Catchment Care – Developing an Auction Process for Biodiversity and Water Quality Gains

A Market-Based Instrument Pilot Project

Report to the Onkaparinga Catchment Water Management Board

Volume 2 - Appendices

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Onkaparinga Catchment Water Management Board

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Cover Photograph:

A stream reach in the Onkaparinga Catchment. Source: Onkaparinga Catchment Water Management Board.

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Appendix A - Trial Publicity Material

Appendix A.1. - Advertorial

Landholders to get paid to manage rural creeks

Up to fifty landholders keen to protect and rehabilitate their watercourses are set to benefit from new environmental funding arrangements to be trialled by the Onkaparinga Catchment Water Management Board.

Landholders participating in the trial will be eligible to put in bids to receive funding assistance to undertake activities that will improve the health of the watercourses running though their properties. Activities could include such things as fencing stock out of the watercourse, removing weeds from native vegetation areas and measures to reduce erosion.

Technical Manager for the Board, Mr Steven Gatti, explained that for a number of years the Board has been providing funding to landholders to undertake environmental works on a fixed rate basis.

"While this has been effective in the past, with the increase in people seeking assistance, the Board has had to look at new ways to make the dollars go further, while still providing good environmental outcomes," said Mr Gatti.

The trial, which is about to commence, will see landholders nominate the funding that they believe they should receive in return for the restoration works they would do.

"Under the bidding system, people who offer to produce the best environmental benefit and who are willing to do the works for a fair price will be the ones rewarded," he said.

The trial is open to private landholders who own property with a watercourse in the Board's trial area. (see map)

Anyone interested in finding out more about the trial should contact the Board on 8374 6000 or visit the website at www.onkaparinga.net and fill out the online registration before 7 May 2004.

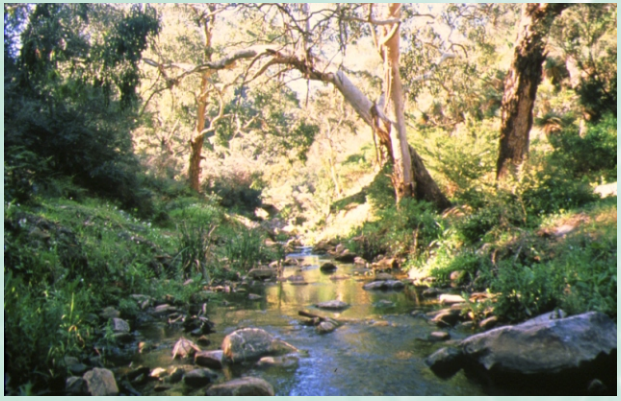
Onkaparinga Catchment Water Management Board

Appendix A.2. - Flyer

ELIGIBLE ACTIVITIES

To be eligible to receive funding, you must commit to control proclaimed weeds such as **Blackberry, Broom and Gorse** in the proposed work area at your own expense. The following activities are eligible for funding:

- Fencing stock from watercourses and remnant native vegetation.
- Removal of non-proclaimed weeds from remnant native vegetation and riparian areas.
- Revegetation with local native species.
- Controlling watercourse erosion.
- Installing low-flow bypasses on dams.



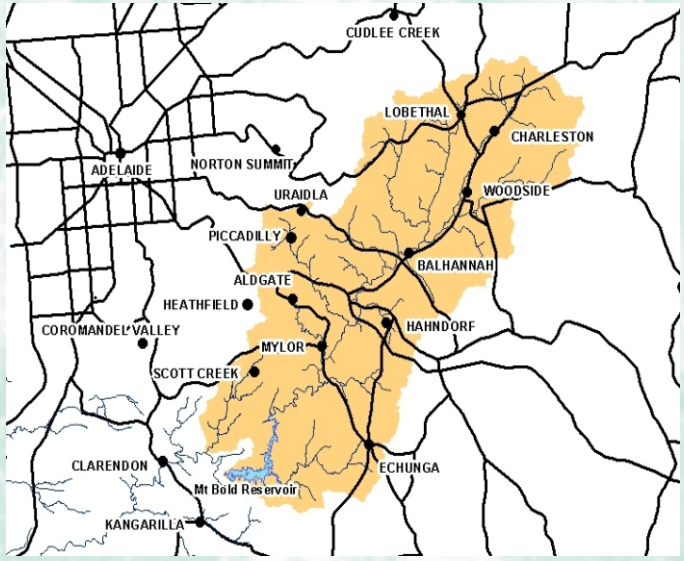
REGISTERING YOUR INTEREST

Would like to be involved in the Catchment Care Funding Tender Trial Program? Please fill out the enclosed Expressions of Interest Form and post it to us at:

Reply Paid 71509
Onkaparinga Catchment Water Management Board
The Salvation Army Complex
The Hub Shopping Centre
Aberfoyle Park 5159

Or visit the website **www.onkaparinga.net**

TRIAL AREA LOCATION



FURTHER INFORMATION

Visit the website at www.onkaparinga.net or Contact Darran King at the Onkaparinga Catchment Water Management Board on 8374 6000 for further information or to register your interest.

Onkaparinga Catchment Water Management Board

2004

CATCHMENT CARE TENDER TRIAL

Onkaparinga Catchment Water Management Board

The Board has been helping landholders protect and rehabilitate watercourses for over five years. With over 4,000 km of watercourses in the region and limited resources available to help landholders, the challenge to protect and rehabilitate all of our watercourses is great!

In recent years the Board has collected data and developed tools to help identify watercourses with high environmental value and at greatest threat, so that they may receive priority consideration.

The Board is trialling a new program, which targets high priority watercourses and delivers fair compensation for watercourse management services provided by landholders.

If you've been thinking about better management strategies for the watercourse on your property, this trial will be of interest to you!

KEY FEATURES OF THE TRIAL

- The trial aims to deliver 'best value for money' by paying a fair price for high priority watercourse rehabilitation works.
- You tell us what you think is a fair price to pay you for the management actions you provide to protect or rehabilitate your watercourse.
- Successful bids are selected based on the priority of your watercourse, the funding you seek to undertake management actions and how your bid compares with other participants.

HOW WILL THE CATCHMENT CARE TENDER WORK?

EXPRESSIONS OF INTEREST

If your property is located in the trial area (refer to map) and you would like to get involved in watercourse rehabilitation works on your property, visit the website to find out more and register your interest. Alternatively fill out the Expression of Interest Form inside this brochure and send it to us.

SITE ASSESSMENT

A Catchment Care Officer will contact you to arrange a site visit. The officer will assess the environmental value of your watercourse and threats to it. They will then discuss watercourse management options with you.

DEVELOP A SITE ACTION PLAN

You will then develop a Site Action Plan outlining the management actions to be undertaken at the proposed site. This plan will form the basis for your bid for financial assistance and will be based on discussions with the Catchment Care Officer and bid preparation information provided by the officer. This plan will also contain the amount of funding you are seeking to undertake the management actions.

BID ASSESSMENT AND SELECTION

Bids submitted by landholders are assessed by the Board. The bids will be assessed based on:

- environmental Value of the site
- threats to those values
- management actions proposed
- cost of the actions
- comparison with bids from other applicants.

MANAGEMENT AGREEMENTS

All bidders will be notified of bid assessment outcomes by mail. Successful applicants will be required to enter into a Management Agreement with the Board. Once signed, the Board will make an initial payment and work on the management actions can proceed.

PROGRESS PAYMENTS AND REPORTING

Progress payments and reporting requirements will be identified in your management agreement with the Board. Payments will be made based on meeting agreed targets.

Appendix A.3. - Web Form

Contact Information

Your first name	Firstname
Your surname	Surname
Postal address	Postal address
Postcode	
Physical address of your property if different from above	Physical address
Home phone number	
Work phone number	
Mobile phone number	
Your e-mail	

Information -

Q1	**Is you property located within the Boards area? Click here to view map.**	☐ **Yes**	☐ **No**	☐ **Don't know**
Q2	**Is there a watercourse located on your property?**	☐ **Yes**	☐ **No**	☐ **Don't know**
Q3	**Do you have any remnant native vegetation on your property?**	☐ **Yes**	☐ **No**	☐ **Don't know**

Send this Now!

Appendix A.4. - Expression of Interest Form

I ‘M INTERESTED IN BEING CONSIDERED FOR THE CATCHMENT CARE TRIAL

NAME.....
POSTAL ADDRESS.....
.....POSTCODE.....….
PROPERTY ADDRESS.....
.....……
PHONE: WORK.....HOME.....MOBILE.....

DOES YOUR PROPERTY CONTAIN A WATERCOURSE? YES NO

IS THERE REMNANT NATIVE VEGETATION ON YOUR PROPERTY? YES NO

Appendix B - Landholder Support Material

Appendix B.1. Eligibility Letters

Successful Letter

27 May 2004

Dear

Thank you for your expression of interest in the Onkaparinga Catchment Water Management Board's 'Catchment Care Tender Trial'. Your property has been selected to be part of the trial and bid for funding of watercourse management activities.

A representative of the Board will telephone you in the near future to organise a convenient time to meet with you at your property. In the meantime, we have enclosed an information pack that you will need to refer to during the development of your bid for funding. The information pack contains the following:

- Guidelines for Bid Development – these guidelines will help you complete your bid.
- Further information for bid development – this will provide you with information on the types of watercourse management activities you may need to undertake.
- An aerial photograph of your property.
- Bid preparation paperwork.
- Brochures and fact sheets containing further information on watercourse management activities.

Please read through the 'Guidelines for Bid Development' before our representative meets with you so that you can ask any questions at that time.

If you have any questions, please contact Steven Gatti or Darran King on 8374 6000.

Yours sincerely

Steven Gatti

Technical Manager

Unsuccessful (WMAP) Letter

27 May 2004

Dear

Thankyou for your expression of interest in the Onkaparinga Catchment Water Management Board's "Catchment Care Tender Trial". Unfortunately your property has not been selected to be part of the trial as you already receive funding for watercourse management activities on the property through the Watercourse Management Assistance Program.

To save on potential confusion, it was decided that properties already receiving financial assistance from the Board would not be eligible for funding through this trial. This does not affect the work currently under way with the Board on your property, or your potential to access further funding in the future.

If you have any questions please contact Steven Gatti or Darran King on 8374 6000.

Yours sincerely

Steven Gatti

Technical Manager

Unsuccessful (outside OCWMB) Letter

Date

Dear …….

Thankyou for your expression of interest in the Onkaparinga Catchment Water Management Board's "Catchment Care Tender Trial". Unfortunately your property has not been selected to be part of the trial as it is located outside of the region of the Onkaparinga Catchment Water Management Board.

It appears that your property is located within the region of the ……. Catchment Water Management Board. If you would like to discuss funding opportunities for watercourse management works on your property, you can contact the ……. Catchment Water Management Board on ……

If you have any questions please contact Steven Gatti or Darran King on 8374 6000.

Yours sincerely

Dr Jill Kerby

General Manager

Appendix B.2. - Guidelines for Bid Development

Catchment Care Tender Trial

Guidelines for bid development

Onkaparinga Catchment Water Management Board

Introduction

The Onkaparinga Catchment Water Management Board (the Board) has been helping landholders to protect and rehabilitate watercourses for over 5 years. In the past watercourse reaches selected for works were based on priorities set by the community at a series of meetings. The priorities were set by casting votes for watercourse reaches that appeared to be in need of rehabilitation.

It has long been recognised that this system of voting did not always recognise the biodiversity or water quality value of the watercourse, or the ability and desire of the landowner to become involved in watercourse protection and rehabilitation.

The Board is trialing a new way of selecting watercourse reaches for protection and rehabilitation works based on:

- the environmental values of the watercourse;
- threats to those environmental values; and
- paying a fair price for watercourse management services provided by the landholder.

The aim of this new way of selecting watercourse reaches is to better target limited financial resources to achieve the best environmental outcomes.

Development of the trial selection process was made possible by the financial support of the Commonwealth Government through the Market Based Instruments Pilot Program. The on ground works component of this trial is funded through the Catchment Environment levy which is collected by the Board.

Please note that this is the first time this trial has been offered in South Australia. The process and all the forms for the trial have been specifically developed but have not yet been tested. We would appreciate receiving any comments on the process and forms you have.

All bids must be received by 4pm on Friday 30 July 2004

What's in this booklet?

This booklet contains information to help you put together your bid for funding to implement watercourse management activities on your property. It also contains information to assist you with those management activities, should your bid prove successful.

Putting together your bid

A Catchment Care officer will visit you at your property to view the site at which you're proposing to undertake watercourse management activities. The officer will discuss with you:

- the environmental values of your watercourse that you should aim to protect;
- the types of threats your watercourse may be experiencing; and
- the range of activities you should consider to reduce those threats when putting your bid together.

The officer may advise you that the watercourse reach should be divided into more than one area and that a separate bid should be developed for each area. The officer may do this where the watercourse can be divided on the basis of different biophysical characteristics or where a significantly different suite of management activities is recommended.

The officer will leave you with recommendations and information for you to consider during preparation of your bid.

A step by step guide to preparing your bid is provided below. Your bid preparation paperwork is enclosed in this information pack.

You must complete and return Sections 1 to 5

Step 1
Provide your personal and property details in Section 1 of the Site Action Plan. Where the Catchment Care officer advises you to divide the watercourse into more than one area, separate Site Action Plans for each area will be required. Where more than one Site Action Plan is completed, please identify the area to which the different plans relate on the aerial photograph and complete "Area ID" in Section 1.

Step 2
Identify the watercourse management services you propose to provide in Section 2. An example of information to be provided in Section 2 is presented in Appendix A.

The likely range of activities eligible under this trial are listed in Table 1. You are encouraged to talk to your Catchment Care officer about other management activities that do not appear in this table. However, any management activities that you propose should have direct environmental benefits for the water quality and biodiversity on your property.

Complete the **Action** column using the categories in the Action section of Table 1

Provide a description of the activities proposed as part of these Actions in the **Activity** column. Use the Activity categories listed in Table 1 where possible. Make sure that you record amounts for Activities using the following units.

Action	Activity	Unit of measure
Stock exclusion	Fencing	length in metres
	Gates	number
	Stock crossings	number
	Stock watering points	number
Exotic tree control	Cut and swab	number or area
	Kill in-situ	number or area
Revegetation	Site preparation	area
	Plant supply	number
	Planting	number or area
	Install tree guards	number
	Plant aftercare	number
Weed control (in remnant vegetation)	Targeted chemical application	area
	Brush cutting	area
	Physical removal	area
Dam modification	Dam removal	volume
	Install low flow bypass	volume
Watercourse bed erosion control	Small scale structures	number
	Revegetation	number
Watercourse bank erosion control	Small scale structures	number
	Revegetation	number

The **Area of proposed activity (m^2)** will be completed by your Catchment Care Officer and provides us with information on the extent of the area over which activities are proposed. To help us please **mark as accurately as possible** the area of the work you propose on the aerial photograph of your property.

To help you determine the cost of providing the listed activities, identify the time and materials you may need in the **Time/material estimate** column. Table 1 provides a guide to the times needed to complete the various activities. You can also list any materials you think you may need in this

column. The amount of detail you enter is up to you as it will help you identify the funding required to complete the Activities listed.

Finally, let us know how much funding you require to complete the Activities by completing the **Funds required** column. Table 1 provides a summary of the broad range of commercial rates offered by professional operators to the Board over the years. You can use these figures as a guide but you must consider your own situation and what you are prepared to be payed for offering these services.

Tally up the funding you're seeking in the **Total** box at the bottom of Section 2. This is the total funding that you're bidding for in order to complete all the management activities you've listed.

Further information on the watercourse management activities listed in Table 1 is provided in the package of information provided with this booklet.

Step 3
To make sure you stay on target with the services you're offering you'll need to complete the **Timing of activities** in Section 4. You can find more information on the optimum timing of activities in the package of information provided with this booklet.

It is vital that you complete this section as you'll gain a much better appreciation of your own time commitment to the Site Action Plan and so that you can keep track of when the activities need to be done so that you get paid according to the agreed payment schedule.

Step 4
Seal your bid in the enclosed postage prepaid envelope and address as follows.

Confidential

Catchment Care Tender Trial
Onkaparinga Catchment Water Management Board
The Salvation Army Complex
The Hub
ABERFOYLE Park SA 5159

All bids must be received by 4pm on Friday 30 July 2004

How your bid is assessed

Your bid will be assessed against all other bids received as part of this trial. The bids that offer the best environmental outcomes at the best price will be successful. All bids and the results of their assessment will remain confidential so that no one receives an unfair advantage during subsequent trials should they occur.

The best environmental outcomes at the best price will be determined using the information on your proposed work site collected by our Catchment Care officer, and the management activities and price you submit as part of the Site Action Plan.

A good environmental outcome is considered to occur where a high value environmental asset (such as good remnant riparian vegetation) in good condition is protected from threats (eg weed invasion and grazing) by activities you undertake. This environmental outcome will then be matched with your funding bid and compared against the environmental outcomes and funding bids of other landholders to determine who offers the best value for money.

The number of landholders that are successful in their bids for funding will depend on the environmental outcomes proposed by the Site Action Plan and the amount of funding sought. As the Board has a limited budget for this trial it can be expected that there will be landholders who will not be successful with their bid.

Letting you know the outcomes

Everyone who submits a bid will be advised in writing whether they have been successful or not. This advice will reach you by **3 September 2004**. If you are successful, you will be required to enter into an agreement with the Board which will include the conditions listed in Section 5 of the Site Action Plan (refer to attachments). The agreement will also include your Site Action Plan, the level of payment you require and a repayment schedule.

If you were not successful, and in the event that we run a second trial you'll be able to resubmit your bid. However, you may need to recalculate the funding you need to give yourself a better chance next time around.

Progress payments and reporting requirements

To help landholders stay on target and to ensure that payments are made according to an agreed time schedule, successful landholders will be required to report on progress every 12 months. We've tried to keep these reporting requirements simple so that you spend more time working on the management activities rather than filling in forms. A copy of the Progress Report is enclosed in this information pack.

Following receipt of your Progress Report, a Catchment Care officer will call you to arrange a site visit.

Progress reports will be linked to progress payments. After we accept your Progress Report we can make our next payment to you. The schedule of progress payments will be based on your Site Action Plan timetable. One payment will be made at the time of signing the agreement with the Board to get you on your way.

Further information and assistance

Development of the financial aspects of the bid is the responsibility of the landholder. However, our Catchment Care Officers will be available to give you advice on the recommended management activities for your Site Action Plan after the initial site visit. Call the Onkaparinga Catchment Water Management Board on 8374 6000 between the hours of 9am and 5pm Monday to Friday to speak to a Catchment Care Officer.

Table 1. Guide to watercourse management actions.

Action	Activity	Time Guide [1]	Indicative commercial rates [2]	Comments
Stock exclusion	Fencing	Landholders may wish to purchase materials and use own labour. Landholders will need to estimate own hours to undertake works.	$4,500 to $10,000/km	Base cost on 5 strand barb wire fence.
	Gates		$150	Stock and vehicle access gates only.
	Stock crossings		Depends on type	Permit may be required for works.
	Stock watering points		$350 for 360 litre tank and 400m poly pipe. $450 for pump.	Can include header tank, poly pipe, trough and pump.
Exotic tree control	Cut and swab	Around 1hr/tree depending on size	Landholders are encouraged to seek quotes as rates are highly variable.	Involves mechanical tree removal and application of herbicide to cut stump.
	Kill in-situ	0.25hr/tree.	$80/operator hour – using specialist equipment	Tree is killed left standing using poison injection method. Direction provided by OCWMB.
Revegetation	Site preparation	0.5hr to 1hr/100 plants	$25/100 plants	Includes preliminary weed control.
	Plant supply	Not applicable	$0.80/plant	Board will supply plants to landholder at cost. Plant species supplied will be the best for their site.
	Planting	2hr to 3.5 hr/100 plants	$100/100 plants	Includes hole digging, watering bowl formation and planting.
	Install tree guards	2hr/100 plants	$30/100 plants $68/box of 330 plastic sleeves $63/bundle of 500 canes	Two bundles of canes required per box of plastic sleeves. Orders can be filled through the OCWMB. Orders for boxes of sleeves or bundles of canes to be multiples of 330 and 500 respectively.
	Plant aftercare	1hr to 3hr/100 plants	$40/100 plants	Includes watering for first year and weed slashing and spraying up to 3 years after planting.
Weed control (in remnant vegetation)	Targeted chemical application	1hr/100m^2 for low density (<10% of area) to 3hr/100m^2 for high density (>50% of area).	$30 to $45/operator hour	Very sensitive techniques are required in remnant bush. Heavy mechanical intervention (tractor slashing etc) is not recommended.
	Brush cutting			
	Physical removal			
Dam modification	Dam removal	Half a day to several days, depending on wall size.	$120/hr machine hire	Available for on stream dams only. Permit may be required for works.
	Install low flow bypass	Half a day to several days, depending on construction.	>$1,000 ($120/hr machine hire)	Low flow bypasses will require some design. Design services may be provided by the Department of Water, Land and Biodiversity Conservation.
Watercourse bed erosion control	Small scale structures	Time varies depending on nature of erosion and structure constructed	$100 to $2,500	Guidelines on suitable erosion control methods available from Board. Permit may be required for works.
	Revegetation	Refer to costs above.	Refer to costs above	Should be a component of every erosion control strategy. Board will supply plants to landholder at cost. Plant species supplied will be the best for their site.
Watercourse bank erosion control	Small scale structures	Time varies depending on nature of erosion and structure constructed	$100 to $2,500	Guidelines on suitable erosion control methods available from Board. Permit may be required for works.
	Revegetation	Refer to costs above.	Refer to costs above.	Should be a component of every erosion control strategy. Board will supply plants to landholder at cost. Plant species supplied will be the best for their site.

1 Time guide is indicative only and is presented to assist landholders develop their bids. Landholders should determine their own time inputs. Time may be higher or lower that those indicated in this table.

2 Based on the OCWMB's purchasing experience over 5 years.

Appendix A

Example Site Action Plan - Sections 2 and 4

SITE ACTION PLAN

Onkaparinga Catchment Water Management Board

SECTION 2 – Proposed Management Actions

No.	Action (year)	Activity	Area of proposed activity (m^2)	Time/material estimate	Funds required
1	Stock exclusion (2004)	Fence 200m of watercourse (both sides) with 5 strand barb wire fence. Install 2 stock gates. Provide watering point	4,000	400m fencing, 2 stock gates 1 tank and pump 8 hours labour	$3,200
2	Weed control (2005)	Brush cutting/hand pulling weeds in remnant riparian vegetation Targeted spot spraying weeds	10,000	40 hours labour 1L herbicide	$820
3	Revegetation (2005/06)	Site preparation for 800 plants – spot spraying Supply 800 plants Planting 800 plants with watering bowl Install tree guards to 200 plants only Plant aftercare – water over summer Plant aftercare - autumn weed control	1,800	4 hours labour 800 plants 20 hours labour 2 hours labour 16 hours labour 20 hours labour	$1,920
4	Weed control (2006)	Brush cutting/hand pulling weed regrowth in remnant riparian vegetation Targeted spot spraying weeds regrowth	10,000	20 hours labour 1L herbicide	$420
5	Revegetation (2006/07)	Site preparation for 400 plants – spot spraying Supply 400 plants Planting 400 plants with watering bowl Plant aftercare for 400 plants - water over summer Plant aftercare for 1,200 plants- autumn weed control	1,800	2 hours labour 400 plants 10 hours labour 8 hours labour 24 hours labour	$1,800
6	Weed control (2007)	Brush cutting/hand pulling weeds regrowth in remnant riparian vegetation Targeted spot spraying weed regrowth	10,000	20 hours labour 1L herbicide	$420
7	Revegetation (2008)	Plant aftercare for 1,200 plants- autumn weed control	1,800	12 hours labour	$250
				Total	**$8,830**

EXAMPLE

Name:

SECTION 4 – Timing of activities

Activity No.	Year 1 - 20…..												Year 2 - 20…..												Year 3 – 20……												Year 4 - 20…..												Year 5 - 20…..											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
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Complete this table by shading in or ruling through the month boxes that you expect to complete the management activities (refer to the package of information provided with this booklet for optimum timing of activities).

EXAMPLE

SITE ACTION PLAN

Onkaparinga Catchment Water Management Board

SECTION 1 – Property and Landholder Details

Landholder Name		**Contact** (if not landholder)	
Telephone	**(Work)**	**(Home)**	**(Mob)**
Postal Address			
Property Address		**Property ID.**	
Catchment Care officer			

SECTION 2 – Proposed Management Actions

Please identify on the aerial photograph of your property where the activities will be undertaken and attach the photograph to this Site Action Plan. Please ensure that the work areas that you propose are MARKED AS ACCURATELY AS POSSIBLE as this may affect the success of your bid.

Action.	No	Activity	Area (m^2) *OFFICE USE ONLY*	Location	Time/material estimate	Funds required

Property ID:

Action.	No	Activity	Area (m^2) *OFFICE USE ONLY*	Location	Time/material estimate	Funds required
				Total		

SECTION 3 – Agreed threat reduction (Office Use Only)

Environmental Threat	TR Score
Bed Erosion	
Bank Erosion	
Dams	
Proposed revegetation area	
Weed % cover	
Invasive weed presence	
Grazing Pressure	

SECTION 4 – Timing of activities

Property ID:

No.	Year 1 - 2005												Year 2 - 2006												Year 3 – 2007											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

Complete this table by shading in or ruling through the month boxes that you expect to complete the management activities (refer to the package of information provided with this booklet for optimum timing of activities).

SECTION 5 – Conditions of receiving Board funding

If your bid for funding is successful, you will be required to enter into an agreement with the Board. This agreement will include the following conditions.

- All works undertaken by the landholder will be done entirely at the landholder's own risk. The Board will not be liable for any loss or damage to property, or injury or death of persons arising from or associated with the landholder's own works.
- The installation of agreed fencing, gates, stock crossings/flood gates, stock watering facilities and minor erosion control structures will be arranged/undertaken by the landholder.
- All stock exclusion fencing must be set back at a minimum of 5 meters from the top of bank in order to qualify for payment. Where top of bank is ambiguous, set-back should be determined in consultation with the Board.
- The landholder will undertake the works identified within the time period indicated in Section 3.
- Reimbursement cannot be guaranteed where management activities are not completed within the time period specified in Section 3.
- The Board will pay for services provided by the landholder as specified in Section 1 according to a payment schedule to be advised upon signing of an agreement with the Board. This will consist of at least one up front payment to allow works to commence. Further payments will be made based on achieving agreed milestones.
- The landholder will be paid for services as specified in Section 1. If actual expenditure exceeds the amounts specified in Section 1, any additional cost will be borne by the landholder.
- The landholder agrees to maintain or replace any of the works and items funded through this Site Action Plan, should they be lost, stolen, damaged or destroyed.
- Stock is to be permanently excluded from areas where revegetation works funded through this Site Action Plan have been undertaken. The regeneration and/or establishment of appropriate vegetation within the fenced area plays an essential role in the stabilisation of watercourse bed and banks, improved water quality and the improved biological health of watercourses.
- Any natural regeneration of indigenous plant species that occurs after stock exclusion from an area is to be protected, and must not be removed, by any means, without seeking and receiving written consent from a representative of the Board.
- Revegetation will only be carried out ***after*** fences have been constructed, unless otherwise advised.
- All areas where weed and/or exotic tree control has been undertaken are to be revegetated with local indigenous species only. No reintroduction of exotic species may be carried out by the landholder, and all reasonable effort must be undertaken to exclude accidental reintroduction. Once initial infestations of exotic plants/weeds have been controlled and areas revegetated with the assistance of the Board, any weed regrowth is to be controlled in future years by the landholder.
- The landholder's responsibility to maintain in good order the works and items funded through this Site Action Plan succeed the term of the agreement with the Board.
- In the event that the landholder sells their property either prior to or following completion of the Site Action Plan, the landholder is required to advise the new property owner of any agreements with the Board during sale negotiations.

GST Requirements

Australian Business Number (ABN) and Goods and Services Tax (GST)
Introduction of the GST legislation from 1 July 2000 has placed certain responsibilities on individuals receiving payments from the Onkaparinga Catchment Water Management Board.

The Board is required in future to deduct a 48.5% withholding tax from any payments it makes to individuals unless:

- An ABN is provided to the Board, or
- An ABN is not required because the recipient is an individual where the activity is done as:
  1. a private recreational pursuit or hobby, or
  2. is wholly of a private or domestic nature.

In the circumstances described in 1 & 2 above recipients must provide the Board with a statement confirming that they are not required to hold an ABN. The Board will seek this information from you at the time you seek reimbursement.

Property ID:

SECTION 6 – Acceptance of Proposed Work Plan

As Land Owner/Manager, I tender this Site Action Plan and, on condition of receiving funding from the Onkaparinga Catchment Water Management Board, agree to undertake the activities listed in Section 2 at the locations shown in the aerial photograph of my property according to the timeline in Section 4. I have also read and accept the "Conditions of Receiving Board Funding" in Section 5.

Name……

Signed:…… Date:……..

Progress Report No. …….

Onkaparinga Catchment Water Management Board

SECTION 1 – Property and Landholder Details

Landholder Name		**Contact**			
Property Address				**Property ID.**	
Catchment Care officer		**Report period**	…….../20….. to ……/20…...		

SECTION 2 – Proposed Management Activities

You need only report on actions completed or that should have been completed during this report period

Task No.	Activity – From Site Action Plan (include completion date from SAP Section 3)	Activity – Actual Progress to date (if not completed estimate % complete)

Property ID:

The work proposed in the Site Action Plan is proceeding according to plan. YES NO

If NO explain why and what activities require completion

……

……

……

……

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……

……

General comments on the progress of your Site Action Plan

……

……

……

……

……

……

……

……

Signed: ……..……. (landholder) Date: ……..……..

Office use only

1. **It is recommended that the next payment be made**
2. **It is recommended that the next payment is not made until the above activities are undertaken**
3. **The Site Action Plan is now complete YES NO**

   (Delete whichever is not applicable)

Signed ……..…….(OCWMB) Dated ……..……..

Appendix B.3. - Further Information for Bid Development

Catchment Care Tender Trial

Further information for bid development

Onkaparinga Catchment Water Management Board

CONTENTS

LIST OF TABLES

1 Introduction

This booklet is specifically designed to support landholders who are involved in the Catchment Care Tender Trial. It contains guidelines and helpful advice on implementing management activities necessary to address watercourse management issues on your property. These guidelines can also help you estimate how much time you may need to invest in implementing the management activities.

These guidelines are not exhaustive and should not be considered as rules. Instead, they provide enough information to help you prepare your bid and ultimately implement your proposed management activities. Further information on management activities is contained in this information pack or is available from the Onkaparinga Catchment Water Management Board.

2 Actions

The range of activities and actions considered as part of this trial are summarised in Table 1. Further details on how to implement these activities are provided in the following sections of this booklet.

Table 1. Summary list of actions and activities

Action	Activity	Target Outcomes	Further Information
Stock exclusion	Fencing Gates Stock crossings Stock watering points	All stock are permanently fenced out of the watercourse and riparian areas.	Section 2.1 "Managing Stock" Fact Sheet
Exotic tree control	Cut and swab Kill in-situ	Autumn leaf load to the watercourse is removed. Regrowth is controlled.	Section 2.2 Weed Control Handbook for Native Vegetation, Revegetation and Creek Lines in the Onkaparinga Catchment
Revegetation	Site preparation Plant supply Planting Install tree guards Plant aftercare	Riparian areas are revegetated with local native species to provide buffer for runoff from adjacent paddocks. Provide vegetation corridors and infill "breaks" in remnant vegetation.	Section 2.3 Manual for Revegetation with Local Native Plants
Weed control (in remnant vegetation)	Targeted chemical application Brush cutting Physical removal	Spread of weeds in bushland is halted and reversed. Weed density is continuously reduced and kept in check.	Section 2.4 Weed Control Handbook for Native Vegetation, Revegetation and Creek Lines in the Onkaparinga catchment
Dam modification	Dam removal Install low flow bypass	Holding capacity of dams not required in production or for stock domestic use is reduced.	Section 2.5 'Low Flow Bypass Device' Fact Sheet
Bed and bank erosion control	Small scale structures Revegetation	Rate of bank and bed erosion is minimised so that sediment input to watercourse is minimised.	Section 2.6 Fact Sheets from "Manual for Small Scale Watercourse Erosion Control Works"

2.1 Stock exclusion

2.1.1 Issue

Watercourses can be severely degraded when stock are allowed free access to them. Allowing stock to freely access watercourses can:

- increase erosion of the stream bed and banks
- degrade existing native vegetation leading to increased erosion, weed infestation, habitat loss and reduced water quality
- increase fouling of the watercourse through deposition of dung and sediment
- decrease water quality.

2.1.2 Methods

Table 2 provides some general guidelines for the fencing of watercourses.

Table 2. Stock exclusion

Activities	Notes
Fencing	*Setting a buffer distance:* your catchment care officer will establish the appropriate buffer distance during the site visit. As a guide the Board requires a minimum buffer distance of 5/m from the top of the watercourse bank. *Fence type*; the Board usually recommends conventional five (or more) strand wire fencing above electric fencing. Conventional fencing requires less supervision and maintenance, and can be made more permanent than electric fencing. *Fencing across watercourses:* fences across watercourses should be separate from the rest of the fence to minimise damage during flood events. There are several methods for fencing across watercourses. 1. drop down fences: these are the cheapest option and are easy to repair. 2. suspended cable fences: more expensive than drop down fences but require little maintenance or repair work 3. hinged flood gates: the most expensive of the three but only suitable where the flow does not rise above the channel. Remember to plan your fence. Watercourses are not straight lines, so it will be necessary to construct your fence with this in mind. The use of an aerial photo can be an effective tool in this process.
Gates	Wherever practical, the use of spring gates and/ or lay down gates is encouraged. These types of gates are cheap to construct and easy to maintain.
Stock crossings	At some point it may be necessary to allow stock to cross your watercourse. It is important to minimise the impact of this by undertaking activities to control where and how stock can cross the watercourse. This can include a single walk through point which has inward swinging gates on either side to prevent crossing stock from moving up or down the watercourse. Landholders are only eligible for funding of this activities if they undertake to fence off their watercourse.
Stock watering points	Where a watercourse is fenced, the Board offers funding for alternative watering points. Alternatives include gravity feeding to stock troughs, membrane pumps or stable stock watering points. Stock troughs or membrane pumps are the preferred options. Rainwater tanks and poly pipe to complete the alternative watering point may also be considered. Landholders must fence off their watercourse to be eligible for assistance. Where appropriate, landholders should locate the trough strategically to enable watering two paddocks from one trough. If providing on stream watering points, a maximum of one watering point per paddock is allowed and should be sited on a stable reach of the watercourse. The best location is upstream of a stock crossing point and on the inside of a bend where flow is the lowest and potential for erosion is limited. If a landholder uses a watering point, he/she is not eligible for a trough system in that paddock.

One of the simplest means of protecting against watercourse and water quality degradation is to permanently fence stock out of riparian areas. Your Catchment Care Officer will discuss the most appropriate location of the fence with you.

Fencing to keep stock out of watercourses is a prerequisite to any Board assisted watercourse works on grazing properties. Alternatives for stock watering are provided as part of the assistance package. Control of stock access is essential to enable revegetation using local native species and the maturation of the vegetation to habitat for native fauna.

2.1.3 Timing

The most appropriate times to undertake this action are indicated below

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

2.2 Exotic tree control

2.2.1 Issue

Some of the problems associated with exotic trees are as follows.

- deciduous tree leaf drop into watercourses during autumn changes the ecosystem to one which many other local plants and animals cannot adapt to
- exotic deciduous trees change the light regime of an ecosystem. This influences the types of plant species that can grow beneath them and therefore the animals which live there
- provide sub-optimal habitat for birds, insects and mammals
- consume lager volumes of water than local natives
- can cause the banks to destabilise and erode.

2.2.2 Methods

The three most effective methods for exotic tree removal are provided in Table 3 below.

Table 3. Exotic trees

Activities	Notes
Cut and swab	Can be used on small woody shrubs to large trees by removing the entire trunk with loppers or a chainsaw to just above ground level. Ensure all green material or small shoots are removed. Using a small paintbrush or weed-wand, paint the cut trunk/stem with herbicide within 30 seconds of making the cut. This will ensure that the plant absorbs the chemical. Where possible remove the cut branches from the site. A water mix ratio of 4:1 (herbicide/water) can be used. The timber can then be stacked for burning when dry and should be stacked away from the watercourse so that it is not transported downstream during times of high river flow. Be sure to observe fire restrictions when burning. Willows can spread vegetatively by broken sticks falling into wet soil or floating down stream. For this reason it is very important to remove all willow debris from the site if the tree is felled green.
Kill in-situ	*Frilling and ringbarking:* choose a part of the stem or trunk as close to the ground as possible. Using a small hatchet, cut away enough of the bark to penetrate the soft tissue about 10 cm long. Continue this process around the trunk or stem and paint the exposed area with herbicide no more than 30 seconds after the cuts have been made. On multi-stemmed willows it is important that all stems are treated this way. If one stem is missed, the tree will not die. A willow killed in this way may take around five years to gradually break down. The process can be promoted by strategic removal of limbs, although you should exercise great caution when underneath any dead tree. This is the cheapest willow removal method, but may result in a safety hazard if humans and livestock access the area. It may also result in a dramatic landscape of dead trees if many are killed in this way. One thing to be particularly mindful of is the potential for dead limbs to fall into the watercourse over time, which can lead to blockage of flow. This may be a particular issue where surrounding land use is sensitive to flooding. *Drill and fill:* drill numerous holes into the trunk or stem and fill with herbicide no more than 30 seconds after the hole has been drilled.

2.2.3 Timing

The most appropriate times to undertake this activity are indicated below. Exotic tree control measures should not be undertaken on deciduous tree species during the autumn or winter months, as deciduous trees are dormant during these periods and the control measures will be ineffective.

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

2.3 Revegetation

2.3.1 Issue

Revegetation should be a part of any watercourse management project. Local natives are the best adapted to the conditions of a site and play an important part in the local ecosystem. Loss of local native vegetation can result in:

- increased land degradation and loss of productivity
- increased erosion as there are no plants to hold the soil together
- reduction in water quality - riparian vegetation provides a buffer to the watercourse protecting it from pollutants
- provides an opportunity for weed invasion
- loss of habitat for ground, airborne and aquatic species
- reduced biodiversity
- lack of shelter for stock.

2.3.2 Methods

The method of revegetation used will depend on the type of plants, the ecology of the areas to be revegetated and the size of the area to be revegetated. Any revegetation project will require some degree of site preparation. Table 4 provides a guide for revegetation projects.

Your Catchment Care Officer will discuss the number and species of local indigenous plants that are right for your situation. You will then be required to place an order for the number of plants you require through the Board.

The Board will fill your order and ensure you get the right plants species for your area. However, all other aspects of revegetation will need to be implemented by you.

Once your revegetation project is completed you will need to undertake some follow up maintenance. Diligent aftercare will ensure the success of the revegetation and this maintenance work will reduce over time.

Table 4. Revegetation

Activities	Notes
Site preparation	Every time you enter your site ensure that your clothes and boots are free of mud, debris and seeds to prevent contamination. Site preparation can include the following: 1. Broadly spraying small areas to accommodate numerous plantings - generally not recommended as it leads to broad scale disturbance and possible more severe weed infestation. 2. Targeted spot spraying for individual plantings - involves spraying individual spots around 1/m in circumference. This method of site preparation should take place up to 6 weeks prior to planting. Where weeds are particularly hardy or invasive, one spot spray around eight weeks prior to planting with a second two weeks prior can be considered. However, you should always aim to minimise chemical use. 3. Manual scraping (no chemical preparation) for individual plantings - can involve no pre-treatment other than preparation for planting on the day. If you are to use this method, ensure that the area has been slashed before scraping to be more effective (see below for more details). Where woody weeds are present it may be necessary to undertake weed control for a number of years prior to planting. Effective woody weed control is essential to long term revegetation success.
Plant Supply	The number and species of plants for your project will be discussed between you and your Catchment Care Officer. Orders for plants are then placed with the Catchment Board. The Board sub-contracts the propagation of plants and will let you know when plants can be made available for planting.
Planting and tree guard installation	Your Catchment Care Officer will suggest the most appropriate locations for your plants. 1. Scrape 1-2 cm of soil from an area of about 30 cm x 30 cm and move to one side, this will remove any weed seeds (to not mix this soil back in) 2. Dig a hole in the scaped area about 15 cm x 15 cm and 5-8 cm deeper than the tube stock depth 3. Orientate the plant. Place the plant in the lowest point in the hole with most leaves facing North 4. Crumble the clean soil back in around the plant with 2-3 cm covering the top of the root mass with a ring of soil 4-5 cm high around the plant about 5 cm from the stem 5. Your finished planting should resemble a flat bottomed bowl 6. Once filled pour about 2 litres of water into the bowl to minimise stress and settle the roots 7. If staking the plant for tree guards be sure to place the stakes to the south of the plant to prevent shading and improve survival rates.
Plant Aftercare	Be sure to follow up your planting with appropriate weed control (see Table 6). During extended dry or hot periods a small amount of watering may be required (3 to 6/L/plant). You may want to allow for up to 2 watering events during dry months in the first year of revegetation. After this time the plants are able to fend for themselves. Regular observations of the revegetation area for damage (eg. rabbits and kangaroos) will ensure long term survival.

2.3.3 Timing

The most appropriate times to undertake this activity are indicated below.

Site preparation

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

Revegetation

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

Aftercare

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

2.4 Weed control (in remnant vegetation)

2.4.1 Issue

Local native vegetation actively competes with weed species for light, nutrients, space and various other resources. This competition reduces the local native plants capacity to survive and therefore reduces the other plants and animals which rely on them. Many people often confuse native plants with local native plants. There are large numbers of native plants in the Adelaide Hills which:

- can dominate areas in the same way as weed species
- exclude local native plants
- change habitat structure forcing many native animals to move elsewhere
- provide refuge for feral animals
- lead to overall loss of biodiversity.

2.4.2 Methods

Table 5. Weed control

Activities	Notes
Physical Removal	*Hand removal:* best undertaken when the soil is wet. The key to hand removal is to exert as little disturbance on the soil as possible, ensure that all of the root or bulb is removed and remove weed material from the site. *Cover or solarisation:* 1. ensure there are no indigenous plants in the area to be covered 2. cover the weed/s with black plastic and secure with tent pegs or similar 3. leave in place for two weeks 4. for best results remove plastic on a hot sunny day as this will assist in killing the plant by burning it 5. remove all plastic from site.
Brush cutting (or grooming)	This is the process of removing the bulk of the weeds by cutting them as close to the ground as possible. Be sure there are no indigenous plants in the area (they may be hidden in deep weed infestations). Some follow-up work with chemicals is likely to be necessary. Following vegetation removal you will need to wait for around nine months for sufficient weed regrowth that can then be sprayed using Roundup Biactive ™ prepared according to the label. Regrowth should be around 500/mm high in general. Only spray when weeds are actively growing, otherwise the herbicide will not be taken into the roots and the plant will not be killed. In winter it is too cold and in late summer it is too dry for active growth for many species of plants. Following death of the blackberries after six months, some landholders elect to reduce the canes using controlled burning techniques. This obviously demands great care and planning.
Targeted chemical application	*Wipe on:* wiping chemicals directly onto the weed can be appropriate in areas where runoff or spray drift may harm native plants. *Cut and swab, frilling and ringbarking, drill and fill - Refer to Table 3.* *Spray application*. refer to Weed Control Handbook

2.4.3 Timing

The timing for control of weeds is variable as it depends on the type of weed to be controlled. The tables below provide a general indication of the most appropriate timing for weed control. It is recommended that anyone intending to undertake some form of weed control refer to the *Weed Control Handbook for Native Vegetation, Revegetation and Creek Lines in the Onkaparinga Catchment*.

Grasses

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

Woody Weeds

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

Before weed control

After weed control

2.5 Dam modification

2.5.1 Issue

Dams are known to significantly reduce watercourse flow by capturing and impounding rainfall runoff, thereby preventing large volumes of water from entering the watercourse, reducing stream flows, degrading water quality and therefore suitability for aquatic species, irrigation and livestock. This is particularly the case in low rainfall months and where low flow bypass structures are not fitted to dams.

- less water available for aquatic ecosystems, riparian ecosystems and other water dependent ecosystems. local plants and trees causing loss of remnant native vegetation
- changes to ecosystem dynamics in estuaries and at the freshwater/marine interface
- reduced capability for the watercourse to “flush” potential contaminants from the system, leading to lower water quality for the aquatic environment, as well as human and stock uses.

2.5.2 Methods

Table 5. Dam modification.

Activities	Notes
Dam removal	Many existing dams perform purely aesthetic functions. While these dams can also provide local habitat, the water they store has been diverted from the downstream watercourse where it would have aided in maintaining vitally important ecosystem processes. Dams not involved in supplying water for agricultural production or for stock and domestic purposes could be considered for removal. This would usually be done with the assistance of a dam sinking or earth-moving contractor. Any dam that is removed should also include a strong revegetation component so that stabilisation of the watercourse bed and banks can be achieved.
Low flow bypasses	A low flow bypass diverts water around a dam during periods of low flow. Watercourse flows during these low flow periods are critical to topping up pools so that aquatic life can survive into the next high flow season. The low flow bypass device ensures that low watercourse flows necessary to keep aquatic biota alive are maintained. It has also been shown in studies in Victoria that low flow bypasses do not have a significant impact on the water harvesting capacity of dams, and so do not have a significant impact on water availability for agricultural or domestic use. Refer to the attached low flow bypass fact sheet or talk to your Catchment Care Officer for more information

2.5.3 Timing

The most appropriate times to undertake this activity are indicated below.

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

2.6 Erosion control

2.6.1 Issue

The erosion of the bed and banks of watercourses is a natural process. However, with the regulation of flow and removal of most of the riparian vegetation cover, the rate of erosion along watercourses has increased dramatically.

The consequences of excessive watercourse erosion include:

- high sediment loads entering the watercourse leading to lower water quality and siltation of habitat pools
- undermining and loss of remnant riparian vegetation leading to loss of habitat and further watercourse erosion.

This activity will only be funded if landholders with stock agree to fence and revegetate their watercourse, and only after the fence has been constructed.

2.6.2 Methods

A summary of possible methods is provided in Table 6.

While the cheapest and most effective treatment for erosion problems is provided by revegetation, the rate of erosion in some cases is so fast that revegetation does not have the time to take control. In these cases, it may be necessary to consider engineering control options. This may include minor erosion control structures such as star dropper and mesh fences or major structures such as rock chutes.

Table 6. Erosion control.

Erosion Control Technique	Erosion Type	Life Time of Structures	Construction Practicality	Materials Cost
Revegetation	Suitable as a sole solution for minor erosion. Should be a component of every erosion control strategy.	Long Term	Suitable for all sites. Relatively easy to implement.	Low
Log Sill or Weir	Bed deepening. Erosion heads up to 0.6 m drop.	Up to 20 years	Easy to construct but requires effort. Most practical on narrow streams.	Low
Hay Bale, Silt Fence or Concrete Bag Sediment Trap	Bed deepening. Erosion heads up to 0.6 m drop.	Hay bale up to 1 year. Silt fence 1 – 5 years. Concrete bags variable. Maintenance and repairs will be required.	Very easy to construct. Most practical on narrow streams. Provide additional support on wide streams.	Low
Porous Weir Sediment Trap	Bed deepening. Erosion heads up to 0.6 m drop.	Materials can last beyond 10 years. Maintenance, repairs and reconstruction may be required.	Very easy to construct. Most practical on narrow streams. Provide additional support on wide streams.	Low
Erosion Control Matting	All minor bank erosion except undermining. Also suitable for minor bed deepening.	1 to 5 years or longer depending on fabric type.	Very easy to install.	Low. Most fabrics cost < $2 per m2
Alignment Training – Large Woody Debris	Bank erosion.	Up to 20 years.	Requires reasonable effort.	Low
Alignment Training – Wire Fencing	Bank Erosion. Undermining, attrition, fretting.	Materials can last beyond 10 years. Maintenance, repairs and reconstruction may be required.	Easy to construct.	Low
Large Woody Bank Protection	All minor bank erosion in combination with battering.	1 – 5 years for direct bank protection. Up to 20 years.	Requires reasonable effort.	Low

2.6.3 Timing

The most appropriate times to undertake this activity are indicated below.

SUMMER		AUTUMN			WINTER			SPRING			SUMMER
Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec

It is important that no flow or low flow conditions are experienced before any erosion control works are undertaken within the watercourse. Erosion control involving revegetation should be undertaken as indicated in section 2.3.

Appendix B.4. - Weed Control Handbook Draft

Weed Control Handbook for Native Vegetation, Revegetation and Creek Lines in the Onkaparinga Catchment

DRAFT ONLY

FEBRUARY 2004

DISCLAIMER

The material in this book is provided as information only and is not to be viewed as recommended practice of the Onkaparinga Catchment Water Management Board. It is the users responsibility to ensure any methodology adopted or adapted from this book is suitable for the purposes intended. The Onkaparinga Catchment Water Management Board cannot take responsibility for the misuse or abuse of any information in this publication.

Acknowledgements

The information in the Weed Control Handbook has been sourced from a variety of documents and individuals. Thanks to Kieran Brewer, Phil Crammond, Tony Paterson, Maeve Dullaghan and Caroline Crawford. Thanks to Kate Smith for compiling the First Manuscript. Stuart Paul from the Environmental Protection Authority has also assisted in supplying the Draft Guidelines for Herbicide Use Near Water bodies.

Introduction

This weed control handbook has been developed to assist landholders and community groups undertaking weed control in native bushland and riparian areas in the Onkaparinga Catchment, it is not intended for broad scale weed control or weed control on pasture or grazing land.

This booklet is design to be easy to use and informative. However it is important to note, that weed control is a specialist skill that requires an in-depth understand of the applied techniques and suitable plant identification skills. Plants of conservation significance may be throughout the target area so therefore if you cannot target just the weed species you are controlling without damaging other plants, seek assistance. If you are unsure of how to undertake a certain type of weed control technique or if you cannot clearly identify a plant species, please seek further advice before commencing to avoid causing off-target damage.

The species highlighted in this document have been selected, as they are common and / or invasive weeds in the catchment area. As the majority of weed control undertaken by the Onkaparinga Catchment Water Management Board occurs along waterways, special consideration has been given to the weed control techniques and the associated effect on water quality. All suggested techniques are based on minimum disturbance methodology and best practice guidelines for chemical use, always refer to the label instructions before using any herbicides.

Why weed control is important

For the purposes of this book a weed is classified as an introduced plant species, or a plant that would not have originally occurred in an area. Many of our priority weeds have been introduced as garden and agricultural plants from other countries. It is important to note, however that Australian native plants can also be weeds if they are planted outside of their natural distribution. For example the Flinders Ranges Wattle (*Acacia iteaphylla*) is a popular garden plant that is now escaping into bushland and considered a weed in the Mount Lofty Ranges.

Native vegetation is highly fragmented in the Onkaparinga Catchment with only around 13% remaining. It is estimated that only around 5% is considered intact or weed free. As the majority of our remaining vegetation is restricted to small patches scattered across the landscape, it is very easy for weeds to invade and drastically change the composition of the habitat. Weeds compete with indigenous plants for water, light, nutrients and pollinators. As many weed species have effective dispersal mechanisms (eg large seed set), overtime they can out-compete the indigenous plants and completely dominate areas.

Native vegetation is found growing in vegetation communities where the tallest plant controls the amount of sunlight, rain and leaf litter reaching the understorey plants. The understorey plants that grow in association with these dominant plants are perfectly suited to growing under these conditions and together they form a vegetation community or habitat type (eg red gum woodland, tea-tree swamp). It is common for intact vegetation communities to contain between 100-200 indigenous plant species. When a weed is introduced to bushland, these fragile balances are damaged leading to a reduction in the number of plants that can compete

with the weeds. For example, very few indigenous plants can survive under the dense canopy and thick leaf litter of a pine tree.

Weed control is extremely important in bushland areas, as it is only through active intervention that these introduced plants will be eradicated. Removing weeds reduces the amount of weed seed entering the environment while freeing up space for indigenous plants to recolonise. Weed control along watercourses is also important as weed seed can easily disperse into the water leading to further problems downstream.

While revegetation of cleared land is important in helping to expand the amount of available habitat, it will take a long time before it is as diverse as remnant vegetation. Therefore the highest priority should be preserving the small amount of vegetation we have left through active weed control.

How to prioritise weeds

Many areas of remaining bushland contain a variety of weed species but due to time and financial constraints they cannot all be removed at the same time. The Bradley Method suggests it is most effective to work from the best areas of native bushland or the most weed free areas out towards the most infested areas. While this is a valuable technique, a few other points must be considered to ensure a successful and logical eradication program. When prioritising weed control it is important to take into account the following:

- Rate of spread – is this weed known to spread rapidly and take over large areas in a short time. It is a higher priority to remove those species that can rapidly disperse as opposed to those species that do not appear to be rapidly increasing in size.

- Number of plants – it is extremely important to tackle a weed if it is currently in low numbers. It may then be possible to eradicate an entire species rather than tackling one that is already well established.

- Effects on native vegetation – some weeds are known to dramatically change the environment if they are introduced to an area. This may include canopy suppression, changing the pH of the soil or reducing water flow. It is important to control these weeds before they start effecting the surrounding vegetation.

- Difficulty to control – it is important to consider how successful the control is likely to be. Is the weed accessible for control? Are there important indigenous plants close by? Will several applications be required? If a plant is difficult to control and not known to spread rapidly it may be considered a lower priority for eradication.

- Impact on rare or threatened plants, animals or habitats – if an important species or habitat has been identified it is important to control any weeds threatening its survival as a priority.

- Location of the weed – it is important to control a small outbreak of a weed if it occurs in native vegetation as opposed to a large population in a mainly weed infested area.

- ❖ Location of the weed throughout the catchment – if a weed is quite common in one area but area not found elsewhere in the catchment it might be considered a priority to remove it to avoid it colonising new areas downstream.

Timing

The timing of weed control is as important as the technique used. It takes a skilled weed controller to assess when is the best time to undertake weed control. Variations in climatic conditions do allow for opportunities to control weeds however there are also associated risks. Timing of weed control is used to achieve the maximum amount of control by causing the least amount of disturbance or using the least amount of chemical. Timing must take into consideration:

Immediate Timing Considerations

1. **Rainfall** – it is important to consider when it last rained and when it is likely to rain again, as this may affect the weed control. In regard to hand removal of weeds this is easily done when the soil is damp from rain. Some chemicals however will not work if it rains during or shortly after application. Unseasonable rain can open a window of opportunity for weed control. For example, summer rain may cause some annual weeds to grow allowing for easy removal when other native plants such as orchids and lilies may not be present.

2. **Wind** – it is very important not to apply chemicals as a spray application when it is windy as it can easily lead to off target damage.

Ecological Timing Considerations

1. **Type of season** – There are no sure fire rules. Every season is different. This means that weed control may need to be earlier or later than previous seasons. In addition some seasons may give you "windows of opportunity". Eg a significant summer downpour may give broom a "perk up" and allow it to be sprayed in summer when native ground flora is dormant. By using a herbicide that is selective, you can apply a woody weed killer (triclopyr) and not kill the native grasses, the only indigenous plant actively growing.

2. **Growth of the plant** – the most effective weed control will take place when the species is actively growing. The timing of this will vary for each species

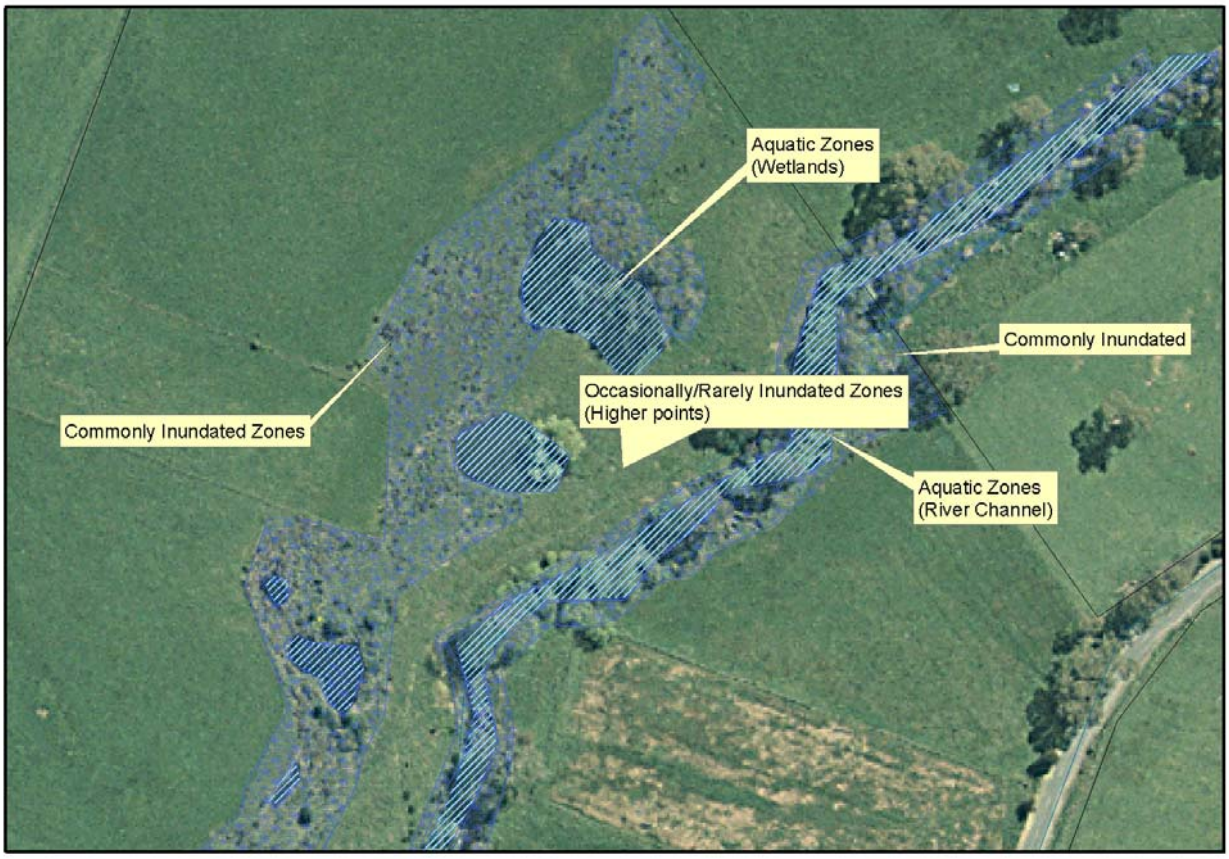
3. **Presence of native plants** – the majority of susceptible flora such as orchids and lilies are present during winter and spring. If it is possible to control a particular weed species at other times of the year it will avoid causing off target damage to these indigenous plants.

Herbicides in Weed Control – Are They Safe?

Applying chemicals in the natural environment, particularly around waterways carries a certain amount of risk. Therefore for safe use of chemicals near water bodies the Onkaparinga Catchment Water Management Board has developed a series of definitions regarding the landform and proximity to aquatic zones that determine the type of chemical and the method of application. These are defined in Table X.

Table 1 – Definitions relating to herbicide use in natural areas

Riparian	Any land that adjoins, directly influences, or is influenced by a body of water
Aquatic	Areas of actively flowing riparian channel and wetlands
Commonly inundated sites **or** **Good quality Native Vegetation**	Riparian channels, banks, flood ways, dry billabongs and backwaters, commonly flooded floodplains. Flooded at least once a year Native Vegetation understorey is diverse and relatively weed free, usually presence of ground flora such as lilies, grasses, orchids, etc.
Occasionally inundated sites **or** **Semi degraded native vegetation**	Riparian areas/floodplains where only occasional floods are experienced. Eg flooded less than once a year Limited native understorey, moderate to severe weed presence, native vegetation understorey species are low in diversity and abundance
Rarely inundated sites **or** **Degraded Native Vegetation Disturbed sites**	Riparian areas/floodplains where only occasional floods are experienced Limited native over storey and/ or understorey. Severe weed invasion, low numbers of common native plant species



There are understandable concerns in the community about the excessive use of herbicides. The Onkaparinga Catchment water Management Board is also aware of these concerns and does not advocate the use of herbicides without a clear ecological benefit. Whilst some bushcare practitioners detest the use of herbicides or limit them to very small range for use (eg cut and swab only or Glyphosate only), there are several good reasons for using herbicides in bushland weed control:

1. The scale of environmental weed control problems is so large that if herbicide use in bushland was abandoned there would be an inevitable and very sever decline in the quality and eventually quantity of remaining indigenous vegetation

2. Herbicides can be used effectively and safely by skilled operators and avoid impacts upon native vegetation and the broader environment

3. Herbicides offer the only effective treatment for removing large infestations of tenacious and aggressive invasive species, eg Three cornered garlic or African Feather Grass.

4. Herbicides are very cost effective and labour saving meaning resources are free for other management or further weed control.

Where the OCWMB suggests a chemical application it is due to the benefits of being able to use a selective herbicide to target a species, kill weeds without disturbing the soil or reducing the need for follow up work. It is very important that all chemicals are used in accordance with the manufactures guidelines – this includes safety and dilution.

In regard to herbicide uptake by weeds or native plants it is important to consider the following principles:

- The type of plant – woody, herbaceous, etc
- Growth stage of plant (ecological timing)
- Season (ecological timing)
- Chemical concentration and active ingredient.
- Method of application

As the majority of the work carried out by the Onkaparinga Catchment Water Management Board is in riparian areas, the EPA Guidelines for Herbicide Use Near Water bodies has been used to ensure best practise chemical use. In the individual species description, if a chemical control has been suggested the methodology will separate between sites that are permanently, commonly or occasionally inundated, as this will affect the type of herbicide that can be used.

When using chemicals in a bushland setting there are four main principles that should be adhered to:

Principle 1 Before using a chemical, complete a test plot, which should be a small area without any significant species. The results of the test plot should be assessed before continuing with any application. Remember that most chemicals take up to two weeks for results to show, so be sure to wait to see the full results.

Principle 2 Flag all susceptible ground flora such as lilies, orchids, ferns, etc. These can then be covered with bottles, coins and boxes to prevent accidental spray drift.

Principle 3 Avoid deliberate or accidental contact with <u>any</u> natives - although certain chemicals may not harm native grasses and shrubs it pays to be cautious.

Principle 4 Avoid applying chemicals past the point of run-off as this will lead to the chemical being applied at a higher than recommended rate. Remember that both the mixing process and the amount of chemical mixture that is applied per unit area controls the rate of chemical application.

Types of Herbicides used commonly for weed control and they safety to use in natural environments.

There are many chemicals available for use today, they can be broadly divided into three main types

1. **Residual** – are active in the soil and are absorbed through root structures of the plant. They are designed to keep areas free of all or some weeds for a specific time period (usually between 3 and twelve months) chemical with a principal mode of action being uptake through root systems and which has a expected half life in the soil of between 3 months and one year

2. **Systemic** – are transported within the plant to the roots, storage organs, stems and foliage. They usually are not absorbed through the soil, but may have an active half life in the soil up to three months.

3. **Non systemic or Knockdown** – destroys only the plant tissue that comes into contact with the herbicide. Effective only for annual species and the young growth of perennial species.

Within these groups herbicides can be Selective or Non selective:

- **Selective** herbicides affect some plant types but not others, they might be broadleaf (herb) slective, grass selecvtive or woody weed selective.

- **Non-selective** herbicides have the potential to affect any type of plant, therefore you would not use a non selective herbicide in broad stands of native grasses.

Some examples are

Roundup® is a non selective systemic herbicide

Brushoff® is a selective systemic herbicide

Garlon® is a selective systemic herbicide

Metsulfuron Methyl (eg Brush Off®)

Metsulfuron Methyl is a broadleaf selective systemic herbicide that can be used in specific situations for spot spraying in bushland. At a rate of between 5g and 7g per 100 litres of water, it will not kill native grasses and will not affect many native shrubs like wattles, unless they are completely covered. Use of Metsulfuron Methyl for spot spraying is generally not recommended in areas of high understorey diversity. Metsulfuron Methyl is residual in the soil for up to six weeks or more, and is absorbed by roots and bulbs; therefore it should not be used in areas with native orchids, lilies and other susceptible ground flora. This chemical is useful in areas where broadleaf weeds (eg salvation Jane, sour sob and bridal creeper) are growing amongst mostly native grasses with a few other native ground flora.

In areas dominated by native grasses (eg Themeda, Danthonia, Stipa) it can be used safely for spot spraying. Take care in identifying native grasses, as some plants that are thought to be grasses are in fact sedges or lilies, this includes genera: Lepidosperma, Lomandra, Gahnia. The use of this chemical is often better left to persons experienced in minimum impact bush care.

Glyphosate (eg Round Up®)

Glyphosate is systemic non selective herbicide and will affect all species of plants which come in contact with the chemical (broadleaf, woody and grassy). Glyphosate can be residual in the soil for up to four weeks and can be absorbed by roots and bulbs. It can be safely sprayed late in the year, when susceptible native ground flora (ie orchids, lilies, ferns, etc) have become dormant and are not active. However Glyphosate will kill any non-dormant species (eg native grasses) that are still growing. Glyphosate is very useful in a wipe

on situation. A form of Glyphosate is available that contains no surfactants or penetrants, this is suited to use in wet areas.

Triclopyr (eg Garlon®)

Triclopyr is a herbicide that is used for cutting and swabbing of large woody weeds in bushland situations. It can also be used as a spray at 1:400 with water to successfully kill blackberry, brooms and bridal creeper. At this rate it should not kill native grasses or ferns. Use of Triclopyr for spot spraying is suited to relatively degraded sites and not areas of high understorey diversity. Triclopyr is residual in the soil for up to six weeks or more, and is absorbed by roots and bulbs. In areas dominated by native grasses (eg Themeda, Danthonia, Stipa) it can be safely used for spot spraying, ensuring. Take care in identifying native grasses, as some plants that are thought to be grasses are in fact sedges or lilies, this includes genera: Lepidosperma, Lomandra, Gahnia. The use of this chemical is often better left to persons experienced in minimum impact bush care. It can be safely sprayed late in the season, when susceptible native ground flora (ie orchids, lilies, ferns, etc) have become dormant and are not active.

Surfactants and penetrants.

When applying chemicals in a spot spray or wipe on situation, it is recommended to use a surfactant or penetrant.

Surfactants allow the herbicide to disperse over the leaf surface but they do not help in the penetration of chemical into the plant tissue. Surfactants are more useful when using a wipe on chemical to spread the chemical.

Penetrants (Organo-silicon penetrants, eg Pulse) help the herbicide to enter the plant tissue even through woody stems.

Care must be used in their application and is often better left to people experienced in minimum impact bushcare. In creek-lines and bogs the use of surfactants has the potential to harm native aquatic fauna, eg frogs. The use of *Roundup Biactive ® is recommended because the surfactants have been removed.

Weed control techniques

There are two main removal types physical and chemical removal these are discussed below:

Type A -Physical Removal

The following methods outline those techniques that do not require chemicals to achieve results. In some cases these methods can be used in combination with chemicals, such as follow up spray after brush cutting.

Method 1 - Hand Removal

Removing weeds by hand is a simple yet important task. The following guidelines should be adhered to:

Hand removal should only be attempted if the species is suited to this techniques (see species description) or a small enough size so that removal does not cause significant soil disturbance.

This is best undertaken in June or July when the soil is damp allowing for easy removal. In permanently wet areas it may be best to wait until August or September to allow easy access.

A knife or screwdriver can be used to push into the soil at the base of the plant.

Gently leaver the handle towards the plant and slowly remove the knife.

Repeat around the base of the plant until the weed is loose enough to remove.

It is important to leave the soil as undisturbed as possible while ensuring all of the weeds root or bulb system is removed.

Collected all the removed weed material in a plastic bag and remove off site to avoid any seeds or bulbs from re-shooting.

Method 2 – Cover or solarisation

Covering weeds is a technique used in situations where a grassy weed has formed a dominant matt across an area. The idea is to prevent any sunlight from reaching the plant causing it to slowly die through lack of photosynthesis. To remove a weed by covering:

Ensure there are no indigenous plants in the area to be covered

Using black plastic cover the entire area where the weed is present and firmly secure down the plastic with tent pegs or similar.

Leave in place for approximately two weeks.

For best results remove the plastic during a sunny day that will assist in the killing process by burning the now very pale plant.

Remove all plastic and pegs from the site.

Method 3 – Grooming or brush cutting

Grooming is a large-scale version of brush cutting and usually undertaken by contractors with the required machinery. The technique however is somewhat similar to brush cutting. In both cases the purpose is to remove the bulk of the weed biomass by cutting the plant as close to the ground as possible. With some species this may significantly reduce their chances of survival, other species however may require a follow up spray with an appropriate chemical. By first grooming or brush cutting however, the total area to be sprayed is greatly reduced and the chemical can be targeted to a specific area.

This method is also useful in removing flower heads of weeds to reduce the amount of seed entering the environment.

Type B Chemical Removal

Method 4 – Wipe On

Wipe on of chemicals suits a situation where chemical run-off or spray drift may harm native plants, particularly native orchids, ferns, lilies and other ground flora. Application of the chemical is made by using a wick-wand (scuff stuff bottles work well) or paintbrush to paint the leaves of plants. This suits broadleaf weed species such as Ribwort and Salvation Jane

For larger species (such as Watsonia) a rubber glove covered by a cotton glove can be dipped in the chemical and wiped over the plant. Care must be taken to ensure no chemical comes in contact with the skin or surrounding vegetation. .

Method 5 - Cut and Swab

Cut and swab is one of the most common weed control techniques used in bushcare a it can be applied to small woody shrubs to large trees. This method does require the use of chemicals however the chemical is applied is a very localised area minimising any off target damage or movement into the soil. There is however the potential to harm small ground flora through trampling therefore cut and swab should be undertaken before or after spring if possible. For those species to be controlled using cut and swab technique the following should be undertaken:

Using loppers or a chainsaw (depending on the size of the species) remove the entire trunk to just above ground level

Ensure all of the green material or small shoots are removed until a single stem is left

Using a small paintbrush, weed wand or similar apply a small amount of chemical to the entire area that has been cut.

It is crucial to apply the herbicide within 30 seconds of making the cut to ensure the plant absorbs the chemical.

Where possible remove large braches off site (without dragging or trampling over native plants) to avoid covering over surrounding vegetation.

If this is not possible select an area free of native plants to stockpile the branches and allow them to slowly breakdown.

Method 6 - Frilling and Ringbarking

Frilling and ringbarking are similar to cut and swab but maybe used in situations where the removal of the entire plant may cause significant damage, if a weeds root system is contributing to erosion control or bank stability or when the specimen is too large to remove and can be killed institute. Frilling and ringbarking work due to the fact that the majority of the fluids travel through a plant in the thin outer layers of the bark. Therefore if a poison is introduced to this outer layer it is quickly transported throughout the plant. To successfully kill a plant using this technique the following must be undertaken:

Choose a part of the stem (or exposed root if it is present) that is as close to the ground as possible

Using a small hatchet, make scrapes into the bark that are deep enough to penetrate the soft tissue and approximately 10 cm long.

Continue this process around the entire circumference of the stem where possible.

Using a small paint brush, weed wand or similar apply a small amount of chemical to the entire area that has been cut

It is crucial to apply the herbicide within 30 seconds of making the cut to ensure the plant absorbs the chemical.

Method 7 - Drill and Fill

Drill and fill is quite similar to frilling or ringbarking where by the plant will be killed while left standing. Drill refers to the action of using a power drill to drill holes into the stem of a plant in several different locations. These holes are then filled with an appropriate chemical within 30 seconds of the hole being made. This method is a lot less time consuming than frilling as the drill does most of the hard work. This may however require the use of a larger quantity of chemicals to fill the hole as opposed to painting over a scrape.

Method 8 - Spray Application

Spot spraying suits areas that are degraded and contain a low density of herbaceous ground flora. It can be an effective method provided all of the above principles are adhered to. Spray application can range from a small hand held spray bottle to a backpack spray or a large spray tank mounted on a vehicle. Regardless of the size of the container, it is extremely important to double-check the rate of dilution.

If all factors suit the application of herbicide using the spray technique (timing, climate) and the above principles have been followed the herbicide can be safely applied.

It is important to consider your starting and finishing point to ensure you are not walking through sprayed areas and potentially wiping chemicals on off target species. Please also ensure you have followed the guidelines in regard to the site being permanently, occasionally or rarely inundated. Priority weed species in the Onkaparinga Catchment

How to use the Weed Control Guides

The control techniques listed in the remainder of this book are aimed at people undertaking weed control in sensitive natural areas. It does not cover broad scale weed control

When determining rates, we have assumed that most people will be undertaking small scale spraying using either knapsacks or low pressure spray machinery, therefore applicable rates are mentioned. If in doubt always consult the manufacturers label recommendations.

The control techniques are listed in tabular form. This describes the techniques used as:

Method of Control
HP – hand pulling or grubbing
CS – Cut and Swab
GR- Grooming
DF- Drill and Fill
RI – Ringbark
CO- Cover or solarisation
SS – Spot spray (using knapsack or low pressure spray equipment)
WO- Wipe On

Period of Control.
Light shadings are potential times depending on the season
Dark shadings are core times for control

Herbicide Options and Rate of Application
Met = Metsulfuron menthyl, Gly = Glyphosate and Tri = Triclopyr

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												
SS					√	1:600 with water												

COOTAMUNDRA WATTLE (*ACACIA BAILEYANA*)

An Australian native plant not indigenous to the Onkaparinga catchment, found growing mainly in the high rainfall areas in the upper catchment. A commonly planted garden species that due to its significant seed set has a potential to spread into bushland. In indigenous bushland it crowds out native ground flora and changes soil conditions making them unsuitable for indigenous plant regeneration.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
CS, DF			√	Neat	√	1:30 with diesel												
SS	√	Seven grams in 100 L water			√	1:600 with water												

DESERT ASH / ASH TREE (*FRAXINUS ROTUNDIFOLIA*)

Most commonly found in creek lines or high rainfall areas, it is widely planted through the region as an ornamental in street and public parks. Plants are highly invasive along waterways, preferring seasonally moist, fertile soil. Due to its large seed set it can spread quickly and form a dense stand preventing other species from growing under it.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						Season											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						Season											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
CS, DF			√	Neat	√	1:30 with diesel												
SS	√	Seven grams in 100 L water			√	1:600 with water												

HAWTHORN (*CRATAEGUS MONOGYNA*)

Originally a native of Europe, Hawthorn is able to grow in most habitats but is usually found in areas with greater than 600mm annual rainfall. Hawthorn was once used for hedges and is spread by berries carried by birds and foxes. It has become invasive in forests, woodlands and riparian areas. It is a slow growing species capable of living for over 100 years. Hawthorn forms dense thickets which have an impact of bushland by shading out ground flora and affecting the growth and regeneration of over-storey plants.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
CS, DF			√	Neat	√	1:30 with diesel												
SS	√	Seven grams in 100 L water			√	1:600 with water												

OLIVE (*OLEA EUROPAEA* SSP. *EUROPAEA*)

Originally a native of southern Europe and northern Africa, Olives have been cultivated in Australia for their fruit and oil. They can be found growing in all habitat types and can be either a compact or scraggly shrub or tall tree. Spread by birds and foxes that eat fruit or carried in water

Control

On small but thick infestations it can be appropriate to brush cut growth and spray reg-growth. It is unlikely you will kill olives on the first attempt, remember there are many ways you can kill olive, each method will be

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
CS, DF			√	Neat	√	1:30 with diesel												
SS	√	Seven grams in 100 L water			√	1:600 with water												

PINE TREE (*PINUS* SP.)

Commonly planted for timber these plants can grow in most habitats from riparian to coastal. Birds, wind and water spread seeds. Control methodology covers both Radiata Pine and Aleppo Pine.

Confusing Species

Native Pine (*Callitris preissii*) and Oyster Bay Pine (*Callitris rhomboidea*) do not have the same aromatic fragrance as pine trees.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat	√	1:30 with diesel												

PLUM (*PRUNUS* SP.)

A large Genus of about 200 species mainly from the temperate regions of the Northern Hemisphere. The genus provides many important horticultural fruits including Apricots, Almonds, Plums, Cherries and Peaches. They usually spread from plantings in mainly high rainfall areas.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat	√	1:30 with diesel												

POPLAR (*POPULUS* SP)

A common weed that has escaped from gardens and windbreaks. Colonises creek areas throughout the catchment and smothers native vegetation through increased competition and leaf litter.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat	√	1:30 with diesel												
SS (re-growth)			√	?	√	1:600 with water												

SALLOW WATTLE / SYDNEY GOLDEN WATTLE (*ACACIA LONGIFOLIA* VAR *LONGIFOLIA*)

A native plant not local to the catchment. Spread rapidly mainly through birds such as Rosellas. Mainly found in the lower catchment along creek lines. Often confused with the indigenous plant Acacia pycnantha. Causes the extinction of local native ground flora and fixes nitrogen changing soil conditions that then exclude some species and prevent over storey regeneration.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat	√	1:30 with diesel												
SS (re-growth)			√	?	√	1:600 with water												

WILLOW (*SALIX* SPP)

Widespread weed throughout creek lines in the catchment. Well known for causing creek bank erosion, dominating sites and restricting all other vegetation.

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS, DF, RI			√	Neat	√	1:30 with diesel												
SS (re-growth)			√	?	√	1:600 with water												

BLACKBERRYS (*RUBUS FRUTICOSUS AGG.*)

Rubus fructicosus aggregate comprises a number of closely related taxa that for convenience are dealt with as one species. All of the species in this aggregate are originally native to Europe. An erect shrub growing in thickets up to several metres high, reproducing by root suckers, seeds and tip rooting. Blackberry was highly regarded by early settlers as a source of fresh fruit for making jam and pies and as a hedging plant. Blackberry is an important weed to control because it is invasive and covers large areas with a dense canopy excluding light from the soil surface and therefore stopping other plants from growing. Evene when not dense it's prickly nature make it objectionable to grazibng animals and so posture values are reduced. It can be spread l;arge distances along riparian areas through seeds, roots and tip roots. Blackberry normally invades disturbed sites but where it does invade native vegetation it disturbs the diversity of plant species and hence wildlife habitats. It can also be a harbour for foxes and rabbits and large clumps of blackberry also form a considerable fire hazard. with seedA number of species of the Rubus genus are put together Widespread through creek lines across the whole catchment, can move out of the creek line in wetter areas of the hills, can cause creek bank erosion, and out compete native plants.

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
CS			√	neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												
SS					√	1:600 with water												

BONESEED (*CHRYSANTHEMOIDES MONILIFERA*)

A weed of national significance, that was originally a native of South Africa, Boneseed is a widespread erect perennial shrub that grows in Coastal Dunes, Heath land, Woodlands, Foothills, Occasionally in Forests. Boneseed was introduced to Australia as an ornamental plant and for sandbinding purposes. It is spread by birds, foxes, rabbits and the seed are effectively carried by water. Boneseed forms dense thickets that can eliminate indigenous ground flora

Control

Permanently inundated/ Good Quality Native Vegetation

Method	Herbicide						Season											
	Met	*Rate*	*Gly*	*Rate*	*Tri*	*Rate*	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	Herbicide						Season											
	Met	*Rate*	*Gly*	*Rate*	*Tri*	*Rate*	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS			√	neat														
SS	√	7 grams to 100 L water																

BRIAR ROSE / WILD ROSE / SWEET BRIAR (*ROSA RUBIGINOSA*) (ALSO *ROSA CANINA*)

Common in woodlands and sometimes in forests on well drained fertile soils. Imported from Europe and India it was once used widely as a hedge, commercially as a source of Vitamin C and in wines, sauces and jellies. The thick stands provide habitat for rabbits and foxes and it can crowd out existing shrubs and prevent over storey regeneration.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
CS			√	neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS			√	neat	√	1:30 with diesel												
SS	√	7 grams to 100 L water			√	1 : 600 with water												

ENGLISH BROOM / COMMON BROOM (*CYTISUS SCOPARIUS*), WHITE SPANISH BROOM (*CYTISUS MULTIFLORUS*)

A common species in the high rainfall areas of the Onkaparinga Catchment. Plants are usually found in moist fertile soils, although they rarely tolerate permanently inundated sites and avoid calcareous soils English Broom is a devastating species capable of totally transforming invaded habitats, crowds out understorey and simplifies the structure and diversity of ground flora. Most growth occurs over the warmer months meaning it is active for control when native ground flora are generally dormant. Plants set seed within three years, can live to thirty years of age and have seed persist in the soil for up to twenty years, seed numbers in the soils can be up to 12,000 seeds per square metre, disturbance (eg Fire) favours their germination and can be an important part of a overall long term broom control strategy.

Control

Brush cutting large infestation can reduce seed set and allow for easier control using spot spray techniques the following season. Burning can also be beneficial as part of a broom control program

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												
SS			√	10 – 13 ml per litre of water	√	1:600 with water												

GORSE / FURZE (*ULEX EUROPAEUS*)

A weed of national significance, originally a native of Europe introduced as a hedging plant. It is widespread in areas receiving between 600 and 900 mm annual rainfall. It is found in woodlands, forests, riparian areas and disturbed agricultural land. Can be found on a variety of soils but usually not on calcareous soils (eg over limestone). Gorse forms dens impenetrable thickets that can exclude all indigenous vegetation and prevents any regeneration. It changes soil structure causing acidity and promoting nitrogen rich leaf litter. It provides a harbour for foxes and rabbits and can pose a serious fire hazard.

Control

Burning removed material should be a component of any gorse control program.

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1:30 with diesel												

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												
SS			√	10ml plus Pulse (2ml) per litre of water	√	1:600 with water												

SPANISH HEATH / PORTUGUESE HEATH (*ERICA LUSITANICA*), TREE HEATH (*ERICA ARBOREA*)

Highly invasive plants in high rainfall areas. Can occur in almost all habitat types. Heaths are capable of complete domination of the shrub layer of invaded habitats with resultant changes to round flora and over storey regeneration. One plant can produce up to 9 million seed annually, with one average there being 45,000 seeds per metre square in invaded habitats.

Control

Spread can be limited by slashing large plants close to the base before flowering occurs, Re-growth can then be sprayed the following year.

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS			√	neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												
SS			√	Between 5 and 10 ml per litre of water.	√	1:600 with water												

MONTPELLIER BROOM (*GENISTA MONSPESSULANA*)

Montpellier Broom is found in areas receiving between 500 and 900 mm annual rainfall, although it can spread along creeks into drier areas. Broom is highly invasive often establishing along disturbed edge areas (eg roads) before moving rapidly into less disturbed areas. Broom is tenacious growing from full sun to shade, on almost all soil types and can tolerate exposed conditions, unfertile soil and seasonally hot and dry conditions. Most growth occurs over the warmer months, although growth may stop for long extended dry periods. Prolific seeders, they can expel seed some distance, and seed numbers in the soil can be in the several thousand per square metre and they can last at least ten years. Disturbance (eg fire) usually causes mass germination. Broom infestations shade out ground flora, stop over storey regeneration and fix nitrogen, changing soil conditions affecting the persistence of some indigenous plants.

Confusing Species : Native Broom (Viminarea juncea)

Control

Broom is not impossible to beat, although a broom control strategy may take several years and should consider the use of fire to cause germination of the seed soil store.

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS			√	neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	neat	√	1: 30 with diesel												
SS			√	Between 5 and 10 ml per litre of water.	√	1:600 with water												

BLUE PERIWINKLE (*VINCA MAJOR*)

A serious problem weed of wet areas and riparian zones in the Adelaide Hills. It prefers moist damp, fertile soils. It reproduces vegetatively to form dense intertwined low mats that completely smother vegetation causing loss of understorey plants and no further regeneration of over storey plants.

Control

Permanently inundated/ Good Quality Native Vegetation Occasionally Inundated/ Slightly Degraded Native Vegetation Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CO																		
SS			√	Between 5 and 10 ml per litre of water														

BRIDAL CREEPER (*ASPARAGUS ASPARAGOIDES*)

Bridal creeper is a weed of national significance. It is widespread in mallee, woodlands, forests, coastal vegetation and riparian areas. Bridal creeper is an aggressive, highly invasive species capable of eliminating almost all ground flora and preventing over-storey regeneration. It usually grows best on lighter, well-drained soils in shaded positions. Bridal Creeper is active over cooler months which poses a problem for management as it grows during the same season as native ground flora.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						Season											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP							■	■	■	■	■						■	■
SS			√	Between 5 and 10 ml per litre of water			■	■	■	■	■	■						

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						Season											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP							■	■	■	■	■						■	■
SS	√	Between 5g and 7g per 100 litres of water	√	Between 5 and 10 ml per litre of water			■	■	■	■	■	■						

CAPE IVY (*SENECIO MIKANOIDIES, DELAIREA ODORATA*)

A highly invasive species found in the higher rainfall parts of the catchment, particularly along creek lines and in gullies. Cape Ivy forms dense carpets over vegetation and spreads rapidly from stem fragments when broken off.

Control

As this plant can grow from pieces of broken stem and roots, it is important when cutting and swabbing or grooming to remove all material and dispose of safely (eg burning).

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
CS			√	Neat														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR					√													
CS			√	Neat	√	1:30 with diesel												
SS	√	Between 5 and 7 grams to 100 L water	√	Between 5 and 10 ml per litre of water														

BULBIL WATSONIA (*WATSONIA MERIANA* VAR. *BULBILLIFERA*, *WATSONIA* SPP.)

Watsonias are perennial herbs to 2 metres high that die back to an underground Corm (Bulb). These two species orange, pink, yellow and white tubular flowers with broad lance shaped leaves. They can spread by corms and seeds and form dense thickets that eliminate virtually all native ground flora. They occur in almost all habitats within the catchment.

Control

Permanently inundated/ Good Quality Native Vegetation

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
CS			√	Neat														
SS			√	Between 5 and 10 ml per litre of water														

HARLEQUIN FLOWER (SPARAXIS BULBIFERA AND S. TRICOLOUR), OTHER WEEDY IRIDACEAE, EG FREESIA

These are all garden plants that are heading bush with dramatic consequences for native ground flora. Harlequin flowers impede the growth and regeneration of indigenous ground flora, they form extensive stands as they spread by underground corms (bulbs).

Control

If you intend to brush cut this species be careful not to slash when it has bulbils or seed, as infestations will be spread.

Permanently inundated/ Good Quality Native Vegetation

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
WO			√	Neat														
CS			√	Neat														
SS			√	Between 5 and 10 ml per litre of water														

THREE-CORNERED GARLIC (*ALLIUM TRIQUETRUM*)

A common weed of riparian areas and wet areas in Native Vegetation throughout the Adelaide Hills, has spread mostly from garden plantings. This plant has a strong odour.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						Season											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
SS			√	Between 5 and 10 ml per litre of water														

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						Season											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
SS	√	15 g per 100 L water	√	Between 5 and 10 ml per litre of water (with pulse)														

KIKUYU (*PENNISETUM CLANDESTINUM*)

A perennial grass, with creeping stems to 3 metres long or more. Has roots at nodes. It is a common lawn grass that is spreading by seed and movement of soils into bushland areas. The dense cover of kikuyu virtually eliminates all native ground flora and prevents over storey regeneration. A problem plant in revegetation as it actively competes for moisture with plantings.

Control

If removing by hand ensure you remove all material and rooting nodes to stop regeneration.

Permanently inundated/ Good Quality Native Vegetation

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
SS			√	Between 5 and 10 ml per litre of water														

PHALARIS (*PHALARIS* SP.)

Perennial grasses to 1.5 metres tall. Promoted and used widely as a pasture grass. If not grazed it will form a full height and readily invades and smothers most ground flora.

Control

Permanently inundated/ Good Quality Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
SS			√	Between 5 and 10 ml per litre of water														

RICE MILLET (*PITAHTERUM MILLIACEUM*)

A perennial grass to 1.5 metres high, originally a native of the Mediterranean area.. Can be confused with native *Stipa* spp. The leaves are fat and glossy about 0.5 – 1.0 cm wide and up to 30 cm long. Forms dense stands that exclude other vegetation, spreads rapidly from the many seeds, hence the common name of many Flowered Millet.

Control

Permanently inundated/ Good Quality Native Vegetation

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
HP																		
SS			√	Between 5 and 10 ml per litre of water														

AFRICAN FEATHER GRASS (*PENNISETUM MACROURUM*)

African Feather Grass is a tall grass (up to 2m) which forms dense stands and excludes almost all other vegetation, it resembles Pampas Grass. The leaves are light green and strongly ribbed with a darker green underside. The erect stems grow from a crown and are cylindrical purplish-white in colour and up to 2m long with many fine hairs which break off if touched causing skin irritations. The flower heads are narrow, cylindrical and spike-like, 10 to 30 cm long and 1-2 cm in diameter. They are made up of many bristly seeds which give the flower head a feather-like look. African Feather Grass forms dense stands and excludes almost all other vegetation. It is spread rapidly by seed, with up to 80% of all seed being viable. Seed is distributed via water or as a bristly seed attaches to animal coats, clothing, etc. It can also be spread by rhizomes, if they are broken and moved by cultivation machinery, road graders or other machinery. Once it becomes established patches increase in size by lateral growth of roots and rhizomes. It is not palatable to stock and is becoming and problem bushland weed as well, so populations of this plant should be controlled.

Control

Grooming dead material and reducing this grass to a compact form that is easy to spray may be a part of control of this species.

Permanently inundated/ Good Quality Native Vegetation

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
HP																		
SS			√	Between 5 and 10 ml per litre of water														

FOUNTAIN GRASS (*PENNISETUM SETACEUM*) AND FEATHER TOP GRASS (*PENNSIETUM VILLOSUM*)

Perennial grasses with extensive rhizomes. The seed is spread easily by wind, water and by attching to clothing and machinery. Both are widely available commercially and used extensively in landscapes. Both are now heading bush.

Control

Grooming dead material and reducing this grass to a compact form that is easy to spray may be a part of control of this species. Do not groom when it has seed to avoid spreading seed into new areas.

Permanently inundated/ Good Quality Native Vegetation

Occasionally Inundated/ Slightly Degraded Native Vegetation

Rarely inundated/ Degraded Native Vegetation

Method	*Herbicide*						**Season**											
	Met	***Rate***	***Gly***	***Rate***	***Tri***	***Rate***	J	A	S	O	N	D	J	F	M	A	M	J
GR																		
HP																		
SS			√	Between 5 and 10 ml per litre of water														

Appendix B.5. - Revegetation Manual

Onkaparinga Catchment Water Management Board

Onkaparinga Catchment Water Management Board

Manual for Revegetation with Local Native Plants

The advantages of using local indigenous plants in revegetation projects have become well accepted over the last 20 years. By using local native species in revegetation projects, you can be confident that what you are planting is suited to the climate and other environmental conditions of your site, as well as contributing positively to the ecology of your local area, and maintaining the genetic diversity of our native vegetation.

Landholders planning to undertake a revegetation project will need to ***place an order*** for local native plant species with the Board

TUBE-STOCK PLANTING REVEGETATION TECHNIQUES

Site Preparation

Good site preparation is critical to the success of tube-stock revegetation.

Woody weeds

Allow at least two years to undertake primary clearance, and follow up control of woody weeds. It is very difficult to control woody weeds emerging amongst your new seedlings, so ensure they are under control before planting.

Pre-planting weed control

Some weeds do not significantly compete with tube-stock. Most annual (winter) grasses have died back by late spring and early summer and pose little competition to new plantings during their peak establishment period. Annual grasses can actually have benefits, such as providing shade during summer, as well as groundcover to suppress and prevent more aggressive weeds from becoming established.

The biggest problem species for new plantings are the perennial grasses and broadleaf species, which actively compete for water over late spring and summer. These species include Phalaris (*Phalaris aquatica*), Rice millet (*Piptatheruem miliaceum*), Plantain (*Plantago lanceolata*), Thistles, Kikuyu (*Pennisetum clandestinum*), and all the woody weed species (Broom, Blackberry, Gorse, etc). These generally grow over late spring to early summer, are aggressive and quickly outgrow tube-stock. We would suggest the following techniques for control:

- Perennial grasses – spot spraying using a glyphosate product.
- Broadleaf weeds – spot spraying using a metsulfuron methyl herbicide or mechanical slashing to reduce growth and therefore competition (it also can stop further seed set).
- Woody weeds – cut and swab using a triclopyr or glyphosate product, foliar spot spray using a triclopyr product.

Planting

The importance of good planting practice is often overlooked. A few easy tips can make a huge difference to the success rate

Digging the hole

First scrape 1-2 cm of soil from an area about 30 cm x 30 cm and move it to one side. Do not mix it back into the planting area. This action will remove any weed seed from the area around your planted stem. Next dig a hole big enough to contain the plant, a 2-3 cm area of soil insulation and a 2-3 cm 'watering bowl' which will catch and deliver precious summer rain to the roots of your seedling. All up, your hole will need to be about 5-8 cm deeper than the size of the tube stock. Save the "clean" soil to one side to backfill around your plant.

1. Healthy tubestock from a Catchment Board nursery ready for planting.

2. Planting techniques: area scraped clear of potential weed seeds.

3. Hole is dug wide enough to provide a watering bowl and deep enough for optimal insulation.

4. Finished planting is upright with maximum face to the winter midday sun, ready to be watered in.

Orientate the plant
Remove your plant from the pot. This may be best achieved by first rolling the tube between your palms to loosen the root mass.

Holding the plant by the stem, place the plant in the hole and face it to maximise leaf exposure to winter midday sun. Most broad leaf plants have many of their leaves facing the same direction to seek the sun, therefore orientate the plant so that most leaves are facing north.

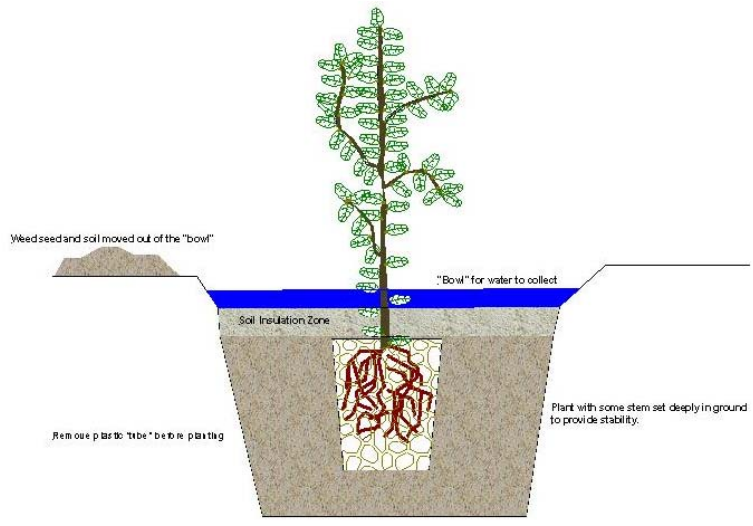
Stability and insulation
Set the plant at the lowest point in the hole and refill the hole using the 'clean' soil you placed to one side. Ensure that the soil is crumbled in around the root mass to minimise any air holes in the soil, and be sure that 2-3 cm of soil covers the top of the root mass. The finished planting should resemble a flat-bottomed bowl with no raised mound of soil around the stem. This provides stability, insulates surface roots against drying or frosts, and gives the plant a better chance of recovering from disturbances such as grazing. Ensure the finished planting is absolutely upright; plants that lean over are more vulnerable to frost damage, weed competition, fungal problems and damage during follow up weed control.

Watering in
Once backfilled, pour up to 2 litres of water into the bowl. This will ensure any stress on the plant is minimised, help to settle the soil around the roots, and give you an opportunity to check that the watering bowl is level and functional.

Prevent shading
If staking the plant for tree guards or for demarcation purposes, place the stake to the south of the plant to prevent shading – winter sun is crucial for good survival rates.

The finished product
Your plant should be sitting at the lowest point of the watering bowl, in clean soil, completely upright, with roots insulated by 2-3 cm of clean soil and leaves facing the midday sun.

The best start to a long and productive life!



Activity	Time	Comments *
Site preparation	July & August	Site preparation should be well underway in July. For hand direct seeding and tubestock planting, a sprayed spot of about 1m in diameter is often used. An alternative method to use in areas of aggressive weed competition is to spray out larger patches (perhaps 25 m^2), to be densely revegetated. These will form dense copses of revegetation, which can help suppress weeds and provide good habitat for small birds. Be sure that you don't spray a greater area, or more spots than you are able to revegetate. Only plan to revegetate areas where your woody weed control has been effective. If you are hoping to order stems for next year, or grow your own, you could contact Trees For Life by the end of July.
Planting	July to September	Whether using a mattock in clay soils or a tree planter in sandy soils, it is important to plant your tube-stock well so that survival is optimised, and the effort of growing and planting is not wasted. Keep your eyes open for damage to your new revegetation. Rabbits, kangaroos, slugs, grasshoppers, and other insects can all impact on your revegetation. If the problem is spotted early enough, you can get advice on the best control option and save the revegetation from destruction.
Site Maintenance	August & September	Aggressive perennial weeds such as Phalaris, Thistle, Plantain and all the woody weeds will actively compete with your new revegetation. Several techniques, including spot spraying, hand pulling, and brush-cutting may be employed to reduce the impact these plants have while your seedlings are establishing.

Weed control in your revegetation

The most important element of tubestock is aftercare-*WEED CONTROL*. Many of the principles will also apply to those people undertaking weed control in remnant vegetation.

It is very common for people in their first year of watercourse revegetation to despair at the flush of weeds which inevitably surround and threaten their precious planted seedlings. The reality is that with good site preparation, healthy vigorous tubestock, and careful planting, many of your revegetated stems will be able to cope with moderate weed competition. However, in the moist, fertile areas along a watercourse, weed competition can become severe during spring and early summer, and threaten the success of your revegetation.

The first and most important consideration when planning follow-up weed control is the priority of the weeds present. Some weeds, while vigorous and apparently competing with you revegetation, pose little real threat. The most common example of such weeds are the annual grasses, which will dry off in early summer leaving your planted stem blissfully competition free over the critical mid to late summer period, when every skeric of moisture counts to a young plant. At the other end of the spectrum are those perennial weeds which will be actively growing over summer and therefore using moisture which would otherwise be available to your revegetation. Examples of such weeds are Phallaris (canary grass), Kikuyu, Brome grass, Paspalum grass, Blackberry, Gorse, Broom, and Thistle. It is important to understand that it impossible to have a weed-free revegetation site, and as one set of

weeds is controlled, another will emerge until the revegetation has matured to a point where it can suppress most weeds.

Once the relative threat posed by weeds present in your revegetation has been assessed, the next consideration is control options. For many lower threat herbaceous weeds, mechanical control to reduce the amount of competition in the first and second years will suffice. This is due to the fact that once revegetated stems have survived their first few years, such weeds will be unable to significantly compete . Mechanical control may take the form of hand weeding, brush-cutting, or trampling weed growth in the immediate area around revegetated stems.

Woody weeds such as Broom, Gorse and Blackberry, and perennial grasses such as Phallaris can compete with vigour, and are unlikely to be suppressed by young revegetation. In these cases, chemical control is often the only pragmatic control option. Careful spraying of weeds in the immediate area around revegetated stems can dramatically boost the growth rate of revegetation by reducing all competition, but care must be taken to avoid any herbicide contact with planted stems. Some operators find it useful to place a shroud, such as a bucket or piece of 150/mm pipe over plants to protect them from overspray while ring spraying them. Alternatively, target weeds may be spot sprayed throughout the revegetation, leaving lower threat weeds in place.

The use of chemicals to control weeds amongst revegetation is limited to 3 active ingredients: metsulfuron Methyl (eg Brush off), glyphosate (eg Roundup) and triclopyr (eg Garlon). Which of these is used will depend on the types of target weeds present. For example, if herbaceous broad leaf weeds are threatening the revegetation, metsulfuron Methyl might be the best herbicide to use, as it will leave any annual or native grasses. If perennial grasses are the threat, spot spraying with glyphosate should be employed. When woody weed re-emergence is threatening revegetation, triclopyr can be used to selectively remove them, while leaving other, less aggressive ground flora such as annual grasses. For more information on weed control techniques and active ingredients, refer to the *Weed Control Handbook for the Onkaparinga Catchment*, available from your Catchment Care Officer.

It is important to keep an eye on your revegetation, and be ready to respond if climatic conditions result in a wild flush of weed growth which threatens your revegetation. By removing the highest threat weeds from the area, and creating even a small space around your stems, survival rates can be improved dramatically.

Revegetation Weed 1: An individual planted stem (marked with bamboo canes and tree guard) being overgrown by Phallaris. As this grass can grow actively over summer, the revegetated stem will be subject to severe competition. The grass has been trampled to make the stem visible. The best course of action here would be to brush-cut the phallaris and spot pray the regrowth.

Revegetation Weed 2: An area of revegetation (stems marked with bamboo canes and tree guard) being overgrown by Phallaris and Wild oats. As these grasses can grow actively over summer, the revegetated stems will be subject to severe competition. As the grasses are not very tall, they could be directly spot sprayed with glyphosate, or spot spray regrowth following brush-cutting.

Revegetation Weed 3: An area of revegetation (stems marked with bamboo canes) where perennial grasses have been controlled using a shrouded ringspray.

Revegetation Weed 4: An individual planted stem (marked with bamboo canes and tree guard) where broad leaf herbaceous weed control using metsulfuron methyl has resulted in a halo of weed-free space around the plant, boosting the chances of survival.

Revegetation Weed 5: An individual planted stem (marked with bamboo cane) being overgrown by annual and perennial grasses, and Wild raddish. Here perennial grasses could be spot sprayed with glyphosate, and wild radish spot sprayed with metsulfuron methyl

Revegetation Weed 6: An area of riparian revegetation entirely swamped by perennial grass weeds and mustard weed. The revegetation in this case will have to endure significant competition to survive. Here perennial grasses could be spot sprayed with glyphosate, and Wild radish spot sprayed with metsulfuron methyl.

DIRECT SEEDING

WHAT IS DIRECT SEEDING?

A quick, easy, low-cost method to establish a wide variety of trees, shrubs and some groundcovers.

Direct seeding is similar to sowing a crop: after creating a weed-free seed bed at the site where you wish to establish the plants, seeds are sown directly onto or in the soil where they germinate with the onset of rains and warm weather. Seeds can be sown in straight lines or in random pattern.

ADVANTAGES

- above all there is a much lower cost and far less labour required than for planting bought tubestock seedlings when revegetating large areas;
- the seedlings generally grow more quickly, with a stronger and straighter root system than those grown in containers;
- direct seeding gives a somewhat random, more natural feel to the vegetation which helps to retain the character of the existing countryside.
- direct seeded plants appear gradually after they germinate and grow - because they do not appear suddenly in the landscape like planted tubestock seedlings, they are less of a target for bird, hare and rabbit attack.

HOW IS IT DONE?

A large variety of seeds may be sown by hand or more quickly, over large accessible areas, by using a direct seeding machine. The fact sheet "Hand direct seeding" in this booklet describes the methods used when machines are not practical.

Direct seeding machines scalp away topsoil which contains most weed seeds and may be affected by the prior use of residual herbicide. A single shallow furrow is formed into which seeds are sown.

Most advanced machines have special tynes which bury large seed (e.g. wattle and sheoak seed) 5 -15 mm below the soil surface while small seed (e.g. gum and tea-tree seed) is sown on top of the soil. The seeds are firmly pressed into the soil by a following press-wheel.

Some machines have useful attachments to spray herbicides and wetting agents at the time of seeding if needed.

SITE SUITABILITY

Soil type

Direct seeding on certain soil types, particularly black cracking clays, flood-prone soils or exposed eroding sands, generally does not give good results. However, stable sands, sandy loams, sand or loam over clay and terra rossa have all proved to be excellent sites for the direct seeding method.

Non-wetting sands

If seeding on non-wetting sands, it is advisable to spray the rows to be seeded with a soil wetting agent prior to and/or during seeding.

Cover crops may be used to help stabilise sandy soils and protect direct seeding - simply leave 2 - 3 metres unsown to crop for the direct seeding lines or spray out crop prior to direct seeding time.

Waterlogged soils

Hand sowing on wide mounded ridges (about 30 - 50 cm high x 50 cm wide) will help improve survival in waterlogged situations. Mounding should be carried out with a machine towing two offset discs at least 6 to 12 months prior to seeding to allow time for the mound to settle.

Stony sites

Rocky sites are difficult to sow with machines unless ripped and rolled first. They can be hand-direct seeded instead in the worst areas.

SITE PREPARATION

Weed control before seeding

The success or failure of direct seeding depends almost entirely on preparing a *weed free* site and then controlling the weeds that germinate afterwards. The first year is *critical*. 'Weeds' are any herbaceous plants at the site, including all pasture species. Bear in mind that other native plants will also compete with new plants and direct seeding will be less successful close to big trees or scrub.

The seedlings that germinate at your site rely entirely on natural rainfall over spring and summer therefore you must do your utmost to give them a head start by eliminating as much competition for moisture, light and nutrients as you can before the seeds are sown. It is the same as cropping - you would not dream of sowing a commercial crop into an unprepared, weedy site.

Knockdown herbicides (e.g. glyphosate) are usually used several times before and after seeding to achieve the best weed control.

Where tough perennials exist, it is best to start spraying in spring/summer the year *before* seeding. This applies especially to phalaris, sorrel, veldt grass, primrose, bracken, lucerne, couch grass, fog grass and clovers.

Soil residual herbicides may also be used to extend weed control over a longer period of time. Any affected soil, however, must be scraped away before

seeding. Most direct seeding machines are equipped with a scalping device to do this. Seek advice before using residuals.

Vermin control
As with all plantings, be sure to control all rabbits and hares in the surrounding areas **before** you do the revegetation.

TIMING OF DIRECT SEEDING

The main requirement for native plant seed to germinate is water and warmth. In the higher rainfall districts, direct seeding takes place in late Winter through to mid Spring. Often people ask why not sow in Autumn to give seedlings longer to establish before summer? In high rainfall areas the answer is that seedlings will not grow in the cold of winter and they will get swamped by weeds. Often you need the Winter period to achieve good weed control prior to sowing in early Spring.

In the very cold or extremely wet areas, direct seeding is sometimes delayed until late spring when soils begin to drain and temperatures warm up, allowing germination. In dry, warm areas where weed control is not such a problem, seeding can occur as early as June-July to allow more time for seedling establishment before summer.

AFTERCARE

Red-legged Earth Mite
These insects can decimate newly germinated seedlings. Get down on your hands and knees and search for them every couple of days from the time you do your seeding. If you know the site has a history of RLEM then a spray program prior to seeding is recommended.

Spray a wider area than just your revegetation site so that the mites have less chance of reinvading. Spray LeMat® or other insecticide as appropriate. Seedlings are vulnerable until the 4-6 leaf stage.

Grasshoppers
Grasshoppers in large numbers can damage direct seeded trees and shrubs. Control can involve either spraying or baiting. Baits generally consist of bran soaked with an insecticide such as maldison. The bait mix is scattered by hand at the site so can be unsuited for very large areas of trees where boom spraying is more feasible instead.

Any grasshoppers which eat the baits are killed but baiting may need to be carried out several times due to new waves of grasshoppers invading the site.

Contact farm chemical supply outlets for advice on rates or other control options.

Weed control the year *after* seeding

n the winter after seeding, the seedlings will probably be about 10 - 30 cm tall. They are vulnerable to being swamped out by new weed growth, particularly capeweed and phalaris. Even if the weeds don't look very competitive in early June, prior experience shows that in most areas your smaller seedlings will be overtopped and struggling by Spring unless you undertake some weed control.

Spraying down each side of the rows of seedlings with a shielded (hooded) spray unit at full label rates of non-selective knockdown will give excellent control.

An alternative if you do not have access to a shielded unit is an 'overspray'. In cases where grasses are the major problem, you can spray over tree and shrub seedlings with a grass-selective spray (e.g. Fusilade®, Verdict® etc) at label rates without any harm to the trees and shrubs.

If broadleaf weeds are a major problem, an overspray often used is a mix of *diluted* glyphosate (e.g. Roundup®) and oxyfluorfen (e.g. Goal®) plus a mixing agent (e.g. Flowrite®) but *please* consult direct seeding contractors or the PIRSA Rural Solutions Revegetation Consultant for case by case advice about rates and make doubly sure that calibration is correct. **Too much of this mix can kill seedlings**. Spraying should be done in the coldest months (June-July) because this is when the natives are most dormant and will be affected less by the spray.

POTENTIAL PROBLEMS

No germination?

Are you sure? Driving alongside the site in your ute you might think there is nothing much there. You really can't tell unless you get out and have a close look. Many natives are quite small and easy to miss in their first few months. Give your seeding at least a full year before you write poor sites off - you may be surprised at how much there turns out to be. Remember, there only needs to be a plant every five metres or so for very effective revegetation.

Poor rainfall

Usually direct seeding does not need watering over summer, but seedlings can fail in years of very dry spring weather. If in summer seedlings are looking stressed you can save them by running along with a watering truck to give a few gentle sprays to soak the area. *Remember though that your best guard against summer dryness is the effort you put into weed control prior to seeding.*

Where direct seeding gives patchy results, spot-sowing of seeds by hand or planting tubestock seedlings the year after then comes in handy to fill any gaps.

SUMMARY OF SITE PREPARATION AND AFTERCARE

Year	Season	Action
Before seeding	Spring	Weed control (spray top for annuals, spray out perennials)
Of seeding	Summer	Weed control (e.g. bracken, couch grass, primrose)
Of seeding	Summer	Seed collection if necessary
Of seeding	Summer	Vermin control
Of seeding	Late summer	Rip (only where extremely necessary, e.g. with impenetrable rock or clay layer), mound if wet site; fencing
Of seeding	Late Autumn	Weed control after break of season; sow cover crop if necessary to control erosion on eroding sites
Of seeding	Early Winter	Sow seeds by hand or machine for areas <450mm or deep non wetting sands
Of seeding	Late Winter	Weed control – knockdown only rainfall 450mm+
Of seeding	Late Winter - Mid Spring	Sow seeds by hand or machine rainfall > 450mm+
Of seeding	First weeks after germination	Spray for Red Legged Earth Mite and other pest grubs/insects - watch for early signs of grasshoppers and snails
After seeding	Summer	Watch for and control grasshoppers, rabbits and hares
After seeding	Mid Winter	Control weeds, use shielded spray unit or special overspray mixture; fill in any big gaps with new seedlings if necessary.

DIRECT SEEDING CONTRACTORS

Some landholders have had good success direct seeding with their own farm machinery e.g. rabbit bait layers, crop seeders. If you are not sure of the process, however, it is helpful to use a contractor with specialised machinery first. Each of the contractors offers advice and equipment for weed control and some can provide specialised local native seed if contacted before summer of the year of sowing.

Contract rates

Rates for direct seeding are generally around $120 - $130 per kilometre sown. If you supply your own seed, the contractor will only charge for the labour rate. Extra costs can involve contract weed spraying and travel costs and pre-seeding consultancies.

The overall rate is based on a minimum seeded length of 2 km. Contractors will generally not do less than this unless there are other jobs close by to do - if you have only a small job, talk to others in your area to see if they would like some done also. Some contractors apply a maximum day rate for very large jobs (seed will still cost extra).

Remember: always contact the contractor as early as possible to establish needs for site preparation and seed supply.

PRIMARY INDUSTRIES AND RESOURCES SA

FACT SHEET

Hand direct seeding of native plants

Direct seeding of native trees and shrubs using hand tools is a simple and low-cost technique developed by Primary Industries and Resources, South Australia, for establishing large areas of native vegetation where machinery is unsuitable or for establishing understorey species where seed is limited.

Direct seeding imitates nature, and seedlings grow with a better root system than conventional seedlings raised in tubes or pots. It is easy, and one person can sow up to 600 plant sites in a day.

Guidelines for success

Carefully plan the direct seeding by selecting the sowing site and species that match your land and farm needs.

The following points are a guide for successful hand direct seeding:

- Plan your project at least 12 months before sowing.
- Sow at the right time.
- Remove weed competition.
- Use local species.
- For special purpose planting (for example fodder or agroforestry), use appropriate species.
- Protect the seedlings from livestock and vermin.

Tools and materials

Tool

Use a fire rake/rake hoe, available from hardware stores or local CFS brigades.

Herbicide

Prior to sowing use glyphosate (360 g/L) at the rate of 1.5 to 2.5 L/ha or 200 mL to a 15 L herbicide knapsack for control of weeds, depending on the types of weeds present - use label rates.

Seed

It is best to collect the seed from your own local provenance, but seed can be purchased from the listed suppliers. Use it at the rate of 200 to 300 g of fine seed (eucalypts) or 300 to 500 of large seed (wattles) a hectare or for 1 000 sites. Some hard-coated seed, for example wattle seed, may need to be soaked in boiling water before sowing. (Refer to "What Seed is That?" for treatment.) If unsure, seek advice from a native seed expert or Revegetation Officer. Seek appropriate permission before seed collecting on public or private property.

Five steps for success

1. Timing

Select the weed control and sowing period corresponding to the average rainfall in your area.

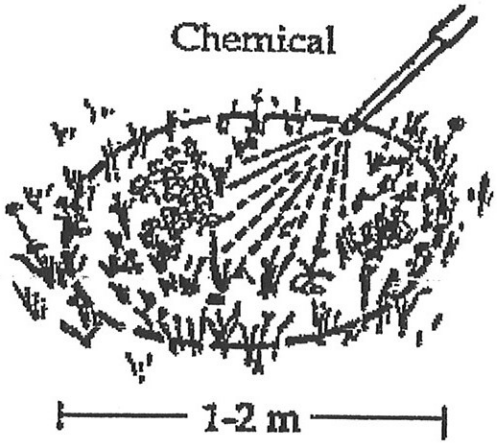
This technique is not recommended for areas that receive less than 300 mm of rainfall annually. Sandy sites in 450mm+ areas should be sown early.

Break in season	April	May	June	July	August	September	November
	Weed control 300- 450 mm Sow 300- 450 mm	Weed control #1 450 mm+		Weed control #2 450mm+ Sow 450- 550 mm Sow 550- 650 mm Sow 650 mm +			

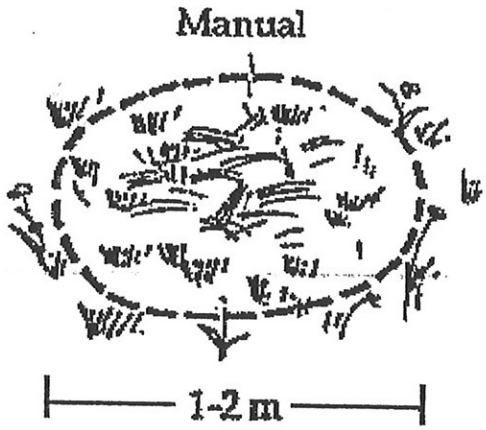
Seed must always be sown into a moist seedbed. Areas subject to waterlogging should be sown in spring. Summer active weeds should be managed the year prior to sowing, and at the time of sowing.

2. Weed control

Good weed control is essential for seedling survival. Control can be either chemical or manual.



Control weeds for a circle of 1 to 2 m diameter.

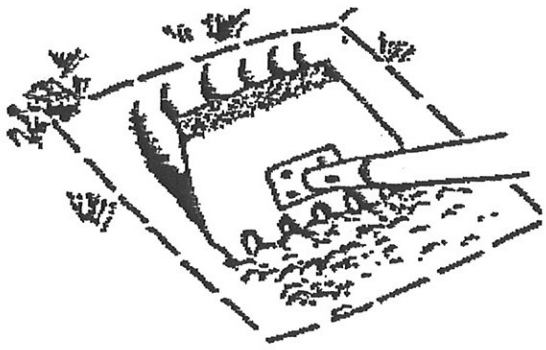


Remove all weeds but leave litter trash to protect the soil.

3. Prepare the sowing site

Preparation of the sowing site can be done about one to three weeks after spraying.

Scrape to remove dead weeds and trash (30 x 30 cm area).



Rake to prepare seedbed.

This technique is not recommended for areas that receive less than 300 mm of rainfall annually. Sandy sites in 450mm+ areas should be sown early.

Break in season	April	May	June	July	August	September	November
		Weed control #1 450 mm+		Weed control #2 450mm+			
	Weed control 300- 450 mm						
		Sow 300- 450 mm		Sow 450- 550 mm			
					Sow 550- 650 mm		
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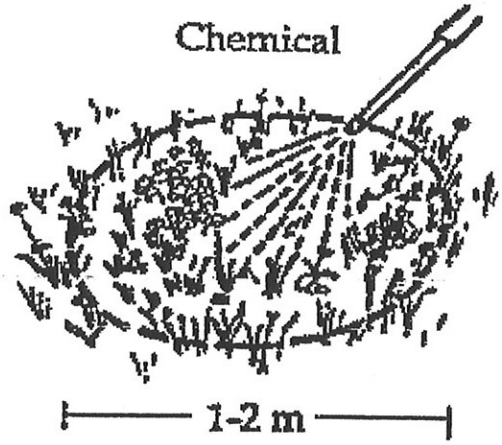

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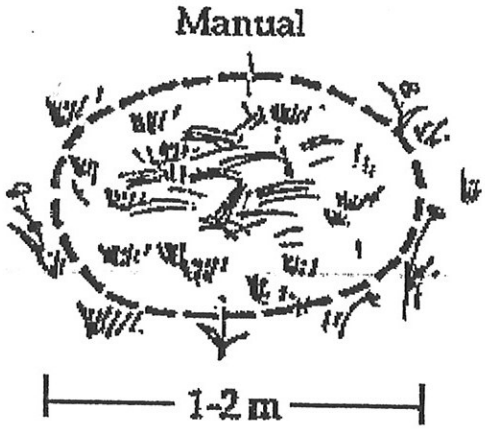
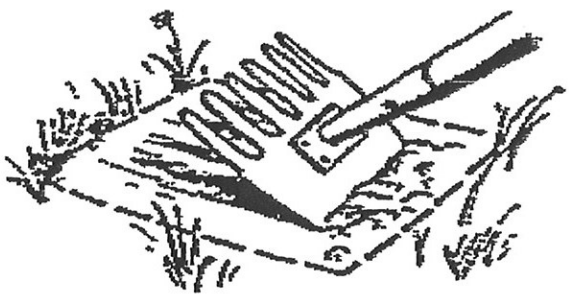


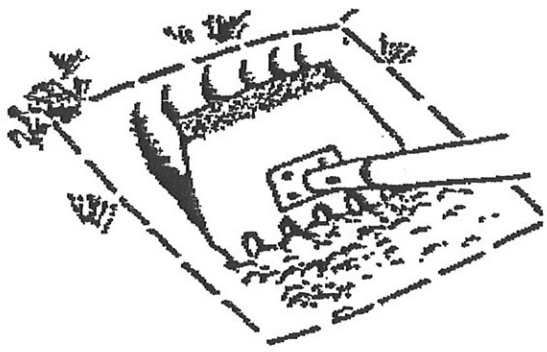
Remove all weeds but leave litter trash to protect the soil.

3. Prepare the sowing site

Preparation of the sowing site can be done about one to three weeks after spraying.

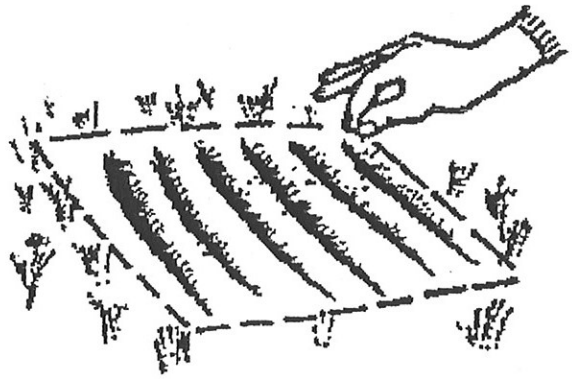


Scrape to remove dead weeds and trash (30 x 30 cm area).



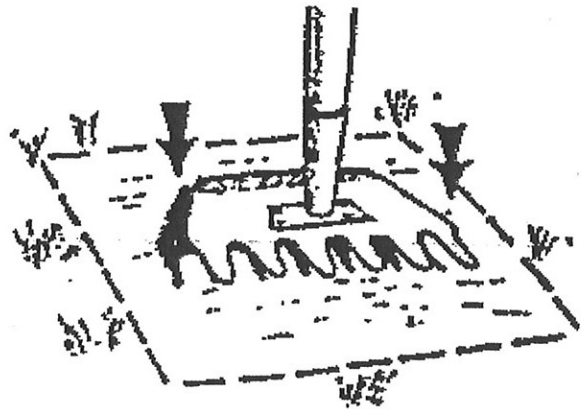
Rake to prepare seedbed.

4. Sow

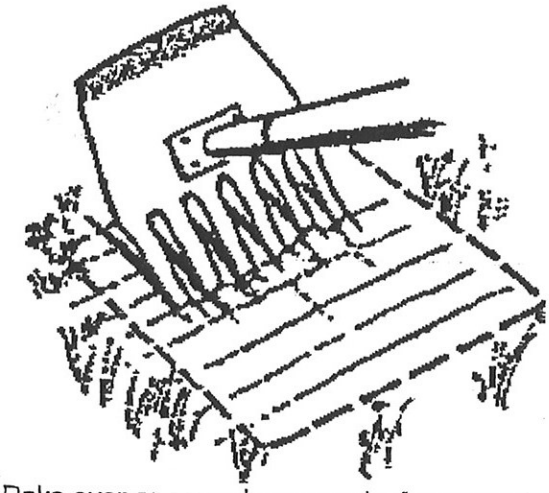


A pinch is plenty (10 to 20 seeds).
Sow only one species per site.

5. Protect the seed



Tamp the surface for fine seed, for example eucalypts and tea tree or firm seed into soil with your shoe.



Rake over or cover large seeds, for example wattle, sheoak.

Ideally, bury the seed to a depth of once or twice its size.

Other hints

Weed control

If weeds become a problem, remove them by hand or spray them with glyphosate while using a protective cover over the seedlings (use rainwater to mix chemical). **Do not spray seedlings with high concentrates of glyphosate.** Good weed control is essential during the first year. Only overspray with 0.5 L/ha of glyphosate (360 g/L) in the second year if there is a risk of them being smothered. This may cause minor damage, especially to Eucalypts.

For roadsides or heavily weed infested areas start your weed control measures 1 to 2 years in advance of seeding. Seek advice.

Too many seedlings

If more than one seedling germinates in a site, let nature take its course rather than thin out.

Vermin / livestock

Fence or use tree guards to protect seedlings from vermin and livestock or eradicate vermin prior to seeding.

Insect pests

Check regularly for red legged earth mite, aphids and other insects. Seek expert advice on chemical control. Earth mite chemical may be added to weed control chemical. Always check the label.

Windy sites

It is important to use a light cover of fine gravel to act as a mulch and to protect the seed.

Cracking clay soils

Cultivation to a depth of 300 to 400 mm encourages good root development and should be done 6 months prior to chemical weed control. Discuss techniques with Revegetation Officers or Community Groups.

Further information

For more information contact Primary Industries and Resources at the State Tree Centre, Brookway Drive, Campbelltown SA 5074, phone: (08) 8207 8767.

Printed information is also available:

Primary Industries and Resources SA Tree Fact *Collecting native plant seed, Red legged Earth Mites and direct seeded native trees and shrubs* and Greening Australia (SA) Inc. publications entitled *How to collect native tree seed easily* and *What Seed is That?*

Seed is available from the following:

Australian Bush Products, phone (08) 8534 4124

Blackwood Seeds, phone (08) 8532 6483

Environmental Regeneration Australia, phone (08) 8277 3661

Land Use Consultants, phone (08) 8552 5266

Merrick Savage, phone (08) 8682 6233

Rivoli Bay Seeds, phone (08) 8735 8131

Trees For Life, phone (08) 8207 8787

Yorke Seeds, phone (08) 8853 1120

Last update: November 1998

Author:
Prepared by Revegetation Officers of Primary Industries and Resources SA.

Agdex: 301/21

Appendix B.6. - Erosion Control Manual

Onkaparinga Catchment Water Management Board

Onkaparinga Catchment Water Management Board

Manual for Small Scale Watercourse Erosion Control Works

Revegetation

Riparian Revegetation with Tubestock

Good Quality Riparian and In-stream Vegetation

Design Guidelines

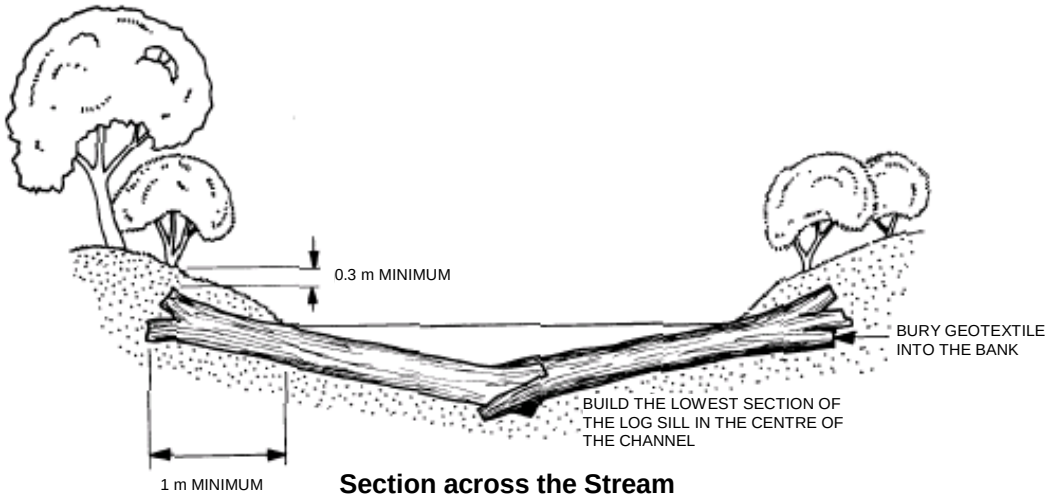
- Revegetation is the most cost effective form of erosion control. Without revegetation most physical erosion control works will be at a high risk of failure in the long term.
- Revegetation must involve a mix of species. Grasses, reeds, rushes, sedges and shrubs will have a greater impact on erosion than trees and should be the primary focus of revegetation for erosion control.
- Revegetation must extend to the stream bed and banks - often the most critical zones for erosion control. Planting vegetation higher on the banks and floodplain will do little to solve many erosion issues.
- Revegetation activities should aim to provide a dense vegetation cover. For example tubestock should be planted at 1 m centres or closer. Natural selection will weed out the less vigorous plants and ensure a sustainable plant density results.
- Grazing pressure must be controlled prior to revegetation. This is best achieved by fencing the watercourse.
- In many instances in-stream plant species such as reeds and rushes will colonise rapidly from adjacent communities. Where beds of reeds or rushes are not present nearby these species will need to be actively planted.

Design Guidelines (Continued)

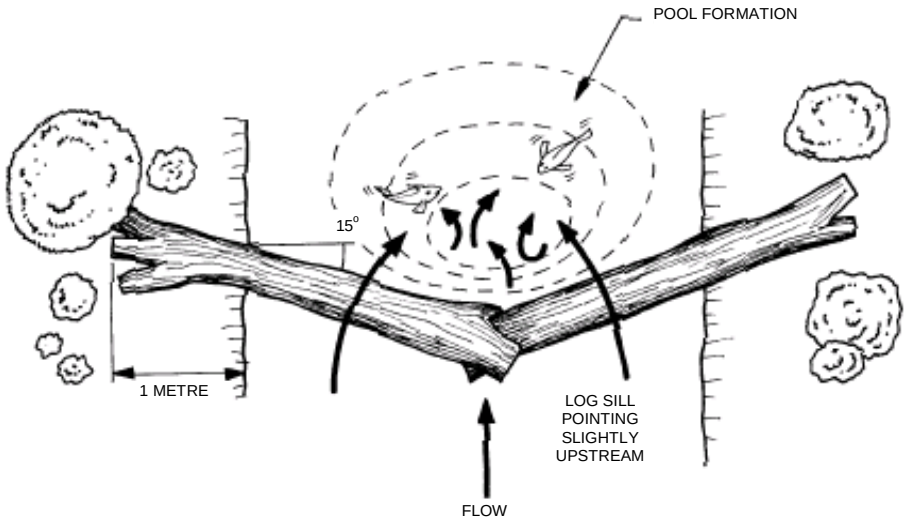
- Revegetation should consist of locally indigenous native species. The species should be selected according to site conditions such as local rainfall patterns, soil type and aspect (i.e. north facing slope v south facing slope). A mix of species is essential and they should be planted in locations that will meet their individual needs.
- Prior to European settlement many of the smaller streams of the Mount Lofty Ranges would have had a "freshwater meadow" character, densely vegetated with reeds, rushes, sedges and grasses, with few stretches of open water. Catchment clearing, grazing, drainage and channelisation works have turned many of these streams into defined channels. Dense beds of reeds and rushes are often viewed as a management problem but these plant communities prevent erosion, trap silt and provide valuable habitat for our native birds and animals.
- The following contacts can provide advice and assistance for revegetation activities:

Onkaparinga Catchment Water Management Board:	Tel: 8374 6000
Mount Lofty Ranges Catchment Centre:	Tel: 8391 7500
Trees for Life:	Tel: 8372 0150

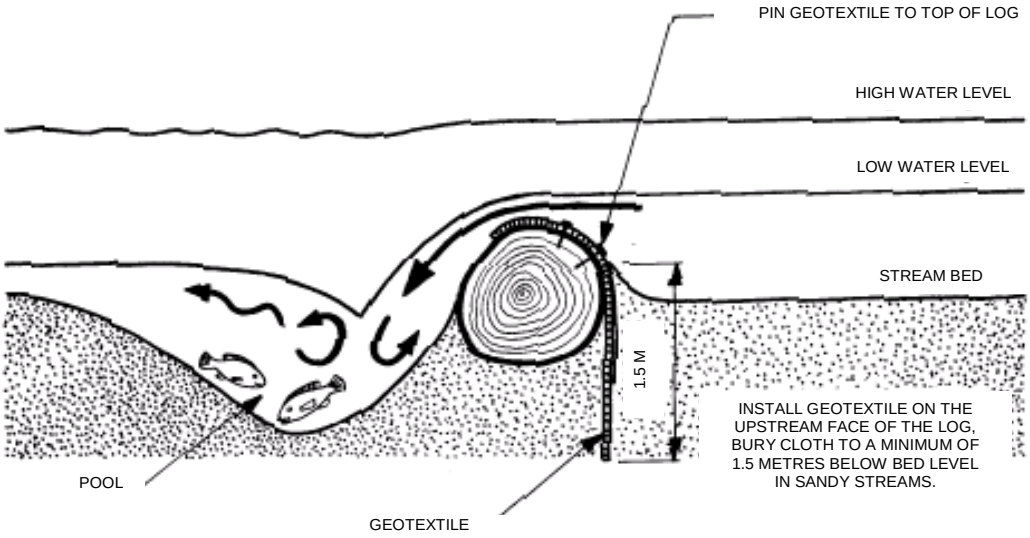
Log Sill or Weir



Section across the Stream



Plan



Section along the Stream

source: Torre, 2001

Design Guidelines

- The diagrams above show a large stream and large timbers, however this technique can be used to stabilise small erosion heads (< 60 cm drop) on small watercourses.
- Most successful in a stream with a large amount of coarse bed sediment (gravels and sands).
- The timbers are used to form a weir type structure that prevents the erosion head moving upstream and helps to trap sediment on the upstream side.
- The most important concern during construction is that the timbers and geotextile are anchored and set in the bed correctly so that undermining of the structure doesn't occur.

Materials List

- Large logs/timbers.
- Medium weight, non-woven, needle punched geotextile. (Geotextile is required to prevent leakage through the log sill. Geotextile is available from most large building materials suppliers.)
- Materials to fix logs to each other (galvanised bolts, threaded rods, or cables).
- Staples to fix geotextile to logs.
- Materials to hold logs in place (star dropper anchors and cable or chain).

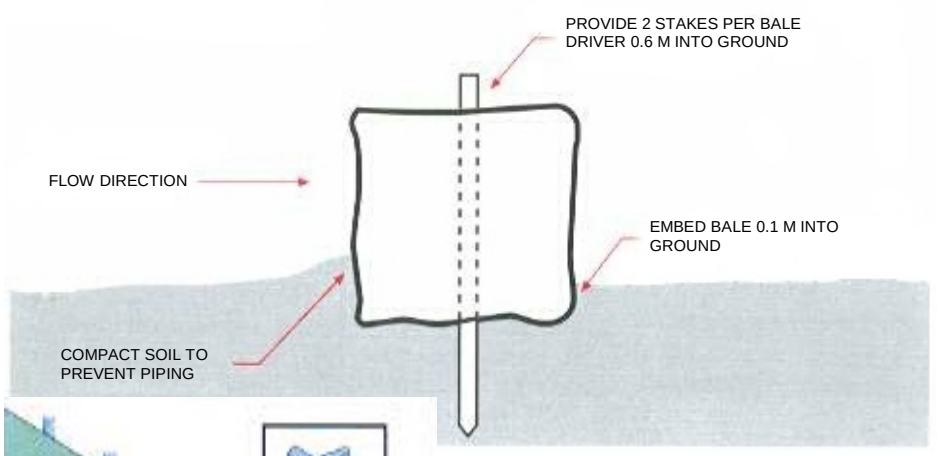
Construction Notes

- Remove excess vegetation and debris from the watercourse bed and banks at site of log sill.
- Excavate a trench in the bed and banks of the stream and stockpile the material. At the centre of the stream the trench should be cut to a minimum depth of 1.5 m below the bed level. From this centre point the trench should angle upstream as shown in the drawings.
- Lay geotextile in trench and backfill to the level of log installation. This level will be such that when the logs are placed their crest level will be lowest in the centre of the watercourse and this crest level will be the level required to control the bed deepening process.
- Place logs and manoeuvre them until they interlock tightly. Various methods are available to fasten the logs together and keep them in place. They may be fastened together using long galvanised bolts, threaded rods or cables to strap them together. To hold them in place anchor them to the stream bed using cable or chain tied to star droppers driven a minimum of 1 m into the bed material. This may not be required if the logs interlock well and are firmly bedded.
- Place geotextile over upstream face of logs and fasten. Back fill bed material around logs and over geotextile.

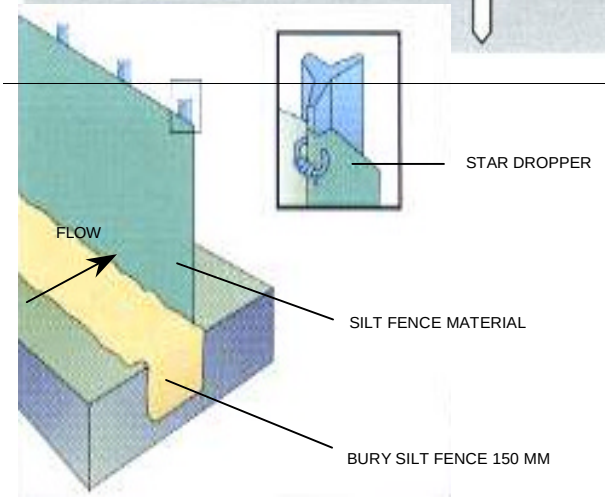
Maintenance

- If the logs move or become loose, additional measures may be required to keep them in place.
  If the logs become undermined the logs should either be reset or rock or additional timbers placed against upstream face of log sill.
- The establishment of vegetation adjacent to the structure should be encouraged.

Hay Bale, Silt Fence or Concrete Bag Sediment Traps



Hay Bale Sediment Trap



Silt Fence Sediment Trap

Silt Fence Sediment Trap

Design Guidelines

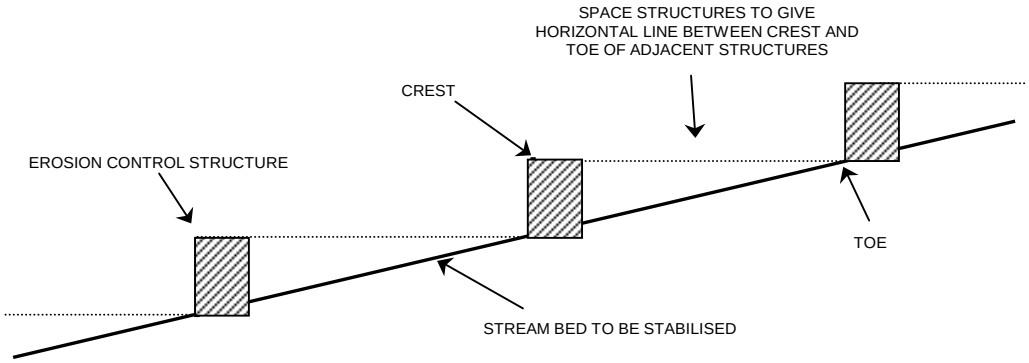
- These structures can be used to stabilise small erosion heads (< 60 cm drop) or minor bed deepening, to trap sediment and to reverse some minor bed deepening processes. These structures are efficient at trapping sediment. In effect they act as small weirs. When multiple structures are placed in series they can greatly improve conditions for revegetation, through reducing stream power and providing sediment for vegetation to grow in.
- As a general rule, when placed in series the structures should be spaced so that a horizontal line from the crest of a structure carries to the toe of the next structure upstream.
- The structures should be 30 – 60 cm high. The lowest point of the structure should be located at the centre of the watercourse so that flows are concentrated in the centre of the stream.
- Care should be taken where the structures meet the stream banks to minimise the threat of flows passing around the edges of the structure.
- Hay bales can be used to form a notched weir. The structure may be one hay bale wide in the centre and two hay bales wide against the banks to encourage most flow to stay away from the banks. Extra stakes should be driven through the hay bales provide extra strength to the structure.
- The structures are simple and the materials are prone to decay or movement. The structures are not recommended as a permanent solution to large erosion issues.
- The structures are best suited to small streams with coarse bed sediments (sands and gravels). The structures can be used in quite steep streams providing the spacing between structures is small.
- Other materials such as sand or cement filled bags can be used as alternatives to hay bales.

Materials List

- Sufficient hay bales and stakes, silt fence and star droppers or concrete filled bags to form a regular series of sediment traps along the watercourse reach.

Construction Notes

- Mark out the site of each structure and ensure structures are spaced so that the crest level of one structure is the same as the toe level of the next structure upstream, as shown below.



- Remove vegetation, debris and loose material from the creek bed in a line across the stream where the structure is to be installed.
- Excavate a key trench in which to bury the base of the hay bale or sediment fence. Key trench should be a minimum of 10 cm for a hay bale and 15 cm for silt fence.
- Insert the hay bales or silt fence and back fill with the excavated materials. Compact well. Poor compaction will lead to water flowing under the structure and consequently failure of the structure. Where soil is very porous or difficult to compact bring in better quality material from elsewhere. Adding moisture to dry soil before compacting it will assist compaction. A thin layer of large gravel or small rock may be used to cover the compacted material to increase its stability.
- Where multiple hay bales are installed across the stream, ensure hay bales are interlocked well and no gap is left where water can pass between hay bales.
- Where a silt fence is used, ensure the base of the silt fence is buried well across the entire stream and that the backfilled trench is on the upstream side of the fence. Drive star droppers at a maximum spacing of 1.5m across the stream on the downstream side of the silt fence. Lift silt fence and tie to star droppers as shown in diagram above.
- If cement filled bags are used they can simply be stacked on top of each other to form a notched weir. They should be placed in an overlapping fashion like bricks in a wall. Stakes or star droppers may be used to prevent the weir toppling over.

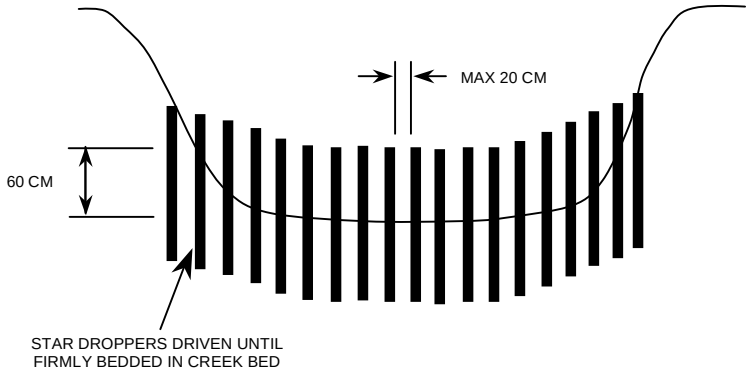
Maintenance

- These structures will require regular monitoring and maintenance.
- With time and sediment accumulation they may require reinforcing, repair or replacement.
- When a structure fills with sediment and becomes degraded it is possible to construct another structure just downstream of the old one. In this way the old structure will become buried with sediment, the trapped sediments and establishing vegetation will not be lost by the failure of the structure and further raising of the stream bed can occur.

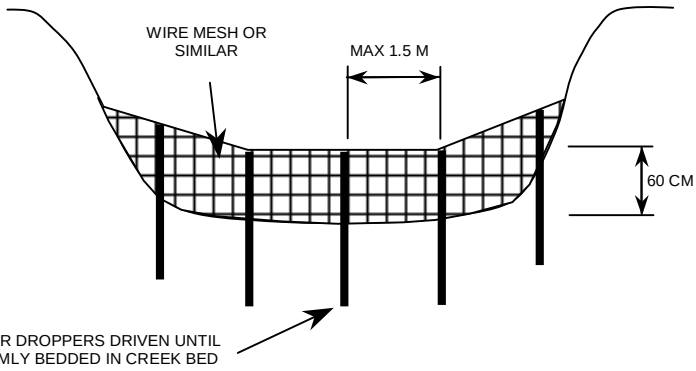
Porous Weir Sediment Traps

Porous Weir Sediment Trap formed by Driving Timbers into the Creek Bed

Porous Weir Sediment Trap formed using Star Droppers or Timber Piles



Porous Weir Sediment Trap formed using Wire Mesh



Design Guidelines

- These structures deliver similar results and benefits to hay bale, silt fence or concrete bag sediment traps but use different materials and a slightly different design strategy.
- They rely on debris carried in the flow to become trapped and reduce the gaps in the structure. In this way a structure that is quite porous will block up and form a leaky weir. This technique will only be successful where the stream carries reasonable amounts of debris such as grass, leaves, twigs and/or small branches.
- Many different materials may be used. Materials that have been used successfully are wire mesh, concrete reinforcing mesh and timber piles driven 10 – 20 cm apart.
- As a general rule, when placed in series the structures should be spaced so that a horizontal line from the crest of a structure carries to the toe of the next structure upstream.
- The structures should be 30 – 60 cm high. The lowest point of the structure should be located at the centre of the watercourse so that low flows are concentrated in the centre of the stream. Attention to where the structures intersect the stream banks must be given to minimise the threat of flows passing around the edges of the structure.
- The structures are simple and the materials can be prone to decay or movement. The structures are not recommended as a permanent solution to large erosion issues but can halt minor bed deepening, trap sediment and improve conditions for vegetation establishment.
- These are best suited to small streams with coarse bed sediments (sands and gravels). The structures can be used in quite steep streams providing the spacing between structures is small.

Materials List

- Sufficient materials to form a regular series of sediment traps along the watercourse reach.

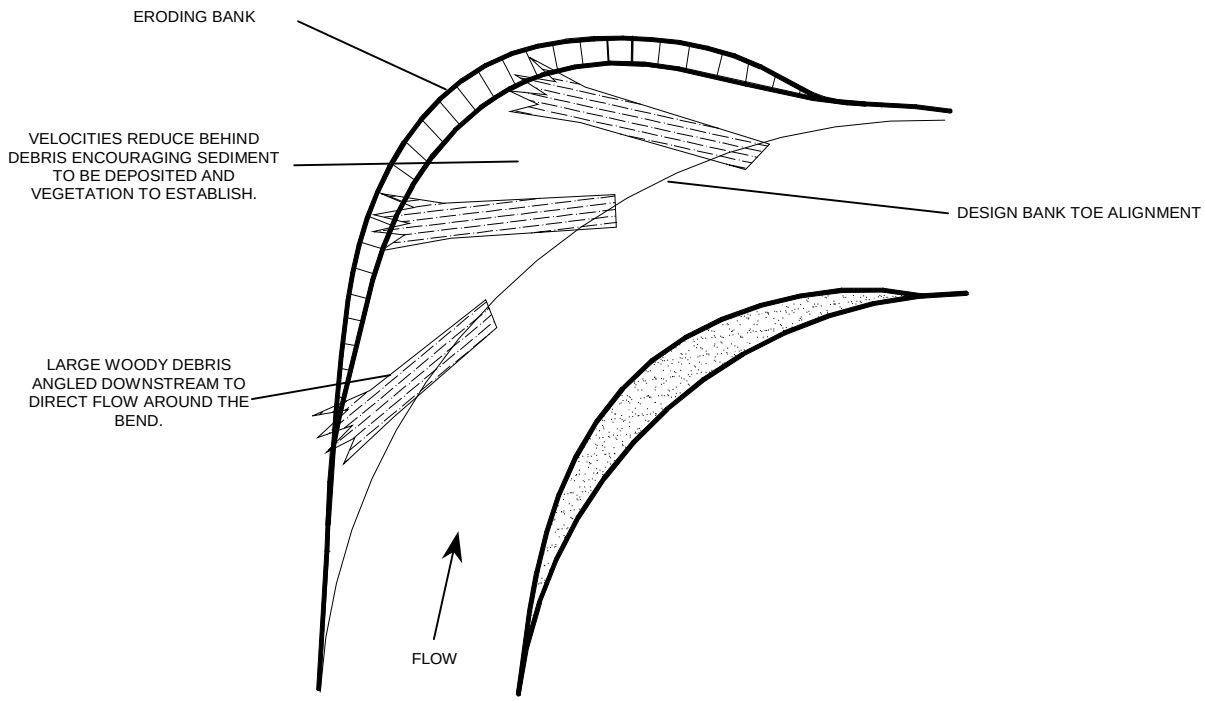
Construction Notes

- Mark out the site of each structure and ensure structures are spaced so that the crest level of one structure is the same as the toe level of the next structure upstream.
- Remove vegetation, debris and loose material from the creek bed in a line across the stream where the structure is to be installed.
- Timbers or star droppers can be driven directly into the bed to form the structure. The gap between timbers or droppers should not exceed 15 cm. The timbers or droppers should protrude about 50 cm above the stream bed.
- Where mesh materials are used, excavate a key trench in which to bury the base of the structure. Key trench should be a minimum 30 cm deep. Insert the mesh into the key trench and back fill with the excavated materials. Compact well. Poor compaction will lead to water flowing under the structure and subsequent failure of the structure. Where soil is very porous or difficult to compact, bring in better quality material from elsewhere. Adding moisture to dry soil before compacting it will assist compaction. A layer of large gravels or small rock may be used to cover the compacted material to increase its stability.

Maintenance

- These structures will require regular monitoring and maintenance.
- With time and sediment accumulation they may require reinforcing or repair.
- When a structure fills with sediment and becomes degraded it is possible to construct another structure just downstream of the old one. In this way the old structure will become buried with sediment, the trapped sediments and establishing vegetation will not be lost by the failure of the structure and further raising of the stream bed can occur.

Alignment Training - Large Woody Debris



Plan View Showing Recommended Alignment of Large Woody Debris

Design Guidelines

- Large woody debris (eg. logs) is used to define a bank alignment and direct flow away from an eroding bank. Flow velocities decrease behind the debris, allowing sediment to deposit and vegetation to establish.
- Most successful in streams carrying coarse sediment such as sand and gravel.

Materials List

- Large woody debris (trees or large logs)
- Materials to anchor the logs in the required location

Construction

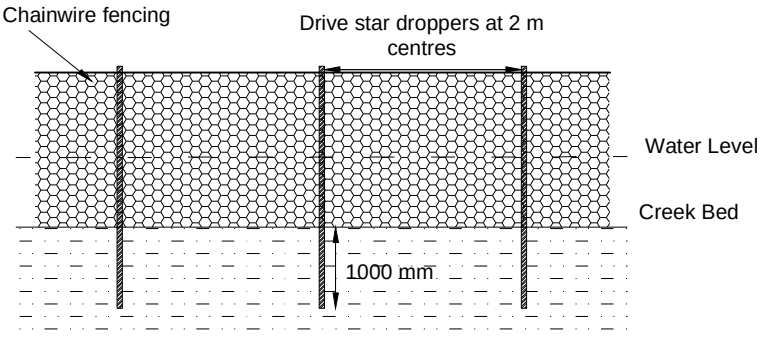
- Mark out the design alignment for the bank toe.
- Remove excess vegetation or debris from the watercourse bed and banks at the site of the alignment training.
- Place the logs and align them so the in-stream end of the logs follows the design bank toe alignment and the logs are angled downstream. The opposite end of the debris should be set flush against or buried in the stream bank to prevent water passing around it.
- The spacing between adjacent logs should be such that the upstream log provides direct protection for the bank side of the next downstream log.
- Numerous methods are available to keep the logs in place. One simple method is to anchor them to the stream bed using rope, cable or chain tied to star droppers driven a minimum of 1 m into the bed material.

Maintenance

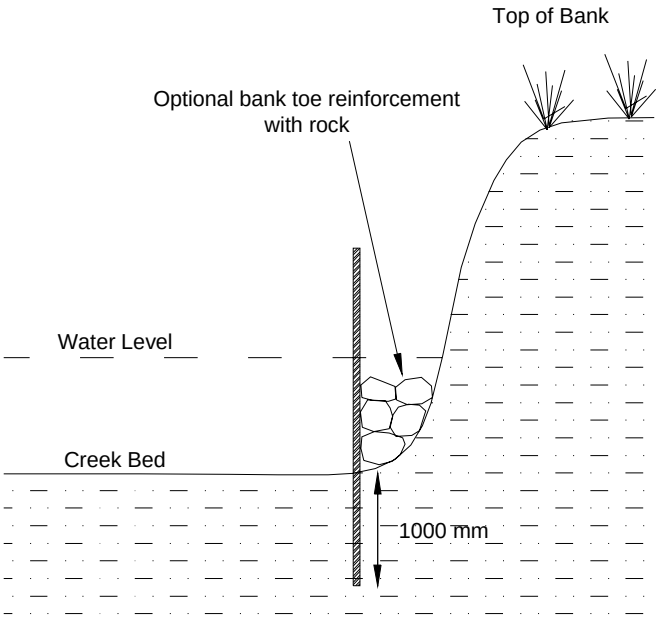
- If the logs move, provide more substantial anchors.
- Monitor for scour of the bank, which will allow water to pass around the outside of the logs. If required place additional logs or rock to prevent bank scour at the upstream end of the alignment training.

Alignment Training – Wire Fencing

Alignment Training Fencing



Section through Typical Fence



Alignment Fencing After Construction

Alignment Fencing After Construction

Design Guidelines

- The wire mesh traps grass, leaves and other debris forming a partial barrier against flow. The velocity of water behind the fence drops allowing sediment to collect and protecting the bank and vegetation from damage.
- The long term aim is for vegetation to establish behind the fence. The vegetation will eventually take the place of the fence and shield the bank from damage. The long term success of this technique relies on vegetation establishment. If soil conditions are such that vegetation will not establish then this technique is not recommended.
- The upstream end of the fence must be constructed to prevent flow getting behind the fence without first passing through the fence. If flow can easily get behind the fence then increased damage may result.
- This technique is relatively cheap and easy to construct but it is prone to damage, particularly from floating debris during large flow events. Maintenance and repairs will be required.

Materials List

- 1.8 m long Star droppers.
- Strong wire mesh fencing. Heavy duty, close strand RINGLOC fencing or chain mesh is recommended.

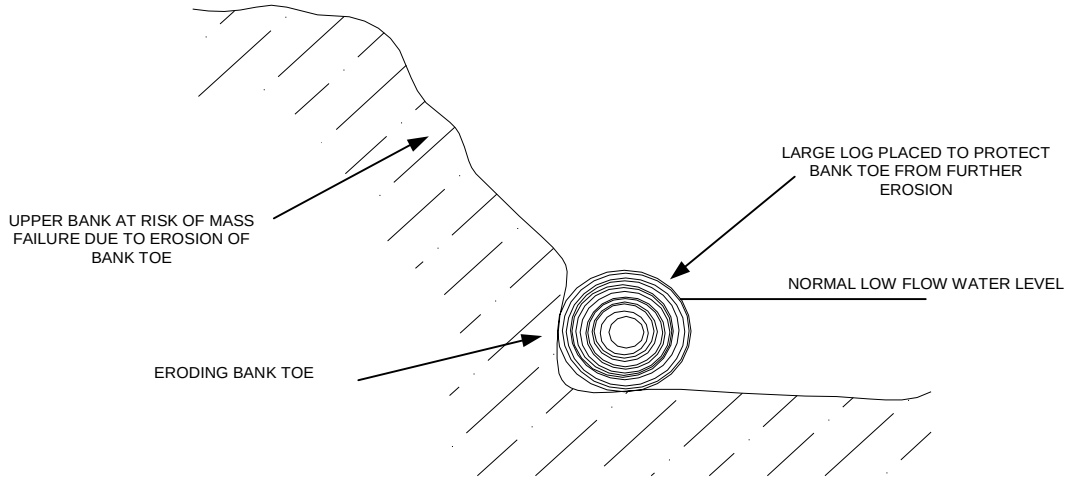
Construction

- Establish the proposed fence alignment and remove any obstructing vegetation, debris or rock.
- The fence must be securely anchored to the bank at the upstream end of the site. One way to do this is to excavate a trench in the bank at this point, placing the end of the fence in the trench and backfilling with large rock. The trench should be a minimum of 50 cm deep.
- An alternative is to run the fence up the bank above the normal high water mark.
- Commencing at the upstream end of the site, drive star droppers along the proposed bank toe alignment. The first dropper should be driven close to the existing bank near the anchor trench. The next few droppers should be spaced at 1m intervals and commence following the proposed alignment. The spacing can then be increased to 2m, except where tight bends are encountered.
- Droppers should be driven until firmly bedded in the stream bed or bank.
- Place heavy duty wire mesh on the stream ward side of star droppers ensuring that the base of the fencing material is resting on the bed of the watercourse. Securely fix the fencing to the droppers using wire ties.
- The effectiveness of the fence may be increase by placing woody debris and/or rock behind the fence and along the bank.

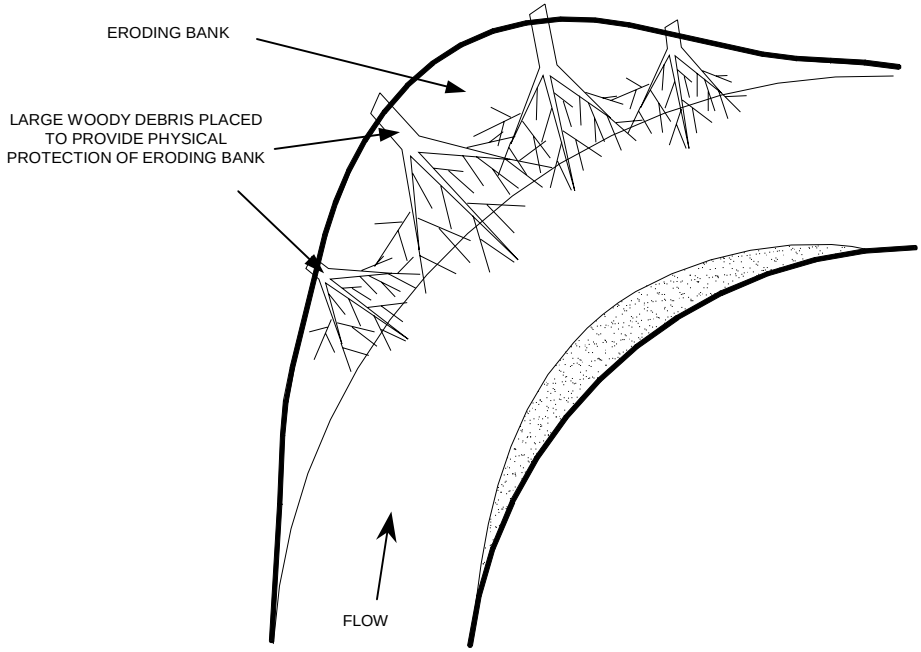
Maintenance

- Large debris that collects on the fence may weigh it down or provide added flow pressure against the fence. Remove this material from the stream ward side of the fence and place it behind the fence.
- The establishment of vegetation along the bank should be encouraged.

Large Woody Bank Protection



Large Woody Debris Placed to Protect Bank Toe



Large Woody Debris Placed Directly onto Bank to Provide Physical Protection

Design Guidelines

- Woody debris can be used in a variety of ways to provide bank protection.
- Large fallen leafy branches can be placed over a bank to act like erosion control matting. The branches will shield the bank from fast flowing water, reducing loss of bank material and providing protection for establishing vegetation. The use of woody debris in this way is a short term means of providing support for other erosion control strategies such as revegetation. In this example, seeding of the bank should be undertaken prior to the placement of the branches. Planting of tubestock should be undertaken after placement of the branches.
- Large timbers can be placed along and parallel to the toe of a bank to protect it from erosion and prevent mass failure of the upper portion of the bank.
- Some bank battering or trimming may be required prior to the placement of woody debris.

Materials List

- Suitable large woody debris

Construction

- Remove excess vegetation or debris from the watercourse bed and banks at the site of the bank protection.
- Place the large woody debris in the required location. Fix in place using star droppers or wooden pegs.

Maintenance

- The structure should be monitored to ensure the debris remains fixed in the desired position. Additional anchoring may be required.

Appendix B.7. - Managing Stock Guide

FACT SHEET 6

Managing stock

Riverlandscapes

This Fact Sheet is the sixth in a series dealing with the management of riparian land.

Uncontrolled access by domestic stock to riparian land can lead to excessive run-off, bank erosion, loss of productive land, decline in important wildlife habitat, reduced water quality and damage to in-stream ecosystems. Unfortunately, domestic stock, particularly cattle, favour riparian frontages and, if not managed carefully, will spend much of their time along streambanks and in the water. The result is usually over grazing that erodes bank soils allowing weed invasion, and develops stock tracks that erode during heavy rain. This results in increased sediment and nutrients being washed into the stream. Inputs of animal dung and urine are important factors in reduced water quality for downstream users.

It is often not necessary to permanently exclude animals from riparian lands, but it is important to control their movement and to manage grazing pressure. This takes a bit of planning and effort, but many landholders are discovering that in the long-run, significant payoffs can be gained through increased production, improved water quality, stable streambanks and healthy riparian vegetation.

FACT SHEET 6

Impact on water quality

Photo George Lukacs.

Uncontrolled stock access results in impacts on riparian lands and degraded water quality.

The impact of stock on water quality

Livestock, as well as native and feral animals, can contaminate streams in several ways:

- their manure and urine directly contributes large quantities of phosphorus and nitrogen to streams. Under conditions of sufficient light, and increased temperatures (i.e. where riparian vegetation has been substantially cleared), this can lead to excessive growth of nuisance water plants and algae, including toxic blue-green algae.
- animal wastes are also an important source of disease-causing bacteria and viruses. These may have significant effects on other animals that drink downstream. There is growing evidence that livestock drinking contaminated water show significantly decreased growth rates and lower productivity than those that have access to clean, uncontaminated drinking water.
- streambanks which contain bare soil and compacted walking tracks and pads as a result of over-grazing, contribute large amounts of soil and nutrients to the stream during heavy rainfall. Over-grazing of riparian vegetation, or poorly-placed watering points along a stream results in concentrated animal numbers, and this can lead to increases in streambank erosion and more sediment and nutrients entering the water.
- animal wastes fouling tributary steams above the catchments for dams and reservoirs can significantly increase treatment costs for downstream users.

Nuisance algae, one result of increased nutrient levels. Photo MDBC.

Photo Phil Price.

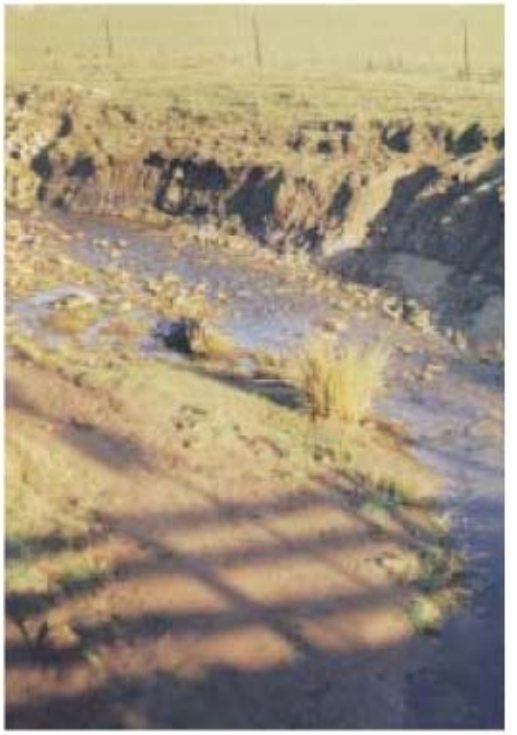
Stock tracks and pugging provide direct routes for sediments and nutrients to wash into the riparian zone.

The impact of stock on riparian vegetation

Other Fact Sheets in this series explain how groundcover and healthy riparian vegetation help to control streambank erosion and to maintain the health of aquatic ecosystems. Over-grazing of riparian lands is a primary cause of vegetation removal and is, therefore, a major problem for both land and stream management.

Streambank erosion

Over-grazing by livestock opens up patches of bare soil along the bank and the land adjacent to it. Walking tracks and pads provide a source of bare and disturbed soil, ready for rapid erosion in the next rain event. Stock moving along the water's edge disturb and pug the soil at the toe of the bank, making it prone to being washed away when rain increases the streamflow. Fact Sheet 2 in this series discusses the issue of bank erosion in more detail.



This stream has had unrestricted stock access that has kept the banks bare and unstable. The area has recently been fenced off in an effort to prevent further bank erosion. Photo Siwan Lovett.

Loss of native plant species

Stock selectively graze the seedlings of some native species, preventing the establishment of new plants and the eventual loss of the species. Loss of species and absence of structural diversity within natural riparian vegetation leads to a loss of biodiversity, increased potential for weed invasion, and loss of habitat and wildlife values.

Soil compaction

Trampling of riparian land during prolonged access by livestock results in soil compaction and physical damage to plants. Soil compaction may affect the ability of seeds to germinate, and reduces the rate at which rainfall or run-off infiltrates the soil. Groundcover species, such as herbs, tufted grasses and tussock species, which help to slow overland flow and to trap sediments, can all be damaged or removed through trampling and excessive grazing.

Weed invasion

The disturbance created by livestock through grazing of plants and opening up of bare ground, together with increased nutrient levels from animal dung and urine, creates an ideal situation for the establishment of weeds. Weeds may also be spread directly by the animals, either through attachment to hair or skin, or through their manure. Troublesome weeds can spread in the other direction, from riparian lands onto adjacent farmland.

Bridal creeper infestation impacting on riparian land.
Photo Sharon Rixon.

Managing stock access and grazing pressure

In areas where restoration of native riparian vegetation is needed to overcome problems created by uncontrolled stock on riparian land, removing or controlling stock access during the period of restoration is the first and most important step in management. However, the long-term aim of management should be sustainable grazing which does not cause direct damage to vegetation cover. Some practical methods to control stock access and grazing pressure are discussed on the following pages.

This riparian zone has been fenced out to restrict stock access. Once the area has been rehabilitated, stock may be permitted access for drought refuge or shelter in times of severe weather events. Photo Siwan Lovett.

Fencing

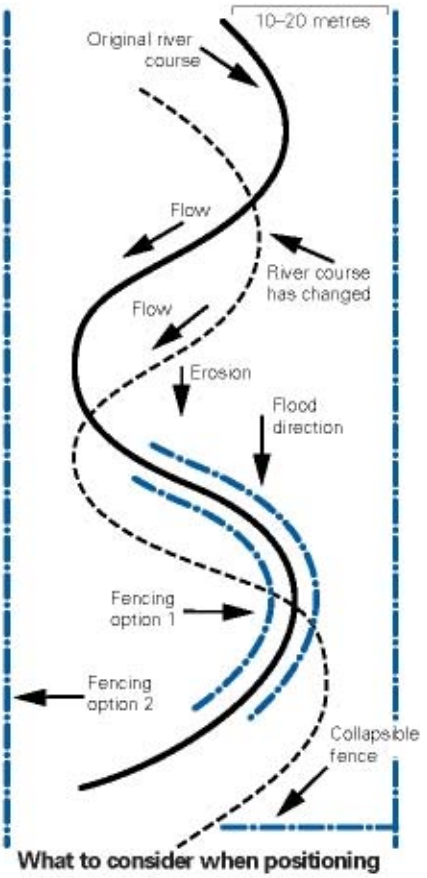
The simplest way of regulating animal access and grazing pressure on riparian land is to erect a fence between it and the rest of the property. Fencing will enable you to manage stock access according to need and available feed, and opens up opportunities for additional or alternative productive use of riparian margins, for example, for forage production or agroforestry.

The use of fenced riparian margins as a living haystack is gaining acceptance as more and more landholders report that carefully-planned, strategic use of the feed available on riparian lands can have a significant benefit to profitability. This type of management requires careful planning to incorporate it into the grazing enterprise, but the rewards can be significant.

The type and location of fencing that best suits your needs will depend on your type of stock, when and how much you want to use the riparian area, the size and shape of the stream channel, flood frequency, and size of the flood peak. Riparian fencing needs careful planning as flooding is a continual threat to conventional fence lines. Landholders and researchers have come up with several alternative methods to cope with these problems. This fact sheet covers some of these, but more detailed information is available from government agencies, catchment management authorities, farm advisers and retailers.

Positioning the fence

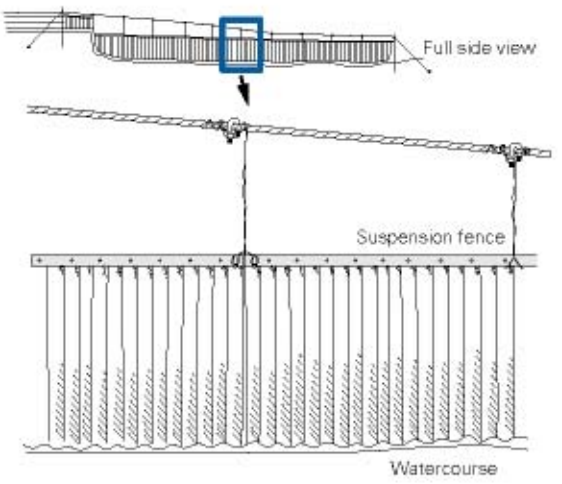
Many landholders make the mistake of placing the riparian fence line too close to the stream. This makes it liable to frequent flood damage, and the fence line may be lost if the stream channel is widening or incising. It is better to do the job properly and be prepared to place the fence line some distance from the current bank, generally at least 10–20 metres. As the plan is to continue to use the riparian land for carefully managed grazing, it should not make a great difference to grazing returns to place the fence at a reasonable distance from the top of the bank. By doing so, you can also take out some of the bends and curves of the stream, reducing the number of end-assemblies that may be required if you are going for conventional fencing. This can help to reduce the capital cost of the fence. As well, there are now in place many local government and community riparian fencing schemes that help with the capital cost faced by landholders.



What to consider when positioning a riparian fence line.

Hanging fences

Hanging fences are built across narrow streams so that animals cannot walk along the stream to bypass fence lines. Hanging fences are usually suspended from steel cable or multi-stranded, high-tensile fencing wire strung across the stream. In order to prevent them being damaged or destroyed during floods, they have hanging panels that are designed to ride up with heavy flows and return to their normal position once the peak flow has passed. The hanging panels are usually galvanised iron or ringlock hinged across the cable. They may be damaged by debris coming down in a big flood, but the damage is usually not severe and the panels can cheaply and easily be repaired or replaced.

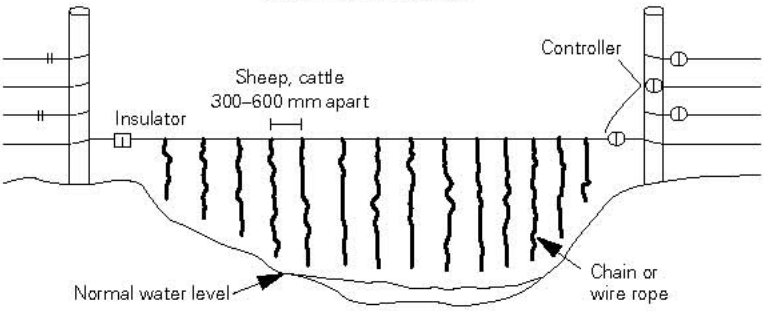


Design for hanging fence

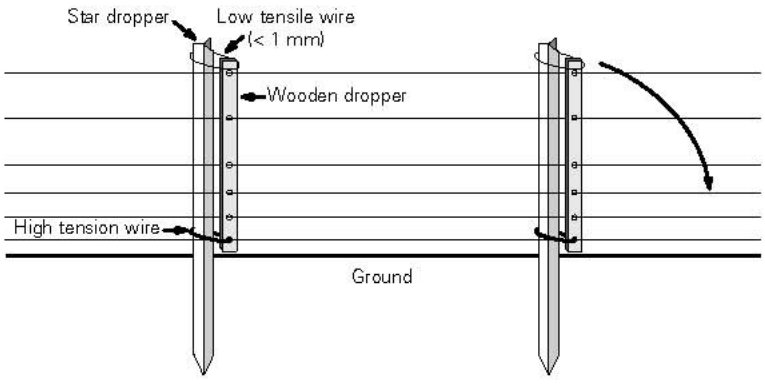
Electric fences

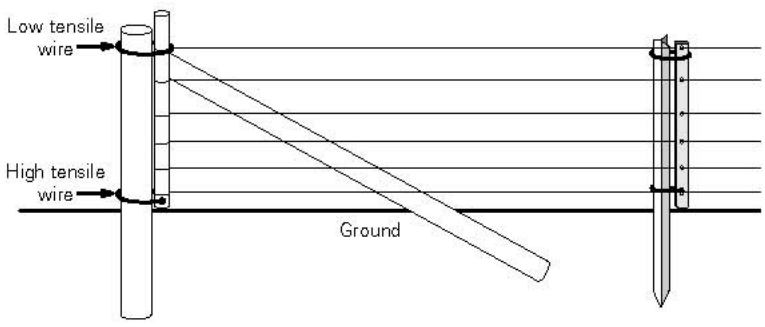
Electric fences have also been designed for use along and across streams. An electric fence is not only much cheaper to construct initially, but it is much cheaper to repair following an unexpectedly large flood. Steel droppers will usually survive a flood unless hit by large debris, so it is often only the cost of a length of electric fencing wire that has to be covered by the landholder.

Electrified flood gate



Below: Drop/lay down fence. Upper diagram showing drop-down wooden posts at star droppers and bottom diagram showing drop-down end strainer post. Photo lower right Ian Bell.





For going across the stream, as with hanging fences, a steel cable is used as a horizontal support, from which steel chains or hinged panels are hung. The chains and/or panels are separated electrically from the grounded cable, and all are electrified and able to move independently, allowing floodwater and debris to pass underneath.

Portable electric fences are another option that allow landholders to control stock movement along waterways. Fully-portable electric fences can also be quickly moved if there is advance notice of a likely flood peak.

Drop fences

Drop fences are designed to be either manually operated (dropped) before a flood, or to drop from their anchor points under the pressure of floodwater and debris. Once the floodwaters have receded, these fences are quick and simple to pull back up and reattach to their anchor points. They can also be dropped to allow stock or vehicle movement from one paddock to another without the need for expensive gateways.

Electronic fences

Electronic fencing has been developed overseas as an alternative to fixed fencing, particularly for cattle. The stock wear a receiver, initially developed in the form of an ear-tag, and transmitter boxes are located to form a boundary between the riparian area and the rest of the paddock. The transmitters emit a continuous signal that defines the boundary. The ear-tags respond by producing firstly an audio signal, followed by an electric stimulus to the animal's ear if it attempts to enter the exclusion zone. Tests have shown that cattle quickly get used to this form of fencing, which is cheaper than conventional fixed fences and can be moved quickly in the event of a flood peak. This type of fencing is under active development in Australia, with the aim of bringing the price down to a level at which it can be adopted widely.

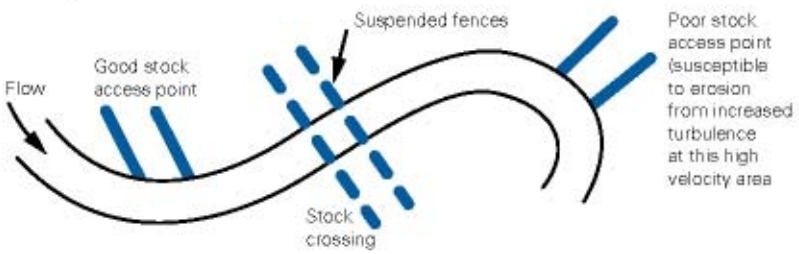
Watering points

Once a streambank has been fenced, or other ways found to control stock access, you may need to consider providing alternative watering points. The careful siting of watering points and supplementary feeding stations where appropriate, can be used as an alternative to fencing, as it helps manage stock access to streams. Some landholders have demonstrated that by providing a shaded access point to clean water, or by providing a watering point closer to preferred pastures, they have been able to significantly reduce the amount of time stock spend in riparian areas without the need for fences.

Ready access to clean, unpolluted water is an important factor in optimising animal health, growth rates and productivity. Hence, the costs of providing alternative water sources for stock, other than through unrestricted access to rivers or streams, may be more than repaid through increased production. Some watering systems to consider are listed below.

Formed access point

Stock can be watered from a stream or river without undue damage to the bank if a formed access point is built at a carefully-selected section of the channel. It is important to avoid boggy area, and the outsides of meander bends where flow speed is high and streambanks are subject to increased erosive forces. Cross-stream fencing may be required to prevent animals wandering along the streambank. Overall, formed access points are a relatively cheap option that result in significant reductions in stock impacts on riparian lands.



Where to site a formed access point

In practice, a graded slope into the stream is selected or constructed as the site for a formed access point. Its surface is then protected by using concrete, compacted gravel, logs or similar materials to form a walkway. It is important to consider likely changes in the depth of flow in order to make sure that access to water is available for as much of the year as possible. When dealing with steep, difficult riverbanks, it is important to recognise that stock show marked preference for using a more-comfortable access point to drink, so a site with a gently sloping bank is preferable.

Alternative water supply

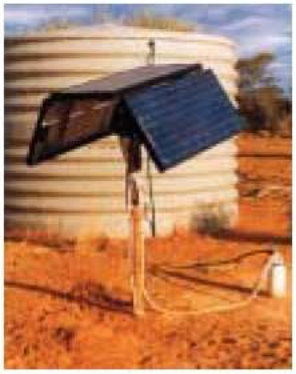
Provision of a water trough connected to a permanent water supply from a dam upslope, or through a reticulated water scheme, is often a cheaper option than attempting to lift and pump from a river. In the more-intensive industries such as dairying, the number and layout of watering points is an important consideration in enabling and encouraging stock to maximise the use of available feed. In these situations, the time taken to walk down to the stream for a drink and back is considered by some landholders to be 'unproductive' time. This means that for these landholders the cost of a reticulated water supply and better-sited watering points more than pays for itself through increased production.

Pumping river water

In many areas, riparian lands overlie old river channels with beds of sand and gravel. These may provide a plentiful supply of good-quality water that can be accessed through a bore powered by an electric pump or windmill. Such aquifers are often not far beneath the land surface, so that even a small-sized pump can provide sufficient water for a large number of animals.

A range of pumps has been developed to use the flow of the stream itself to pump a small volume to a header tank and stock trough, with the tank providing a storage buffer. Solar pumps, which are becoming more cost-effective, are ideally-suited to watering stock in remote areas.

Another pump type, used more commonly overseas than in Australia, is a nose pump (see below) operated by cattle. As the animals drink from the pump bowl, they push against a lever, which in turn operates a piston and diaphragm and pumps more water from the stream. Their low cost and small number of moving parts has made this type of pump an attractive option.



Solar powered water pump.

Nose pump.

Managing grazing pressure

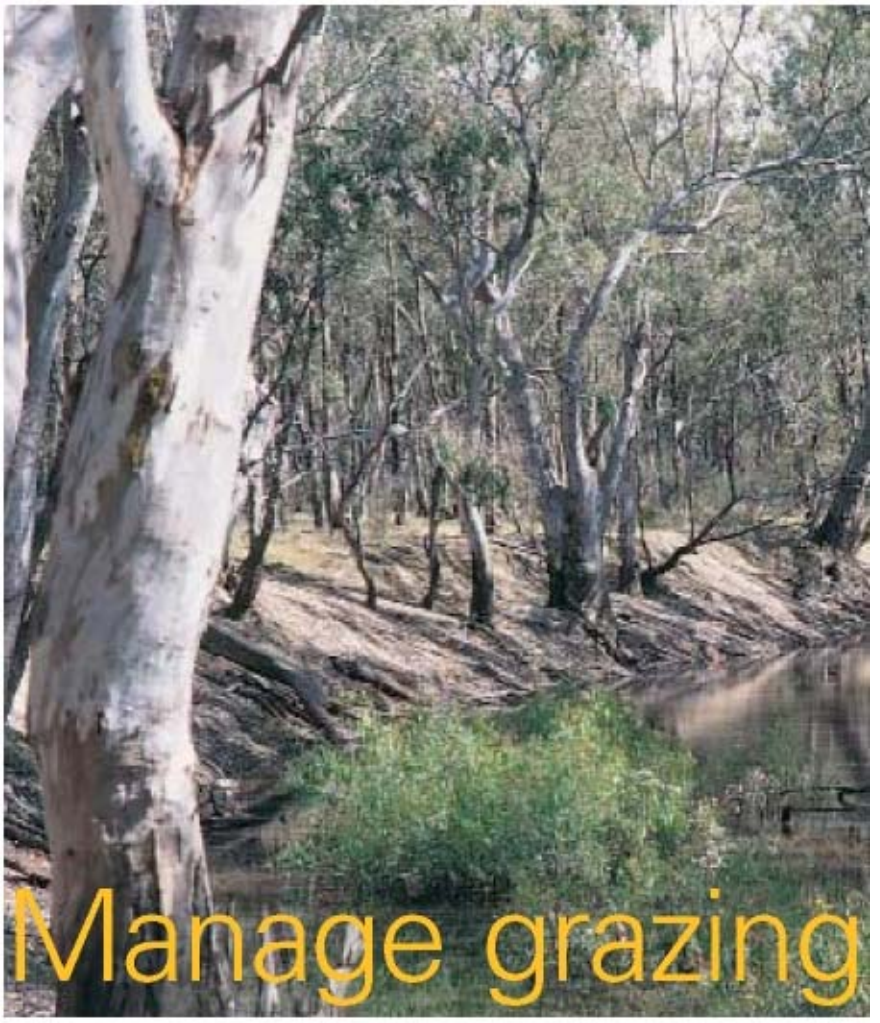
In managing stock grazing on riparian lands, the aim is to maintain continuous groundcover, with enough vegetation to protect the soil surface from heavy rain and to provide a filtering capacity where this is required. You may also wish to maintain vegetation for bank stability, as well as for wildlife and in-stream habitat. Your particular management objectives have an important bearing on how you manage grazing pressure on the riparian land. In general, timing, intensity and duration of grazing all need to be considered.

Timing

Grazing should be restricted or prevented altogether when plants are starting their annual growth cycle. Heavy grazing during this time can substantially weaken pastures and natural vegetation. Grazing should occur when plants are either dormant, such as in winter, or when there will be less impact upon plant vigour, seed and root production. Vegetation should be spelled around the time of flowering and seed production in order to allow for continual replacement and maintenance of good vegetation cover. This is especially important for native species. In addition, grazing on riparian lands should be restricted or removed altogether during that period of the year when maximum rainfall is expected. This will help to ensure maintenance of a complete groundcover when the potential for erosion and soil loss is at its greatest.

Intensity

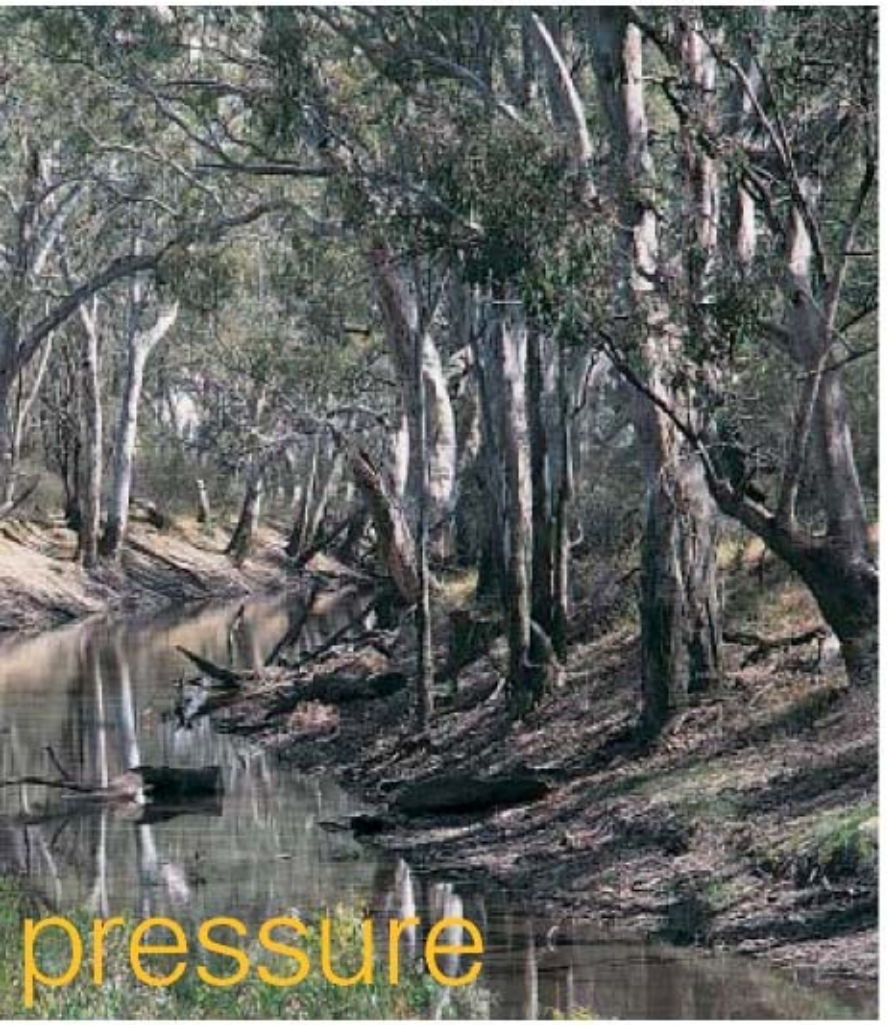
You will need to monitor the impact of grazing during the period when the animals have access to the riparian area. This will enable you to assess whether grazing intensity is too high or too low, and to move the stock before vegetation degradation becomes a problem. Grazing intensity can also be managed as a tool to reduce weed populations where these are palatable, or to reduce total plant material if fire management is an issue. The key to successful management of intensity is careful inspection and the ability to move stock elsewhere before damage occurs.



Duration

Continuous grazing of riparian areas all year round, which is usually the situation when no attempt is made to control stock access, gives vegetation no chance to recover. In this situation, native grasses, herbs and shrubs will eventually die out, and be replaced by unpalatable, weedy species. Riparian areas, where the dominant vegetation is native or sown pastures, also need careful management in order to maintain the preferred botanical composition and feed quality.

Through careful management riparian lands can be used for both economic and environmental gains. Photo CSIRO Ecosystem Services Project.



Reducing costs

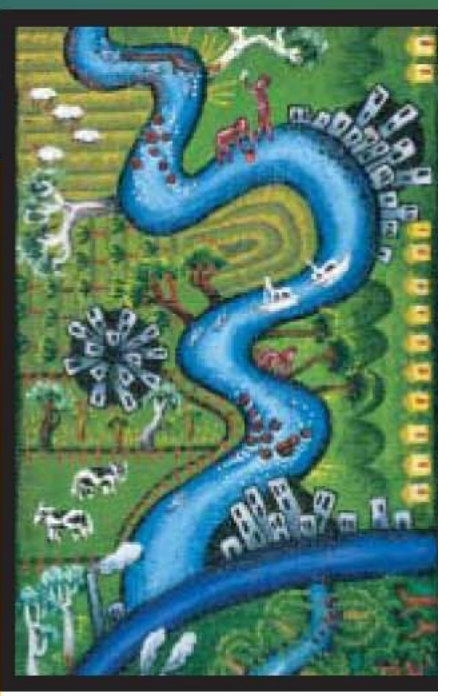
The costs of fencing and providing alternative sources of water are often substantial. Increasingly, individual landholders and groups have access to public assistance to help manage the capital costs involved. This is because many of the benefits of controlling stock along riparian lands are enjoyed by the wider community, as well as the landholder. The capital cost of effective fencing remains a significant problem, particularly for extensive grazing properties in inland regions. The development of electronic fencing methods may provide a solution to this long-standing problem.

For further information

Wright, D. & Jacobson, T. 2000, *Managing Streamsides: Stock control, fencing and watering options*, Department of Primary Industries Water & Environment, Tasmania.

Askey-Doran, M. 1999. 'Managing stock in the riparian zone' in Price, P. & Lovett, S. *Riparian Land Management Technical Guidelines, Volume Two: On-ground management tools and techniques*, Land & Water Australia, Canberra.

FACT SHEET 6
BACK PAGE



These **Fact Sheets** are grouped according to whether they deal with riparian land, in-stream issues, river contaminants or other matters. They aim to set out the general principles and practices for sound management. Other information that focuses on local conditions and management issues is available from state government agencies, local governments, catchment management authorities, rural industry bodies and community organisations. Together, this information should assist users to understand the key issues in river and riparian management, and enable them to adapt general management principles to their particular situation, and to know where to go for advice specific to local conditions.

Other relevant Fact Sheets

1 Managing riparian land
2 Streambank stability
3 Improving water quality
4 Maintaining in-stream life
5 Riparian habitat for wildlife
7 Managing woody debris in rivers
8 Inland rivers and floodplains
9 Planning for river restoration
10 River flows and blue-green algae
11 Managing phosphorus in catchments

Numbers 1–7 of these Fact Sheets are based on the previous *Riparian Management* series produced in the 1990s. The authors involved in the development of the earlier series were: Michael Askey-Doran, Stuart Bunn, Peter Hairsine, Ian Prosser, Ian Rutherfurd, Brian Finlayson, Ian O'Neill, Chris Gippel and Wendy Tubman.

Further information on river and riparian management can also be found at the Land & Water Australia 'River Landscapes' website.

www.rivers.gov.au

This website provides access to projects, fact sheets, guidelines and other information designed to assist people to better manage river and riparian areas across Australia.

River Landscapes

Edited by Phil Price and Siwan Lovett and produced by Land & Water Australia's National Riparian Lands Research and Development Program.

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Cover illustration from River Landscapes, a painting by Annie Franklin

Design by Angel Ink, Canberra
Printed by Goanna Print, Canberra

Appendix B.8. - Low-Flow Bypass Guide

Fact Sheet

19

Water Affecting Activities

Low Flow By-pass Device

Section 9 Permits – *Water Resources Act 1997*

'A low flow by-pass is a device used to direct low-flows around your dam and back to their normal course of flow.'

The Department of Water, Land and Biodiversity Conservation

Government of South Australia

Low Flow By-pass Device

Section 9 Permits – *Water Resources Act 1997*

Fact Sheet 19

What is a low flow by-pass?

A low flow by-pass is a device used to direct low-flows (sometimes called environmental flows) around your dam and back to their normal course of flow. This device is only a requirement of on-stream dams as these dams are considered to have a greater impact on water dependent ecosystems.

A low flow by-pass will divert water around your dam through a pipe ie PVC. The diameter of the pipe is important as it will determine the volume of water to be diverted. The volume of water to be diverted (in litres/second) is called the threshold flow rate.

Threshold flow rate

This is the volume of water to be diverted around your dam through the low flow by-pass device. It is calculated by multiplying the run-off rate in litres/second by the number of square kilometres of catchment that contribute to the watercourse above the point where the water is diverted.

The run-off rate will vary according to the catchment your dam is located in with the wetter catchments having larger run-off rates. The Department of Water, Land and Biodiversity Conservation will determine the catchment above your dam and calculate the volume of water in litres per second that will need to be diverted.

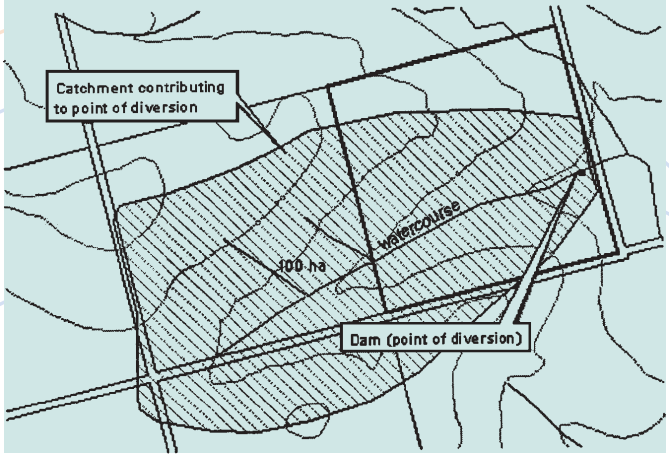
Refer to the adjacent figure for an example of the way the threshold flow rate is calculated.

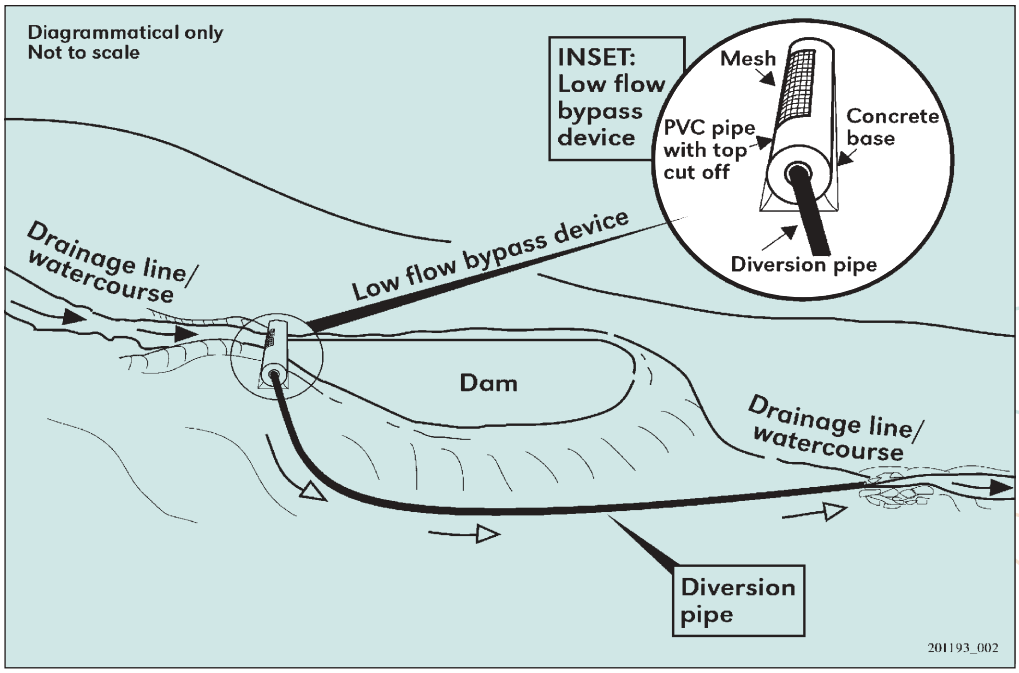
To calculate the threshold flow rate using the map below as an example, the following steps are taken:

1. Work out the number of square kilometers of catchment above the point of diversion (the dam). This means the total catchment contributing water to the dam, not just the area of catchment within the property boundary. This is done by DWLBC using a Geographical Information System. (GIS).
2. In the above example there are 100ha of catchment above the dam which can be converted to 1.0Km^2 .
3. If we assume a threshold flow rate of 2.0 litres per second, per square kilometre of catchment above the dam, the threshold flow rate is as follows:

   1.0km^2 x 2.0litres/second = 2 litres per second

   Therefore any flow of 2.0 litres/second or less needs to be diverted away from the dam and returned back to the same watercourse or drainage path below or downstream of the dam.





Why install a low flow by-pass?

Low flow by-passes are a requirement of a number of water plans because they help provide water for the environment and those people located further down in the catchment. Through the provision of water for the environment, DWLBC is helping to protect water dependent ecosystems.

A water dependent ecosystem is comprised of those parts of the environment whose species composition and natural ecological processes are determined by the permanent or temporary presence of either flowing or standing surface or groundwater.

Examples of water dependent ecosystems are; rivers, springs, wetlands, floodplains, estuaries and riparian vegetation. Sometimes water dependent ecosystems are not so obvious. For example, hyporheic zones are the sand and gravel beds that are saturated below streams and rivers. In dryland streams, most water flows through this zone which may act as a "biological filter" improving water quality and supporting a diverse range of fauna.

Low flow by-pass designs

If you wish to apply for a permit to construct an on-stream dam, you will need to provide the Department with a design of your low flow by-pass.

You will be informed in writing after your application has been received as to the amount of water to be diverted so a low flow by-pass can be designed accordingly by a qualified professional such as an engineer. As an alternative to this, you may choose to accept DWLBC's design by endorsing it with your signature.

An example of a simple and inexpensive diversion device is outlined below. In this example a 6-inch PVC pipe is set in concrete across the diversion channel to the dam. The pipe could be part of a weir, earth bank, concrete bank or sump. The top of the pipe is cut out and covered with mesh. The mesh is designed to keep debris out of the diversion pipe.

A diversion pipe is joined up with PVC pipe to divert flows at or below the threshold flow rate. The diversion pipe's diameter, length and head difference between start and end of pipe will need to be designed to ensure all flows at or below the threshold flow rate are diverted, taking into consideration the friction loss in the pipe.

The outlet of the diversion pipe needs to be located so that the diversion flows do not scour the drainage line or watercourse. Placement of rocks at the outlet may be required.

It is important to note that designs may vary depending on; the catchment area, topography and the lay-out of the dam. Small weirs and diversion channels can form part of other designs, but all aspects of the design should be carefully considered to meet hydraulic design principles.

To ensure that the device continues to divert water, the mesh, pipes or weir should be kept free of any blockages. This requirement that the low flow by-pass is maintained may be a condition of your licence or permit.

Further Information

Department of Water, Land and Biodiversity Conservation
Resource Management Division
Level 1, 25 Grenfell Street

GPO Box 2834
ADELAIDE SA 5001

Contact:
Michelle Lewis
Permit Assessment Officer
Resource Management Division
Phone: 8463 6850
Email: lewis.michellel@saugov.sa.gov.au
Web: www.dwlbc.sa.gov.au

Catchment Water Management Boards

Northern Adelaide and Barossa
Phone: 8285 2033

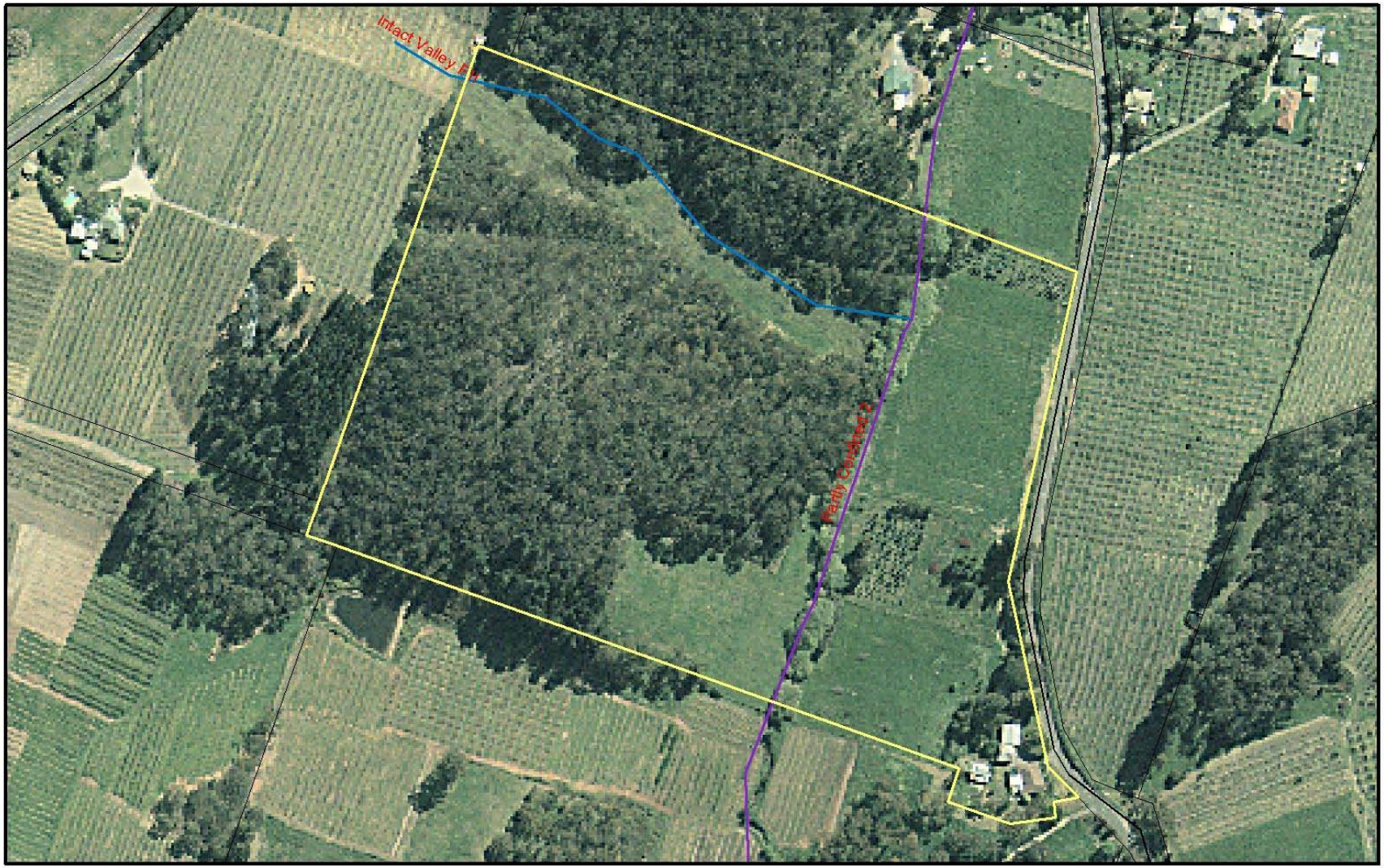
Torrens and Patawalonga
Phone: 8271 9190

Onkaparinga
Phone: 8374 6013

River Murray
Phone: 8582 4477

Northern Adelaide and Barossa Catchment Water Management Board
Torrens Catchment Water Management Board
Patawalonga Catchment Water Management Board
Onkaparinga Catchment Water Management Board
River Murray Catchment Water Management Board

Appendix B.9. Clean Map



Id Number
MBI-005

0 50 100 200 300 400
Meters

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Appendix C - Site Assessment Material

Appendix C.1. - Site Assessment Sheet

SITE ASSESSMENT SHEET

Onkaparinga Catchment Water Management Board

Landholder Name				**Officer(s)**	
Property Location					
Prop. ID No.		**Area ID**		**Date**	

GEOMORPHOLOGY (from GIS database and confirmed in field)

GEOMORPHOLOGY VALUE

River Style ©	Score	River Style ©	Score	River Style ©	Score
Chain of ponds	5	Alluvial continuous 5	3	Partly Confined 2	2
Anabranching Swamp Belt	5	Alluvial continuous 6	3	Partly Confined 3	2
Tidal	5	Steep headwater	3	Cut and fill	1
Gorge	4	Flood out	3	Urban, Quarry, Farm Dam, Reservoir	1
Intact valley fill	3	Confined	2	Constructed watercourse	1
Alluvial continuous 2	3	Partly Confined 1	2	No watercourse	0

River Style © (VALUE)		**Score**	

Comments

GEOMORPHOLOGY THREAT

Bed instability	Score
Intact	**1**
Stable	**2**
Limited instability	**3**
Moderate instability	**4**
Extensive instability	**5**
Bed Aggradation	**5**

Bank Instability	Score
Intact	**1**
Stable	**2**
Limited instability	**3**
Moderate instability	**4**
Extensive instability	**5**

Comments

Bed instability (THREAT)		**Score**	

Bank instability (THREAT)		**Score**	

GEOMORPHOLOGY CONDITION TRAJECTORY

Trajectory	Tick
Getting better	
Stabilising	
Stable	
Getting worse	
Getting worse rapidly	

Comments

HYDROLOGY (from GIS database)

HYDROLOGY VALUE

Degree of hydrological disturbance (season)		
Low Flow (Dec - May)	**High Flow (Jun - Nov)**	**Score**
Low	Low	5
Moderate	Low	4
High	Low	2
High	High	1
No watercourse		0

Comments

Hydrological disturbance (VALUE)	**Low flow**		**High Flow**		**Score**	

HYDROLOGY THREAT

Dams and offtakes	**Score**
Active on stream dam/offtake with no low flow bypass	5
Large inactive on stream dam/offtake with no low flow bypass	4
Small inactive on stream dam/offtake with no low flow bypass	3
On stream dam/offtake with low flow bypass	2
No on stream dams/offtakes	1
No watercourse	0

Comments

Dams/offtake (THREAT)		**Score**	

HYDROLOGY TRAJECTORY

Trajectory	**Tick**
Continued dam/offtake development likely upstream	
Stable but high impact on low flows	
Stable but moderate impact on low flows	
Stable but low impact on low flows	
Dam/offtake development upstream unlikely	

Comments

REMNANT VEGETATION

REMNANT VEGETATION VALUE

Conservation significance		**Score**
Very High	Project Site is predominantly comprised of a veg association that is classed as Vulnerable or Endangered, and known to contain species of conservation significance	5
High	Project Site is predominantly comprised of a veg association that is classed as Uncommon, and known to contain species of conservation significance	4
Moderate	Project Site is predominantly comprised of a veg association that is classed as Common, and known to contain species of conservation significance	3
Moderate	Project Site is predominantly comprised of a veg association that is classed as Common, and may contain species of conservation significance	2
Low	Project Site is predominantly comprised of a veg association that is classed as Common, and appears to contain no species of conservation significance	1
Very Low	So little remnant vegetation remaining on Project Site that Pre European Veg Association cannot be considered extant on the site	0

Comments

Conservation significance (VALUE)		**Score**	

Remnant Vegetation Condition			
Category	**Description**	**Cover (%)**	**Score**
Completely Intact	Dense understorey, very little or no clear ground. Canopy completely intact.	>80	5
Mostly Intact	Medium understorey however some bare ground. Canopy cover is close to complete.	60 - 80	4
Slightly Degraded	Very little understorey. Generally good canopy cover.	40 - 60	3
Moderately Degraded	No understorey. Canopy cover around 50%. Usually in form of group of remnant trees.	20 - 40	2
Very Degraded	Scattered remnant vegetation, usually in form of remnant eucalypts over herbaceous grasses (paddock). Canopy discontinuous.	<20	1
Completely Degraded	No, or very little remnant vegetation	0	0

Comments

Condition Category (VALUE)		**Score**	

Landscape Connectivity		
Category	**Description**	**Score**
Continuous	Project Site highly connected, directly buffering or is contained within a significant (>10Ha) remnant block.	5
Almost Continuous	Project Site highly connected, directly buffering or is contained within a significant (>1<10Ha) remnant block.	4
Partly Fragmented	Project Site of >1Ha functionally linked (ie not more than 100m from) a significant remnant block (>1Ha).	3
Fragmented	Project Site of <1Ha functionally linked (ie not more than 100m from) a significant remnant block (>1Ha).	2
Highly Fragmented	Project Site of >1Ha NOT functionally linked (ie more than 500m from) a significant remnant block (>1Ha).	1
None	Project Site of <1Ha NOT functionally linked (ie more than 500m from) a significant remnant block (>1Ha).	0

Comments

Landscape Connectivity (VALUE)		**Score**	

REMNANT VEGETATION THREATS

Patch Size	**Score**
< 1	5
1 to 3	4
3 to 5	3
5 to 10	2
> 10	1
No vegetation	0

Comments

Patch Size (THREAT)		**Score**	

Weed % Cover	Score
Low cover or not many 1-10 individuals <10%	1
Any number of individuals covering 10 – 25% of area	2
Any number of individuals covering 26 –50% of area	3
Any number of individuals covering 51 – 75% of area	4
Covering more than 75% of the area	5

Comments

Weed % Cover (THREAT)		Score	

Invasive Weeds Presence				
Common Name	**Scientific Name**	**Score**	**Proclaimed**	**Score**
African Boxthorn	*Lycium ferocissimum*	3	Yes	
Blackberry	*Rubus species*	4	Yes	
Boneseed	*Chrysanthemoides mon.*	4	Yes	
Broad-leaved Cotton Bush	*Asclepias rotundifolia*	2	No	
Cape Broom	*Genista monspessulana*	4	Yes	
English Broom	*Cytisus scoparius*	4	Yes	
Erica	*Erica species*	4	No	
Gorse	*Ulex europaeus*	4	Yes	
Olive	*Olea europaea*	4	Yes	
Pittosporum	*Pittosporum undulatum*	3	No	
Radiata Pine	*Pinus radiata*	3	No	
Wattles	*Acacia sp*	2	No	
Willow	*Salix sp*	3	No	
Ash, Popular, Elm	*Fraxinus sp etc*	2	No	
African Daisy	*Senecio pterophorus*	3	No	
Cape Weed	*Arctotheca calendula*	1	No	
Salvation Jane	*Echium plantagineum*	3	Yes	
Bulbil Watsonia	*Watsonia*	3	Yes	
Monadenia	*Monadenia bracteata*	4	Yes	
Bridal Creeper / Veil	*Myrsiphyllum sp*	4	Yes	
Periwinkle	*Vinca major*	3	No	
Fountain Grass	*Pennisetum macrourum*	3	Yes	
Phallaris	*Phallaris sp*	4	No	
Exotic grasses	*Various species*	3	No	
			Sum score	

Comments

Normalised Score	
Score	**Sum Score**
1	<10
2	10 to 17
3	18 to 24
4	25 to 29
5	>29

Score (THREAT)	

Controlling proclaimed plants must form part of Site Action Plan

Grazing Pressure	Description	Score
No grazing	No loss of foliage due to grazing	1
Lightly grazed	There is some loss of foliage due to grazing, and/or broken branches, but the plant essentially retains its natural growth form.	2
Moderately grazed	There is more obvious loss of foliage due to grazing, and/or broken branches, but the plant essentially retains its natural growth form.	3
Heavily grazed	There is obvious loss of foliage OR the plant's height is stunted due to grazing OR there is an obvious browse line. In some species, epicormic shoots may be present (e.g. reshooting foliage from the woody stems).	4
Severely grazed	The plant is grazed back severely, with little foliage remaining, OR plant has been severely physically damaged due to broken/crushed stems or branches.	5

Grazing Pressure (THREAT)		Score	

Comments

REMNANT VEGETATION TRAJECTORY

Trajectory	Tick
Existing vegetation condition stable - good reruitment	
Existing vegetation under some pressure - some recruitment	
Existing vegetation under moderate pressure - no recruitment	
Existing vegetation under strong pressure - no recruitment	

Notes

Area	Actions	Activities	Description

Action	Activity				
Stock exclusion	Fencing	Gates	Stock crossings		Stock watering points
Exotic tree control	Cut and swab	Kill in-situ			
Revegetation	Site preparation	Plant supply	Planting	Plant aftercare	Install tree guards
Weed control (in remnant vegetation)	Brush cutting	Physical removal	Targeted chemical application		
Dam modification	Dam removal	Install low flow bypass			
Watercourse bed erosion control	Small scale structures	Revegetation			
Watercourse bank erosion control	Small scale structures	Revegetation			

Appendix C.2. - Catchment care Officer Guidelines

Catchment Care Tender Trial

Guidelines for completion of the Site Assessment Sheet

Onkaparinga Catchment Water Management Board

Introduction

This document provides information to assist with the completion of the Site Assessment Sheets that form part of the Catchment Care Tender trial.

Geomorphology

Geomorphology Value

Where available, the River Style © is identified on the property aerial photograph. You should attempt to confirm the River Style © by comparing with the description presented in the booklet "Mt Lofty Ranges Watercourse Priority Setting Project – Geomorphic Condition Assessment". Similarly, us ethe booklet to identify the River Style © if not identified on the aerial photograph.

River Style ©	Score	River Style ©	Score
Chain of ponds	5	Steep headwater	3
Anabranching Swamp Belt	5	Flood out	3
Tidal	5	Confined	2
Gorge	4	Partly Confined 1	2
Intact valley fill	3	Partly Confined 2	2
Alluvial continuous 2	3	Partly Confined 3	2
Alluvial continuous 5	3	Cut and fill	1
Alluvial continuous 6	3	Urban, Quarry, Farm Dam, Reservoir	1
		No watercourse	0

Geomorphology Threat

Bed Stability	Score	Description
Intact	1	The watercourse is intact, with natural rates of erosion observed.
Stable	2	Un-natural rates of erosion may have been experienced, but the rates of erosion are now stable.
Limited instability	3	Bed contains erosion head(s) less than 0.5m in height and which may be partly stabilised/confined by vegetation, instream debris, or partly armoured by rock. Erosion head(s) may be travelling towards a closely located confining feature (such as rock).
Moderate instability	4	Bed contains erosion head(s) 0.5m to 1m in height. Features that may contain erosion head movement are not evident.
Extensive instability	5	Bed contains erosion head(s) greater than 1m in height. Features that may contain erosion head movement are not evident.
Bed Aggradation	5	Bed level is rising and/or pools are filling due to excessive sediment loads to reach.

Bank Instability	Score	Description
Intact	1	The watercourse is intact, with natural rates of erosion observed.
Stable	2	Un-natural rates of erosion may have been experienced, but the rates of erosion are now stable.
Limited instability	3	Bank instability affects less than 25% of proposed project area and/or bank instability is less than 0.5m high (vertically).
Moderate instability	4	Bank instability affects less than 25% to 50 %of proposed project area and/or bank instability is 0.5m to 1m high (vertically).
Extensive instability	5	Bank instability affects more than 50 %of proposed project area and/or bank instability is greater than 1m high (vertically).

Geomorphology Condition Trajectory

Trajectory	Description
Getting better	Un-natural bed and bank erosion has climaxed and the reach is recovering.
Stabilising	Un-natural bed and bank erosion has climaxed or is near climax and the reach is entering a period of stability.
Stable	Bed and bank erosion at the site is occurring at a natural rate, or un-natural bed and bed erosion has climaxed and erosion has stabilised.
Getting worse	Un-natural bed and bank erosion is still occurring. Some fresh soil from banks can be seen at the slope toe. Tension cracks in the bank slope and at bank top can be observed.
Getting worse rapidly	Un-natural bed and bank erosion is still occurring. Fresh soil from banks can be seen at the slope toe at numerous locations. Numerous tension cracks in the bank slope and at bank top can be observed.

HYDROLOGY

Hydrology Value

The Hydrology Value score is based on an assessment of the disturbance to watercourse flow at a subcatchment level. Disturbance is calculated by determining the proportion of flow trapped in dams up stream of the reach under assessment. The score is identified on the property aerial photograph.

Degree of hydrological disturbance (season)		
Low Flow (Dec - May)	**High Flow (Jun - Nov)**	**Score**
Low	Low	5
Moderate	Low	3
High	Low	2
High	High	1
No watercourse		0

As there are likely to be new dams constructed on some watercourses since aerial photography was taken, you should attempt to confirm the disturbance in the field. This will

be a subjective assessment based on the observation of new dams on the property being assessed, or immediately up stream on adjoining properties.

Where a new dam is observed, the disturbance may be upgraded under either or both of the flow seasons. As a guide:

- a new small (<2ML) dam with no low flow bypass can increase the hydrological disturbance by one category (eg Low/Low to Moderate /Low);
- a new moderate (2ML to 5ML) dam with no low flow bypass can increase the hydrological disturbance by two categories(eg Low/Low to High/Low); or
- a new large (>5ML) dam with no low flow bypass can increase the hydrological disturbance by three categories (eg Low/Low to High/High).

Hydrology Threat

Dams and offtakes	Score	Description
Active on stream dam/offtake with no low flow bypass	5	Dam located on stream, or there is an in stream off-take (diversion or pump) for off stream dam. Dam has no low flow bypass and is actively used for agricultural and domestic purposes.
Large inactive on stream dam/offtake with no low flow bypass	4	Greater than 2ML dam located on stream, or in stream off-take (diversion or pump) for off stream >2ML dam. Dam is not actively used, but offers aesthetic or fire fighting value.
Small inactive on stream dam/offtake with no low flow bypass	3	Less than 2ML dam located on stream, or there is an in stream off-take (diversion or pump) for off stream <2ML dam. Dam is not actively used, but offers aesthetic or fire fighting value.
On stream dam/offtake with low flow bypass	2	Dam located on stream, or there is an in stream off-take (diversion or pump) for off stream dam. Dam has low flow bypass.
No on stream dams/offtakes	1	No on stream dams/offtakes
No watercourse	0	No watercourse

Hydrology Trajectory

Trajectory	Description
Continued dam/offtake development likely upstream	There is good opportunity for more dams to be constructed up stream.
Stable but high impact on low flows	There is some opportunity for more dams to be constructed up stream, although there has been high impact on low flows.
Stable but moderate impact on low flows	There is some opportunity for more dams to be constructed up stream, although there has been moderate impact on low flows.
Stable but low impact on low flows	There is some opportunity for more dams to be constructed up stream, although there has been low impact on low flows.
Dam/offtake development upstream unlikely	Construction of dams upstream unlikely. For example, site is located high up on first order watercourse, subcatchment upstream of site is public land/conservation.

REMNANT VEGETATION

Remnant Vegetation Condition			
Category	**Description**	**Cover (%)**	**Score**
Dense	Dense understorey, very little or no clear ground. Canopy completely intact.	>80	5
Medium Dense	Medium understorey however some bare ground. Canopy cover is close to complete.	60 - 80	4
Medium	Very little understorey. Generally good canopy cover.	40 - 60	3
Sparse	No understorey. Canopy cover around 50%. Usually in form of group of remnant trees.	20 - 40	2
Very Sparse	No remnant vegetation to scattered remnant vegetation, usually in form of remnant eucalypts over herbaceous grasses (paddock). Canopy discontinuous.	<20	1
None	No remnant vegetation	0	0

Appendix C.3. - Geomorphology Guidelines

Mt Lofty Ranges Watercourse Priority Setting Project – Geomorphic Condition Assessment

Job 36002023

November 2002

APPROVED	CHECKED
DATE	DATE

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Mt Lofty Ranges Watercourse Priority Setting Project

Job 36002023

Contents

Introduction

The document provides a set of guidelines and reference conditions for field assessors of geomorphic condition in the streams of the Mt Lofty Ranges. For each stream category found there are set of questions to be answered to describe its condition, the trajectory of that condition and assess threats to that condition. This document provides:

- An understanding of the characteristics of each of the stream categories (comparable to River Styles®) that have been found in the Mt Lofty Ranges. The elements within the River Styles® framework, on which the categorization was based, have been modified to more aptly describe the geomorphic character and behaviour of the region.

- A guiding train of thought when considering the condition of a particular stream category and what controls any potential change from an intact (geomorphic) state.

- A more detailed perspective on the traditional bed and banks elements of condition assessments applicable to each of the stream types found.

- A set of questions to describe the site and develop thinking for that stream type that help to answer the subsequent questions about risks and threats, condition trajectory and recovery potential.

Principles

- Compare like with like – style, order, geology, hydrology, vegetation.
- Compare against intact or reference state – what should or should not be there.

Process

- Assess capacity for adjustment (or susceptibility to change) – inherent with style.
- Determine changes to boundary conditions from intact state (mostly desktop, using results from vegetation and hydrology assessments).
- Record stream condition characteristics within context of style, examples:
    - Gorge; presence and stabilisation of sediment accumulations indicates change from intact state.
    - Channelised fill where vegetation and hydrology have altered indicates probable change from intact state due to Post European influences (Intact being Intact Valley Fill, Chain of Ponds/Freshwater Meadow or Floodout).
    - Meandering fine grained stream with smothered sand bed indicates excess bedload sediment for Mt Lofty Ranges streams.

- Record bank stability and apparent rates of erosion/deposition processes. Record reasons for bank stability, eg. Mud drape, bedrock, sand, etc. and vegetation. Record location on bend – inside, outside or straight.
- Record current bed trend – stable, aggradation or degradation.
- Record reasons for bed trend – e.g. Incision due to channelisation. Armouring or bedrock. Excess sediment inputs.
- Is geomorphic change at site reversible? Eg. Channelisation of valley fill. Consider land use aspirations and compatible vegetation associations, especially where stream is whole valley floor and sediment supply.

Description of Stream Categories

The following descriptions of stream categories should be read in conjunction with the River Styles® stream categorisation information provided in Appendix A.

STREAM CATEGORY: Intact Valley Fill

Description of Stream Category

Valley setting can be confined or broad floodplain. No channel, generally featureless valley floor, comprised of mud / sand, generally swampy, may contain freshwater meadows.

Relatively broad valley – 2nd order (cleared vegetation)

More confined valley floor – 2nd order (modified vegetation)

Near intact broad valley floor, swampy fill (slightly modified vegetation)

STREAM CATEGORY: Cut and Fill (Channelised Fill or Cut Phase)

Description of Stream Category

Valley setting can be confined or alluvial. Featureless swampy valley floor/floodplain (as per intact valley fill). Channel incision (gully erosion) has created some degree of spatial and temporal continuity of channel. Incised channel is laterally inactive and low sinuosity, may have or be developing benches. A low flow inset channel may be developing features such as pools (possibly chain of ponds). Macrophytes may completely cover the bed. Channel likely to have incised to bedrock or resistant stratigraphy.

Near intact valley fill

Discontinuous scours, small erosion heads, channel becoming continuous

Box Channel, continuous (excavated)

Recovering inset features

Recovering inset features and infilling

STREAM CATEGORY: Chain of Ponds

Description of Stream Category

Valley setting can be confined or alluvial. Ponds separated by valley fill that may contain a swampy depression or freshwater meadow, generally featureless floodplain. Valley floor comprised of mud / sand. Ponds may take a meandering path, be longitudinal or round.

Left to right (aerial image): intact chain of ponds (1st order), abandoned chain of ponds and channelised chain of ponds recovering inset features (4th order), chain of ponds currently undergoing channelisation (2nd and 3rd order)

STREAM CATEGORY: Floodout

Description of Stream Category

Valley setting alluvial. Upstream channel disperses onto floodplain, possibly through an alluvial fan deposit. Valley floor comprised of mud / sand, often swampy as per valley fill. Floodout generally occurs at decrease in gradient and/or where stream debouches from a much more confined valley.

Excavated from floodout area at base of hill slope to a roadside table-drain

STREAM CATEGORY: Anabranching Swamp Belt

Description of Stream Category

The valley is relatively broad and low gradient. There are multiple flow paths that generally don't have continuous well defined channels. The flow paths are similar to that of chain of ponds, open water ponds being separated by poorly defined flow paths. These poorly defined flow paths interchange in an anabranching manner. Sediments are fine grained, sediment input and transport rates are low.

STREAM CATEGORY: Steep Headwater

Description of Stream Category

Generally a 1st or 2nd order stream that is steep and has very little accumulated sediment in the valley floor. Typically a 'V' notch bedrock valley floor.

STREAM CATEGORY: Gorge

Description of Stream Category

Bedrock valley without floodplain units in the valley floor. Geomorphic units in the channel may include cascades, rapids, pools, boulder bars, islands and occasional waterfalls. The bed material texture is bedrock, boulders and gravel.

STREAM CATEGORY: Confined

Description of Stream Category

Confined valley setting with occasional, small, narrow, discontinuous floodplain pockets. Stream may be steep or moderate gradient. Geomorphic units in the channel may include bedrock steps, cascades, plunge pools, pools, riffles, glides / runs, bank attached and mid-channel bars. The bed material is likely to be bedrock, cobbles or gravel. Banks are likely to have sediment ranging from course to fine.

2nd order example with soil cover

6th order, higher energy environment

3rd order higher energy environment

STREAM CATEGORY: Partly Confined 1

Description of Stream Category

The valley is relatively straight or irregular. The channel meanders within the valley floor, largely independent of valley alignment, exhibiting moderate sinuosity and abutting the valley margin for 10-50% of its length. The floodplain is dis/semi-continuous. Geomorphic units in the channel include pools, riffles, benches, point bars, rarely lateral or longitudinal bars. The bed material can be gravel or fine grained, banks can be fine or coarse sediment depending on valley setting.

Channel meanders independent of valley alignment

STREAM CATEGORY: Partly Confined 2

Description of Stream Category

The valley is relatively straight or irregular and the valley planform controls the channel planform. The channel has low sinuosity and abuts the valley margin for 10 – 50% of its length. The floodplain is discontinuous and may be terraced. Geomorphic units in the channel include pools, riffles, benches, point bars, rarely lateral or longitudinal bars. The bed material is likely to be gravels, banks likely to be layered fine and coarse sediment.

6th order stream in deep valley fill, channel planform controlled by valley planform

5th order, broader floodplain, vertical and lateral bedrock controls

STREAM CATEGORY: Partly Confined 3

Description of Stream Category

The valley configuration is irregular or sinuous, often spurred. The floodplain is likely to be discontinuous arcuate and often stripped with terraces and bedrock/valley margin controlled. The planform of the channel is controlled by the valley planform, it has low sinuosity with 50 – 90% of the channel abutting the valley margin. Geomorphic units in the channel include compound point bars, point benches, chute channels, benches, concave pools, riffles and bedrock steps / outcrops. The bed material is dominated by bedrock, gravels and coarser sediment.

STREAM CATEGORY: Alluvial Continuous 1 (Low to moderate sinuosity fine grained)

Description of Stream Category

The valley is broad relative to the stream, valley margin impingements by the channel are rare. The floodplain is likely to be flat and contain few geomorphic units such as terraces and flood channels. The channel is generally laterally stable being comprised of mixed clay, silt and sand. Geomorphic units in the channel include benches, pools and runs.

STREAM CATEGORY: Alluvial Continuous 2 (Low to moderate sinuosity gravel bed)

Description of Stream Category

The valley is broad relative to the stream, valley margin impingements by the channel are rare. The floodplain is likely to contain few geomorphic units such as terraces and flood channels. The channel exhibits some lateral activity, cut bank erosion may be common. The bed is often armoured with gravel and occasional bedrock impingements may occur. Geomorphic units in the channel include benches, pools, runs, riffles, lateral bars and longitudinal bars. Reach may have evolved from Cut and Fill.

STREAM CATEGORY: Alluvial Continuous 4 (Meandering fine grained)

Description of Stream Category

The valley is broad relative to the stream, valley margin impingements by the channel are rare. The floodplain is likely to contain few geomorphic units such as terraces, cut offs and flood channels. The channel exhibits low rates of lateral activity. The bed and banks are comprised of clay, silt and sand and are likely to be stable. Geomorphic units in the channel include benches, pools and runs.

STREAM CATEGORY: Alluvial Continuous 5 (Meandering Sand Bed)

Description of Stream Category

The valley is broad relative to the stream, valley margin impingements by the channel are rare. The floodplain is likely to contain few geomorphic units such as terraces, cut offs and flood channels. The channel exhibits moderate rates of lateral activity due to sinuous planform. The bed and banks are comprised of sand and are likely to be stable if vegetated. Geomorphic units in the channel include benches, bars and runs.

Condition Assessment Guidelines

Scope for Adjustment

The capacity of a stream to undergo adjustment in response to changed land use conditions and other human induced changes in the stream or catchment gives an indication of the potential for a change (from intact or reference state) in geomorphic condition. The major controls on adjustment of a stream are bedrock, sediment, gradient, vegetation and hydrology. The following table gives a capacity for adjustment of each stream category found in the Mt Lofty Ranges.

Stream Category	Capacity for Adjustment
Steep Headwater	Very low
Gorge	Very low
Confined	Low
Partly Confined 1	Low to High
Partly Confined 2	Low to High
Partly Confined 3	Low
Alluvial Continuous 1	Moderate
Alluvial Continuous 2	Low to High
Alluvial Continuous 4	Low to High
Alluvial Continuous 5	Moderate to High
Anabranching Swamp Belt	Moderate to High
Intact Valley Fill	Low to High
Chain of Ponds	Moderate to High
Floodout	Moderate to High
Channelised Fill	High

Examples of this are:

Steep Headwater – has a very low capacity for adjustment owing to the streambed and banks generally being bedrock, which may have a thin cover of colluvium or alluvium in transport. Steep headwater streams are generally 1st or 2nd order, hence have small catchment areas above them, which limits the amount of sediment that will enter the zone and the steep gradient will ensure all sediment is transported through.

Valley Fills – often have a high potential for adjustment (channelisation) under altered land use conditions.

Note: it should be remembered that valley fills are a subset of cut and fill streams which may, over space and time, undergo incision and aggradation through a combination of events not related to human land use change.

Partly Confined 1 and 2 – while having some lateral bedrock controls and possibly vertical bedrock controls, many partly confined streams can undergo significant incision (if depth of alluvium exists) and subsequent bank erosion.

Morphologic Diversity

One of the key elements contributing to the type, abundance and diversity of aquatic organisms in a stream is habitat. The foundation of that habitat is the geometry of the stream. The basic components of stream geometry are represented by planform, cross section shape and longitudinal profile, these elements describe the morphologic diversity of the stream.

Morphologic diversity varies across the different categories of streams. It is dependent on the controls that have formed that stream such as; sediment, gradient, hydrology, vegetation and bedrock.

When undertaking the condition assessment morphologic diversity should be compared to the intact (or reference) state of the stream. Some streams will naturally have a low morphologic diversity, i.e. Relatively uniform cross section, few geomorphic units, little variation in depth of longitudinal section. Valley fills will often naturally have low morphologic diversity, as they are basically a uniform swale. Confined (including partly confined) streams on the other hand may have a high morphologic diversity, being comprised of many geomorphic units, exhibiting a diverse cross section and long section.

It should be remembered that because a stream naturally has a low morphologic diversity, does not mean that its intact state is any less valuable, it's just different and so will be the ecosystem that has evolved on that stream category. Discontinuous alluvial systems are generally naturally swampy low energy environments by comparison with confined streams being higher energy environments.

Stream Category	Morphologic diversity
Steep Headwater	Low to High
Gorge	Moderate to High
Confined	Moderate to High
Partly Confined 1	Moderate
Partly Confined 2	Moderate to High
Partly Confined 3	Moderate to High
Alluvial Continuous 1	Moderate
Alluvial Continuous 2	Moderate to High
Alluvial Continuous 4	Moderate
Alluvial Continuous 5	Low to High
Anabranching Swamp Belt	Moderate
Intact Valley Fill	Low
Chain of Ponds	Low to Moderate
Floodout	Low to Moderate
Channelised Fill	Low to Moderate

Bank Stability

The assessment of bank stability needs to consider the following:

- Does bank erosion occur naturally in this stream category, at this planform location? e.g. Bank on outside of bend.
- At what rate do banks erode in that category of stream?
- If bank erosion is occurring, is it at the natural rate?
- Is the bank erosion as a consequence of lateral migration or incision?
- Vegetation association on top of bank and on bank face.
- If this stream is an intact discontinuous alluvial system it generally **doesn't have banks** (except in ponds).

What is current bank stability?

- Erosion.
- Deposition.
- Stable.

Apparent rate of process: - i.e. Rapid erosion or smothering with sediment.

The geomorphic assessment undertaken to date has revealed there are few active laterally accreting streams in the Mt Lofty Ranges. This is due to geological influences. Most streams are vertically accreting and the dominant mechanism of change post European settlement has been incision (see Bed Stability). Therefore bank erosion is not a significant process in the Mt Lofty Ranges. Where bank erosion does occur it is generally as a response to incision.

Factors affecting bank (in)stability:

- Bedrock.
- Sediment type.
- Channelisation.
- Vegetation.
- Planform location.
- Mud drape.
- Excess sediment loads.
- Sediment starvation.

Bed Stability

The majority of streams of the Mt Lofty Ranges are dominated by vertical processes, very few are laterally active streams. Most of the valley floors have undergone accretion in the late Holocene.

Current Bed Trend:

- Stable.
- Degrading.
- Aggrading.

Apparent rate of change in bed, i.e. active or not

Factors affecting bed (in)stability:

- Incision due to catchment adjustments.
- Incision due to downstream channelisation.
- Bedrock.
- Armouring.

- Vegetation.
- Excess Sediment Inputs.
- Woody debris.
- Artificial Structures.

Behaviour / Change of Stream Category

Many streams in the narrower valleys cross the definitions of Partly Confined (1 or 2) and Cut and Fill. The channel that exists in these may be cut phase, but behaves like a partly confined stream, except that there is very little lateral migration of the channel. The channel incises to bedrock controls or until armoured bed, develops an inset low flow, which may meander in the channel, benches and bars and is probably going to fill again if vegetation colonises the channel.

Examples of sites that have incised and re-filled in historic times are those where dense willow planting/colonisation has occurred.

Threats to Physical Condition

Nature of Threat

Downstream of the Site:

- Headward erosion, channel bed incision
- Structures with hydraulic and geomorphic influence that may either pond, disperse or concentrate flows
- Active lateral migration

Upstream of Site:

- Excess sediment loads
- Active and/or historic incision
- Active and/or historic bank erosion
- Active and/or historic lateral migration
- Structures with hydraulic and geomorphic influence that may alter sediment loads, disperse or concentrate flows

Extent of 'offsite' threat assessments

Downstream threat assessment will generally continue until a control is encountered that diminishes the possibility of that threatening process or feature impacting on the site. For example, downstream valley controls such as vertical or lateral bedrock limit the possibility for headward erosion or lateral migration. In general, downstream assessment of threats need not extend beyond 1km of the site.

Upstream threat assessment will predominantly be involved around identifying imminent influences on sediment balance within the reach being assessed. Increased sediment inputs can arise from active erosion upstream. Conversely sediment starvation effects can arise from structures such as impoundments. A degree of pragmatism needs to be applied when searching for these threats. Imminent sediment threats would be excess bedload or active erosion immediately upstream ie. within 1km. Most impoundments are mapped, therefore the location and proximity should be known before field assessment

Geomorphic Condition Assessment Pro Forma

Method of Project Sheet Development

Condition assessment pro-forma have been developed to obtain information relevant to each of the stream categories identified (see Table 1) in the Mt Lofty Ranges catchments. Example answers are provided in Appendix B. The categorization of the streams and these condition assessment pro-forma have been developed by adapting the River Styles® framework for each of the types of streams found in the Mt Lofty Ranges.

Table One – Stream Categories found in the Mt Lofty Ranges

Code	Description	
1	Cut and Fill	Intact Valley Fill
2		Channelised Fill (Cut Phase)
10		Chain of Ponds
22		Floodout
11	Anabranching Swamp Belt	
12	Steep Headwater	
21	Gorge	
3	Confined	
4	Partly Confined 1	
5	Partly Confined 2	
6	Partly Confined 3	
13	Low - Moderate sinuosity fine grained (AC 1)	
7	Low - Moderate sinuosity gravel bed (AC 2)	
15	Meandering fine grained (AC 4)	
8	Meandering sand bed (AC 5)	
23	Tidal	
95-99	Modified	

A descriptive condition information collection sheet has been developed to collect information about each stream type to be used in field assessment. All streams have been classified using aerial photographs and ground truthing exercises. The appropriate questions should be filled in for each site, as indicated on the field sheet, as ratings are different within each Stream Type.

A planform and cross sectional sketch should be completed for a functional set, e.g. meander wavelength, pool-riffle sequence, etc. at the site assessed. Dimensions and geomorphic units should be detailed on the sketch.

Stream Type			
	☐ CF – Channelised Fill	☐ SH – Steep Headwater	☐ PC3 – Partly Confined 3
	☐ CP – Chain of Ponds	☐ G - Gorge	☐ AC1 – Alluvial Continuous 1
	☐ F - Floodout	☐ C - Confined	☐ AC2 – Alluvial Continuous 2
	☐ IVF – Intact Valley Fill	☐ PC1- Partly Confined 1	☐ AC4 – Alluvial Continuous 4
	☐ ASB – Anabranching Swamp Belt	☐ PC2 – Partly Confined 2	☐ AC5 – Alluvial Continuous 5

Site Details	Date		Reach No/Section (id)	
	Collected By:		Watercourse/ Catchment	

	Valley Setting Features					
VS1	Describe the topographic and surficial geologic features of the surrounding area.					
All Stream Types						
VS2	Is the reach in a narrow confined valley or broader floodplain? (Quantitative measure)					
IVF CF CP ASB						
VS3	Is there any evidence of bedrock/valley control on the stream?	Yes		No		Describe Below
IVF CF CP F AC1 AC2 AC4 AC5 ASB						
VS4	Describe the nature and extent of bedrock/valley margin horizontal and/or vertical control on the stream?					
CF SH G C PC1 PC2 PC3						

	Valley Floor Features					
VF1	Are there any geomorphic units on the valley floor?			Comments		
IVF CF CP F ASB		Benches				
		Terraces				
		Freshwater Meadow				
		Chain of Ponds				
VF2	Is there evidence of scour, gullying or erosion in the valley floor?					Scour
						Gullying
	If so, what is its extent? Comment below.					Other Erosion
IVF CF CP F ASB						
VF3	Describe the dominant sediment types in the valley floor.					
IVF CF CP F ASB						
VF4	Describe the planform and geometry of the ponds and connecting flow paths/floodout/stream. Show on sketch.					
CP F ASB						

	Floodplain Features					
FF1	What are the geomorphological features of the floodplain? Comments					
C PC1 PC2 PC3 AC1 AC2 AC4 AC5		Abandoned Channel				
		Flood Channel				
		Back Swamps				
		Terraces				
FF2	Is there evidence of recent erosion/deposition in the floodplain? If so, what is its extent?					Erosion / Deposition
C PC1 PC2 PC3 AC1 AC2 AC4 AC5						
FF3	Describe the dominant sediment types in the floodplain.					
C PC1 PC2 PC3 AC1 AC2 AC4 AC5						
FF4	Is sediment stored in		or transferred through		the floodplain?	
C PC1 PC2 PC3						

	Channel Features					
CF1	Describe geomorphological units & structure of the channel					
CF SH G C PC1 PC2 PC3 AC1 AC2 AC4 AC5		Inset Low Flow Channel		Pool		Lateral Bars
		Benches		Riffle		Point Bars
		Chain of Ponds		Glide/Run		Bedrock Steps
		Terraces		Longitudinal Bars		Island
	Are any of these features vegetated? Show on sketch					
	Comments					
CF2	Channel geometry –What are the dimensions of the high flowand low flow channels? Estimate slope of the channel in the reach. Show features on sketch.					
CF SH G C PC1 PC2 PC3 AC1 AC2 AC4 AC5	Comments					
	What is the shape of the channel?		Compound		Asymmetrical	
			Irregular		Symmetrical	
CF3	Describe the dominant sediment types in the bed. Is the bed		armoured?			
CF G C PC1 PC2 PC3 AC1			bedrock controlled?			
CF4	What are the dominant sediment types in the banks? Any stratigraphic sequence evidence?					
CF C PC1 PC2 PC3						

CF5	Bed stability						
CF C PC1 PC2 PC3 AC1 AC2 AC4 AC5	Is the bed		Stable	Is there evidence of			
			Experiencing limited instability			Incision	
			Experiencing extensive instability			Infilling	
	Does the bed impinge on bedrock?						
	Comments						

CF6	Left Bank		Right Bank	
CF C PC1 PC2 PC3 AC1 AC2 AC4 AC5		Stable		Stable
		Experiencing limited erosion		Experiencing limited erosion
		Experiencing moderate erosion		Experiencing moderate erosion
		Experiencing extensive erosion		Experiencing extensive erosion
	Does the L bank impinge on bedrock?		Does the R bank impinge on bedrock?	
	Comments			

CF7	What is the contemporary behaviour of the cut phase?						
CF	Alluvial continuous		Partly Confined	1	2	3	

CF8	How recent is incision? What age is vegetation on benches if present?
CF	

	Land Use and Vegetation Influence			
LV1	How does vegetation affect the form of the valley floor and channel?			
All stream types				
LV2	Give an estimate of the Manning's 'n' for the valley floor and the channel			
All stream types				
LV3	What is the land use within and adjacent to the reach?			
All stream types	0101	=Orchards	0201	=Vines
	0203	=Vegetables	0204	=Floriculture
	0301	=Field Crops	0401	=Forestry Exotic
	0501	=Forestry Native	0601	=Urban Manufacturing
	0701	=Residential Urban & Vacant Allot	1001	=Mining/Extraction
	1101	=Water Body	1201	=Broadscale Grazing
	1401	=Reserve	O	=Other

	Connectivity
C1	Describe the upstream and downstream transitions of the floodout reach.
F	
C2	Has the floodout been channelised and/or incorporated into roadside drainage network?
F	

	Valley Floor Structures		
VFS1	Is there large woody debris or other structural habitat elements? List		
IVF CP F ASB	Is there any scour or deposition associated with such features?		
	Comments		
VFS2	Are there any structures affecting the intact status of the valley fill of the reach?		
IVF CP F ASB			
VFS3	Have any stream rehabilitation works been carried out?		
IVF CP F ASB	Location and description.		

	Instream Structures		
IS1	Is there large woody debris or other structural instream physical habitat? List		
CF CP SH G C PC1 PC2 PC3 AC1 AC2 AC4 AC5 ASB	Is there any scour or deposition associated with such features?		
	Comments		
IS2	Are there any instream structures affecting the geomorphology of the reach?		
CF CP SH G C PC1 PC2 PC3 AC1 AC2 AC4 AC5 ASB			
	What is the stability of the channel adjacent to the structure?		
		Stable (minor scouring only)	
		Moderately unstable (minor erosion)	
		Unstable (extensive scouring or undermining of structure)	
	Comment		
	Is maintenance required on the structure?		

IS3	Have any stream rehabilitation works been carried out?
CF CP SH G C PC1 PC2 PC3 AC1 AC2 AC4 AC5 ASB	Location and description.

	Condition Threat & Risk					
CTR1 All	Capacity for Adjustment:					
		Low		Moderate		High
	Comments:					
CTR2 SH G C PC1 PC2 PC3 AC1 AC2 AC4 AC5 ASB	Stage of Condition Trajectory:					
		Intact		Modified (or now different stream type)		
		Slight Modification		Highly Modified / Degraded		
	Comments:					
CTR3 CF	Stage of Condition Trajectory:					
		Intact Valley Fill		Continuous Box Channel		
		Discontinuous Scours		Compound Continuous Channel (inset low flow)		
		Semi Continuous Enlarging Channel		Infilling		
	Comments:					
	Threats to Physical Condition:					
CTR4 All	Within the Site:					
		Low				
		Moderate				
		High				
CTR5 All	Downstream of the Site:					
		Low				
		Moderate				
		High				
CTR6 All	Upstream of the Site:					
		Low				
		Moderate				
		High				

Photos:	

Site Comments:

Sketch: Include planform and located cross sections with estimated dimensions and labelled geomorphic units.

STREAM CATEGORY: ORIGINAL

Description of Stream Category

Valley-setting features

VS1. Is the valley confined or unconfined? How so? Describe the topography and geology of the surrounding area.

VS2. Is there any evidence of control on the geometry of the stream?

Floodplain features

FF1. What are the geomorphological features of the floodplain? Abandoned channel, anabranch, flood channel, point bar, terraces.

FF2. How has the reach evolved? Is there evidence of significant changes?

FF3. Is there evidence of scour, gullying or erosion in the floodplain? If so, what is its extent?

FF4. What are the dominant sediment types in the floodplain? Clay, silt, sand, gravel, cobbles, boulders, bedrock.

FF5. Is sediment stored in the floodplain? Q. Is sediment transferred through the floodplain?

FF6. Where there is a channel, does the planform appear stable, or has the channel migrated laterally? Are there any potential cut-offs or avulsions? What is the sinuosity of the channel?

FF7. Where there is a channel, is it singular, or multiple?

FF8: How does vegetation affect the form of the floodplain?

FF9. Give an estimate of the Manning's 'n' for the floodplain.

FF10. Is there livestock access to the floodplain?

FF11. What is the land-use adjacent to the reach?

Channel features

CF1. What are the dominant sediment types in the bed? Clay, silt, sand, gravel, cobbles, boulders, bedrock.

CF2. Bed stability – (1) Is the bed: stable, experiencing limited instability or experiencing extensive instability? (2) Is there evidence of deepening or infilling in the bed?

CF3. Bank stability – assess both the left bank and the right bank separately. (1) Is the channel bank stable, or experiencing limited, moderate, extensive or extreme erosion?

CF4. Is sediment stored in (aggrading), transferred through (transportational / storing) or being removed from (incising) the channel?

CF5. Channel features – are there any notable geomorphic features in the channel? Pool, riffle, glide/run, rapid, cascade, waterfall, longitudinal bar, diagonal bar, transverse bar, lateral bar, point bar. Are any of these features vegetated, indicating stability?

CF6. Channel geometry – what is the average depth and width of the channel? Are there any notable exceptions? What are the dimensions of the high flow channel, active channel and the low flow channel? What is the shape of the channel? Compound, Asymmetrical, Symmetrical or Irregular. What is the approximate grade / slope of the channel?

CF7. Give an estimate of the Manning's 'n' for the channel.

CF8: How does vegetation affect the form of the channel?

CF9. Is there livestock access to the channel?

Instream structures

IS1. Is there evidence of any instream physical habitat such as Large Woody Debris? Is there any scour or deposition associated with such features?

IS2. Are there any instream structures affecting the geomorphology of the reach? What is the stability of the channel adjacent to the structure? Stable (minor scouring only), moderately unstable (minor erosion), unstable (extensive scouring or undermining of structure). Is maintenance required on the structure?

IS3. Have any stream rehabilitation works been carried out? Location and description.

Appendix A - River Styles Framework Outline

As noted in **Figure 4.1**, procedures used to identify River Styles vary for each class of valley setting, as differing constraints are imposed on river character and behaviour. In essence, the differentiation of River Styles becomes progressively more complex as capacity for river adjustment increases, and the influence that bedrock exerts on river morphology decreases (i.e. from Confined through Partly-confined to Alluvial valley settings). For this reason, the distinguishing attributes of River Styles are considered separately dependent on the valley setting in which the river occurs. Each River Style within each class of valley setting has a discrete set of distinguishing attributes, based on the combination of the assemblage of geomorphic units, river planform, and bed material texture. In many cases, there may be an overlap in the range of attributes for differing River Styles (e.g. pool-riffle sequences are a common attribute for many River Styles), but there are unique identifying attributes (or combinations of attributes) for each River Style. All endeavours have been undertaken in the development of the River Styles framework to create and maintain an inclusive procedure based on a set of generic criteria. Examples of a River Styles tree and schematic representations of a range of River Styles observed in coastal valleys of NSW are presented in **Figures 4.2** and **4.3**. The distinguishing attributes of these River Styles are outlined in **Tables 4.1 - 4.4**.

Figure 4.1 The River Styles® procedural tree (modified from Brierley et al., 2002)

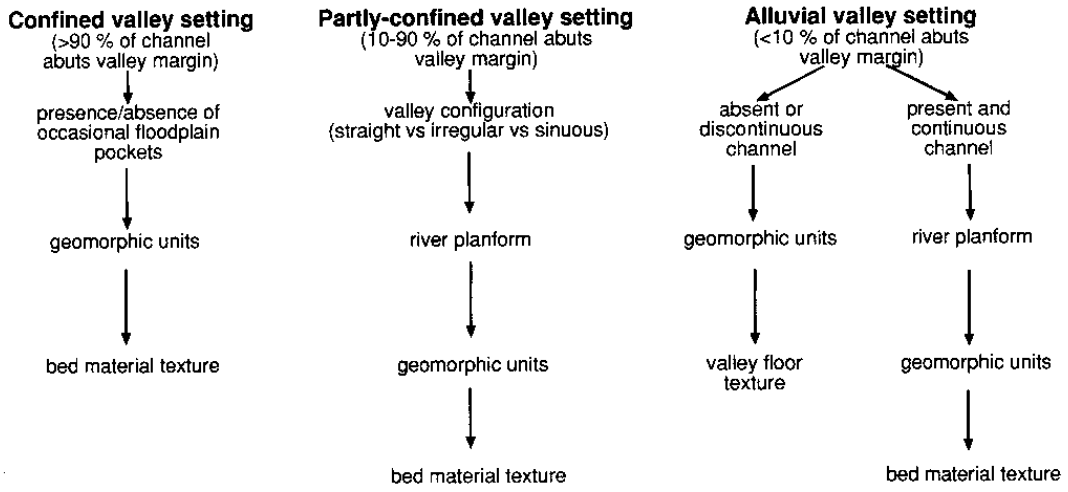


Figure 4.3 Examples of River Styles identified in coastal valleys of NSW

(modified from Brierley et al., 2002)

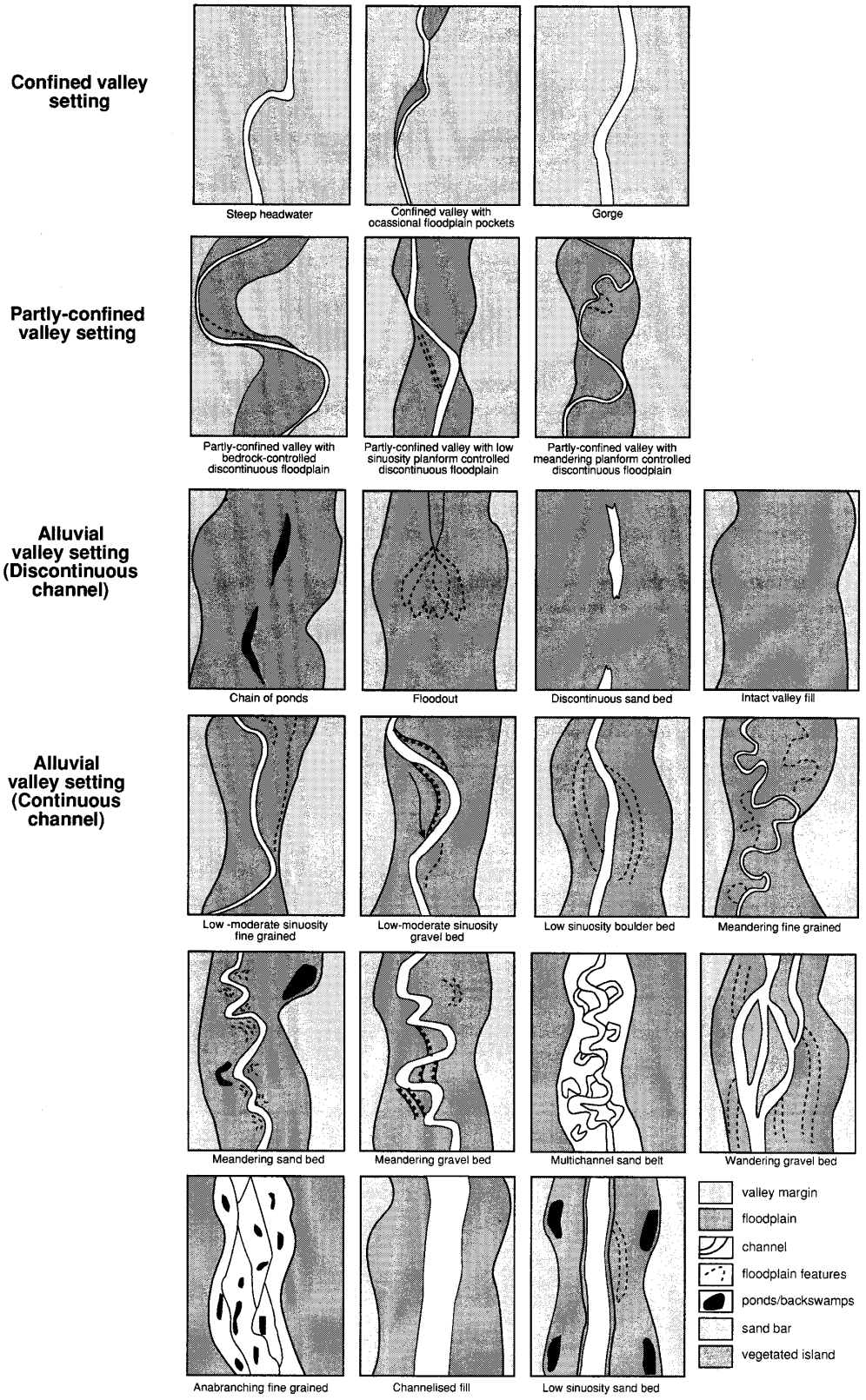
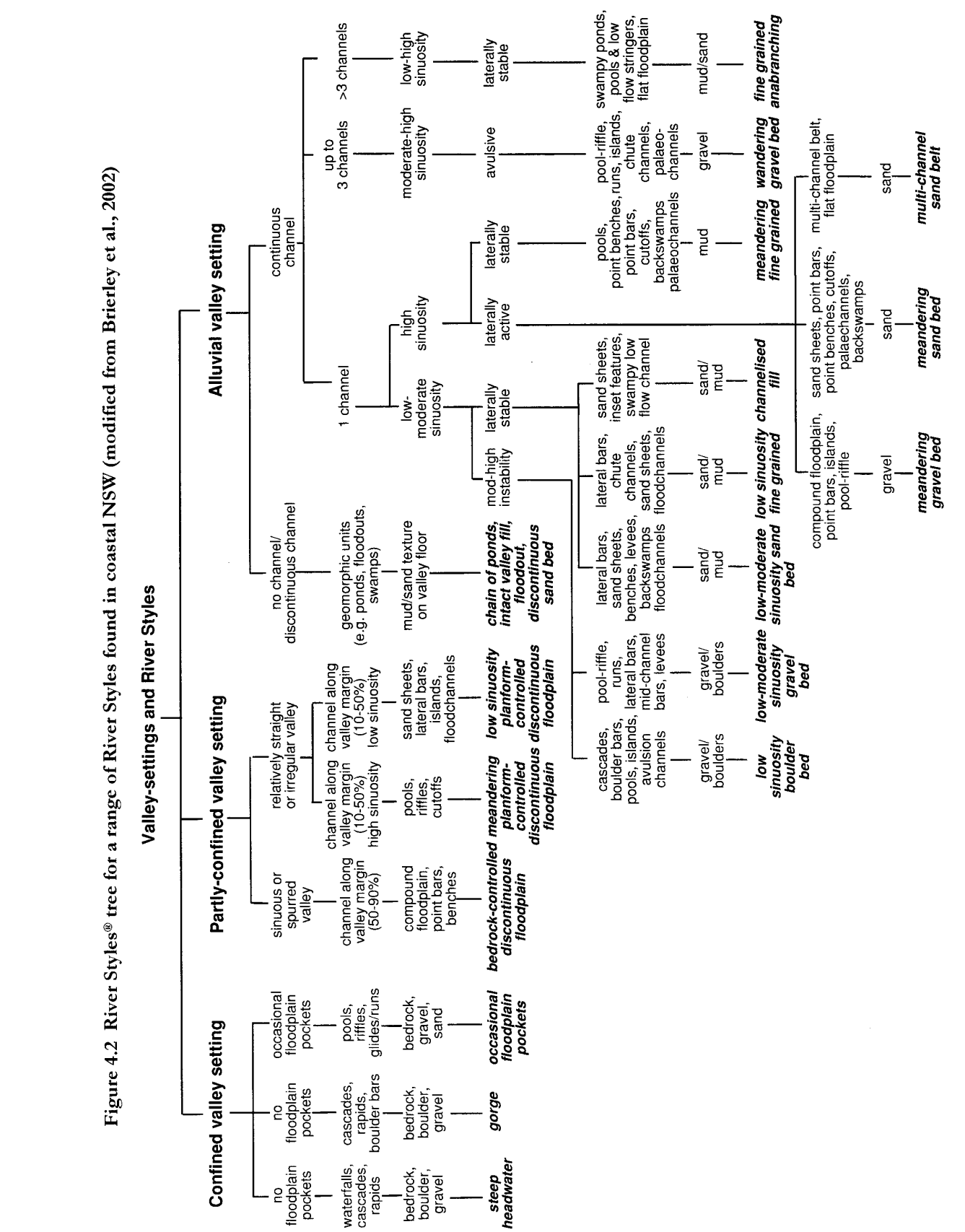


Figure 4.2 River Styles® tree for a range of River Styles found in coastal NSW (modified from Brierley et al., 2002)



Appendix B - Example Field Responses

STREAM CATEGORY: *Intact Valley Fill*

Site Details

Date:		Reach No/Section:	
Collected By:		Watercourse/Catchment:	

Valley Setting Features

VS1	*The reach is in a relatively broad floodplain setting. Valley floor width ~100m.*
VS2	*Low relief, rounded hills with persistent soil cover, no bedrock outcrops visible.*
VS3	*No. Broad swale, no bedrock or valley margin controls.*

Valley Floor Features

VF1	*None apparent. Uniform valley fill.*
VF2	*No.*
VF3	*Dark, organic rich mud with developing soil profile.*

Land Use & Vegetation Influences

LV1	*All woody plants cleared, only grasses & sedges present. Reasonable cover helping to resist scour of valley floor.*
LV2	*n=0.03*
LV3	*Grazing within site. Road at d/s limit. Remnant bush, grazed u/s.*

Valley Floor Structures

VFS1	*None present.*
VFS2	*Roadside drain & culvert concentrates flow at end of reach.*
VFS3	*None apparent. Possible pasture improvement.*

CONDITION, RISK & THREAT

Confirmation of Categorisation (if no, what category):

Yes	No

Capacity for Adjustment:

Low	Moderate	High

Condition (Physical) Relative to Intact or Reference:

Intact	Slight Modification	Modified (or now different stream category)	Highly Modified/Degraded

Threats to Physical Condition:

Within the Site:	Low	Moderate	High
Downstream of the Site:	Low	Moderate	High
Upstream of the Site:	Low	Moderate	High

Comments:

STREAM CATEGORY: *Cut & Fill (Channelised Fill)*

Site Details

Date:		Reach No/Section (id):	
Collected By:		Watercourse/Catchment:	

Valley Setting Features

VS1	*The valley floor widens through the reach approaching confluence with larger*
	stream. Valley Floor ~50m wide at upstream end, >150m wide at downstream
	near confluence.
VS2	*Relatively moderate relief on hills. No bedrock in valley margins, deep valley fill.*
VS3	*No evidence of valley planform or bedrock control on the developing channel.*

Valley Floor Features

VF1	*Valley floor is uniform flat surface.*
VF2	*No scour evident on valley floor.*
VF3	*Dark, organic rich mud.*
VF4	*Long periods of fine grained sediment accumulation. Rare, event driven scour &*
	coarse sediment deposition.

Channel Features

CF1	*Grey/black silty sandy clay. Some gravel & sand in active scour zones.*
	Bed not yet armoured.
CF2	*Bed is undergoing scour, connecting small ponds. No bedrock impingements*
	observed. Several erosion heads 0.3-0.8m high.
CF3	*Bank sediment is dark organic mud interspersed with a thin (<5cm) layer of sand*
	and gravel. Valley fill depth unknown.
CF4	*Channel banks vary considerably along site. Where active scour of bed is*
	occurring, cut banks appear. These banks don't appear to be retreating or
	migrating yet. No bed rock impingements observed.
CF5	*See sketch. Small ponds are being connected through incision of bed (erosion*
	heads migrating u/s).
CF6	*See sketch.*
CF7	*Incision is active, channel not yet fully continuous. No benches developed.*
CF8	*Contemporary behaviour is alluvial, no lateral controls on semi-continuous*
	channel.

Land Use and Vegetation Influence:

LV1	*All vegetation cleared, only pasture grasses.*
LV2	*n=0.025-0.03.*
LV3	*Grazing. Road and culvert d/s.*

Instream Structures:

IS1	*No LWD. Scour pools and bars.*
IS2	*Road and culvert at d/s end concentrates flow. May have helped initiate/ progress incision u/s*
IS3	*No stream rehab works.*

CONDITION, RISK & THREAT

Confirmation of Stream Category:

Yes	No

Capacity for Adjustment:

Low	Moderate	High

Stage of Condition Trajectory:

Intact Valley Fill	Discontinuous Scours	Semi Continuous Enlarging Channel
Continuous Box Channel	Compound Continuous Channel (inset low flow)	Infilling

Appendix D - Threat Reduction Score Template

THREAT REDUCTION SCORE

Onkaparinga Catchment Water Management Board

Landholder Name		Prop. ID	

GEOMORPHOLOGY

The Geomorphology threat reduction scores assume that the specific erosion threat is removed

Bed Instability	TR Score WITH interv	TR Score NO interv
Intact	0	0
Stable	1	0
Limited instability	2	0
Moderate instability	3	0
Extensive instability	3	0
Bed Aggradation	3	0
No watercourse	0	0

Bank Instability	TR Score WITH interv	TR Score NO interv
Intact	0	0
Stable	1	0
Limited instability	2	0
Moderate instability	3	0
Extensive instability	3	0
No watercourse	0	0

Bed Instability	TR Score	

Bank Instability	TR Score	

HYDROLOGY

Dams and other hydrological obstructions	TR Score		
	Remove dam	Install bypass	No intervention
Active on stream dam/offtake with no low flow bypass	4	2	0
Large inactive on stream dam/offtake with no low flow bypass	3	2	0
Small inactive on stream dam/offtake with no low flow bypass	2	0	0
On stream dam/offtake with low flow bypass	1	0	0
No on stream dams/offtakes	0	0	0
No watercourse	0	0	0

Dams	TR Score	

REMNANT VEGETATION

	Original Patch Size plus Revegetation (m^2)				
OriginalPatch Size (m2)	<1000	1000-2000	2000-5000	5000-10,000	>10,000
<1000	0	1	2	3	4
1000-2000	0	0	1	2	3
2000-5000	0	0	0	1	2
5000-10,000	0	0	0	0	1
>10,000	0	0	0	0	0

Proposed revegetation area	TR Score	

Weed % Cover (assessed)	TR Score (% weed cover following intervention)					
	No interv.	<10	10 - 25%	26 - 50%	51 - 75%	>75%
Low cover or not many 1-10 individuals <10%	0	1				
Any number of individuals covering 10 – 25% of area	0	1				
Any number of individuals covering 26 –50% of area	0	2	1			
Any number of individuals covering 51 – 75% of area	0	3	2	1		
Covering more than 75% of the area	0	4	3	2	1	

Weed % cover	TR Score	

Invasive Weeds Presence			
Common Name	**Scientific Name**	**Proc. Plant**	**TR Score**
African Boxthorn	*Lycium ferocissimum*	Yes	3
Blackberry	*Rubus* species	Yes	4
Boneseed	*Chrysanthemoides mon.*	Yes	4
Broad-leaved Cotton Bush	*Asclepias rotundifolia*	No	2
Cape Broom	*Genista monspessulana*	Yes	4
English Broom	*Cytisus scoparius*	Yes	4
Erica	*Erica* species	No	4
Gorse	*Ulex europaeus*	Yes	4
Olive	*Olea europaea*	Yes	4
Pittosporum	*Pittosporum undulatum*	No	3
Radiata Pine	*Pinus radiata*	No	3
Wattles	*Acacia sp*	No	2
Willow	*Salix sp*	No	3
Ash, Popular, Elm	*Fraxinus sp etc*	No	2
African Daisy	*Senecio pterophorus*	No	3
Cape Weed	*Arctotheca calendula*	No	1
Salvation Jane	*Echium plantagineum*	Yes	3
Bulbil Watsonia	*Watsonia*	Yes	3
Monadenia	*Monadenia bracteata*	Yes	4
Bridal Creeper and Bridal Veil	*Myrsiphyllum sp*	Yes	4
Periwinkle	*Vinca major*	No	3
Fountain Grass	*Pennisetum macrourum*	Yes	3
Phallaris	*Phallaris sp*	No	4
		Sum score	

Sum Score	Normalised TR Score
<10	**1**
10 to 17	**2**
18 to 24	**3**
25 to 29	**4**
>29	**5**

Invasive weed presence	**TR Score**	

Grazing Pressure	Description	TR Score	
		Pressure removed	**No interv.**
No grazing	No loss of foliage due to grazing	**0**	**0**
Lightly grazed	There is some loss of foliage due to grazing, and/or broken branches, but the plant essentially retains its natural growth form.	**1**	**0**
Mod grazed	There is more obvious loss of foliage due to grazing, and/or broken branches, but the plant essentially retains its natural growth form.	**2**	**0**
Heavily grazed	There is obvious loss of foliage OR the plant's height is stunted due to grazing OR there is an obvious browse line. In some species, epicormic shoots may be present (e.g. reshooting foliage from the woody stems).	**3**	**0**
Severely grazed	The plant is grazed back severely, with little foliage remaining, OR plant has been severely physically damaged due to broken/crushed stems or branches.	**4**	**0**

Grazing Pressure	**TR Score**	

Appendix E - Conditions of Receiving Board Funding

If your bid for funding is successful, you will be required to enter into an agreement with the Board. This agreement will include the following conditions.

All works undertaken by the landholder will be done entirely at the landholder's own risk. The Board will not be liable for any loss or damage to property, or injury or death of persons arising from or associated with the landholder's own works.

The installation of agreed fencing, gates, stock crossings/flood gates, stock watering facilities and minor erosion control structures will be arranged/undertaken by the landholder.

All stock exclusion fencing must be set back at a minimum of 5 meters from the top of bank in order to qualify for payment. Where top of bank is ambiguous, set-back should be determined in consultation with the Board.

The landholder will undertake the works identified within the time period indicated in Section 3.

Reimbursement cannot be guaranteed where management activities are not completed within the time period specified in Section 3.

The Board will pay for services provided by the landholder as specified in Section 1 according to a payment schedule to be advised upon signing of an agreement with the Board. This will consist of at least one up front payment to allow works to commence. Further payments will be made based on achieving agreed milestones.

The landholder will be paid for services as specified in Section 1. If actual expenditure exceeds the amounts specified in Section 1, any additional cost will be borne by the landholder.

The landholder agrees to maintain or replace any of the works and items funded through this Site Action Plan, should they be lost, stolen, damaged or destroyed.

Stock is to be permanently excluded from areas where revegetation works funded through this Site Action Plan have been undertaken. The regeneration and/or establishment of appropriate vegetation within the fenced area plays an essential role in the stabilisation of watercourse bed and banks, improved water quality and the improved biological health of watercourses.

Any natural regeneration of indigenous plant species that occurs after stock exclusion from an area is to be protected, and must not be removed, by any means, without seeking and receiving written consent from a representative of the Board.

Revegetation will only be carried out ***after*** fences have been constructed, unless otherwise advised.

All areas where weed and/or exotic tree control has been undertaken are to be revegetated with local indigenous species only. No reintroduction of exotic species may be carried out by the landholder, and all reasonable effort must be undertaken to exclude accidental reintroduction. Once initial infestations of exotic plants/weeds have been controlled and areas revegetated with the assistance of the Board, any weed regrowth is to be controlled in future years by the landholder.

The landholder's responsibility to maintain in good order the works and items funded through this Site Action Plan succeed the term of the agreement with the Board.

In the event that the landholder sells their property either prior to or following completion of the Site Action Plan, the landholder is required to advise the new property owner of any agreements with the Board during sale negotiations.

GST Requirements

Australian Business Number (ABN) and Goods and Services Tax (GST)

Introduction of the GST legislation from 1 July 2000 has placed certain responsibilities on individuals receiving payments from the Onkaparinga Catchment Water Management Board.

The Board is required in future to deduct a 48.5% withholding tax from any payments it makes to individuals unless:

An ABN is provided to the Board, or

An ABN is not required because the recipient is an individual where the activity is done as:

1. a private recreational pursuit or hobby, or
2. is wholly of a private or domestic nature.

In the circumstances described in 1 & 2 above recipients must provide the Board with a statement confirming that they are not required to hold an ABN. The Board will seek this information from you at the time you seek reimbursement.

Appendix F - Recommended Actions and Site Action Plan

Appendix F.1. - Recommended Actions

Catchment Care Trial - Recommended Activities

Onkaparinga Catchment Water Management Board

Name		Property ID No.	MBI-034
Catchment Care Officer	Michael Garrod	Telephone No	(08) 8374 6016

Action	No.	Recommended Activities	Location	Timing
Exotic Tree Control	1	Patrol for and Cut and Swab all large Acacia longifolia, Olives, Broom and Rhamnus (Buckthorn) using Triclopyr (eg Garlon). Small plants can be hand pulled	All Areas	Autumn Winter Spring 05
Weed Control	2	Physical Removal - Control population of Three cornered garlic by hand pulling while flowering. Three cornered garlic can also be controlled by spot spraying with Glyposate **being sure to avoid contact with other vegetation.**	Area E	Winter Spring 04,05
	3	Physical Removal - Control population of watsonia by hand pulling or grubbing with a small lever, be sure to get the bulb up. Bag and destroy. As an alternative Watsonia can be controlled by wiping on Glyphosate	Area B	Spring-Summer 04,05
Small Scale Bed Erosion Control	4	Remove Impoundment (small Dam) from watercourse and pack rocks into small erosion heads formed in watercourse. Also colapse small dug channel between impoundment and dam.	See map	Summer 05
Weed Control	5	Targeted Chemical Application - Spot spray Bridal Creeper with Glyposate. **When spot spraying Bridal Creeper, gather as much of the plant as you can into a pile (preferably on top of a piece of masonite) and spot spray the pile. This will minimise the chance of off target damage.** You can also hand dig Bridal creeper being sure to remove all tubers. Bag and Remove	Mainly C & F and all other areas	June Aug 05
	6	Physical Removal - Patrol for and hand pull all re-emerging Boneseed	Mainly A & all other	Autumn Winter Spring 05,06,07
Weed Control	7	Patrol for and Cut and Swab all large Acacia longifolia, Olives, Broom and Rhamnus (Buckthorn) using Triclopyr (eg Garlon). Small plants can be hand pulled	All Areas	Autumn Winter Spring 06,07
	8	Follow up control of Three cornered garlic by hand pulling while flowering. Three cornered garlic can also be controlled by spot spraying with Glyphosate **being sure to avoid contact with other vegetation.**	Area E	Winter Spring 06,07
	9	Follow up control of Watsonia by hand pulling or grubbing with a small lever, **be sure to get the bulb up**. Bag and destroy. As an alternative Watsonia can be controlled by wiping on Glyphosate	Area B	Spring-Summer 06,07
	10	Follow up - Spot spray Bridal Creeper with Glyposate. **When spot spraying Bridal Creeper, gather as much of the plant as you can into a pile (preferably on top of a piece of masonite) and spot spray the pile. This will minimise the chance of off target damage.** You can also hand dig Bridal creeper being sure to remove all tubers. Bag and Remove	Areas C & F	June Aug 06,07

Refer to your Landholder Information Pack for further information on all the activities listed above

Appendix F.2. - Site Action Plan

Catchment Care Trial

Onkaparinga Catchment Water Management Board

SITE ACTION PLAN

Onkaparinga Catchment Water Management Board

SECTION 1 – Property and Landholder Details

Landholder Name		**Contact** (if not landholder)	
Telephone	(Work) (Home) (Mob) —		
Postal Address			
Property Address		**Property ID.**	MB1034
Catchment Care officer	MICHAEL GARROD		

SECTION 2 – Proposed Management Actions

Please identify on the aerial photograph of your property where the activities will be undertaken and attach the photograph to this Site Action Plan. Please ensure that the work areas that you propose are MARKED AS ACCURATELY AS POSSIBLE as this may affect the success of your bid.

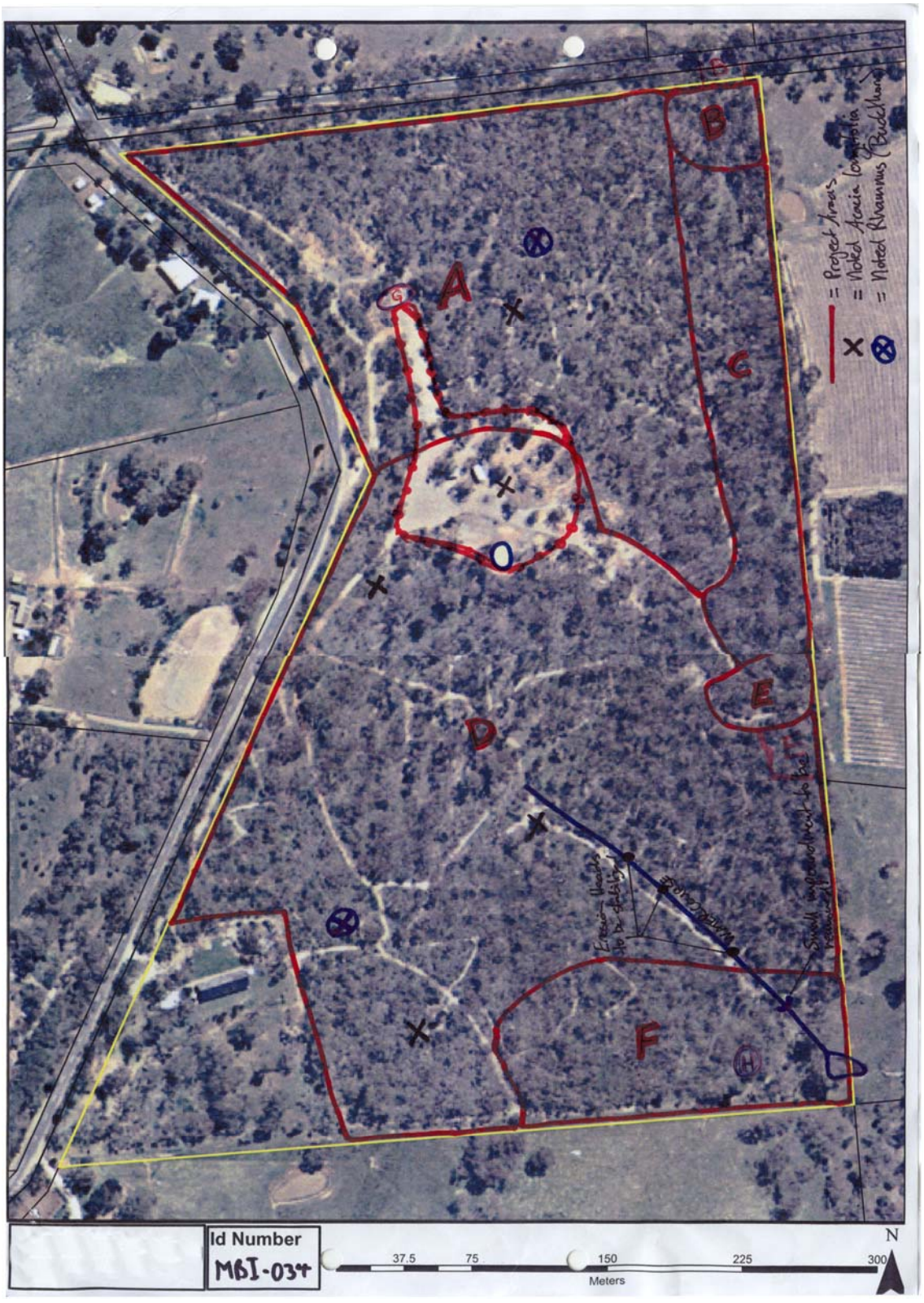
Action.	No	Activity	Area (m²) OFFICE USE ONLY	Location	Time/material estimate	Funds required
EXOTIC TREES	1	CUT & SWAB ACACIA LONGIFOLIA OLIVES, BROOM, RHAMNUS FOLLOW UP FOR NEXT 2 YEAR	~~AREA~~ ~~AREAS~~	ALL AREAS	120 HRS FOR 3 YEARS	1800
WEEDS	2	THREE CORNED GARLIC SPRAY & WEED BY HAND		AREA E	42 HRS FOR 3 YEAR	630
WEEDS	3	WATSONIA DIG OUT & TAKE AWAY		AREA B & ROADWAY	6 HRS FOR 3 YEARS	90
WEEDS	4	BONESEED HAND PULLING		A & ALL OTHER	192 HRS FOR 3 YEARS	2880
WEEDS	5	SALVATION JANE HAND PULLING		G & ANY OTHER	120 HRS FOR 3 YEARS	1800
WEEDS	6	BRIAR ROSE DIG IT OUT & CUT & SWAB		AREA A & ANY OTHER	21 HRS FOR 3 YEAR	315
WEEDS	7	BLACKBERRYS DIG IT OUT TAKE IT AWAY & CUT & SWAB		H & ANY OTHER	3 HRS FOR 3 YEARS	45
WEEDS	8	BRIDAL CREEPER DIG IT OUT & SPRAY		C & F & ANY OTHER	240 HRS FOR 3 YRS	3600
SMALL SCALE BED EROSION	9	REMOVE SMALL DAM & PACK ROCKS INTO EROSION COLAPSE SMALL DUG CHANNEL		SEE MAP	21 HRS	315
		WATER, PLANT & WEED FOR NEXT 3 YEARS			WATERING FOR NEXT 3 YEARS	
		THIS IS THE AMOUNT FOR 3 YEARS TO WEED THIS PROPERTY & FOLLOW UP AFTER SPAYING.				$11,575

SECTION 4 – Timing of activities

Property ID:

	Year 1 - 2005												Year 2 - 2006												Year 3 – 2007											
No.	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
1				/	/	/			/							/	/	/			/							/	/	/			/				
2						/	/	/	/									/	/	/	/									/	/	/	/				
3									/												/												/				
4				/	/	/	/	/	/	/						/	/	/	/	/	/	/						/	/	/	/	/	/	/			
5								/	/	/										/	/	/										/	/	/			
6						/	/	/	/									/	/	/	/									/	/	/	/				
7									/	/	/	/									/	/	/	/									/	/	/	/	
8							/	/	/										/	/	/									/	/	/					
9	/	/	/							/	/																										
10			/	/	/						/	/	/	/	/								/	/	/	/	/								/	/	

Complete this table by shading in or ruling through the month boxes that you expect to complete the management activities (refer to the package of information provided with this booklet for optimum timing of activities).


= Project Areas
= Noted Acacia (Acacia Senegalia)
= Noted Rhamnus (Buckthorn)
A
B
C
D
E
F
G
H
Id Number
MBI-034
37.5
75
150
225
300
Meters
N

Appendix F.3. Recommended Actions Letter

Dear

Catchment Care Tender Trial Development and Submission

Thank you for your participation in the Onkaparinga Catchment Water Management Board's Catchment Care Tender Trial. The site visit to your property has now been completed. Based on this visit and discussions with you, we have developed a recommended list of activities that you should consider when putting together your Site Action Plan.

Enclosed with this letter you will find the following documents:

- a list of recommended activities for your property ('Catchment Care Trial - Recommended Activities')
- a **new** Site Action Plan
- an aerial photograph of your property indicating the location of the recommended activities.

You will also find some additional advice in relation to putting together your bid for funding of your Site Action Plan.

The attached Site Action Plan has been revised, based on some feedback we have received from landholders. It allows more room for additional activities. Some landholders have also expressed concern at estimating areas associated with the activities. To make it easier for you, we no longer need you to estimate the amounts of activities as indicated in page 2 of the 'Guidelines for Bid Development' (for example, area of revegetation, length of fencing). Instead, simply outline, as accurately as possible, the location of the activities on the aerial photograph of your property (it would be useful to include a simple legend on your aerial photo).

The activities that we have recommended have been developed in order to maximise watercourse recovery potential and produce the best environmental benefits. They are also made in recognition that funding is only available for three years. We recommend that you include these activities in your Site Action Plan as your bid will be assessed against their implementation.

To develop your bid, you will need to transfer the recommended actions and activities to the revised Site Action Plan provided with this letter and nominate the funding you need for each activity. We can help you with the recommended actions and activities, but must leave the nomination of funding required up to you. **Please include all actions and activities you plan to undertake, even if you do not request funding for them**.

If you do not require funding for an activity please record as 'not required' in the 'Funds required' column. This confirms to us the full range of activities you are planning and highlights your contribution towards the works. You are free to request whatever funding you

require to see activities undertaken. However, this is a competitive process and those bids representing best value for money have the greatest likelihood of success.

You are of course free to omit activities recommended by us, and/or include your own. However, you should ensure that the activities that you propose are in line with those included in Table 1 of the 'Guidelines for bid development' booklet in your information pack. If offering to undertake other activities not recommended, please provide the following details:

- the location of the activity, clearly marked on the aerial photo included in your information pack; and
- the proposed techniques to be used.

Please contact the person listed below if you need advice on contractors in your area that may be able to provide you with a paid service in the area of bushcare, weed control or revegetation.

Given that this trial is experimental and that it is the first time that this type of funding arrangement is being offered in South Australia, we expect that there may be issues that will require further clarification. Indeed we have already received suggestions and comments from some landholders, and made changes along the way. We are happy to hear from you should you have any concerns or questions, or should you require further help in putting together your bid.

To allow more time for you to develop your Site Action Plan we have extended the due date to Friday, 6 August 2004. Please ensure that your bid for funding reaches the Board by 4pm on this day.

If you do require further assistance please contact Michael Garrod on 8374 6016

Yours sincerely

Steven Gatti

Technical Manager

Catchment Care Tender Trial

Additional information be aware of when putting your bid together

The following table provides information that you should consider when putting together your Site Action Plan.

Action/Activity	**Comments**
Stock crossings, erosion control works or any other works involving removal or deposition of soil, rock or any other material in or adjacent to the watercourse	You may require a Water Affecting Activity Permit. You can include the cost of this permit in your bid. Permit applications cost $36.25. For further information please contact the Board.
Weed control	Your works should comply with the recommendations in the 'Guidelines for Bid Development' and the 'Weed Control Handbook' provided in your information pack. If you are proposing to undertake controlled burn techniques you must first have the approval of your local Council. Broad scale removal of blackberry and gorse may result in damage to native animal habitat. If you are planning this activity first talk to us so that weed control is conducted in a manner that minimises the risks to native animals.
Revegetation	The Board will supply plants to you at a flat rate of 85 cents per plant (include this cost in your bid). In your Site Action Plan, you will need to provide the Board with an indication of the number of plants required and the total cost for those plants (ie number. of plants x 85 cents).

Appendix G - Reporting and Payment Schedule and Tax Invoice

Catchment Care Tender Trial

Reporting and Payment Schedule

Name		Property ID	MBI-034

Subject to the satisfactory completion of the tasks listed below and described in your Site Action Plan, by the completion date shown, the following payments will be provided.

*** Payment will only be made after we receive and approve your Progress Report. Progress Reports are required from you according to the reporting schedule shown below.**

****** An Initial Payment to help you commence your works, will be made upon recipt of you signed and completed 'Reporting and Payment Schedule' and 'Application for Payment' forms

The funding total for projects that include plant supply from the Board has been reduced by the cost of supplying those plants as quoted in your tender. Where no separate price for plant supply was quoted we have used our "at cost" rate of 80 cents/stem.

Payment Schedule

Task number	Payment	Date
Intitial payment	$2,000.00	See Above **
Progress Payment 1	$2,500.00	Mid August 2005*
Progress Payment 2	$2,000.00	Mid Febuary 2006*
Progress Payment 3	$1,500.00	Mid August 2006*
Progress Payment 4	$1,000.00	Mid Febuary 2007*
Progress Payment 5	$1,000.00	Mid August 2007*
Progress Payment 6	$1,575.00	Mid Febuary 2008*
Total	$11,575.00	

Reporting Schedule

Report	For Period	Date required
Progress Report 1	January to June 2005	Friday 15th July 2005 5:00pm
Progress Report 2	July to December 2005	Friday 13th January 2006 5:00pm
Progress Report 3	January to June 2006	Friday 14th July 2006 5:00pm
Progress Report 4	July to December 2006	Friday 14th January 2007 5:00pm
Progress Report 5	January to June 2007	Friday 13th July 2007 5:00pm
Progress Report 6	July to December 2007	Friday 15th January 2008 5:00pm

As Land Owner/Manager, I accept this Payment and Reporting Schedule as part of receiving funding from the Onkaparinga Catchment Water Management Board to undertake the works listed in my Site Action Plan (Section 2).

Name……

Signed…… **Date……..**

Catchment Care Trial

APPLICATION FOR PAYMENT

Onkaparinga Catchment Water Management Board

SECTION 1 – Property and Landholder Details

Landholder Name:……**Contact** (if not Landholder)……

Postal Address:……..

Property Address:……..

Property ID (MBI No.)……**Date**. ……

SECTION 2 – Landholder Taxation Registration Details

Our/My Australian Business Number (ABN) is:……

(If no ABN, please complete reverse side of this form)

Registered for GST? **Yes** ☐ **No** ☐

SECTION 3 – Payment Details

Payment		**Payment Sought ($)**
Initial Payment		
Please note that for Landholders that are registered for GST, this is a TAX INVOICE once completed. Please take a copy for you records.	**A. TOTAL Payment sought** (excluding GST)	
	B. GST (10% total only if registered for GST)	
	C. TOTAL value of Tax Invoice (A+B)	

Australian Business Number (ABN) and Goods and Services Tax (GST)

Introduction of the GST legislation from 1 July 2000 has placed certain responsibilities on individuals receiving grants from the Onkaparinga Catchment Water Management Board.

The Board is required to deduct a 48.5% withholding tax from any payments it makes to individuals unless:

- An ABN is provided to the Board, or
- An ABN is not required because the recipient is an individual where the activity is:

1. done as a private recreational pursuit or hobby, or
2. is wholly of a private or domestic nature.

In the circumstances described in 1 & 2 above recipients must provide the Board with a statement confirming that they are not required to hold an ABN (supplied below).

Declaration Required From Non ABN Holders

I/We are not required to hold an ABN because:

I/We are not carrying on an Enterprise as defined under The New Tax System
AND,
I/We are performing the agreed services for the Onkaparinga Catchment Water Management Board as a private recreational pursuit or hobby,

I/We have confirmed with the ATO that I/we do not need an ABN: YES / NO
(Please circle one)

We certify that the information set out in this declaration is true and correct.
Please note that for group declarations, 2 signatures are required below.

<table>
<tr><td colspan="2">Name of landholder</td><td colspan="3"></td></tr>
<tr><td colspan="3">Signatory 1</td><td colspan="2">Signatory 2</td></tr>
<tr><td colspan="3">Signature:</td><td colspan="2">Signature:</td></tr>
<tr><td>Name:</td><td colspan="2">Date:</td><td>Name:</td><td>Date:</td></tr>
<tr><td colspan="3">Position Held:</td><td colspan="2">Position Held:</td></tr>
<tr><td>Phone No.:</td><td colspan="2">Fax No.:</td><td>Phone No.:</td><td>Fax No.:</td></tr>
</table>

Please post completed form to the offices of the Onkaparinga Catchment Water Management Board *(The Salvation Army Complex, The Hub, Aberfoyle Park, SA. 5159)*

Appendix H - Survey Questionnaires

Catchment Care Trial

Questionnaire

Onkaparinga Catchment Water Management Board

Onkaparinga Catchment Water Management Board

1) Did you read the background information provided?

Yes No Some

2) If No or Some please indicate why

☐ Too much information ☐ No time

☐ Didn't understand it/confusing ☐ Did not apply to my situation

Other……

3) If Yes how did you find it?

☐ Informative/useful ☐ Too much

☐ Difficult to understand ☐ Not Useful

Other……

4) How would you rate your understanding of watercourse and remnant vegetation management issues prior to your involvement in this trial?

Poor 1 2 3 4 5 Good

5) Did you find the site visit informative/useful?

No 1 2 3 4 5 Yes

6) Were you happy with the level of advice you received during the trial?

No 1 2 3 4 5 Yes

7) How well do you believe you were informed of how the trial works and what would be required of you?

Poorly informed 1 2 3 4 5 Well informed

8) Do you feel you were made fully aware that you would be competing against other landholders for limited funding?

No 1 2 3 4 5 Yes

9) Do you feel you were treated fairly?

No Yes

PTO

10) Did the background material in the ‘Landholder Information Pack’ help you develop your Site Action Plan?

Not at all | 1 | 2 | 3 | 4 | 5 | Very helpful

11) Please rate the ease in which you completed your Site Action Plan.

Very Difficult | 1 | 2 | 3 | 4 | 5 | Very easy

12) Do you think the ‘Landholder Information Pack’ provided will help you implement Site Action Plan?

No | 1 | 2 | 3 | 4 | 5 | Yes

13) How much support did you receive from your Catchment Care Officer when developing your Site Action Plan?

Not enough | 1 | 2 | 3 | 4 | 5 | Enough

14) Would you have implemented the actions in your Site Action Plan if you had not received funding?

No | Yes | Some

15) Would you participate if you had to attend occasional land management workshops?

No | 1 | 2 | 3 | 4 | 5 | Yes

16) Do you expect to expand your works into other areas of your property in the future?

No | 1 | 2 | 3 | 4 | 5 | Yes

17) Do you feel this process has made you more aware of the environmental issues affecting your property and the local area?

No | 1 | 2 | 3 | 4 | 5 | Yes

18) Has the trial increased your enthusiasm to undertake environmental restoration works?

No | 1 | 2 | 3 | 4 | 5 | Yes

19) Please rate your satisfaction with the level of ongoing support provided to date?

Very dissatisfied | 1 | 2 | 3 | 4 | 5 | Very Satisfied | Not yet required

20) What do you feel could be done to improved the process?……
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……
……
……

Catchment Care Trial

Questionnaire

Onkaparinga Catchment Water Management Board

1) Did you read the background information provided?

Yes No Some

2) If No or Some please indicate why

☐ Too much information ☐ No time

☐ Didn't understand it/confusing ☐ Did not apply to my situation

Other……

3) If Yes how did you find it?

☐ Informative/useful ☐ Too much

☐ Difficult to understand ☐ Not Useful

Other……

4) How would you rate your understanding of watercourse and remnant vegetation management issues prior to your involvement in this trial?

Poor 1 2 3 4 5 Good

5) Did you find the site visit informative/useful?

No 1 2 3 4 5 Yes

6) Were you happy with the level of advice you received during the trial?

No 1 2 3 4 5 Yes

7) How well do you believe you were informed of how the trial works and what would be required of you?

Poorly informed 1 2 3 4 5 Well informed

8) Do you feel you were made fully aware that you would be competing against other landholders for limited funding?

No 1 2 3 4 5 Yes

9) Do you feel you were treated fairly?

No Yes

PTO

10) Did the background material in the ‘Landholder Information Pack’ help you develop your Site Action Plan?

Not at all | 1 | 2 | 3 | 4 | 5 | Very helpful

11) Please rate the ease in which you completed your Site Action Plan.

Very Difficult | 1 | 2 | 3 | 4 | 5 | Very easy

12) Do you think the ‘Landholder Information Pack’ provided will help you implement Site Action Plan?

No | 1 | 2 | 3 | 4 | 5 | Yes

13) How much support did you receive from your Catchment Care Officer when developing your Site Action Plan?

Not enough | 1 | 2 | 3 | 4 | 5 | Enough

14) Will you implement the actions in your Site Action Plan even though you have not received funding?

No | Yes | Some

15) Would you participate if you had to attend occasional land management workshops?

No | 1 | 2 | 3 | 4 | 5 | Yes

16) Do you expect to expand your works into other areas of your property in the future?

No | 1 | 2 | 3 | 4 | 5 | Yes

17) Do you feel this process has made you more aware of the environmental issues affecting your property and the local area?

No | 1 | 2 | 3 | 4 | 5 | Yes

18) Has the trial increased your enthusiasm to undertake environmental restoration works?

No | 1 | 2 | 3 | 4 | 5 | Yes

19) What do you feel could be done to improved the process?……
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Catchment Care Trial

Questionnaire

Onkaparinga Catchment Water Management Board

1) Did you read the background information provided?

Yes No Some

2) If No or Some please indicate why

☐ Too much information ☐ No time

☐ Didn't understand it/confusing ☐ Did not apply to my situation

Other……

3) If Yes how did you find it?

☐ Informative/useful ☐ Too much

☐ Difficult to understand ☐ No help

Other……

4) How would you rate your understanding of watercourse and remnant vegetation management issues prior to your involvement in this trial?

Poor 1 2 3 4 5 Good

7) How well do you believe you were informed of how the trial works and what would be required of you?

Poorly informed 1 2 3 4 5 Well informed

8) Do you feel you were made fully aware that you would be competing against other landholders for limited funding?

No 1 2 3 4 5 Yes

9) Do you feel you were treated fairly?

No Yes

15) Would you participate if you had to attend occasional land management workshops?

No 1 2 3 4 5 Yes

PTO

17) Do you feel this process has made you more aware of the environmental issues affecting your property and the local area?

No	1	2	3	4	5	Yes

18) Has the ‘Landholder Information Pack’ increased your enthusiasm to undertake environmental restoration works?

No	1	2	3	4	5	Yes

12) Is there a particular reason you chose not to continue your involvement in the trial?

No

Yes Please provide details……
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19) What do you feel could be done to improved the process?……
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