Boodjidup Brook Action Plan

Cape to Cape Catchments Group

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THE GOVERNMENT OF WESTERN AUSTRALIA

Boodjidup Brook
Action Plan

Prepared for the Cape to Cape Catchments Group (CCG)

by

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How to use the Boodjidup Brook action plan

This river action plan (RAP) was prepared for the Cape to Cape Catchments Group and the Boodjidup Brook community. It contains a detailed description of the current health of the waterways 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 stream ecology. 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	Geographe Catchment Council
RoB	Ribbons of Blue
GPA	Gracetown Progress Association
NHT	Natural Heritage Trust
CALM	Department of Conservation and Land Management (now DEC)
DEC	Department of Environment and Conservation
WRC	Water and Rivers Commission (now DoW)
DoE	Department of Environment (now DEC or DoW)
DoW	Department of Water
DAFWA	Department of Agriculture and Food WA
AMRSC	Augusta-Margaret River Shire Council
LBLCDC	Lower Blackwood Land Conservation District Committee
SWCC	South West Catchments Council

Acknowledgments

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The assistance provided by Andrew Webb of Department of Environment and Conservation in compiling a species list for the brook is much appreciated.

This river action plan has drawn extensively on previous river action plans developed by GeoCatch and the CCG. Special acknowledgment is extended to GeoCatch for developing the template and methodology used for this river action plan.

The project was funded by a joint initiative of the State and Australian Governments administered by the South West Catchments Council.

Reference details

The recommended reference for this publication is: Cape to Cape Catchments Group, 2009, *Boodjidup Brook action plan.*

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Summary

Boodjidup Brook is situated in the Cape to Cape subregion, rising just south of Rosa Brook Rd in State Forest and flowing to the ocean between Gnarabup and Redgate Beach. The brook has a main channel approximately 15 km long and many small tributaries totalling another 40 km. It has a catchment area of 60 km². Agricultural practices dominate landuse within the catchment (49%), with a mix of grazing (22%), dairy (4%), horticulture (3%) and viticulture (20%). Native vegetation, including National Park and remnant vegetation, makes up 36% of the catchment. 10% of the catchment area is made up of rural residential area which has a range of landuses. Other uses making up the remainder are plantation and services (Hunt *et al*., 2002).

The aim of the foreshore condition survey was to provide the community with information on the condition of the brook to assist and guide management. The surveys were conducted using the Foreshore Condition Assessment method developed by Dr Luke Pen and Margaret Scott (Pen & Scott, 1995). Many landholders assisted with the surveys.

A summary of the foreshore condition ratings and length of fencing required is presented in Tables 1 and 2 below.

The condition of the Boodjidup Brook varies considerably. Some areas are totally cleared of native vegetation and in parts actively eroding. Other areas have an overstorey of peppermint, karri and marri with little understorey except introduced grasses. Parts of the brook are within native vegetation that although grazed at some stage still contains many species of native understorey. The headwaters are wholly contained in State Forest which is in near pristine condition. The main channel has a near continuous overstorey of karri/peppermint forest until it reaches just east of Caves Road. The channel is severely incised and suffering from significant weed invasion from the end of the karri forest through to Devils Pool.

Key issues identified

Issues of concern identified during the foreshore surveys and community consultation were:

- Loss of native fringing vegetation and degradation of remaining vegetation by stock grazing and trampling.
- The effect of altered hydrology including declining rainfall and on-stream dams on the timing and quantity of flow and the ecology of the brook.
- Environmental and agricultural weeds threatening good vegetation.
- The planting of invasive non-local plants including deciduous trees which threaten the character of the area and have the potential to impact on brook ecology.
- Deep incision of the main channel as a result of increased flow from catchment clearing and removal of riparian vegetation.
- The fragmentation of habitats through the loss of vegetation connectivity and introduction of instream barriers to fish migration.

In response to these issues, recommendations have been made in this report to protect and improve the condition of the brook

General recommendations to protect and improve the health of Boodjidup Brook

It is recommended that landholders consider the following (advice is available from the CCG to assist):

- Make the commitment to care for the brook and its tributaries by retaining and protecting the remaining fringing vegetation.
- Fence the riparian zone of the brook to exclude stock permanently, or to achieve management that allows for bank stability and vegetation establishment and protection.
- Undertake management actions to abate erosion including control of stock access, allowing grasses to colonise to provide bank stability, revegetation with native species and/or construction of riffles to slow water velocity.
- Manage dams to minimise impacts on the timing and amount of flow. This can be achieved through the installation of a low flow bypass system or opening dam underwall pipes as soon as possible after stream flow begins in winter so that natural flows are maintained.
- Undertake planting of local native species in degraded areas of the brook and around dams to improve habitat and protect water quality.
- Avoid planting of non-local species, particularly those that self seed and have the potential to spread into areas of native vegetation. Where ornamental and horticultural plantings have spread to riparian and native bushland areas undertake control activities.
- Eradicate weeds, particularly invasive weeds that can dominate the riparian zone such as figs, arum lily and blackberry.
- Use management techniques that will minimise soil erosion and nutrient loss to waterways.
- When intensifying landuse minimise impacts on water quality and the fringing vegetation through ensuring adequate buffers and minimising clearing and erosion.

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

- Continue to encourage and support community efforts to fence the riparian zones to enable control of stock access.
- Continue to 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).
- Develop restoration sites to demonstrate effective bank stabilisation and revegetation techniques (particularly in areas infested with kikuyu).
- Work with the community, DEC and AMRSC to facilitate catchment wide weed and feral animal control.
- Work with the community, DoW and AMRSC to increase awareness of the impact of on-stream dams on the timing and amount of flow and potential impacts on stream ecology. Develop and publicise best practice management of dams to minimise impacts on stream ecology including supporting the installation of low flow dam bypass systems and fishways.
- In partnership with the DAFWA, promote management techniques that minimise soil erosion and nutrient loss to waterways, such as: buffer strips, soil testing and appropriate fertiliser regimes, and maximising vegetation cover on the soil.

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 actions such as community education and strategic planning.

A summary of the foreshore condition rating of the creeks is presented in Table 1. Table 2 indicates the length of fencing required to enable control of stock and protection of stream banks and vegetation.

Condition	Boodjidup Brook
	%
A (pristine)	15%
B (weedy)	38%
C (erosion prone/eroding)	30%
D (ditch)	17%

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

Condition	Boodjidup Brook
A grade	0 km
B grade	5.5 km
C grade	13 km
D grade	18 km

Table 2: Approximate length of Boodjidup Brook requiring fencing
(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 landuse 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.

Joint initiatives of the State and Federal Governments administered by SWCC provided the funding to complete this plan initiated by the CCG in 2007.

The 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 all the catchments which drain west into the Indian Ocean. 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 action plan are to:

- Engage landholders and the community in waterway management and increase awareness of the importance of healthy waterways and riparian vegetation;
- Provide a description of the current state of the brook and identify priority actions to improve and protect its health;
- 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, Boodjidup Brook was considered to include the main channel and its tributaries. The location of the study area is shown in Figure 1.

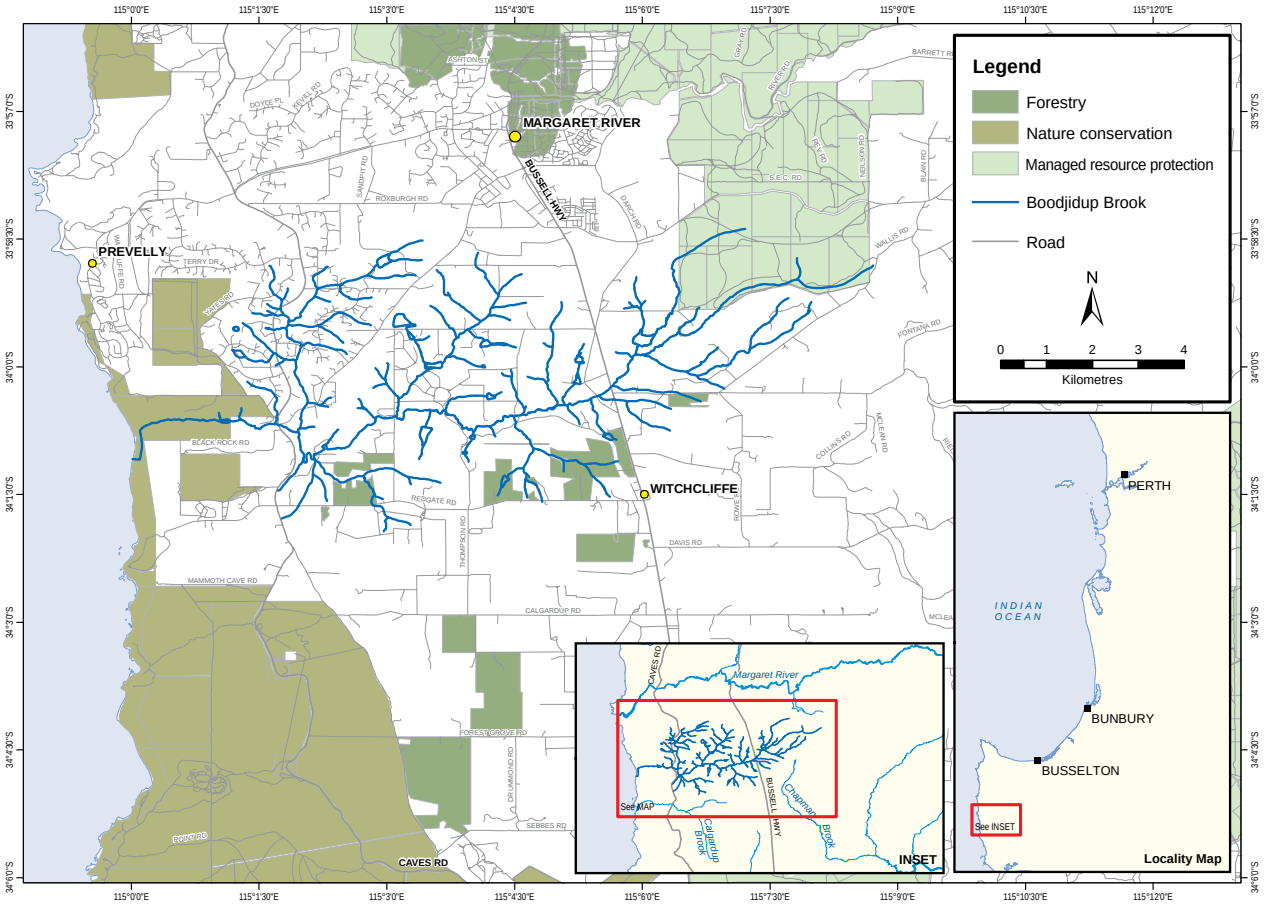


Figure 1: Study area.

The brook and its catchment

Boodjidup Brook is a small waterway with a catchment area of 60 km². The majority (49%) of the catchment is used for a range of agricultural purposes. Landuse in the area includes beef cattle and sheep grazing, dairy farming, vineyards and rural residential. The brook starts in State Forest and ends running through National Park between Gnarabup and Redgate Beach. Devils Pool west of Caves Rd is a wetland on the main channel of the brook and is an important feature.Landform and soils

Landform and soils

Boodjidup Brook occurs within two distinct landform units. Most of the creek system is within the Margaret River Plateau. The Margaret River Plateau is a gently undulating plateau dissected by a series of valley systems. It has formed on granitic and gneissic basement rock of the Leeuwin Block. It is 5 to 15 km wide and extends from Dunsborough to Augusta.

At the coast the creek enters the Leeuwin-Naturaliste Coast. The Leeuwin-Naturaliste Coast is a narrow strip of land 0.2 to 6 km wide, running along the coast between Cape Naturaliste and Cape Leeuwin. It is a discontinuous ridge of Tamala Limestone, with the underlying Leeuwin Block granite being exposed in places.

Within the Margaret River Plateau and the Leeuwin-Naturaliste Coast, the Boodjidup catchment is contained within four land systems as identified by Tille and Lantzke (1990). These land systems contain a variety of soil types. There is a brief description of the land systems and the soil types below (Tille & Lantzke, 1990).

Margaret River Plateau

Within the Margaret River Plateau the brook is found within the Wilyabrup Valleys and the Cowaramup Uplands land systems.

Wilyabrup Valleys land system

The Wilyabrup Valleys form undulating to rolling

[1] Land systems are defined as an area, or group of areas, throughout which there is a recurring pattern of topography, soil and vegetation (Tille and Lantzke, 1990).

low hills. Generally they have incised from an elevation of between 80-100 m above sea level down to between 20-40 m. The sideslopes of the valleys commonly have yellow-brown gravelly duplex and red-brown gravelly, gradational soils. Some patches of deep bleached sands, shallow gravel over ironstone or rocky soils occur on these slopes.

Cowaramup Uplands land system
The Cowaramup Uplands is a gently undulating to undulating plain, with an elevation ranging from 80-140 m above sea level. The major portion of the Cowaramup Uplands consists of flats and gentle slopes with yellow-brown gravelly duplex and pale grey mottled soils. Shallowly incised drainage depressions commonly have broad poorly drained floors, but are sometimes narrow and v-shaped. There are also poorly drained slight depressions, flats and low rises of deep bleached sands, areas with laterite cap at or near the surface, and shallow rocky soils.

Leeuwin-Naturaliste Coast
Within the Leeuwin-Naturaliste Coast the brook continues in the Wilyabrup Valleys surrounded by the Gracetown Ridge and Kilcarnup Dunes land systems.

Gracetown Ridge land system
The Gracetown Ridge consists of sand dunes that have lithified to form Tamala Limestone. It rises from sea level to a height of between 140-210 m above sea level. The Ridge has a gently undulating crest and moderately inclined sideslopes. Soils are deep, brownish yellow, siliceous sands. In some places, these sands are shallow with outcropping limestone. Although the Ridge rises directly from the ocean or granitic coastline, much of the western slopes is overlain by the more recent Kilcarnup Dunes land system.

Kilcarnup Dunes land system
The Kilcarnup Dunes usually rise from sea level to a height of 100 m, but can be as high as 200 m above sea level. The most recently formed dunes consist of pale calcareous sands and are sparsely vegetated. The older dunes tend to be more densely vegetated and have an accumulation of organic matter in the topsoil. Blowouts are sometimes present. In the oldest dunes, aeolianite has begun to form and this, combined with the build up of organic matter, has resulted in dark calcareous sands containing limestone rubble.

For more information on soil-landscape mapping, landuse 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 for the area from 1975 to 2003 is 1000 mm.

Available data supports the anecdotal evidence from landholders of decreased rainfall. The Margaret River long-term average (1929-1974) compared to the 1975 - 2003 average shows a 12 % decline in annual rainfall (Coppolina, undated). 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 flora of the Cape to Cape subregion is part of the Menzies and Warren subdistricts (Darling District) of the South-West Botanical Province (Beard, 1990). The Menzies subdistrict is characterised by woodland and forest of jarrah (*Eucalyptus marginata)*, or jarrah-marri (*E. marginata-Corymbia calophylla*) with blackbutt *(E. patens*), flooded gum (*E. rudis*) and bullich (*E. megacarpa*) found in some areas. The dominant vegetation communities of the Warren subdistrict are karri forest (*E. diversicolor*) on deep loams and forest of jarrah-marri on the leached sands. Extensive paperbarks (Melaleuca) and sedge swamps exist in the valleys.

The area is situated within a region known for its high level of species diversity with many species located only in the south-west. Around 61% of the Cape to Cape subregion is covered with native vegetation (South West Biodiversity Project, 2008). Much of this is within State Forest in the east of the region and along the coast. The central plain has been heavily cleared and the remaining remnants are generally small and dispersed.

Species composition within the vegetation communities changes along the brook depending on topography and soil type. When developing a species list for revegetation the first step should be to compile a list of species close to the area to be planted.

Appendix 2 contains a species list for Boodjidup Brook and identifies priority flora. Appendix 1 can be used as a guide to selecting species for revegetation.

Fauna

Riparian (creekline) vegetation provides a rich habitat for a variety of native fauna. Various types of fauna including mammals, frogs, reptiles and birds were sighted during foreshore assessments or have been noted by landholders or recorded in other reports. Feral species such as foxes, rabbits and cats were also noted. Any rehabilitation of creekline vegetation will help to enhance the suitability of all sites for native fauna habitat.

Some species of significance in the Boodjidup Brook catchment are listed top below.

Other fauna noted include the brushtail possum (*Trichosurus vulpecular*), the pygmy possum (*Ceratetus concinnus*), western grey kangaroo (*Macropus fuliginosus*), emus (*Dromaius novae-hollandiae*) and bats.

A fish and freshwater crustacean survey of Boodjidup Brook was carried out in 2007 by the Centre for Freshwater Fish Research. Six species of fish were found, three of which are obligate freshwater species that are endemic to the South West Coast Drainage Division of Western Australia (i.e. Western Mud Minnow (*Galaxiella munda*), Western Minnow (*Galaxias occidentalis*) and Nightfish (*Bostockia porosa*)); two species that are considered to be estuarine species (i.e. Swan River Goby (*Pseudogobius olorum*) and Western Hardyhead (*Leptatherina wallacei*)); and one introduced species (i.e. Eastern Mosquitofish (*Gambusia holbrooki*)). It is worth noting that Jaensch (1992) also recorded 11 individuals of the South-western Goby (*Afurcagobius suppositus*) in Devils Pool.

Four species of freshwater decapods (crayfish and shrimp) were captured within Boodjidup Brook, including two native freshwater crayfish species (i.e. Gilgie (*Cherax quinquecarinatus*) and Smooth Marron (*Cherax cainii)*), one introduced freshwater crayfish (i.e. Yabbie (*Cherax destructor)*) and the native Freshwater Shrimp (*Palaemonetes australis*).

Boodjidup Brook offers good habitat for native fish and crustaceans, such as shade, pools and riffles and in-stream habitat such as large woody debris and in-stream vegetation.

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).

Several sites in the Boodjidup Brook catchment have been registered with the Department of Indigenous Affairs (DIA). It is very likely that there

Common name	Scientific name	Conservation status
Water rat	*Hydromys chrysogaster*	P4
Western ringtail possum	*Pseudocheirus occidentalis*	Vulnerable
Southern brown bandicoot or quenda	*Isoodon obesulus*	Near threatened
Brushtail phascogale	*Phascogale tapoatafa tapoatafa*	Near threatened
Baudin's cockatoo	*Calyptorhynchus baudinii*	Vulnerable
Mud minnow	*Galaxiella munda*	Restricted
Freshwater mussel	*Westralunio carteri*	P4 Near threatened

Table 3: Significant fauna of Boodjidup Brook.

are many more sites of Aboriginal significance in the catchment that have not been registered as this area and waterways are of particular importance to Nyungar people.

Consultation with the local Aboriginal 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. Gold was found in Boodjidup Brook in the early 1890s with official claims being laid in 1896. Gold rush claims were made across large sections from east of Bussell Highway through to west of Caves Road. The gold rush was short lived with landholders returning to concentrate on grazing. In the mid to late 1920s three group settlements were established in the catchment, Groups 57, 63 and 72.

Vineyards started to develop in the catchment from 1975. The catchment is now home to a number of highly regarded wineries.

Population growth

The Shire of Augusta-Margaret River is growing rapidly, with an average growth rate for 2001-2006 of 3.3%. This compares to the WA average for the same period of 1.6% per annum (ABS, *Regional Population Growth 2001-2006*). This population growth across the Shire 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 Boodjidup Brook catchment, including accommodation and cellar doors.

The catchment has a spectacular coastline where 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 Boodjidup Brook are privately owned, and corresponding lot and location numbers are shown on the maps in Section 7. The brook also flows through a number of reserves and National Park

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 Boodjidup 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 Boodjidup Brook is listed in Appendix 2.

Habitat zones

Permanent pools

Over the summer season the only water in the brook is in deep permanent pools (such as Devils Pool), dams and the estuary. The pools provide an essential summer drought refuge for many aquatic animals, including waterbirds, turtles, water rats, fish, crayfish, shrimps 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 brook. Most years floodplains are inundated to some degree by floodwaters, creating a seasonal

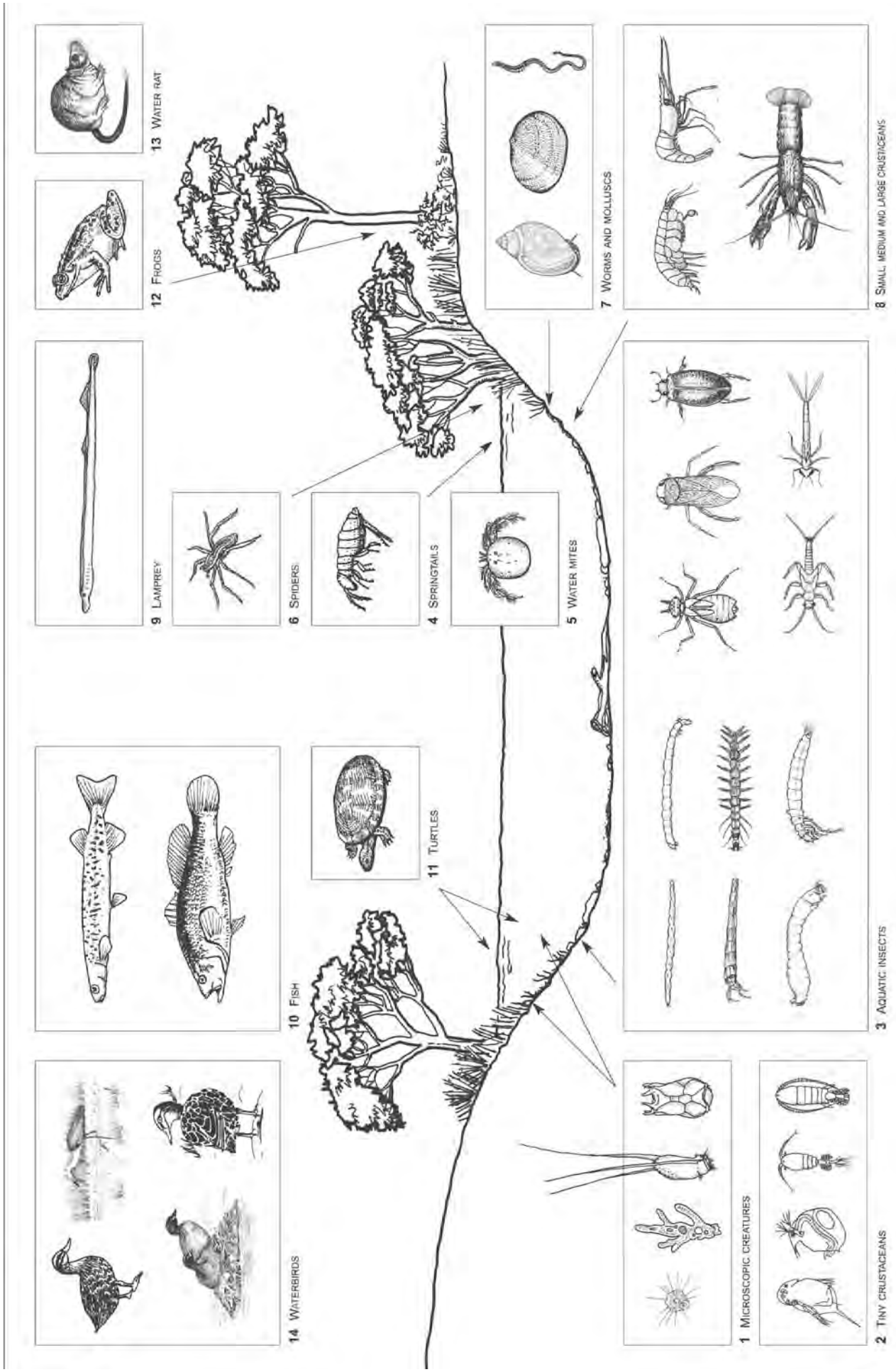


Figure 2. River fauna of south-western Western Australia.

habitat which may be used for feeding and breeding by a variety of animals such as tiny crustaceans, burrowing crayfish, birds and frogs. 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 brook 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 the brook. 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 creek 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.

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 macroinvertebrates and hunting spiders, as well as cover for shrimps and crayfish.

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 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 in the Coppin Grove area on Boodjidup 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 creek system, such as tributaries, 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, 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. Two community meetings were held.

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, 1999). 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 grasstrees, 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.

Variation: The Pen-Scott method is not ideally suited to smaller waterways like the Boodjidup Brook. 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.

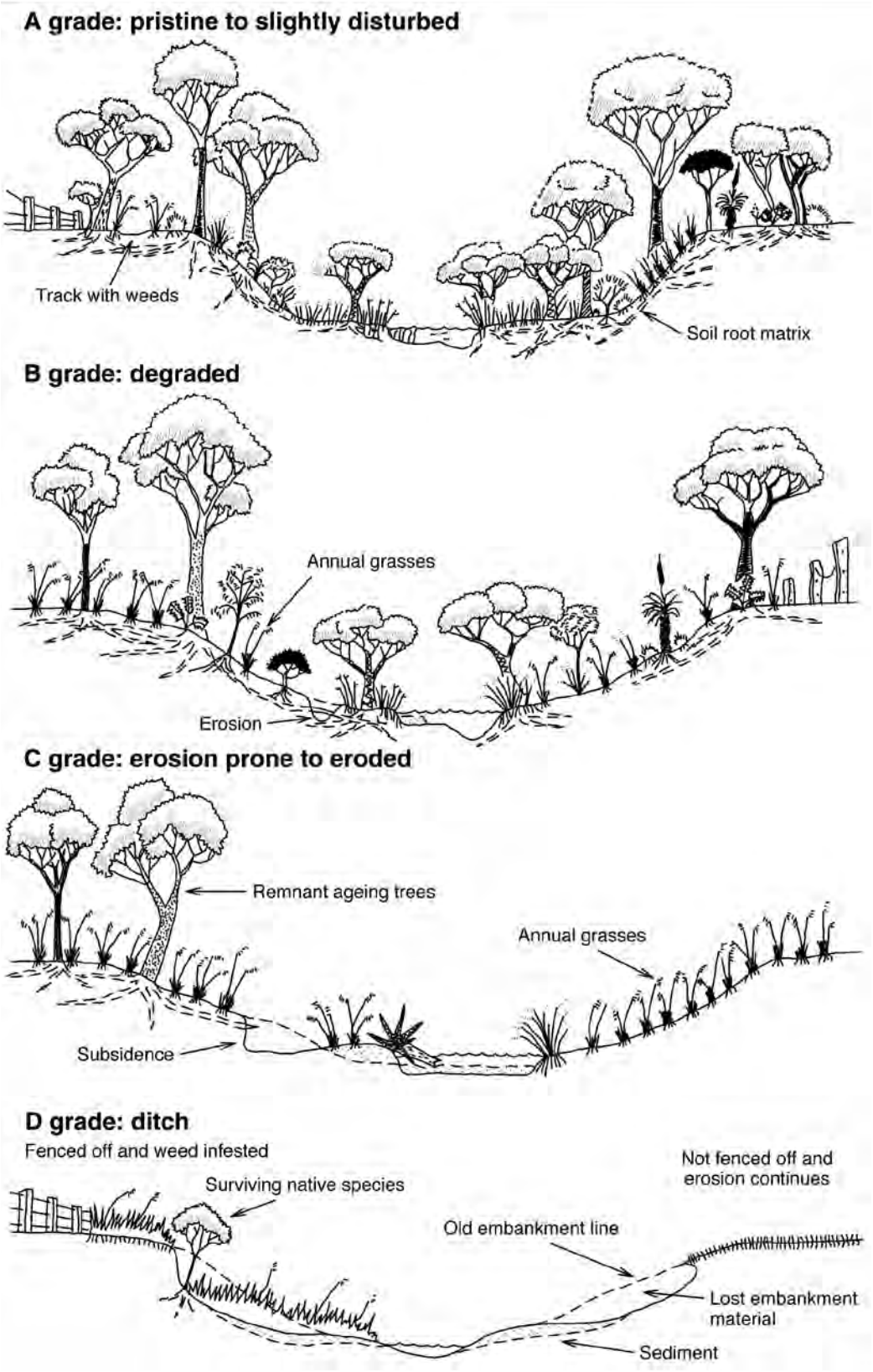


Figure 3: The four grades of river foreshore condition - (A) pristine to ditch (D).

A grade foreshore: Rocky riffle section of the main channel of the brook with a diverse range of rushes and sedges and dense understorey.

B1 grade foreshore: Native vegetation is still dominant on the banks with minor weed invasion (arum lily). It is a priority to control weeds as they will out-compete native species.

C2 grade foreshore: An overstorey of peppermints and marri remains and stock has removed all understorey vegetation including grasses, exposing and pugging the soil.

D2 grade foreshore: No fringing vegetation remains and stock have destabilised the banks. The channel is freely eroding.

5. Management issues

The Boodjidup 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, soils, past and current landuse and management practice. These interrelated issues are summarised below.

Stock access

Large sections of Boodjidup Brook are unfenced with stock accessing approximately 27% 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;
- destabilised banks and erosion; and
- poor water quality.

Stock are primarily grazing heavily degraded sections of the brook which no longer support native vegetation. The main issue in the catchment resulting from stock access is erosion from destabilised banks. Table 2 in the Summary details the length of fencing required.

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

Loss of native fringing vegetation

Much of the fringing vegetation on Boodjidup Brook is degraded to some degree through weed invasion, clearing and stock access. In many areas there is an overstorey of mature trees, mainly peppermint and marri trees, but little else.

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 stream 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 stream 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 stream 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 the brook 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, 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*., 2000).

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, edible fig, apple of Sodom, wavy gladiolus, watsonia, Sydney golden wattle and nightshade.

Grasses such as kikuyu and paspalum, and non-native rushes and sedges such as *Isolepis prolifera*, *Cyperus* sp and *Juncus microcephalus* are found throughout the catchment. Where there is no native vegetation these plants are stabilising the banks and providing some filtering of pollutants such as sediments. Where there is good quality native vegetation these plants change the structure of the vegetation and should be controlled.

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 region include poplars 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 number 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 which have been planted in the catchment and are becoming weedy as they thrive in our ideal conditions include: *Acacia melanoxylon* (blackwood) and *A.longifolia* (Sydney golden wattle). 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, vinca and watsonia. These garden plants are often referred to as 'garden escapees' and are threatening our native bushland. Plants such as freesias, dolichos pea, pittosporum and edible fig are spreading in areas along the brook 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. They have also developed a Woody Weed booklet which has detailed information on some of the most serious woody weeds. Appendix 1 provides a list of plant species local to the Boodjidup Brook catchment which are available for landscaping and revegetation.

Environmental flows

Throughout the foreshore surveys and community consultation concern was raised regarding the quantity and timing of flows in Boodjidup Brook. The potential impact of dams, groundwater abstraction and declining rainfall on stream flows was of particular concern. Flow period or the length of time water flows in our waterways has a large impact on the in-stream ecology. Many animals living in the brook and in the fringing vegetation rely on flows to complete reproductive cycles.

There are a number of in-stream dams on Boodjidup Brook and its tributaries, varying in size from small soaks up to 2 ha dams. Not all dams have bypass systems. An in-stream dam on an ephemeral (seasonal) waterway can have significant impacts on the timing and amount of flow downstream. If a dam doesn't have a bypass system such as an underwall scour valve or it is not operated correctly, the dam must fill to overflowing before the waterway 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. In-stream dams are also barriers to fish migration, isolating populations and preventing them reaching breeding areas.

The Boodjidup Brook catchment, along with other catchments in the Whicher Water Resource Region, has been proclaimed to ensure sustainable use of water resources. This involves licensing all water users and ensuring there are sufficient and sustainable environmental flows. All new dam applications will be assessed by the Department of Water.

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

Water quality

Boodjidup Brook is not regularly monitored. Two water quality studies have been undertaken in the past:

1. In 2001 the AMRSC, WRC and LBLCDC initiated a catchment water quality project which took samples from the creek over a six month period.

2. In 2002, as part of a wider Cape to Cape stream condition monitoring project, snapshots were taken from three sites on the creek in June, August and October. The main concern identified in this study was nitrate concentrations as they were consistently above Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines.

In Table 4 below, the average results from the DoW snapshot and the 2002 stream condition report 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.

PARAMETER	BOODJIDUP VALUES	ANZECC TRIGGER VALUE
Total nitrogen	0.2 to 2.5 mg/L	1.2 mg/L
Total phosphorous	0.01 to 0.06 mg/L	0.065 mg/L
Ammonia	0.01 to 0.08 mg/L	0.08 mg/L
Nitrate	0.2 to 1.7mg/L	0.15mg/L
Conductivity (salinity)	0.04 to 0.1 mS/cm	0.12 to 0.3 mS/cm
pH	7 to 7.5	6.5 to 8

Table 4: Water quality parameter values

Nutrients
Total nitrogen and ammonia is generally below the ANZECC trigger value. The nitrate levels in the brook were consistently above guidelines. Total phosphorous levels were consistently below the guidelines.

Salinity
The amount of dissolved salt in water is measured by conductivity. The Boodjidup Brook is considered fresh.

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

In conclusion the water quality in Boodjidup Brook is fair. Of concern are levels of nitrates. Nitrate and nitrite are naturally occurring oxides of nitrogen formed as part of the cycling of nitrogen between air, land and water environments. Nitrate is formed from the oxidation of organic wastes such as manure, by the action of nitrogen-fixing bacteria in soils. Nitrates can also be manufactured from chemicals and combined to form inorganic fertilisers. Water runoff from farming lands and urban areas to inland waterways containing fertilisers, detergents, faeces and decomposing organic matter has led to increased levels of nitrate in water bodies. High levels of nitrate can cause excessive plant growth, e.g. algal blooms.

Erosion and siltation

Stream bank and bed erosion is a problem on Boodjidup Brook. Incision, undercutting and bank slumpage is occurring in areas where native vegetation has been removed, where the brook has been channelised and stock are baring the banks and destabilising them. The cohesive soils and presence of rock has protected some areas from serious erosion.

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 causes 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.

Issues associated with erosion 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

Where to start

The main principles for foreshore (riparian) management are:

- conserve the best areas first;
- move on to those reaches 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 technical advice.

Stock control

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

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 9). 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 9 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 9 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 9 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.'

Grassy and bulbous weeds such as kikuyu and watsonia can become a problem once grazing is excluded and control may be required where they are out-competing native species or presenting a fire hazard.

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 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.*

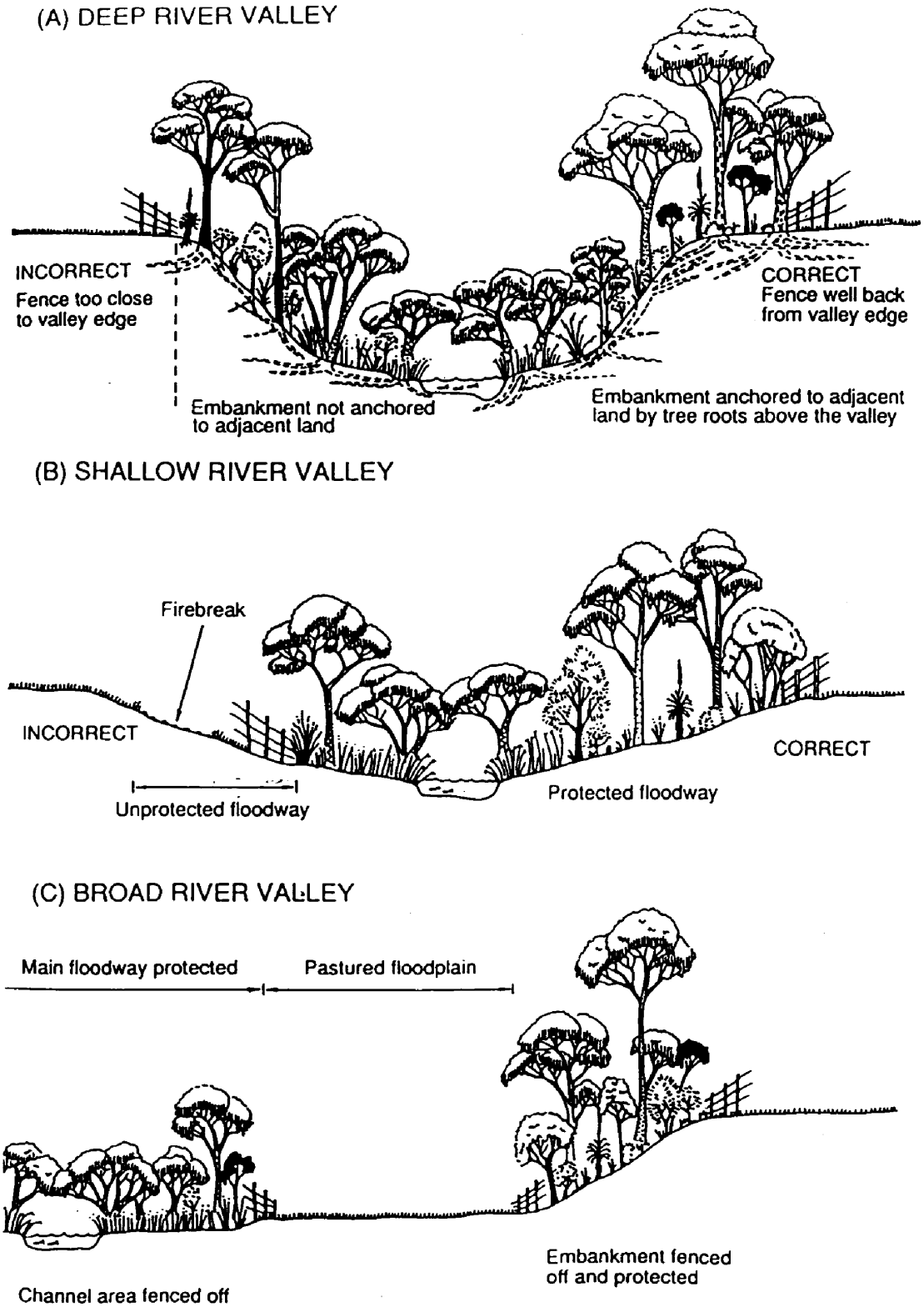


Figure 4: The correct placement of fences in relation to the river valley: (A) the deep river valley, (B) the shallow river valley and (C) the broad river valley with broad floodplain (APACE Green Skills & Pen, 1995).

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 creek that have potential for the collection of local provenance 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;
- 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 grown from local provenance seed. A rule of thumb guide for planting densities is 5-6 rushes per 1 m^2, 1 shrub per 1 m^2, and 1 tree every 3-5 m^2. 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 to summer, 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. A list of nurseries specialising in local native plants can be found in Appendix 1.

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 way of using 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 the brook, and in the catchments as a whole. Fencing the brook and restricting stock access will result in the need for extra weed control. This is also evident in properties where stock is not present. Bulbous weeds and grasses in particular should be controlled in ungrazed situations as they will spread into bushland.

Control of declared and environmental weeds should be a priority in the creek catchments and will need to be undertaken in a coordinated way, 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.

[2] The 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 the ecological integrity of existing native plant communities (GeoCatch, 1999).

- 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.

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 S*outhern Weeds and Their Control*, 2nd Edition (Moore & Wheeler, 2008), *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 for landholders in the south-west, providing 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 the creeks. 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 and stream banks will need to be stabilised. Herbicide control is most effective by spraying in summer when the blackberry is actively growing. A number of herbicides can be used including Grazon, metsulfuron and glyphosate. It can take up to 12 months for the chemical to take full effect. Further research is currently underway to develop effective biological controls.

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 transverse (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.

Kikuyu *(Pennisetum clandestinium),* buffalo grass (*Stenotaphrum secundatum*), paspalum sp. 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, poplars, pittosporum and Sydney golden wattle 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.

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. (2008) *Southern Weeds and Their Control,* 2nd Edition. Department of Agriculture, Bulletin No. 4744. 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

Best practice dam management can reduce the potential impacts of gully-wall dams on the stream ecology and downstream users and protect water quality in dams. Some recommended dam management practices include:

- The correct use of underwall pipes or bypass valves. 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.

- Retrofitting a bypass system to an existing dam if no underwall pipe is present. This could be a channel or pipe system which automatically bypasses low flows around the dam and into the creek. When constructing new gully-wall dams consider installing a bypass system. See Figure 5 below which depicts a channel low flow bypass system which also allows fish passage.
- Setting up a siphon system if an existing dam does not have an underwall pipe. 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 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. For more information see the 'Converting Dams into Living Wetland' brochure available from CCG.
- 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 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 crustaceans as they prey on them and reproduce more vigorously.

Investigation is required to determine the ecological impacts of altered timing and quantity of flows and water table changes.

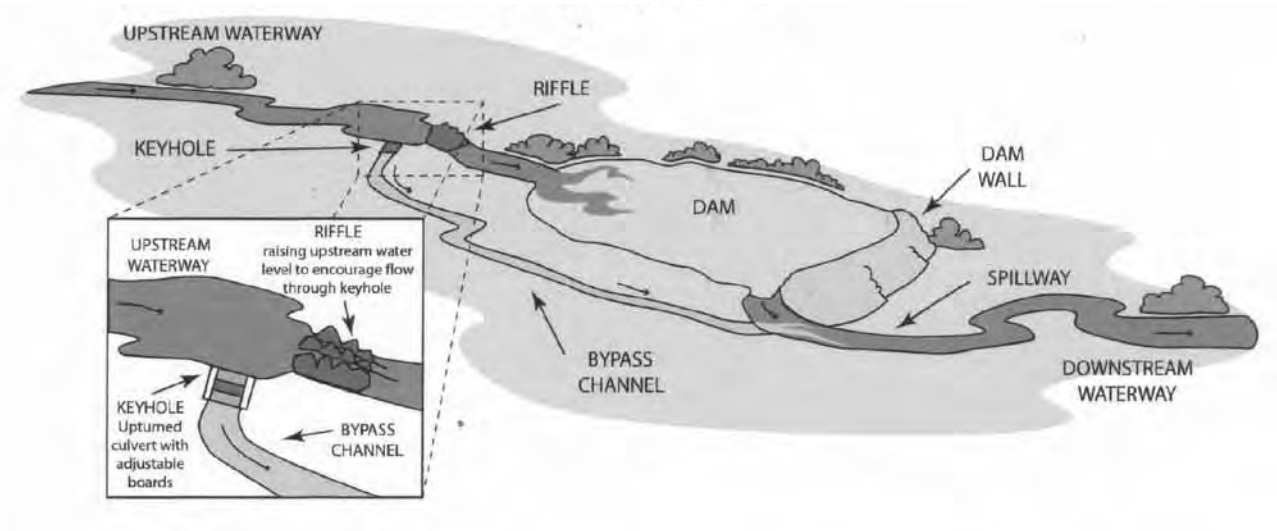


Figure 5: A low flow bypass and fish passage reinstatement design concept being trialled by the CCG

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.

Ongoing monitoring is required to monitor trends in all water quality parameters based on elevated levels of nitrates found in past sampling. Outlined below are a number of ways to 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 brook 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:

- 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 please contact DAFWA or the CCG.

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

A number of properties 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 DAFWA.

Managing stock access

Uncontrolled stock access to riparian areas contributes significantly to the amount of sediment and nutrients entering the brook. Stock bare the soil, create tracks and destabilise banks, increasing erosion. They also directly input nutrients into the creek 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.*

Erosion control

Strategies for controlling erosion include control of stock access, allowing grasses to colonise to provide bank stability, revegetation with native species and/or construction of riffles to slow water velocity.

It is important to remember that creeks 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. These are most relevant to eroding areas on the main channel.

Point bars

Once a stream bank becomes disturbed to the point where it is actively eroding, there is great 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 6).

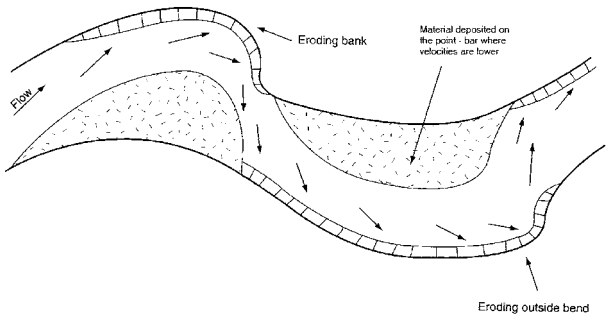


Figure 6: Outside bend bank erosion – Arrows mark the direction of flow showing that outside bends have the greatest erosion potential, so the meanders migrate downstream (Raine & Gardiner, 1995).

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 creek channel. As discussed previously, detailed stream surveys of the problem areas are essential before this type of restoration procedure is contemplated.

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 7. Previous experience has shown that supporting and protecting the toe of the bank can 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.

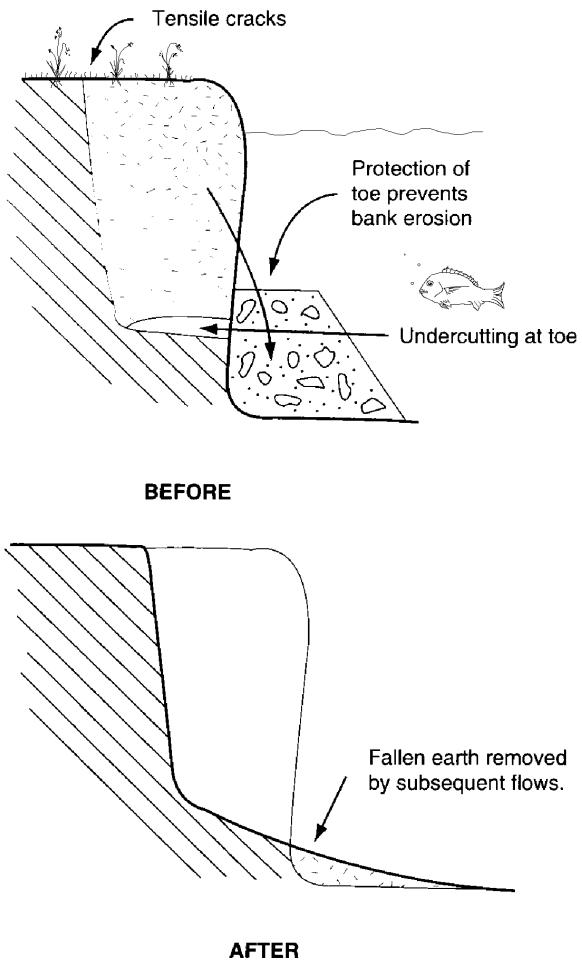


Figure 7: The use of structural works, such as a rock toe, will prevent the process of undercutting (adapted from Raine & Gardiner, 1995).

Bank slumping

Bank slumping can occur when poorly drained material within the bank becomes heavy with saturation and collapses into the stream channel (Figure 8). 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:

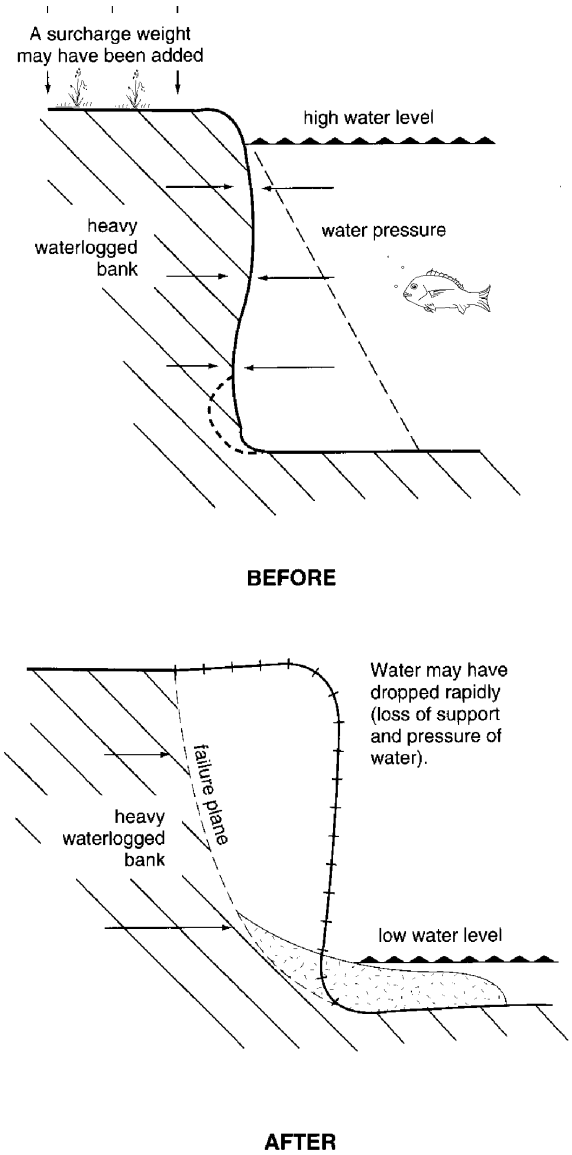


Figure 8: The process of bank slumping caused by excessive weight and lack of support (adapted from Raine & Gardiner, 1995).

- 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 brook. 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 9). 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.

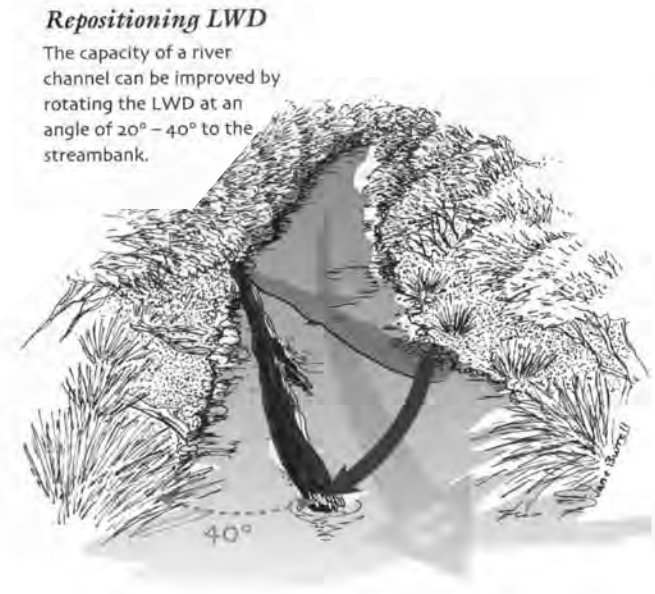


Figure 9: Repositioning large woody debris (Gippel et al., 1998).

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.
- Department of Water (2008) *Crossing Creeks: Stream Crossings on Farms.* Government of Western Australia.

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 there has been some success 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 CCG in partnership with the AMRSC and DAFWA has an ongoing Shire-wide fox control program for local landholders. For advice and assistance on feral animal control contact DAFWA, CCG 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 Boodjidup Brook. For a summary of the condition rating and length of creek foreshore requiring fencing to exclude stock, please see Table 1 and Table 2 in Summary.

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.

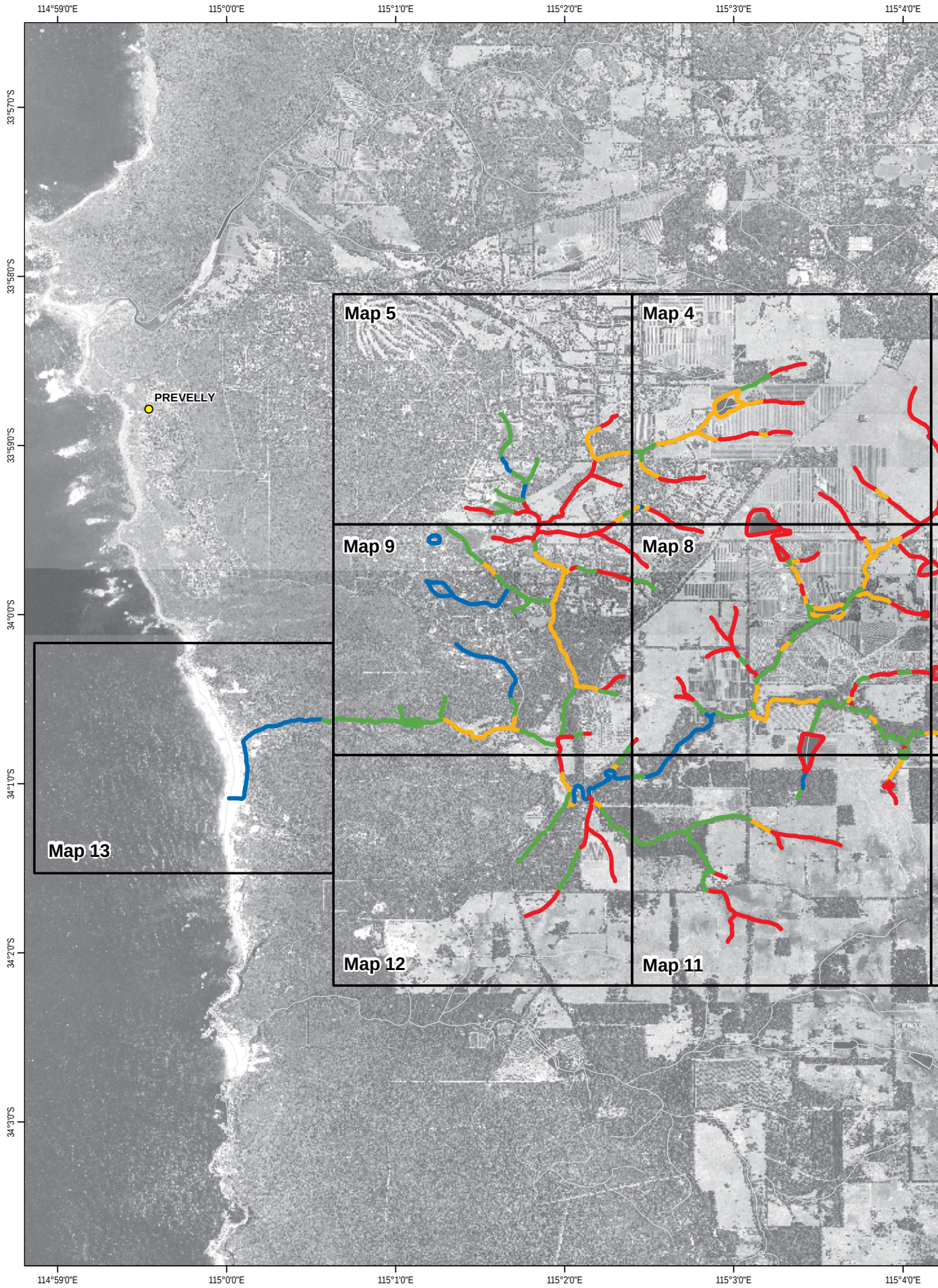
Management recommendations

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. Where necessary, 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 Shire of Augusta-Margaret River and Department of Indigenous Affairs and/or the South West Land and Sea Council (SWLSC) and local elders.

Technical advice and assistance is available from CCG to assist with the implementation of these actions.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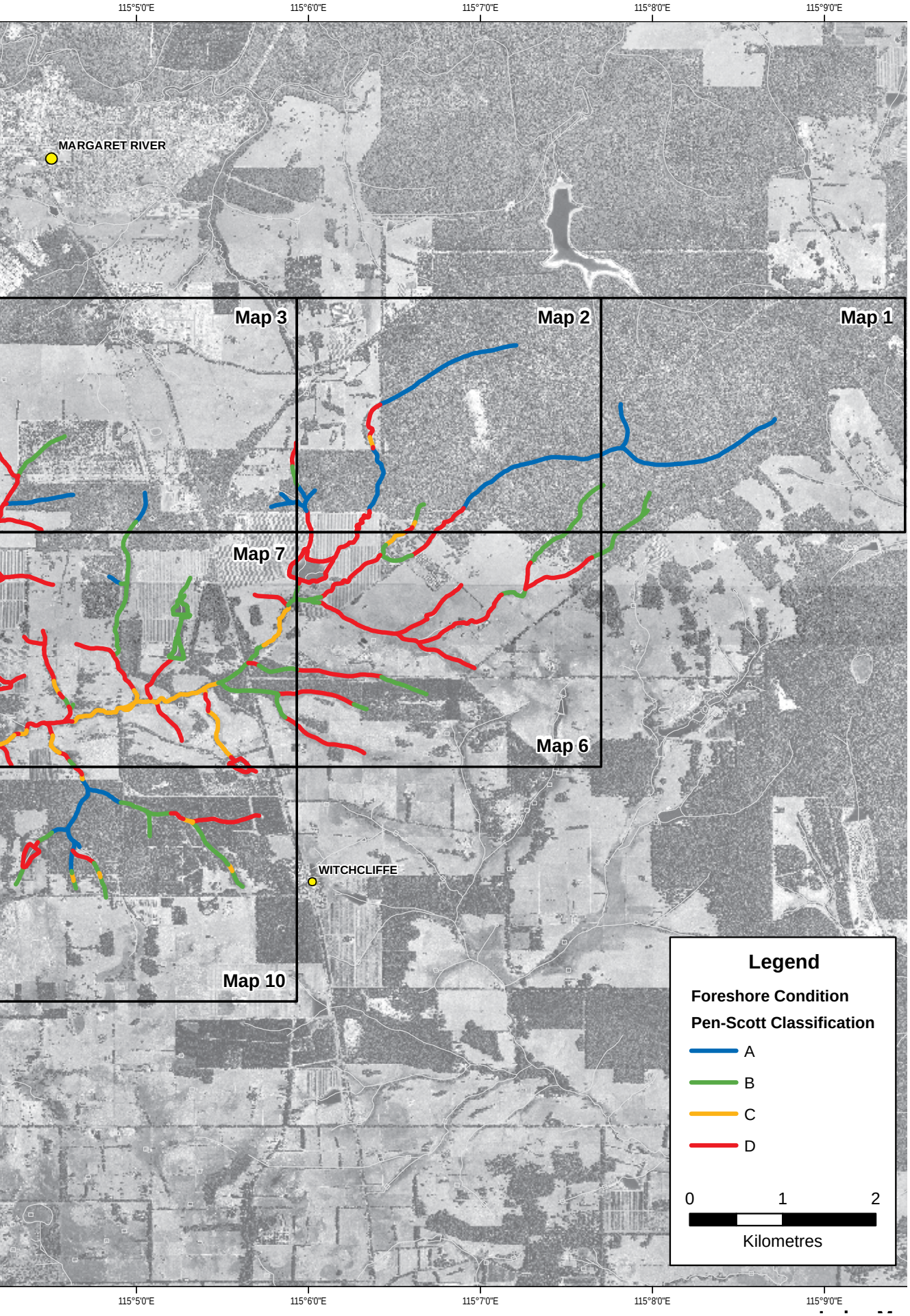
PREVELLY
Map 5
Map 4
Map 9
Map 8
Map 13
Map 12
Map 11


115°5'0"E
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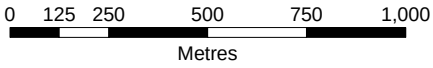
MARGARET RIVER
Map 3
Map 2
Map 1
Map 7
Map 6
WITCHCLIFFE
Map 10
Legend
Foreshore Condition
Pen-Scott Classification
A
B
C
D
0
1
2
Kilometres

Legend

Foreshore Condition

Pen-Scott (LBDS) Classification

- A1
- A2
- A3
- B1
- B2
- B3
- C1
- C2
- C3
- D1
- D2
- D3
- Creek
- Dam
- Formal crossing
- Informal crossing
- Fencing linework

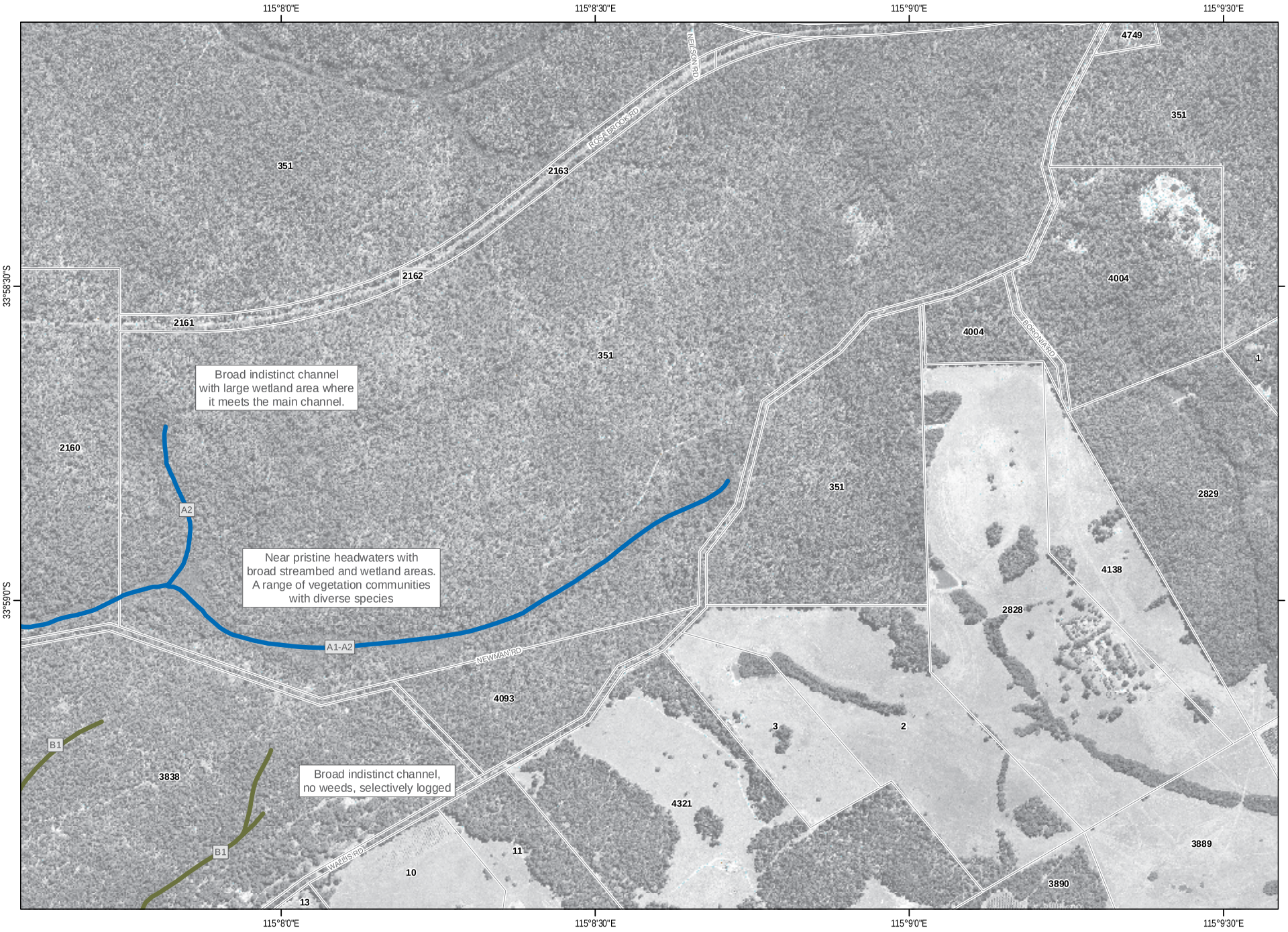


Map No. 1

Issues	Comments
Landuse and fencing	This section is the headwaters of Boodjidup Brook and is wholly within State Forest.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. The riparian zone is broad with poorly drained alluvial soils. In the very headwaters there are deep grey sandy soils which change to loam on this map. Erosion is not an issue in this area.
Native vegetation	Remnant vegetation in this area is in excellent condition. There are deep grey sandy soils either side of dense creekline vegetation dominated by a thicket of *Taxandria linearifolia, T.fragans, Homalospermum firmum* over sedges. This changes to a *Eucalyptus megacarpa* dominated community with large numbers of *Dasypogon hookeri* in the understorey.
Weeds	Due to limited disturbance and access to this area weeds are not present.
Other comments, special features	

Map 1: Management recommendations and advice

1. Monitor the area periodically to ensure weeds are not invading this near pristine section of the brook.
2. Ensure the area is protected in the long term and that any logging or gravel extraction in the State Forest does not impact on the riparian zone.



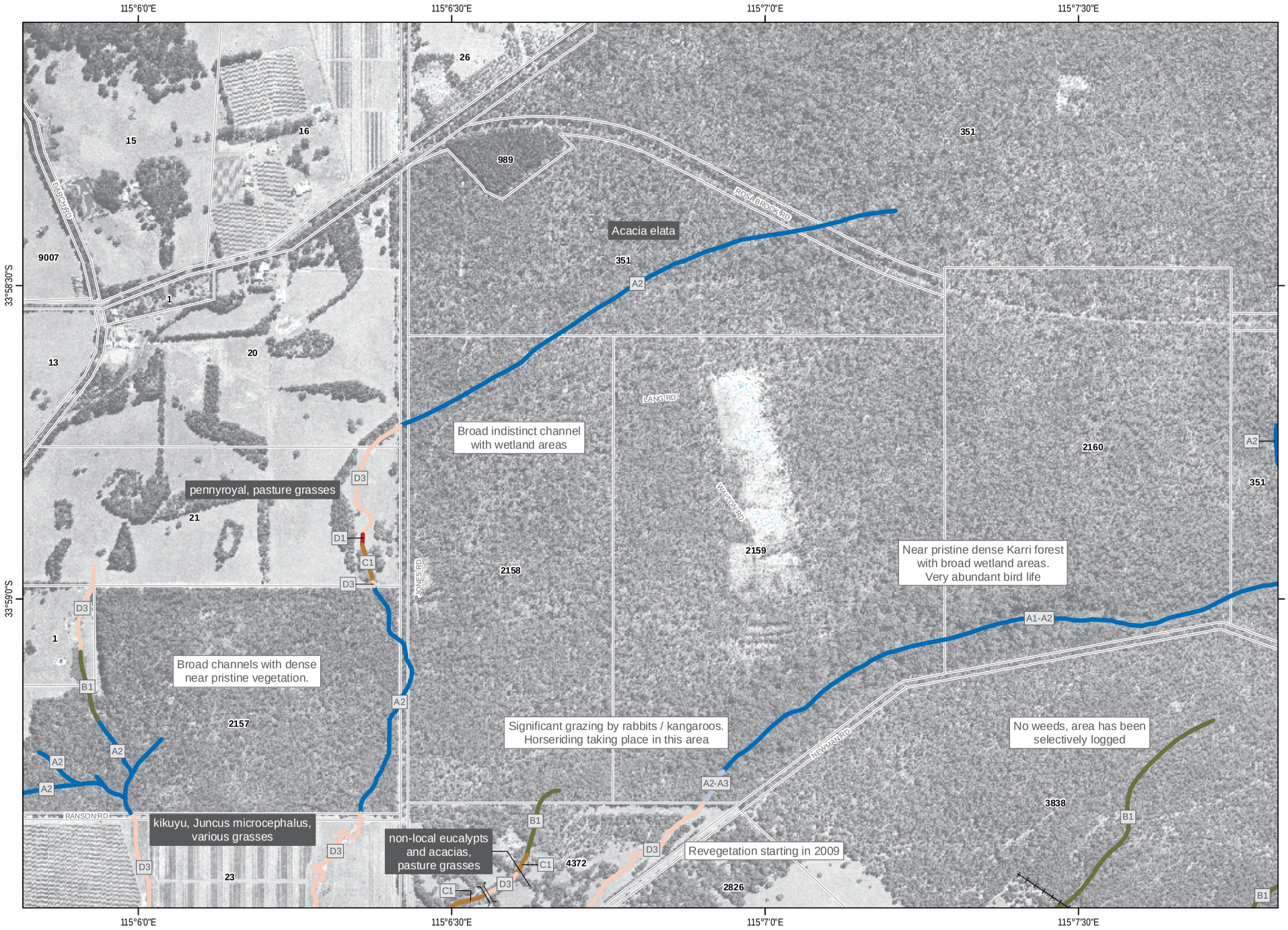
Boodjidup Brook Map 1

Map No. 2

Issues	Comments
Landuse and fencing	This section is largely contained in State Forest before entering private properties which are largely lifestyle blocks with some viticulture. The brook is grazed and unfenced on Location 2156. The brook is unfenced on all other locations but is not grazed.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. The riparian zone is broad with swampy floors with poorly drained alluvial soils. There is minor erosion in the State Forest near Location 4372 and on Locations 2156 and 4372 and Lot 23 due to small areas of bare and destabilised banks.
Native vegetation	The native vegetation is generally excellent in this section where it is contained in State Forest and on Location 2157. The eastern main channel starts as a broad dense creekline dominated by a thicket of *Taxandria linearifolia, Acacia divergens, Astartea fascicularis, Boronia molloyae* over dense sedges. It the becomes a dense *Eucalyptus diversicolor* forest moving into shallow ironstone based creekline with *Eucalyptus patens.* The northern tributary is a broad *Eucalyptus patens, Corymbia calophylla* dominated creekline.
Weeds	In the State Forest and on Location 2157 weeds are very limited. There is a large Acacia elata tree in the State Forest near the northern tributary. Dominant weeds on the other locations are pasture grasses, *Juncus microcephalus* and non-local acacias and eucalypts.
Other comments, special features	Birdlife was abundant in the dense karri forest. Two small areas will be revegetated on Location 4372 in 2009.

Map 2: Management recommendations and advice

1. Ongoing protection and maintenance of the State Forest and Location 2157 is a priority as it is rare to find riparian zones and surrounding bushland in excellent condition.
2. Arum lily is isolated in this section therefore should be eradicated as a priority.
3. Non-local acacias and eucalypts are self seeding in this section and species such as Acacia longifolia (Sydney golden wattle) should be removed as a priority.
4. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. As the best approach to achieve this is different for each situation it is recommended that advice is sought from CCG. Appendix 1 contains a list of local species suitable for planting in this area.
5. Fence the creek on Location 2156 to enable control of stock access. As the creek is not deeply eroded here keeping stock out may allow grasses to colonise and provide an easy solution to erosion. If only using grasses for erosion control it will be necessary to check that this measure is adequate to achieve erosion control aims. Alternatively techniques such as revegetation with native species can be used to control erosion while providing added biodiversity and aesthetic benefits. See Section 6 regarding fence location.



Boodjidup Brook Map 2

Map No. 3

Issues	Comments
Landuse and fencing	The landuses include grazing, viticulture and lifestyle on these tributaries. The section on Lot 1 is fenced as the vineyard is grazed by sheep. The remaining sections of the tributaries are unfenced with Lot 6 grazed by cattle.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. The riparian zone consists of poorly drained flats and broad swampy floors. Historical grazing practices and alterations to the channel have resulted in erosion. This is in areas where all native vegetation has been lost and the banks and bed of the brook have been exposed to water erosion.
Native vegetation	Native vegetation in this area varies from very good to extremely degraded. Where vegetation remains in a near natural state there is karri forest near the Rails to Trails and marri, peppermint in other areas.
Weeds	Dominant weeds are *Juncus microcephalus, Isolepis prolifera* and pasture grasses.
Other comments, special features	A new vineyard has been established on Lot 1. The riparian zone has been fenced and stage one of revegetation will begin in 2009. Location 1007 was not assessed, it was rated from the neighbouring property and aerial photography.

Map 3: Management recommendations and advice

1. The creek on Lot 6 is actively eroding. Controlling this erosion will require management of stock access. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.

2. The native vegetation on Location 2172 and Lot 6 should be monitored and any weeds identified controlled to protect the quality and integrity of this vegetation.

3. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. As the best approach to achieve this is different for each situation it is recommended that advice is sought from CCG. Appendix 1 contains a list of local species suitable for planting in this area

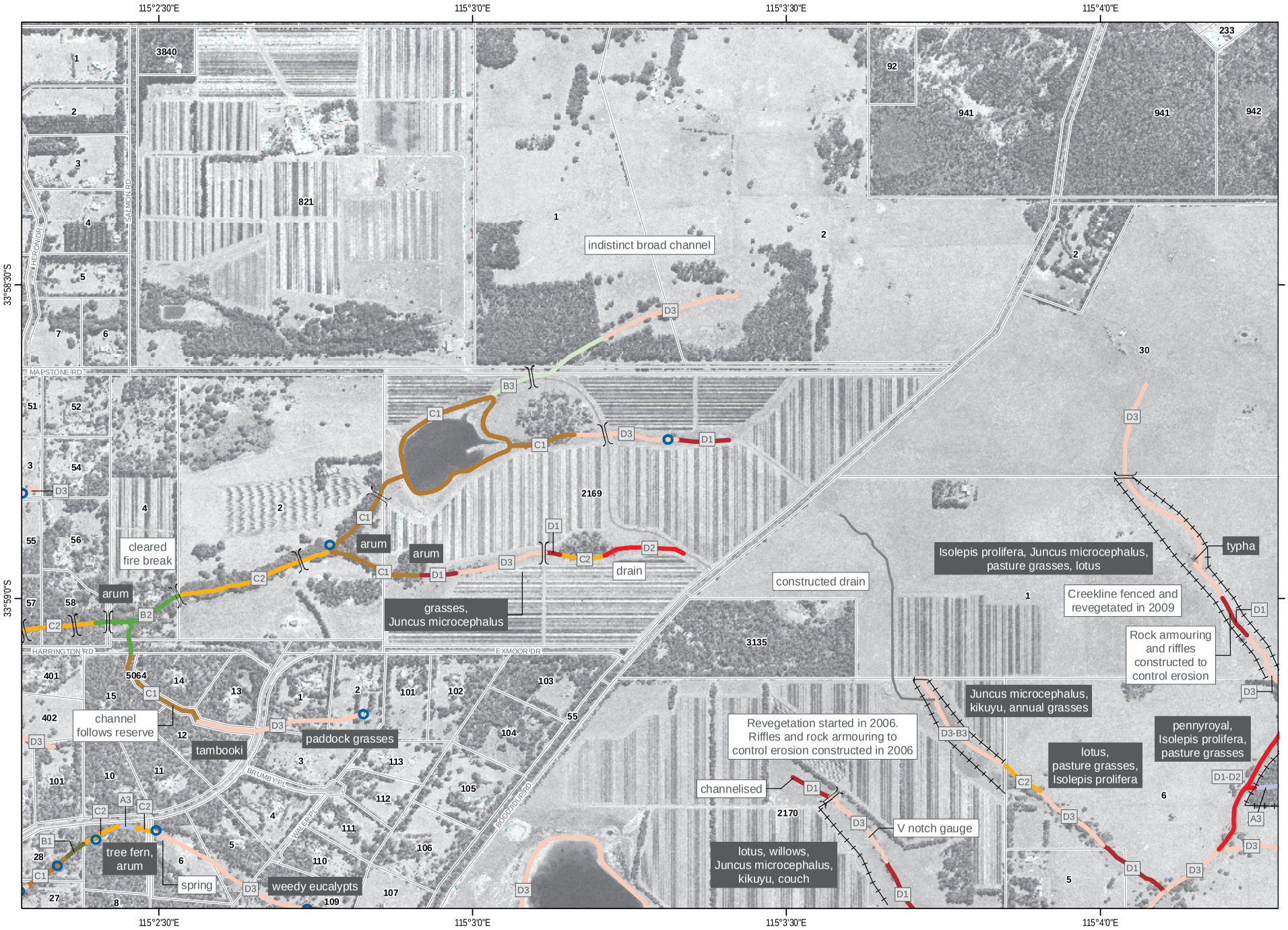
Boodjidup Brook Map 3

Map No. 4

Issues	Comments
Landuse and fencing	There are a number of tributaries on this map. Landuse is dominated by viticulture and special rural properties. The stream is unfenced.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. The riparian zone is primarily broad with poorly drained soils. Historical grazing practices have led to the loss of in-stream vegetation in some areas around Exmoor Drive. Erosion has been controlled in these areas by kikuyu grass that dominates the stream zone. Shadier areas such as Lot 2 are more erosion prone due to the lack of understorey vegetation. Alterations to the channel and increased drainage to reduce water logging have resulted in erosion in areas such as Lot 1. This erosion has largely been stabilised through rock placement, stock exclusion and revegetation.
Native vegetation	Remnant vegetation in this are is generally degraded, especially in the stream zone. Where vegetation is intact it is dominated by jarrah/marri overstorey with grass trees and peppermints making up the mid sections. Very little native groundcover or riparian vegetation remains.
Weeds	Dominant weeds are pasture grasses, tambooki grass, arum lily and Juncus *microcephalus.*
Other comments, special features	Most landholders have reported lower water flows and dam levels. Rehabilitation has been occurring on Lot 1 and Location 2170 for a number of years.

Map 4: Management recommendations and advice

1. Arum lily control has the potential to be very successful in this area while the infestation is at manageable levels.
2. Landholders in the special rural areas on Exmoor Drive could improve the environmental values of their stream by planting colonising species such as local native eucalypts and acacias. This would provide shade and weed management for future plantings of understorey and riparian species.
3. Manage dams to minimise the impact on timing and amount of creek flow and to protect water quality and create habitat. Maintain natural stream flows to protect downstream flora and fauna by opening dam underwall pipes as soon as the stream begins to flow in winter. If dams don't have underwall pipes install a siphon system or retrofit a low flow bypass system (see Section 6). Revegetate around dams with local native species to protect water quality and provide habitat for native fauna.
4. The creek on Lots 5 and 6 and Location 2170 is actively eroding. Controlling this erosion will require management of stock access. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.



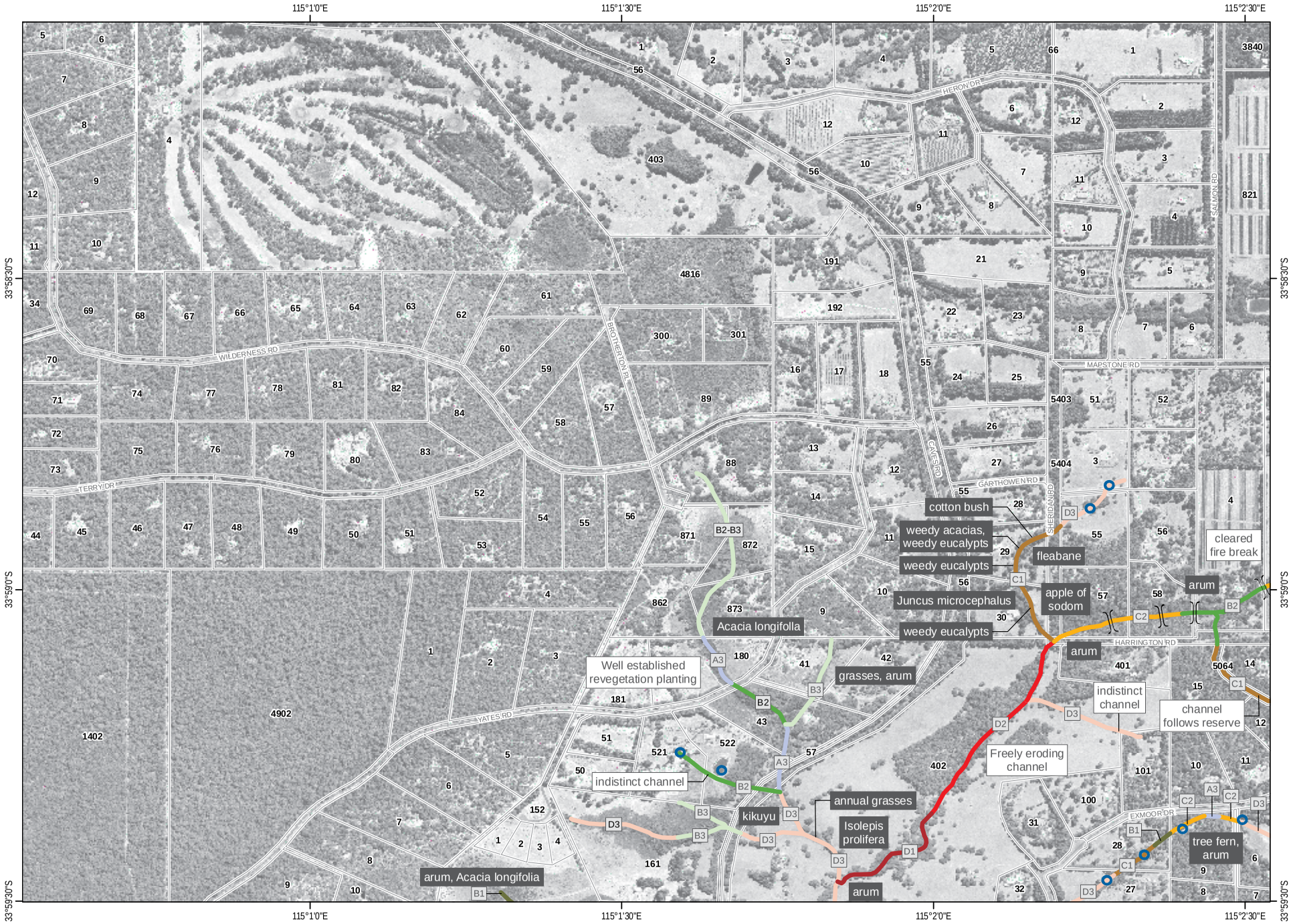
Boodjidup Brook Map 4

Map No. 5

Issues	Comments
Landuse and fencing	Landuse in this section is primarily special rural on formerly grazed farm land. The only remaining rural property is Lot 402 which is unfenced and grazed.
Landform soils and erosion	This section from west to east consists of the Cowaramup Uplands system including wet sandy flats with deep sandy wet soils, deep sandy rises with pale deep sands and Cowaramup vales with wet gravels and loams towards the east. East of Caves Rd historic (and current) grazing activity has degraded understorey vegetation and in loamy areas this has led to erosion and stream degradation. West of Caves Rd more of the understorey is intact and lower flows have prevented erosion problems.
Native vegetation	Much of the remnant vegetation east of Caves Rd has been degraded by grazing activity but an overstorey of marri/peppermint remains in some areas. West of Caves Rd there are some stretches in excellent condition with remnant jarrah/marri over *Lepidosperma* and paperbark.
Weeds	Arum lily is a problem east of Caves Rd particularly at the corner of Sheridan and Harrington Rds and throughout the stream zone on Lot 402. The landholders and CCG undertook arum control throughout this area in 2007.
Other comments, special features	Non-local eucalypts and acacias have become weedy on the special rural properties around Sheridan Road and Exmoor Drive.

Map 5: Management recommendations and advice

1. Arum control east of Caves Rd should be continued to help prevent the spread of this weed downstream.
2. Control of weedy eucalypts and acacias and their replacement with locally appropriate species would help reduce the risk of their establishment in more pristine areas and the National Park.
3. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. Appendix 1 contains a list of local species suitable for planting in this area.
4. The creek on Lot 402 is actively eroding. Controlling this erosion will require management of stock access. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.



Boodjidup Brook Map 5

Map No. 6

Issues	Comments
Landuse and fencing	There is a variety of landuse in the section of the brook including lifestyle, dairy, grazing and viticulture. The creeks are largely unfenced and are grazed on Locations 2822, 2824, 2826, 3857 and 2813, Lot 3 and part of Locations 2825 and 3838.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. The riparian zone is broad with swampy floors with poorly drained alluvial soils. Little erosion is present in the tributaries on this map as the creeks are broad, slowing the water velocity, and they are largely stabilised by kikuyu or native vegetation. Where grass has been removed from banks and where the creeks have been channelised (drained) there is minor erosion occurring.
Native vegetation	Little native vegetation remains on the creeks in this section. Some native vegetation remains on Locations 3838, 4372 and 2816. The vegetation comprises marri/peppermint overstorey with thickets of *Gastrolobium ebracteolatum*, tea tree and dense rush and sedge layers of *Meeboldina, Lepidosperma, Baumea* and *Chorizandra*.
Weeds	The main weeds of concern in this section are blackberry and non-local acacias and eucalypts, including *Acacia longifolia*. Other weeds include apple of Sodom, pennyroyal, perennial grasses, non-local rushes and sedges. There were a couple of arum lily.
Other comments, special features	Rehabilitation of the southern creekline on Location 2825 including fencing and revegetation is looking excellent. The dairy effluent settlement ponds on Location 2822 are close to the creekline. The water in the dam on Location 3857 was very brown and there looked to be heavy stocking the paddocks. The landholder of Location 2826 noted the stream runs almost year round.

Map 6: Management recommendations and advice

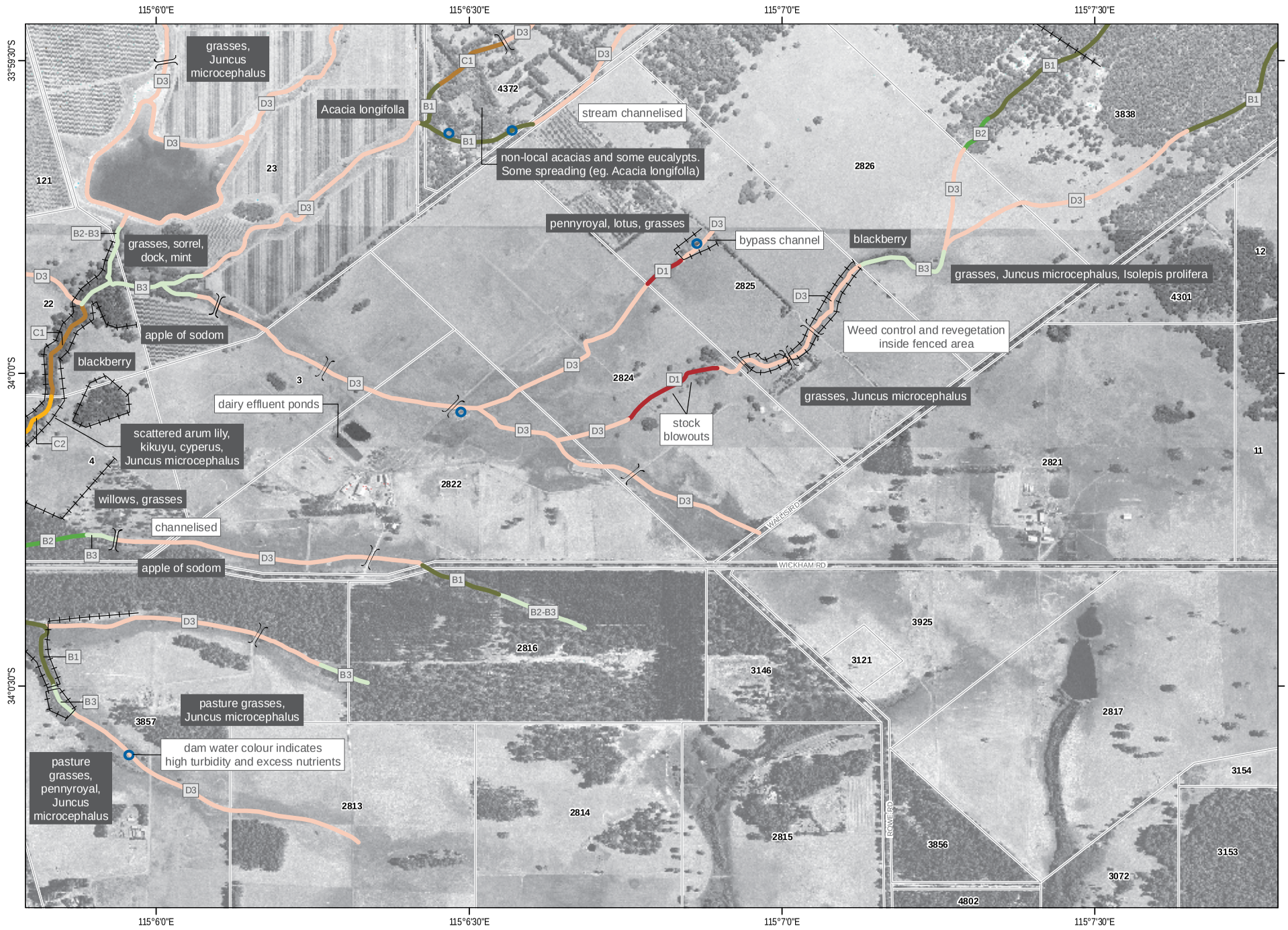
1. Consider fencing the creeks on Locations 2822, 2824, 2826, 3857 and 2813, Lot 3 and unfenced parts of Locations 2825 and 3838 to enable control of stock access. This will protect any remaining native vegetation, prevent serious erosion and protect water quality in dams and the brook. Perennial grasses stabilise banks but should be checked to ensure they are providing adequate erosion control. Alternatively techniques such as revegetation with native species can be used to control erosion while providing added biodiversity and aesthetic benefits. See Section 6 regarding fence location.

2. *Acacia longifolia* should also be controlled on the boundary of Lot 23 and Location 4372 and on Location 4372. Other non-local acacias and eucalypts should be monitored and removed or managed where self seeding.

3. Control blackberry on Location 2826, monitor arum lily and eradicate throughout this section and manage other weeds where native vegetation is threatened.

4. Ensure environmental risks from nutrient pollution are managed on the dairy with technical advice from the Department of Agriculture and Food and Western Dairy.

5. Manage dams to minimise the impact on timing and amount of creek flow and to protect water quality and create habitat. Maintain natural stream flows to protect downstream flora and fauna by opening dam underwall pipes as soon as the stream begins to flow in winter. If dams don't have underwall pipes install a siphon system or retrofit a low flow bypass system (see Section 6). Revegetate around dams with local native species to protect water quality and provide habitat for native fauna.



Boodjidup Brook Map 6

Map No. 7

Issues	Comments
Landuse and fencing	This section is dominated by cattle grazing (including dairy cattle) and viticulture. All tributaries are unfenced apart from a section on Location 2836 and the main channel is also largely unfenced apart from Lot 22.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands and Wilyabrup Valleys land systems consisting of loamy and sandy gravels. There are sections of broad swampy riparian zone along with well defined drainage depressions of the main channel with rich fertile soils, often red-brown loams. Erosion is occurring on both the main channel and smaller tributaries as a result of grazing baring the bank and bed of the brook exposing them to the erosion forces of water.
Native vegetation	Native vegetation in the riparian zone is mostly degraded by clearing and grazing. There is still a karri/peppermint or just peppermint overstorey on most locations but the understorey has been lost. Where vegetation is intact it is dominated by karri or blackbutt/marri with peppermint over tea tree and a dense rush and sedge layer including *Lepidosperma* and *Baumea* sp. On Location 24 next to the Rails to Trails there is a little treasure with a marri/peppermint overstorey and very diverse understorey.
Weeds	The main weeds of concern in this section are blackberry, arum lily, apple of Sodom and blackwood. Other common weeds include pasture grasses, *Juncus microcephalus*, *Isolepis prolifera*, *Cypress* sp. and poplars.
Other comments, special features	Lot 28 was not assessed; it was rated from neighbouring properties and aerial photography. Lot 24 has been fenced for about 4 years and is regenerating well, there were some broad swampy areas noisy with frogs. The main channel on the western section of Location 661 will be fenced in 2009.

Map 7: Management recommendations and advice

1. Grazing on Lot 28 and Locations 661and 2176 is resulting in ongoing degradation of creekline vegetation. Protecting the area from stock grazing and trampling as soon as possible will ensure that the creek bank doesn't become bare and destabilised requiring an increased investment in erosion control in the future. Grassy weeds such as kikuyu can become a problem once grazing is excluded and control may be required where they are out-competing native species or presenting a fire hazard.
2. Parts of the brook on Lot 28 and Locations 661 and 2176 are actively eroding. Controlling this erosion will require management of stock access. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.
3. Infestations of blackberry, arum lily, apple of Sodom and blackwood are currently limited therefore eradication is possible at this stage. If left these weeds will spread further and require a much larger effort to control.
4. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. Appendix 1 contains a list of local species suitable for planting in this area.
5. Manage dams to minimise the impact on timing and amount of creek flow and to protect water quality and create habitat. Maintain natural stream flows to protect downstream flora and fauna by opening dam underwall pipes as soon as the stream begins to flow in winter. If dams don't have underwall pipes install a siphon system or retrofit a low flow bypass system (see Section 6). Revegetate around dams with local native species to protect water quality and provide habitat for native fauna.

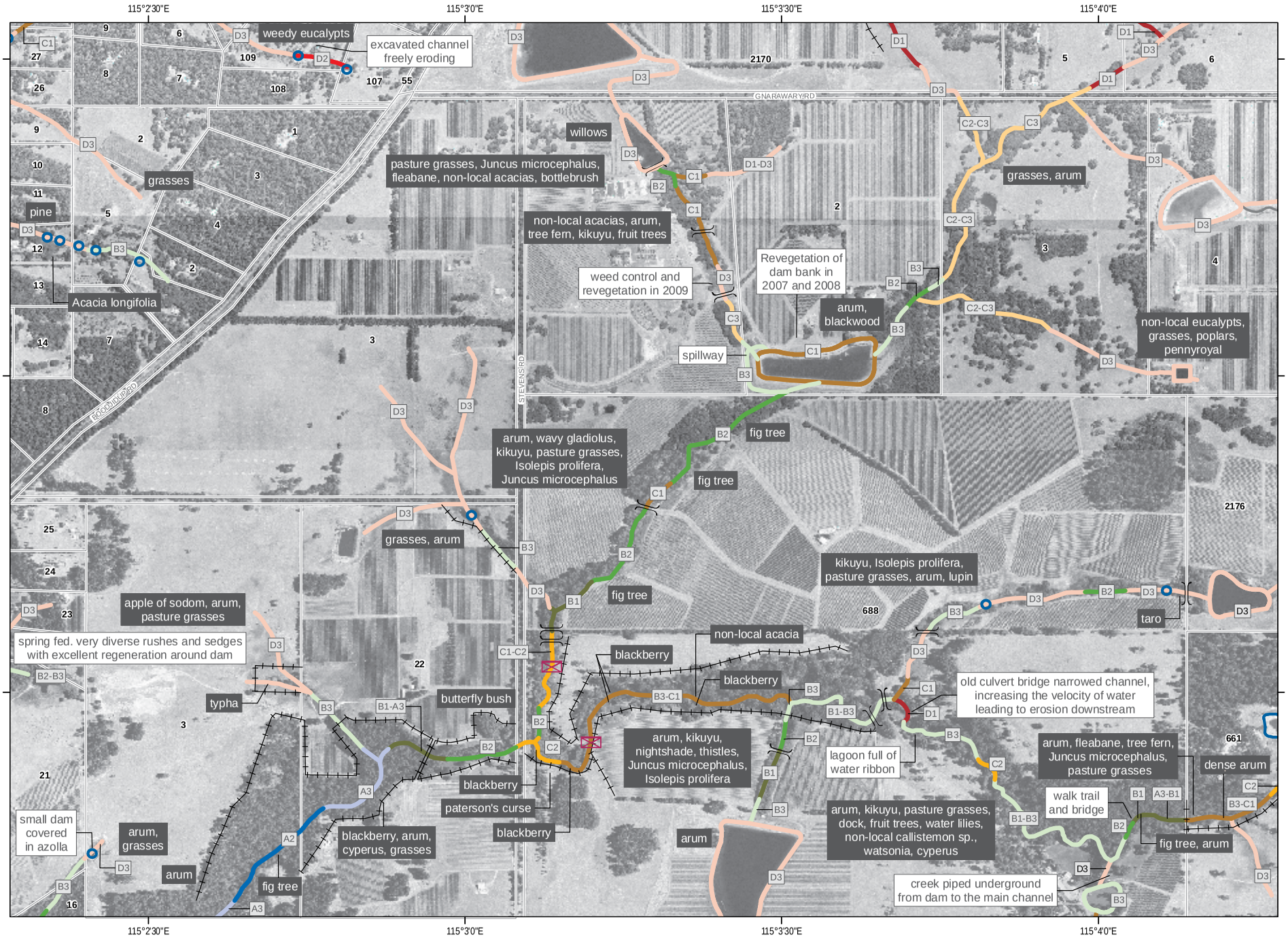
Boodjidup Brook Map 7

Map No. 8

Issues	Comments
Landuse and fencing	North-west of Boodjidup Rd includes special rural blocks without stock. None are fenced. South-east of Boodjidup Rd landuse is dominated by viticulture and grazing. Lots 5, 6, 3 (Gnarwary Rd) and 3 (cnr Stevens and Boodjidup Rds) and Location 688 are grazed and unfenced. Location 688 will be fenced in 2009.
Landform soils and erosion	Loamy sands and gravels as part of the Cowaramup Uplands system north of Boodjidup Road. South of Boodjidup Road is part of the Wilyabrup Valleys land system comprising graveley soils and well drained rich loams. Erosion is occurring on both the main channel and smaller tributaries as a result of grazing baring the bank and bed of the brook exposing them to the erosion forces of water. Where there is no stock there are no major erosion issues because grass (kikuyu) has stabilised the stream in most areas. Most rural residential properties have small on-stream dams, only two are eroding.
Native vegetation	On the main channel there are areas of good to excellent native vegetation as a result of long-term stock exclusion. The vegetation comprises karri/peppermint forest over native willow, trymalium, grass trees and a dense rush and sedge layer of predominantly *Lepidosperma* and *Baumea*. The tributaries have peppermint/jarrah/marri overstorey and in areas have little or no understorey vegetation remaining.
Weeds	Weeds of concern invading native vegetation on the brook in this section are blackberry, arum lily, kikuyu, apple of Sodom, typha, edible fig, non-local acacias (including Sydney golden wattle and blackwood), butterfly bush and wavy gladiolus. Other weeds include non-local rushes and sedges (*Juncus microcephalus, Cypress, Isolepis prolifera*), taro, willows, poplars, tree fern, watsonia and perennial grasses. Non-local eucalypts and acacias were planted when the area to the north of Boodjidup Rd was subdivided and have started to become weedy.
Other comments, special features	Most landholders reported reduced stream flows and some have experienced increased salt levels in groundwater. Foxes were seen during foreshore assessments along with lots of kookaburras. There are good permanent pools in this section.

Map 8: Management recommendations and advice

1. Grazing on Location 668 and Lot 3 (Gnarwary Rd) is resulting in ongoing degradation of creekline vegetation. Protecting the area from stock grazing and trampling as soon as possible will ensure that the creek bank doesn't become bare and destabilised requiring an increased investment in erosion control in the future. Grassy weeds such as kikuyu can become a problem once grazing is excluded and control may be required where they are out-competing native species or presenting a fire hazard.
2. Parts of the brook on Lot 28 and Locations 661 and 2176 are actively eroding. Controlling this erosion will require management of stock access. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.
3. Infestations of blackberry, arum lily, edible fig, apple of Sodom, watsonia, taro, typha, butterfly bush and blackwood are currently manageable therefore eradication is possible at this stage. If left these weeds will spread further and require a much larger effort to control.
4. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. Appendix 1 contains a list of local species suitable for planting in this area.
5. Manage dams to minimise the impact on timing and amount of creek flow and to protect water quality and create habitat. Maintain natural stream flows to protect downstream flora and fauna by opening dam underwall pipes as soon as the stream begins to flow in winter. If dams don't have underwall pipes install a siphon system or retrofit a low flow bypass system (see Section 6). Revegetate around dams with local native species to protect water quality and provide habitat for native fauna.
6. The restricted mud minnow, a small native fish, is present on three properties in this map. They are very sensitive to changes in water quality therefore runoff and the riparian zone should be managed carefully.
7. Landholders should note that earthworks in the stream zone should be undertaken by qualified operators and with Shire and Department of Water approval to avoid stream degradation.



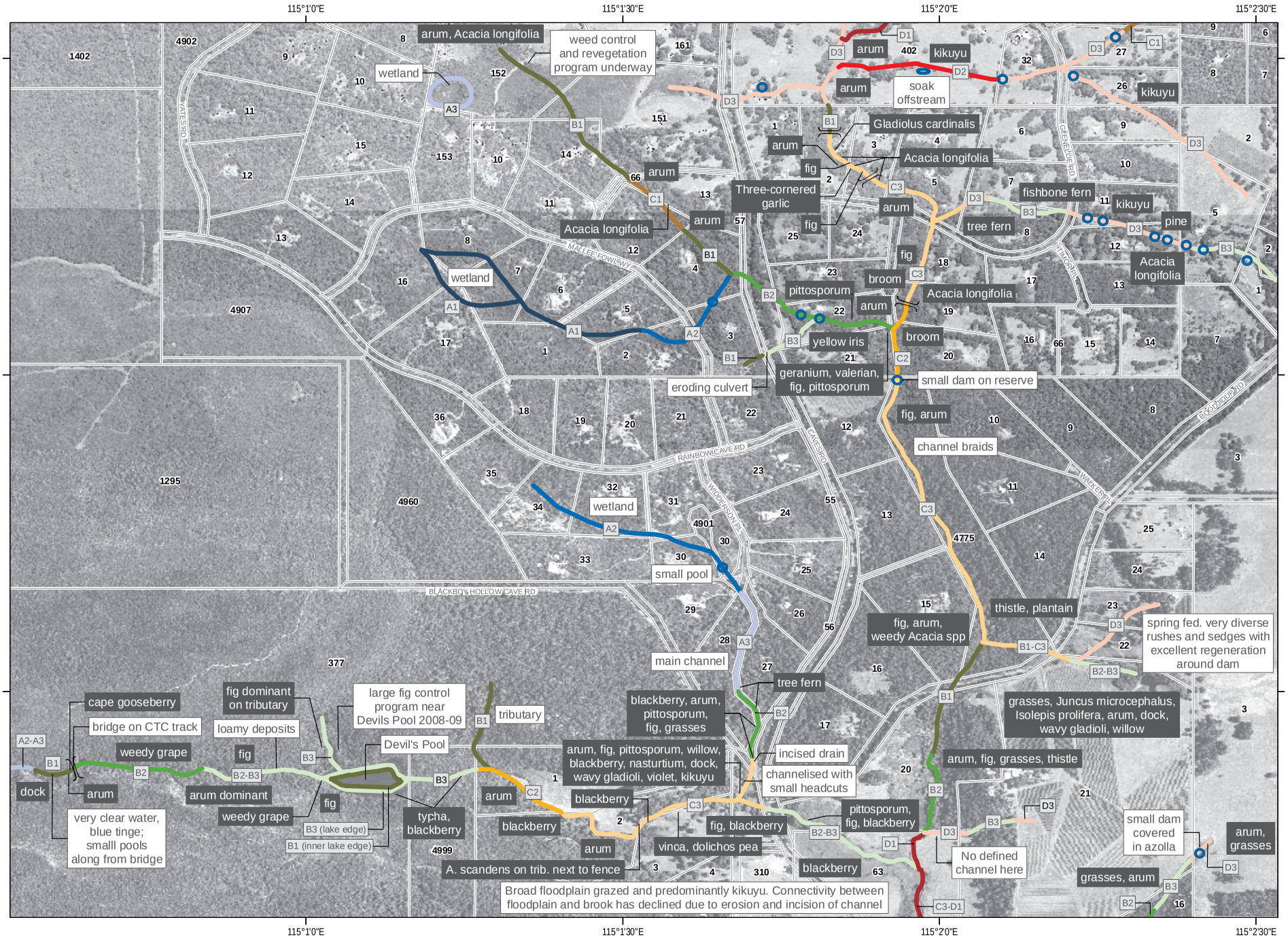
Boodjidup Brook Map 8

Map No. 9

Issues	Comments
Landuse and fencing	The only locations on this map with stock are the southern section of Lot 402 and Lot 63 which are unfenced. The dominant landuse is conservation and lifestyle with viticulture starting in the south-east corner at Lot 21.
Landform soils and erosion	Soils in this area are a combination of Cowaramup vales phase including loamy gravels and the Wilyabrup hillslopes phase that consists of medium slopes of loamy gravels and deeper loams. The tributary running south from Lot 402 and through Reserve 4775 is reasonably steep with loamy soils making the stream prone to erosion. West of Caves Rd on the tributaries the soils are more coastal sands but well vegetated with low flows. The main channel on this map has suffered significant erosion in the past as a result of loss of fringing vegetation and clearing in the catchment increasing flows. The ability of water to move into the floodplain has been reduced due to the incision of the main channel. In areas there remains active erosion particularly on bends.
Native vegetation	West of Caves Rd and north of Blackboy Hollow the stream is generally in excellent condition. Thick coastal swamp vegetation is mostly intact with a stunted jarrah/marri/blackbutt overstorey with *Kunzea spathulata/Anarthria/Meeboldina* understorey. East of Caves Rd and around the Glenellie area the vegetation is more jarrah/marri/blackbutt forest over wonnich and peppermint in the riparian areas. The vegetation on the main channel is largely degraded. Peppermint overstorey remains along most of its length. In the floodplain there are areas of dense rushes and sedges dominated by *Lepidosperma, Baumea*, *Carex* sp.
Weeds	The main weeds of concern are blackberry, arum lily, non-local acacias, edible fig, sweet pittosporum, dolichos pea, vinca, typha, broom and wavy gladiolus. Other weeds include tree fern, perennial grasses, willow, grapes and non-local rushes and sedges. Arum lily is a problem in the areas around Glenellie Rd and through Reserves 4775 and 490 and the National Park. Blackberry and edible fig are well established through the lower reaches around Devils Pool – blackberry control was undertaken in summer 2007 on Reserves 490 and 4999, around Devils Pool in the National Park and on Lots 1 and 2 Caves Rd. A large edible fig control program was undertaken in late 2008 and early 2009. Arum lily control near the Cape to Cape Track bridge started in 2007 with community volunteers.
Other comments, special features	Most landholders have reported reduced water flows and lower dam levels in recent years. Devils Pool and the surrounding area is a special feature with a dense floodplain, permanent pools and springs and caves. The area is degraded and should be a high priority to manage for its unique nature. The Devils Pool area is site of the last known recording of the noisy scrub bird in the Capes region. The wetland features in the Wilderness area are also unique.

Map No 9: Management recommendations and advice

1. Weed control needs to be undertaken on most properties if the weeds of concern listed above are to be controlled in this area to prevent further degradation to native vegetation. Control will take a number of years and it is recommended landholders contact the CCG for advice on techniques. Blackberry, fig trees and arum lily are well established around Devils Pool (upstream and downstream) and will require significant investment from DEC, Shire of Augusta-Margaret River and private landholders over a number of summer seasons to reduce the infestation.
2. Significant erosion problems east of Caves Rd in the rural residential area and west of Caves Rd has been caused through clearing and old grazing practices reducing the amount of vegetation in and along the brook. The loamy soils exacerbate the problem. Although no longer grazed the banks are not stabilising therefore revegetating with riparian species on the banks and stream bed should be a priority because there is good overstorey in this area. Rock placement at significant erosion points could also be considered and will need to be considered west of Caved Rd where riffles are needed.
3. Parts of the brook on Lots 402 and 63 are actively eroding. Controlling this erosion will require management of stock access. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.
4. This area is an example of the invasiveness of garden escapee plants such as pittosporum, vinca, dolichos pea and edible fig that need to be contained to prevent their further spread.
5. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. Appendix 1 contains a list of local species suitable for planting in this area.



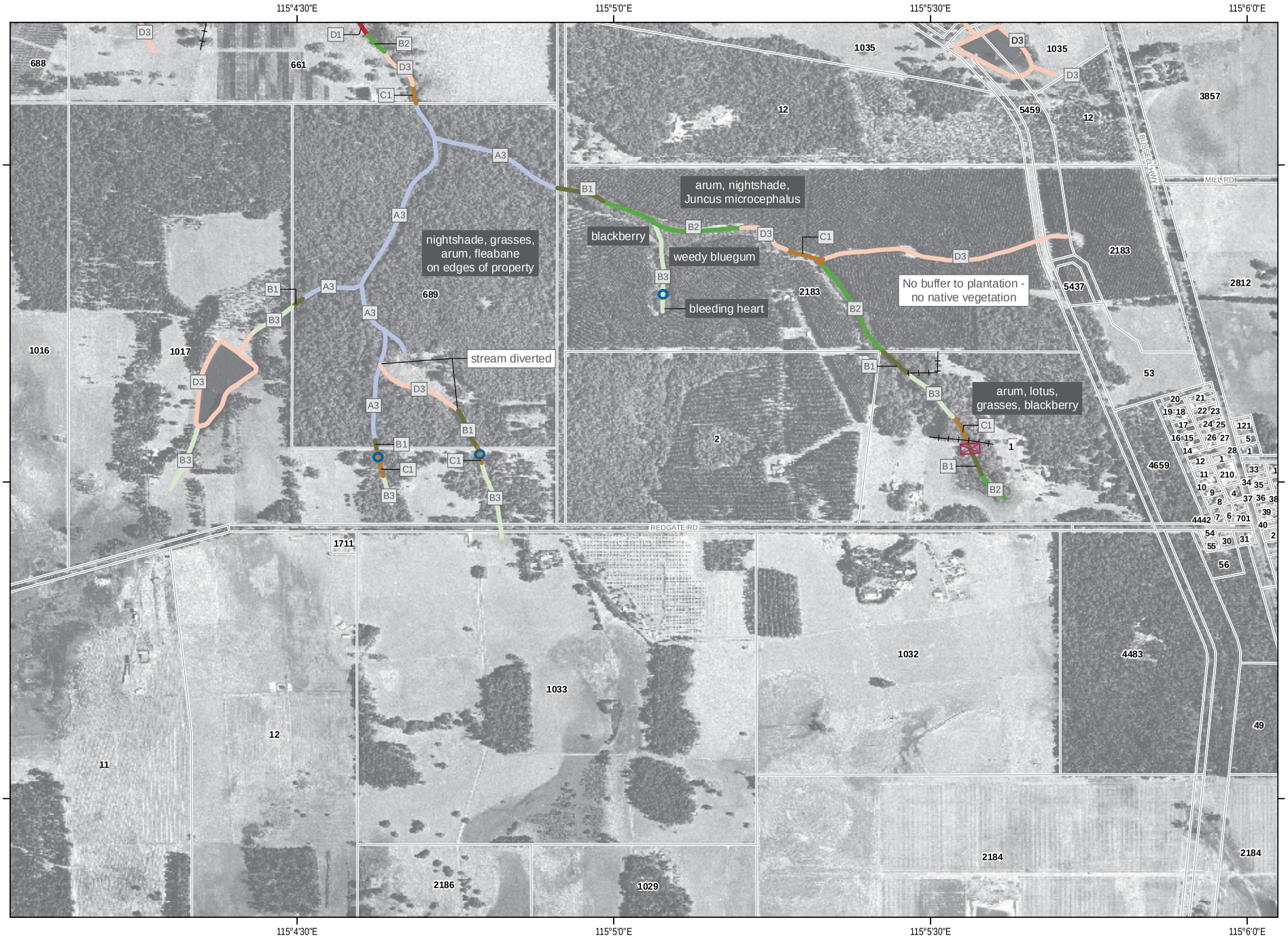
Boodjidup Brook Map 9

Map No. 10

Issues	Comments
Landuse and fencing	The landuse in this section is dominated by plantation and lifestyle properties. The stream is unfenced and grazed on Location 1017 and part of Lot 1.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. In the headwaters of the tributaries are broad areas with swampy poorly drained soils. Lower down are more defined channels with gravel soils. Erosion is minimal in this section of the brook as fringing vegetation largely remains, stabilising banks.
Native vegetation	The native riparian vegetation in this section varies in condition. On Location 689 the vegetation is in excellent condition comprising marri/peppermint and karri/marri/peppermint forest with a diverse understorey of dense rushes and sedges including *Lepidosperma* and *Baumea* species.
Weeds	The main weeds of concern in this section are blackberry and arum. Other weeds degrading the riparian zone include perennial grasses, bleeding heart, bluegum and *Juncus microcephalus.*
Other comments, special features	Location 2183 and Lot 1 are in the process of being developed for residential subdivision. The plantation on Location 2183 will be cleared for this subdivision.

Map 10: Management recommendations and advice

1. Infestations of arum lily, blackberry and woody weeds such as bleeding heart and blue gum are currently manageable therefore eradication is possible at this stage. If left these weeds will spread further and require a much larger effort to control.
2. Manage dams to minimise the impact on timing and amount of creek flow and to protect water quality and create habitat. Maintain natural stream flows to protect downstream flora and fauna by opening dam underwall pipes as soon as the stream begins to flow in winter. If dams don't have underwall pipes install a siphon system or retrofit a low flow bypass system (see Section 6). Revegetate around dams with local native species to protect water quality and provide habitat for native fauna.
3. During site preparation for the development of Location 2183 and Lot 1 appropriate sediment control and stormwater measures should be in place to prevent turbid water entering the creeklines thus impacting the ecological values of the brook.
4. The development on Location 2183 and Lot 1 should have appropriate buffers and incorporate rehabilitation of the creeklines on the properties including weed control and revegetation where necessary.



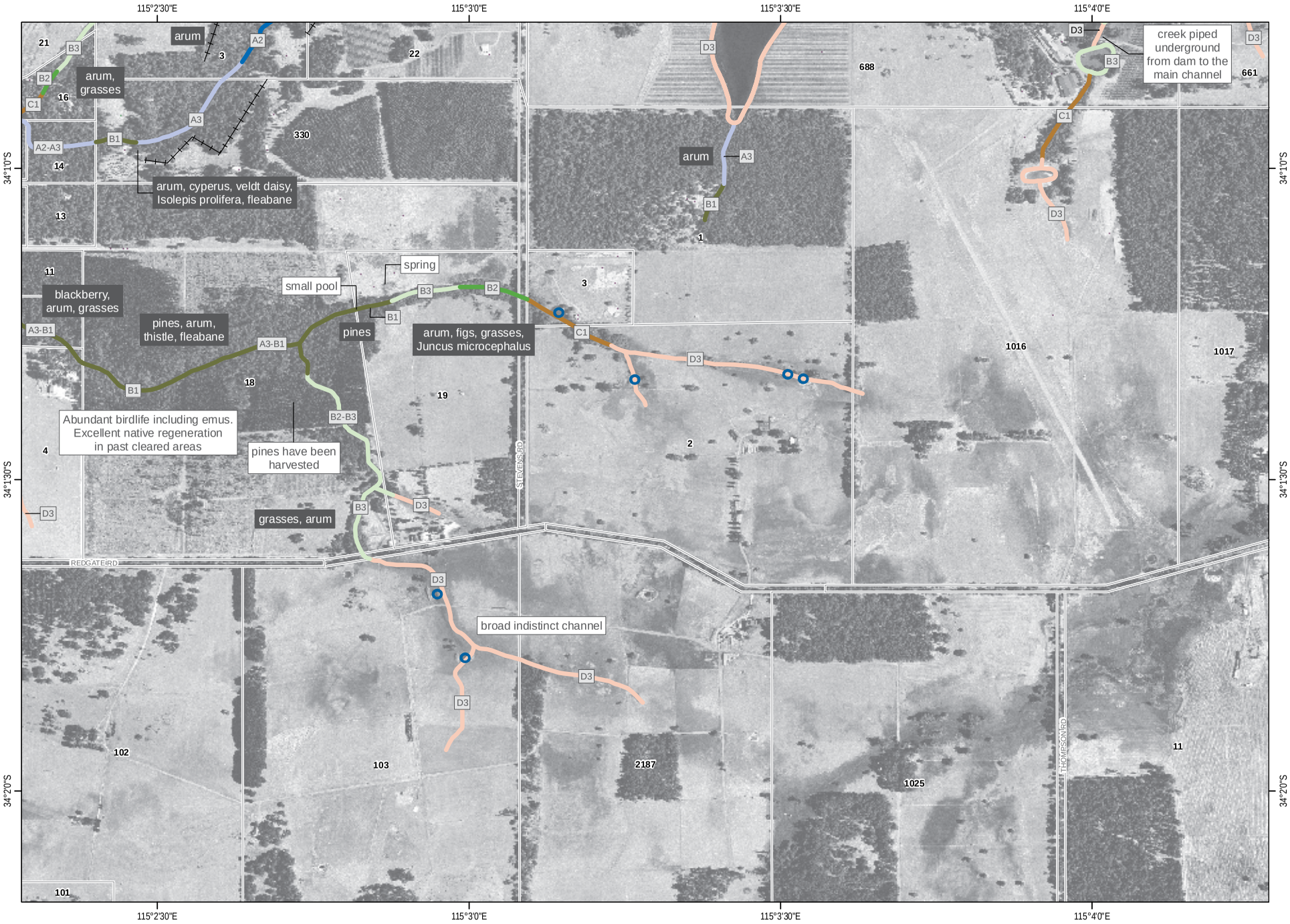
Boodjidup Brook Map 10

Map No. 11

Issues	Comments
Landuse and fencing	There is a variety of landuse in this section of the catchment including dairy, grazing and lifestyle. The brook is unfenced and grazed on Lots 103, 2 and 19 and Locations 2187 and1016.
Landform soils and erosion	Most of the land in this area is part of the Cowaramup Uplands system consisting of loamy and sandy gravels. This compromises broad swampy poorly drained areas moving into well defined graveley and granite channel. A small portion of the Wilyabrup Valleys land system is freely drained with a well defined channel. The brook is largely stable in this area due to native vegetation and perennial grasses such as kikuyu holding the banks together. Water is also slow moving in areas where native vegetation has been completely removed.
Native vegetation	The condition of the native vegetation varies significantly in this section of the catchment from completely degraded to excellent. The dominant vegetation type is marri/peppermint over wonnich, Trymalium, Astartea, Hibbertia and a dense rush and sedge layer of *Lepidosperma* sp. and *Baumea* sp.
Weeds	The main weeds of concern in this section are arum, fig and pine trees. Other weeds include apple of Sodom, pasture grasses, fleabane, veldt daisy, *Cyperus* and *Juncus microcephalus.*
Other comments, special features	Abundant birdlife and excellent regeneration on Lot 18.

Map 11: Management recommendations and advice

1. Infestations of arum lily, blackberry, figs and pines are currently manageable therefore eradication is possible at this stage. If left these weeds will spread further and require a much larger effort to control.
2. Grazing in the riparian zone (waterway and fringing vegetation) will result in ongoing degradation of creekline vegetation, bank stability and water quality. Protecting the area from stock grazing and trampling as soon as possible will ensure that the creek bank doesn't become bare and destabilised requiring an increased investment in erosion control in the future. It also allows increased management of grazing in the riparian zone. Grassy weeds such as kikuyu can become a problem once grazing is excluded and control may be required where they are out-competing native species or presenting a fire hazard.
3. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. Appendix 1 contains a list of local species suitable for planting in this area.



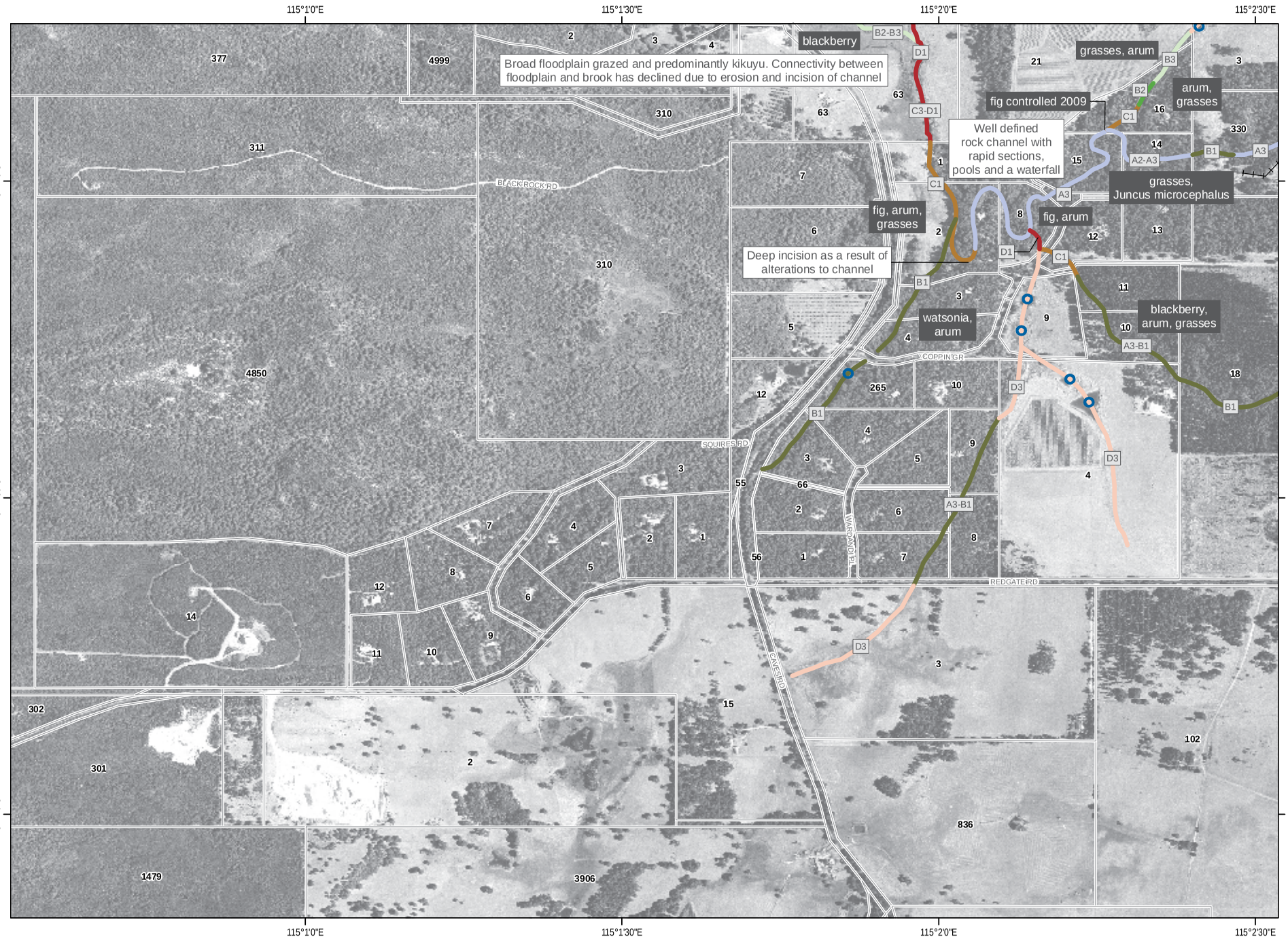
Boodjidup Brook Map 11

Map No. 12

Issues	Comments
Landuse and fencing	This section is dominated by lifestyle/special rural properties. The brook is unfenced and grazed on Lots 63, 1 and 3.
Landform soils and erosion	Most of the land in this area is part of the Wilyabrup Valleys land system consisting of well drained red-brown loams and deep alluvial soils with well defined channels. The main channel is actively eroding where there has been clearing of the native vegetation and where alterations have been made to the brook. There is a broad degraded floodplain on Lot 63 which is largely disconnected from the brook as a result of incision of the channel. There is also a small section of eroding tributary as a result of a road culvert on Coppin Grove.
Native vegetation	The native vegetation in this section is generally good. Karri forest over peppermint and wonnich with a dense rush and sedge layer of *Lepidosperma* and *Baumea*.
Weeds	The weeds of concern in this section are arum lily, blackberry, fig and watsonia. Other weeds include pasture grasses, *Cyperus* and *Juncus microcephalus.*
Other comments, special features	The main channel is very rocky in this section with some beautiful rapid and cascade areas. Many landholders in this section commented on decreased flow in the brook and an increase in algal and emergent plant growth. Excellent native fish populations were found in this area. Lots 3, 4, 265, 7, 8, 9, 10, 11 and 12 were not assessed, they were rated from the neighbouring properties and aerial photography

Map 12: Management recommendations and advice

1. Infestations of arum lily, blackberry, figs and watsonia are currently manageable therefore eradication is possible at this stage. If left these weeds will spread further and require a much larger effort to control.
2. Assist regeneration of native vegetation to improve the invaluable functions of creekline vegetation in protecting water quality, controlling erosion and providing habitat. Appendix 1 contains a list of local species suitable for planting in this area.
3. Parts of the brook on Lots 63, 1 and 2 are actively eroding. Controlling this erosion will require management of stock access on Lots 63 and 1. In areas where the creek is not deeply eroded keeping stock out may allow grasses to colonise and provide an easy solution to erosion. Monitoring will be required to determine if erosion control aims are being met. Other techniques such as revegetation with native species and construction of riffles to slow water velocity will be required in more deeply eroded areas or areas where grass does not recolonise and stabilise banks. See Section 6 regarding fence location.



Boodjidup Brook Map 12

Map No. 13

Issues	Comments
Landuse and fencing	The stream in Map 13 runs through the Leeuwin-Naturaliste National Park to the coast. The Cape to Cape Track follows the stream along the lower reaches and crosses as the track heads north to Prevelly.
Landform soils and erosion	The estuarine stretch in the lowest reaches of the brook runs through the Kilcarnup subsystem which consists of steep exposed sand dunes. Upstream the stream zone is classified as a fertile flat phase of the Wilyabrup subsystem. Soils here are red, loamy and friable. In-stream vegetation is mostly intact throughout the lower reaches and although the banks are steep in places, there are no significant erosion problems.
Native vegetation	Coastal heath sections consist of wind-pruned peppermints and *Melaleuca huegelii* with understorey species including *Olearia axillaris* and *Rhagodia*. In this section riparian vegetation consists of salt-tolerant rushes including *Juncus kraussii, Ficinia nodosa* and *Lepidosperma gladiatum*. Upstream the overstorey is mostly paperbark and peppermint over *Lepidosperma* and *Baumea* species.
Weeds	Arum lilies and edible figs are the dominant weeds through this section but decline as the water becomes saline. Other weeds of concern include Cape gooseberry, grape and *Cyperus.*
Other comments, special features	There are a number of small springs in this area providing refuge to native fish over the summer months. Hooded plovers are sited regularly at the mouth of Boodjidup Brook. Dedicated volunteers have been controlling arum lily near the Cape to Cape Track bridge for the past 3 years with excellent results.

Map13: Management recommendations and advice

1. With the help of members of the Cape to Cape Track and DEC, arum lily could be controlled in areas close to the coast. Upstream the infestation becomes unmanageable and considerable investment is required.
2. Figs could also be controlled in this area while the infestation is at manageable levels – access is difficult though. If control occurs the area will need to be monitored for erosion and regeneration.
3. Access to the brook at the Cape to Cape Track bridge is resulting in some degradation to the remaining native vegetation. Tracks and access points should be defined to reduce further degradation.

Boodjidup Brook Map 13

8. Priority actions

The Boodjidup Brook retains many natural features, with areas of excellent native vegetation and an excellent diversity of freshwater life including the restricted mud minnow. The protection and enhancement of these values is a priority. Specific priority recommendations to ensure our interactions with the unique natural values minimise harm are listed below:

1. An investment of time and money is required in **weed management** as the quality and habitat value of native vegetation is being undermined. Catchment wide arum lily, blackberry and edible fig control is essential to follow up on the good work already done and while the infestations remain manageable. Control of invasive non-local wattles and eucalypts and ornamental and horticultural plants that have spread to riparian and native bushland areas is also required.
2. **Fence** stock out of riparian areas particularly where there is still an opportunity for the vegetation to recover.
3. **Control erosion** in areas with grading D1, D2, C2 and C3 through measures such as restricting stock access, allowing grass to stabilise the banks and/or planting native vegetation, and through slowing the water velocity with structures such as riffles. Ongoing erosion will lead to increasing loss of valuable land, undermining of infrastructure and the infilling of deep pools which are home to many aquatic animals.
4. **Raise community awareness** of the importance of this area and the presence of rare and endangered flora and fauna species.
5. CCG, DoW and AMRSC continue to promote the installation of low flow dam bypass systems and evaluate their effectiveness in delivering **environmental flows**, which includes quantity of water along with timing of flows.
6. DoW **actively manage surface and groundwater allocations** in the catchment to ensure the environment and current water users have secure access to water and ecologies do not degrade through over-allocation. It is also important to ensure all new dams licensed in the catchment install low flow bypass systems and attempt to address fish passage as there are good native fish populations in the brook.
7. **Maintain and enhance corridors** for wildlife movement in the catchment.
8. **Restore and enhance vegetation buffers** along degraded sections of creekline to protect water quality and provide habitat.

Summary of important management actions

The table below summarises all management actions listed in the report. They are in no particular order of importance but are grouped according to type of project. It should be noted that, although listed separately, a number of these projects could be combined (for example fencing and revegetating after erosion control measures are taken) to increase effectiveness and to reduce costs.

Project	What	Why	Who	When
Control stock access	**Fence areas of A and B grade foreshore where stock have access or will have access, to protect remnant vegetation.** **Fence C and D grade areas where stock are destabilising banks causing erosion.**	**Areas of A and B grade foreshore should be fenced as a priority as this represents the best value for money.** These areas are likely to regenerate. **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 sediment and nutrient inputs.	**Landholders.**	**As soon as possible as the longer stock remain in riparian areas the more degradation will occur.** It is easier and cheaper to protect vegetation than to restore it once it has been degraded.
Erosion control	**Erosion management.** Address severe erosion such as gully erosion through reducing the speed of flow and allowing vegetation to stabilise banks.	**Freely eroding waterways transport 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 and DoW.** 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.
Control of declared and environmental weeds	**Target invasive species in or adjoining good quality bushland, aiming to reduce their impact on biodiversity.** Coordinated control of invasive species throughout the catchments is encouraged. **Encourage the use of local native species in revegetation and landscaping.** Also consider replacement of self seeding and suckering non-local plants with local native species.	**To address a major cause of riparian vegetation degradation and prevent and reduce further infestations downstream.** Target weeds include: blackberry, arum lily, fig, dolichos pea, pittosporum and non-local wattles and eucalypts. **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, CCG, AMRSC, DAFWA and DEC.** Priority should be given to areas of bushland in excellent condition. **Landholders and AMRSC supported by CCG.**	**Ongoing.** Specific timing depends on target weeds and control methods employed. Strategic community education activities are required to support on-ground work. **Ongoing.** Planting should occur in winter to ensure plants are established by summer.

Project	What	Why	Who	When
Dam management	**Promote the correct use of dam underwall pipes.** If an existing dam does not have an underwall pipe encourage the use of a siphon system. Correct use involves opening the valve when the brook starts flowing and not closing it until the dam is overflowing.	**Ensures the downstream ecosystem receives water at the break of the season.** If pipes 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 pipes are opened.	**AMRSC, DoW and CCG to promote to landholders.** Landholders responsible for correct use of underwall pipes.	**Ongoing.** Reminders should be published in the paper in autumn.
	Trial and promote the installation of alternative low flow dam bypass and fish passage reinstatement systems. The system should be automatic and allow base flows to bypass dams at the break of the season and at the end of the season.	**Allows a mimicking of natural flow regimes with the early 'fresher' flows bypassing dams thus reaching downstream environments.** A channel or pipe system that automatically bypasses in-stream dams addresses environmental flows without the requirement for landholders to open a scour valve. **Allows native fish to migrate upstream to breed and reduces isolation of populations of fish.**	**CCG and DoW to lead the trial then assist landholders and promote.**	**As soon as possible.** Systems must be installed in summer or early autumn.
	Environmental Water Provisions (EWPs) determined and more detailed assessment of dam applications. The cumulative impact of dams on the creeks, particularly small tributaries, needs consideration when dam applications are assessed.	**It is important to ensure the creek ecosystems receive adequate water at the appropriate time.** 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 creeks. This could be a combination of climatic conditions and the number and size of dams on the creek.	**DoW and AMRSC.** If new in-stream dams are approved conditions for approval should include the instalment of low flow dam bypass systems.	**As soon as possible.** 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.

Project	What	Why	Who	When
Promote regeneration and undertake revegetation	**Establish buffer strips of native vegetation on cleared banks of the brook.** This should be undertaken around dams as well as on the brook.	**Riparian vegetation is essential to healthy and stable waterways.** 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.	**Landholders with assistance from CCG.** Locations with limited fringing vegetation situated between 2 areas with creekline vegetation are a priority.	**Revegetation projects require planning.** Seed collection should be undertaken in spring/early summer as this is when the majority of local plants are holding seed. The seed should be given to local nurseries to contract grow seedlings for plantings in early winter. Erosion, weed and stock control must be in place prior to planting if required.
	Weed control, brushing and planting in areas retaining remnant vegetation. Some areas still retaining native vegetation have lost 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.	**Riparian vegetation is essential to healthy and stable waterways.** Areas retaining some native vegetation can recover much faster and with less inputs. Simple measures such as eradicating invasive environmental weeds can protect an area from degradation.	**Landholders and the community with assistance from CCG.** Priority should be areas of A & B grade.	**Ongoing.** Protection and enhancement of remnant vegetation requires ongoing management. The time required reduces as the area recovers.

Project	What	Why	Who	When
Water quality	**Establish regular water quality testing in the catchment to gain trend data.**	**To gain a more detailed understanding of the current health of the Boodjidup Brook and determine trends.** A priority is to gain better understanding of the trend in nitrate levels and what the key sources of nitrate are.	**DoW, CCG, Ribbons of Blue, landholders and community groups.**	**Ongoing testing required.** Timing of samples dependent on the parameter.
	Seek funding for developing and implementing projects that will contribute to minimising pollutant export to the brook. Examples may include soil testing and fertiliser plans, stock exclusion and stormwater management.	**Pollutants including nutrients cause water quality problems and may impact on the aquatic flora and fauna of the brook.** Excess nutrients in the brook can cause algal growth and impact on the ecology of the brook.	**CCG, DoW, DAFWA, industry bodies, AMRSC and landholders.**	**Ongoing.** Future developments near the creek including residential and agricultural intensification should ensure they do not export pollutants into the brook and adequately address stormwater treatment.
Feral animal control	**Implement a coordinated program targeting feral cats, rabbits and foxes.**	**Foxes and feral cats harm our native fauna. Rabbits impact on native vegetation and can hinder revegetation efforts.** There are many priority fauna species in the catchments including quendas and ringtail possums.	**Landholders, CCG, DEC, DAFWA, and AMRSC.**	**Ongoing.** Specific timing depends on target and control methods employed. Strategic community education activities are required to support on-ground work.
Project monitoring and evaluation	**Monitor and evaluate landholder and community participation in restoration activities.** **Ongoing monitoring and evaluation of the success of the management recommendations against baseline data.** Are the desired outcomes of the management recommendations being met?	**To establish baseline information and data for comparison in the future. This can:** • **determine effectiveness of activities;** • **provide justification for funding;** • **demonstrate progress to the community and funding bodies.**	**Landholders, CCG and the community.**	**Ongoing.**

9. References

ABS *Regional Population Growth 2001-2006*.

ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Volume 1. ANZECC, Canberra, Australia.

AMRSC (2002) *PE.31: Dams and Watercourses.* Augusta-Margaret River Shire Council, Margaret River, Western Australia.

AMRSC (undated) *Shire of Augusta-Margaret River: Size and Population - Community Profile*. Shire of Augusta-Margaret River. Retrieved (11/01/2005) from: http://www.amrsc.wa.gov.au/population.html

APACE Green Skills & Pen, L. (1995) *Condition of the Denmark and Hay River Foreshores 1995.* Waterways Commission Report No. 60. Wilson Inlet Management Authority.

APACE Green Skills & Pen, L. (1997) *Survey of River Foreshores in the Oyster Harbour Catchment 1997.* A report to the Albany Waterways Management Authority. Water and Rivers Commission Report No. WRT 17. Water and Rivers Commission, Perth, Western Australia.

Berndt, R.M. & Berndt, C.H. (1996) *World of the First Australians.* Aboriginal Studies Press, Canberra.

Blond, P. (1988) *A Short History of the Cowaramup District.* Dynamic Print.

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.

Cape to Cape Catchments Group (2004) *Cape to Cape Landcare Companion.* CCCG, National Heritage Trust, Margaret River, WA.

Carter, J. (1993) *Exotic Trees Along Watercourses,* Waterwise Fact Sheet No.6.

Collard, L. (1994) A Nyungar interpretation of Ellensbrook and Wonnerup homesteads.

Connell, S., Franke, B. & Alder, J. (2000) *Remnant Vegetation Strategy for the Geographe Catchment.* Busselton, Western Australia.

Coppolina, M. (undated) *Cowaramup Brook Hydrology Summary.* Department of Water.

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

GeoCatch (1999) *Capel River Action Plan*. Water and Rivers Commission, East Perth, Western Australia.

Gippel, C., Finlayson, B. & O'Neill, I. (1998) *Managing Snags in Rivers.* Riparian Management 7. Land and Water Resources Research and Development Corporation, Canberra.

Government of Western Australia (2003) *Securing our Water Future: A State Water Strategy for Western Australia*. Perth, WA.

Hopkins, Morgan and Shepherd (2001) *Bush and Biodiversity in the South West Region, Technical Report #2 South West Regional Strategy for Natural Resource Management.* SWCC, Bunbury.

Hunt, K., Sivapalan, M., Smettem, K. and Oldham, C. (2002) *Stream Condition in the Cape to Cape Subregion, Southwest Western Australia*. Centre for Water Research, University of Western Australia, Nedlands, Western Australia.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. and 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. and Wallace, K.J. (1993) *Managing Your Bushland*. Department of Conservation and Land Management, Como, Western Australia.

Moore, J. & Wheeler, J. (2008) *Southern Weeds and Their Control*. 2nd Edition. Department of Agriculture, Perth, Western Australia.

Morgan, D. & Beatty, S. (2008) *Fish and freshwater crayfish fauna of the Boodjidup Brook, south-western Australia*. Report to Cape to Cape Catchments Group.

O'Connor, R., Quartermaine, G. & Yates, A. (1995) *An Investigation into the Aboriginal Significance of Wetlands and Rivers in the Busselton-Walpole Region*. Water Authority, Perth, Western Australia.

Pen, L.J. & Scott, M. (1995) *Stream Foreshore Assessment in Farming Areas.* Blackwood Catchment Coordinating Group, Western Australia.

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

Raine, A.W. & Gardiner, J.N. (1995) *Rivercare — Guidelines for Ecologically Sustainable Management of Rivers and Riparian Vegetation.* Land and Water Resources Research and Development Corporation, Canberra.

Sinden, J., Jones, R., Hesten, S., Odom, D., Kalisch, C., James, R. and Cacho, O. (2004) *The Economic Impact of Weeds in Australia: Report to the CRC for Weed Management.* CRC for Australian Weed Management Technical Series No.8. CRC for Australian Weed Management, University of Adelaide, South Australia.

Tille, P. J. and Lantzke, N. C. (1990). *Busselton, Margaret River, Augusta Land Capability Study.* Land Resource Series No. 5. Department of Agriculture, Perth, Western Australia.

Water and Rivers Commission (1999) *Planning and Management: Foreshore Condition Assessment in Farming Areas of South-West Western Australia.* River Restoration Report No. RR3. Water and Rivers Commission, East Perth, Western Australia.

Appendix 1: Recommended species for revegetation

Use the list below as a guide if you plan to landscape or revegetate. You can identify locations closest to your property in order to identify which species would have been present.

Sites	Map	Description
1	1	Deep grey sandy headwaters
2	1	Broad seasonal bullich and teatree creekline
3	1 & 2	Broad dense teatree and sedge creekline
4	2	Broad karri creekline
5	2	Shallow ironstone karri/blackbutt creekline
6	2	Loc 2157 Broad blackbutt/marri creekline
7	8	Reserve 4775- steep marri/peppermint creekline
8	8	Main channel between Bussell Hwy and Caves Rd- Granite based brook surrounded by red-brown loam and gravel.
9	9 & 10	West of Caves Rd- includes wetland, coastal and estuarine areas.

Scientific Name	Common name	Form	Flower colour	Sites								
				1	2	3	4	5	6	7	8	9
Acacia alata	Winged wattle	shrub	yellow				x		x		x	
Acacia cyclops	Red eyed wattle	shrub	yellow									x
Acacia divergens		shrub	yellow		x	x	x	x	x	x	x	
Acacia gilbertii		shrub	yellow		x	x		x	x		x	
Acacia lateriticola	Thornless wattle	shrub	yellow						x			
Acacia myrtifolia		shrub	yellow	x	x	x	x		x	x	x	
Acacia pulchella	Prickly Moses	shrub	yellow	x	x	x	x	x	x		x	
Acacia saligna	Orange wattle	shrub	yellow									x
Acacia urophylla	Net-leaved wattle	shrub	yellow				x	x	x		x	
Agonis flexuosa var. *flexuosa*	Peppermint tree	tree	white	x	x	x	x	x	x	x	x	x
Anigozanthos flavidus	Tall kangaroo paw	herb	red	x	x	x	x	x	x		x	
Astartea fascicularis		shrub	white			x	x	x	x	x	x	
Banksia grandis	Bull banksia	tree	yellow	x	x				x		x	x
Banksia littoralis	Swamp banksia	tree	yellow						x			
Baumea articulata	Jointed twig rush	sedge	brown									x
Baumea juncea	Bare twig rush	sedge	brown			x	x	x	x	x	x	
Baumea vaginalis	Sheath twig rush	sedge	brown					x	x		x	x
Billardiera fusiformis	Australian bluebell	climber	blue	x					x	x	x	x
Bossiaea linophylla		shrub	yellow & red	x	x	x	x		x	x	x	x
Callistachys lanceolata	Native willow or Wonnich	tree	yellow		x	x			x	x	x	x
Carex appressa		sedge	green							x		x
Centella asiatica	Gotu kola	herb	white				x	x	x	x		x
Chorilaena quercifolia	Chorilaena	shrub	white		x	x	x	x	x			x
Clematis pubescens	Old man's beard	climber	white				x			x	x	x
Conostylis aculeata	Prickly conostylis	herb	yellow	x	x		x	x	x		x	x
Corymbia calophylla	Marri	tree	white	x	x	x	x	x	x	x	x	x
Darwinia citriodora	Lemon scented darwinia	shrub	orange								x	x

Scientific Name	Common name	Form	Flower colour	Sites								
				1	2	3	4	5	6	7	8	9
Dichondra repens	Kidney weed	herb	white				x	x				
Eleocharis acuta	Common spike-rush	rush	brown						x			
Eucalyptus diversicolor	Karri	tree	white			x	x	x			x	
Eucalyptus marginata	Jarrah	tree	white	x	x				x		x	x
Eucalyptus megacarpa	Bullich	tree	white		x	x						
Eucalyptus patens	Blackbutt	tree	white			x	x	x	x	x	x	
Ficinia nodosa	Knotted club rush	rush	brown									x
Gastrolobium bilobum	Heartleaf poison	shrub	orange									x
Gastrolobium ebracteolatum	River pea	shrub	yellow & red						x			
Hakea amplexicaulis	Honey bush	shrub	yellow		x		x	x	x		x	
Hakea lissocarpha	Honey bush	shrub	white		x		x	x		x	x	
Hardenbergia comptoniana	Native wisteria	climber	purple	x	x	x	x	x	x	x	x	x
Hibbertia cuneiformis	Cutleaf hibbertia	shrub	yellow							x	x	x
Hibbertia hypericoides	Yellow buttercups	shrub	yellow		x	x	x	x	x	x	x	x
Hovea elliptica	Tree hovea	shrub	purple	x	x	x	x	x	x	x	x	x
Juncus kraussii	Sea rush	rush	brown									x
Juncus pallidus	Pale rush	rush	brown						x	x	x	x
Juncus pauciflorus	Loose flower rush	rush	brown							x		x
Kennedia coccinea	Coral vine	climber	pink & orange		x	x			x	x	x	x
Lasiopetalum floribundum	Free flowering lasiopetalum	shrub	pink/purple				x	x				
Lepidosperma effusum	Spreading sword sedge	sedge	brown							x	x	x
Lepidosperma gladiatum		sedge	brown									x
Lepidosperma tetraquetrum	Square sedge	sedge	brown			x	x	x	x	x	x	x
Lobelia alata	Angled lobelia	herb	purple			x	x	x	x	x	x	x
Logania vaginalis	White spray	shrub	white	x	x		x	x				
Meeboldina scariosa	Velvet rush	rush	reddy brown			x	x	x	x	x	x	
Melaleuca huegelii	Chenille honey myrtle	shrub	white									x
Melaleuca incana		shrub	yellow						x			
Melaleuca preissiana	Stout paperbark	tree	white									x

Scientific Name	Common name	Form	Flower colour	Sites								
				1	2	3	4	5	6	7	8	9
Melaleuca thymoides		shrub	yellow	x	x							
Microlaena stipoides	Weeping grass	grass	green		x	x	x	x	x	x	x	x
Mirbelia dilatata	Holly-leaved mirbelia	shrub	pink		x	x	x	x	x	x	x	
Olearia axillaris	Coastal daisy bush	shrub	yellow									x
Paraserianthes lopantha subsp. *lopantha*	Albizia	tree	cream						x	x	x	x
Patersonia occidentalis	Purple flag	herb	purple			x	x	x	x	x	x	
Phyllanthus calycinus	False boronia	shrub	white			x	x		x	x	x	x
Pimelea ferruginea	Coastal banjine	shrub	pink									x
Pimelea rosea	Rose banjine	shrub	pink					x	x			
Pultenaea reticulata		shrub	yellow & red	x								
Rhagodia baccata	Salt berry bush	shrub	cream									x
Ricinocarpos glaucus	Wedding bush	shrub	white				x	x	x		x	x
Scaevola calliptera		herb	purple				x	x	x		x	
Scaevola crassifolia	Thick leaved fan flower	shrub	purple									x
Schoenoplectus validus		sedge	light brown									x
Spyridium globulosum	Basket bush	shrub	cream									x
Taxandria fragrans		shrub	white	x	x							
Taxandria linearifolia		shrub	white	x	x	x	x	x	x	x	x	
Taxandria juniperina	Wattie	shrub	white						x			
Taxandria parviceps		shrub	white						x	x	x	
Templetonia retusa	Cockies tongue	shrub	red									x
Thomasia paniculata		shrub	pink		x	x	x	x	x	x	x	
Thysanotus multiflorus	Many-flowered fringe lily	herb	purple						x			
Tremandra stelligera		shrub	purple				x		x	x	x	x
Trymalium floribundum		shrub	white			x	x	x	x	x	x	x
Villarsia latifolia		herb	yellow			x	x	x	x	x	x	x
Viminaria juncea	Swishbush	shrub	yellow						x	x	x	x
Xanthorrhoea preissii	Grass tree	shrub	cream	x	x	x	x	x	x	x	x	x

The Cape to Cape Catchments Group can provide assistance with developing a species list for your 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

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

Leschenault Community Nursery
Johnston Rd, Bunbury
Ph: 9791 4670

Boyanup Botanical
South West Highway, Boyanup
Ph: 9731 5470

Sedgewick
Ph: 9727 2101

Augusta Community Nursery
Ph: 9758 0890

Appendix 2: Boodjidup Brook species list

This list is not exhaustive and was kindly contributed to by Andrew Webb from the Department of Environment and Conservation.

Scientific name	Common name
Acacia alata	Winged wattle
Acacia divergens	
Acacia gilbertii	
Acacia lateriticola	
Acacia myrtifolia	
Acacia pulchella	Prickly moses
Acacia saligna	Orange wattle
Acacia urophylla	Net-leaved wattle
Actinotus sp. Walpole (J.R. Wheeler 3786) (P3)	
Agonis flexuosa	Peppermint
Agrostocrinum hirsutum	
Amphipogon laguroides subsp. laguroides	
Anarthria prolifera	
Anigozanthos flavidus	Tall kangaroo paw
Aphelia cyperoides	
Astartea fascicularis	
Astroloma ciliatum	Candle cranberry
Banksia grandis	Bull banksia
Banksia littoralis	Swamp banksia
Baumea juncea	
Baumea vaginalis	Sheath twigrush
Billardiera floribunda	White-flowered billardiera
Boronia crenulata	Aniseed boronia
Boronia fastigiata	Bushy boronia
Boronia molloyae	Tall boronia
Boronia stricta	
Bossiaea linophylla	
Burchardia umbellata	Milkmaids
Caesia micrantha	Pale grass-lily
Caladenia sp.	Spider orchids
Caladenia flava	Cowslip orchid
Callistachys lanceolata	Wonnich
Carex appressa	

Scientific name	Common name
Cassytha racemosa	Dodder laurel
Centrolepis fascicularis	
Cheilanthes austrotenuifolia	Rock fern
Chorilaena quercifolia	Chorilaena
Chorizandra cymbaria	Heron bristle rush
Chorizema diversifolium	
Chorizema nanum	
Chorizema rhombeum	
Clematis pubescens	Common clematis
Comesperma virgatum	Milkwort
Conostylis aculeata	Prickly conostylis
Corymbia calophylla	Marri
Cryptostylis ovata	Slipper orchid
Cyathochaeta avenacea	
Cyathochaeta teretifolia (P3)	
Dampiera hederacea	Karri dampiera
Dampiera linearis	Common dampiera
Dasypogon hookeri	Pineapple bush
Diuris sp.	Donkey orchid
Drosera sp	Sundews
Elythranthera brunonis	Purple enamel orchid
Empodisma gracillimum	
Eriochilus dilatatus	White bunny orchid
Eucalyptus diversicolor	Karri
Eucalyptus marginata	Jarrah
Eucalyptus megacarpa	Bullich
Eucalyptus patens	Swan River blackbutt
Ficinia nodosa	
Gahnia decomposita	
Gompholobium confertum	
Gompholobium polymorphum	
Gonocarpus benthamii	
Grevillea quercifolia	Oak leaf grevillea
Haemodorum laxum	Blood root
Hakea amplexicaulis	Prickly hakea
Hakea lissocarpha	Honey bush
Hemigenia rigida	
Hibbertia amplexicaulis	
Hibbertia commutata	
Hibbertia cunninghamii	
Hibbertia hypericoides	Yellow buttercups
Homalospermum firmum	
Hovea chorizemifolia	Holly-leaved hovea
Hovea elliptica	Tree hovea
Hypolaena exsulca	
Hypolaena pubescens	
Isolepis cernua	Nodding club-rush
Isotropis cuneifolia	Granny bonnets

Scientific name	Common name
Johnsonia lupulina	Hooded lily
Juncus kraussii	Sea rush
Juncus pallidus	Pale rush
Juncus pauciflorus	Loose flowered rush
Juncus planifolius	Broadleaf rush
Kennedia carinata	
Kennedia coccinea	Coral vine
Kunzea spathulata	
Lagenophora huegelii	
Lasiopetalum floribundum	Free Flowering lasiopetalum
Lepidosperma effusum	Sword sedge
Lepidosperma gladiatum	Coastal sword sedge
Lepidosperma leptostachyum	
Lepidosperma squamatum	
Lepidosperma tetraquetrum	Square sedge
Lepyrodia macra	Large scale rush
Leucopogon australis	Spiked beard-heath
Leucopogon capitellatus	
Leucopogon hirsutus	
Leucopogon verticillatus	Tassel flower
Lindsaea linearis	Screw fern
Lobelia alata	Angled lobelia
Logania serpyllifolia	
Logania vaginalis	White spray
Lomandra drummondii	
Lomandra pauciflora	
Macrozamia riedlei	Zamia
Marianthus tenuis	
Meeboldina roycei	
Melaleuca incana	Grey honeymyrtle
Mesomelaena graciliceps	
Mesomelaena tetragona	Semaphore sedge
Microlaena stipoides	Weeping grass
Microtis media	Tall mignonette orchid
Mirbelia dilatata	Holly-leaved mirbelia
Opercularia hispidula	Hispid stinkweed
Opercularia volubilis	Twining stinkweed
Patersonia occidentalis	Purple flag
Patersonia umbrosa	Yellow flags
Pentapeltis peltigera	
Persoonia longifolia	Snottygobble
Petrophile diversifolia	
Philotheca spicata	Pepper and salt
Phlebocarya ciliata	
Phyllanthus calycinus	False boronia
Pimelea lanata	
Pimelea sp.	
Pimelea spectabilis	Bunjong

Scientific name	Common name
Platysace tenuissima	
Poaceae sp.	
Podocarpus drouynianus	Wild plum or Emu bush
Prasophyllum sp.	Leek orchid
Pteridium esculentum	Bracken
Pterostylis sp.	
Pultenaea reticulata	
Ranunculus colonorum	Common buttercup
Rhadinothamnus anceps	Blister bush
Ricinocarpos glaucus	Wedding bush
Scaevola calliptera	
Scaevola microphylla	Small-leaved scaevola
Schoenoplectus validus	
Sphaerolobium grandiflorum	
Sphaerolobium medium	
Sporadanthus rivularis	
Spyridium globulosum	Basket bush
Stackhousia monogyna	White candles
Stylidium adnatum var. propinquum	
Stylidium junceum	Reed triggerplant
Stylidium scandens	Climbing triggerplant
Stypandra glauca	Blind grass
Taxandria fragrans	
Taxandria juniperina	Wattie
Taxandria linearifolia	Swamp peppermint, tea tree
Taxandria parviceps	Fine tea tree
Tetraria octandra	
Tetrarrhena laevis	Forrest ricegrass
Thelymitra sp.	Sun orchid
Thomasia heterophylla	
Thomasia paniculata	
Thysanotus dichotomus	Branching fringe lily
Thysanotus multiflorus	Many-flowered Fringe Lily
Tremandra diffusa	
Tremandra stelligera	
Trymalium floribundum	
Veronica distans	
Villarsia latifolia	
Xanthorrhoea gracilis	Graceful Grass Tree
Xanthorrhoea preissii	Grass tree
Xanthosia huegelii	
Xyris inaequalis	

Appendix 3: Weeds found in the study area

Name	Common name
Acacia iteaphylla	Flinders Range wattle
Acacia longifolia	Sydney golden wattle
Acacia melanoxylon	Blackwood
Allium triquetrum	Three cornered garlic
Ammophila arenaria	Marram grass
Anagalis avensis	Pimpernel
Andropogon sp.	Tambooki
Arctotheca calendula	Capeweed
Arundo donax	Giant reed
Asparagus asparagoides	Bridal creeper
Asparagus scandens	Asparagus fern
Avena barbata	Bearded oat
Brassica tournefortii	Mediterranean turnip
Briza maxima	Blowfly grass
Briza minor	Shivery grass
Bromus spp.	Brome grass
Cakile maritima	Sea rocket
Callistemon spp.	Bottlebrush
Carduus spp.	Scotch thistle
Centranthus ruber	Valerian
Colocasia esculenta	Taro
Crastium glomeratum	Mouse ears
Chamaecytisus palmensis	Tagasaste
Chasmanthe floribunda	African cornflag
Conyza albida	Fleabane
Cortaderia selloana	Pampas grass
Crepis spp.	Hawksbeard
Cynodon dactylon var. *dactylon*	Couch grass
Cyperus spp.	
Dipogon lignosus	Dolichos pea
Echium plantagineum	Patersons curse
Ehrharta longiflora	Annual veldt grass
Ehrharta villosa	Pip grass
Emex australis	Doublegee
Eucalyptus platypus	Platypus gum
Eucalyptus spp.	Non-local Eucalypts
Euphorbia paralias	Sea spurge
Euphorbia peplus	Petty spurge
Euphorbia terracina	Geraldton carnation weed
Ficus carica	Edible fig
Genista sp.	Broom
Gladiolus undulatus	Wavy gladioli
Holcus lanatus	Yorkshire fog
Hordeum spp.	Barley grass
Hypochaeris glabra	Flatweed

Name	Common name
Isolepis prolifera	Budding club rush
Juncus microcephalus	
Lagurus ovatus	Hare tail grass
Leptospermum laevigatum	Victorian tea tree
Lolium perenne	Perennial rye grass
Lotus spp.	Lotus
Malva parviflora	Marshmallow weed
Melaleuca nesophila	
Mentha diemenica	Garden mint
Mentha pulegium	Pennyroyal
Modiola caroliniana	Red flowered mallow
Monadenia bracteata	South African orchid
Olea europa	Olive
Omalanthus popufolius	Bleeding heart
Orbanche minor	Lesser broomrape
Osteospermum ecklonis	Veldt daisy
Oxalis pes-caprae	Soursob
Oxalis purpurea	Mauve oxalis
Paspalum dilatatum	Paspalum
Pelargonium capitatum	Rose pelargonium
Pennisetum clandestinum	Kikuyu
Petrorhagia velutina	Velvet pink
Phalaris aquatica	Canary grass
Physalis minima	Chinese gooseberry
Pinus spp.	Pine tree
Pittosporum undulatum	Sweet pittosporum
Plantago lanceolata	Ribwort plantain
Polygala myrtifolia	Butterfly bush
Populus spp.	Poplars
Psuedognaphalium luteoalbum	Jersey cudweed
Ranunculus muricatus	
Raphanus raphanistrum	Wild radish
Romulea rosea	Guilford grass
Rubus spp.	Blackberry
Rumex spp.	Dock
Salix babylonica	Weeping willow
Samolus valerandi	Water pimpernel
Senecio elegans	Purple groundsel
Silene gallica var. *gallica*	Silene
Solanum linnaeanum	Apple of Sodom
Solanum nigrum	Nightshade
Sparaxis bulbifera	Freesia
Sphaeropteris cooperi	Tree fern
Stellaria media	Chickweed
Stenotaphrum secondatum	Buffalo grass
Syzygium sp.	Lilly pilly
Tetragonia decumbens	Sea spinach
Trachyandra divaricata	Dune onion weed

Name	Common name
Trifolium spp.	Clover
Tropaeolum sp.	Nasturtium
Vinca major	Vinca
Viola hederacea	Native violet
Vitus sp.	Grape
Watsonia meriana	Watsonia
Zantedeschia aethiopica	Arum lily

Appendix 4: Useful contacts and phone numbers

Cape to Cape Catchments Group
33 Tunbridge Street, Margaret River
PO Box 1749, Margaret River, 6285
Ph: 9757 2202
Fax: 9757 3740
Email: ccg@capetocape.org.au
Web: http://www.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 5533
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.ribbonsofblue.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