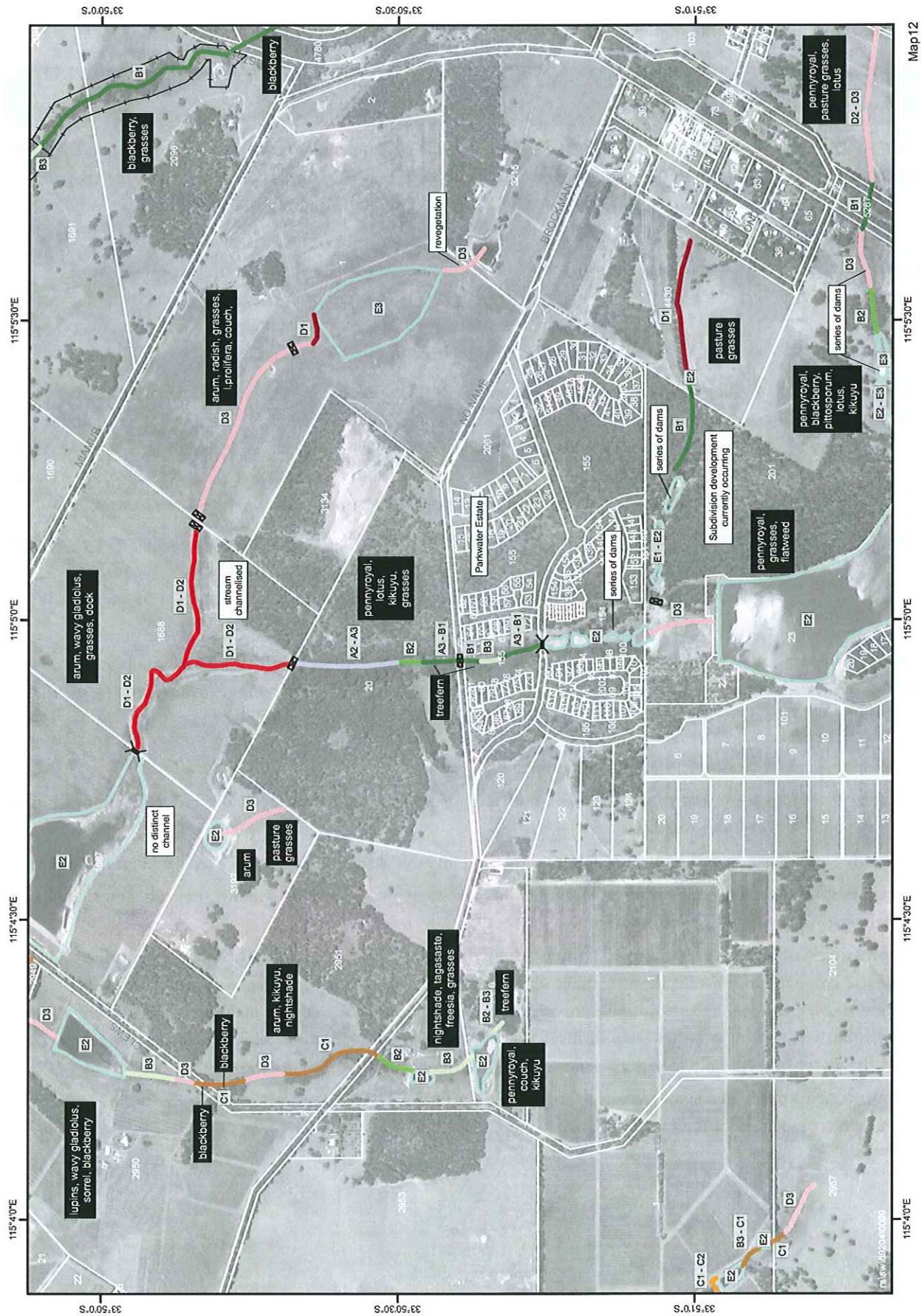
Map 12

This map shows the beginning of a number of tributaries which are heavily dammed and flow through a range of landuses. The main channel is in the top right corner flowing north-west.

Issues	Comments
Land use and fencing	Loc 2951 and 3192 have stock and are not fenced. Loc 4430 is a vineyard and has stock, the brook is not fenced. Loc 2096 has stock and is fenced. Lot 7 is an olive grove. Lot 6, Loc 2950, 1687, 1688, 1, 3215 and 101 are vineyards. Lot 20 is currently a bush block. Parkwater Estate (housing estate) and the village precinct are being developed on Lot 21, 201 and 9000.
Landform, soils and erosion	The dominant systems are Cowaramup vales and wet vales consisting of loamy and sandy gravels. There are areas of Wilyabrup narrow valley floor with loamy gravels, stony soil and bare rock. The two tributaries on Loc 1688 have been channelised and stripped of all native vegetation. The area is very rocky but still experiencing some erosion.
Native vegetation	Very little native vegetation remains on tributaries in this section. Previously, jarrah, marri and peppermint over tea tree would have been dominant. Lot 20 and 21 have very good vegetation remaining. This is karri forest over peppermint, wonnich, karri boronia, wattles, thomasia, hoveas, karri hazel and a range of rushes and sedges including <i>Lepidosperma</i> , <i>Gahnia</i> and <i>Baumea</i> spp.
Weeds	The main weeds of concern are blackberry, arum lily, wavy gladiolus, pennyroyal and annual and perennial grasses. Kikuyu, <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on most locations in this section.
Other comments, special features	Loc 4430 currently has a development application in the AMRSC for rezoning for subdivision. Parkwater Estate has implemented a stormwater management plan which aims to capture contaminants before they reach the brook.

Map 12: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry and arum lily as a priority. The good riparian vegetation on Lot 155 and 20 should be protected by ongoing weed control.
- New residents in Parkwater Estate should be encouraged to use local native plants in their gardens and to protect the brook. A 'friends of' group could be initiated.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.
- Future development of the well vegetated areas on this map should be discouraged as there is little remnant vegetation in good condition in the catchment and the value of this vegetation is therefore very high.



Map 12

Wilyabrup Brook Map 12

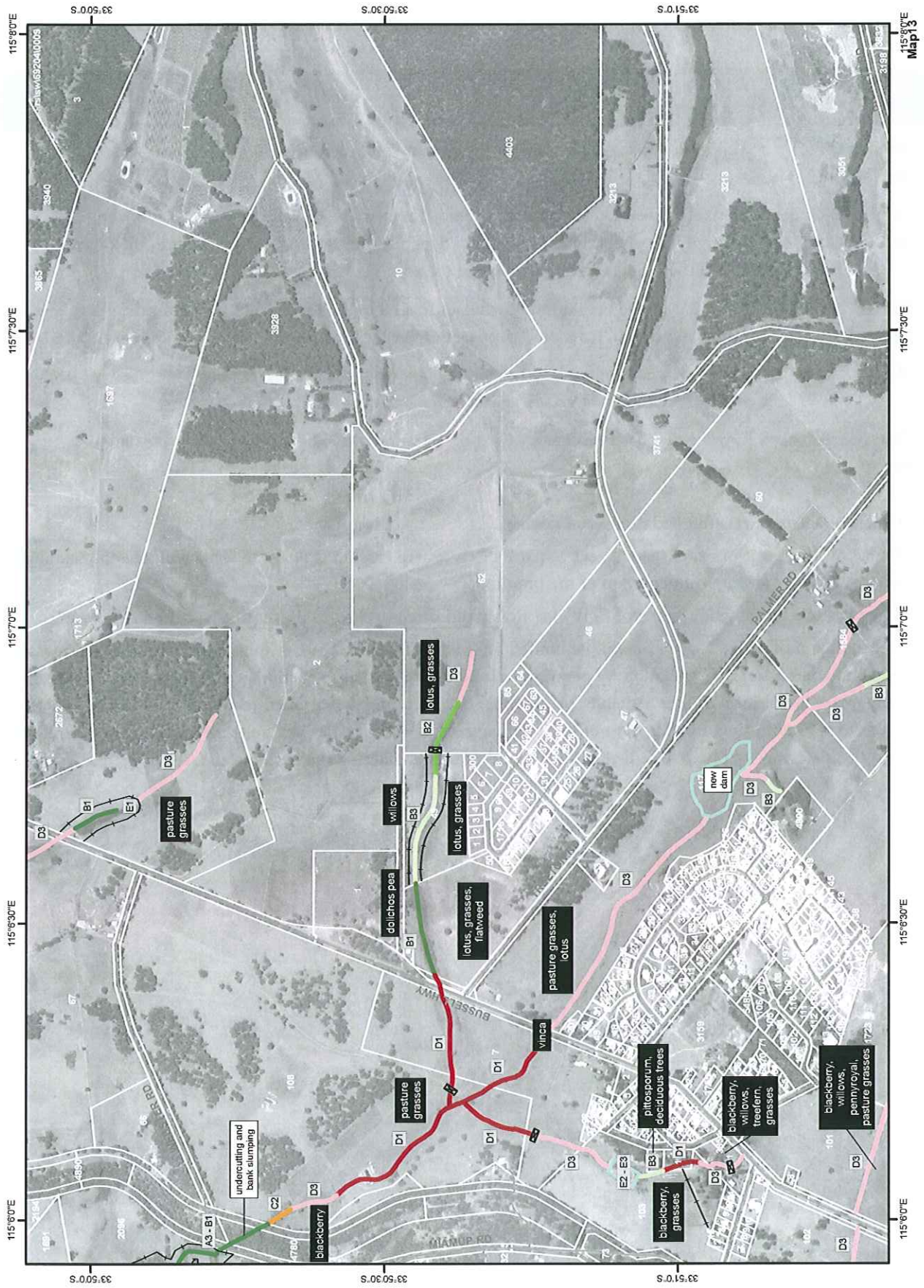
Map 13

This map shows the beginning of a number of tributaries near Cowaramup townsite flowing west.

Issues	Comments
Land use and fencing	Loc 108, 7, 117, 1584, 1, 62, 48 and 101 have stock and are not fenced. Part of Loc 1 will be fenced soon. Lot 49 has stock and is fenced. Loc 103 is a vineyard and a grazing property and the brook is partly fenced. Loc 4780 is the Rails to Trails Reserve. Loc 1721 is Pioneer Park.
Landform, soils and erosion	The tributaries are broad undefined channels primarily Cowaramup wet vales system consisting of sandy loams and gravels. As the tributaries do not carry high velocity flows and they spread out as broad channels, erosion is a minor issue. On Loc 7 and 108 erosion is evident as the stream has been channelised in this section increasing water velocity.
Native vegetation	Little to no native vegetation remains in this section apart from Loc 1 where there is a section of dense vegetation and the Rails to Trails Reserve. The roadside and remaining vegetation provides evidence of the vegetation prior to clearing. It would have consisted of karri, marri, peppermint, wonnich over tea tree and a range of rushes and sedges. The Rails to Trails Reserve has good remnant riparian vegetation which can be seen from walk trails.
Weeds	The main weeds of concern are blackberry, deciduous trees, vinca and annual and perennial grasses. Blackberry in the Rails to Trails Reserve was controlled this year. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on most locations in this section. There is a heavy infestation of dolichos pea in the road reserve north of Lot 49.
Other comments, special features	Loc 117, 101 and 103 are part of the Cowaramup Village Strategy zoned for subdivision. The creation of living streams is planned on these locations, involving stormwater treatment areas and extensive revegetation. This will be part of the public open space.

Map 13: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry as a priority.
- Deciduous trees and pittosporum need careful management or removal to ensure they do not spread onto neighbouring properties or into bushland.
- Regeneration of native vegetation will be limited once areas are fenced due to limited seed bank, weed invasion and soil compaction. Revegetation by planting of local native species is encouraged in these areas. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.
- Best practice stormwater management is encouraged in future developments along with the use of local native plants in revegetation of the living streams.



Wilyabrup Brook Map 13

Map 14

This map shows the beginning of the southernmost tributary which flows west as a broad indistinct channel.

Issues	Comments
Land use and fencing	All locations are beef grazing properties and are not fenced.
Landform, soils and erosion	This section is a broad indistinct channel part of the Cowaramup wet flats system. It is primarily poorly drained sandy loam flats. Erosion is a minor issue where stock have destabilised banks through exposing the soil.
Native vegetation	Very little native vegetation remains in this section with isolated peppermint trees in parts. Previously, jarrah, marri and peppermint over tea tree would have been dominant.
Weeds	The main weeds of concern are fig tree and watsonia. As the primary land use is grazing annual and perennial grasses and clovers are dominant.
Other comments, special features	The channel has been channelised on Locations 1656 and 1657 causing erosion.

Map 14: Management recommendations and advice

- Fence off the creek to restrict stock access, particularly where erosion is an issue. This will assist in stabilising the banks and prevent sedimentation of the brook.
- The watsonia in the road reserve of Fifty One Rd should be controlled to prevent its spread downstream.
- Regeneration of native vegetation will be limited once areas are fenced due to limited seed bank, weed invasion and soil compaction. Revegetation by planting of local native species is encouraged in these areas. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.

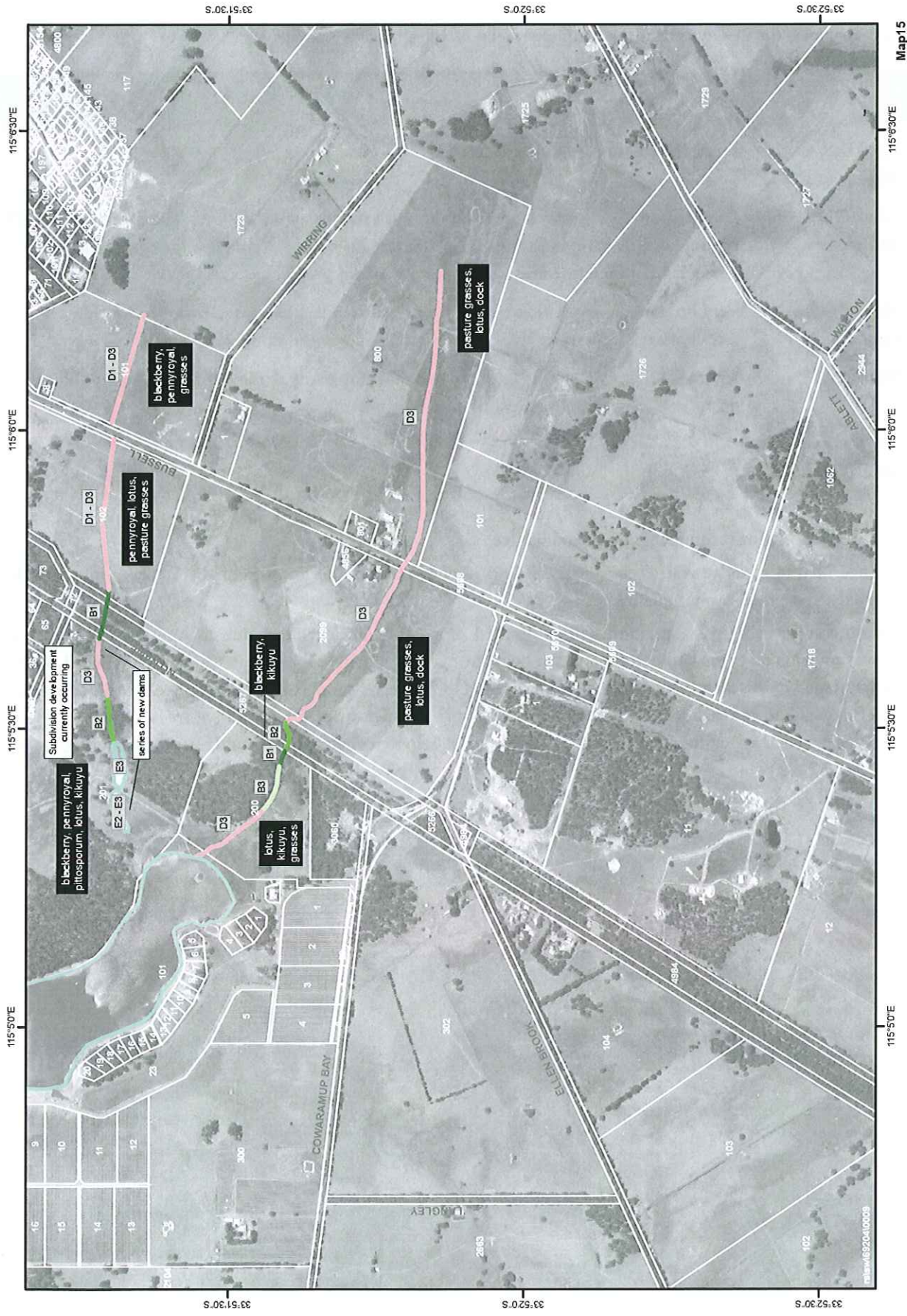
Map 15

This map shows the headwaters of the south-easterly tributaries which generally start as broad wet areas.

Issues	Comments
Land use and fencing	Lot 101, 102 and Loc 2099 and 800 have stock and are not fenced. Loc 800 has a dairy. Loc 5267 is part of the Rails to Trails Reserve. Lot 200 is zoned for a tourism development. Lot 201 is being developed for residential purposes.
Landform, soils and erosion	Cowaramup wet flats and wet vales system consisting of sandy loams and gravels occur in this section. The channel is broad and indistinct on most locations. As the tributaries do not carry high velocity flows and they spread out as broad channels erosion is not an issue.
Native vegetation	Very little native vegetation remains on the tributaries. Previously jarrah/marri, peppermint over tea tree would have been dominant. The Rails to Trails has good remnant riparian vegetation with marri, blackbutt, peppermint and wonnich over <i>Lepidosperma</i> spp. which can be seen from the walk trail.
Weeds	The main weeds of concern are blackberry, pittosporum and pennyroyal. Annual and perennial grasses dominate as the area is primarily grazed. Kikuyu is invading the Rails to Trails Reserve. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are present on most locations in this section.
Other comments, special features	A development application for a resort has been lodged with the AMRSC for Loc 200. The proposal includes a large dam and townhouse style accommodation. Loc 201 is being developed currently and will contain a recreation oval along with housing lots. There was a noticeable odour near the Rails to Trails downstream of the dairy on Loc 800. In this area, the kikuyu invading the reserve appeared to have increased vigour probably due to elevated nutrient levels.

Map 15: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs, targeting invasive declared species such as blackberry as a priority.
- The owners of the dairy on Loc 800 should consider improving effluent management. Contact CCG for information on technical and financial assistance.
- Regeneration of native vegetation will be limited once stock are excluded due to limited seed bank, weed invasion and soil compaction. Revegetation by planting of local native species is encouraged in these areas. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.
- Best practice stormwater management is encouraged in future developments along with the use of local native plants in revegetation associated with developments.
- The cumulative impact of gully-wall dams on tributaries needs further investigation and consideration when approving development applications.



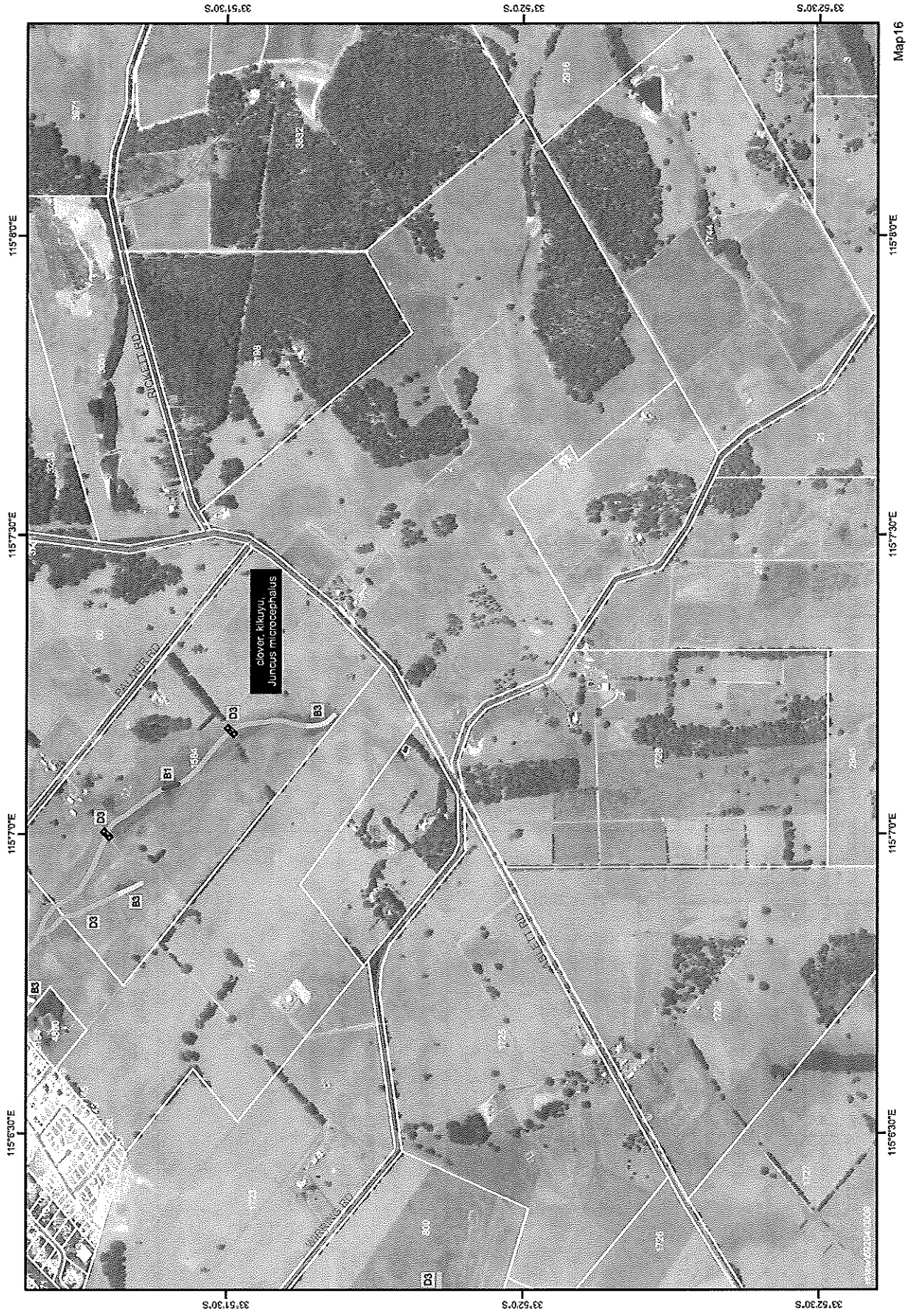
Map 16

This map shows the headwaters of the main channel which begins as broad wet area.

Issues	Comments
Land use and fencing	Loc 1584 has stock and is not fenced.
Landform, soils and erosion	Cowaramup wet vales system occurs in this area consisting of sandy loams and gravels. The channel is broad and indistinct. The tributary does not carry high velocity flows and there is dense kikuyu therefore erosion is not an issue.
Native vegetation	Very little native vegetation remains, with isolated patches of tea tree. Previously, jarrah/marri, peppermint over tea tree would have been dominant.
Weeds	Annual and perennial grasses and clover cover the area as the location is grazed. <i>Juncus microcephalus</i> and <i>Isolepis prolifera</i> are also present.
Other comments, special features	

Map 16: Management recommendations and advice

- Fence off the creek to restrict stock access, and provide stock water away from the creek to minimise bank damage and protect water quality.
- Regeneration of native vegetation will be limited once stock are excluded due to limited seed bank, weed invasion and soil compaction. Revegetation by planting of local native species after undertaking weed control is encouraged in this area. Appendix 1 contains a list of local species suitable for planting. See Section 6 for detailed techniques and information. In particular, establishing a buffer strip of local native trees, shrubs, rushes and sedges between agricultural land and the waterway will help to reduce sediment and nutrients entering the brook or dams.



Wilyabrup Brook Map 16

8. Priority Actions

These actions are not listed in order of importance, they are grouped according to project type. It should be noted that although listed separately a number of these projects could be combined to increase effectiveness and to reduce costs.

Project	What	Why	Who	When
Control stock access	<ol style="list-style-type: none"> 1. Fence areas of B grade foreshore to protect remnant vegetation. 2. Fence C and D grade areas to protect water quality. <p>Stock graze and trample native vegetation, spread weeds, cause erosion and bank instability, and introduce nutrients into the waterway.</p>	<ul style="list-style-type: none"> • Areas of B grade foreshore should be fenced as a priority as this represents the best value for money. These areas are likely to regenerate well particularly areas of B1. • C and D grade foreshore areas are a secondary priority as recovery will require greater investment. It is still important to exclude stock from these areas to stabilise banks and reduce nutrient inputs. 	<p>Landholders with assistance from CCG.</p> <p>Priorities - Loc. 1677 and Lot 1 on Map 4. Loc. 4130 on Map 7. Loc 1690 and 3175 on Map 9. Lot 62 on Map 13.</p>	<p>As soon as possible as the longer stock remain in riparian areas the more degradation will occur.</p> <p>It is easier and cheaper to protect vegetation than to restore it once it has been degraded.</p>
Promote regeneration and undertake revegetation	<p>Establish buffer strips of native vegetation in denuded areas to strip nutrients and sediment.</p> <p>This should be undertaken on the brook as well as around dams.</p>	<p>Riparian vegetation is essential to healthy and stable waterways.</p> <p>A combination of trees, shrubs, rushes and sedges is required to hold soil and banks in place and to provide ecological functions such as habitat provision and nutrient stripping. This will provide an effective buffer between agricultural land and the waterway.</p>	<p>Landholders with assistance from CCG. All locations with limited fringing vegetation are a priority.</p>	<p>Revegetation projects require planning.</p> <p>Seed collection should be undertaken in spring/early summer as this is when the majority of local plants are holding seed. Planting occurs in early winter. Erosion, weed and stock control must be in place prior to planting if required.</p>
Weed control, brushing and planting in areas retaining remnant vegetation.	<p>Weed control, brushing and planting in areas retaining remnant vegetation.</p> <p>Some areas still retaining native vegetation have lost some structural integrity and diversity. In many instances, there is an overstorey of native trees/tall shrubs but none or very few rushes, sedges and groundcovers.</p>	<p>Riparian vegetation is essential to healthy and stable waterways.</p> <p>Areas retaining some native vegetation can recover much faster and with less inputs. Simple measures such as eradicating invasive environmental weed can protect an area from degradation.</p>	<p>Landholders and the community with assistance from CCG.</p> <p>Priority should be areas of A & B grade.</p>	<p>Ongoing</p> <p>Protection and enhancement of remnant vegetation requires ongoing management. The time required reduces as the area recovers.</p>

Project	What	Why	Who	When
Erosion control	Erosion management. Utilise existing funding that is available to address severe erosion (headcutting, incision and bank slumpage).	These channels are freely eroding and transporting large amounts of sediment downstream. Benefits of actions include protection of infrastructure and valuable soil and improved waterway health due to reduced sediment and nutrient loads.	Landholders, CCG. In-kind support, such as the provision of machinery or materials (rock) may be required.	As soon as possible Extensive planning and design will be required. Construction works need to be done when there are no flows.
	Dam spill way stabilisation Stabilise eroding spillways through appropriate design	Eroding spillways transport sediment downstream. Stabilising spillways will protect stream pools from filling in with sediment and protect valuable land from eroding.	Landholders, CCG, earthmovers.	As soon as possible Extensive planning and design will be required. Construction works need to be done when there are no flows.
Control of declared and environmental weeds	1. Target invasive species in A and B grade areas or areas neighbouring good quality bushland, aiming to reduce their impact on biodiversity. 2. Coordinated control of invasive species throughout the catchment.	To address a major cause of riparian vegetation degradation and prevent and reduce further infestations downstream. Target weeds include: blackberry, arum lily, apple of sodom, bridal creeper, watsonia.	Landholders, CCG, SoB, AMRSC, DAFWA and CALM. Priority areas: properties west of Caves Rd where arum lily is starting to displace native species.	Ongoing Specific timing depends on target weeds and control methods employed. Strategic community education activities are required to support on-ground work.
	Encourage the use of local native species in revegetation and landscaping. Also consider replacement of deciduous trees and non-local plants with local native species.	Protect remnant bushland from invasion by garden escapees and suckering or self seeding non-local plants. Replacement of deciduous trees with local native species also assists in protecting water quality and improves habitat for local fauna.	Landholders, SoB and AMRSC supported by CCG.	Ongoing Local native plants look great, grow well and protect the character of this area.

Project	What	Why	Who	When
Dam management	<p>Promote the correct use of bypass valves. If an existing dam does not have a bypass valve encourage the use of a siphon system.</p> <p>Correct use involves opening the valve when the brook starts flowing and not closing it until the dam is overflowing.</p>	<p>Ensures the downstream ecosystem receives water at the break of the season. If valves are not opened the water flow to downstream ecosystems will be delayed. Also salts and sediment accumulate in the bottom of dams and can be flushed when valves are opened.</p>	<p>SoB, AMRSC, DoW and CCG to promote to landholders. Landholders responsible for correct use of bypass valves</p>	<p>Ongoing</p> <p>Reminders should be published in the paper in autumn.</p>
	<p>Environmental Water Requirements (EWR) determined and more detailed assessment of dam applications.</p> <p>The cumulative impact of dams on the brook, particularly small tributaries, needs consideration when dam applications are assessed.</p>	<p>It is important to ensure the ecology of the brook is receiving adequate water. The ecosystem of the catchment is dependent on receiving a certain amount of water otherwise it will not function. There is evidence of reduced flows in the brook. This could be a combination of climatic conditions and the number and size of dams of the brook.</p>	<p>DoW, SoB and AMRSC.</p>	<p>As soon as possible</p> <p>With changing climate and an increased demand for surface water it is important to ensure the environment is receiving enough water to sustain itself along with sustaining agricultural production.</p>
	<p>Dam spillway design and investigate the possibility of removing barriers to native fish migration such as weirs and dam walls.</p> <p>The removal of certain barriers may be possible or alternatively, a series of fishways may be constructed to allow native fish movement.</p>	<p>Weirs and dam walls provide a barrier to fish movement.</p> <p>The removal of these obstacles (or an alternative route such as a fishway like the two constructed on the Margaret River) will facilitate the natural movement and migration of native fish such as pygmy perch and western minnows.</p> <p>New dam construction should incorporate appropriate spillway design for fish passage.</p>	<p>Murdoch</p> <p>Freshwater Fish Research, DoW, CCG and landholders.</p>	<p>Ongoing</p>
Water quality	<p>Expand current water quality monitoring in the catchment.</p> <p>Establish regular water quality testing in the catchment, including monitoring to determine the effectiveness of revegetation programs.</p>	<p>To gain a more detailed understanding of the current health of Wilyabrup Brook and to determine the effectiveness of buffer strips and revegetation works.</p> <p>A priority is to gain better understanding of chemicals entering the brook.</p>	<p>DoW, CCG, Ribbons and community groups.</p>	<p>Ongoing testing required</p> <p>Timing of samples dependent on the parameter.</p>

Project	What	Why	Who	When
	<p>Seek funding for developing and implementing projects that will contribute to minimising nutrient export to the creek system. Examples may include soil testing and fertiliser and dairy effluent management plans, stock exclusion and riparian revegetation.</p>	<p>Nutrient enrichment is a significant cause of water quality problems. Excess nutrients in waterways can cause algal growth and impact on the ecology of streams.</p>	<p>CCG, DoW, DAFWA, industry bodies and landholders.</p>	<p>Ongoing</p>
	<p>Promote BMPs for the wine industry. This would include winery wastewater and vineyard management practices.</p>	<p>Viticulture is a significant land use in the Willyabrup catchment. Implementation of BMPs on vineyards and in wineries will help protect water quality and biodiversity in the catchment.</p>	<p>CCG, MRWIA, Curtin to work with landholders.</p>	<p>Ongoing</p>
<p>Feral animal control</p>	<p>Implement a coordinated program targeting feral cats, rabbits and foxes.</p>	<p>Foxes and feral cats harm our native fauna. Rabbits impact on native vegetation and can hinder revegetation efforts.</p>	<p>Landholders, CCG, DEC, DAFWA, SoB and AMRSC.</p>	<p>Ongoing Specific timing depends on target and control methods employed. Strategic community education activities are required to support on-ground work.</p>
<p>Project monitoring and evaluation</p>	<p>Monitor and evaluate landholder and community participation in restoration activities. Engagement of landholders in implementing the management actions such as fencing. Ongoing monitoring and evaluation of the success of the management recommendations against baseline data.</p>	<p>To establish baseline information and data for comparison in the future. This can:</p> <ul style="list-style-type: none"> • determine effectiveness of activities; • provide justification for funding; • demonstrate progress to the community and funding bodies. 	<p>Landholders, CCG and the community</p>	<p>Ongoing</p>

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Appendix 1: Recommended species for revegetation

MJ: Marri-jarrah-blackbutt-peppermint forest or woodland on loamy gravels found throughout the catchment.

MP: Marri-peppermint-tea tree woodland on poorly drained flats and depressions, mainly in the headwaters of tributaries

K: Karri forest near Cowaramup in Parkwater Estate, on the Rails to Trails and on the main channel on Miamup Rd east of the bridge

JB: Jarrah-peppermint banksia woodland on sandy soils. Reserve 9110, cm Caves Rd and Fifty One Rd and Wilyabrup Reserve, Puzey Rd.

H: Heathland with kunzea and darwinia on steep granite slopes primarily west of Caves Rd

MC: Melaleuca woodland and coastal heath near the mouth

Availability: Good (G) - at most local nurseries, Limited (L) - only available at a small number of nurseries

Scientific name	Common name	Form	Flower colour	MJ	MP	K	JB	H	MC	Availability
<i>Acacia alata</i>	Winged wattle	shrub	yellow	x		x				L
<i>Acacia browniana</i> var <i>browniana</i>		shrub	yellow							L
<i>Acacia divergens</i>		shrub	yellow	x		x				L
<i>Acacia extensa</i>	Wiry wattle	shrub	yellow							L
<i>Acacia littorea</i>	Shark tooth wattle	shrub	yellow						x	G
<i>Acacia myrtifolia</i>		shrub	yellow	x	x					L
<i>Acacia pulchella</i> var <i>pulchella</i>	Prickly moses	shrub	yellow	x	x	x	x			G
<i>Acacia saligna</i>	Orange wattle	shrub	yellow							G
<i>Acacia urophylla</i>	Net-leaved wattle	shrub	yellow	x		x				L
<i>Adenanthos barbiger</i>	Hairy jug-flower	shrub	red				x			L
<i>Agonis flexuosa</i>	Peppermint tree	tree	white	x	x	x	x	x	x	G
<i>Allocasuarina fraseriana</i>	Sheoak	tree	brown				x			G
<i>Allocasuarina humilis</i>	Dwarf sheoak	shrub	brown				x			G
<i>Anigozanthos flavidus</i>	Tall kangaroo paw	herb	red/green	x	x	x	x	x	x	G
<i>Anigozanthos manglesii</i>	Mangles kangaroo paw	herb	red & green	x			x	x		G
<i>Anigozanthos viridus</i>	Green kangaroo paw	herb	green	x			x			G
<i>Astartea aff fascicularis</i>	Astartea	shrub	white	x	x	x	x	x		G
<i>Banksia attenuata</i>	Slender banksia	shrub	yellow				x			G
<i>Banksia grandis</i>	Bull banksia	tree	yellow	x			x			G
<i>Banksia littoralis</i>	Swamp banksia	tree	green/yellow				x			G
<i>Baumea articulata</i>	Jointed twig rush	sedge	brown						x	G
<i>Baumea juncea</i>	Bare twig rush	sedge	brown	x		x	x	x		G
<i>Baumea rubiginosa</i>	River twig rush	sedge	brown	x	x		x			L
<i>Baumea vaginalis</i>	Sheath twig rush	sedge	brown	x	x	x				L
<i>Billardiera heterophylla</i>	Australian bluebell	climber	purple	x		x	x			G
<i>Boronia alata</i>	Winged Boronia	shrub	pink					x	x	L

Scientific name	Common name	Form	Flower colour	MJ	MP	K	JB	H	MC	Availability
<i>Boronia gracilipes</i>	Karri Boronia	shrub	pink			x				L
<i>Bossiaea aquifolium</i>	Water bush	shrub	yellow & red	x	x	x				L
<i>Bossiaea linophylla</i>	Golden spray	shrub	yellow & red	x			x			L
<i>Callistachys lanceolata</i>	Native willow	tall shrub	yellow	x	x	x	x			G
<i>Calothamnus sanguineus</i>	Silky leaved bloodflower	shrub	red	x			x	x		G
<i>Carpobrotus virescens</i>	Coastal pigface	herb	pink						x	G
<i>Centella asiatica</i>	Gotu kola	herb	white	x	x	x				G
<i>Clematis pubescens</i>	Old mans beard	twiner	white	x		x	x	x	x	L
<i>Conostylis aculeata</i>	Prickly constylis	herb	yellow	x		x	x	x		G
<i>Corymbia calophylla</i>	Marri	tree		x	x	x		x	x	G
<i>Dampiera linearis</i>	Common dampiera	herb	purple	x	x	x				L
<i>Darwinia citriodora</i>	Lemon-scented darwinia	shrub	red	x				x		L
<i>Daviesia cordata</i>	Bookleaf	shrub	yellow & red	x			x			L
<i>Dianella revoluta</i>	Flax lily	herb	purple	x				x		G
<i>Eucalyptus diversicolor</i>	Karri	tree				x				G
<i>Eucalyptus marginata</i>	Jarrah	tree		x			x	x		G
<i>Eucalyptus megacarpa</i>	Bullich	tree		x				x		G
<i>Eucalyptus patens</i>	Blackbutt	tree		x	x	x				G
<i>Ficinia nodosa</i>	Knotted club rush	sedge	yellow/brown		x				x	G
<i>Gastrolobium bilobum</i>	Heartleaf poison	shrub	orange	x			x	x		L
<i>Gastrolobium ebracteolatum</i>	River pea	tree	red & yellow	x			x	x		L
<i>Hakea amplexicaulis</i>	Prickly hakea	shrub	white	x	x	x	x			L
<i>Hakea lissocarpha</i>	Honey bush	shrub	white	x		x	x			G
<i>Hakea trifurcata</i>	Two-leaf hakea	shrub	white/pink	x			x	x		G
<i>Hardenbergia comptoniana</i>	Native wisteria	climber	purple	x	x	x	x	x		G
<i>Hibbertia cuneiformis</i>	Cutleaf hibbertia	shrub	yellow	x		x		x		L
<i>Hibbertia hypericoides</i>	Yellow buttercups	shrub	yellow	x		x	x			L
<i>Hovea elliptica</i>	Tree hovea	shrub	purple	x		x	x			L
<i>Hypocalymma angustifolium</i>	White myrtle	shrub	white/pink				x	x		G
<i>Hypocalymma cordifolium</i>		shrub	white	x		x				L
<i>Hypocalymma robustum</i>	Swan River myrte	shrub	pink	x			x	x		L
<i>Juncus kraussii</i>	Sea rush	rush	dark brown						x	G
<i>Juncus pallidus</i>	Pale rush	rush	brown	x	x			x		G
<i>Juncus planifolius</i>	Broadleaf rush	rush	brown	x	x					L

Scientific name	Common name	Form	Flower colour	MJ	MP	K	JB	H	MC	Availability
<i>Kennedia coccinea</i>	Coral vine	climber	orange & pink	x		x	x	x		G
<i>Kennedia prostrata</i>	Running postman	climber	red & yellow	x			x	x		L
<i>Kunzea ciliata</i>		shrub	pink				x	x	x	L
<i>Kunzea ericifolia</i>		shrub	cream				x			G
<i>Lepidosperma effusum</i>	Spreading sword sedge	sedge	brown	x	x	x				L
<i>Lepidosperma gladiatum</i>	Coast sword sedge	sedge	brown						x	L
<i>Lepidosperma tetraquetrum</i>	Square sedge	sedge	brown	x	x	x	x	x		L
<i>Lobelia alata</i>	Angled lobelia	herb	purple	x	x	x	x	x	x	G
<i>Meeboldina scariosa</i>	Velvet rush	rush	red-brown	x			x	x		G
<i>Melaleuca laterita</i>	Robin red-breast	shrub	red					x		G
<i>Melaleuca preissiana</i>	Stout paperbark	tree	white		x					G
<i>Melaleuca thymoides</i>		shrub	yellow				x	x		G
<i>Microlaena stipoides</i>	Weeping grass	grass	green	x		x	x	x		L
<i>Mirbelia dilatata</i>	Holly leaved mirbelia	shrub	purple	x		x	x	x		L
<i>Neurachne alopecuroides</i>	Foxtail mulga grass	grass	greyish	x			x	x		L
<i>Olearia axillaris</i>	Coastal daisy bush	shrub	yellow						x	
<i>Orthrosanthus polystachys</i>	Many spike orthrosanthus	herb	purple	x			x			G
<i>Paraserianthes lophantha</i>	Albizia	tree	green/yellow	x			x	x	x	G
<i>Patersonia occidentalis</i>	Purple flag	herb	purple	x		x	x	x		G
<i>Phyllanthus calycinus</i>	False boronia	shrub	white	x			x	x		G
<i>Pimelea rosea</i>	Rose banjine	shrub	pink					x	x	G
<i>Ricinocarpus glaucus</i>	Wedding bush	shrub	white	x		x		x		G
<i>Scaevola calliptera</i>		herb	purple	x		x	x	x		L
<i>Spyridium globulosum</i>	Basket bush	shrub	cream	x	x	x				L
<i>Taxandria linearifolia</i>	Swamp peppermint	shrub	white	x	x	x	x	x		G
<i>Taxandria parviceps</i>	Fine teatree	shrub	white	x	x	x	x	x		G
<i>Tempellonia retusa</i>	Cockies tongues	shrub	red					x	x	G
<i>Thysanotus multiflorus</i>	Many flowered fringe lily	lily	purple	x			x	x		G
<i>Trymalium floribundum</i>	Soapbush	tree	cream	x		x				L
<i>Villarsia latifolia</i>	Marshwort	herb	yellow	x	x	x	x			L
<i>Villarsia parnassifolia</i>		herb	yellow	x	x	x	x			L
<i>Viminaria juncea</i>	Swishbush	shrub	red yellow	x		x	x	x		G
<i>Xanthorrhoea gracilis</i>	Graceful grasstree	grasstree	cream	x			x	x		L
<i>Xanthorrhoea preissii</i>	Grasstree or Balga	grasstree	cream	x			x	x		G
<i>Xylomelum occidentale</i>	Woody pear	tree	white	x			x			L

The Cape to Cape Catchments Group can provide assistance with developing a species list for you revegetation project. The list above includes species which are currently available. You can take this list to your local nursery when ordering plants for revegetation or for landscaping.

Every year nurseries are including other species therefore plants from the list in Appendix 2 may be available soon so ask the nursery.

Local native plant suppliers

The following local nurseries grow or can order local plants:

Geographe Community Landcare Nursery

Queen Elizabeth Ave, Busselton

Ph: 0409 376 976

The Tube Nursery

Blond St, Cowaramup

Ph: 9755 5509

Everyday Potted Plants

Sebbes Rd, Forest Grove

Ph: 9757 7424

Margaret River Nursery and Irrigation

Stewart St, Margaret River

Ph: 9757 2691

Nuralingup Gardens Nursery

Sebbes Rd, Forest Grove

Ph: 9757 7542

Banyula Garden Centre

Caves Rd, Dunsborough

Ph: 9755 3705

Bandicoot Nursery

Mt Barker

Ph: 9851 1802

Appendix 2: Wilyabrup Brook species list

Scientific name	Common name	Form	Flower colour
<i>Acacia alata</i>	Winged wattle	shrub	yellow
<i>Acacia browniana</i> var <i>browniana</i>		shrub	yellow
<i>Acacia divergens</i>		shrub	yellow
<i>Acacia extensa</i>	Wiry wattle	shrub	yellow
<i>Acacia gilbertii</i>		shrub	yellow
<i>Acacia huegelii</i>		shrub	cream
<i>Acacia littorea</i>	Shark tooth wattle	shrub	yellow
<i>Acacia mooreana</i>		shrub	yellow
<i>Acacia mytifolia</i>		shrub	yellow
<i>Acacia pulchella</i> var <i>pulchella</i>	Prickly moses	shrub	yellow
<i>Acacia saligna</i>	Orange wattle	shrub	yellow
<i>Acacia urophylla</i>	Net-leaved wattle	shrub	yellow
<i>Adenanthos barbiger</i>	Hairy jug-flower	shrub	red
<i>Adenanthos meisneri</i>		shrub	purple
<i>Agonis flexuosa</i>	Peppermint tree	tree	white
<i>Agrostocrinum hirsutum</i>		herb	purple
<i>Agrostocrinum scabrum</i>	False blind grass	herb	purple
<i>Allocasuarina fraseriana</i>	Sheoak	tree	brown
<i>Allocasuarina humilis</i>	Dwarf sheoak	shrub	brown
<i>Alternanthera nodiflora</i>	Common joyweed	herb	white
<i>Alyogyne wrayae</i>	Lilac hibiscus	shrub	lilac
<i>Amphipogon amphipogonoides</i>		grass	green/grey
<i>Amphipogon turbinatus</i>		grass	greyish
<i>Andersonia</i> sp		shrub	white
<i>Anigozanthos flavidus</i>	Tall kangaroo paw	herb	red-green
<i>Anigozanthos manglesii</i>	Mangles kangaroo paw	herb	red and green
<i>Anigozanthos viridus</i>	Green kangaroo paw	herb	green
<i>Apium prostratum</i> var. <i>prostratum</i>	Sea celery	herb	white
<i>Astartea</i> aff <i>fascicularis</i>	Astartea	shrub	white
<i>Astroloma cillatum</i>	Candle cranberry	gcover	deep red
<i>Banksia attenuata</i>	Slender banksia	shrub	yellow
<i>Banksia grandis</i>	Bull banksia	tree	yellow
<i>Banksia ilicifolia</i>	Holly-leaved banksia	tree	yellow
<i>Banksia littoralis</i>	Swamp banksia	tree	green/yellow
<i>Baumea rubiginosa</i>		sedge	brown
<i>Baumea vaginalis</i>	Sheath twig rush	sedge	brown
<i>Billardiera floribunda</i>		climber	white
<i>Billardiera heterophylla</i>	Australian bluebell	climber	purple
<i>Billardiera varifolia</i>		climber	purple/blue
<i>Boronia alata</i>	Winged boronia	shrub	pink
<i>Boronia gracilipes</i>	Karri boronia	shrub	pink
<i>Bossiaea aquifolium</i>	Water bush	shrub	yellow-red
<i>Bossiaea linophylla</i>	Golden spray	shrub	yellow-red
<i>Bossiaea ornata</i>	Broadleaved brown pea	shrub	yellow-brown
<i>Bossiaea praetermissa</i>		shrub	yellow-red
<i>Burchardia multiflora</i>	Dwarf burchardia	herb	pink

Scientific name	Common name	Form	Flower colour
<i>Burchardia umbellata</i>	Milkmaids	herb	white
<i>Caesia micrantha</i>	Pale grass lily	lily	white
<i>Caesia occidentalis</i>		lily	white
<i>Caladenia attingens</i>	Forest mantis	orchid	green/yellow/red
<i>Caladenia flava</i>	Cowslip	orchid	yellow
<i>Caladenia infundibularis</i>	orchid	herb	yellow/red
<i>Callistachys lanceolata</i>	Native willow	tall shrub	yellow
<i>Calothamnus sanguineus</i>	Silky leaved bloodflower	shrub	red
<i>Calystegia sepium</i>	Greater bindweed	twiner	white/pink
<i>Calytrix</i> sp.		shrub	white/yellow
<i>Carpobrotus virescens</i>	Coastal pigface	herb	pink
<i>Centella asiatica</i>	Gotu kola	herb	white
<i>Chamaescilla corymbosa</i> var. <i>corymbosa</i>	Blue squill	herb	purple
<i>Cheilanthes austrotenuifolia</i>	Rock fern	herb	
<i>Chorilaena quercifolia</i>	Oak leaved chorilaena	tree	cream
<i>Chorizandra cymbaria</i>	Heron bristle rush	sedge	brown
<i>Chorizema diversifolium</i>		shrub	orange & red
<i>Chorizema nanum</i>		shrub	orange & red
<i>Chorizema rhombeum</i>		shrub	red
<i>Clematis pubescens</i>	Old mans beard	twiner	white
<i>Comesperma ciliatum</i>		shrub	blue
<i>Comesperma confertum</i>		shrub	pink
<i>Comesperma virgatum</i>	Milkwort	shrub	pink
<i>Conospermum</i> sp.		shrub	
<i>Conostephium pendulum</i>	Pearl flower	shrub	red and white
<i>Conostylis aculeata</i>	Prickly conostylis	herb	yellow
<i>Convolvulus angustissimus</i>		twiner	white
<i>Corybas recurvus</i>	Forest helmet orchid	herb	red/purple
<i>Corymbia calophylla</i>	Marri	tree	
<i>Craspedia variabilis</i>	Billy buttons	daisy	yellow
<i>Cryptostylis ovata</i>	Slipper orchid	herb	green/red
<i>Cyanicula sericea</i>	Silky blue orchid	herb	purple
<i>Cyathochaeta</i> sp.		sedge	brown
<i>Cyrtostylis huegelii</i>	Midge orchid	herb	green
<i>Dampiera hederacea</i>	Karri dampiera	herb	purple
<i>Dampiera linearis</i>	Common dampiera	herb	purple
<i>Darwinia citriodora</i>	Lemon-scented darwinia	shrub	red
<i>Dasypogon bromeliifolius</i>		herb	
<i>Dasypogon hookeri</i>		herb	
<i>Daucus glochidiatus</i>	Australian carrot	herb	pink
<i>Daviesia cordata</i>	Bookleaf	shrub	yellow/red
<i>Daviesia horrida</i>	Prickly bitter pea	shrub	orange/red
<i>Daviesia inflata</i>		shrub	orange/red
<i>Dianella revoluta</i>	Flax lily	herb	purple
<i>Diuris corymbosa</i>	Donkey orchid	herb	orange
<i>Diuris species</i>	Donkey orchid	herb	orange
<i>Drosera macrantha</i>	Bridal rainbow	climbing herb	pink
<i>Drosera pallida</i>	Pale rainbow	climbing herb	

Scientific name	Common name	Form	Flower colour
<i>Dryandra bipinnatifida</i>		shrub	cream
<i>Dryandra lindleyana</i>	Couch honeypot	shrub	yellow
<i>Elythranthera brunonis</i>	Purple enamel orchid	herb	purple
<i>Elythranthera emarginata</i>	Pink enamel orchid	herb	pink
<i>Eriochilus dilatatus</i>	White bunny orchid	herb	white
<i>Eucalyptus diversicolor</i>	Karri	tree	
<i>Eucalyptus marginata</i>	Jarrah	tree	
<i>Eucalyptus megacarpa</i>	Bullich	tree	
<i>Eucalyptus patens</i>	Blackbutt	tree	
<i>Eutaxia obovata</i>		shrub	red/yellow
<i>Ficinia nodosa</i>	Knotted club rush	sedge	yellow/brown
<i>Gahnia decomposita</i>	Saw sedge	sedge	yellow/brown
<i>Gahnia scleroides</i>		sedge	brown
<i>Gahnia trifida</i>	Coast saw sedge	sedge	yellow/brown
<i>Gastrolobium bilobum</i>	Heartleaf poison	shrub	orange
<i>Gastrolobium ebracteolatum</i>	River pea	tree	red/yellow
<i>Geranium solanderi</i>	Native geranium	herb	pink
<i>Gompholobium capitatum</i>	Yellow pea	shrub	yellow
<i>Gompholobium marginatum</i>		shrub	yellow
<i>Gompholobium polymorphum</i>		shrub	yellow
<i>Goodenia eatoniana</i>		herb	purple
<i>Goodenia pusilla</i>	Delicate goodenia	herb	yellow
<i>Haemodorum laxum</i>		herb	brown
<i>Haemodorum simplex</i>		herb	brown/orange
<i>Hakea amplexicaulis</i>	Prickly hakea	shrub	white
<i>Hakea lissocarpha</i>	Honey bush	shrub	white
<i>Hakea trifurcata</i>	Two-leaf hakea	shrub	white/pink
<i>Hardenbergia comptoniana</i>	Native wisteria	climber	purple
<i>Hemigenia podalyrina</i>		shrub	purple
<i>Hemigenia rigida</i>		shrub	purple
<i>Hibbertia commutata</i>		shrub	yellow
<i>Hibbertia cuneiformis</i>	Cutleaf hibbertia	shrub	yellow
<i>Hibbertia cunninghamii</i>		shrub	yellow
<i>Hibbertia hypericoides</i>	Yellow buttercups	shrub	yellow
<i>Hibbertia pilosa</i>	Hairy guinea flower	shrub	yellow
<i>Hibbertia racemosa</i>	Stalked guinea flower	shrub	yellow
<i>Hovea chorizemifolia</i>	Holly leaved hovea	shrub	purple
<i>Hovea elliptica</i>	Tree hovea	shrub	purple or white
<i>Hovea stricta</i>		shrub	purple
<i>Hovea trisperma</i>	Common hovea	shrub	purple or white
<i>Hypocalymma angustifolium</i>	White myrtle	shrub	white/pink
<i>Hypocalymma cordifolium</i>		shrub	white
<i>Hypoclymma robustum</i>	Swan River myrte	shrub	pink
<i>Hypolaena exsulca</i>		rush	brown
<i>Isopogon</i> sp.		shrub	
<i>Isotoma hypocrateriformis</i>	Woodbridge poison	herb	pink
<i>Isotropis cuneifolia</i>	Granny bonnets	herb	yellow-red
<i>Jacksonia horrida</i>		shrub	red/yellow

Scientific name	Common name	Form	Flower colour
<i>Juncus kraussii</i>	Sea rush	rush	brown
<i>Johnsonia lupulina</i>	Hooded lily	tufted	white & pink
<i>Juncus pallidus</i>	Pale rush	rush	brown
<i>Juncus planifolius</i>	Broadleaf rush	rush	brown
<i>Kennedia carinata</i>		groundcover	red/yellow
<i>Kennedia coccinea</i>	Coral vine	climber	orange and pink
<i>Kennedia macrophylla</i>	Augusta kennedia	climber	red/yellow
<i>Kingia australis</i>		shrub	yellow/brown
<i>Kunzea ciliata</i>		shrub	pink
<i>Kunzea ericifolia</i>		shrub	cream
<i>Lagenophora huegelli</i>		daisy	white/pink
<i>Lasiopetalum floribudum</i>		shrub	purple
<i>Laxmannia sessiliflora</i>	Nodding lily	herb	white/red
<i>Lechenaultia biloba</i>	Blue lechenaultia	herb	purple
<i>Lepidosperma effusum</i>	Spreading sword sedge	sedge	brown
<i>Lepidosperma gladiatum</i>	Coast sword sedge	sedge	brown
<i>Lepidosperma leptostachyum</i>		sedge	brown
<i>Lepidosperma longitudinale</i>		sedge	brown
<i>Lepidosperma squamatum</i>		sedge	brown
<i>Lepidosperma tetraquetrum</i>	Square sedge	sedge	brown
<i>Leptomeria squarrolosa</i>		shrub	yellow
<i>Leucophyta brownii</i>	Cushion bush	shrub	yellow
<i>Leucopogon capitellatus</i>		shrub	pinky white
<i>Leucopogon elatior</i>		shrub	white
<i>Leucopogon propinquus</i>		shrub	white
<i>Leucopogon</i> sp.		shrub	white
<i>Leucopogon verticillatus</i>	Tassel flower	shrub	red and white
<i>Levenhookia pusilla</i>	Midget stylewort	herb	pink
<i>Lindsaea linearis</i>	Screw fern	fern	
<i>Lobelia alata</i>	Angled lobelia	herb	purple
<i>Lobelia tenuior</i>	Slender lobelia	herb	purple
<i>Logania campanulata</i>	Bell flowered logania	herb	white
<i>Logania serpyllifolia</i>	White stars	shrub	white
<i>Logania vaginalis</i>	White spray	shrub	white
<i>Lomandra caespitosa</i>	Tufted mat rush	herb	yellow
<i>Lomandra drummondii</i>		herb	vary
<i>Lomandra hermaphrodita</i>		herb	purple/yellow
<i>Lomandra nigricans</i>		herb	white
<i>Lomandra pauciflora</i>		herb	cream
<i>Lomandra purpurea</i>	Purple mat rush	herb	purple
<i>Lomandra sericea</i>	Silky mat rush	herb	purple/yellow
<i>Lomandra suaveolens</i>		herb	vary
<i>Loxocarya cinerea</i>	Chinese puzzle	rush	brown
<i>Luzula meridionalis</i>	Field woodrush	rush	brown
<i>Lyginia barbata</i>		rush	red-brown
<i>Macrozamia riedlei</i>	Zamia	tree	
<i>Marianthus tenuis</i>		climber	purple/blue
<i>Meeboldina scariosa</i>	Velvet rush	rush	red-brown

Scientific name	Common name	Form	Flower colour
<i>Melaleuca laterita</i>	Robin red-breast	shrub	red
<i>Melaleuca preissiana</i>	Stout paperbark	tree	white
<i>Melaleuca thymoides</i>		shrub	yellow
<i>Mesomelaena tetragona</i>	<i>Semaphore sedge</i>	sedge	brown spike
<i>Microlaena stipoides</i>	Weeping grass	grass	green
<i>Millotia tenuifolia</i>	Soft millotia	herb	cream
<i>Mirbelia dilatata</i>	Holly leaved mirbelia	shrub	purple
<i>Neurachne alopecuroidea</i>	Foxtail mulga grass	grass	greyish
<i>Olearia axillaris</i>	Coastal daisy bush	shrub	yellow
<i>Opercularia apiciflora</i>		herb	vary
<i>Opercularia echinocephala</i>	Bristly-headed stinkweed	herb	green/pink
<i>Opercularia hispidula</i>	Hispid stinkweed	herb	vary
<i>Opercularia vaginata</i>	Dog weed	herb	green/yellow
<i>Orthrosanthus laxis</i>		herb	purple
<i>Orthrosanthus polystachys</i>	Many spike orthrosanthus	herb	purple
<i>Paracaleana nigrita</i>	Flying duck	orchid	red/green
<i>Paraserianthes lophantha</i>	Albizia	tree	green/yellow
<i>Patersonia babianoides</i>		herb	purple
<i>Patersonia occidentalis</i>	Purple flag	herb	purple
<i>Patersonia umbrosa</i> var. <i>xanthina</i>	Yellow flags	herb	yellow
<i>Pentapeltis peltigera</i>		herb	white
<i>Persoonia elliptica</i>	Spreading snottygobble	shrub	yellow
<i>Persoonia longifolia</i>	Snottygobble	shrub/tree	yellow
<i>Petrophile lineararis</i>	Pixie mops	shrub	pink
<i>Philotheca spicata</i>	Pepper and salt	shrub	pink
<i>Phlebocarya ciliata</i>		tufty	white/brown
<i>Phyllanthus calycinus</i>	False boronia	shrub	white
<i>Pimelea rosea</i>	Rose banjine	shrub	pink
<i>Pimelea</i> sp.		shrub	light pink
<i>Pimelea spectabilis</i>	Bunjong	shrub	white
<i>Platysace tenuissima</i>		herb	white
<i>Poaceae</i> sp.		grass	
<i>Podocarpus drouynianus</i>	Emu bush	shrub	yellow
<i>Podotheca angustifolia</i>	Sticky longheads	herb	yellow
<i>Poranthera huegelii</i>		shrub	white
<i>Prasophyllum brownii</i>	Christmas leek	herb	white/green
<i>Prasophyllum</i> sp.	Leek orchid	herb	white
<i>Pteridium esculentum</i>	Bracken fern	herb	
<i>Pterostylis nana</i>	Snail orchid	herb	white/green
<i>Pterostylis vittata</i>	Banded greenhood	herb	white/green
<i>Ptilotus drummondii</i>	Pussytail	herb	white & pink
<i>Ptilotus manglesii</i>	Pom poms	herb	pink
<i>Pultenaea</i> sp.		shrub	yellow/red
<i>Pyrorchis nigricans</i>	Red beaks	herb	red
<i>Quinetia urvillei</i>		herb	pink
<i>Ranunculus colonorum</i>	Common buttercup	herb	yellow
<i>Rhodanthe citrina</i>		herb	yellow
<i>Ricinocarpus glaucus</i>	Wedding bush	shrub	white

Scientific name	Common name	Form	Flower colour
<i>Scaevola calliptera</i>		gcover	purple
<i>Scaevola microphylla</i>	Small leaved scaevola	herb	purple
<i>Senecio</i> sp.		herb	yellow
<i>Sowerbaea laxiflora</i>	Purple tassels	tufted	purple
<i>Sphenotoma capitatum</i>		shrub	white
<i>Spyridium globulosum</i>	Basket bush	shrub	cream
<i>Stackhousia monogyna</i>	White candles	herb	white
<i>Stylidium amoenum</i>	Lovely trigger plant	herb	purple
<i>Stylidium dichotomum</i>	Pins-and-needles	herb	white
<i>Stylidium diversifolium</i>	Touch-me-not	herb	white
<i>Stylidium junceum</i>	Reed trigger plant	herb	pink
<i>Stylidium piliferum</i>	Common butterfly triggerplant	herb	cream
<i>Stylidium schoenoides</i>	Cow kicks	herb	white
<i>Stylidium</i> sp.		herb	orange
<i>Stypantra glauca</i>	Blind grass	herb	purple
<i>Taxandria juniperina</i>	Wattie	tree	white
<i>Taxandria linearifolia</i>	Swamp peppermint	shrub	white
<i>Taxandria parviceps</i>	Fine tea tree	shrub	white
<i>Tempeltonia retusa</i>	Cockies tongues	shrub	red
<i>Tetraria capillaris</i>	Hair sedge	sedge	brown
<i>Tetraria octandra</i>		sedge	brown/black
<i>Tetrarrhena laevis</i>	Forest ricegrass	grass	green
<i>Tetradlea setigera</i>		shrub	pink
<i>Thelymitra</i> sp.	Sun orchid	herb	
<i>Thomasia macrocarpa</i>	Large fruited thomasia	shrub	purple
<i>Thomasia paniculata</i>		shrub	purple
<i>Thomasia</i> sp.		shrub	purple
<i>Threlkeldia diffusa</i>	Coast bonefruit	herb	red fruit
<i>Thysanotus arbuscula</i>		lily	purple
<i>Thysanotus multiflorus</i>	Many flowered fringe lily	lily	purple
<i>Thysanotus</i> sp. (<i>patersonii/manglesoides</i>)		lily	purple
<i>Trachymene pilosa</i>	Native parsnip	herb	white
<i>Tremandra diffusa</i>		shrub	white or pink
<i>Tremandra stelligera</i>		shrub	pink to purple
<i>Trichocline spathulata</i>	Native gerbera	herb	purple
<i>Tripterococcus brunonis</i>	Winged stackhousia	herb	yellow
<i>Trymalium floribundum</i>	Soapbush	tree	cream
<i>Trymalium ledifolium</i>		shrub	cream
<i>Velleia trinervis</i>		herb	yellow
<i>Villarsia latifolia</i>	Marshwort	herb	yellow
<i>Villarsia parnassifolia</i>		herb	yellow
<i>Viminaria juncea</i>	Swishbush	shrub	red yellow
<i>Xanthorrhoea gracilis</i>	Graceful grasstree	grasstree	cream
<i>Xanthorrhoea preissii</i>	Grasstree or Balga	grasstree	cream
<i>Xanthosia candida</i>		herb	vary
<i>Xanthosia huegelii</i>		herb	vary
<i>Xanthosia tasmanica</i>		herb	vary

This list is not exhaustive. It is based on species identified at Wilyabrup Reserve identified by Andrew Webb and at Parkwater Estate and Lot 7 Woodlands Rd by Jenny Stevens. The other species were noted by Cassandra Jury while completing foreshore assessments.

Appendix 3. Common weeds found in the study area

Name	Common name
* <i>Agapanthus praecox</i>	Agapanthus
* <i>Amaryllis belladonna</i>	Easter lily
* <i>Ammophila arenaria</i>	Marram grass
* <i>Anagalis avensis</i>	Pimpernel
* <i>Arctotheca calendula</i>	Capeweed
* <i>Arundo donax</i>	Giant reed
* <i>Asparagus asparagoides</i>	Bridal creeper
* <i>Avena barbata</i>	Bearded oat
* <i>Brassica tournefortii</i>	Mediterranean turnip
* <i>Briza maxima</i>	Blowfly grass
* <i>Briza minor</i>	Shivery grass
* <i>Bromus</i> spp.	Brome grass
* <i>Cakile maritima</i>	Sea rocket
* <i>Carduus</i> spp.	Scotch thistle
* <i>Cerastium glomeratum</i>	Mouse ears
* <i>Conyza albida</i>	Fleabane
* <i>Crepis</i> spp.	Hawksbeard
* <i>Cynodon dactylon</i> var. <i>dactylon</i>	Couch grass
* <i>Cyperus</i> spp.	
* <i>Ehrharta longiflora</i>	Annual veldt grass
* <i>Ehrharta villosa</i>	Pip grass
* <i>Emex australis</i>	Doublegee
* <i>Erythrina sykesii</i>	Coral tree
* <i>Euphorbia paralias</i>	Sea spurge
* <i>Euphorbia peplus</i>	Petty spurge
* <i>Euphorbia terracina</i>	Geraldton carnation weed
* <i>Ficus carica</i>	Edible fig
* <i>Gladiolus undulatus</i>	Wavy gladioli
* <i>Hedera helix</i>	Ivy
* <i>Holcus lanatus</i>	Yorkshire fog
* <i>Hordeum</i> spp.	Barley grass
* <i>Hypochaeris glabra</i>	Flatweed
* <i>Isolepis prolifera</i>	Budding club rush
* <i>Juncus articulatus</i>	Jointed rush
* <i>Juncus microcephalus</i>	
* <i>Lagarus ovatus</i>	Hare tail grass
* <i>Leptospermum laevigatum</i>	Victorian tea tree
* <i>Lolium perenne</i>	Perennial rye grass
* <i>Lotus</i> spp.	Lotus
* <i>Mentha diemenica</i>	Garden mint
* <i>Mentha pulegium</i>	Pennyroyal
* <i>Modiola caroliniana</i>	Red flowered mallow
* <i>Monadenia bracteata</i>	South African orchid
* <i>Morus nigra</i>	Mulberry
* <i>Olea europaea</i>	Olive

Name	Common name
* <i>Orbanche minor</i>	Lesser broomrape
* <i>Oxalis pes-caprae</i>	Soursob
* <i>Oxalis purpurea</i>	Mauve oxalis
* <i>Paspalum dilatatum</i>	Paspalum
* <i>Passiflora edulis</i>	Passionfruit
* <i>Pelargonium capitatum</i>	Rose pelargonium
* <i>Pennisetum clandestinum</i>	Kikuyu
* <i>Petrorhagia velutina</i>	Velvet pink
* <i>Phalaris aquatica</i>	Canary grass
* <i>Physalis minima</i>	Chinese gooseberry
* <i>Pinus spp.</i>	Pine tree
* <i>Plantago lanceolata</i>	Ribwort plantain
* <i>Psuedognaphalium luteoalbum</i>	Jersey cudweed
* <i>Ranunculus muricatus</i>	
* <i>Raphanus raphanistrum</i>	Wild radish
* <i>Romulea rosea</i>	Guilford grass
* <i>Rorippa nasturtium-aquaticum</i>	Watercress
* <i>Rubus spp.</i>	Blackberry
* <i>Rumex spp.</i>	Dock
* <i>Samolus valerandi</i>	Water pimpernel
* <i>Senecio elegans</i>	Purple groundsel
* <i>Silene gallica var. gallica</i>	Silene
* <i>Solanum linnaeanum</i>	Apple of Sodom
* <i>Solanum nigrum</i>	Nightshade
* <i>Sparaxis bulbifera</i>	Freesia
* <i>Stellaria media</i>	Chickweed
* <i>Stenotaphrum secundatum</i>	Buffalo grass
* <i>Tetragonia decumbens</i>	Sea spinach
* <i>Trifolium spp.</i>	Clover
* <i>Vinca major</i>	Vinca
* <i>Vitus sp.</i>	Grape
* <i>Watsonia meriana</i>	Watsonia
* <i>Zantedeschia aethiopica</i>	Arum lily

Appendix 4. Useful contacts and phone numbers

Cape to Cape Catchments Group
27 Tunbridge Street, Margaret River
PO Box 1749, Margaret River, 6285
Ph: 9757 2202
Fax: 9757 3740
Email: rivercare@capetocape.org.au

Department of Agriculture and Food (Busselton)
RSM 184, Busselton, 6280
Ph: 9752 1688
Web: <http://www.agric.wa.gov.au>

Department of Environment and Conservation (Busselton)
14 Queen Street, Busselton, 6280
Ph: 9752 1677
Web: <http://www.naturebase.com.au> and
<http://www.environment.wa.gov.au>

Department of Water (Busselton)
72 Duchess St, Busselton
PO Box 269, Busselton, 6280
Ph: 9781 0111
Fax: 9754 4335
Web: <http://www.water.wa.gov.au>

Ribbons of Blue
Ph: 9757 2202
Web: <http://www.wrc.wa.gov.au/ribbons>

Shire of Busselton
Southern Dve, Busselton
Locked Bag 1, Busselton WA 6280
Ph: 9781 0444
Fax: 9752 4958
Web: <http://www.busselton.wa.gov.au>

Shire of Augusta-Margaret River
Townview Terrace, Margaret River
PO Box 61, Margaret River, 6284
Ph: 9780 5255
Fax: 9757 2512
Web: <http://www.amrsc.wa.gov.au>

Department of Indigenous Affairs
129 Aberdeen Street, Albany
Ph: 9842 3000
Fax: 9842 3517
Web: <http://www.dia.wa.gov.au>

South West Aboriginal Land & Sea Council
1490 Albany Highway, Cannington
Ph: 9358 7400
Fax: 9358 7499
Web: <http://www.noongar.org.au>