



CHAPMAN RIVER FORESHORE ASSESSMENT



WATER AND RIVERS
COMMISSION

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Cover photograph: Fringing vegetation on the Chapman River [Taken by Nicole Siemon, 2000]



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Summary

The Chapman River is a regionally significant waterway in terms of biodiversity, habitat provision, aesthetic values, cultural values and recreation in the Mid West region. The Chapman River commences near Yuna approximately 60 kilometers north east of Geraldton, Western Australia. To protect and enhance the ecological integrity and social values of the Chapman River a foreshore assessment survey was conducted to identify foreshore condition and present management recommendations for the surveyed sections of the waterway.

This document provides the results of a foreshore assessment survey of the Chapman River in accordance with the Pen and Scott (1999) foreshore condition assessment proforma. Testing and refining the assessment protocol in this work was required to overcome any shortcomings or limitations of the proforma related to this survey occurring in a different environment to that in which the standard was developed.

The foreshore assessment process has been developed to aid interested community groups, officers of State and local government authorities and private landholders in rural, semi-rural and urban areas to gain an understanding of the condition of foreshore areas within their own community. By using a standard methodology to gather information it is possible to compare and contrast the foreshore condition of the same area over time, or of different sites in the same survey season, to prioritise works.

The key findings of the study showed that the health of Chapman River and its tributaries, rated in accordance with the Stream Condition Index, ranged from Very Poor to Very Good. Four areas rated Very Good. Of interest is that the Very Poor ratings occurred throughout the catchment. The key issues requiring action in the sections surveyed are:

- Poor bank stability – because of increased water volumes and loss of vegetation and rising groundwater levels;
- Loss of native vegetation and high levels of weed invasion, particularly in the verge vegetation;

- Lack of stream cover – due to loss of fringing vegetation;
- Reduced habitat diversity;
- Relatively low increases to land values and reduced ability to utilise the land to earn a living; and
- Difficulties associated with managing access.

The priority weeds for control include the grasses (Couch, Red Natal, African lovegrass and Fountain grass), Castor oil, Arum lily, Blackberry and pasture weeds including Doublegee, Lupins, Paterson's curse and Saffron thistle. There are considerable opportunities to protect remnant native vegetation through fencing, weed control and managing access for fire management and recreation.

There are also sections of the brook that have been re-contoured by private landholders and a considerable number of dams blocking the flow. The landholders need to be approached to determine the feasibility of restoring the function of the brook.

Many of the issues require all landholders to work collectively in order to make a difference. The importance of catchment groups in raising awareness, providing technical and on-ground support and encouraging all landholders to become involved, cannot be stressed enough.

This report of foreshore condition is one of many being undertaken. There is a push to assess the health of rivers in rural, semi-rural and urban areas Statewide.





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1. Introduction

The Chapman River is a regionally significant waterway in terms of ecological integrity and social value in the Mid West Region. The Chapman River commences at Yuna approximately 60 kilometres north east of Geraldton, Western Australia and meanders through the sandplains of the northern Perth Basin to the granites and alluviums of the Northampton Block and cuts across the Moresby Ranges to the mouth located at Sunset Beach Geraldton. The catchment of the Chapman River has historically been utilised for broad acre agriculture. Significant clearing of remnant vegetation in the catchment area of the river and degradation of the riparian zone of the Chapman River from past and present land uses has resulted in declining water quality, loss of biodiversity and habitat provision, poor bank stability, rising groundwater tables and sedimentation.

The riparian zone next to natural watercourses acts as a buffer to the surrounds. Healthy foreshore vegetation stabilises the foreshore banks and slows and filters water thus reducing erosion of the banks and sedimentation of major channels. Foreshore vegetation also provides stream cover and suitable habitats for aquatic and terrestrial animals. Often these areas are a haven for native fauna, particularly during the dry summer months.

Riparian areas have always been a focus for development and as a consequence are often highly degraded. The major threats to foreshore health are the loss of native vegetation or a decline in health due to weed invasion. The loss of deep-rooted native plants often causes the destabilisation of foreshore banks, leaving these areas prone to erosion, particularly during peak flow events.

Gaining an understanding of the health of river foreshores is the first step towards developing appropriate management strategies to protect and enhance these areas.

Reminding ourselves of the value of rivers

Before European settlement, native vegetation covered both the catchments and foreshores of the rivers and other waterways. The vegetation used most of the

rainfall and surface runoff moved very slowly across the ground, which was well covered so there was little erosion. Similarly within the river systems the dense root systems of the native plants helped to hold the banks together. These plants provided habitat and the foundation of the food chain. Aquatic invertebrates such as snails, beetle larvae and insect larvae were fed on by native fish, which in turn were preyed on by waterbirds and other animals. Once the insects hatched, they provided a food source for shrubland and woodland birds, reptiles and other fauna. The deep pools provided drought refuge for these creatures during the dry summer months.

Since European settlement, clearing for mining, agriculture, townships and other developments has occurred and native vegetation has gradually been lost from both the catchments and river systems. As a general rule, there has been an increase in the amount of water running off the land into the waterways following clearing. Rising groundwater and more recent issues with salinity are other widely publicised results of clearing. With the surface water come sand, silt, loam and all types of sediment particles. The faster the water movement, the larger the sediment particle that can be moved. Sediment loaded water acts like liquid sandpaper, scratching the surfaces of plant leaves and trunks, increasing their vulnerability to insect attack and disease, filling up deep pools and being deposited as the flow slows on the floodway. Nutrients, heavy metals and other contaminants are also carried in the water.

The clearing of native vegetation has fundamentally altered the rate of sediment movement within the landscape. Wind and water erosion of topsoil is another outcome of native vegetation loss, which contributes to reduced productivity of the land. While crop plants and weeds that have replaced native vegetation restore some cover, they have a reduced ability to trap sediment or hold the soil during peak rainfall or river flow events, and have minimal habitat value for native fauna.

Rivers and the pools also provide important summer refuges for larger mobile animals, e.g. birds, kangaroos, echidnas and other fauna.



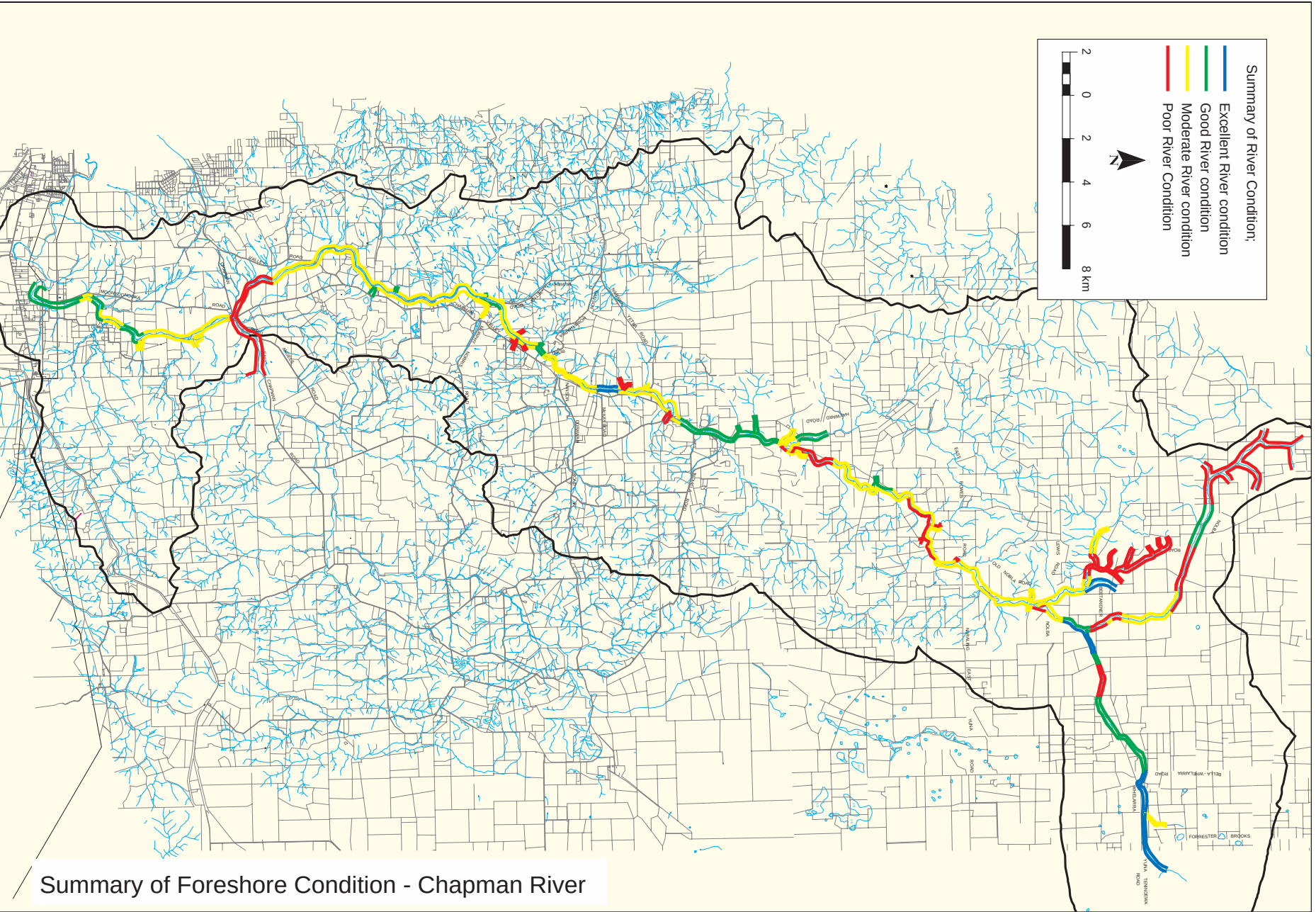
Weed symbol	Common name	Scientific name
	African boxthorn	Lycium ferocissimum
	African lovegrass	Eragrostis curvula
	Annual ryegrass	Lolium spp.
	Arum lily	Zantedeschia aethiopica
	Blackberry	Rubus sp.
	Black berry nightshade	Solanum nigrum
	Blue lupin	Lupinus cosentinii
	Buffalo grass	Stenotaphrum secundatum
	Bulrush	Typha orientalis
	Cape weed	Arctotheca calendula
	Castor oil plant	Ricinus communis
	Chinese pepper	Schinus molle
	Couch	Cynodon dactylon
	Dock	Rumex spp.
	Double gee	Emex australis
	Fleabane	Conyza spp.
	Fountain grass	Pennisetum setaceum
	Giant reed	Arundo donax
	Introduced annual grasses	
	Japanese pepper	Schinus terebinthifolia
	Kikuyu	Pennisetum clandestinum
	Lupins	Lupinus spp.
	Nasturtium	Tropeolum sp.
	Paterson's curse	Echium plantagineum
	Perennial grasses	
	Pie melon	Citrullus lanatus
	Red Natal grass	Melinis repens
	Roly poly	Salsola kali
	Saffron thistle	Carthamus lanatus
	Tamarisk	Tamarix aphylla
	Tree tobacco	Nicotiana glauca
	Vetch	Vicia sativa
	Watsonia	Watsonia sp.
	Weed wattles	Acacia spp.
	Wild radish	Raphanus raphanistrum
	Wild turnip	Brassica tournefortii
	Willow	Salix babylonica

Infrastructure and other symbols

	Blowouts		Power poles
	Boulders		Quarry
	Crossing		Railway bridge
	Culvert		Revegetation lines
	Dam		Riparian Vegetation
	Discarded farm material		Rubbish tip
	Erosion		Ruins
	Excavation		Rural buildings
	Fence line		Single row of trees
	Ford (Historic crossing)		Slumping
	Former river channel		Step in river channel
	Gate		Stock crossing
	Granite outcrops		Tanks
	Levee bank		Tracks
	LWD Lots of woody debris		Trough
	Plumes		Verge vegetation
	Pools		Windmill
	Power lines		

Map Legend





Summary of Foreshore Condition - Chapman River



It is therefore possible to assess river health by looking at the plants, animals and physical features present. By assessing entire lengths of rivers, it is also possible to make predictions about likely changes to the river system in the longer term.

Points to remember

Some significant erosion events occurred in the past to form the landscape that is seen today, and some of these events would have been relatively catastrophic floods and peak flows. Comments are often made that because erosion is a natural process and has been ongoing since time began, the land shaping processes of erosion and sedimentation should be left to do what waterways have always done. Some landholders therefore consider river management activities to minimise the rate of changes to the course of river flow to be irrelevant and a waste of money.

While it is true that erosion is a natural process the rate of degradation of the river systems is increasing and becoming more widespread, with dramatic changes being seen in decades rather than over hundreds or thousands of years. For example, as mentioned above, many older members of communities throughout Western Australia recall swimming in river pools that were considered to be bottomless but are now full of sediment. The anecdotal evidence from different families who have owned and farmed properties along the Chapman and Greenough Rivers for generations, indicates that many of these changes have occurred since 1950.

Further, some properties are losing hectares of arable land (up to 10% of the property) following flood events as a result of erosion events. The financial and social implications of unstable river systems are substantial, irrespective of the environmental impacts. Reviewing community opinion following the 1999 flood events reinforces the hardship experienced and the need to actively support the natural physical and biological processes that keep rivers healthy.

Because many of the river management issues arise in the catchments, there is a need to include catchment processes in any designs for works in the river system.

The widespread loss of habitat for native animals can make revegetation works more difficult as the native animals that would benefit from the plantings destroy the plants while they are young. This is particularly conspicuous with damage wrought on River Gum and other eucalypts by cockatoos, corellas and other parrots. Windbreaks can act as corridors for animals to move between bushland remnants, but all of the animals are focussed into one thin strip of vegetation. Small ground-dwelling animals are easy pickings for predators such as foxes, cats and others.

In summary, the environment in which we live continually evolves but the rate of change achieved in almost 180 years of settlement within WA has resulted in significant modifications to the landscape and plants and animals within it. This report aims to describe the physical and biological features of the river system and provide suggestions for management by landholders, land conservation district committees, local and State government agencies and community members. Practical achievable suggestions are the key to continue to help maintain and improve the features that are loved and respected along the Chapman and Greenough rivers.

1.1 The need for this study

To date there have been few studies of the Chapman River and this lack of information about the health of the river has provided the impetus for this study. Further, many landholders and landcare groups are becoming increasingly interested in active foreshore management and are seeking more help from agencies such as the Water and Rivers Commission and Agriculture WA to deal with issues affecting the river.

The development of a standard methodology to assess foreshore condition in both rural and urban environments is helping to ensure consistency of information gathering. There are two standards for foreshore assessment – for rural areas Pen and Scott (1999), and in urban and semi-rural zones Shepherd and Siemon (1999).

This report presents the findings of work undertaken for the Water and Rivers Commission.



1.2 Community involvement process

The intended audience for the Foreshore Assessment is farmers, landcare district committees, State and local government officers and the community. A considerable amount of work went in to determining farmer interest in the river systems, identifying priority areas for survey and determining the level of support for this project. This was a critical component in gaining the funding from the Natural Heritage Trust.

Discussions were held with LCDC groups and individual landholders to determine specific areas of interest for each group. Each group identified priority river sections to undergo foreshore assessment. The locations selected included areas that were already a focus or are potential sites for future rehabilitation works.

The sites to be surveyed, as nominated by the people of the Chapman River region for these surveys, were as follows:

Table 1. Chapman River catchment selected sites

Site No	Location	Situated	Length km
1	Chapman River main channel	Upstream of Cutubury Reserve to Nolba	58.8
2	Chapman River east branch	Upstream from confluence	30.3
3	Chapman River	Nolba to Yuna	48.4

As a result of time constraints and access difficulties only a small section of the Chapman River east branch nominated was surveyed.

The community living along both the Chapman and Greenough rivers were encouraged to participate in the foreshore assessment survey of these rivers.

Landholders owning properties adjoining the rivers were contacted by mail to advise them of the intention to undertake the assessment. This letter also extended an invitation to attend one of three workshops at which the foreshore assessment survey process was described.

Articles were published in local papers and radio interviews held to encourage community involvement and to inform the wider community of the survey process and early findings.

Further letters were sent to keep landholders informed of the progress of the works. Finally, in September a letter was sent inviting landholders to a series of workshops at which the results of the survey were presented.

A total of 65 people attended the meetings collectively.

The community response was generally very supportive with many landholders providing valuable information on the history of the property and river, landuse, fires, fencing and erosion. Landholders also provided advice about the best way to access difficult parts of the river within their properties.

1.3 This report

This report summarises the results of the Foreshore Assessment Surveys using the foreshore condition assessment proforma (Pen and Scott 1999). It provides a description of the current status of the foreshore environment, and identifies major threats to the health of the area. Recommended strategies for appropriate management of future works on the focus foreshore areas are also detailed in the document. Information is provided on weed control techniques, recommended native species for foreshore rehabilitation and how to undertake soft engineering works.



2. The study area

The study area extends from the middle to upper reaches of the Chapman River. The foreshore assessment was conducted on the main channel of the Chapman River from upstream of Cutubury Reserve, Moonyoonooka, to Yuna and incorporates assessment of the lower section of Chapman River East.

2.1 The physical environment

The physical environment plays a major role in determining the vegetation complexes associated with the riparian zone of the waterway and susceptibility of the riverbanks and foreshores to erosion processes.

2.1.1 Geology, geomorphology and soils

The Chapman River commences near Yuna approximately 60 kilometres north east of Geraldton. The river meanders through the undulating sandplains of the northern Perth Basin to the granites and alluviums of the Northampton Block and cuts across the Moresby Ranges to the mouth located at Sunset Beach in Geraldton.

The undulating Eradu sandplain system that is dominant in the upper reach of the Chapman River (Yuna to Nolba catchment) comprises mainly of deep yellow siliceous sands and some alluvial deposits in the channel of the waterway. The foreshore of the Chapman River from Nabawa to Nolba is a component of the Northampton system, the gradational and duplex reddish brown sands and loams of the foreshore and alluvial terraces continuing to extend from Nabawa to Moonyoonooka on the eastern boundary of the waterway. The western boundary of the Chapman River from Nabawa to Moonyoonooka is within the Moresby system. This system on sedimentary rocks consists of clays, loams and sands on clay and sandy duplex soils on footslopes.

The sediments of the riverbed consists of well drained gradational red sands and loams that consist of minor areas of clay deposits which is characteristic of the alluvial valley system. Degredation of the riverbank, the riparian zone and the catchment area of the Chapman River has resulted in the mobilisation of sediment from erosion processes.

2.1.2 Climate

The Geraldton area of the Midwest region has a Mediterranean climate with distinctly dry hot summers. Maximum temperatures range from 19.0°C in winter (May to August) to 32°C in summer (November to March). The average rainfall for the Geraldton area is 464.9mm. Rainfall is receivable on an average of 85 days in the year, falling mainly during the winter season (May to August).

2.1.3 Hydrology

Annual rainfall and groundwater dynamics influence the hydrology of the Chapman River. The estuarine reach of the Chapman River is also subject to the hydrodynamics of tidal exchange.

Flow of the Chapman River is mainly dependent on rainfall events. During summer, the middle and upper reach of the Chapman River is sustained by the influence of groundwater discharge maintaining sections of the waterway that are ephemeral.

2.1.4 Bathymetry

The Chapman River is an intermittently closed estuarine system by the formation of a sand bar at the mouth of the river. Winter flows breach the sand bar separating the Chapman River from the ocean allowing tidal exchange of water. The estuarine reach of the Chapman River extends approximately 1.5 kilometres upstream from the mouth of the river.



3. Methodology

3.1 Implementing the survey

The foreshore assessment survey proforma has been developed to enable community groups to assess the condition of foreshores in rural areas. For detailed information on the methodology used to assess foreshore condition refer to Pen and Scott (1999). This methodology was developed for the southwest land division. There are some features of the proforma that reduce its effectiveness in the mid-west region, principally, downgrading of rivers due to a lack of permanent water and presence of salinity. For example, healthy saltmarshes are a natural part of these river systems and are not necessarily the result of degradation.

Further, the use of the summary forms for long river sections was inadequate due to the scale of properties. Providing yes or no answers is not particularly useful over tens of kilometres. These summary forms were modified to include proportional information. Documentation would otherwise have been minimal.

Geographic Positioning Systems (GPS) were also tested to assess the effectiveness of GPS in river mapping. This involved obtaining point data for the upstream and downstream end of key features in the riparian environment, i.e. significant sediment plumes or pools, large weed infestations or equivalent. Dimensions such as depth and width were also recorded.

As outlined above, the idea of the foreshore assessment survey process is to ensure consistency of information gathered over time, allowing the information collected from multiple surveys by various people to be collated. The accumulated information can then be used to prepare management plans and identify priority areas for rehabilitation. The results can also be used to monitor changes over time and to compare different foreshore areas; and be shared amongst State and local government authorities and the community.

3.1.1 Undertaking foreshore surveys

The foreshore areas were traversed and divided into relatively homogeneous sections of similar vegetation structure and landuse. A survey was conducted for each of these sections, and the condition of the foreshore parameters determined. Finally, the overall Stream Condition Index was determined.

In areas where foreshore vegetation was very dense on both banks, both sides were surveyed separately and a form was completed for each side. On highly degraded rivers where the foreshore along both banks was easily observed from one side, and the vegetation and disturbance factors were similar, a single survey form was completed for both sides.

Scaled baseline maps were prepared by WRC showing cadastral boundaries and the waterway. The cadastral information assists in identifying location out in the field. As each homogeneous section was identified, information was sketched onto baseline maps. Other information such as the composition and location of native vegetation along the foreshore, the location and extent of predominant weeds and the presence of disturbance factors such as discharge pipes and other infrastructure were detailed on each map. Fences and remedial works were also noted.

Note that the left and right sides of the main channel are defined by looking upstream.

3.1.2 Environmental parameters of foreshore condition

Principal environmental parameters are used as indicators of foreshore condition and are assessed during the foreshore survey to determine the overall Stream Condition Index.

These parameters are:

- bank stability;
- foreshore vegetation;
- stream cover;
- habitat diversity; and
- verge vegetation.



River zone assessment

The survey used a rating system to assess the health of the foreshore based on a method developed by Pen and Scott (1999). This system was developed for rivers in the southwest land division, and therefore required some amendments to improve the descriptions for rivers in the semi-arid zone.

The variations to the Pen and Scott (1999) methodology relate principally to the breakdown between erosion prone and unstable (C grade). In these systems, perennial grasses such as Couch contribute better support to the soil than annual grasses and herbs. This is because generally the likelihood of cyclone generated rains is greater than in the southwest, which is a winter rainfall dominated system. The frequency of summer rains in the mid-west regions increases the importance of having understorey cover all year round. The annual grasses have died back at this time of year, leaving the soil exposed and more prone to erosion during any flow event. Sections dominated by annual plants are rated lower than those retaining perennial vegetation cover.

Further, the Pen and Scott (1999) system rates rivers with permanent water more highly. While there are permanent pools in some sections of the Chapman River, this criterion has limited usefulness in rivers that are overall considered to be seasonal. The time taken for pools to dry out is more important in this environment. Permanent water may become a feature of these environments if there continue to be changes to groundwater levels in the mid-west region.

Verge vegetation is also included in the summary table for each river section to highlight this issue, however the overall ratings do not include this rating. The decision to exclude the presence of verge vegetation was made because the overall lack of vegetation would downgrade almost all ratings.

A brief overview of the key features and the grading system follows. This document provides ratings only to the four key levels (A, B, C and D). Landholders may wish to try to determine which sub-category is most appropriate for their land.

A grade foreshore

This overall rating is used for river embankments and floodways that are entirely vegetated by native plants. Occasional weeds may be present in small numbers, but if removed the native plants would retain their dominance. There is little evidence of erosion or slumping of the channel banks and across the floodway, limited sedimentation, seasonal river pools and little evidence of human interference. Limited evidence of livestock or feral animal damage also characterises this section.

This general category is divided further to reflect principally the level of weed invasion and evidence of disturbance into three sub-categories.

Rating	Key features
A1 Pristine	Entirely vegetated with native plant species and there is no evidence of human presence, livestock or feral animal damage.
A2 Near pristine	Native vegetation is dominant but with some introduced weeds in the understorey. The weeds are not displacing native species.
A3 Slightly disturbed	Native plants dominate but there are localised infestations of weeds and some exposed soil. This area would regenerate rapidly if there was reduced disturbance

B grade foreshore

This category covers foreshore areas where weeds have become a significant component of the understorey vegetation. The regeneration of all components of the native plant community is threatened and not all species are persisting within the community. There are some localised areas of erosion associated with weed dominated zones.

This general category is divided further to reflect principally the level of weed invasion and evidence of disturbance into three sub-categories.



Rating	Key features
B1 Weed infested	Weeds have become a significant component of the understorey vegetation and are starting to replace the native plants.
B2 Heavily weed infested	Introduced weeds are represented equally with native plants, particularly in the understorey. The weeds are limiting natural regeneration of native species.
B3 Weed dominated	Weeds dominate the understorey and the extent, diversity and abundance of native plants has been reduced significantly.

C grade foreshore

Trees and occasional large shrubs persist along the river lengths but the understorey consists entirely of weeds, particularly annual grasses. The trees are generally long-lived species but there is little or no evidence of young trees or tree seedlings. Physical disturbances to the soil tend to expose the soil, making it vulnerable to erosion.

The sub-categories now focus on the level of vegetation cover and the susceptibility of the substrate to wind and water erosion. Undercutting of mature trees, blowouts and other significant erosion features are common.

Rating	Key features
C1 Erosion prone	The understorey vegetation comprises exclusively or almost exclusively weeds. Typically there are mostly perennial weeds, some annual weeds and a single row or occasional stand of mature trees. Regeneration of native trees and shrubs is minimal. Most of the channel banks and floodway are vulnerable to erosion.
C2 Soil exposed	Older trees remain but there is minimal groundcover provided by annual weeds or any other plant. There is extensive physical disturbance to the soil and there is some evidence of erosion.
C3 Eroded	Weeds dominate the understorey and the extent, diversity and abundance of native plants has been reduced significantly. The soil is being washed away, particularly from around and beneath trees. There is considerable bank collapse, mobile sediment and washouts across the floodway.

D grade foreshore

There is not enough fringing vegetation to control erosion. While some trees and shrubs remain and slow the rate of erosion in localised areas, they are likely to be undermined. Large sediment plumes are visible along the river channel and it is likely that the course of river flow will increasingly fluctuate in the future.

Rating	Key features
D1 Eroding ditch	Weeds have become a significant component of the understorey vegetation and are starting to replace the native plants.
D2 Freely eroding ditch	Introduced weeds are represented equally with native plants, particularly in the understorey. The weeds are limiting natural regeneration of native species.
D3 Simple drain	

Greater detail about the system is provided in Table 3.

The Stream Condition Index is a summary of the foreshore environmental parameters and is an indication of the overall stream condition (Table 2).

Table 2: Stream Condition Index

Colour Code	Parameter Rating	Description
Blue A	Very Good	All parameters rated Blue.
Green B	Moderate	Three to four parameters rated Green or better with only one parameter rated Yellow and no Red ratings.
Yellow C	Poor	Three parameters rated Yellow or better with no more than one Red.
Red D	Very Poor	Three to all parameters rated Red.

3.1.3 Collating the results

The results compiled from the foreshore surveys of the selected sites were collated and a series of maps produced. These maps were digitised to enable presentation of the foreshore information in a visual format with corresponding text.



Table 3: The summary conditions of the environmental parameters assessed to determine foreshore health

	Bank stability	Foreshore vegetation	Stream cover	Habitat diversity	Verge vegetation
Blue (A) Very good	No significant erosion, slumping or sediment deposits in floodway or on lower banks; good native vegetation cover; only isolated areas of exposed soil or thinning vegetation.	Vegetation structure dominated by native plants that comprise 80-100% of the total number of species; weeds only scattered or rarely evident in small clusters; nil or minor signs of disturbance (i.e. tracks, rubbish dumping).	Abundant shade from overhanging vegetation; occasional instream cover from patches of aquatic vegetation and isolated heaps of leaf litter or rocks and logs.	Good water quality and some permanent water; at least three aquatic habitat types; at least one habitat type for terrestrial invertebrates; at least one habitat type for each terrestrial vertebrate category (frogs, reptiles and birds).	Relatively intact shrubland and woodlands adjoining the riparian zone. Structure dominated by native plants with minimal weed invasion and few signs of disturbance.
Green (B) Moderate	Some localised erosion, slumping and sediment deposits; native vegetation cover on verges may be patchy and interspersed with patches of exposed soil.	Some changes in vegetation structure, native plants comprising 50-80% of the total species composition; little revegetation of trees and shrubs; weeds occurring occasionally; moderate levels of disturbance.	Scattered fringing vegetation with occasional patches of shade; infrequent in-stream cover with little aquatic vegetation, very infrequent rocks and logs.	No apparent problems with water quality (i.e. muddy or cloudy in winter); at least two aquatic habitat types; at least one habitat type for terrestrial invertebrates; at least one habitat type for any two of the terrestrial vertebrate categories.	Vegetation patchy but comprises mostly native species. Native vegetation covers more than 50% of the section. Moderate levels of disturbance.
Yellow (C) Poor	Extensive active erosion, slumping and sediment deposition particularly during peak flows; bare banks and verges common.	Modified vegetation structure with native plants comprising only 20-50% of the total species composition. Trees remain with only scattered shrubs and an understorey dominated by weeds; high prevalence of disturbance.	Stream channel mainly clear; fringing vegetation almost absent providing very little permanent shade; instream cover almost absent with generally no instream vegetation and very infrequent rocks and logs.	Possible seasonal problems with water quality and no permanent water; at least one aquatic habitat type; at least one habitat type for terrestrial invertebrates; at least one habitat type for one of the terrestrial vertebrates.	Verge vegetation minimal with occasional individual plants or small groups of plants. Usually shrubs and occasional trees with a dense understorey of weeds. Numerous signs of disturbance and minimal regeneration of native seedlings.
Red (D) Very Poor	Almost continuous erosion; over 50% of banks slumping; sediment heaps line or fill much of the floodway; little or no vegetation cover.	Insufficient vegetation to control erosion; natural vegetation structure absent with occasional native trees and shrubs comprising less than 20% of the total species composition; weeds abundant; very high prevalence of disturbance and extensive areas of exposed soil.	Zero or minimal stream cover with no permanently shaded areas and no instream cover.	Poor water quality; almost no healthy habitats available for aquatic and terrestrial organisms.	Vegetation adjoining the riparian zone is minimal or absent. Disturbance is conspicuous.

Modified from Shepherd and Siemon (1999).

The summary codes of the condition of environmental parameters and the Stream Condition Index are included on the summary map for each site.

This report also contains a detailed description of the key findings for the five environmental parameters assessed for each survey section within the nominated survey sites. Strategies for appropriate remedial works are recommended for each section.



4. Summary results

The overall breakdown of river condition assessed in this mapping process is outlined below. The total lengths of river achieving each rating has been measured.

Rating	No kilometres
A – Very Good	7,370m
B – Moderate	31,795m
C – Poor	67,910m
D – Very Poor	47,970m

Within this framework, the river was divided into 21 overall sections. The Chapman River section ratings have been averaged and are summarised below. Within this average, there is a range of ratings. The average ratings for each river section are listed below.

SECTION 1: YUNA TOWNSITE TO YUNA ROAD CROSSING MAPS 1 – 9

Length of section (m): 8,520m

Recorders' name: N Siemon and T Rebola

Date surveyed: 9 May 2000

Nearest road access: Geraldton-Yuna Highway

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Moderate – B	Very Good – A	Moderate – B	Very Good – A

SECTION 2: YUNA ROAD CROSSING TO ROCKWELL MAPS 1 – 2

Length of section (m): 2,340m

Recorders' name: N Siemon and T Rebola

Date surveyed: 9 May 2000

Nearest road access: Geraldton-Yuna Highway

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Very Good – A	Poor – C	Poor – C	Moderate – B	Moderate – B

SECTION 3: ROCKWELL MAPS 1 – 2

Length of section (m): 1,680 m

Recorders' name: N Siemon and T Rebola

Date surveyed: 10 May 2000

Nearest road access: Geraldton-Yuna Highway

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

SECTION 4: CHAPMAN RIVER MAPS 1 – 4

Length of section (m): 3,470m

Recorders' name: N Siemon and T Rebola

Date surveyed: 10 May 2000

Nearest road access: Chapman Valley Road

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Very Good – A	Very Good – A	Good – B	Very Good – A



SECTION 5: NOLBA CREEK CATCHMENT MAPS 1 – 8**Length of section (m):** 4,030m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 11 May 2000**Nearest road access:** Old Nolba Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Poor – C	Very Poor – D	Very Poor – D	Poor – C	Poor – C

SECTION 6: NOLBA CATCHMENT MAPS 1 – 17**Length of section (m):** 3,300m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 11 May 2000**Nearest road access:** Old Nolba Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

SECTION 7: NOLBA CATCHMENT MAPS 1 – 2**Length of section (m):** 2,150m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 11 May 2000**Nearest road access:** Nolba Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Moderate – B	Poor – C	Poor – C	Moderate – B	Moderate – B

SECTION 8: CHAPMAN RIVER MAPS 1 – 11**Length of section (m):** 16,320m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 12 May 2000**Nearest road access:****Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Very Poor – D	Very Poor – D	Very Poor – D	Poor – C	Very Poor – D

SECTION 9 UPSTREAM OF DINDILOA ROAD MAPS 1 – 2**Length of section (m):** 1,190m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 15 May 2000**Nearest road access:****Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Moderate – B	Moderate – B	Moderate – B	Very Poor – D	Moderate – B



SECTION 10: CHAPMAN RIVER MAPS 1 – 3**Length of section (m):** 3,240m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 15 May 2000**Nearest road access:** Dindiloa Bowles Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Left bank					
Poor – C	Poor – C	Very Poor – D	Poor – C	Very Poor – D	Poor – C
Right bank					
Poor – C	Poor – C	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

SECTION 11: CHAPMAN RIVER MAPS 1 – 3**Length of section (m):** 1,730m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:****Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Very Poor – D	Poor – C	Very Poor – D	Very Poor – D	Very Poor – D

SECTION 12: RUSHY GULLY MAPS 1 – 2**Length of section (m):** 1,300m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Nabawa - Northampton Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Very Good – A	Very Good – A	Poor – C	Very Good – A

SECTION 13: RUSHY GULLY MAPS 1 – 2**Length of section (m):** 2,680m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Nabawa - Northampton Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Poor – C	Moderate – B	Poor – C	Very Poor – D	Poor – C

SECTION 14: NABAWA TOWNSITE MAPS 1 – 5**Length of section (m):** 6,850m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Moderate – B	Moderate – B	Moderate – B	Very Poor – D	Moderate – B



SECTION 15: DOWNSTREAM OF NABAWA TOWNSITE MAPS 1 – 3**Length of section (m):** 6,560m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Poor – C	Poor – C	Very Poor – D	Very Poor – D	Poor – C

SECTION 16: CHAPMAN RIVER MAP 1**Length of section (m):** 1,210m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Very Good – A	Very Good – A	Very Poor – D	Very Good – A

SECTION 17: NANSON TOWNSITE MAPS 1 – 3**Length of section (m):** 3,470m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Moderate – B	Very Good – A	Moderate – B	Poor – C	Moderate – B

SECTION 18: CHAPMAN RIVER MAPS 1 – 15**Length of section (m):** 20,430m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 19 May 2000**Nearest road access:** Chapman Valley Hwy and Murphy Yetna Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Moderate – B	Poor – C	Poor – C	Very Poor – D	Poor – C

SECTION 19: CHAPMAN RIVER AND CHAPMAN RIVER EAST MAPS 1 – 6**Length of section (m):** 7,000m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 19 May 2000**Nearest road access:** Moonyoonooka Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Poor – C	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D



SECTION 20: CHAPMAN RIVER MAPS 1 – 7**Length of section (m):** 8,690m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 22 May 2000**Nearest road access:** Narratarra Moonyoonooka Road and Giles Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Poor – C	Poor – C	Very Poor – D	Poor – C	Poor – C

SECTION 21: CHAPMAN RIVER MAPS 1 – 5**Length of section (m):** 4,830m**Recorders' name:** N Siemon and T Rebola **Date surveyed:** 5 October 2000**Nearest road access:** Moonyoonooka Road and Narratarra Moonyoonooka Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Moderate – B	Moderate – B	Moderate – B	Moderate – B	Moderate – B



5. Site reports

This section of the report provides a series of descriptions of river sections with characteristics in common. The length of the river sections covered by the descriptions ranges from less than 200 m to several kilometres. The report follows the standards set for naming flora in a recent publication by Paczkowska and Chapman (2000). All common names for plants observed have been taken from this document. The maps provide indicative information about the vegetation characteristics at the time of survey. The river sections surveyed prior to the onset of winter rains have fewer weed species listed, however this does not

necessarily mean that they are not there as many annual weeds had not yet germinated. The maps are a tool for each landholder to use to continue documenting changes to their river section, and to monitor the health of their river section. Each landholder should feel free to add information to the map for their section to monitor weed control success for example.

The suggestions in the report are intended to help landholders meet their land management objectives while protecting and potentially improving the natural values of the waterways.

5.1 Specific site reports

SECTION 1: YUNA TOWNSITE TO YUNA ROAD CROSSING MAPS 1 – 9

Length of section (m): 8,520m

Recorders' name: N Siemon and T Rebola **Date surveyed:** 9 May 2000

Nearest road access: Geraldton-Yuna Highway

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Moderate – B	Very Good – A	Moderate – B	Very Good – A

Bank stability

The Chapman River originates in the Yuna region. The waterway runs through a low saltmarsh, with a wide shallow floodplain. The bank stability is very good. The channel banks are generally flat or rise on a slight gradient along the entire length. While waterlogging is common, it is not currently causing a decline in vegetation or channel bank stability. The main river channel at the time of survey ranged between 2 m and 12 m. There is evidence of some river training in the past. The flow is constricted in two locations because of the construction technique used to provide access across the river. These crossings generally have minimal numbers of culverts, and rarely meet the natural flow width. The floodplain ranges from 80 m to 140 m wide. The soil is generally crust forming clay.

Comments

The culvert beneath Forrester Brooks Road is unstable and would benefit from some modification to reduce ponding and subsequent stagnation of water upstream of the crossing. Stormwater drainage from the townsite

does not currently appear to be impacting on the health of this marsh, however any future changes to surface water hydrology should be considered, to minimise the rate of influx into the saltmarsh.

Vegetation

The characteristic vegetation in this section is low, dense herbland dominated by salt tolerant plants such as Shrubby samphire (*Halosarcia halocnemoides*), Beaded samphire (*Sarcocornia quinqueflora*) and some Bluebush (*Maireana* spp.) on the margins. The saltmarsh is healthy, actively regenerating and maintaining a stable equilibrium. There are occasional stands of long dead trees, indicative of a change in the environment in the past. There are occasional stands of native Cumbungi (*Typha domingensis*). Fleabane (*Conyza bonariensis*) occurs in moderate to high densities in limited areas within this section.

The verge vegetation comprises an open mallee woodland, patchy shrubland and minimal understorey. York gum (*Eucalyptus loxophleba*) occurs periodically with Broom bush (*Melaleuca uncinata*) and Sheoak



(*Allocasuarina campestris*) forming a relatively dense middlestorey with Flax lily (*Dianella revoluta*) and Yam (*Dioscorea*) periodically. Persistent native grasses such as Silky heads (*Cymbopogon oblectus*) and Kangaroo grass (*Themeda australis*), remain in the understorey.

Comments

There is limited revegetation work on the margins of the floodway. The instream and floodway vegetation is currently in very good condition, however there are localised areas of death associated with ponding of the water. The rate of the decline needs to be monitored and action taken to improve through flow if the loss of plants becomes more widespread.

The verge vegetation is also in moderate to very good condition. The low stocking levels and/or stock-free status are helping to protect this vegetation.

Stream cover

There is minimal stream cover. There is some instream debris and aquatic vegetation, providing cover for aquatic animals.

Comments

Protecting any existing stream cover is important within saltmarsh systems. These systems often have limited overhanging vegetation and little stream cover. Minimising loss of remnant vegetation immediately adjoining the main channel is an important part of maintaining some stream cover.

Habitat diversity

The water is unlikely to be permanent and was clear in colour. The water depth varies but is shallow, ranging between 0.1 and 0.4 m in depth. The instream vegetation and scattered rocks and branches also provide some habitat. The dense stands of Cumbungi along the floodway currently provide some cover for terrestrial organisms. Waterbirds feeding in the mudflats also have access to trees in which they can roost and nest. The instream vegetation provides protection for aquatic invertebrates.

Comments

As outlined above, it is important to monitor the saltmarsh health to ensure that it is not left to decline with increasing waterlogging.

Other issues

This section is partially fenced. Where fences exist they are in excellent to very good condition.

Suggestions

Bank stability

- B Modify the culvert beneath Forrester Brooks Road if the opportunity arises, to improve water movement.
- B Ensure that drainage plans for any future developments within the townsite of Nolba and nearby areas are considered in the context of additional freshwater flows to the river system.
- B Investigate groundwater conditions to determine whether or not it is likely that the waterlogging will occur for a longer duration and cover a wider area. If it becomes necessary, develop a strategy to manage water movement to prevent widespread loss of the saltmarsh.

Vegetation

- V Monitor the saltmarsh health and act to improve water flow if widespread deaths start to occur.
- V Encourage landholders to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Maintain instream branches and logs where these features do not exacerbate erosion.

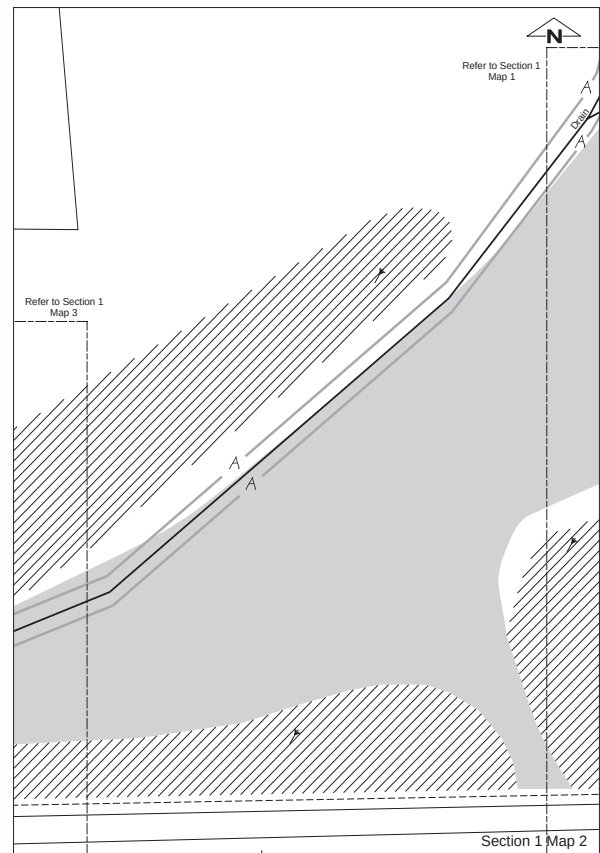
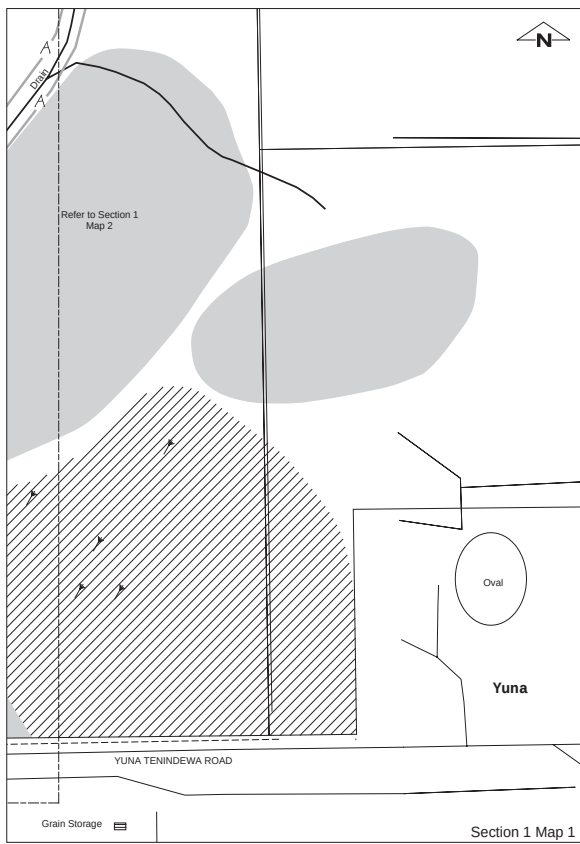
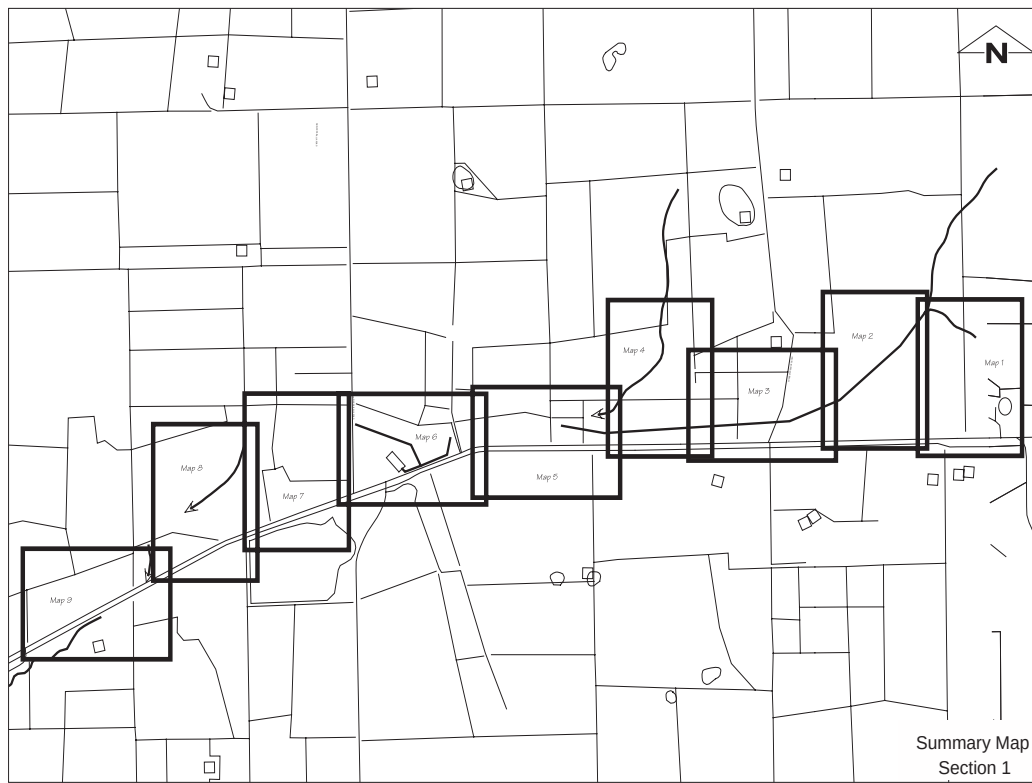
Habitat diversity

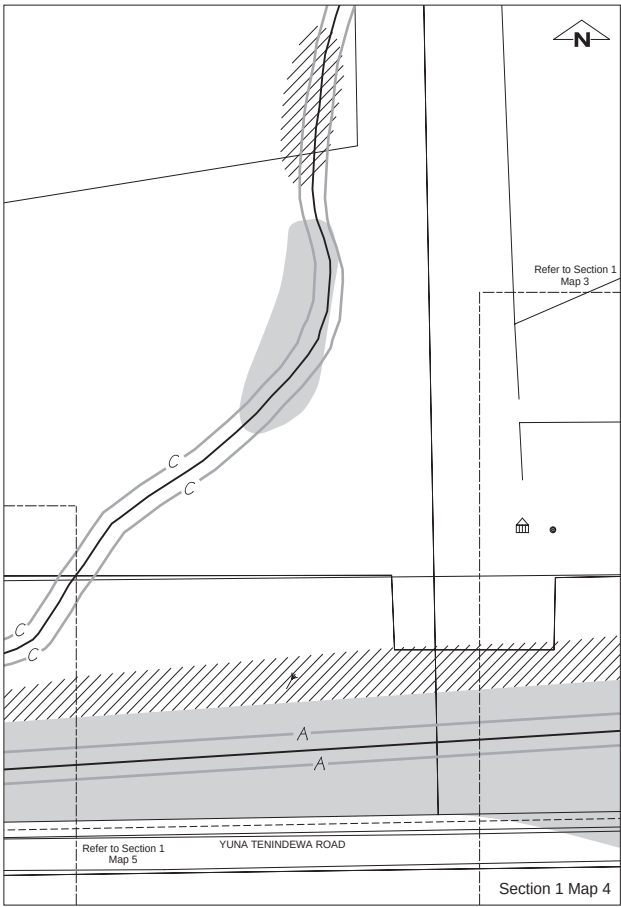
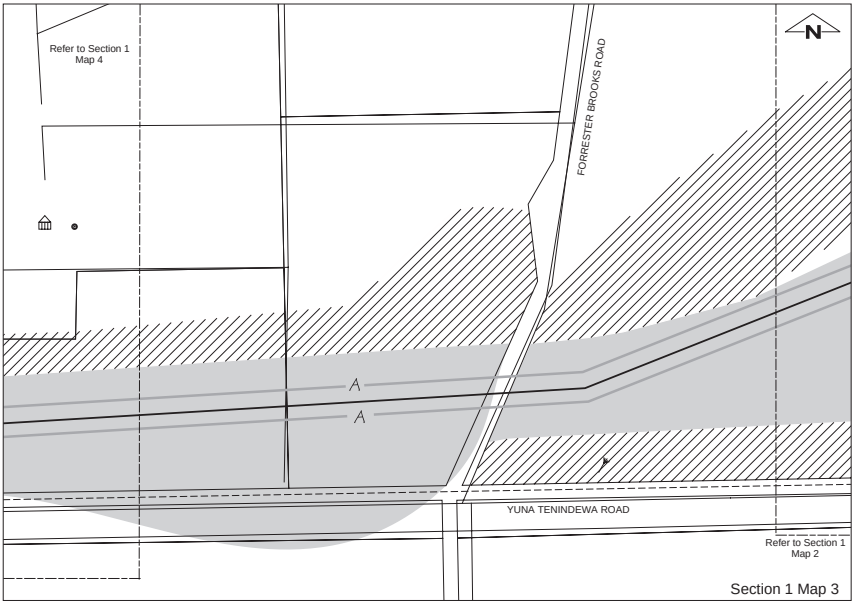
- H Monitor groundwater expression and develop contingency plans to enhance water flow at causeways and crossings to minimise the extent and duration of waterlogging.

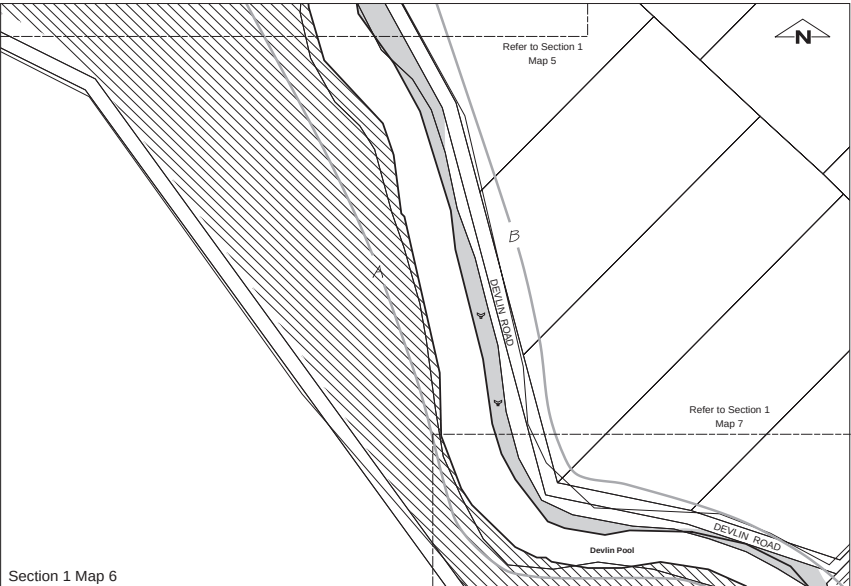
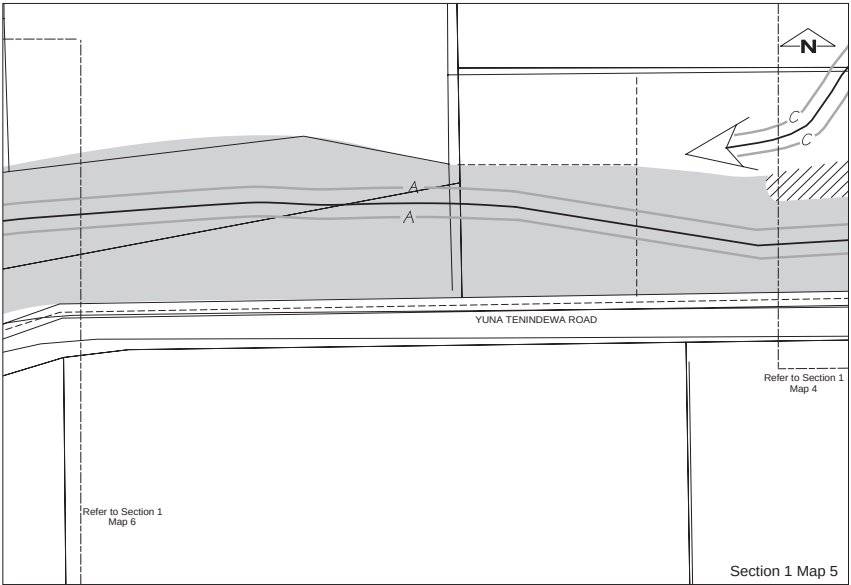
Other issues

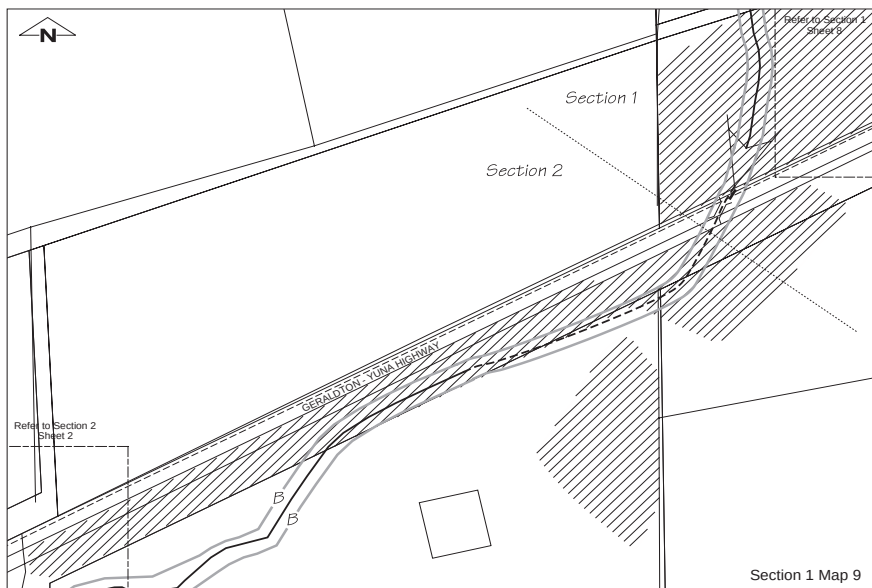
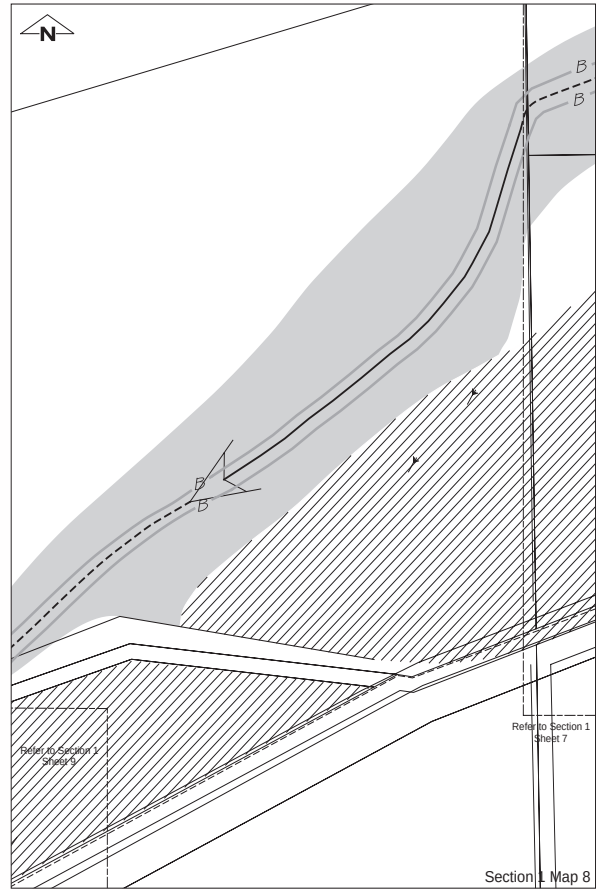
- O Maintain current fencing and fence any currently unfenced sections prior to any short-term addition of stock.
- O Aim for a 'no stock' policy in the samphire flats to protect the soil structure.











SECTION 2: YUNA ROAD CROSSING TO ROCKWELL MAPS 1 – 2**Length of section (m):** 2,340m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 9 May 2000**Nearest road access:** Geraldton-Yuna Highway**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Very Good – A	Poor – C	Poor – C	Moderate – B	Moderate – B

Bank stability

The channel banks are more clearly defined in this section than through the saltmarsh. The low flow channel banks have moderate to steep slopes rising to a height of 1 m, and are between 1.5 m and 4 m apart. The section has localised areas of undercutting and erosion. The erosion occurs on less than 20% of the section and is associated with semi-formal and formal crossings. There is often pooling of water upstream of the crossings.

Comments

It is unlikely that the banks will be subject to any significant change if current conditions are maintained. If there are changes to the groundwater conditions in the future, then this may impact on some aspects of bank stability. In the event that the township is developed and additional infrastructure established, the increased surface runoff may impact on the flow characteristics of the waterway.

Vegetation

Saltmarsh vegetation continues to be the dominant vegetation type close to the main channel. The density of *Halosarcia*, *Sarcocornia* and related saltmarsh plants is lower than in the previous section, and is classified as moderate. On the margins of the floodway, there is some weed invasion. Lupins (*Lupinus cosentinii* and *L. angustifolius*) are present along with Wild radish (*Raphanus raphanistrum*), Fleabane (*Conyza bonariensis*) and Saffron thistle (*Carthamus lanatus*).

The verge vegetation is quite diverse and of moderate density, with a range of hakeas, wattles and occasional York gum (*Eucalyptus loxophleba*). The understorey retains some native plants, and introduced grasses are common along road verges. There are numerous trees that have been dead for many years.

Comments

There is limited natural regeneration in this river section. There is limited weed invasion within the floodway, with most of the weeds occurring along tracks, in disturbed areas and adjoining farmed land. The tree deaths are likely to be the result of prolonged inundation caused by insufficient flow beneath crossings.

Stream cover

The stream cover is moderate in this section. There are some saltmarsh plants overhanging the main river channel. Further, there is patchy overstorey contributing shade. There is occasional woody debris.

Comments

Protecting the health and extent of vegetation is the key principle for retaining and improving stream cover.

Habitat diversity

The habitat diversity is also moderate. There is instream vegetation and rocks that aerate the water as it flows downstream. Well-oxygenated (aerated) water provides excellent habitat for aquatic animals. Very few aquatic invertebrates were seen or heard at the time of the survey, which may have been a reflection of the time of year. The water was very clear, lacking tannins, which is expected as the waterway has very little vegetation producing leaves with these compounds. The clarity of the water is another indicator of high salt levels. Scattered instream features such as branches and logs provide limited habitats for aquatic animals.

Shrubland birds are present where the verge vegetation is relatively dense, and there are roosting and nesting sites in the patchy York gum. Waterbirds may occasionally access the dam.



Comments

The lack of aquatic invertebrates is likely to be a reflection of the relatively high salt levels in this section of the Chapman River. This site would be an interesting location for comparative studies against areas downstream.

Protecting the verge vegetation from fire is considered to be important. The lack of continuity of vegetation in this position across the landform threatens the long-term survival of many species within this category. The populations are becoming more isolated.

Other issues

As mentioned above, there are some crossings, particularly a former rail crossing that is impacting on stream flow. There is some road drainage that is also contributing to localised erosion issues. The railway bund is acting as a levee bank across the floodplain, which, while reducing the impact on the road, is likely to be increasing tree deaths following prolonged inundation.

The road itself is also acting as a bund, with small culverts that are insufficient to maintain water movement. The culverts appear to be sufficient for low flow conditions only.

There are fences along both sides of this section, in variable condition.

There is a dam and water extraction point within the floodplain, and one windmill present.

Comments

There is a need to maintain consistent water flow and ensure adequate drainage. The dam provides a useful site to assess water quality.

Suggestions

Bank stability

- B Link with groundwater monitoring programs and review the status of the levels regularly to determine if there is a threat of increased fluctuations in the course of river flow.
- B Ensure surface water management and disposal is considered when upgrading access roads, causeways and the townsite.

Vegetation

- V Eradicate Wild radish, Lupins, Fleabane and Saffron thistle while their populations are manageable.
- V Control weeds along access tracks and roadsides leading to the river.
- V Monitor natural regeneration processes within the saltmarsh and verge vegetation, and if necessary reinforce with overstorey, middlestorey and understorey species.
- V Control introduced annual grasses using flauzifop-butyl or slashing to reduce the fire risk associated with these species.
- V Review river flow through this section and upgrade to increase culvert capacity during low flow conditions if feasible.
- V Encourage landholders to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Maintain instream branches where these features do not exacerbate stream erosion.
- S Monitor plant health in the floodway with the aim of preventing any widespread loss of samphire species.

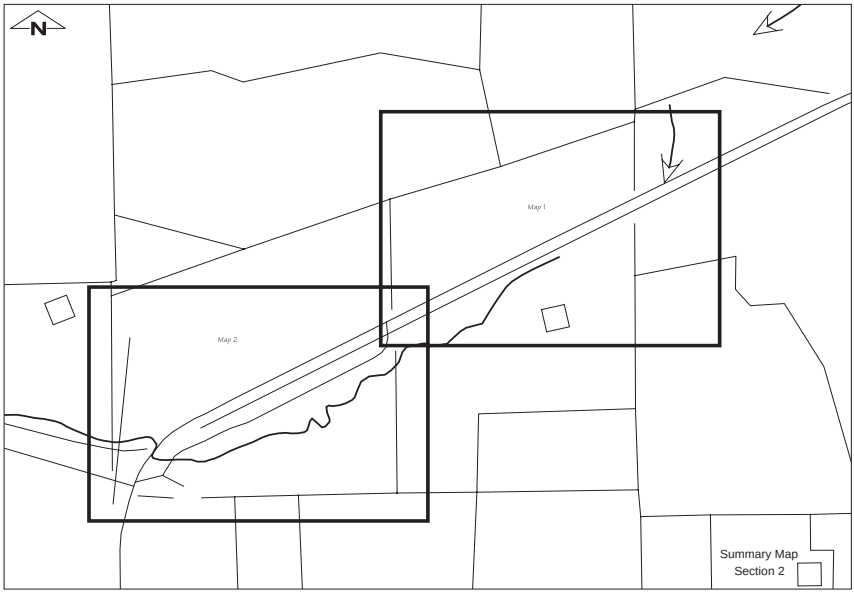
Habitat diversity

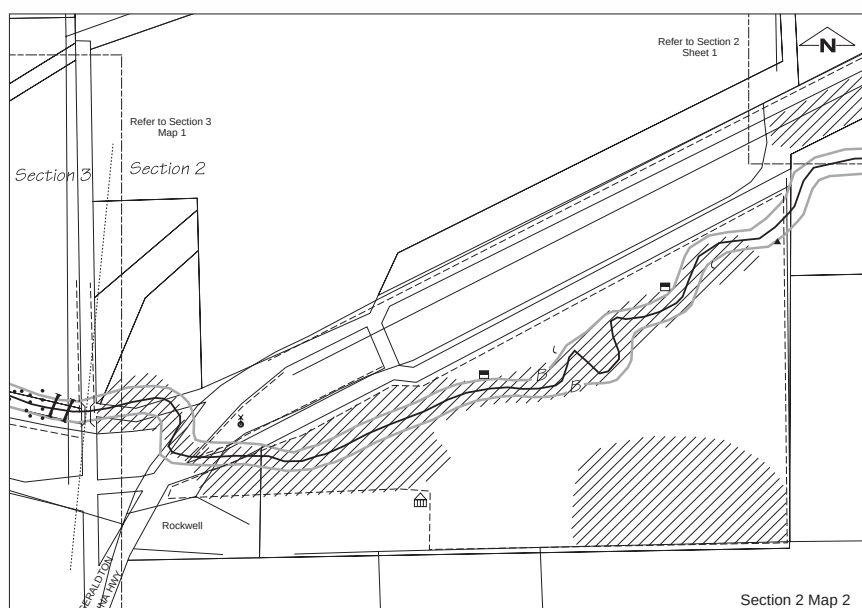
- H Control weeds, especially those that increase the fire risk, along the margins of the verge vegetation.
- H Reinforce the overstorey if required by planting tubestock where weeds are effectively controlled.
- H Monitor the health of vegetation in the floodway and on the verge over time, and liaise with Water and Rivers Commission, Department of Conservation and Land Management and Agriculture WA if a decline is noted. This will enable a strategy to be developed to sustain vegetation cover in the long-term.

Other issues

- O Review flows beneath all of the crossings in this section under different flow conditions to develop a strategy to reduce ponding.







SECTION 3: ROCKWELL MAPS 1 – 2

Length of section (m): 1,680 m

Recorders' name: N Siemon and T Rebola

Date surveyed: 10 May 2000

Nearest road access: Geraldton-Yuna Highway

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

Bank stability

The channel banks are more clearly defined in this section than through the saltmarsh, as a result of considerable modifications to the river channel that have negatively impacted on the river's form and function. These appear to relate to management of saline waters. The main river channel is between 1.5 m and 4 m wide with the foreshore banks rising on a moderate to steep slope to a height of 2 m. At the time of survey, the water depth ranged from less than 0.15 m to 0.4 m. There are localised areas of undercutting, slumping and erosion. Erosion occurs on between 20% - 40% of the section. There are erosion rills in areas where cropping occurs within 2 m of the main river channel.

The river crossing (ford) at the uppermost end of this section is impacting on stream flow, and is likely to be difficult to cross during peak flow conditions.

The substrate comprises loam, white clay and some granite.

There was a seep on the left bank at the downstream end of this section. The seep (water expression) occurs approximately 100 m upslope of the floodplain. There are small areas of mud erupting in this region.

Comments

The rocks comprising the river crossing could be rearranged slightly to improve the ford. The current arrangement blocks the flow and deflects the water into an existing fenceline. These rocks could be realigned to direct the flow into the main channel.

The constructed drains in the river channel need to be reviewed urgently. Restoring river function and re-establishing boundaries are important. Modifying the bed and banks without approval from the Water and Rivers Commission is not permitted under the *Rights of Water and Irrigation Act 1914*.

Vegetation

There is very little vegetation in this section. Annual grasses, crop plants and pasture weeds are the dominant plants in this entire section. There are occasional native understorey plants that are indicative of moderate to high salt levels including Water buttons (*Cotula coronopifolia*) and Bluebush (*Atriplex* spp.), Shrubby and Beaded samphires (*Halosarcia halocnemoides* and *Sarcocornia quinqueflora*) and occasional Shore rush (*Juncus kraussii*). These occur in the areas that have not been subject to modification. There are also two isolated clumps of Knotted club rush (*Isolepis nodosa*) and one small stand of the native Cumbungi (*Typha domingensis*). There is a dense stand of Shore rush (*Juncus kraussii*) between the seep and the river channel.

There are some trees in this section that have been dead for a long time.

The verge vegetation is quite diverse but very limited in extent and density. There is a range of *Hakeas*, Wattles and occasional York gum (*Eucalyptus loxophleba*) and *Lasiopetalum*. The understorey is very limited with only occasional Mulla mulla (*Ptilotus* spp.) and one native grass persisting in the weed assemblage.

There has been some revegetation effort with variable success. This is generally limited to five rows. Some of these areas are fenced.

The range of weeds in this section has increased considerably in comparison to the upstream sections. Weeds present include Cape weed (*Arctotheca calendula*), Pie melon (*Citrullus lanatus*), Annual Wimmera ryegrass or Drake (*Lolium rigidum* or *L. temulentum*), Wild radish (*Raphanus raphanistrum*), Wild turnip (*Brassica barrelieri*), Lupins (*Lupinus cosentinii* and *L. angustifolius*), Roly poly (*Salsola kali*), some Couch in the main river channel, Black berry nightshade (*Solanum nigrum*). There was also one small stand of Tamarisk.

Some cropping wheat has escaped into the understorey and river verges.

Comments

The presence of the Knotted club rush (*Isolepis nodosa*) is unusual and is likely to be as a result of a direct seeding project. This species was limited to a very small section of the Chapman River, and does not occur again until the estuary and river mouth.

Stream cover

The stream cover is negligible in this section. There is no vegetation overhanging the stream. There is insufficient instream woody debris, algae or rocky zones to maximise habitat. This is not to say that there are no flora or fauna present in this section, just that the diversity and numbers are likely to be low. The salt levels appear to be extremely high in this section. The water was exceptionally clear and salt was crusted on the clay banks.

The seep (groundwater expression) at the downstream end of this section, however, has excellent stream cover for the surface water from the point of discharge to the river channel.

Comments

The modifications to the channel characteristics have resulted in the loss of almost all stream cover. By restoring vegetation to the margins of the channel and through the verge, additional detritus and leaf and branch litter may enter the watercourse. The occasional green filamentous alga present has a limited capacity to provide habitat.

Habitat diversity

There is minimal habitat in this river section. Considerable modifications to the river environment have resulted in a loss of available instream and bank habitat and vegetation cover. The hypersaline, clear waters have limited habitat value as very few aquatic animals are tolerant of such conditions. There were some small fish present. Two significant remnants of verge vegetation (beyond the floodway) enhance the habitat values of this area.

The seep in comparison has considerable habitat diversity, but is limited in extent. Frogs were heard



calling at the time of survey, and there was considerable invertebrate life including herbivores, predators and omnivores. This indicates relatively good health for this section. The water coming from the spring is likely to be brackish or at the fresher end of the scale. This assumption is based on the vegetation types and frogs present.

Comments

The value of the remnant wetland through which the seep runs cannot be emphasised enough. This was the first area providing suitable habitat for a wide range of invertebrate and vertebrate species. The river needs considerable work to restore ecological attributes.

Other issues

The fencing is variable, occurring adjacent to the road on the right bank while the left bank is unfenced. Where fences are present the alignment is excellent, provided the area has minimal use for stock. Cropping is occurring within 2 m of the top of the altered channel banks and minor levee banks have been constructed. These banks, along with the proximity of the crops, have increased the risk of severe erosion arising from any peak flow events. These ditches are draining hypersaline water to the river in a continuous flow, rather than the periodic slug that is likely to have occurred in the past.

Comments

This site requires urgent review to minimise damage to the wetland and riparian zones downstream. Further, the levee banks are altering the flow characteristics of the river. The current strategy of cropping close to the main river channel is one that has considerable risks attached. Peak flows are likely to remove most of the topsoil from the floodway and there is the potential for the course of river flow to fluctuate in the future.

The river crossing is likely to be difficult to use during peak flow conditions.

Suggestions

Bank stability

- B Encourage the landholder to contact the Water and Rivers Commission to review the changes to the waterway and modify as appropriate.

- B Provide information to the landholder about preferred management techniques: encouraging protection of the foreshores and native vegetation, and techniques to minimise other potential impacts of poor management.
- B Encourage the landholder to fence off at least 15 m on the left bank to prevent cropping in this section.

Vegetation

- V Implement intensive revegetation effort on left bank.
- V Stop cropping within 2 m of channel and restore a sufficient buffer of native vegetation to reduce the likelihood of the course of river flow changing in the future.
- V Control Roly poly and other species occurring in low densities, before their populations take off.
- V Encourage landholders to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Focus attention on restoring vegetation cover to the riparian and verge zones along this entire section.
- S Consider stream cover if a strategy to restore the river channel is developed.

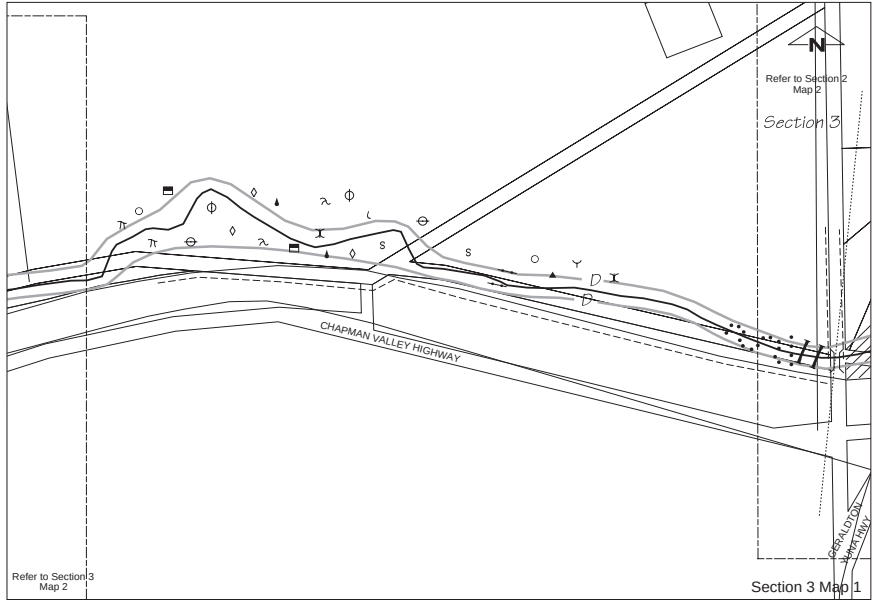
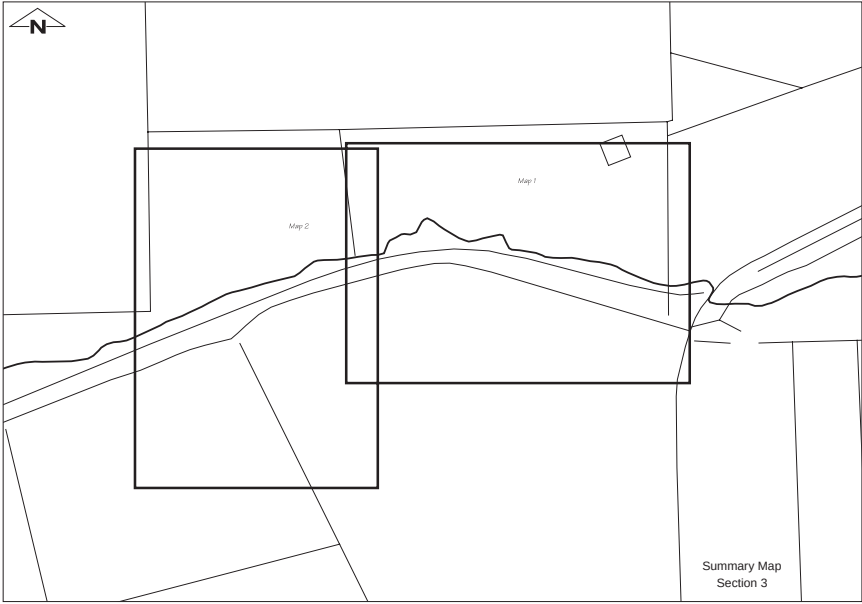
Habitat diversity

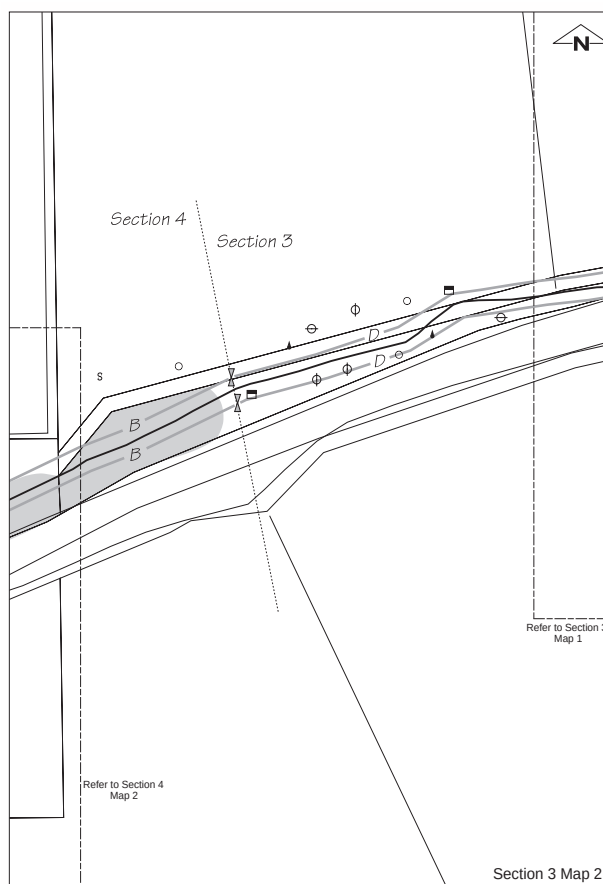
- H Link the existing remnant vegetation with revegetation works in the floodplain.
- H Continue revegetation works across the channel and floodway. Plantings may need to be protected from peak flows.

Other issues

- O Provide landholder with information packs about river processes and encourage discussion about modifying the channel characteristics.
- O Obtain advice about river crossings and re-arrange existing materials to improve it.
- O Encourage the landholder to modify current cropping practices and aim to restore vegetation cover to this river section.







SECTION 4: CHAPMAN RIVER MAPS 1 – 3

Length of section (m): 3,470m

Recorders' name: N Siemon and T Rebola

Date surveyed: 10 May 2000

Nearest road access: Chapman Valley Road

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Very Good – A	Very Good – A	Good – B	Very Good – A

Bank stability

The main river channel ranges between less than 1 m to 8 m wide. In areas retaining dense vegetation, the channel is narrow and the banks have slight to moderate slopes only 1 m apart. The channel width spreads up to 4 m and 8 m apart in areas lacking understorey. The wider sections have localised areas of undercutting and erosion, with the erosion occurring along less than 20% of the section. The erosion is associated with semi-formal and formal crossings and at the base of trees growing along the foreshore banks. Stock crossing points are resulting in the breakdown of the soil structure, resulting in localised slumping. Sedimentation is also localised along the river channel with deposition evident along 5 – 20% of the main

channel. The width of the floodplain varies from 30 m to 100 m. The right valley bank was generally steeper than the left bank.

Comments

The bank stability is generally excellent due to the dense understorey of rushes and sedges, protecting the foreshore and riverbanks from the erosive forces of water. The localised areas of erosion are linked with stock and vehicle crossings of the floodway. Formalising these crossings may reduce the localised erosion. Further, maintaining current stock access or reducing this access may help to protect the vegetation in the longer term. Careful monitoring will help prevent any additional damage from occurring.



Vegetation

The dominant vegetation has changed in this section, reflecting the significant fresh to slightly brackish water influx from a natural spring. The dominant species of plants are Shore rush (*Juncus kraussii*) with patches of Spiny flatsedge (*Cyperus gymnocaulos*). The rushes form closed sedgelands with limited sections that are tree dominated.

The first significant stands of Swamp sheoak (*Casuarina obesa*) and River gum (*Eucalyptus camaldulensis*) occur in this section. The overstorey is patchy (20 – 80% cover), ranging from a single row of trees to dense closed woodlands providing small areas of continuous cover. The middlestorey is absent, with juvenile trees uncommon. The understorey is continuous (>80% cover), and is dominated by native plants in the floodway. The native Cumbungi (*Typha domingensis*) is present in large stands, and there are occasional patches of Saw sedge (*Gahnia* sp.). Weed infestation is minimal within the floodway. Occasional Fleabane (*Conyza bonariensis*), Black berry nightshade (*Solanum nigrum*) and Wild turnip (*Brassica barrelieri*) occur periodically. The groundwater seep has enabled the wetlands to extend up the slope.

On the margins of the floodway, there is frequent weed invasion. The dominant weeds include Fleabane (*Conyza bonariensis*), Saffron thistle (*Carthamus lanatus*), Pie melon (*Citrullus lanatus*), Wild turnip (*Brassica barrelieri*) and Black berry nightshade (*Solanum nigrum*). Annual grasses and Doublegee (*Emex australis*) are also present.

The verge vegetation is quite poor and is only present to a limited extent on the right bank. The overstorey and middlestorey are very patchy (<20%) and include a range of *Hakeas*, wattles and occasional York gum (*Eucalyptus loxophleba*).

Comments

The remnant vegetation is sufficient to exclude most weeds, however weeds are gaining a foothold in areas that have been disturbed. The disturbance is mostly associated with stock movement across the foreshore area. Controlling weeds on the margins will ultimately benefit the river environment. The density and extent of Pie melon on the floodway margins in this area were

significant, while other weed species are present in moderately low numbers. Selective management of weeds is currently achievable. The extent and diversity of verge vegetation is limited, although there are some remnants on the hill slopes. Increasing the native vegetation on the floodway margins will help to direct any peak flows, as well as providing habitat for native fauna. Dense native vegetation between paddocks and the riparian zone also helps to reduce weed invasion by trapping seeds and segments and out-competing the introduced plants.

Stream cover

The stream cover is moderate in this section. There are some saltmarsh plants and rushes and sedges overhanging the main river channel. Further, the relatively dense overstorey contributes some shade. Instream leaf material, branches and occasional rocks provide considerable areas of localised cover.

Comments

Maintaining the vegetation health and reducing stock traffic would help to maintain good stream cover in the long-term. This vegetation community has sufficient resilience to deal with changing hydrology but may be threatened if additional stresses are placed on the vegetation. The spring that feeds into this river section provides an important haven for native animals during the dry summer months.

Habitat diversity

The habitat diversity is also moderate. There is instream vegetation and rocks which aerate the water as it flows downstream. Well-oxygenated (aerated) water and instream vegetative material provide excellent habitat for aquatic animals. The water depth ranged from less than 50 mm to 300 mm deep at the time of survey. Very few aquatic invertebrates were seen or heard during the survey, although this site warrants further investigation. The water was very clear, lacking tannins, which is expected as the waterway has very little vegetation producing leaves with these compounds. The clarity of the water may also have been indicative of high salt levels. The dense understorey and patchy overstorey provide considerable habitat for native fauna including many predators (spiders, woodland birds, frogs and small reptiles).



Comments

The lack of evidence of aquatic invertebrates may have been a reflection of the time of year and prevailing weather conditions. It would be worth assessing the invertebrate communities associated with the springs and comparing them with the invertebrates in the Chapman River itself. This could be undertaken at different times of the year to develop a baseline data set from which to make comparisons over time. The Ribbons of Blue program may be willing to provide support.

The presence of a diverse range of predators indicates a relatively high level of foreshore health as the top order consumers are still present. This means that the ecosystem has sufficient resilience to manage crop pest animals such as grasshoppers.

Other issues

As mentioned above, there is a crossing that is impacting on stream flow. There is some road drainage that is also contributing to localised erosion issues.

There are fences along both sides of this section, in variable condition. If re-stocking these paddocks is proposed in the future, then the fence maintenance and the possible addition of fencing should be considered.

Suggestions

Bank stability

- B Seek advice from the Water and Rivers Commission on stock crossing designs that have minimal impact on stream dynamics.
- B Monitor stock impact on the river system and implement removal if necessary.
- B Protect the remnant vegetation from disturbance to enable the vegetation to continue to stabilise the riverbed, banks and floodways.

Vegetation

- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

- V Liaise with TAFE, Water and Rivers Commission and other agencies and request support to undertake weed control, vegetation studies and other activities that will contribute to maintaining the health of this section. This section helps to demonstrate relatively healthy, stable foreshore environments, and the impact of significant contributions of water and sand from tributaries.
- V Encourage restoration of the verge by increasing the setback and fire access tracks from the riparian zone.
- V Monitor the level of natural regeneration, and if inadequate source tubestock of middlestorey and overstorey species to plant some zones of verge.

Stream cover

- S Protect the spring, surrounding wetland and river system from disturbances that will reduce the health and resilience of this plant and animal community, through fencing, good fire protection, stock rotation and weed control.

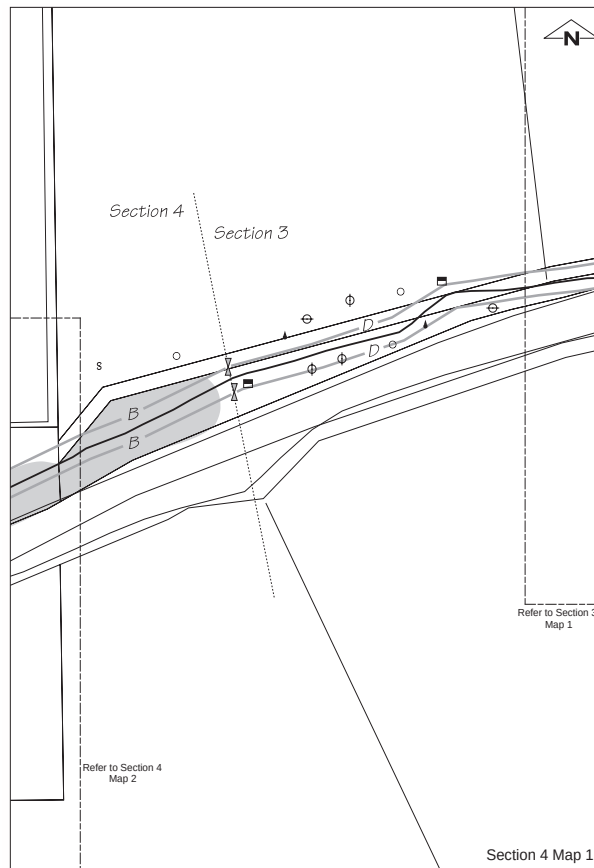
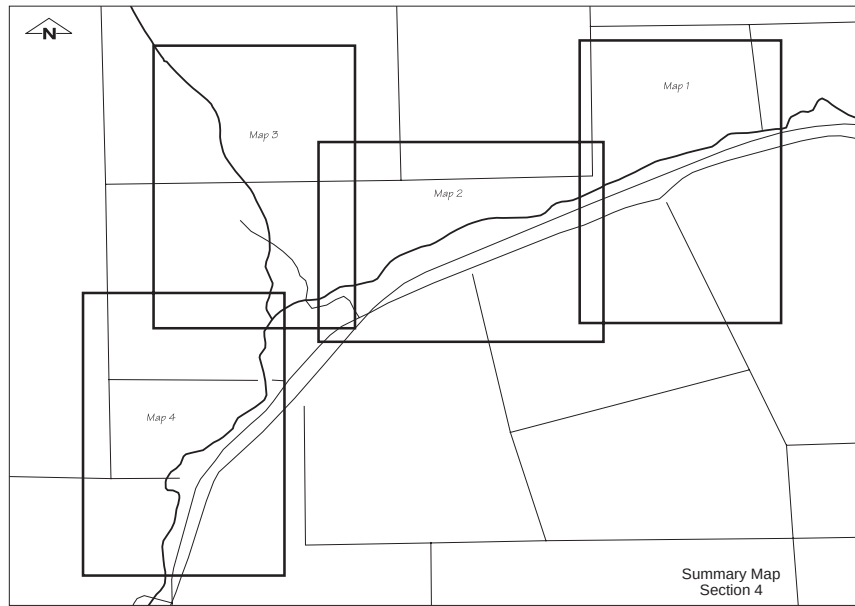
Habitat diversity

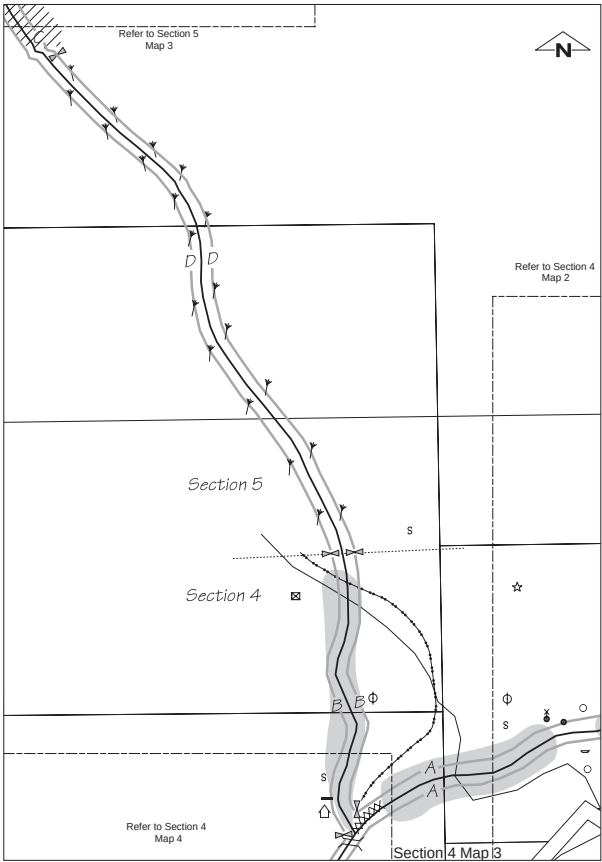
- H Encourage the Ribbons of Blue program to develop and implement an invertebrate survey (snapshots) of the two ecosystems present within this section to enable future monitoring of population diversity and numbers.
- H Focus on protecting the remaining vegetation and encourage natural regeneration processes through controlling soil disturbance and undertaking localised areas of weed control.
- H Work on re-establishing dense nodes of verge vegetation to increase habitat availability for shrubland bird species that feed on insects such as grasshoppers.

Other issues

- O Obtain advice on crossing design to reduce the impact on river flow characteristics.
- O Ensure that fences are maintained and improved prior to re-stocking.







SECTION 5: NOLBA CREEK CATCHMENT MAPS 1 – 8**Length of section (m):** 4,030m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 11 May 2000**Nearest road access:** Old Nolba Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Poor – C	Very Poor – D	Very Poor – D	Poor – C	Poor – C

Bank stability

The confluence of Nolba Creek with the Chapman River coincides with the first significant decline in the health of the Chapman River. Considerable volumes of mobile white sand are being transported from these two catchments into the river. The tributary channels average between 18 and > 50 m wide with the foreshore banks rising on a slight to moderate slope to a height of 0.6 m. The main channel of the Chapman River through this section is 6 – 10 m wide. Significant levels of erosion are occurring along 20 – 80% of the foreshore, particularly at the base of plants growing along the foreshore banks. The course of water flow along the tributaries is highly variable. There are sections of large woody debris acting as natural dams, which is exacerbating erosion in localised areas. Sedimentation is continuous along the river channel and on the margins of the floodway with deposition evident along > 50% of the river section.

Comments

The course of river flow is subject to increasing fluctuations as a result of land management practices. Loss of vegetation on sandy soils, some poor stock management practices along with the rising groundwater table and changes to the salinity levels are all contributing to the degradation of this system. There needs to be considerable effort to re-establish perennial vegetation cover in the floodway and zone.

Vegetation

The vegetation is patchy at all levels, and ranges from saltmarsh vegetation communities, through those growing on red loamy sand to sandplain species. The overstorey is sparse (< 20 % cover) and characterised by occasional Swamp sheoak (*Casuarina obesa*), Quandong (*Santalum acuminata*) and a variety of eucalypts that have been planted in revegetation lines along the creeks.

The middlestorey is limited to occasional patches of Sand sheoak (*Allocasuarina campestris*), Mohan (*Melaleuca viminea*), an unidentified paperbark (*Melaleuca* sp.) and some hakeas. The largest populations of middlestorey plants occur close to the Chapman River, however there is one significant stand of sandplain vegetation on one tributary. The understorey is confined to annual grasses including Annual Wimmera ryegrass (*Lolium rigidum*), Wild oats (*Avena fatua*) and a type of Brome (*Bromus* sp.) and along the Chapman River there are occasional patches dominated by Couch (*Cynodon dactylon*). There are occasional patches of Shore rush (*Juncus kraussii*) and Spiny flatsedge (*Cyperus gymnocaulos*) present within the floodway. Some rows of saltbush have been planted to provide feed. The understorey within the small remnant is excellent and retains many rushes, sedges, herbs and other species that are now uncommon in this area.

African lovegrass (*Ehrharta curvula*) is present in low densities.

Comments

The extent and diversity of remnant vegetation is minimal for most of this river section and there is insufficient groundcover to minimise erosion processes. The parts lacking vegetation correlate with the sections with the widest main channel. The few remnants of verge vegetation are excellent and would benefit from protection from grazing.

Stream cover

The stream cover is patchy (20 – 80%) and is provided by the overstorey. The clusters of rushes and sedges also provide occasional instream cover. The creeklines are poorly defined and are wide and shallow, limiting the extent of cover.



Comments

The remnant vegetation provides the only stream cover. The current lack of permanency of water flow may change as conditions in the catchment also change. The stream cover is insufficient to support much aquatic life or enhance the length of time water stays in the shallow pools.

Habitat diversity

The habitat diversity is limited due to the minimal native vegetation cover and lack of continuity of vegetation cover. The sections retaining vegetation provide some habitat for woodland and shrubland birds, small reptiles and occasional herbivorous invertebrates. The diversity and abundance of these animals is low. The waterways were flowing at the time of survey, but no aquatic life was observed or heard. Further, flying insects with aquatic stages in their lifecycle were not observed during the survey.

Comments

The overall lack of cover limits the number of suitable habitats for terrestrial and aquatic life forms. Although occasional trees were present, there was no evidence of nesting or roosting by birds.

Other issues

There are some ruins close to the confluence of one of the creeks and the river. Fencing is limited, but where fences exist they are generally in good condition and have good alignments. There is some evidence that stock has considerable access to the river and its foreshores and is contributing to poor bank stability and lack of vegetation.

Suggestions

Bank stability

- B Focus on restoring vegetation cover to improve bank stability, keeping in mind that the rate of establishment is likely to be slow.
- B Liaise with Agriculture WA, Nolba Catchment Group and Water and Rivers Commission to continue to develop implementation schedules for the catchment management plan in this region.

- B Try to source external funds to assist in managing this sub-catchment as it has a significant impact on sediment movement in the Chapman River.

Vegetation

- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.
- V Encourage the landholders to fence off the persistent native remnant vegetation within their properties and establish shelter belts of deep-rooted trees to provide shade and shelter for stock.
- V Protect the riparian zone from grazing and trampling for some time to enable the vegetation to recover. Periodic crash grazing may be useful to control fire hazard and limit the production of weed seed.

Stream cover

- S Fence off the tributary and protect the remaining vegetation along the length of the waterways. These fences need to be set back to the edge of the floodplain to ultimately encourage the river to reform a single main channel and reduce the fluctuations in river flow characteristics.

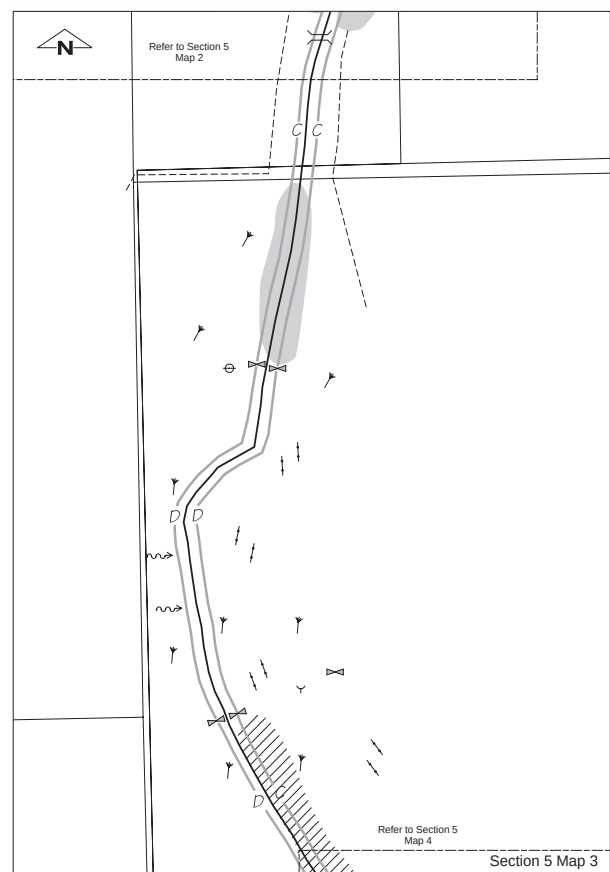
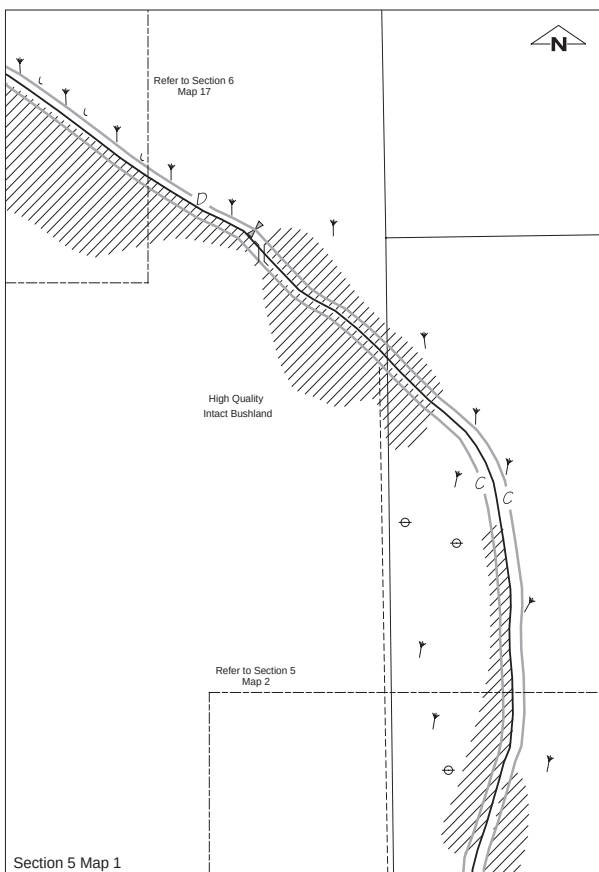
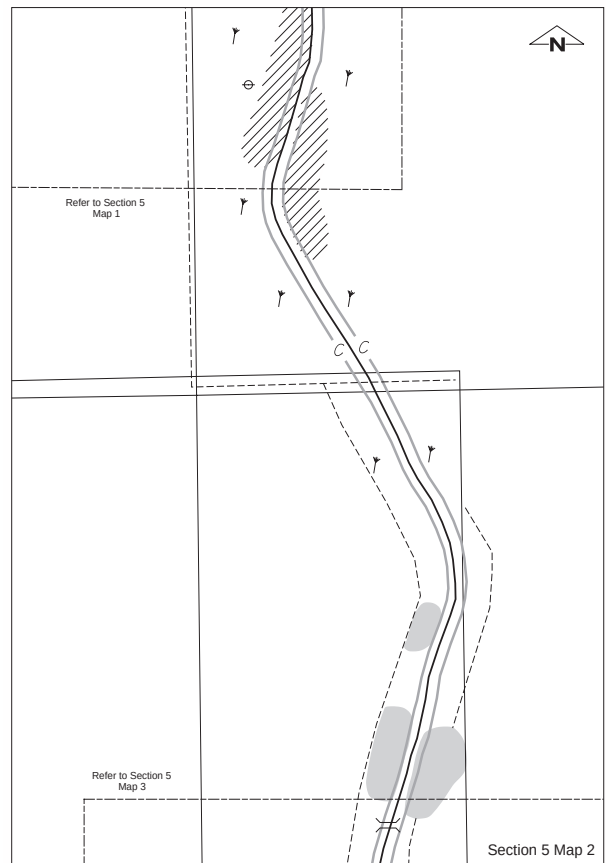
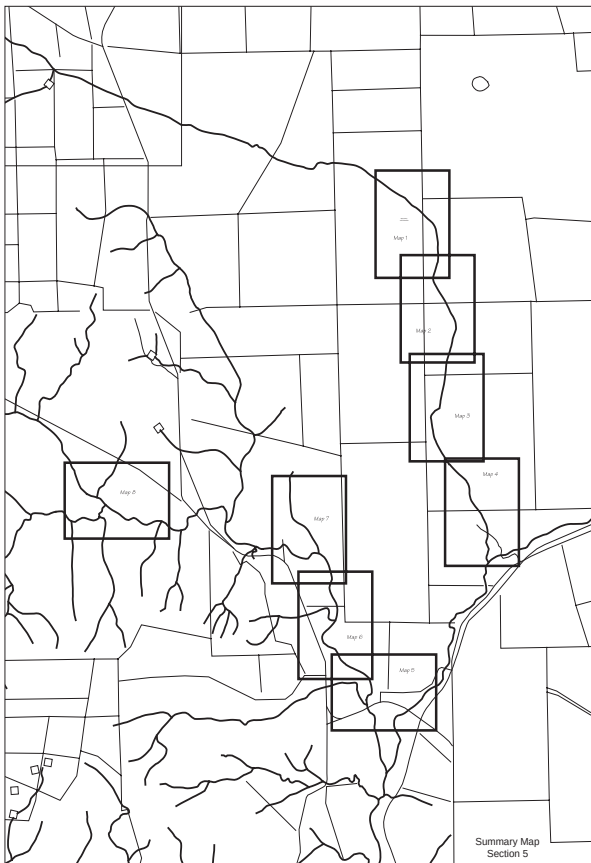
Habitat diversity

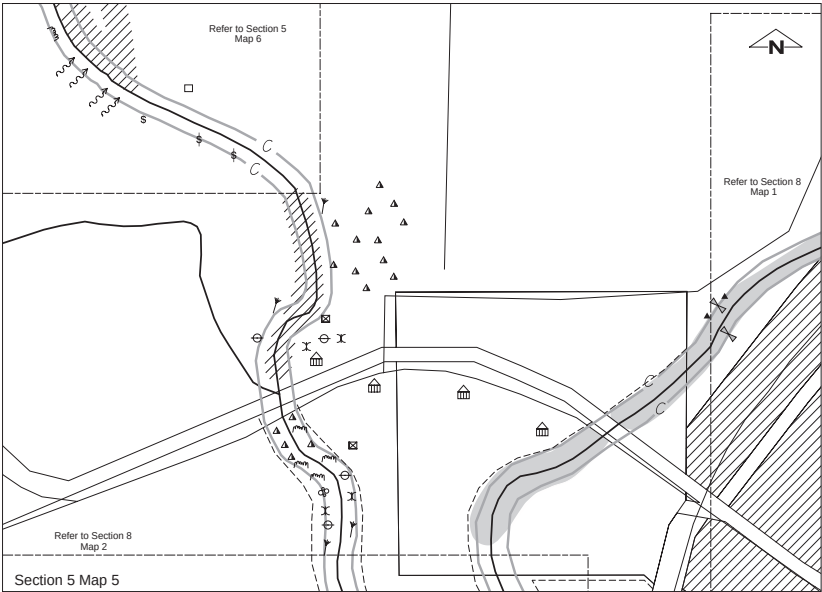
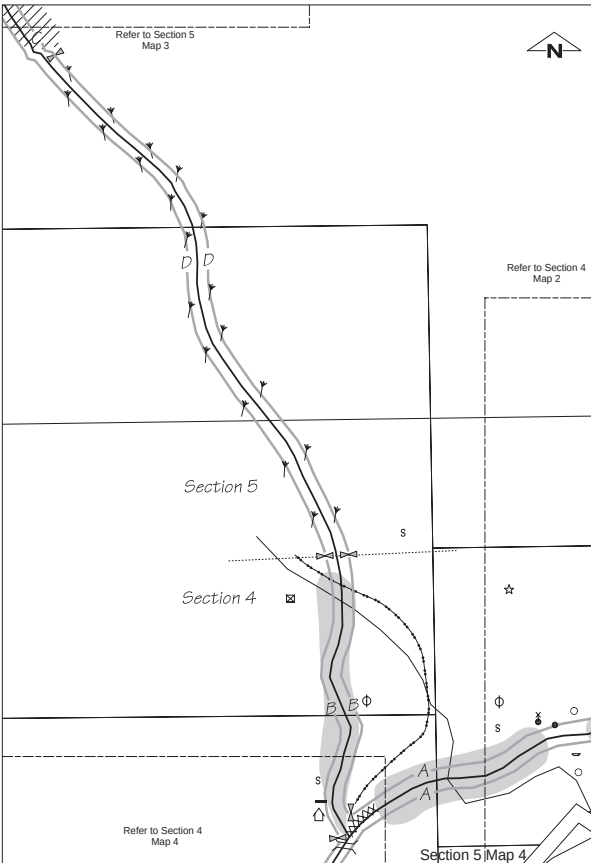
- H Work to restore vegetation and minimise disturbance to the soil structure for the length of the waterway.
- H Develop strategies to control water flow and sediment movement throughout this section length with the support and advice of relevant government agencies.

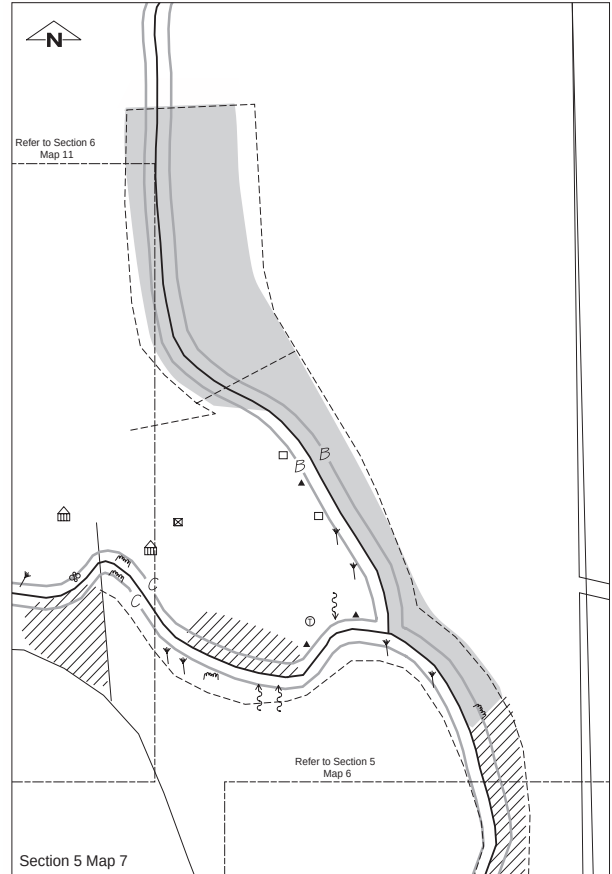
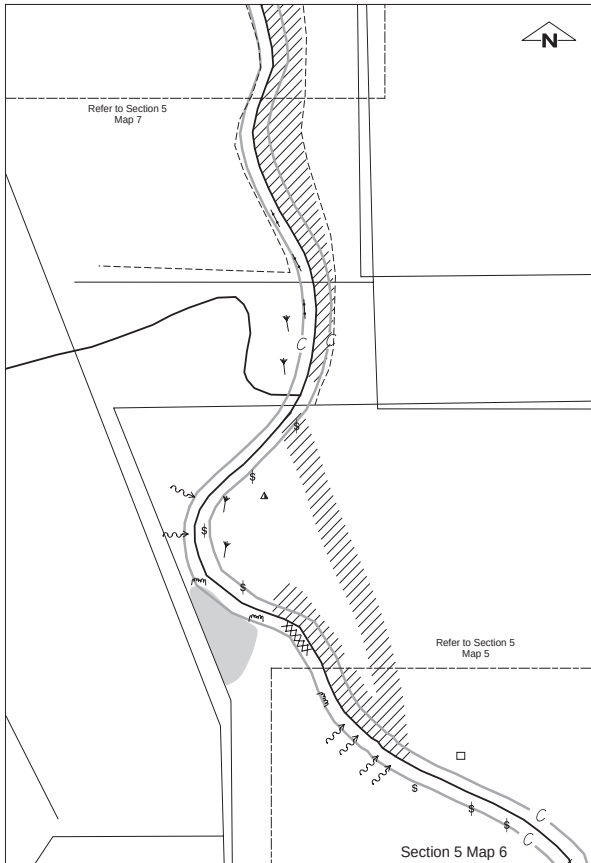
Other issues

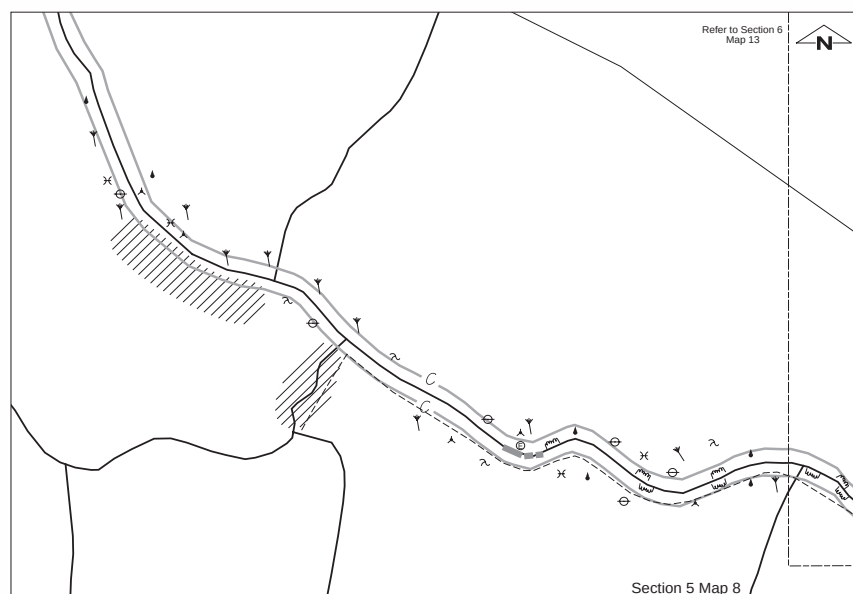
- O Modify current stock management practices to exclude stock until 70% perennial vegetation is achieved, if practical. Some short-term grazing may be useful to control weed species and fire hazard.











SECTION 6: NOLBA CATCHMENT MAPS 1 – 17

Length of section (m): 3,300m

Recorders' name: N Siemon and T Rebola

Date surveyed: 11 May 2000

Nearest road access: Old Nolba Road

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

Bank stability

The creeklines through this section are highly unstable due to a lack of perennial vegetation cover, limited exposed rocks and a steep fall in the riverbed. This section has significant amounts of mobile sand. The main river channel is between 4 and 17 m wide with a relatively wide floodway in the upper reaches, while in the lower reaches the floodway is narrow. The surrounding landscape rises steeply on both sides of the river in the lower parts of this section. Erosion is occurring on more than 50% of the river section, with significant sedimentation (> 50%) along the entire length. Many of the tributaries are actively eroding and contain significant amounts of mobile sediment. The valley floors are affected by salinity to some degree.

Comments

The lack of perennial vegetation cover, changing groundwater conditions and long-term stock damage are increasing the susceptibility of this river section to severe erosion. This area corresponds with the top of

the catchment, and the riverbed falls along a relatively steep gradient. This inherent instability increases the difficulty in managing this environment, simply from natural river processes. Restoring vegetation in such unstable conditions is difficult and any rainfall events are likely to result in a peak flow occurring rapidly. Slowing water movement consistently within the catchment and the waterway itself is critical.

Seven years ago the Nolba Catchment Group developed a catchment management plan to guide their actions in this region. The plan recognises the issues relating to the changing groundwater conditions and the difficulty in managing this additional resource. Many landholders are actively working to improve the extent of vegetation, constructing contour banks and practising farm management techniques that minimise the impact of farming on the environment.

Vegetation

There is minimal vegetation cover along these sections. The overstorey is absent, middlestorey patchy and



uncommon with stands of Mohan (*Melaleuca viminea*), and the understorey is also sparse and dominated by annual weeds. Weeds present include Cape weed (*Arctotheca calendula*), Pie melon (*Citrullus lanatus*) and Wild radish (*Raphanus raphanistrum*). There is one section retaining good verge vegetation and some riparian vegetation on one tributary of the upper catchment.

There has been some effort towards revegetating some of the lowland areas using eucalypts which has achieved various levels of success.

Comments

Installing riffles across the floodway will help to slow water flow and assist in plant establishment and could also contribute to instream cover.

Stream cover

There is almost no stream cover within this river section.

Comments

Again, installing riffles across the floodway to work to slow water flow and assist in plant establishment could also contribute to instream cover.

Habitat diversity

The habitat diversity is extremely limited due to minimal vegetation cover, shallow soils and minimal linkage to bushland that has been retained in the catchment. There is one significant area of remnant vegetation community on a tributary on the top of the catchment that appears to be dying back as a result of rising groundwater levels and changing salinity. The vegetation on the higher ground remains diverse and intact, and there was evidence of small vertebrates. The revegetation works on the margins of the salt pans are starting to contribute some habitat. As this section comprises the top of the catchment, there is no permanent water. In addition, the water appears to be hypersaline. This would limit the diversity of aquatic invertebrates during flow events.

Comments

Habitat diversity will be restored along with vegetation. Placing large woody debris to help direct and slow the

runoff would provide some habitat for fauna. Protecting the remnant vegetation that persists on the hilltops will help to support fauna, until the waterway vegetation is established. Further, limiting trampling of the banks will protect burrowing animals that assist in plant establishment, such as ants.

Other issues

The Nolba Catchment Management Plan (Clarke *et al.* 1993) is an excellent source of information for landholders both within and beyond this region. The management principles contained within the report are useful and can be applied elsewhere.

The impact of previous farm management techniques resulting in degradation of the drainage lines was recognised, with one contributor to the plan stating that ‘some of the drainage lines appear to be suffering more from over-clearing, over-grazing and the impact of cloven hoofed animals than salinity.’ Most landholders within this region have put considerable effort into farm planning to improve their management, while others appear to be relatively complacent about land management. There is an urgent need to restore perennial species in the valley floors and on the hillsides. Further, if there is the potential to use perennial grasses such as the Saltwater couch (*Sporobolus virginicus*) then they should be used. If non-local species are being used, then grazing systems to prevent the plants from producing seed and use of contour banks/bunds to catch the seed are preferred.

Suggestions

Bank stability

- B Continue to implement farm management practices to manage groundwater resources and minimise disturbance to any remnant vegetation.
- B Fence valley floor and exclude stock until perennial vegetation covers at least 70% of the floodplain area. Stock will need to be excluded from this zone until the plants are sufficiently established. It is important that the perennial vegetation is predominantly understorey with occasional middlestorey and dense overstorey on the margins of the floodway.



- B Protect any plantings by staking or installing riffles across currently denuded areas, creating steps in the riverbed to break the water flow. Note that riffles can be made out of green waste tied in bundles, rock or other simple structures. Obtain advice from the Water and Rivers Commission.
- B Monitor sediment movement down the waterway and trace sources of excessive sediment should high loads occur.
- B Identify sources of sediment upstream and implement best management practice to control erosion.

Vegetation

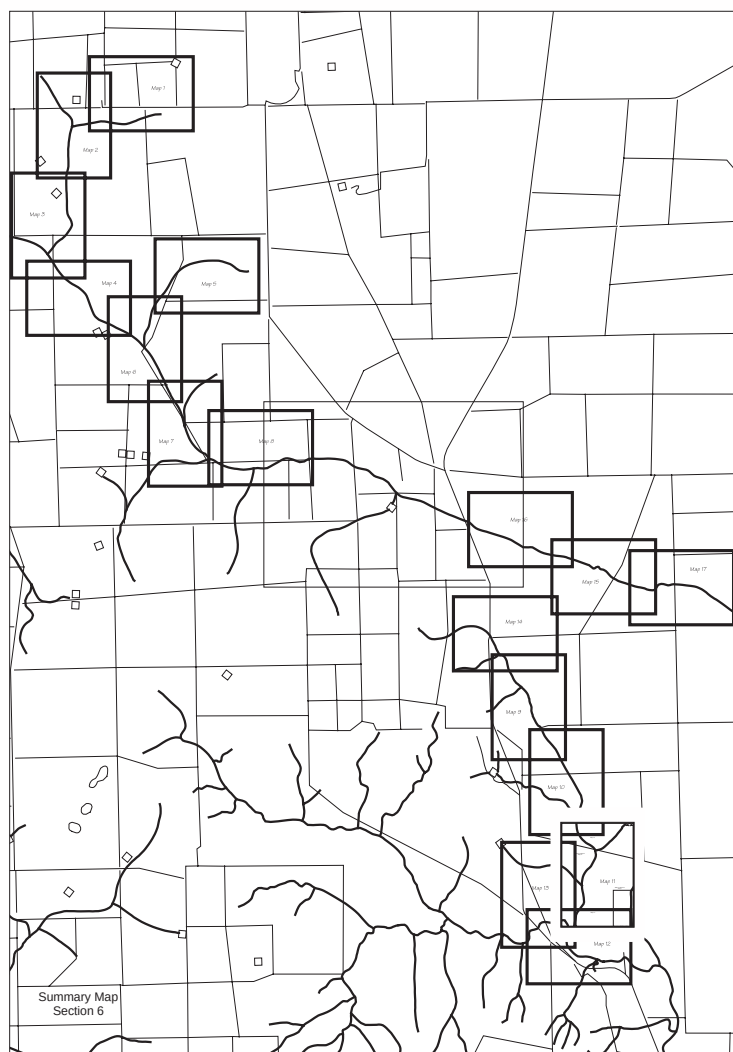
- V Design and install a series of riffles across the valley floor to hold the water consistently across the valley floor.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

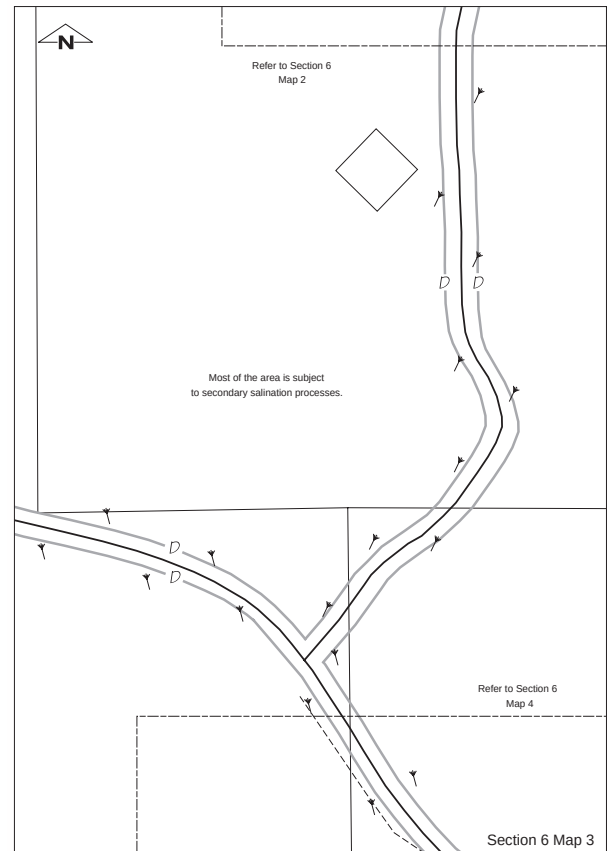
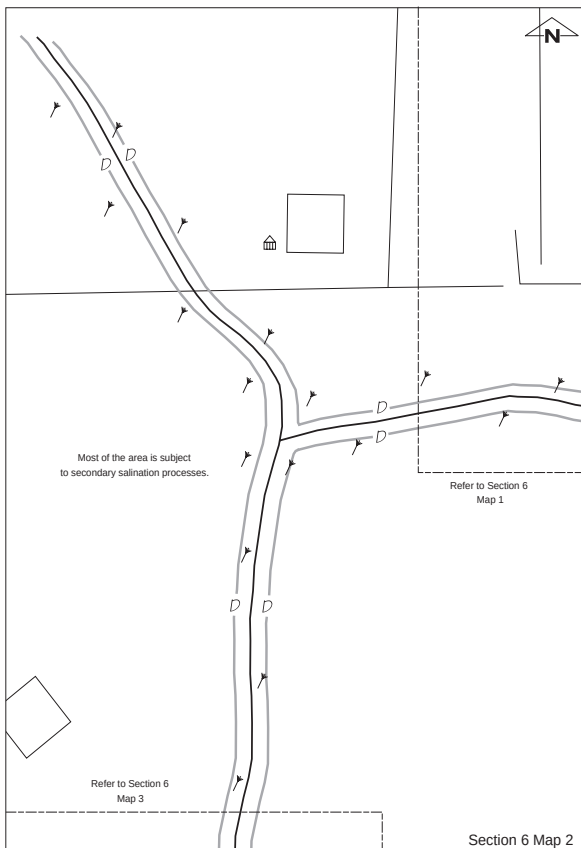
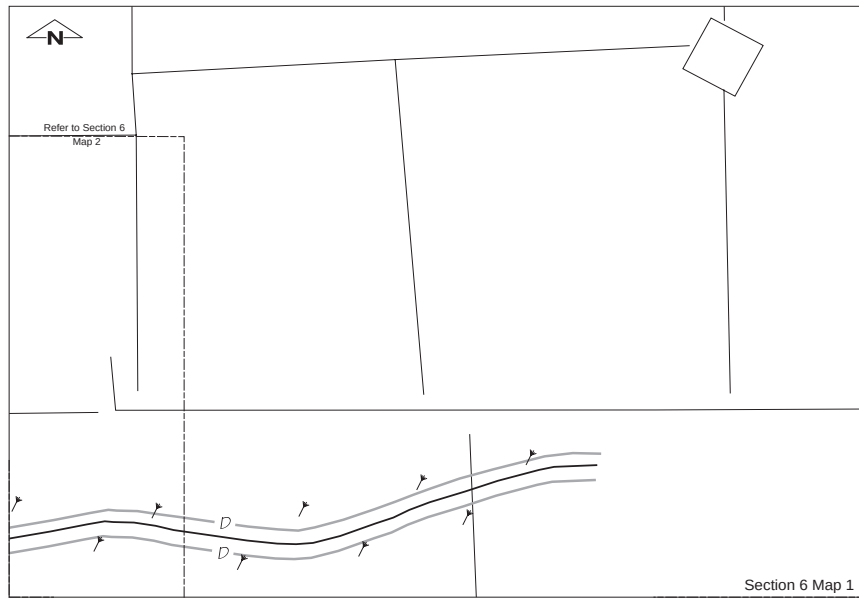
Stream cover

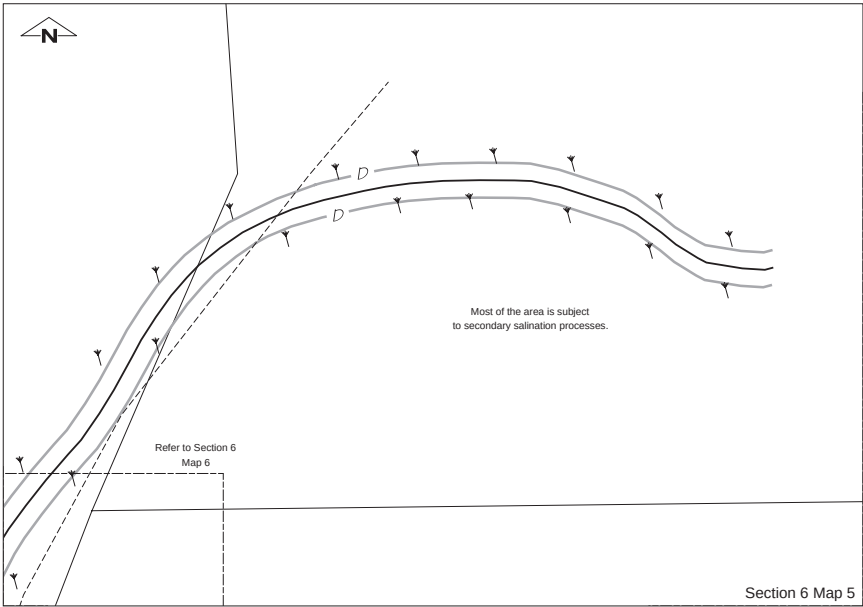
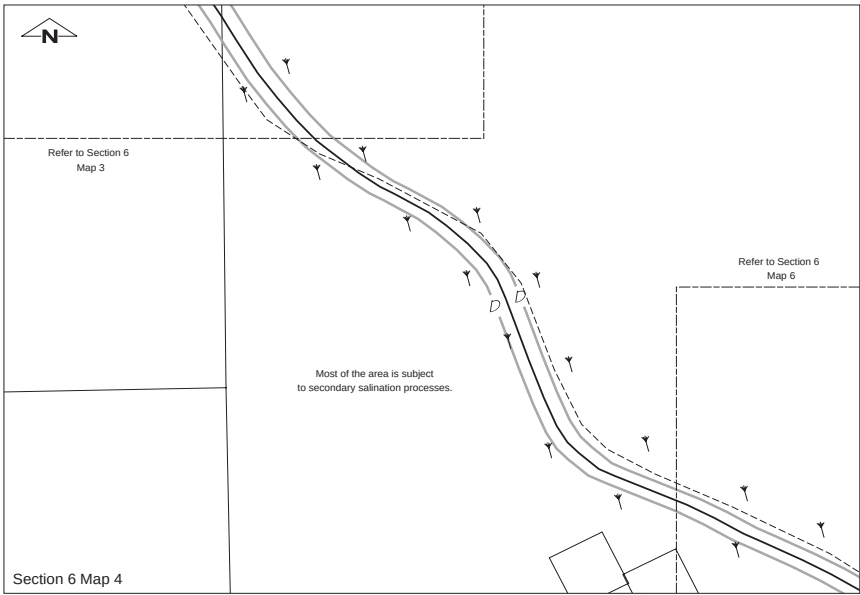
- S Design and install a series of riffles across the valley floor to hold the water consistently across the landscape.
- S Direct seed or spread fragments of samphire species manually within barriers (possibly straw placed across the contours) at the end of the season when the ground is waterlogged.

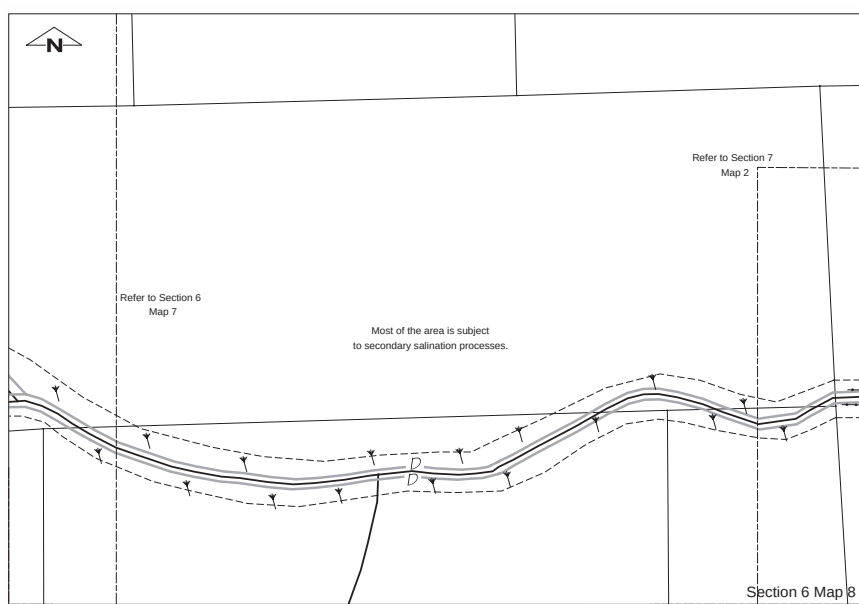
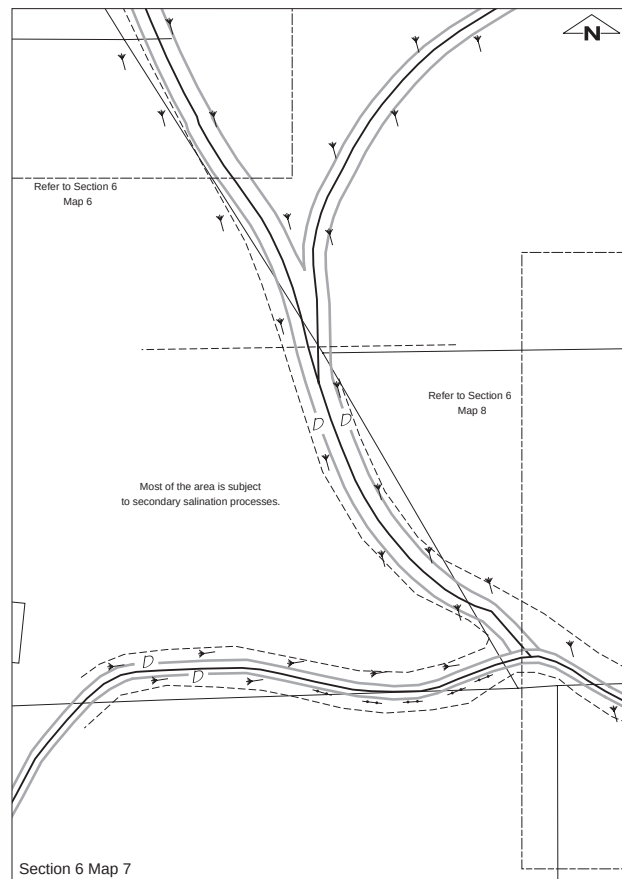
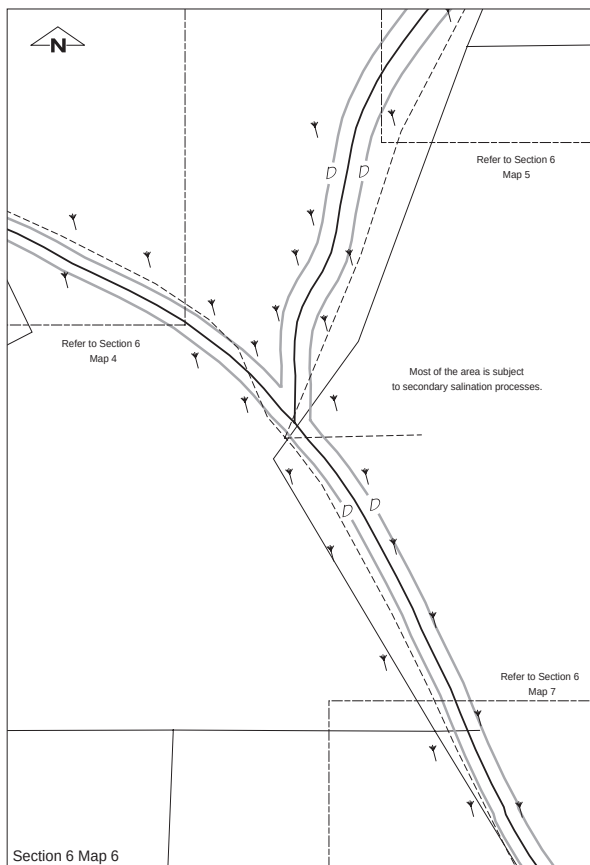
Habitat diversity

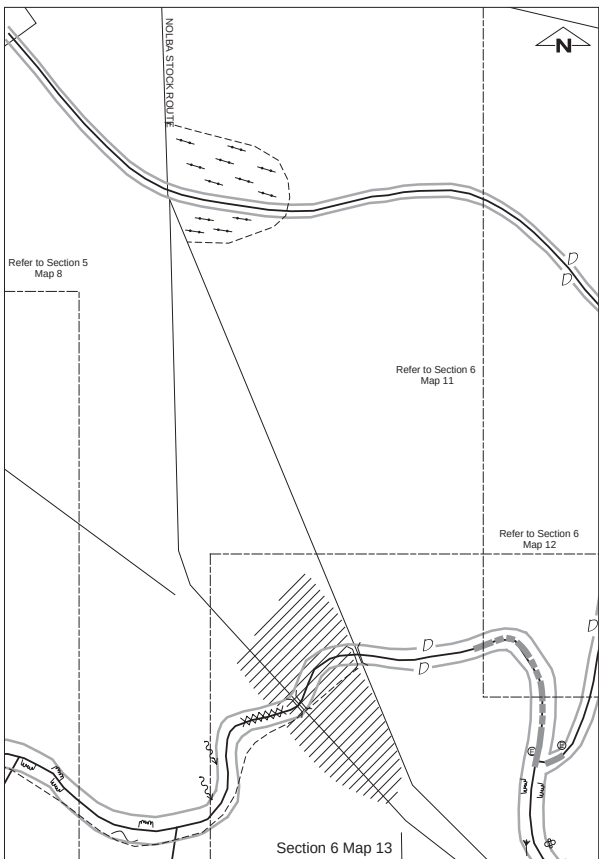
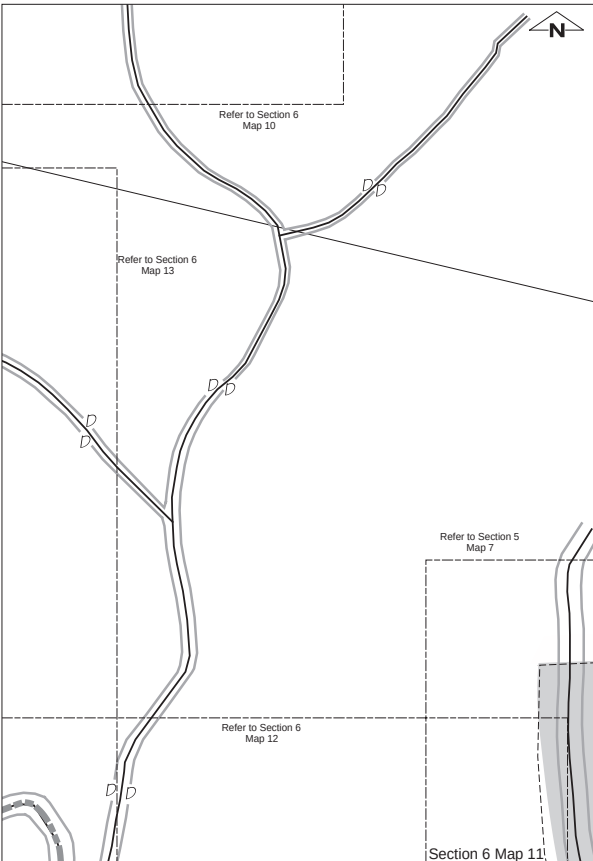
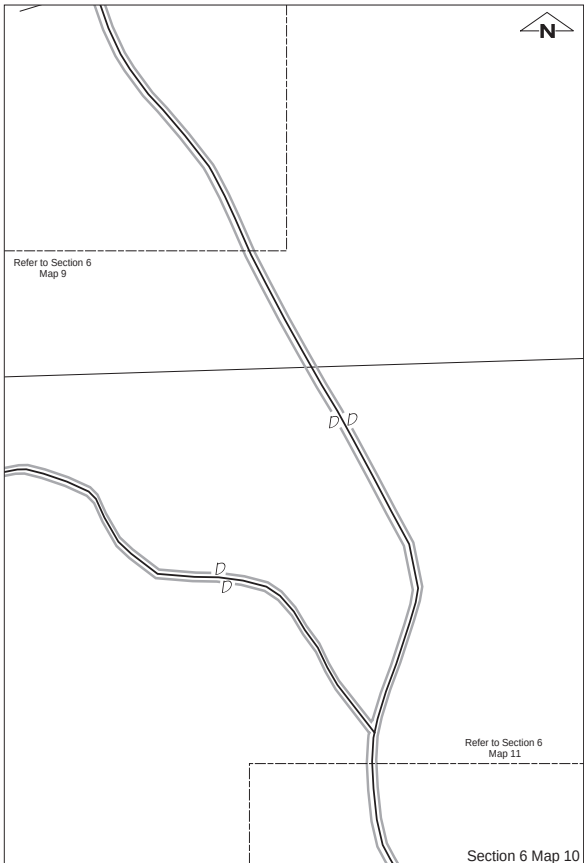
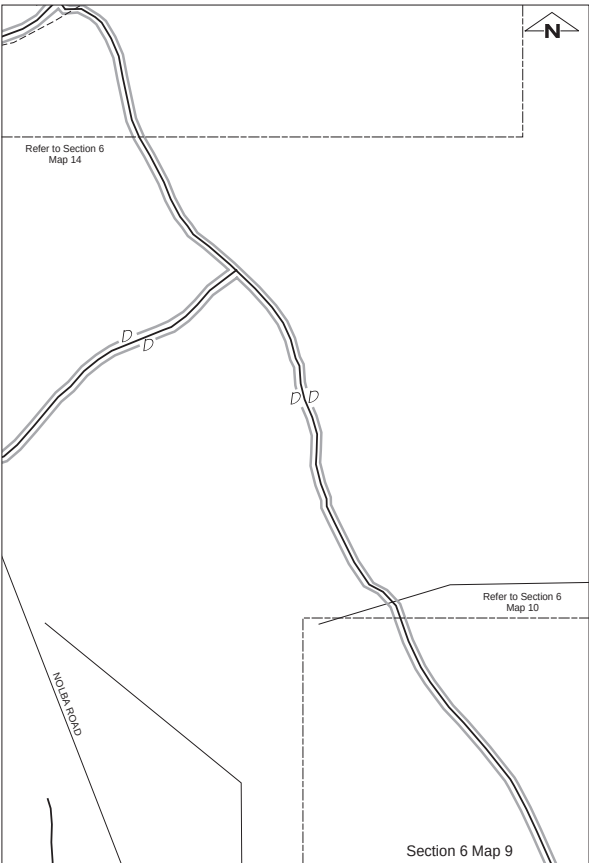
- H Implement fencing and revegetation programs to restore vegetation to the waterways, thus contributing habitat.
- H Salvage some of the woody debris within the floodway and align to help slow flows and provide habitat. Seek advice from Water and Rivers Commission officers.

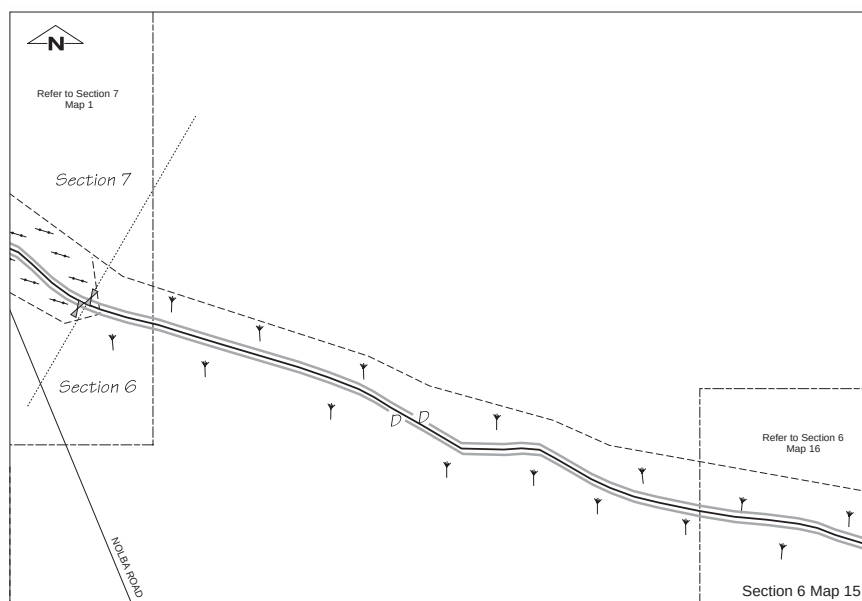
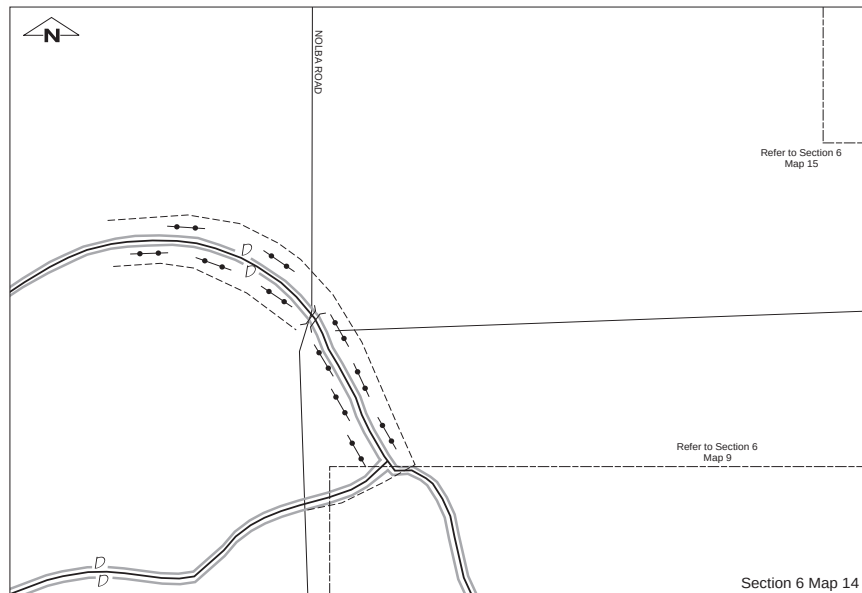
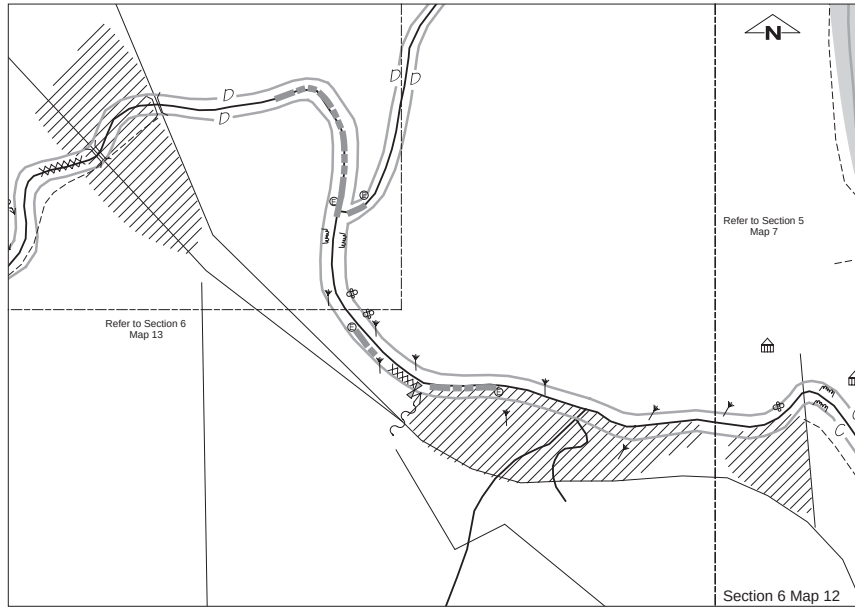


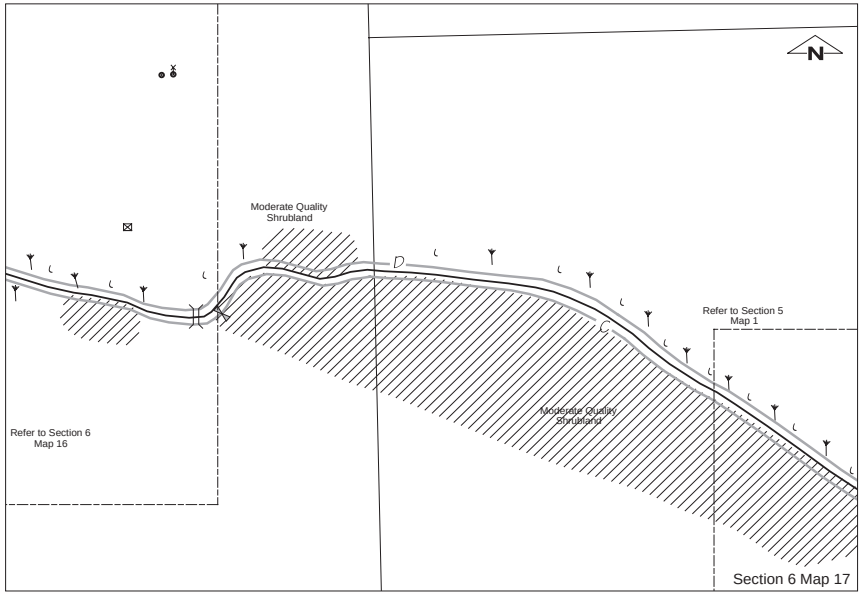
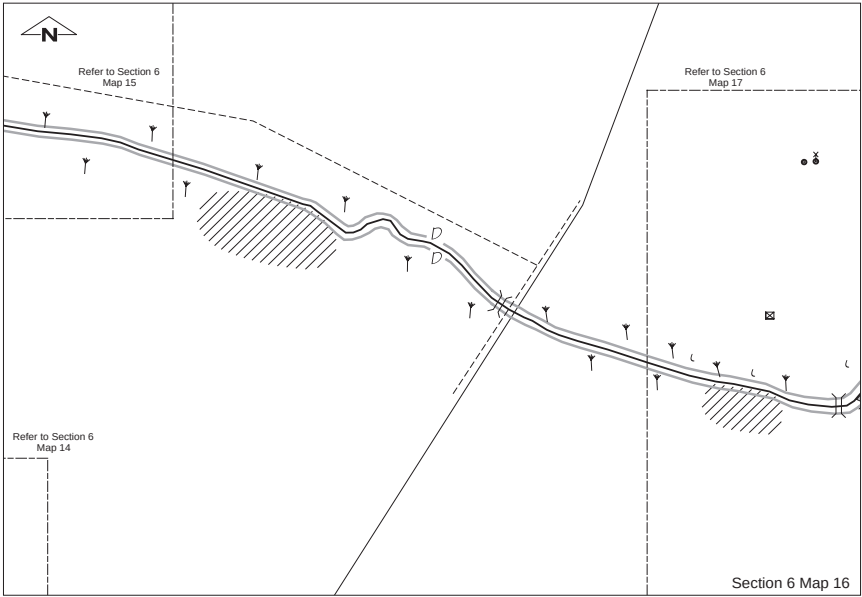












SECTION 7: NOLBA CATCHMENT MAPS 1 – 2**Length of section (m):** 2,150m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 11 May 2000**Nearest road access:** Nolba Rd**Summary of river health**

Moderate – B	Moderate – B	Poor – C	Poor – C	Moderate – B	Moderate – B
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Bank stability

The bank stability within this river section is moderate. The main waterway channel is 4 – 8 m wide. Both foreshore banks rise on a medium gradient to 0.5 – 1 m in height. The floodway is wide. Isolated areas of erosion occur along 0 – 5% of the foreshore, particularly adjoining crossings. There is little evidence of slumping.

Comments

The continuing evolution of improved land management practices demonstrated within this section is improving the foreshore health. The localised erosion reflects the lack of instream features to help slow water flow.

Vegetation

There are some significant areas of saltmarsh vegetation in the lower reaches of this section within the reserve. Upstream, the landholders have put considerable effort into revegetating the creeklines. Assorted eucalypts have been planted in lines and provide patchy (20 – 80%) cover, and there are infrequent relic York gum (*Eucalyptus loxophleba*). There is patchy middlestorey in the water supply reserve on the floodway margins and the verge. The diversity of species within the reserve is quite high. The density of the shrubland increases moving away from the waterway into the verge and is more than 80 % native.

The riparian understorey ranges from patchy to continuous cover (20 - > 80%), and also varies in the level of weed infestation. Saltmarsh species including Bluebush (*Atriplex* spp.), *Halosarcia*, *Sarcocornia*, *Maireana* and *Rhagodia* are common and relatively widespread throughout the reserve and upstream property. There are occasional infestations of the introduced Annual barbgrass (*Polypogon monspeliensis*), however this is not considered to be a major problem.

Comments

The revegetation works have contributed positively to waterway health and bank stability. The area could benefit from having greater diversity of vegetation types to improve habitat values. Future endeavours could be focussed on increasing diversity, and planting low shrubs and groundcovers between the established trees.

Stream cover

The native understorey vegetation overhanging the main channel within the water reserve provides patches of permanent shade along the waterway. The presence of instream vegetation (algae) provides some suitable habitats for aquatic invertebrates. There are limited leaf litter and instream branches to provide additional substrate for instream fauna. The continuous habitat for terrestrial animals is limited to the areas retaining dense saltmarsh cover, decreasing upstream in the areas that are still subject to revegetation works. Over time, this habitat will improve as the vegetation structure improves.

Comments

The stream cover provides some water-cooling and would contribute to a reduction in evaporation while the waterway is flowing. The cover also provides some habitat for aquatic invertebrates.

Habitat diversity

It is not known whether there is permanent water but in the past the water is likely to have been seasonal. The dense saltmarsh provides good habitat for terrestrial invertebrates, while the trees that have been established provide roosting and nesting sites for birds. There are almost no mature trees with hollows in which birds can nest. As the verge vegetation is limited to small areas and the reserve, the availability of habitat for shrubland birds is patchy to minimal.



Comments

The limited extent and diversity of vegetation types limits habitat availability. The lack of mature trees with hollows has limited the usefulness of this region to birds such as cockatoos, Corellas, Pink and grey galahs and other species that utilise hollows. This has probably helped to protect the revegetation works from significant damage. The landholder has planted many shelterbelts that adjoin the waterways, which are likely to act as corridors along which animals can move.

Other issues

The presence of the water supply on the Old Nolba Stock Route indicates that groundwater has been an important available feature for over one hundred years. Anecdotal evidence suggests that the groundwater levels are rising and that the quality has deteriorated.

The land management practices exhibited in this section are excellent and provide strong evidence of the value of constantly adapting ideas and styles to protect the land from degradation processes. Fencing is set well back from the waterway and all fences are well maintained.

The Nolba catchment management plan is an excellent tool to support landholder activities and help landholders to contribute to minimising issues arising both locally and downstream.

Suggestions

Bank stability

- B Continue to actively revegetate, and assess the feasibility of encouraging vegetation growth on the channel banks.
- B Investigate opportunities to slow water flow using riffles along the length of the property, to help absorb some of the high energy flows that occur.

- B Monitor crossings for evidence of erosion upstream and downstream and, if problems arise, modify the design. The Water and Rivers Commission has a brochure detailing considerations when designing crossings. Agriculture WA also has a publication on common conservation works that is very useful.

Vegetation

- V Continue revegetation works, focussing on shrubs and groundcovers with some tree reinforcement. Start increasing use of smaller plants between rows of trees to improve habitat for a wider variety of birds.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Protect existing vegetation to maintain stream cover.
- S Continue to reinforce vegetation diversity and structure with plants of different growth forms.

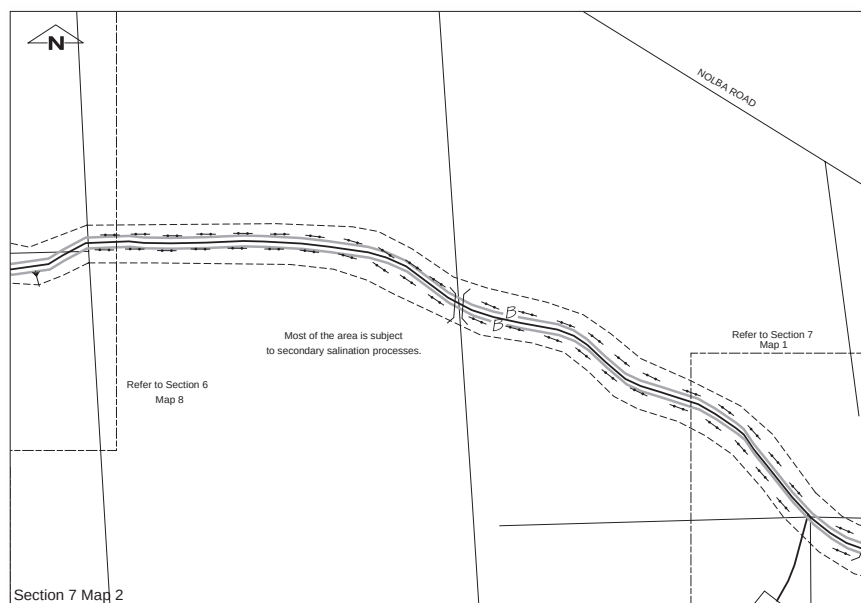
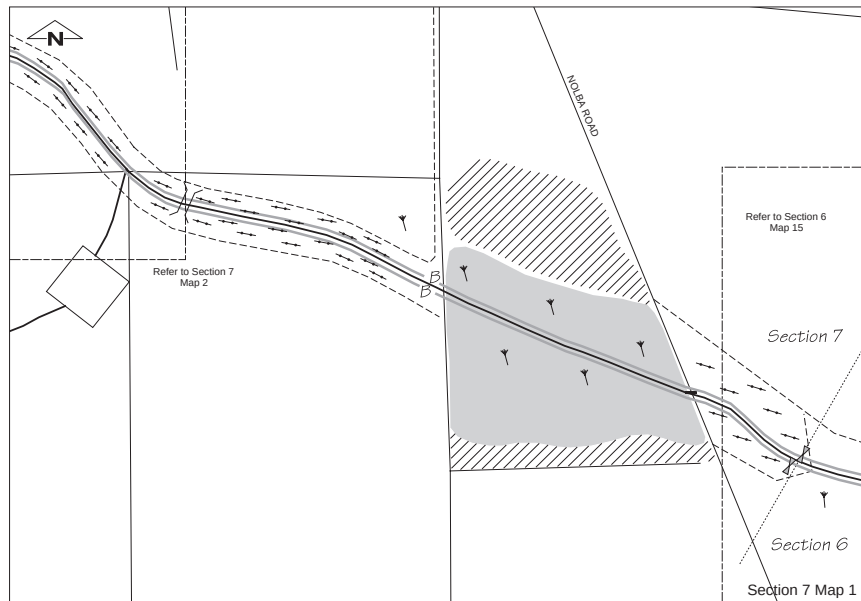
Habitat diversity

- H Continue revegetation works and increase plant diversity to encourage a wider range of fauna to inhabit the area.
- H Continue to control feral animals as resources permit.

Other issues

- O Review the foreshore reserve boundary alignment and suitability, and clearly mark any current amended or revised boundary.





SECTION 8: CHAPMAN RIVER MAPS 1 – 11**Length of section (m):** 16,320m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 12 May 2000**Nearest road access:****Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Moderate – B	Very Poor – D	Very Poor – D	Very Poor – D	Poor – C	Very Poor – D

Bank stability

The main river channel flows through a clearly defined river valley. The main channel is 5 – 8 m wide with the floodway occurring on the right bank. The floodway is constricted by the surrounding landform and, while the channel banks have slight to moderate slopes, the river valley is steep-sided. There are areas of localised erosion coinciding with ant or stock trails, and at the base of trees growing adjacent to the low flow channel. There are frequent exposed granite boulders in the riverbed, that act to break up the flow, aerate the water and dissipate the erosive force of the water. Sedimentation is common in 20 – 50% areas and the plumes are located where the main flow is constricted or where tributaries feed into the main river channel. The sediment plumes are well-sorted white sand, with coarse material accumulating amongst the granite boulders.

Comments

The exposed granite boulders instream and on the channel banks are significant features of the landform that are protecting the tributaries and Chapman River from severe erosion damage from all flow conditions. Further, the soil types and geology help to confine the flow to the river valley. The riverbed is very steep. Stock movements on the valley banks are compacting the soil and leaving it denuded, making it more susceptible to erosion. These stock tracks have lower friction than vegetated areas, which allows the water to move more quickly across these areas. This is resulting in bank collapse and the erosion along many of the river sections.

Vegetation

The overstorey is sparse (< 20% cover) and comprises single rows and occasional groups of Swamp sheoak (*Casuarina obesa*) and infrequent River gum (*Eucalyptus camaldulensis*). The middlestorey is patchy (20 – 80% cover) and dominated by native

shrubs including Stand back (*Hakea preissii*), two species of Wattle (*Acacia* spp.) and Common baeckea (*Baeckea camphorosmae*).

The understorey is continuous (> 80% cover). Isolated clumps of Spiny flatsedge (*Cyperus gymnocaulos*) and Shore rush (*Juncus kraussii*) are present, but the majority of understorey cover is provided by weed species. Widespread weed species include Annual ryegrass (*Lolium* spp.), Pie melon (*Citrullus lanatus*), Wild radish (*Raphanus raphanistrum*), Wild turnip (*Brassica barrelieri*), Doublegee (*Emex australis*) and Lupins (*Lupinus angustifolius* and *L. cosentinii*).

There is a significant infestation of the introduced Fountain grass (*Pennisetum setaceum*).

Comments

Fountain grass is very difficult to manage once widespread populations are established, but currently in the Chapman River the populations of this plant are focussed in one property and along roadsides. This plant has a tussock form, with dense cores. They are highly flammable and unpublished research data indicates that when burnt, their core temperature by far exceeds that achieved by most grasses. This plant therefore poses a significant fire hazard that could cause a considerable threat to infrastructure such as fences, timber framed sheds and dwellings once alight. Other weeds present are declared noxious and landholders are required to control these species on their properties.

Stream cover

Infrequent patches of permanent shade are present in areas where the fringing vegetation is extensive and dense, and overhangs the main channel. There were small pools persisting at the time of survey that are unlikely to be permanent. There is leaf litter and frequent rocks and branches also providing instream cover.



Comments

The stream cover is relatively good, however continuing loss of native vegetation will reduce its quality feature shortly. The need to maintain good vegetation cover and therefore good stream cover cannot be emphasised enough.

Habitat diversity

Water flow is not permanent along this river section. Riffle zones and cascades aerate the water as it flows over exposed instream rocks. Large boulders periodically slow water flow. There are some pools present within the main river channel, usually retaining open expanses of water 4 m wide and between 10 and 15 m long. There is little fine suspended sediment, however there are large volumes of mobile white sand that are starting to infill these pools. The minimal diversity and extent of native vegetation minimises the habitat diversity for aquatic and terrestrial invertebrates. The patchy shrubs were homes for finches, wrens and fantails, while Willy wagtails frequented the remaining trees. Burrows of some lizards were seen during the survey. There were few flying insects that have a water-dependent part of their life cycle.

Comments

Protecting the remaining vegetation is one of the keys to maintaining and possibly improving habitat availability and diversity for native animals. Reducing disturbance to the substrate will also help. Stock movement along the riverbed keeps the mobile drift sand uneven and able to be more readily moved during the next flow event.

Other issues

The presence of a foreshore reserve is not always apparent in this river section. Fencing is present in most sections and the alignment may identify the reserve boundary. The boundaries are unclear and this needs to be amended as the opportunity arises. Further, the current reserve boundary does not necessarily reflect the landform and does not incorporate areas with wide shallower floodplains. The location should also be investigated if feasible.

Fencing is present for most of the section length, and ranges from excellent to moderate condition. Most landholders have fire access tracks adjoining the fences.

Suggestions

Bank stability

- B Monitor the level of large and small woody debris and remove or realign if forming natural dams. The realignment should aim to support sediment movement downstream.
- B Reduce stocking rates and length of time spent in the river reserve to reduce the formation of tracks on the valley slopes and help the vegetation to recover. This will help reduce erosion and broadscale changes to the shape of the valley.

Vegetation

- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.
- V Focus weed control effort on declared species and also on Fountain grass to minimise the threat posed by this highly flammable species.
- V Reduce the length of time stock spend within the foreshore reserve to encourage natural regeneration.

Stream cover

- S Exclude stock from river reserve to allow the vegetation to recover. Consider stocking for brief periods to achieve weed control.
- S Monitor the accumulation of woody debris instream and determine where it is causing a greater problem than benefit as habitat. Realign or move upslope if necessary.

Habitat diversity

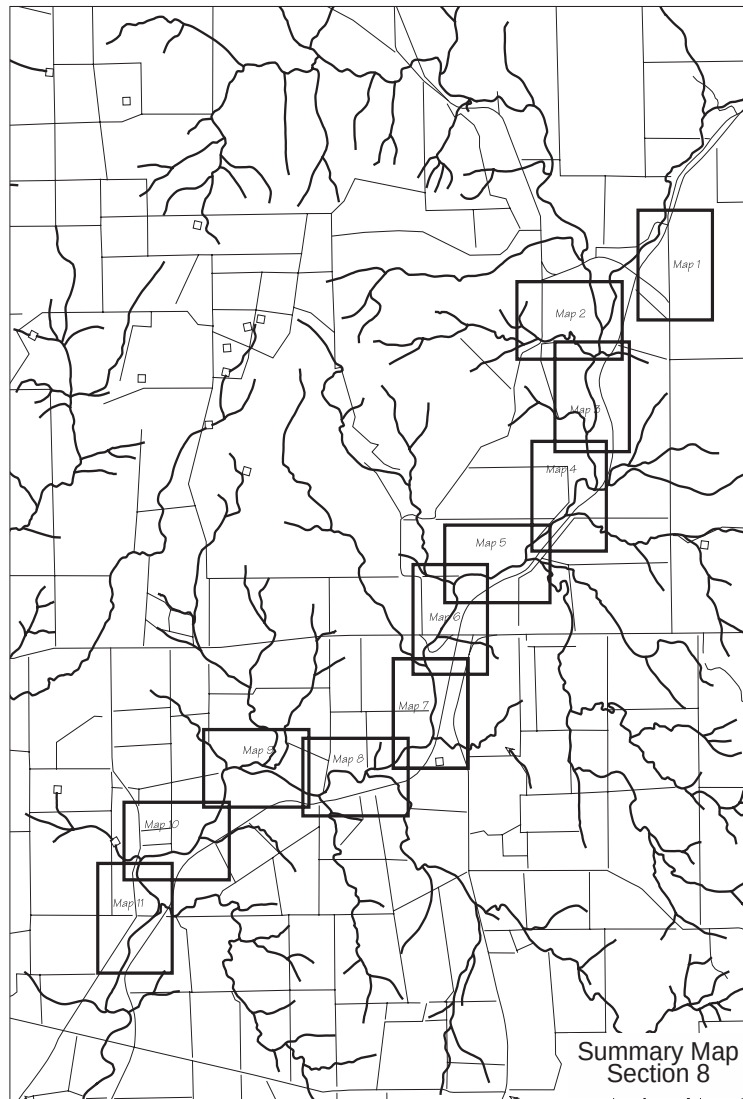
- H Review current stock management practices and endeavour to keep stock from accessing the foreshore reserve until there is sufficient vegetation cover to protect the banks from erosion during the next flow event.

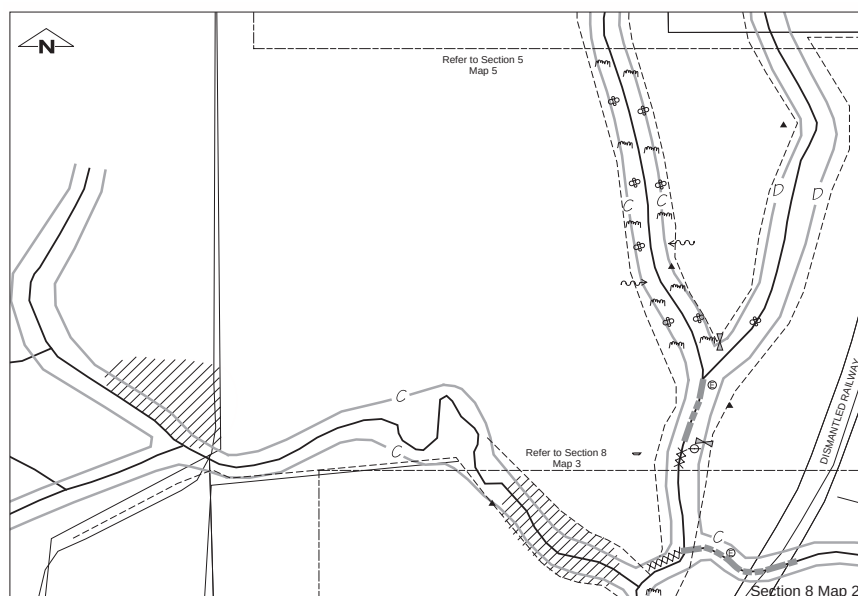
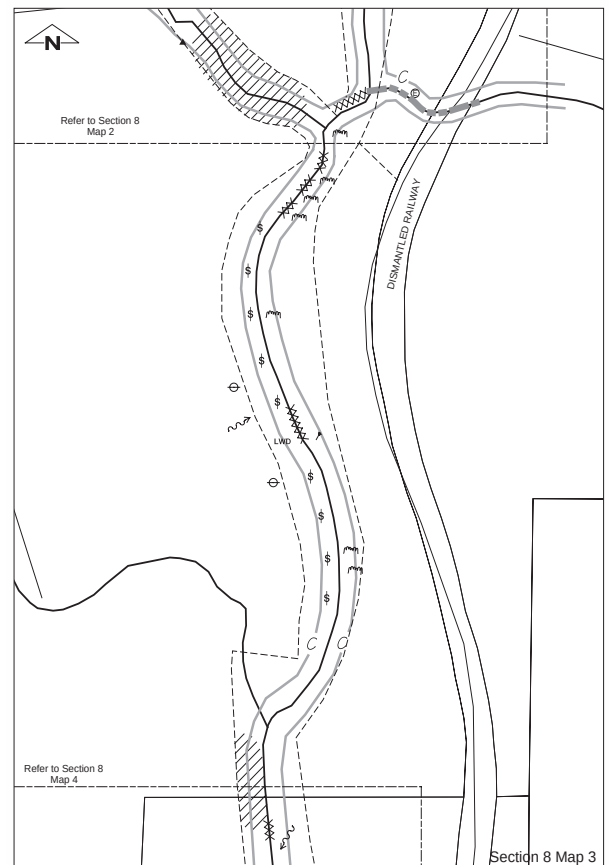
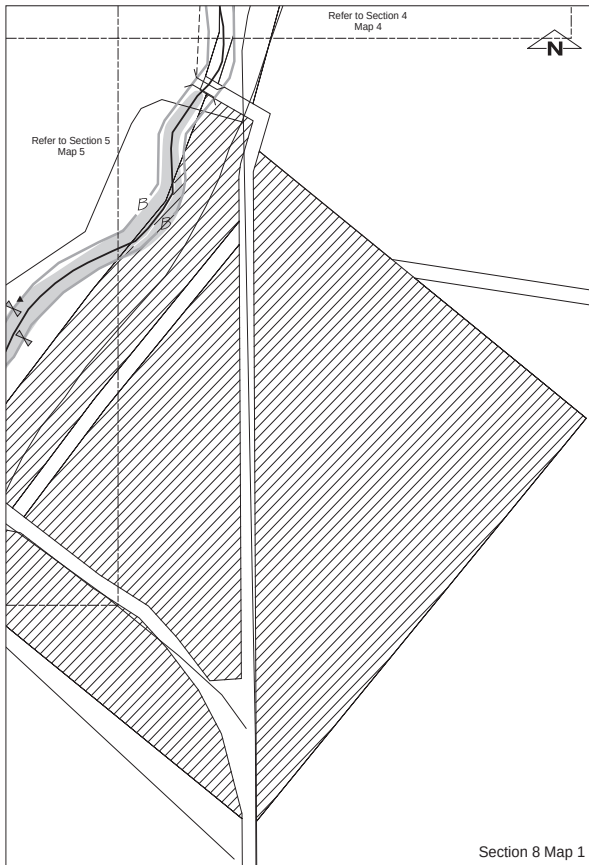


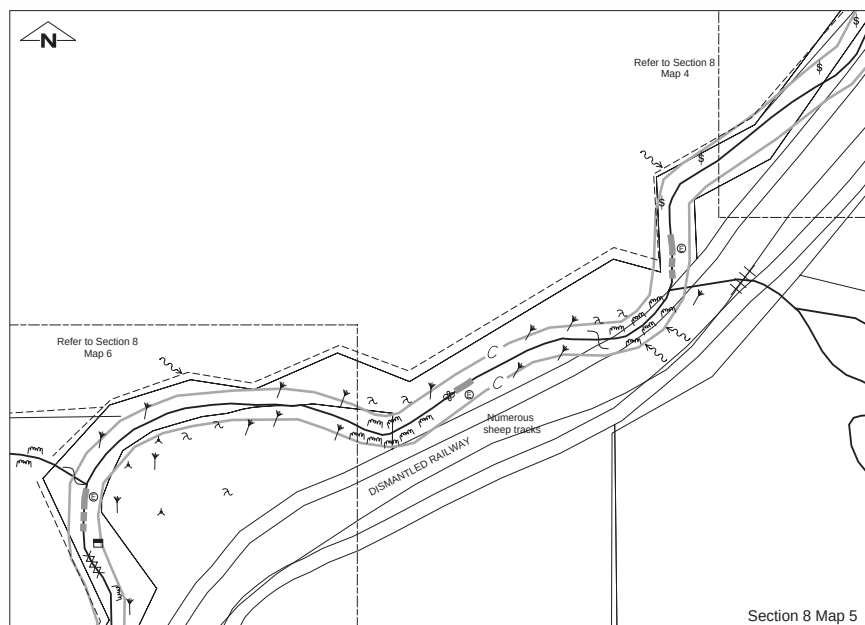
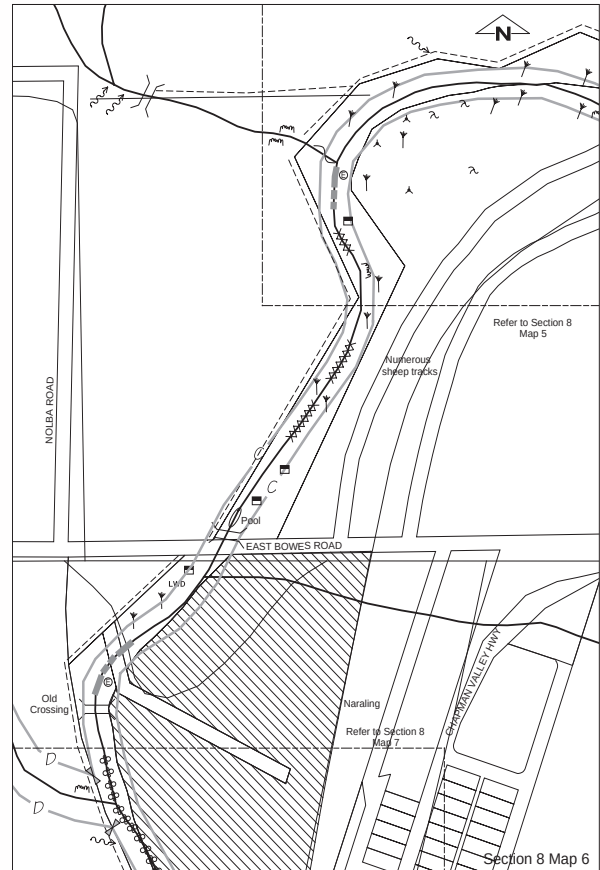
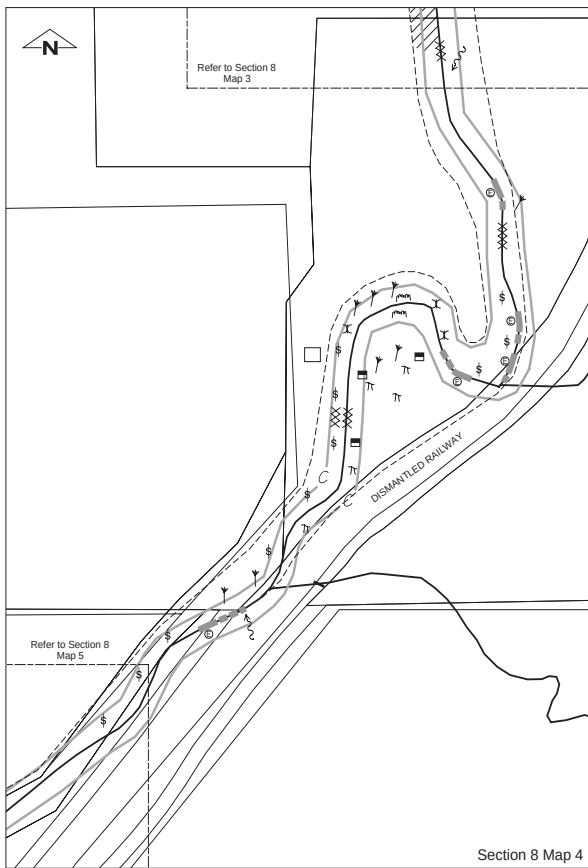
- H Monitor the level of natural regeneration and if insufficient, plant tubestock in areas where stock exclusion can be guaranteed until the plants are established. These would be best in nodes that are a manageable size.

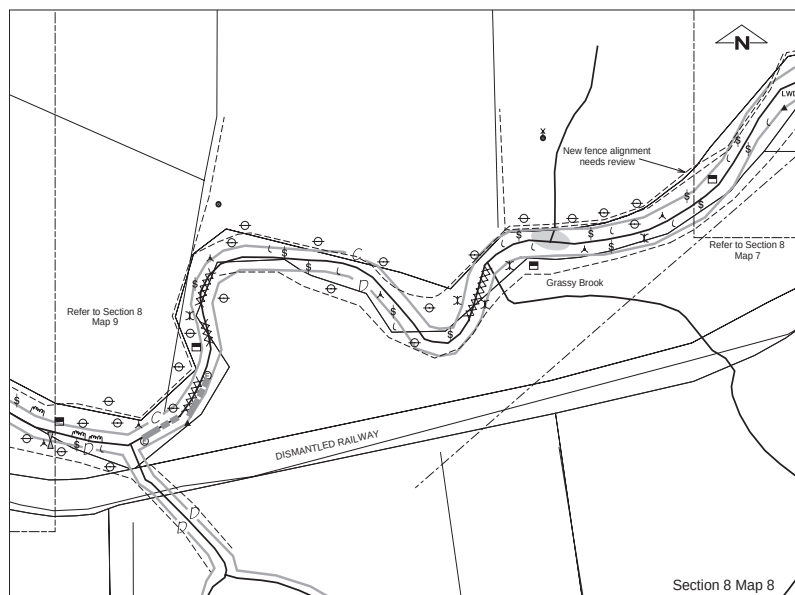
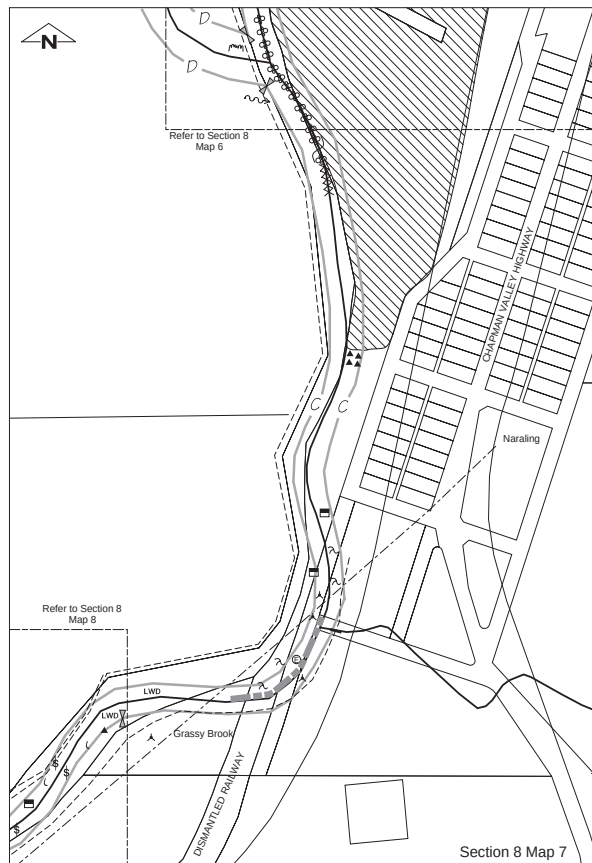
Other issues

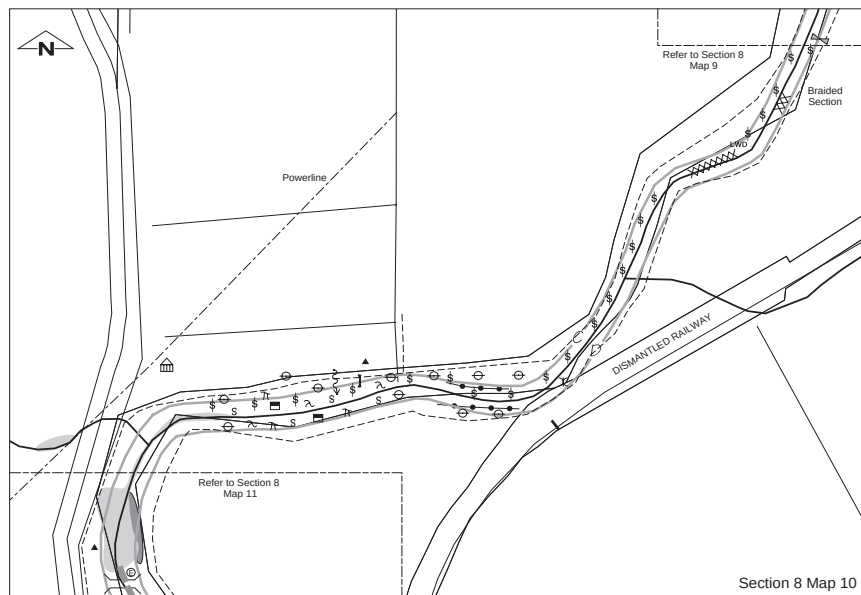
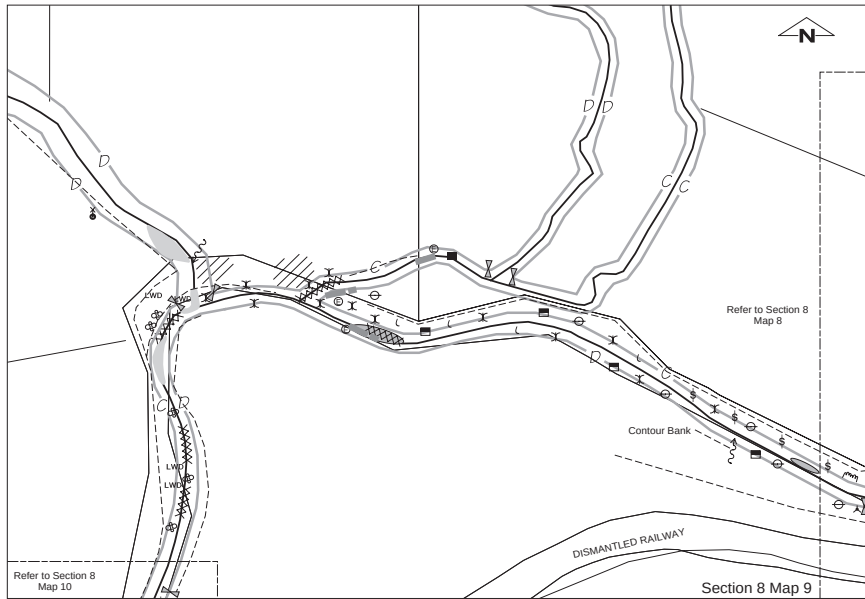
- O Review the foreshore reserve boundary alignment and suitability, and clearly mark any current amended or revised boundary.

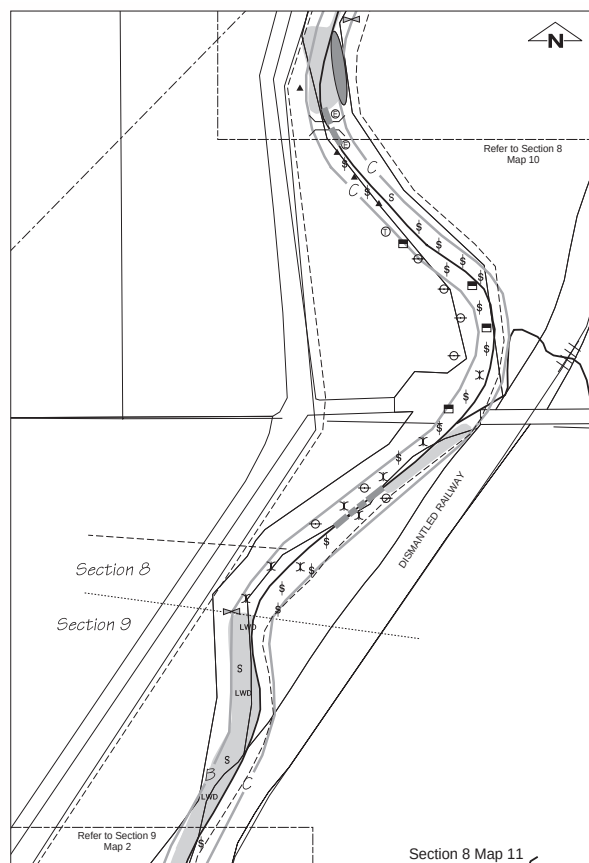












SECTION 9 UPSTREAM OF DINDILOA ROAD MAPS 1 – 2

Length of section (m): 1,190m

Recorders' name: N Siemon and T Rebola

Date surveyed: 15 May 2000

Nearest road access:

Summary of river health

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Moderate – B	Moderate – B	Moderate – B	Very Poor – D	Moderate – B

Bank stability

The main river channel ranged between 2 and 6 m wide. The channel banks rise on a slight to moderate slopes to a height of 0.8 m to 1.5 m. There are limited areas of erosion occurring but little evidence of severe undercutting or slumping with 5% of the foreshore affected. Mobile sediment is localised, occurring along less than 20% of the river channel.

An indication of water levels during peak flow events is provided by the size of debris trapped in trees, and the height at which the debris is trapped above the low flow channel. In this section, woody debris is trapped up to 2 m above the low flow channel banks.

Comments

This is the first significant stand of riparian vegetation since the Nolba section. The vegetation provides an important flood attenuation function, directing the flow into the main river channels rather than allowing the water to spread across the floodway. This slowing of the peak flows pushes the flood height up, depositing large woody debris into the canopy. This increases deposition on both sides (upstream and downstream) of the dense vegetation, and also can increase blowouts occurring in poorly vegetated areas as the water banks back. The vegetation is currently sufficient to protect the riverbanks and floodway but requires monitoring to ensure that stock does not damage the vegetation.



structure or denude areas. This will increase the susceptibility of this river section to erosion during future events.

Vegetation

The overstorey is continuous (> 80% cover) and consists of Swamp sheoak (*Casuarina obesa*) forming an open to closed woodland. There are infrequent juvenile River gums (*Eucalyptus camaldulensis*). The middlestorey is absent, and the understorey is continuous (> 80% cover). Dense homogeneous stands of Spiny flatsedge (*Cyperus gymnocaulos*) characterise the understorey. There are occasional clusters of Annual Wimmera ryegrass (*Lolium rigidum*) that have colonised drift sand in the main channel. Black berry nightshade (*Solanum nigrum*) occurs occasionally.

The verge vegetation is patchy, and characterised by occasional Coojong (*Acacia saligna*) with a dense crop of Lupins (*Lupinus cosentinii* and *L. angustifolius*) providing continuous annual groundcover.

Comments

There is minimal weed invasion in the main river channel, but considerable disturbance to the vegetation structure on the margins of the floodway and up the verge. This weed invasion results in the downgrading of this section. The paddock was stocked at the time of survey, however there was no evidence of overgrazing. The stock management system must be effective to retain the vegetation cover at the current level.

The dead Lupins constitute a significant fire hazard and put this section at risk. Any significant rainfall that results in a flow event is likely to cause significant damage to the riparian zone if there is a loss of vegetation cover.

Stream cover

This section has very good stream cover provided by both overhanging trees and rushes. The main channel is shaded for more than 80% of the section. There is instream leaf litter and frequent branches also providing cover.

Comments

The level of stream cover slows the rate of evaporation from the small pools within this section. This helps

native animals adapted to drought conditions to complete their life cycle prior to the pools drying.

Habitat diversity

Water flow is not permanent in this river section, however there is likely to be soil moisture close to the surface of the riverbed. The instream and bank vegetation helps to aerate the water while it is flowing. At the time of survey, there was little suspended solid material in the water column. The water is light brown due to the presence of tannins. The presence of seasonal pools provides suitable habitat for aquatic invertebrates including dragonflies and damselflies and vertebrates such as the introduced Mosquito fish (*Gambusia holbrooki*). There is good habitat for terrestrial invertebrates and lizards due to the dense patches of streamside vegetation. The continuous overstorey also provides suitable nesting and roosting sites for birds.

The salinity levels at the time of survey were moderate, with no evidence of salt crusting on the margins of the river pools or a strong taste of salt.

The lack of verge vegetation, however, minimises the usefulness of this region for shrubland birds including finches, orioles, wrens and similar species that require dense shrubs for habitat.

Comments

Closely managing stock access is an important component in protecting native animals. Many terrestrial invertebrates, frogs and lizards burrow in sandy / loamy soils. During droughts often these animals aestivate (similar to hibernating) in the burrows. These burrows are easily trampled by stock. Disturbance to animals while they are in this state often results in their death. This reduces the populations, making recolonisation difficult.

This also occurs in river pools. As the pools dry out many invertebrates and vertebrates such as frogs and fish, burrow into the mud to help survive the summer drought. An alternative strategy used by animals to survive drought periods involves depositing egg sacs or equivalent mechanisms.

Plants, along with herbivorous invertebrates, tend to occur at the base of the food chain for all of the other animals that inhabit river systems. Loss of breeding



sites due to trampling and changing sediment deposition and erosion patterns can reduce the number of animals, reducing food availability for animals such as frogs and birds. This can ultimately result in the loss of the larger predators from the site. Because the riparian vegetation is not continuous along the entire river system any more, it makes the process of recolonising much slower and erratic, particularly for ground dwelling animals.

Protecting what persists in this section is important to help restore the ecological functions of the river.

Working to re-establish verge vegetation is another critical aspect of restoring river health, not only in this section but along more than 70 % of the Chapman River subject to this survey. These shrubs also act to reduce weed invasion along the river margins. When the native vegetation is continuous and dense it is often able to out-grow any weed seeds that arrive. This helps to reduce the diversity and extent of weed species within the river reserve.

Other issues

There are two water tanks, a windmill and trough located close to the confluence of a creek and the Chapman River. The right bank only is fenced. This paddock structure is effective for minimising stock movement parallel with the waterway. This is acceptable when it is linked with close monitoring of the impact of stock on the riparian zone.

Suggestions

Bank stability

- B Protect the riparian zone from vegetation loss (possibly resulting from fire, excessive grazing or weed invasion) which is likely to cause a reduction in bank stability.
- B Maintain existing native vegetation cover and ensure that weed control activities do not threaten bank stability.
- B Monitor water quality particularly sediment load, and trace sources of excessive sediment should high loads occur.
- B Identify sources of sediment upstream and implement best management practice to control erosion.

Vegetation

- V Continue to manage and monitor the impact of stock in these sensitive river paddocks to protect the existing native vegetation.
- V Start to control Lupins on the boundary between the tree line and the crop, to encourage natural regeneration of perennial species.
- V Focus control on weeds occurring in neighbouring areas in significant densities, such as Paterson's curse, Doublegee and Black berry nightshade.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Protect native plants occurring on riverbank to maintain stream cover.
- S Monitor natural regrowth in areas subject to weed control and, if regeneration of native species is limited, implement a selective replacement program.
- S Ensure that instream features such as branches and leaf litter are protected where they are not exacerbating erosion.
- S Monitor stock impact on the river environment, and work to maintain consistent stream cover.

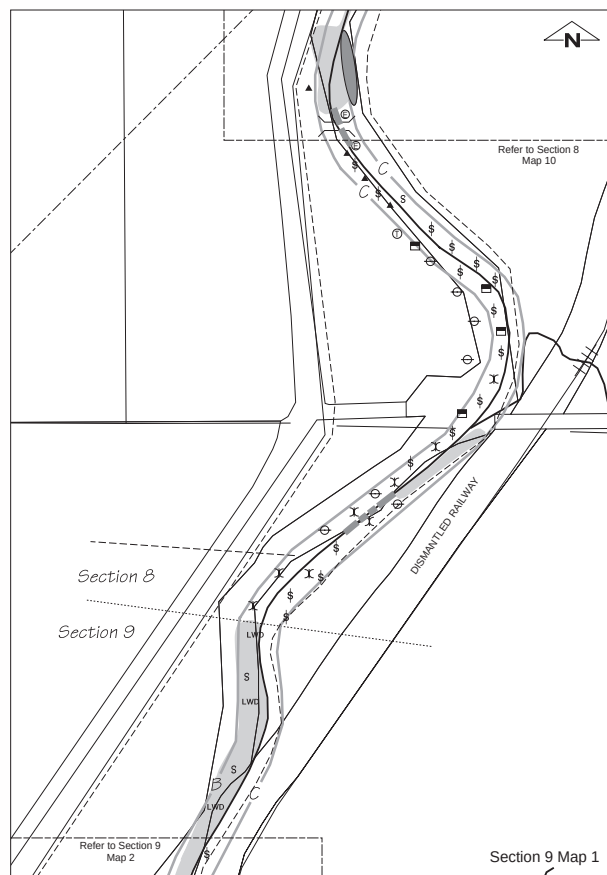
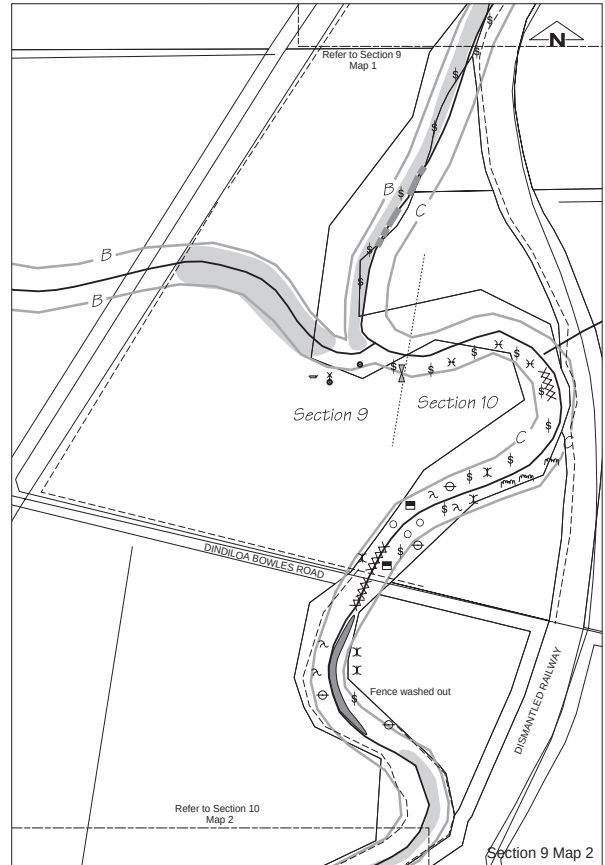
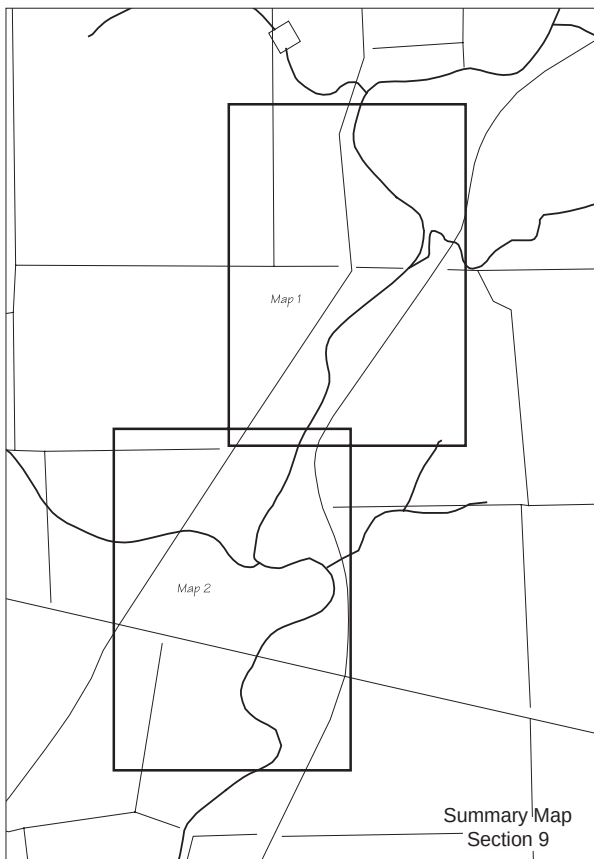
Habitat diversity

- H Implement weed control in localised areas of the verge, and plant native shrubs in relatively high density where stock can be effectively excluded until the plants are sufficiently established.
- H Monitor the length of time that stock spend in the sensitive river paddocks and try to minimise access during the breeding seasons of many native ground-dwelling animals (September to January).

Other issues

- O Clarify boundaries between reserve and freehold land, and realign fences as required if stocking.
- O Monitor stock impacts on the foreshore reserve in terms of weed invasion and disruption to soil cohesion, and exclude from riparian area if a decline in health is apparent.





SECTION 10 CHAPMAN RIVER MAPS 1 – 3**Length of section (m):** 3,240m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 15 May 2000**Nearest road access:** Dindiloa Bowles Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Poor – C	Very Poor – D	Poor – C	Very Poor – D	Poor – C
Poor – C	Poor – C	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

Bank stability

The channel varies between a single channel and braided sections across the floodplain. The main river channel ranges between 4 and 8 m wide, where it is a single channel. The braided sections are characterised by numerous narrow channels. The main river channel reflects the floodplain width and extent of vegetation, ranging from 1 and 5 m wide to between 8 – 24 m wide with some braided sections due to large amounts of sediment deposition along the main channel. The sections with a wide main river channel correspond with areas where the floodplain is poorly defined while the 1 – 5 m wide channel sections correspond with the sections where the floodplain is 25 m wide.

The sediment deposition often occurs immediately downstream of large woody debris. The right channel bank rises on a steep gradient to approximately 4 m for half of this section and then drops to a moderate bank gradient to a maximum bank height of less than 2 m above the low flow channel. The left channel bank also rises on a steep gradient to less than 1 m high. The river valley is clearly defined along most of this river section.

Five significant sediment plumes are present on the right bank. There are considerable volumes of large woody debris throughout this river section. There are also significant sediment plumes upstream and downstream of the Dindiloa Road crossing. There are some sections with exposed granite boulders both instream and on the valley banks. Slumping is minimal (0 – 5%) and corresponds with a major stock access point.

There are significant volumes of mobile sand on the outer margins of the floodway. There are two large and severe blowouts (scour) on the floodplain margins

that appear to have occurred during the 1999 peak flow events. One of these formed as a result of dense vegetation on the left bank deflecting the flow into land that had less vegetation cover. The water found exposed non-cohesive sand and was able to wash out a significant volume of sand. The second significant blowout is downstream of the Dindiloa Road crossing and is 3 m wide and 200 m long on the inside of the powerbend.

There is a rocky river crossing (ford) and a floodway crossing at Dindiloa Road within this section. A drain has been excavated that directs runoff from the paddocks into the river. There is an old river crossing at the beginning of one powerbend. A new river crossing has created an eddy and enabled the formation of a pool upstream of the crossing. There is evidence that the river is starting to cut back on the upstream margin of the pool. There is a 0.5 m change in riverbed heights.

Comments

Both of the crossings appear to impact on the river flow characteristics, deflecting the flow around them and into the riverbanks. This is starting to result in trees being undermined and causing erosion of the floodway. The ford has also resulted in the formation of a pool upstream.

Vegetation

This section of foreshore has been highly disturbed. The overstorey is patchy (20 – 80%) and extends only a few metres either side of the Chapman River. The overstorey is dominated by single rows of Swamp sheoak (*Casuarina obesa*) or River gum (*Eucalyptus camaldulensis*) and a middlestorey comprising occasional Coojong (*Acacia saligna*) present in less



than 20 % of the river section. The understorey in the riparian zone is also patchy (20 – 80% cover) characterised by weeds including Black berry nightshade (*Solanum nigrum*), Lupins (*Lupinus cosentinii* and *L. angustifolius*), Cape weed (*Arctotheca calendula*), with Pie melon (*Citrullus lanatus*), Paterson's curse (*Echium plantagineum*), Doublegee (*Emex australis*) and Wild radish (*Raphanus raphanistrum*) prevalent. Annual grasses including Annual Wimmera ryegrass (*Lolium rigidum*), Wild oats (*Avena fatua*) and an assortment of others are common.

In some river sections the riverbanks and floodplain are stabilised by couch (likely to be Saltene), but these are limited. Most of the vegetation occurs on the left bank, with more than 50% of the right bank lacking riparian and verge vegetation. There are some relic saltmarsh patches retaining dense stands of Shrubby samphire (*Halosarcia halocnemoides*), Beaded samphire (*Sarcocornia quinqueflora*) and Spiny flatsedge (*Cyperus gymnocaulos*). The extent of these is insufficient to upgrade the rating of this entire river section.

The verge vegetation is limited to three small patches along the entire section length. There is no overstorey and the middlestorey retains minimal diversity. The dominant species include Stand back (*Hakea preissii*), Kurara (*Acacia tetragonophylla*), and an unidentified species of *Hakea*. The understorey in the verge is characterised by frequent annual grasses, Pie melon (*Citrullus lanatus*) and occasional Roly poly (*Salsola kali*) and Lupins (*Lupinus cosentinii* and *L. angustifolius*).

Comments

Some of the landholders within this river section expressed an interest in gaining support to continue their revegetation works to help slow the water flow consistently through their property. This section appears to correspond with the zone in the river system where the riverbed gradient changes from a relatively steep system to a more moderate gradient. Having sufficient perennial groundcover to help slow the water that has been moving rapidly up to this point, is critical to help minimise damage to the channel and floodplain during peak flow events.

Areas lacking vegetation cover particularly during the cyclone season (December to April) are at the greatest

risk of causing erosion either locally or further downstream. Annual grasses help to protect the riverbanks and floodplain between August and November, after which they contribute little to bank stability. The rivers tend to have a boom and bust cycle, and their unpredictability is the main reason for needing perennial groundcovers. Similar processes occur if there is insufficient groundcover to protect the topsoil from wind erosion. The need for perennial groundcovers to minimise excessive change to the river environment cannot be emphasised enough.

Stream cover

The stream cover is minimal in this section and is limited to three regions where overhanging trees provide some shade. The narrow overstorey is insufficient to meet stream cover needs. There are intermittent rocks, logs and branches and some vegetative material present in the river channel that also provide localised areas of cover.

Comments

The lack of continuous shading of the water increases the rate at which the pools dry up and also the rate of deterioration in water quality particularly as it relates to algal growth. Anecdotal evidence suggests that filamentous algae are becoming increasingly prevalent. Shade reduces water temperature, which in turn discourages the growth of algae. By increasing the availability of shade, it is possible to minimise the growth of nuisance algae.

Habitat diversity

The water within the main channel is not permanent, although there was clear to light brown water running at the time of survey. The water depth varies and is shallow. The instream boulders and rocks act as riffle zones, aerating the water and providing habitat for aquatic animals. The paucity of riparian and verge vegetation limits the availability of suitable habitats of terrestrial invertebrates and vertebrates. The dense stands of Swamp sheoak and the annual weed assemblage provide scattered habitat. It is important to note that this vegetation is weed-dominated, which will affect habitat diversity as weed control is undertaken. The patchy overstorey provides suitable nesting and roosting sites.



Comments

The minimal habitat available currently for native animals will limit any future weed control works. There is the potential to not only reduce bank stability, but also cause loss of habitat for most native animals in this section.

Other issues

The riparian zone is frequently the summer paddock for stock as it often retains the only tree cover. While selective grazing in the foreshore is a good management practice to control weeds and the fire hazard associated with annual grasses, the trampling and grazing can also stop natural regeneration of the vegetation. This section generally lacked seedlings and juvenile plants. The lack of regeneration means that when the current trees die, there will be no replacements. This then allows the water to move faster, making replanting very difficult. Mobile floodplains and riverbanks are extremely costly to revegetate, as the plants need to be protected from being washed away through erosion processes or smothered by sedimentation processes.

There are sections lacking fencing and other sections that have double fencing. There is a need to clarify the location of the reserve boundary prior to installing or realigning fencing in the future. The alignment is variable and in some locations appears to be below the foreshore reserve boundary. This is not an issue as long as the paddocks are not stocked. The proximity of a road to the left bank and ownership spanning the river are two likely reasons that there is no fencing of one part of the river reserve. The paddock design has avoided treating the river as a linear paddock, which often encourages stock to walk parallel with the flow, thus creating areas that are more susceptible to erosion. However, the lack of regeneration indicates that the riparian zone and verge vegetation need time to recover.

There were some discarded farm materials within the floodway that are at risk of being washed downstream during a peak flow event. These materials should be disposed of more carefully.

The rail reserve also connects with the foreshore reserve in five places. This may provide an opportunity for viewing the riparian system, if the proposed walk trail is ever established along the rail reserve. Some sections

of the railway reserve are unfenced and being cropped. This may be contrary to the intention of the reserve.

There are two windmills with tanks and troughs close to the river in this section. One of the troughs is located on the opposite river bank to that which has the tank. Where poly pipes cross the river to feed water to distant troughs, there is a risk of them being washed away. Also the disturbance to the riverbed when digging the pipes in, can impact on future flow events.

The presence of a blowout provides information about the vegetation extent prior to the major flow events in 1999. The lack of vegetation cover minimised support provided to the riverbanks and floodplain against erosive forces. While erosion is natural, this would not have occurred in an area with intact riparian and verge vegetation.

Suggestions

Bank stability

- B Review the river crossings with a Water and Rivers Rivercare officer who can provide advice on the design to reduce the downstream and upstream impacts of the crossings.

Vegetation

- V Exclude stock for a period of time and undertake localised areas of weed control to encourage natural regeneration of instream vegetation.
- V Direct seed or plant rushes and sedges including Shore rush (*Juncus kraussii*), Spiny flatsedge (*Cyperus gymnocaulos*) or the native Saltwater couch (*Sporobolus virginicus*) to provide all year groundcover.
- V Beyond the riparian zone, tag all native plants prior to treating weeds with herbicide to minimise the unnecessary loss of native plants.
- V Monitor natural regeneration following weed control activities and implement intensive planting programs if required.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.



Stream cover

- S Protect native plants occurring on riverbank to maintain stream cover.
- S Monitor natural regeneration processes in areas subject to weed control, and if regeneration of native species is limited implement a selective replacement program.
- S Ensure that instream features such as branches and leaf litter are protected where they are not exacerbating erosion.

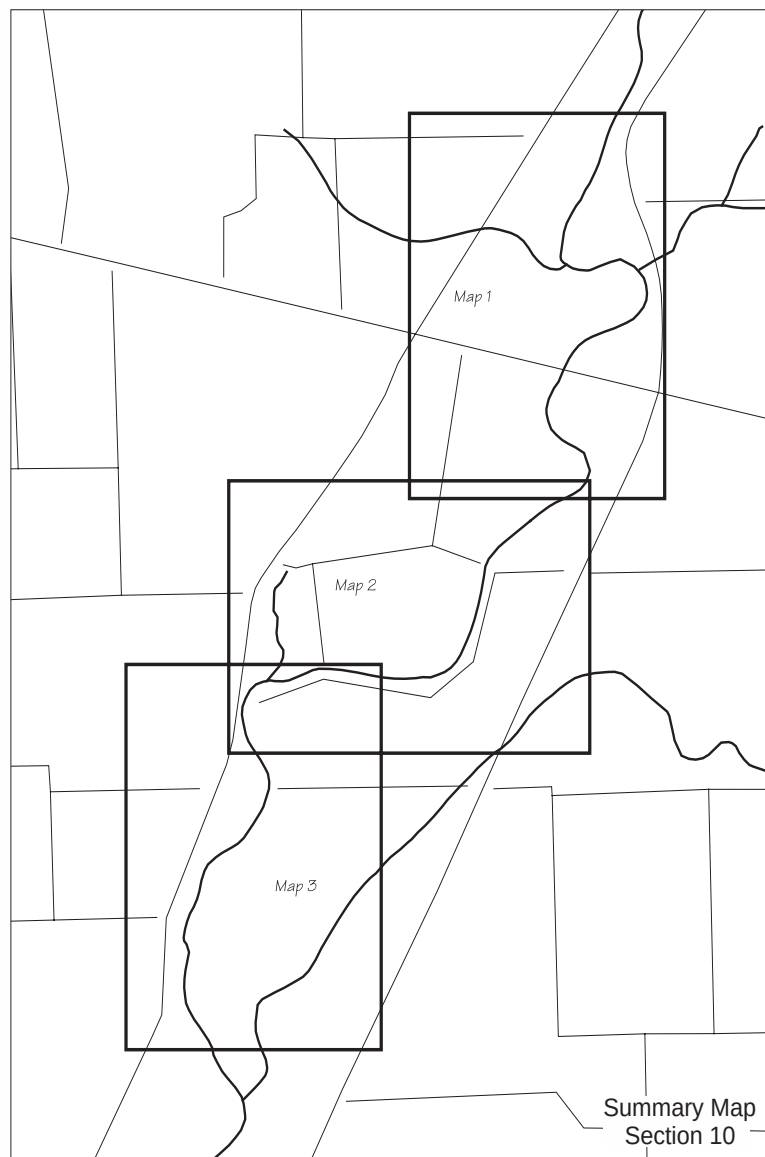
Habitat diversity

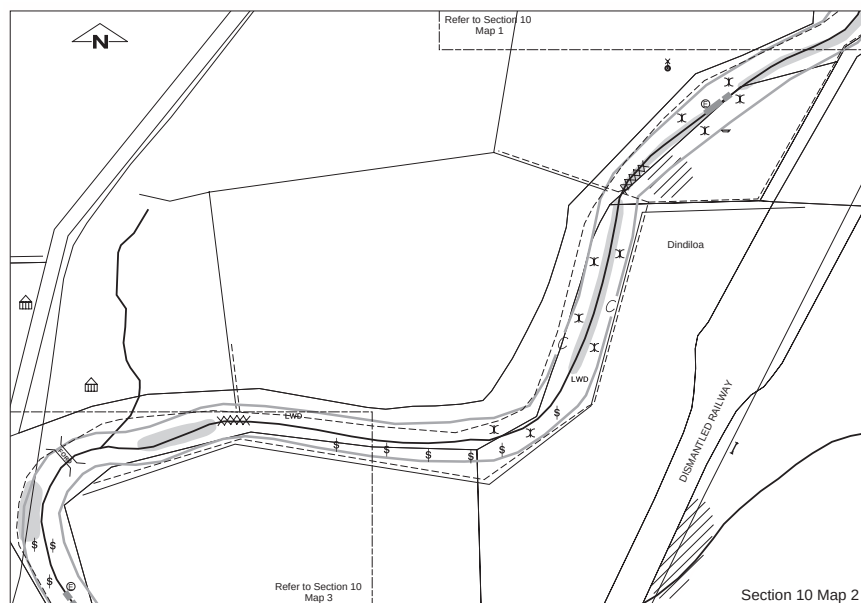
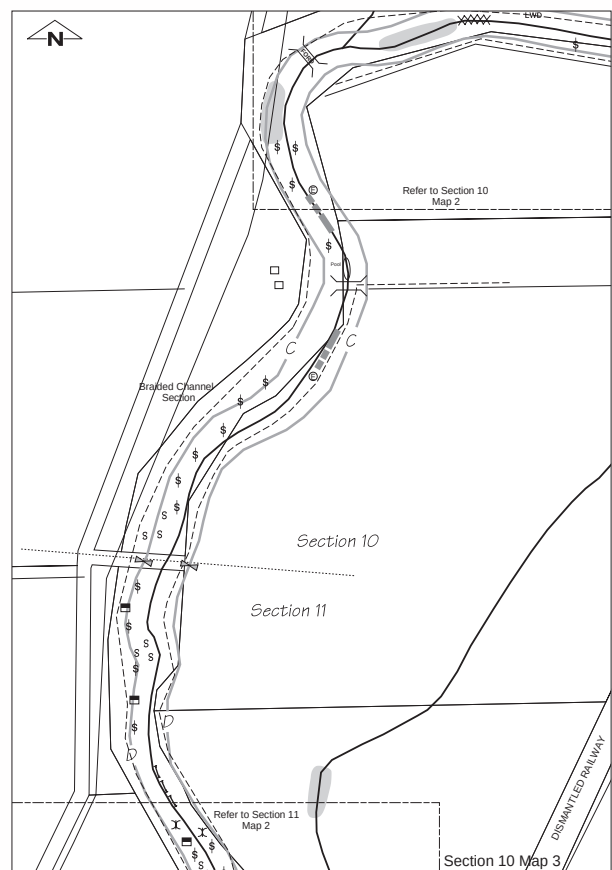
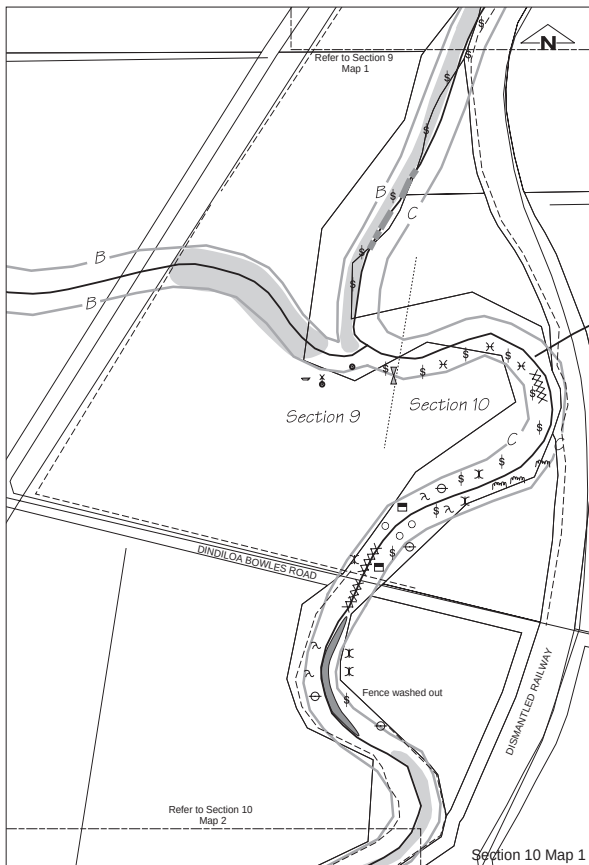
- H Ensure that weed control activities occur in nodes and that continuous corridors of vegetation are left to provide habitat until replacement species have established.

- H Ensure that weed control occurring on the banks and the floodway takes into consideration the impact of increasing water velocity in peak flows resulting from vegetation removal, by implementing control in sections and not on powerbends.

Other issues

- O Clarify boundaries between reserve and freehold land, and realign fences as required if stocking.
- O Work to revegetate sections of the river to help slow water movement through this river section, to reduce the rate at which peaks move downstream. Use upright understorey species including the rushes and sedges, with 10 % tree cover.





SECTION 11: CHAPMAN RIVER MAPS 1 – 3**Length of section (m):** 1,730m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:****Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Very Poor – D	Poor – C	Very Poor – D	Very Poor – D	Very Poor – D

Bank stability

The main river channel reflects the floodplain width and extent of vegetation, ranging from multiple narrow channels between 1 and 5 m wide in the braided sections up to between 6 and 8 m wide in areas where a single channel persists. The braids are forming as a result of sediment deposition in some sections and loss of vegetation in others. Some sediment deposition occurs immediately downstream of large woody debris. Introduced couch stabilises many of these plumes. The channel banks rise on a moderate to very steep gradient to a height of 1 – 1.8 m. Erosion is significant (20 – 50%), often occurring near the base of trees and along the new river channel. There are three significant blowouts within this river section. The maximum depth of soil loss within these blowouts is about 1.2 m, and all are approximately 200 m long and greater than 30 m wide.

There is a well-vegetated former river channel in the central part of this river section. The new channel is highly unstable, lacks vegetation cover, and in many places has eroded the riverbed to a relatively stable clay base.

The riverbed, banks and floodway have been subject to considerable interference and these changes have impacted on the way in which the river flow behaves. Levee banks have been constructed and additional pools excavated.

There are two river crossings in this section. One of these is set high, trapping the mobile sediment upstream, and the other crossing has been washed out.

A significant tributary known as Rushy Gully meets the Chapman River within this section. This influx of water would contribute to the slowing and banking back of the Chapman River, increasing erosion and deposition in this area.

Comments

The build-up of mobile sediment in this section over time has been colonised by Couch, resulting in the formation of a braided river section. It is likely that in the past, large and fine woody debris was trapped at the base of instream trees, forming natural dams and increasing erosion of the riverbanks and loss of trees through undermining. A combination of river and catchment processes including increased sedimentation, loss of vegetation upstream to slow the movement of peak flows consistently along the entire river length, and possible changes to the groundwater dynamics of the region are likely to have exacerbated damage in this section. The perception that instream vegetation slows the water flow, causing it to spread across the floodplain is correct, however it is a critical part of natural river processes to manage peak flow events.

Further, the loss of dense vegetation on the floodplain and riverbanks appears to have increased the ability of the floodwaters and peak flows to exceed the main river channel and spread. Where dense vegetation occurs consistently across the floodplain and on the verge, it contributes to the deflection of peak flow back into the main river channel. Any poorly vegetated areas have reduced resistance to water flow, allowing the water to travel faster as there is reduced friction. This can increase the susceptibility of the soil to erosion and enable the flow to spread across the floodplain. In addition, the loss of vegetation in many river sections upstream increases the overall rate at which the water travels, so when braided and well-vegetated sections are reached, the flow banks up. In this location, such banking back of water is likely to have threatened infrastructure.

The modifications to the river channel, floodplain and bank structure are likely have been intended to 'improve or speed up' water movement through this river section.



There is an urgent need to re-assess this part of the river system to determine alternative mechanisms to slow water movement and encourage the flow back into the floodplain and main river channel.

The sandy loam topsoil has lower soil cohesion than the clay bed in the new river channel, which enables the water to wash away the channel banks and spread across the floodplain. This will continue to occur until such time as there is sufficient vegetation to contain the flow and help to stabilise the channel banks.

Vegetation

The overstorey vegetation is infrequent to patchy and consists of Swamp sheoak (*Casuarina obesa*) and River gum (*Eucalyptus camaldulensis*). The vegetation is in variable condition and is typically a discontinuous single row of trees on both banks. Some sections lack tree, shrub and continuous groundcover. The middlestorey is absent within the floodplain and on the verge. The understorey is patchy (20 – 80%) and is dominated by weeds. There are occasional closed herblands comprising Samphire (*Halosarcia* and *Sarcocornia*) interspersed with occasional Spiny flatsedge (*Cyperus gymnocaulos*). A variety of Couch (likely to be *Cynodon dactylon*) occurs periodically. Common weeds include Roly poly (*Salsola kali*), Black berry nightshade (*Solanum nigrum*), Statice (*Limonium sinatum* and *L. lobatum*), Wild radish (*Raphanus raphanistrum*), Cape weed (*Arctotheca calendula*), Pie melon (*Citrullus lanatus*) and Annual Wimmera ryegrass (*Lolium rigidum*). Doublegee (*Emex australis*), Smooth catsear (*Hypochaeris glabra*) and Curled dock (*Rumex crispus*) are also present.

There is one large stand of the Giant reed (*Arundo donax*) on a tributary and some Tamarisk within the river reserve.

The verge vegetation comprises a chaotic weed assemblage including the weeds listed above, and the addition of Wild oats (*Avena fatua*).

The landholder is trialling the use of Sorghum in seasonally waterlogged floodplain sections to improve the productivity of the land and help to stabilise the floodplain.

Comments

The lack of continuous perennial groundcovers and dominance of only a single row of trees along this section is contributing to destabilisation of the riverbed,

banks and floodplain. There is insufficient vegetation to help stabilise the floodplain. Further, the presence of Couch on the formerly mobile sediment plumes is likely to trap more sediment than the native equivalents. There is a need for weed control in nodes, focussing in areas that can be effectively managed. A technique that may be useful in this environment is establishing a buffer zone around remnant vegetation, which helps to prevent further weed invasion and encourage natural regeneration. Consideration needs to be given to the potential impact of any weed control works on floodplain stability.

There are insufficient perennial groundcovers to armour the riverbanks and the floodplain from any peak flows during the summer and autumn months.

Anecdotal evidence suggests that the Annual Wimmera ryegrass (*Lolium rigidum*) that occurs along the river length includes some herbicide resistant strains.

Stream cover

The stream cover in this section is patchy, reflecting limited vegetation extent. There are some rocks and branches providing limited instream cover.

Comments

There is insufficient stream cover to help prolong the length of time that pools persist in the river channel. Further, there is a strong likelihood that the water quality within the pools would deteriorate more rapidly as a result of the lack of shade enabling water temperatures to climb quickly.

Habitat diversity

Water is unlikely to be permanent and while it flows varies from very clear to light brown. Due to high levels of sedimentation the water depth in the main channel varies and is shallow in many areas, ranging from < 0.2 m to 0.7 m. Scattered instream branches provide limited habitats for aquatic invertebrates. The dense patches of annual weeds and patchy relic native understorey plants provide some cover for terrestrial organisms but with minimal habitat diversity. The patchy overstorey provides occasional nesting and roosting sites for birds.

There is some significant accumulation of large and fine woody debris. This provides excellent habitat for lizards and many terrestrial invertebrates.



Comments

There are two areas where large woody debris has accumulated on the left bank. It coincides with an area where the channel bed has eroded back to a relatively stable base. This combination has contributed to the course of water flow and the erosion dynamics. While the debris provides good habitat, it is increasing erosion both upstream and downstream of it. Realignment of the debris to the floodplain margins would retain the habitat values and reduce the impact of the debris on peak river flows.

Other issues

Some landholders appear to be quite sceptical about the role and intentions of government agencies, and are likely to be unreceptive to some of the recommendations for this waterway.

Some of the river section is fenced, while other sections are not. While the paddocks are not stocked this is not a significant problem. One benefit of fences, however, is that they effectively delineate the boundary between river reserve and freehold land. The location of the reserve boundary needs to be determined and marked in some way. The current reserve alignment is possibly not in the most appropriate location. In some parts it appears to occur less than 5 m from the main river channel.

Suggestions

Bank stability

- B Liaise with officers of the Water and Rivers Commission to address river dynamics in this section and gain advice in river crossing design.
- B Provide landholders with information packs including Water Notes, Water Facts and relevant materials to support their interest in river management.
- B Assess the sediment and water contributions of Rushy Gully and the upper Chapman River catchment and work to slow the movement of both along the entire river section.

Vegetation

- V Localise weed control around persistent native plants if a minimalist approach to weed control within the foreshore reserve is more realistic. Remove weeds occurring in low numbers by spot spraying to prevent their numbers from increasing in the future.
- V Focus weed control on annual grass species and pasture weeds as these species pose the greatest fire hazard and threat to the integrity of the persisting riparian vegetation.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Reinforce plant community by planting overstorey trees where no natural regeneration is occurring.
- S Re-establish fencing if stock is to be grazed in paddocks adjoining this river section.
- S Undertake weed control around existing clumps of rushes/sedges to encourage their spread and promote stream cover.

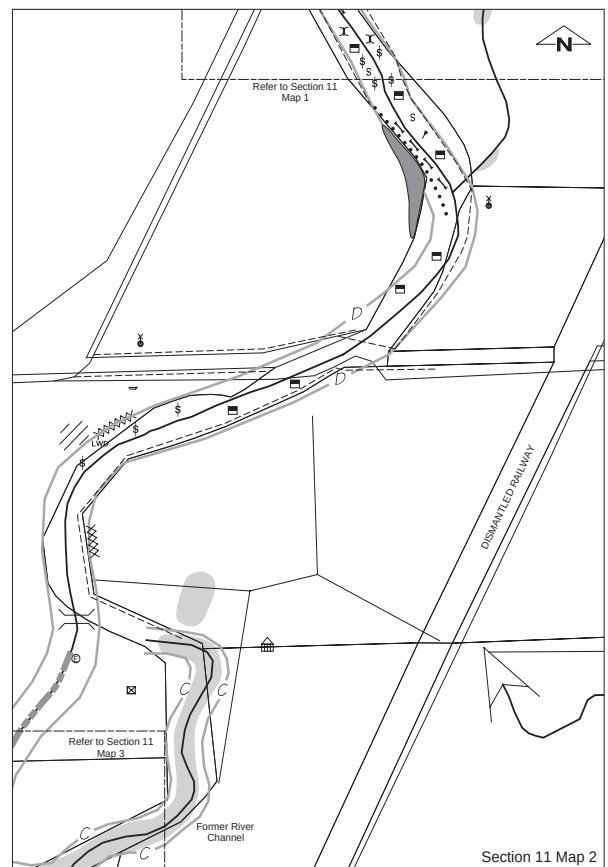
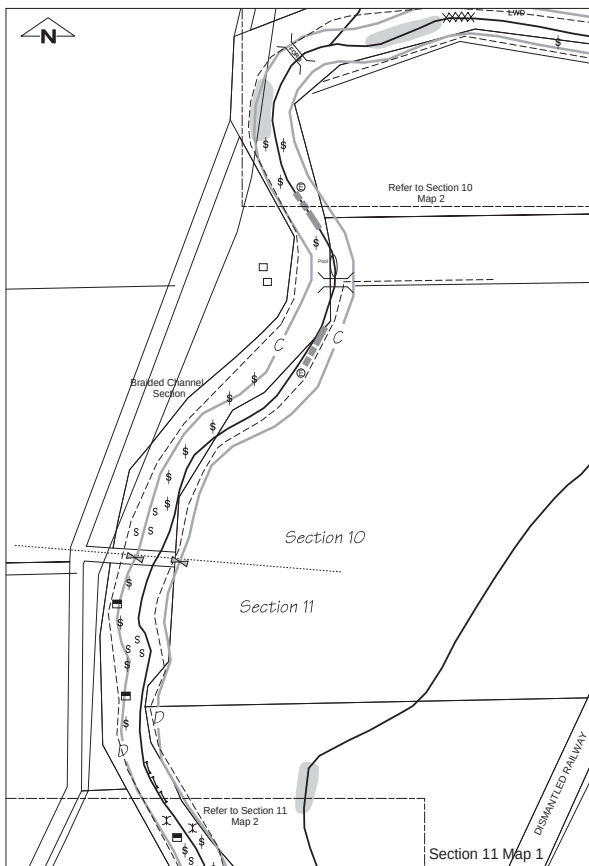
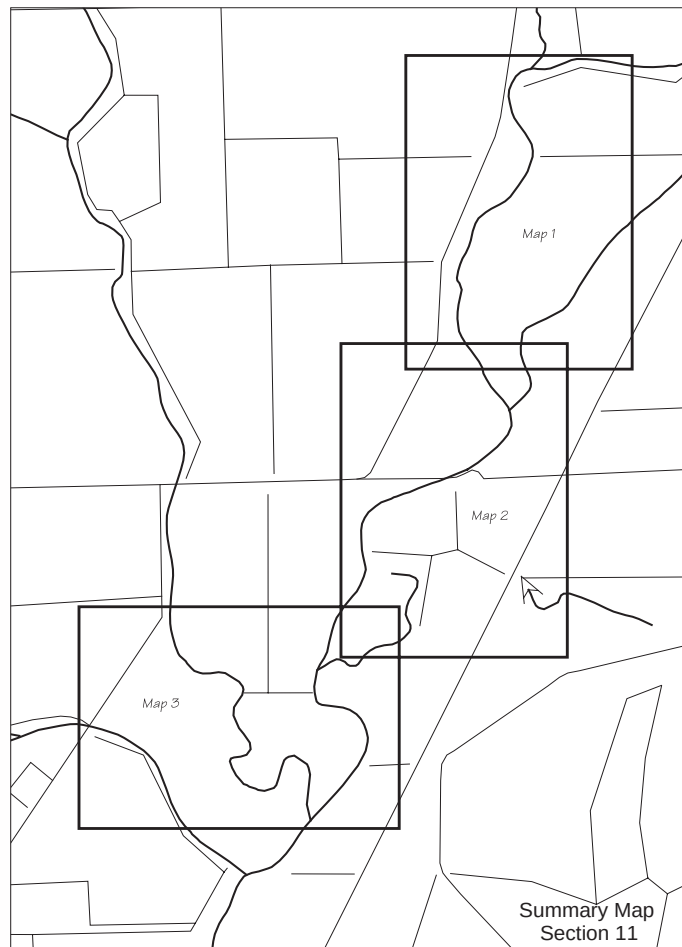
Habitat diversity

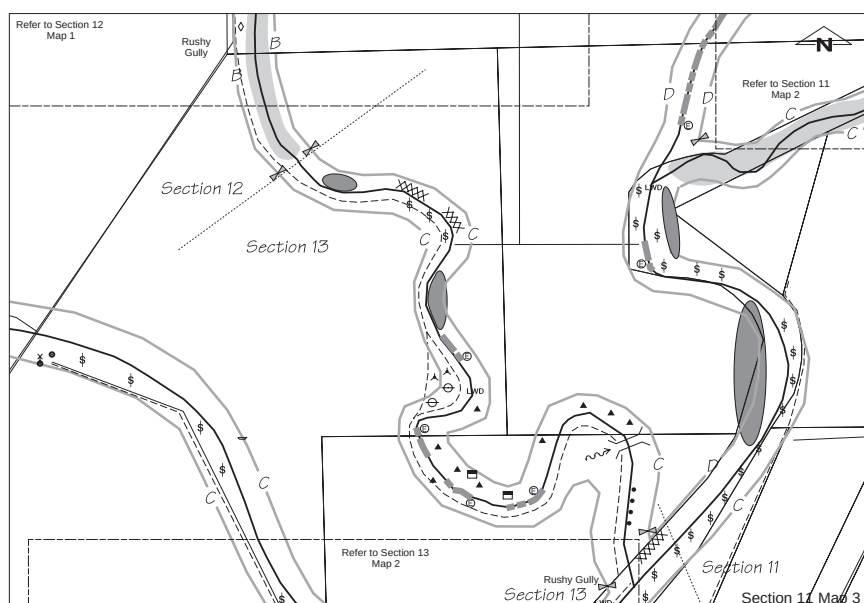
- H Remove the large woody debris and arrange it beyond the floodplain adjacent to the fire access track.
- H Endeavour to restore continuity of vegetation by modifying management practices to encourage natural regeneration processes within the riparian zone and the verge area.

Other issues

- O Provide non-threatening support and information to landholders about ways in which they can contribute to protecting the river, its banks and the associated vegetation, on a one-to-one basis not a bulk mail out.
- O Seek assistance from Water and Rivers Commission officers and Agriculture WA to develop farm management plans that include the river system.
- O Clarify the reserve boundary location and review the alignment.







SECTION 12: RUSHY GULLY MAPS 1 – 2

Length of section (m): 1,300m

Recorders' name: N Siemon and T Rebola

Date surveyed: 16 May 2000

Nearest road access: Nabawa - Northampton Rd

Summary of river health

Bank Stability	Foreshore Vegetation	Stream Cover	Habitat Diversity	Verge Vegetation	Stream Condition
Very Good – A	Very Good – A	Very Good – A	Very Good – A	Poor – C	Very Good – A

Bank stability

The bank stability in this section is excellent. The main channel is 3 – 6 m wide with the foreshore banks rising on a slight to medium gradient to 0.5 – 1.5 m in height. Localised points of erosion are present along 5% of the survey section. The most common location of erosion is around the base of trees growing along the foreshore and on both sides of a causeway (road crossing). Slumping is localised around the river crossing where undercutting has occurred. Sedimentation is minimal in this section.

There is a formal and an informal crossing in this section. Both of these crossings are causing localised erosion upstream and downstream.

Comments

The dense native vegetation across the entire width of the floodplain is successfully protecting the banks from erosion. Because native rushes are cylindrical and long they tend to 'lie down' when peak flows occur. The frictional forces associated with the water moving over these plants are sufficient in this case to protect the

banks from erosion. This is seen immediately downstream, where the instream vegetation has been lost and there are significant areas of erosion.

Vegetation

The overstorey is continuous (< 80% cover) extending 15 – 30 m from the brook on the left foreshore and approximately 8 – 15 m on the right foreshore. The overstorey consists of abundant River gum (*Eucalyptus camaldulensis*) and frequent Swamp paperbark (*Melaleuca raphiophylla*). There are occasional Swamp sheoak (*Casuarina obesa*) and the introduced Pepper tree (*Schinus molle*). The middlestorey is absent and the understorey is continuous (< 80% cover). The characteristic understorey species are Shore rush (*Juncus kraussii*) and Spiny flatsedge (*Cyperus gymnocaulos*) forming a dense sedgeland. Other native species present include infrequent patches of the Bare twig rush (*Baumea juncea*). Weed species present in the understorey include Fleabane (*Conyza bonariensis*) and uncommon occurrences of Black berry nightshade (*Solanum nigrum*).

There is minimal verge vegetation.



Comments

Localised weed control would benefit this foreshore area and help to maintain the integrity of this river section. It will be important to establish clearly defined access points to minimise widespread trampling of the understorey. It is possible that greater damage could occur than benefit gained if the weed control is not managed well.

Stream cover

The continuous overstorey and dense streamside vegetation provides areas of permanent stream cover and shade along the waterway. The presence of leaf litter and detritus, logs and branches and occasional rocks provides good instream cover.

Comments

Protecting and maintaining the vegetation cover will maintain the current status of this area. Any activity that disturbs the vegetation cover and extent will significantly impact on stream health.

Habitat diversity

The water in the waterway was clear and light brown and the channel is $< 0.2 - 0.5$ m in depth. The leaf litter and material, instream logs and rocks all provide suitable habitat for aquatic invertebrates. The water is slow moving, however the extent of instream vegetation facilitates aeration of the water. The emergent rushes and sedges also provide for aquatic invertebrates that emerge from the water for a flying phase. One of the key features missing from the river systems is vegetation that insects such as dragonflies, damselflies and other large creatures can use to break the surface tension to leave the water. These animals develop their wings in the water and then when they crawl out, need to rest and dry their wings.

There were large numbers of predators such as orb weaver spiders in this section, which is indicative of good waterway health. Healthy ecosystems retain large invertebrate predators such as spiders. Woodland birds and other vertebrate fauna such as frogs then feed on these animals. Some fish were observed during the survey. The dense streamside vegetation is suitable for terrestrial invertebrates as outlined above, and vertebrates such as frogs and lizards. The continuous overstorey and dense cover provides nesting and roosting sites for birds.

Comments

This site can be used to help landholders identify a healthy foreshore environment. This section retains the necessary values to design and implement other revegetation works in the area. This area will also reflect any changes to groundwater conditions including higher water levels and salinity fluxes. The diversity of habitats here also provides a node from which seed and juvenile animals can disperse downstream to recolonise other areas.

Other issues

This section is fenced on both banks. The location of the fence and the fire access track on the right bank is excellent as it is set beyond the floodplain. The alignment on the left bank is not completely ideal and if the opportunity arises could be realigned beyond the floodway. Some sections are also in need of repair, if the adjoining paddocks are to be stocked in the future. This area could provide an excellent recreation and training location to provide comparisons against other sections of the Chapman River.

Suggestions

Bank stability

- B Review the causeway design and if the opportunity arises develop alternative designs to spread peak water flows, possibly by increasing the number and extent of culverts. Modifying the causeway design may become more critical if the waterway begins to flow all year round.
- B Protect the dense remnant vegetation from disturbance to maintain its function in stabilising the foreshore and floodplain.
- B Monitor the flows in this waterway and changes to the groundwater levels in the catchment.

Vegetation

- V Focus attention on localised weed control.
- V Commence a program to restore verge vegetation, possibly using this site as a demonstration. Consider making part of the area a 'landscaped zone' to enable use of this site for picnics.



- V Monitor the vegetation health in case changes to the length of inundation and salinity levels result from changing groundwater conditions.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Protect the remnant vegetation in the area from clearing, fire and/or other activities that will increase degradation.
- S Ensure that designated access points are established for visitors if the area is to be used as a demonstration site.

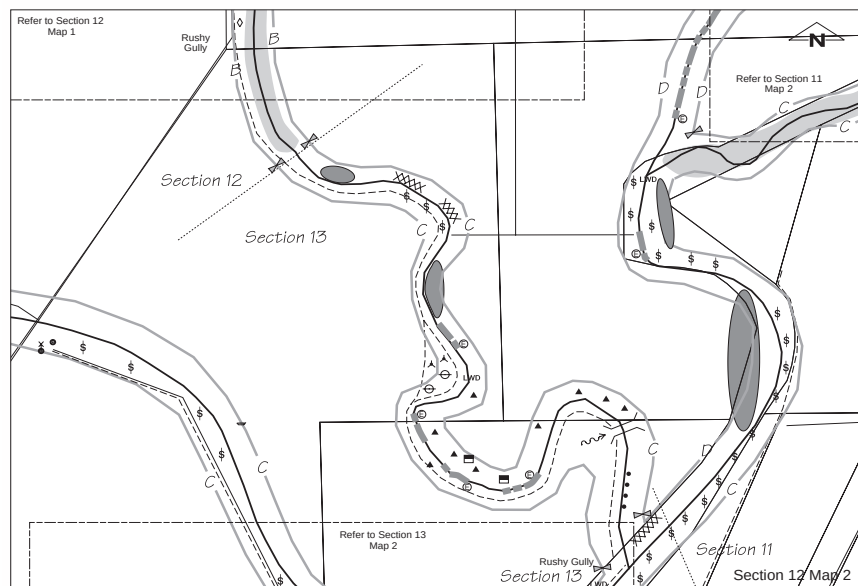
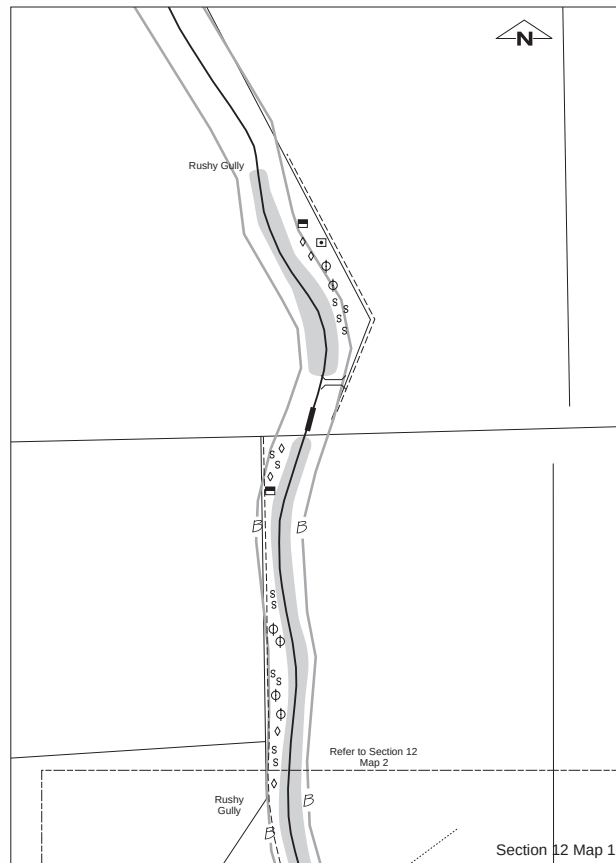
Habitat diversity

- H Undertake a survey of the aquatic and terrestrial invertebrates to obtain baseline data, against which future studies can be compared.
- H Monitor the health of this remnant annually to determine whether or not there are any significant changes to the foreshore health.

Other issues

- O Determine the feasibility of establishing a meeting point within this reserve and include some minor recreation facilities.
- O Realign the fence on the left bank to the floodplain margin if the opportunity arises.





SECTION 13: RUSHY GULLY MAPS 1 – 2**Length of section (m):** 2,680m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Nabawa - Northampton Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Poor – C	Moderate – B	Poor – C	Very Poor – D	Poor – C

Bank stability

The main channel is 1.5 – 6 m wide with the foreshore banks rising on a steep to very steep gradient to between 1 and 3 m in height. Localised points of erosion are present along 5 – 20% of the survey section. The most common location of erosion is along steep banks on the powerbends and around the base of trees growing along the foreshore. Slumping is localised (5 – 20% of the foreshore) where undercutting has occurred following modifications to the channel characteristics. These modifications have included deepening and straightening the channel. Some of the dredged material has been dumped in the confluence of the two waterways.

There are three significant blowouts. The sediment removed from one has been deposited immediately downstream of its origin. The instream woody debris is deflecting the peak flows into some banks.

There are erosion rills forming along a river crossing.

Comments

Some of the piles of woody debris are exacerbating bank erosion and could be realigned or removed. Selective removal is critical to the protection of the bank stability and action needs to be taken urgently.

Vegetation

The overstorey is discontinuous and comprises a combination of single rows of River gum (*Eucalyptus camaldulensis*) and occasional Swamp sheoak (*Casuarina obesa*) grading into sections with continuous cover dominated by River gum (*Eucalyptus camaldulensis*) and the Swamp paperbark (*Melaleuca raphiophylla*). There are two Pepper trees (*Schinus molle*). A 700 m section of this survey was characterised by dead Swamp sheoak (*Casuarina obesa*), possibly as a result of fire. The middlestorey

is patchy (20 – 80%) and dominated by Coojong (*Acacia saligna*). The understorey is also patchy (20 – 80% cover) and is dominated by weed species. Pie melon (*Citrullus lanatus*), Doublegee (*Emex australis*), Statice (*Limonium sinatum* and *L. lobatum*), Curled dock (*Rumex crispus*), Fleabane (*Conyza bonariensis*), Wild radish (*Raphanus raphanistrum*) and Annual Wimmera ryegrass (*Lolium rigidum*) are widespread. One species present in lower numbers is Black berry nightshade (*Solanum nigrum*).

There is no verge vegetation apart from occasional Coojong (*Acacia saligna*).

Comments

The loss of considerable numbers of large Swamp sheoaks is an issue. The fact that the deaths are confined to a single species is unusual and difficult to explain. It is likely, as mentioned above, that the deaths are as the result of a fire. However, other causes cannot be ruled out.

Some weed species that are relatively uncommon at the moment include Pepper trees and Black berry nightshade. These should be removed before they spread and require more resources to control. The scale of weed infestation makes broadscale control difficult although landholders are required to control declared weeds within their properties.

Stream cover

Overhanging vegetation along the foreshore provides patches of permanent shade along this section of Rushy Gully. The presence of leaf litter, occasional branches and fallen trees, and rocks provides intermittent instream shade.

Comments

Some of the fallen trees and occasional branches in some locations are exacerbating erosion of the creek



banks. Their ecological value in terms of providing shade and habitat for animals is minimal in comparison to the damage occurring to the riverbanks. Selective removal and realignment is recommended to help protect the riverbanks from further erosion.

Habitat diversity

Water is not currently permanent in Rushy Gully, however this situation may change with changing groundwater conditions in the catchment. The water was clear and light brown in colour due to the presence of tannins leached from vegetation detritus in the water column. The channel is shallow along the entire length of the survey section. Water depth at the time of survey varied from < 0.2 m to 0.4 m. Scattered instream rocks, logs and branches provide limited habitats for aquatic invertebrates. Almost no instream life was observed. The continuous understorey provides shelter for terrestrial animals, but the lack of native plants means that overall there is low habitat diversity. The patchy overstorey provides nesting and roosting sites for birds.

Comments

The diversity of weed species present in this river section contributes to an increased fire risk. The dead Swamp sheoaks from this foreshore section following fire will provide increased roosting sites for birds and possibly hollows. The lack of regeneration of young sheoaks will reduce the habitat values of this section in the long-term.

Other issues

The modifications to the confluence of Rushy Gully with the Chapman River have affected the flow characteristics of both waterways. The modifications need to be monitored and assessed prior to the next peak flow to ensure that there will be no additional stress placed on the river system both upstream and downstream of this point.

Anecdotal evidence suggests that the considerable volumes of rubbish and discarded farm materials were dumped along the waterway while the land was owned and managed by Agriculture WA Research Station.

The waterway is partially fenced, which is not an issue unless stocking is proposed for the future.

Suggestions

Bank stability

- B Contact the Water and Rivers Commission Rivercare officer to gain advice and support to de-slag the woody debris and develop/upgrade a farm management plan that addresses river management issues.
- B Assess the locations of sediment dumps with Water and Rivers Commission officers to determine the suitability of the site.

Vegetation

- V Monitor natural regeneration at this site following selective herbicide application and maintain vigilant weed control in areas already treated.
- V Eradicate Pepper trees and Black berry nightshade from Rushy Gully while these species remain in small populations. Monitor for these species every year to ensure no new populations occur.
- V Undertake weed control in areas where native species persist and where bank stability will not be threatened. This may need to be limited to nodes that can be effectively managed. Protect native species by using a person familiar with native plants to tag these species prior to implementing weed control activities, to reduce unnecessary loss.
- V Establish dense plantings of middlestorey and understorey species in areas once weeds are eradicated to ensure bank stability and suppress further weed invasion.
- V Develop a program as part of the farm planning process to help restore verge vegetation beyond the riparian zone along this waterway.
- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Protect stream cover by ensuring the long-term survival of remnant vegetation and encouraging natural regeneration processes to replace the dead and sick trees.



S Protect instream features from removal by land managers (where there is no threat to bank stability) through an awareness campaign of the importance of such features.

S Liaise with Water and Rivers Commission officers to identify the woody debris that should be removed, possibly gaining assistance from WRC out-sourced labour.

Habitat diversity

H Undertake weed control to reduce fire risk and protect habitat diversity.

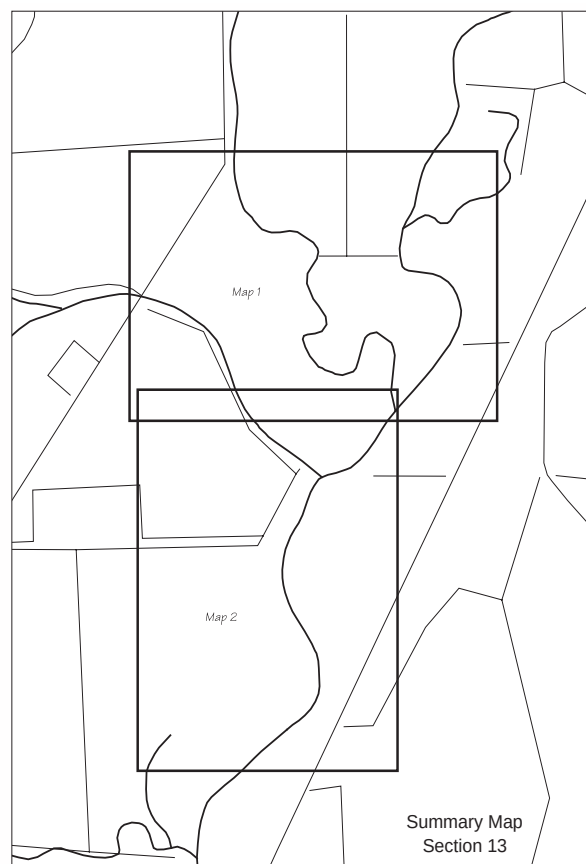
H Maintain the fire access track between the crops and the waterway beyond the floodplain of the creek. Use this as a weed control buffer.

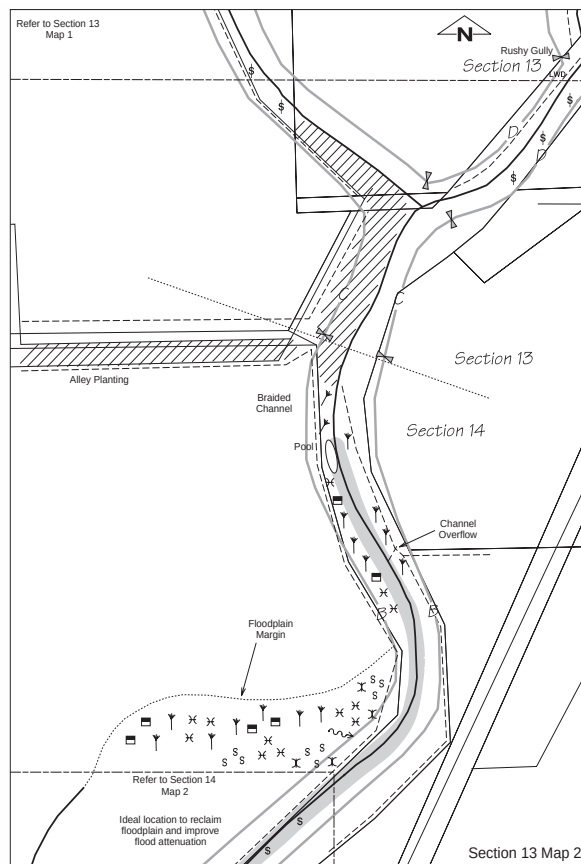
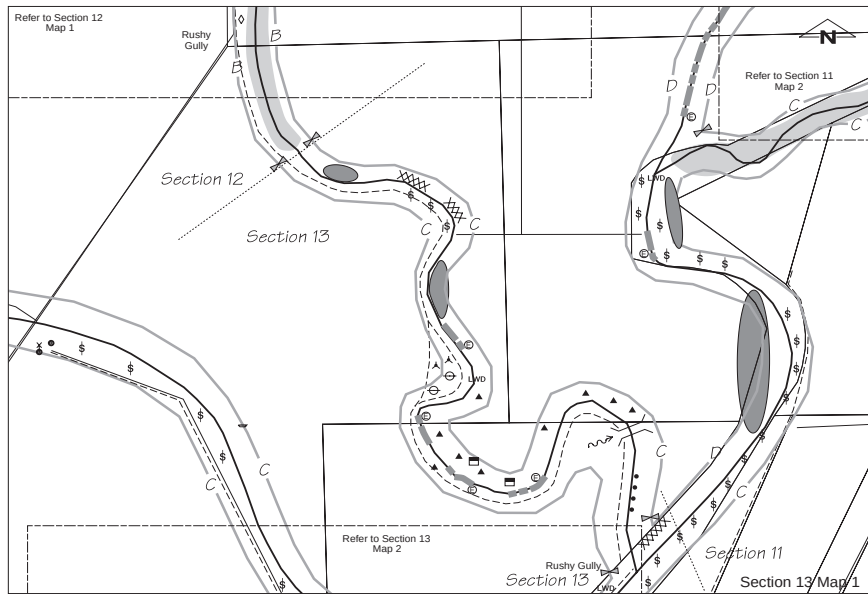
H Maintain instream features where they do not exacerbate foreshore erosion.

Other issues

O Consider holding a CleanUp Australia Day working bee to remove as much of the rubbish as possible in a joint project between the landholder, Agriculture WA, Water and Rivers Commission and the Shire of Chapman Valley.

O Ensure fencing is established prior to stocking again. The preferred alignment is beyond the floodplain of the waterway.





SECTION 14: NABAWA TOWNSITE MAPS 1 – 5**Length of section (m):** 6,850m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Moderate – B	Moderate – B	Moderate – B	Very Poor – D	Moderate – B

Bank stability

The main channel of the Chapman River ranges from 5 to 15 m wide and is braided for approximately 75% of this section due to large amounts of sediment deposition. Where it is a single channel the foreshore banks rise on a medium to steep slope to 0.8 - 1.5 m in height. Erosion is localised along 5 - 20% of the foreshore, particularly near the base of trees growing along the foreshore banks, where woody debris is forming natural dams and in areas where coarse gravel has accumulated. Severe erosion on the margin of the floodplain is more frequent with three significant blowouts of the floodway. These blowouts occur upstream and downstream of a road crossing and bridge. Slumping is significant (20 - 50%) along the channel banks.

There are seven tributaries joining the Chapman River in this section. Two of these are significant contributors of water flow. There is some localised erosion associated with runoff near the townsite. There is one section with a wide low floodplain that adjoins a lake. This is currently partially cropped. A levee bank has been constructed downstream of the townsite perpendicular to the main channel to direct floodwaters. There are two formal river crossings.

Comments

There is evidence that cropping within the section of waterlogged floodplain is difficult. There may be an opportunity to use this site for flood attenuation, by restoring native sedgeland and rushes. The flood history of the townsite has resulted in the Water and Rivers Commission investigating options to manage water flow past the townsite during peak flow events. It may be useful to collect additional information about each of the major tributaries feeding the Chapman River using a similar foreshore assessment process. Some of the woody debris within this river section needs to be realigned to reduce erosion of the channel banks.

Vegetation

Riparian vegetation is patchy (20 - 80% cover). The overstorey consists of a mosaic of Swamp paperbark (*Melaleuca raphiophylla*) and River gum (*Eucalyptus camaldulensis*) and occasional stands of Swamp sheoak (*Casuarina obesa*) instream. River gum and Swamp paperbark become increasingly dominant downstream of the Nabawa townsite. Tree weeds are limited to occasional Pepper tree (*Schinus molle*) and Castor oil plant (*Ricinus communis*). The vegetation extends approximately 25 m on either side of the main river channel.

The middlestorey is localised (less than 20% base cover) and comprises occasional stands of Cumbungi (*Typha domingensis*) and Coojong (*Acacia saligna*).

The understorey is continuous (> 80% cover) and is dominated by weeds. Persisting native understorey species are Spiny flatsedge (*Cyperus gymnocaulos*), Shore rush (*Juncus kraussii*) more infrequently, and uncommon Loose-flowered rush (*Juncus pauciflorus*). The weed community is very diverse but is dominated by Wild radish (*Raphanus raphanistrum*), Paterson's curse (*Echium plantagineum*), Wild oats (*Avena fatua*), Annual Wimmera ryegrass (*Lolium rigidum*) with Pie melon (*Citrullus lanatus*) and Doublegee (*Emex australis*) occurring on higher ground. Additional species present are Statice (*Limonium lobatum*), Cape weed (*Arctotheca calendula*), Lupins (*Lupinus cosentinii* and *L. angustifolius*), Saffron thistle (*Carthamus lanatus*), Black berry nightshade (*Solanum nigrum*) and occasional African boxthorn (*Lycium ferocissimum*) at the downstream end of this section. Some of the tributaries feeding into the river retain some dense sedgeland communities with numerous young Swamp sheoak in patches. Verge vegetation is absent for 75% of the length of this section. Where there are localised areas of verge vegetation, the diversity and health are very good.



Comments

The use of fire to remove understorey vegetation and woody debris within the riparian zone is impacting on the flow and erosion characteristics of the main river channel. This section is naturally braided and has alternating sedimentation and erosion phases. The loss of understorey within this section has enabled the flow to move through this section more rapidly, due to a loss of frictional forces increasing the amount of sediment able to move. Recolonisation of the islands between the braids will be slow and difficult as a result of the lack of physical protection from mobile sand, and the density of the tree canopy blocking light.

It would be useful to target weed species that have the potential to spread rapidly such as African boxthorn (*Lycium ferocissimum*), Pepper tree (*Schinus molle*), Black berry nightshade (*Solanum nigrum*) and Castor oil plants (*Ricinus communis*) before their populations become unmanageable. Creating a buffer between crops and the foreshore reserve would also benefit the native plant communities and enable improved management. The difficulty with this suggestion relates to the location such a buffer would require (e.g. fire access track). The wide and shallow landform means that the flood and peak flow events spread across large sections of the whole Chapman Valley. Any disturbance used to create this buffer is likely to be a weaker point in the soil structure when large flows are passing through. Buffers should aim to be aligned beyond the floodplain but this may be impractical.

Stream cover

The almost continuous overstorey along this length of the Chapman River provides some permanent shade. The frequent leaf litter, branches and very infrequent logs provide good instream cover.

Comments

The protection of remnant vegetation will retain stream cover. Reducing the use of fire in the riparian zone will help understorey rushes and sedges to regenerate, thus increasing stream cover. Broadscale removal of woody debris by fire results in some loss of stream cover. As mentioned above, not all of the instream woody debris is exacerbating erosion or blocking flood flows, therefore current management practices are inappropriate.

Habitat diversity

There is no permanent water but the bed is likely to remain waterlogged all year. The Nabawa Pool is no longer evident which indicates high levels of sedimentation. The channel is shallow and < 0.5 m in depth. Scattered instream rocks, logs and branches provide limited habitats for aquatic invertebrates. Large numbers of dragonflies were observed near the lake indicating a relatively healthy aquatic system. The almost continuous overstorey provides roosting and nesting sites for woodland birds. There is minimal habitat for shrubland bird species. The woody debris trapped in the trees more than 3 m above the main channel bed, provides good habitat for terrestrial invertebrates and reptiles.

Comments

There is evidence that cropping within this waterlogged floodplain is difficult. This is a second suitable site to achieve flood attenuation. Increasing vegetation densities beyond the floodplain would improve habitat availability for shrubland birds.

Other issues

The fence alignment along this section of foreshore is variable with some sections requiring review to minimise damage from peak flow events. There is a foreshore reserve along part of this foreshore section. Some of the fence alignments appear not to correspond with the location of the reserve boundary. The reserve boundary alignment does not reflect the natural landform or the location of the river channel. There are some fences that trap debris during peak flows that would require less maintenance if located at the top of the verge.

There are three areas where rubbish has been dumped within the floodplain.

One road crossing has been washed out and has resulted in a significant large gravel plume 200 m downstream. There is one small orchard close to the river. There is evidence that stock utilise the foreshore for feed and for water. The significant tributaries in this region would be ideal locations for future foreshore assessment surveys. Some landholders have excellent firebreak maintenance and have located these tracks well above flood levels. There is some evidence of the use of fire to remove woody debris and understorey plants. Some



areas are regenerating while others remain denuded over widespread areas. The lack of groundcovers has increased the susceptibility of the main riverbank to erosion and undermining of mature trees.

Suggestions

Bank Stability

- B Liaise with landholders to discuss the option of restoring native vegetation to the floodplain to improve flood mitigation.
- B Activate a 'no-burn' policy and undertake weed control within the foreshore section to encourage the regeneration of sedges and rushes that will help to armour the banks against erosion.
- B Hold working bees with support or training from Water and Rivers Commission to realign woody debris, where it is exacerbating erosion, to a more suitable alignment.

Vegetation

- V Focus weed control activities on African boxthorn, Pepper trees, Castor oil plants, and Black berry nightshade, keeping in mind that the first plant listed provides the bulk of habitat for shrubland birds. Assess each plant for nests prior to control works commencing.
- V Where feasible, establish a herbicide buffer around persisting native vegetation to encourage natural regeneration.
- V Hold working bees to weed and re-plant rushes and sedges across the floodplain.

- V Encourage townsfolk to become actively involved in foreshore management to help increase awareness of river processes.

- V Aim for a 'no-burn' policy if any revegetation works are to be undertaken.

- V Encourage landholders to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.

Stream cover

- S Protect the remnant vegetation from further disturbance and maintain instream debris where it is not exacerbating erosion.

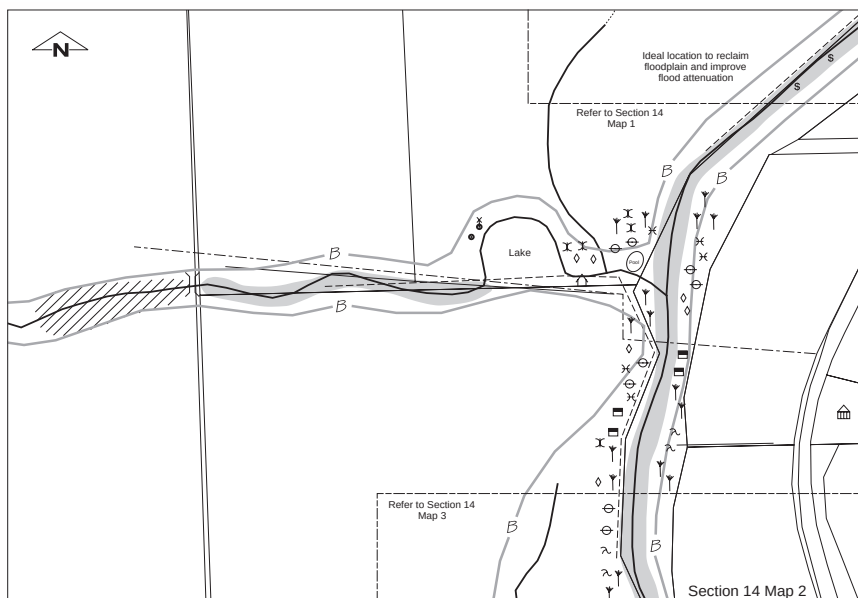
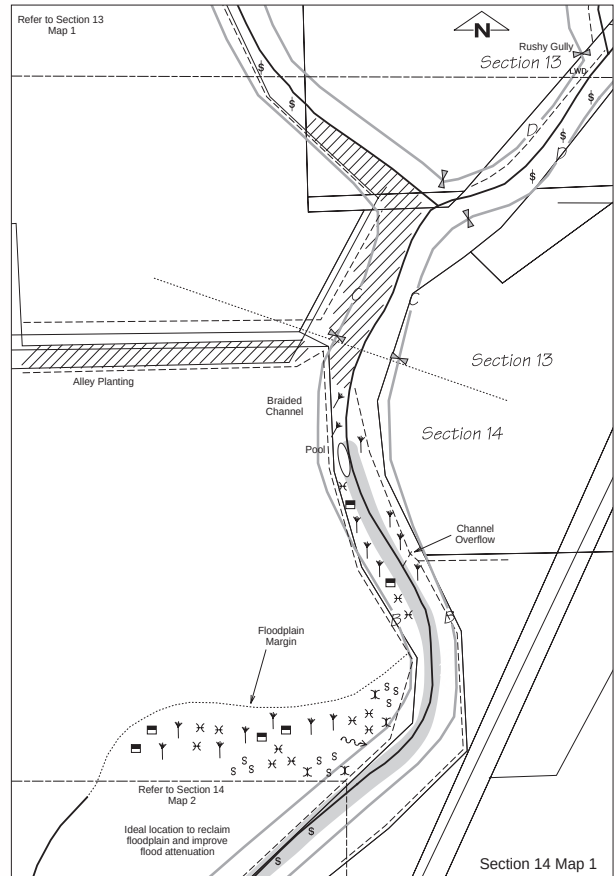
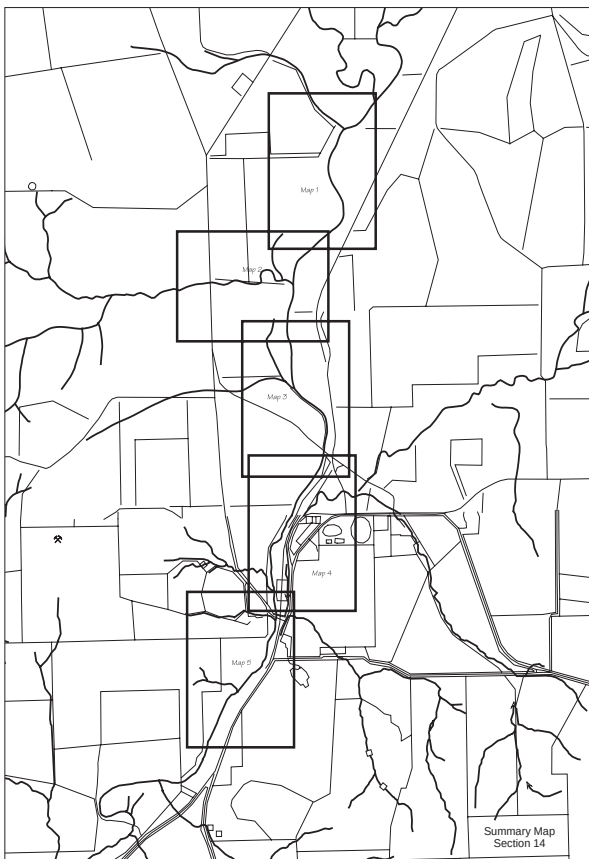
Habitat diversity

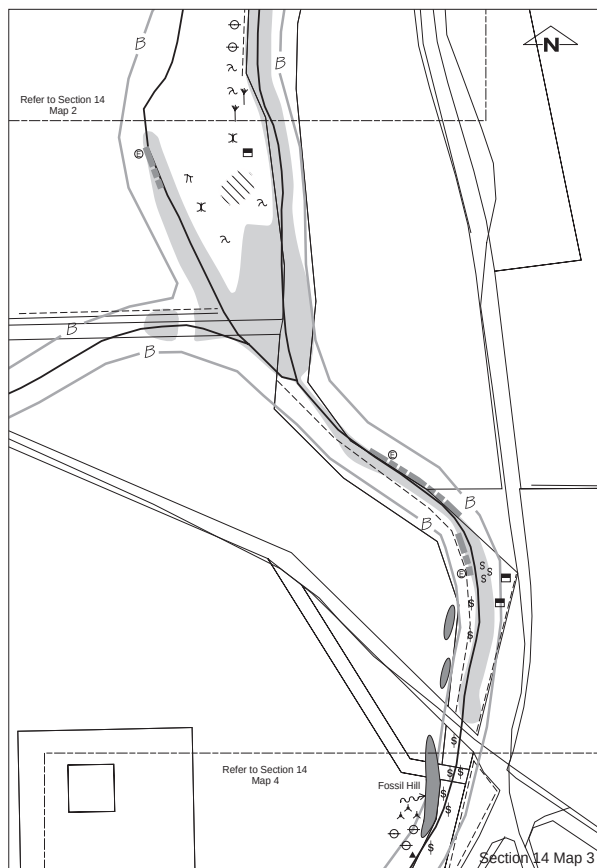
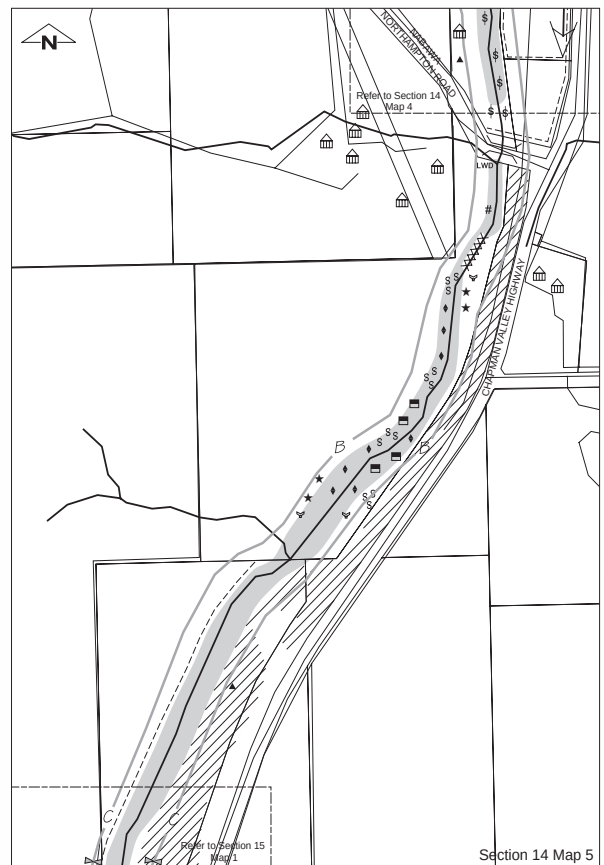
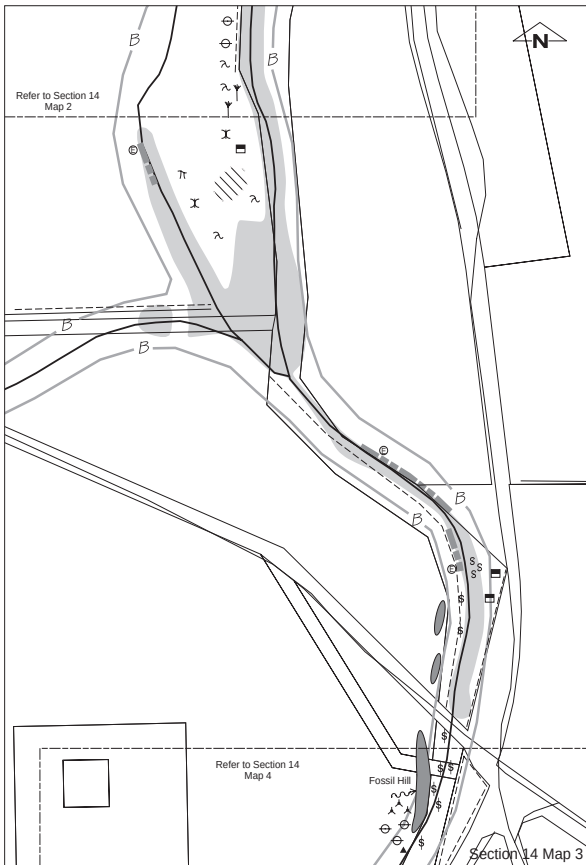
- H Develop a staged revegetation program for the verge, to increase habitat availability and diversity for fauna.
- H Encourage instream vegetation to recover and improve bank stability, protecting the longevity of pools.

Other issues

- O Implement a 'no-burn' policy to encourage regeneration.
- O Continue to maintain fences where stock have access to the foreshore.
- O Undertake a regular review of the foreshore to identify any woody debris that is exacerbating erosion and act to improve the situation if feasible.







SECTION 15: DOWNSTREAM OF NABAWA TOWNSITE MAPS 1 – 3**Length of section (m):** 6,560m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Poor – C	Poor – C	Poor – C	Very Poor – D	Very Poor – D	Poor – C

Bank stability

The main channel ranges from 4 to 8 m wide with the foreshore banks rising on a medium to steep gradient to 1 m in height. The river valley is clearly defined with steep banks to 4 m above the low flow channel in some parts. Localised points of erosion are present along 5 - 20% of the survey section. The most common location is along steep banks opposite junctions with creeklines and around the base of trees growing on the channel banks. Sedimentation is significant with large deposits observed along 20 - 50% of the main channel. There are two sections where the course of river flow during peak events is directed across an off-line depression. There is one instream pool and ten off-line blowouts. Anecdotal evidence indicates the presence of a seasonal waterfall in the main river channel.

There is a relatively high probability that the course of river flow in parts of this section will fluctuate in the future. Woody debris is trapped in the single row of trees between 2.5 and 3 m above the main channel bed which provides an indication of the flood height.

There are seven tributaries feeding into the Chapman River in this section.

Comments

The sections where the floodway is confined are relatively stable but lack sufficient vegetation cover to protect the banks from peak flow events. The floodprone land on either side is developed and considerable infrastructure is at risk. Investigations into the health of the tributaries and rate of flow from each may also help to predict peak flow pulses. The blowouts during the flood occurred in areas lacking perennial vegetation cover. As outlined elsewhere in the document, these blowouts may ultimately facilitate a change in the course of river flow in future years. Establishing vegetation in these areas can take many years due to the type of sand, mobility and exposure.

Vegetation

The overstorey is sparse (<20%) cover and consists of a single row of Swamp paperbark (*Melaleuca raphiophylla*), River gum (*Eucalyptus camaldulensis*) or Swamp sheoak (*Casuarina obesa*). River gum and Swamp paperbarks are more abundant. Occasional tree weeds are present - Castor oil plants (*Ricinus communis*) and Pepper tree (*Schinus molle*). The middlestorey is absent within the riparian zone. The understorey is patchy (20 - 80 % cover) and dominated by weed species. Scattered native species present include Spiny flatsedge (*Cyperus gymnocaulos*) and Shore rush (*Juncus kraussii*). An abundant weed species present is Doublegee (*Emex australis*). Introduced grasses frequently present are Annual Wimmera ryegrass (*Lolium rigidum*) and Wild oats (*Avena fatua*). Other occasional weed species include Curled dock (*Rumex crispus*), Marshmallow (*Malva parviflora*), Black berry nightshade (*Solanum nigrum*) and Statice (*Limonium lobatum*). There are two small areas of remnant verge vegetation along this entire section. There are six Tamarisk trees on a tributary.

Comments

This river section has been recently burnt to clear the floodplain. The fire resulted in some of the River gums dropping their branches and the fire has also made it difficult to fully assess the composition of the plant community. The branches that have been dropped may be washed downstream during the next significant event, causing management problems for other landholders. The lack of continuous dense native vegetation means that water flow is not slowed and the banks and floodplain are more susceptible to erosion.

Stream cover

The minimal overhanging vegetation provides occasional patches of permanent shade along the main river channel. There are two occurrences of instream woody debris that provide intermittent instream shade.



Comments

The minimal stream cover is insufficient to shade the water, keeping the temperature down to provide sufficient habitat for a high diversity of aquatic invertebrates. Because the water is shallow in this section it is critical to protect the stream cover to support ecological function.

Habitat diversity

Anecdotal information suggests that this section of river currently retains some permanent water. The water was clear to light brown in colour at the time of survey due to the presence of tannins leached from vegetation detritus in the water column. The channel is shallow and varies from < 0.1 m where sediment has accumulated to < 0.6 m where the channel is incising. There are limited instream habitats for aquatic invertebrates such as leaf litter and algae and at the time of survey no aquatic life was seen. The minimal understorey vegetation also limits cover for terrestrial organisms. Further, regular burning of the foreshore has minimised leaf litter and fine woody debris. The single row of trees provides some roosting and nesting sites for birds, particularly Willie wagtails and Magpie larks. There are three areas containing large woody debris that are suitable habitat for reptiles.

Comments

There has been considerable management activity in this river section, indicating a strong interest in the river and its foreshores. Some of the current agricultural management techniques being used are often unsuitable for river environments as they reduce the ecological values of the river. There appears to be a strong focus on improving river flow through this river section.

Prior to European settlement, native vegetation covered both the catchments and foreshores of the rivers and other waterways. The vegetation used most of the rainfall and surface runoff moved very slowly across the ground, which was well covered so there was little erosion. Similarly within the river systems the dense root systems of the native plants helped to hold the banks together. These plants provided habitat and the foundation of the food chain. Aquatic invertebrates such as snails, beetle larvae and insect larvae were eaten by native fish, which in turn were preyed on by waterbirds and other animals. The deep pools many

older people remember swimming in as children provided drought refuge for these creatures during the dry summer months.

This is a summary of features that are no longer evident in this section of river. Putting the ecological needs of the river back into the picture may help to reduce continued disturbance to this environment. The current management techniques are contributing to the loss of these features.

Other issues

There are two informal river crossings. There is a Water and Rivers Commission groundwater monitoring bore close to the main channel. There are two seasonal wetlands approximately 400 m from the river on the left bank. These form the headwaters of the creekline. Sheep appear to have access to most of the riverbank. Vehicle tracks within the floodway provide an area along which peak flows can move quickly and are eroding. There is a levee bank running perpendicular to the river on the right bank that appears to be linked with road drainage.

Suggestions

Bank Stability

- B Practise a 'no-burn' policy for a couple of seasons to encourage regeneration of native plants. Occasional grazing may be required to facilitate weed control and reduce the fire hazard.
- B Monitor vegetation growth and sediment movement across this section using photographs taken from the same location following any peak flow event.
- B Monitor for large woody debris that is functioning as a natural dam and realign if required.

Vegetation

- V Encourage landholders to continue to meet their statutory requirements to control declared weeds, extending their work into the foreshore reserve where practical.
- V Implement a 'no burn' policy for a couple of seasons to encourage natural regeneration. If with no burning the banks become more stable, then



reconsider use of this management tool.

- V Remove Castor oil plants and Pepper trees from the floodway to reduce their spread downstream before their populations become prolific. Monitor for new germinants and remove on a regular basis.
- V Spray Statice and Black berry nightshade prior to flowering to reduce these plants' ability to seed.

Stream cover

- S Modify stock and foreshore management practices to encourage natural regeneration of trees and understorey rushes and sedges. The trees are likely to go through a natural selection process where only the most vigorous will survive. This natural culling of trees is likely to be sufficient to minimise blockage of peak flow events.

Habitat diversity

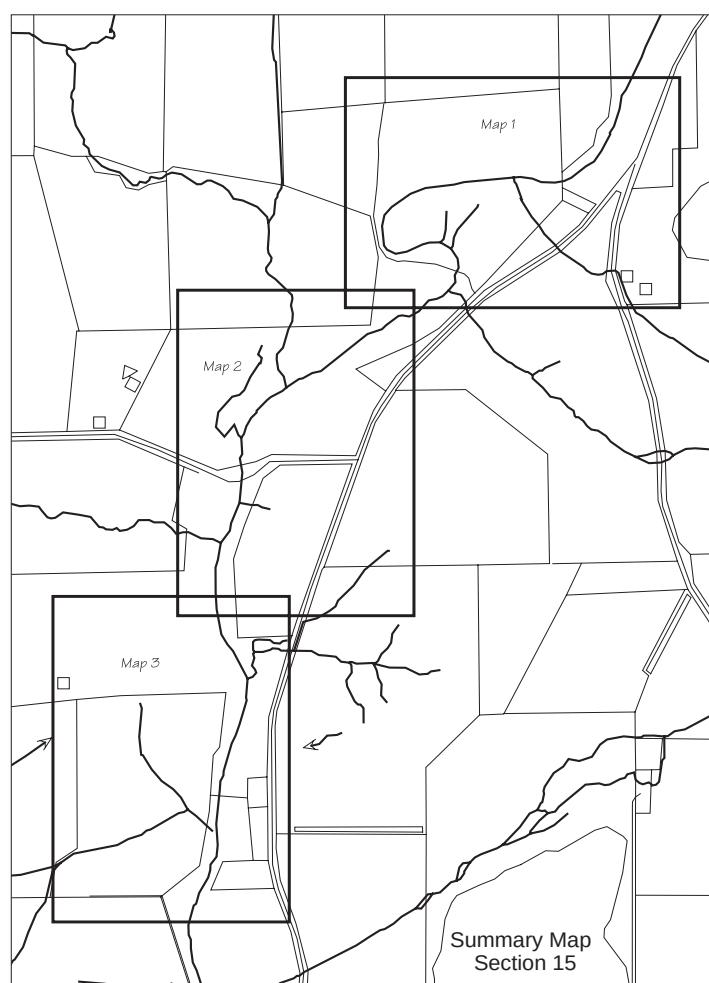
- H Trial alternative management techniques that aim to protect the foreshore vegetation and increase its

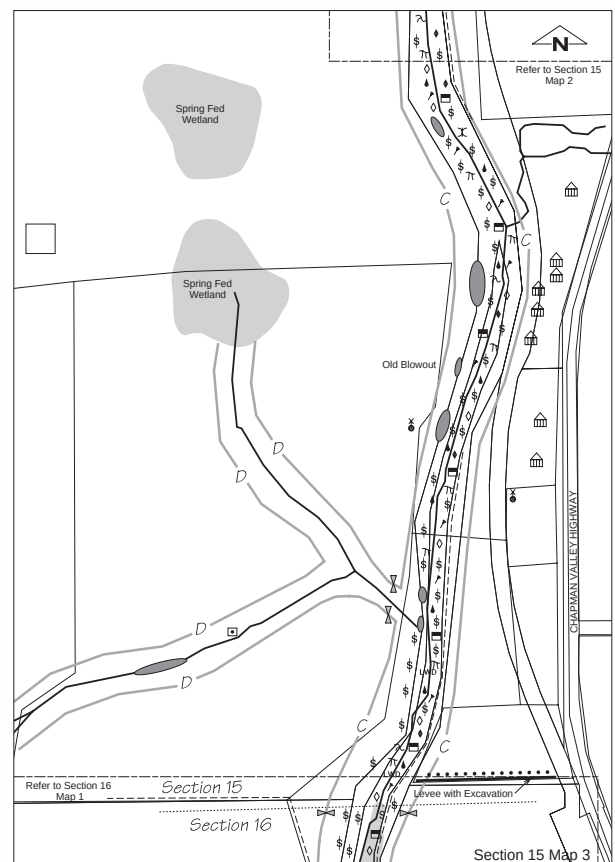
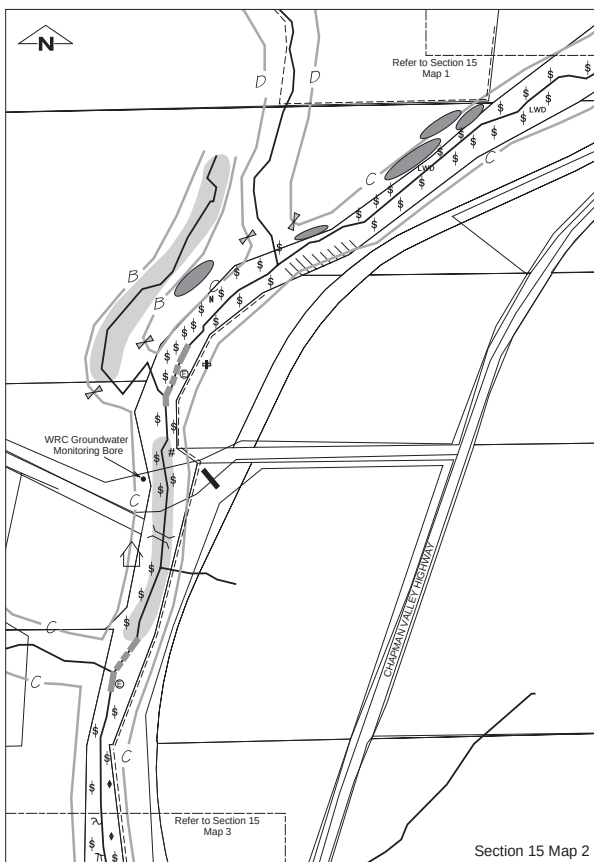
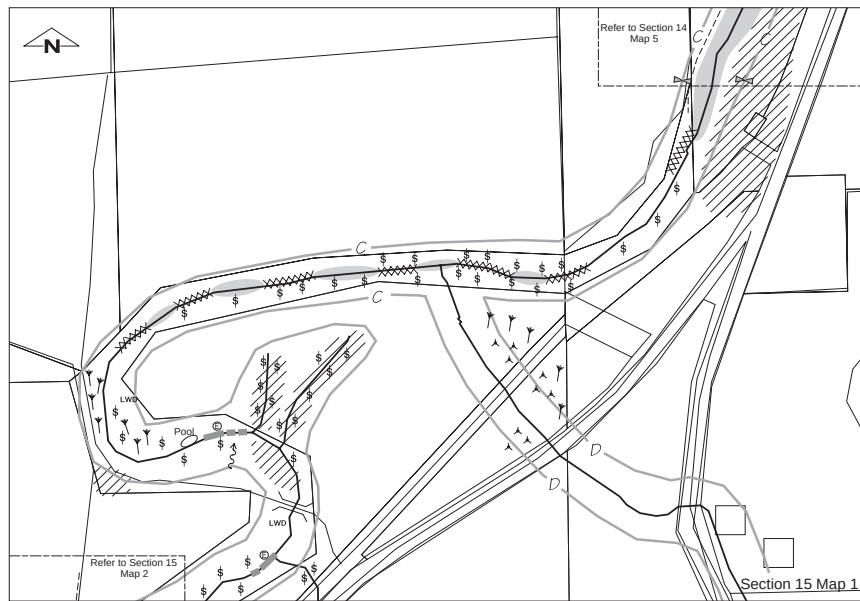
extent, and monitor the way in which the river flows.

- H Manually remove or realign woody debris only where it is acting or is likely to act as a natural dam and deflect water flow and exacerbate erosion, with advice from the Water and Rivers Commission.
- H Minimise stocking rates within the foreshore reserve, using stock to achieve weed control and minimise fire hazard.

Other issues

- O Realign tracks where they are eroding and/or formalise the tracks so that they do not disrupt the natural flow of water.
- O Maintain the perched wetland vegetation to minimise the risk of significant creeks forming.
- O Locate and mark clearly the boundary between foreshore reserves and freehold land, and amend to reflect the natural landform if necessary.





SECTION 16: CHAPMAN RIVER MAPS 11**Length of section (m):** 1,210m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 16 May 2000**Nearest road access:** Chapman Valley Hwy**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Good – A	Very Good – A	Very Good – A	Very Good – A	Very Poor – D	Very Good – A

Bank stability

The main river channel is 2 – 6 m wide with occasional braided channels forming on the left bank. The left foreshore rises on a medium gradient to 0.7 m. Erosion is localised (5 - 20% of the foreshore) and occurs particularly around the outer bends of the river meanders and where large logs have fallen into the river. There is some accumulation of fine and medium-sized woody debris, which is acting as natural dams. These dams are deflecting water flows into the channel banks. There is a 50 m long pool that has a maximum depth of 1.5 m. There are two significant blowouts on the upper margin of the floodway. One that is 80 m long and 20 m wide is located immediately upstream of a river crossing that has constricted peak flows. The second is approximately 400 m long and 20 m wide and corresponds with an area lacking continuous vegetation cover. There is little evidence of slumping or sedimentation. There are occasional rocky outcrops that protect the toe (base) of the steep left banks from undercutting and related erosion processes.

Comments

This site demonstrates the relationship between channel width and riparian vegetation. Where dense vegetation exists, the main channel is narrow, as are the small braids that form during major flow events. The blowouts occur adjacent to sections with minimal vegetation cover and ultimately may result in the formation of braided channels.

Vegetation

The overstorey is continuous and extends between 15 and 35 m from the main river channel. The overstorey is a mosaic of closed Swamp paperbark (*Melaleuca rhaphiophylla*) woodland and predominantly River gum (*Eucalyptus camaldulensis*) on the margins. Castor oil plants (*Ricinus communis*) occur infrequently. The middlestorey is absent which is characteristic of this

vegetation type. The understorey is continuous (> 80% cover) with natives dominating to the tree line with dense homogeneous stands of Spiny flatsedge (*Cyperus gymnocaulos*) and Shore rush (*Juncus kraussii*). Beyond the riparian zone the diversity of weeds increases. Abundant species include Wild radish (*Raphanus raphanistrum*), Pie melon (*Citrullus lanatus*), Lupins (*Lupinus cosentinii* and *L. angustifolius*), Paterson's curse (*Echium plantagineum*), Black berry nightshade (*Solanum nigrum*) and Marshmallow (*Malva parviflora*). There is a single Pepper tree (*Schinus molle*). There are infrequent infestations of Watsonia (*Watsonia bulbifera*) and Arum lily (*Zantedeschia aethiopica*) and this appears to be the upstream limit of their occurrence. Introduced grasses present are Annual Wimmera ryegrass (*Lolium rigidum*) and African lovegrass (*Eragrostis curvula*). Verge vegetation is absent along this section.

Comments

This is one of the few populations of African lovegrass close to the Chapman River. As mentioned above, this section has the only occurrence of Watsonia and Arum lily and targeted control of these species is considered an urgent priority.

Stream cover

The continuous overstorey and dense streamside vegetation provides areas of permanent stream cover along the river. Large branches washed down have partially blocked river flow. Significant volumes of leaf litter and detritus are also present within the channel, providing excellent instream cover.

Comments

Protecting remnant vegetation in this area from clearing, burning, stocking and/ or other activities which will increase degradation is essential to protect this area in the long-term.



Habitat diversity

The water within this section of the Chapman River is dark brown in colour with little suspended solids within the water column. The dark coloured water is due to the presence of tannins resulting from the breakdown of vegetative material in the water. The channel is shallow, between 0.2 and 1.5 m deep. There is one extensive pool and numerous small off-line pools with instream logs and vegetation. This instream material provides attachment sites for aquatic invertebrates and water movement is sufficient to facilitate aeration of the water. Diverse aquatic invertebrates were observed at the time of survey. The dense streamside vegetation and the presence of deep leaf litter provide suitable habitats for aquatic invertebrates, reptiles and other animals. The continuous dense overstorey provides excellent roosting and nesting habitats for birds. It appears that there are some springs contributing water throughout the year.

Comments

This section has extremely high conservation values because of the intact nature of the plant and animal communities. The large amount of mobile sediment that is being transported down the river system has the potential to reduce the health of this section. This area is a suitable site for detailed studies of the aquatic life and could be used to monitor changes over time.

Other issues

Fences are discontinuous and in some need of repair and there was no evidence of stock access to the shore. A foreshore reserve appears to be present in this section, however its alignment is unclear and does not correlate to landform features.

Suggestions

Bank Stability

- B Assess instream woody debris following each major flow event, and determine whether or not the debris is acting as a dam and exacerbating erosion. If so, realign with advice from the Water and Rivers Commission.
- B Monitor regeneration in the blowouts, and support vegetation growth in these two zones to minimise further scouring from these areas in future major flow events.

Vegetation

- V Target control on isolated populations of African lovegrass, *Watsonia* and Arum lily to prevent their populations from becoming more widespread.
- V Remove Black berry nightshade, Castor oil and Pepper tree once the other target species have been removed.
- V Monitor annually to determine the success of previous weed control.
- V Define clear access tracks for weed control to minimise disturbance and trampling of native plants to minimise their loss.
- V Establish a buffer around remnant vegetation.
- V Encourage landholder to implement weed control and revegetation works along the verge to restore these habitat values.

Stream cover

- S Protect the remnant vegetation in the area from clearing/ or other activities which will increase degradation.
- S Review the level and impact of instream woody debris on bank erosion, to ensure no unnecessary removal of stream cover.

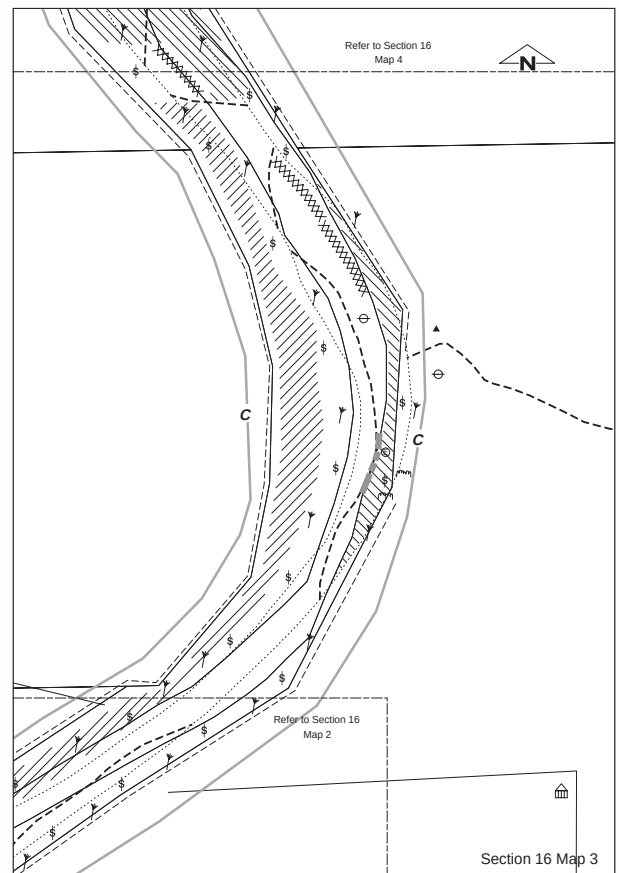
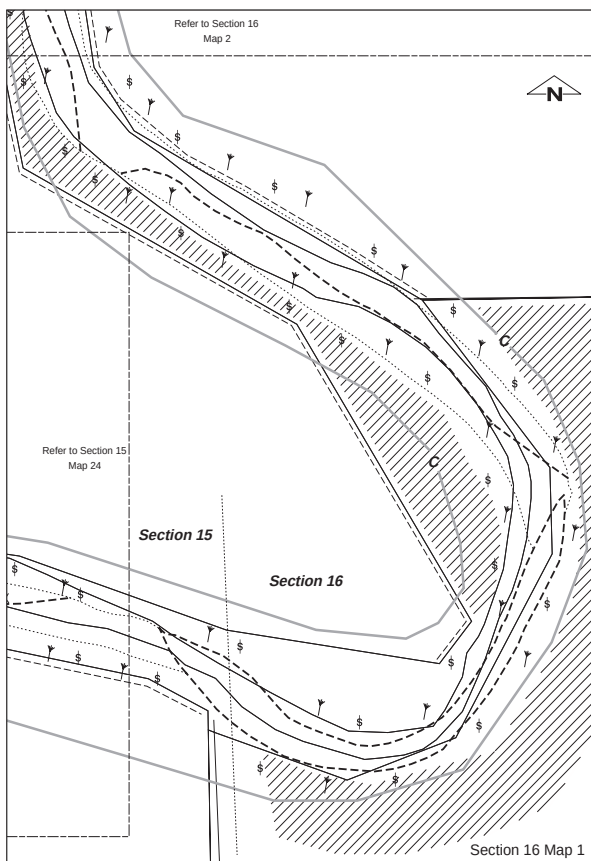
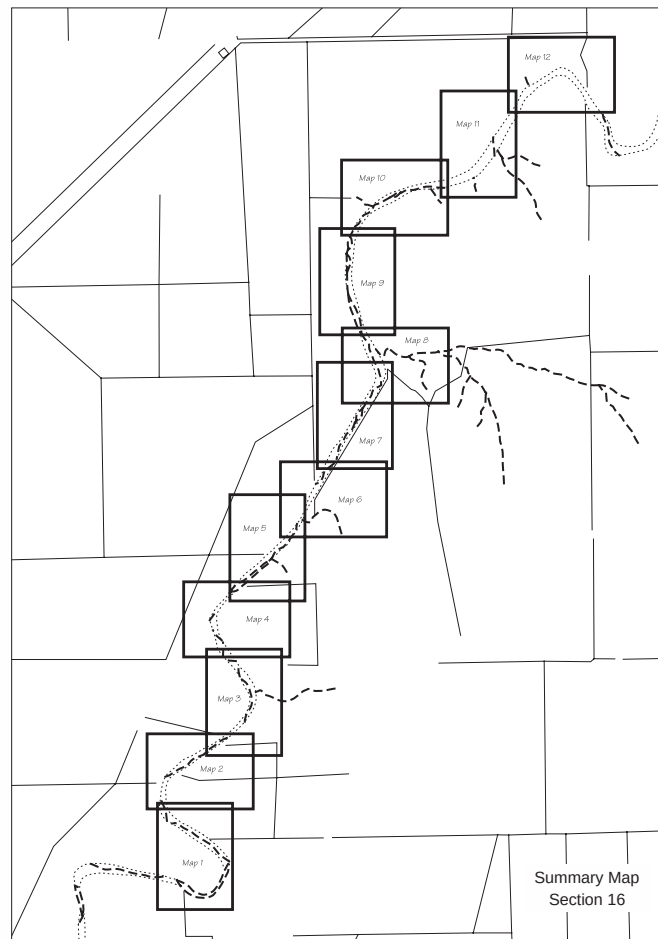
Habitat diversity

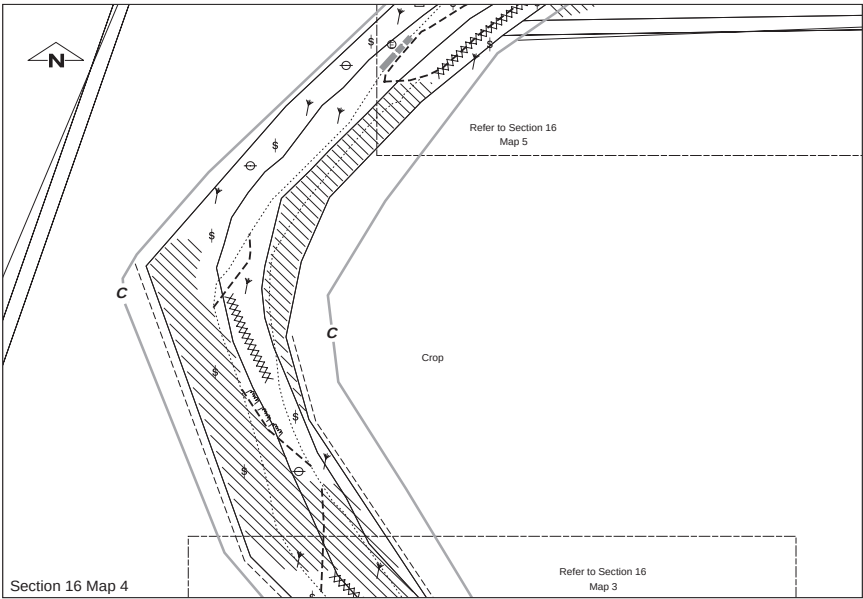
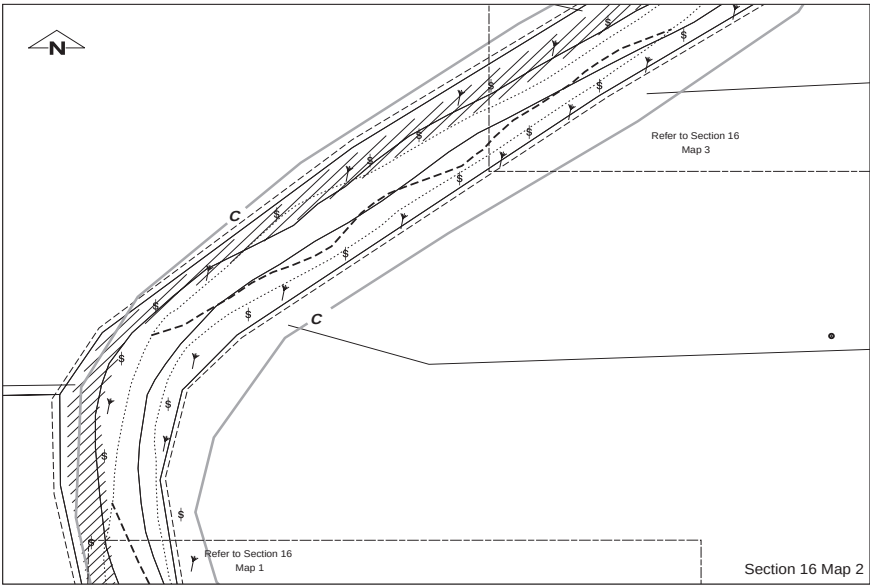
- H Undertake a fauna survey of aquatic and terrestrial invertebrates to develop baseline data sets against which comparisons can be drawn in the future.
- H Protect the remnant vegetation in the area from clearing/ or other activities which will increase degradation.
- H Manage stock access to limit damage to the native vegetation while achieving weed control.

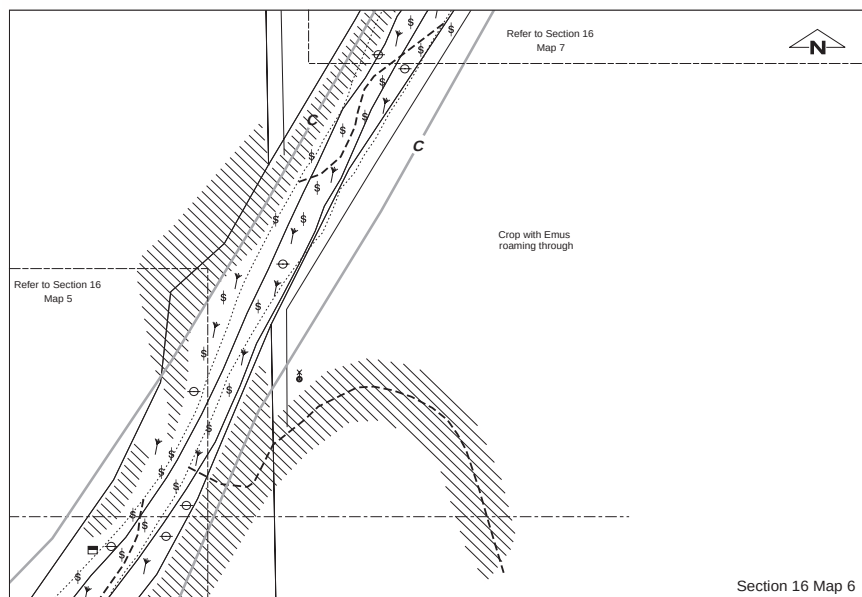
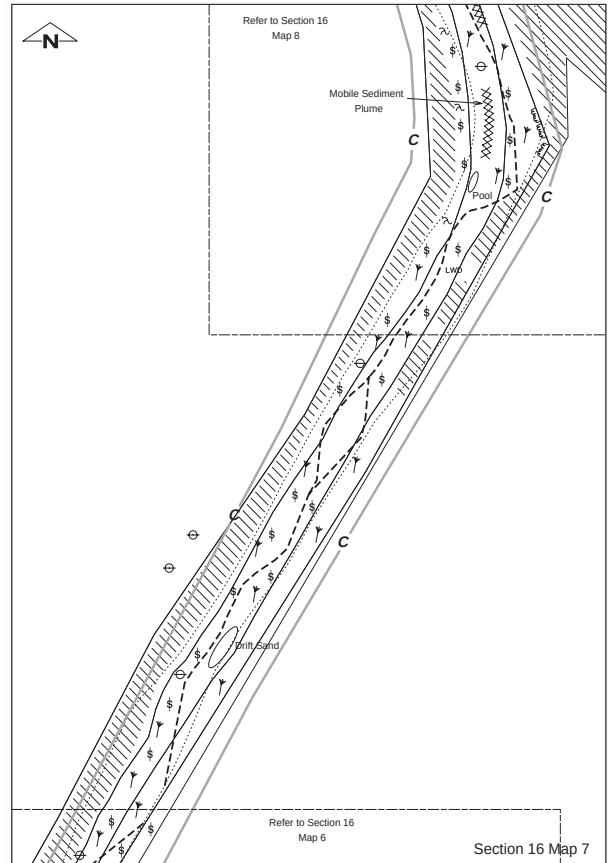
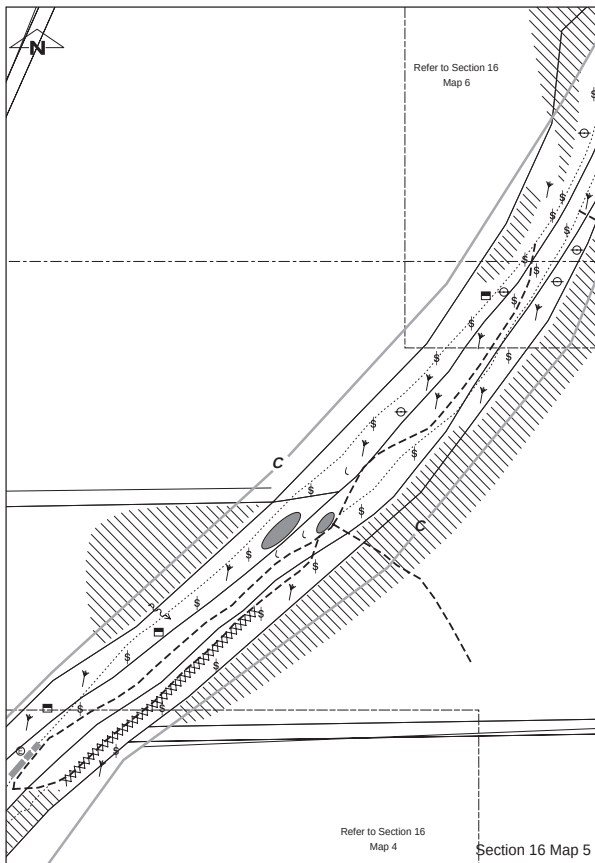
Other issues

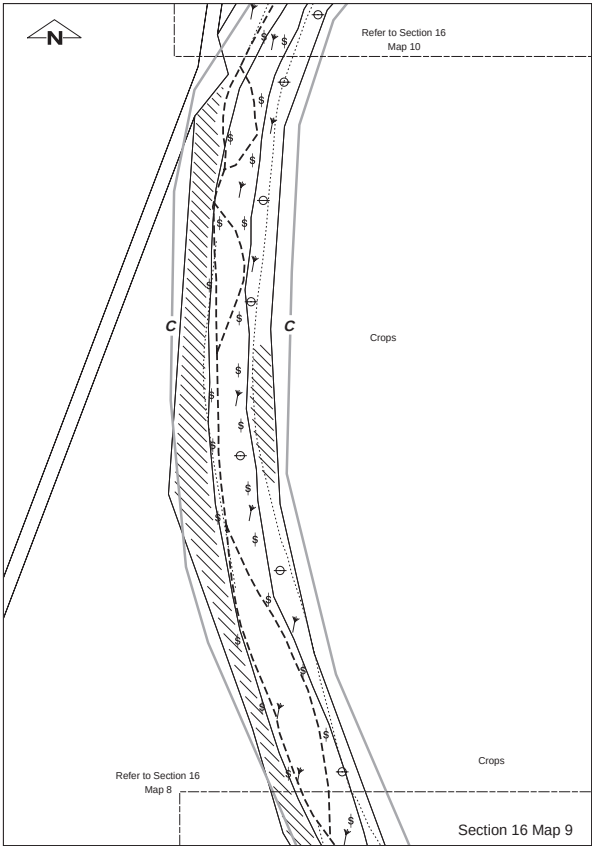
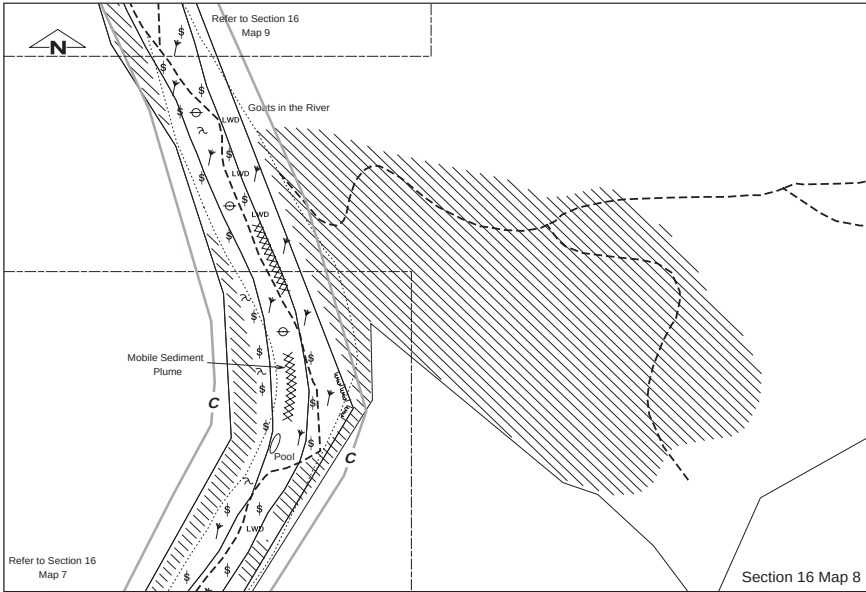
- O Ensure fences are established along the foreshore reserve boundary, or on the appropriate contour to minimise the risk of fences being washed away, prior to restocking these paddocks.
- O Define the reserve boundary and determine the suitability of the current alignment, if practical. Delineate boundary by some means.

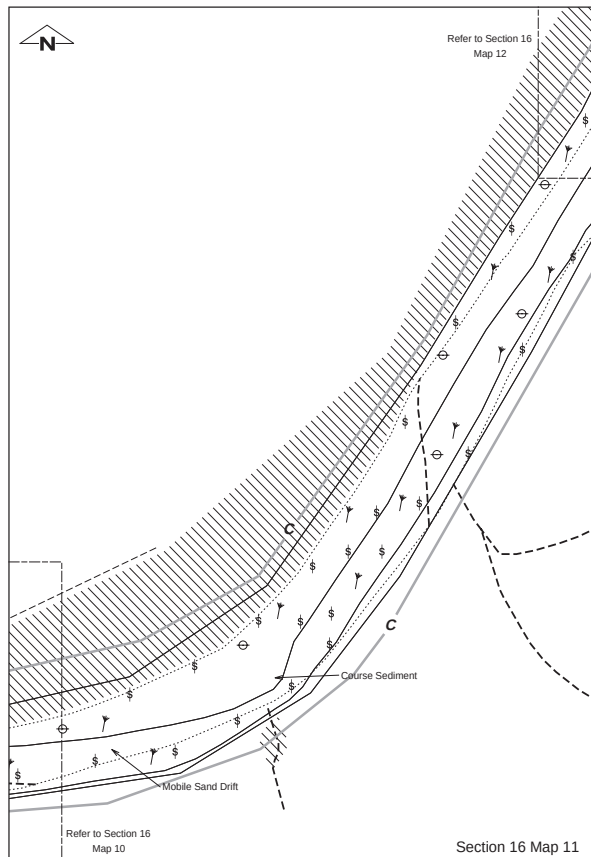
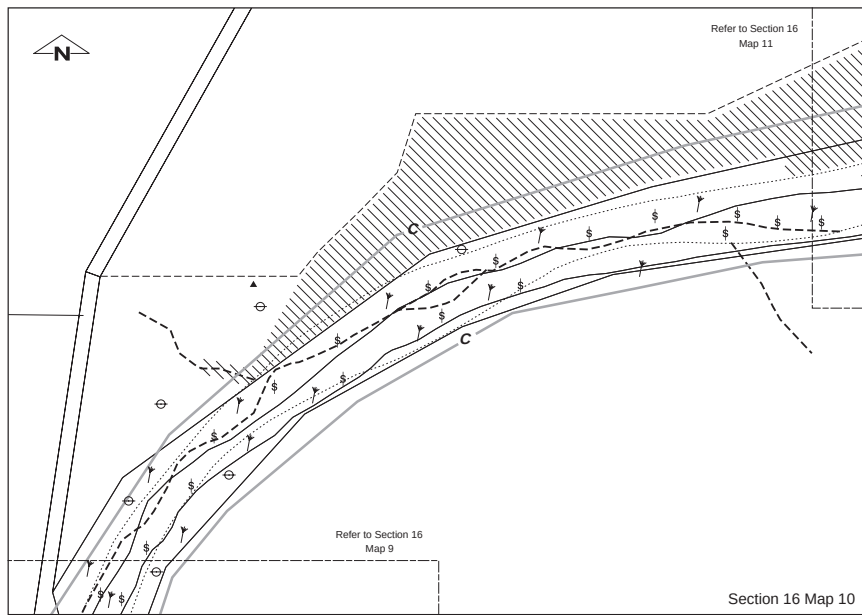


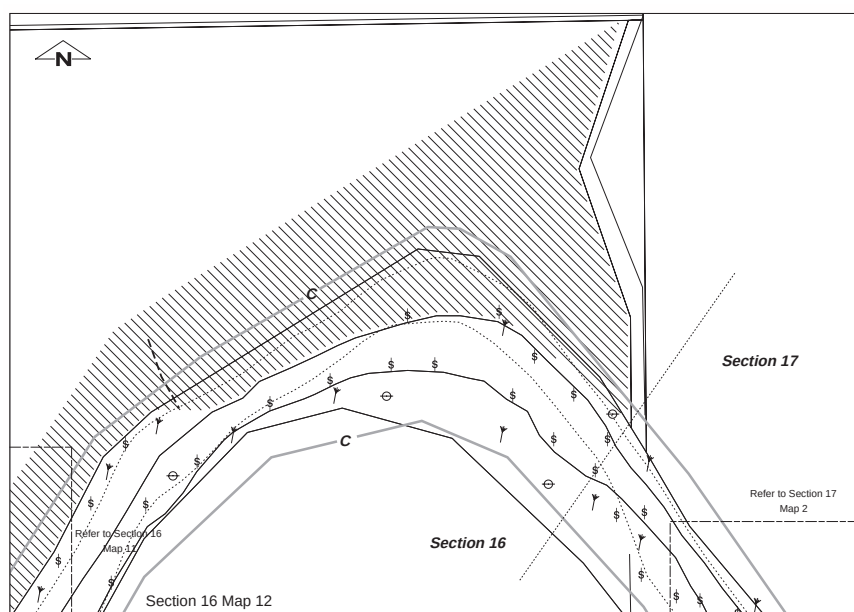












SECTION 17: NANSON TOWNSITE MAPS 1 – 3

Length of section (m): 3,470m

Recorders' name: N Siemon and T Rebola

Date surveyed: 16 May 2000

Nearest road access: Chapman Valley Hwy

Summary of river health

Bank Stability	Foreshore Vegetation	Stream Cover	Habitat Diversity	Verge Vegetation	Stream Condition
Very Poor – D	Moderate – B	Very Good – A	Moderate – B	Poor – C	Moderate – B

Bank stability

The upstream portion of this river section (approximately 1.6 km) is characterised by a single channel ranging from 4 to 9 m wide with very steep banks and foreshore banks rising on a steep gradient to 2.5 – 4.0 m in height. This section has severe erosion damage present for > 50% of the foreshore length. This erosion damage is associated with significant volumes of large woody debris, the outer margins of powerbends and where poorly designed crossings have resulted in changes of up to 1 m in riverbed height. Sedimentation is minimal as the riverbed gradient is relatively steep, and sediment continues to be moved downstream even in low flow events. Three tributaries feed into this section, including Durawah Gully.

Comments

The steepness of the channel bed is sufficient to minimise sedimentation, however it also ensures that river flow passes through this section at relatively high velocities. This increases the erosive power of the flow which, coupled with high sand loads, has high abrasive

capacity. The steep river valley limits the extent of cutting away from the banks, however new processes associated with undercutting and slumping are possible in the floodway.

Vegetation

The overstorey vegetation is patchy (20 – 80% cover) and consists of River gum (*Eucalyptus camaldulensis*), Swamp paperbark (*Melaleuca raphiophylla*) and occasional Swamp sheoak (*Casuarina obesa*). The overstorey extends 10 – 30 m either side of the river. There are large numbers of tree weeds particularly adjacent to the Nanson townsite including Cape lilac (*Melia azedarach*), Pepper trees (*Schinus molle* and *S. terebinthifolius*) and Castor oil plants (*Ricinus communis*). The middlestorey is limited to scattered wattles including Coojong (*Acacia saligna*), and one stand of Giant reed (*Arundo donax*). The understorey is continuous (> 80% cover) and is dominated by weed species. There are occasional patchy Spiny flatsedge (*Cyperus gymnocaulos*) and Shore rush (*Juncus kraussii*) and the small herb Gibbous-fruited scaevola



(*Scaevola thesioides*). Saltbushes (*Atriplex* spp.) and Marsh club rush (*Bolboschoenus caldwellii*) occur sporadically along the main channel. The native Saltwater couch (*Sporobolus virginicus*) occurs sporadically. Common flowering weeds include Soursob (*Oxalis pes-caprae*), Saffron thistle (*Carthamus lanatus*), Paterson's curse (*Echium plantagineum*), Pie melon (*Citrullis lanatus*), Ribwort plantain (*Plantago lanceolata*), Curled dock (*Rumex crispus*), Wild radish (*Raphanus raphanistrum*) and Doublegee (*Emex australis*). Common introduced grasses are Couch (*Cynodon dactylon*), Annual Wimmera ryegrass (*Lolium rigidum*), and Wild oats (*Avena fatua*). Perennial introduced Buffalo grass (*Stenotaphrum secundatum*) is limited to small patches adjacent to the townsite. There is one isolated Century plant (*Agave americana*) on the main channel and one occurrence of a Blackberry (*Rubus* sp.) on a tributary feeding into the river.

Comments

It is critical that the population of Blackberry on the tributary be monitored if the fruits are being harvested, but preferably eradicate this species to prevent it from spreading. It is possible that it would struggle in the brackish to saline waters of the Chapman River, but it is not worth the risk of creating a significant management issue.

There is significant potential for garden plants to become weeds in this foreshore section due to the proximity of the townsite and dumping of garden waste in the foreshore reserve. One example of this is Buffalo grass that has regenerated from lawn cuttings.

Stream cover

Stream cover is patchy with the open, continuous overstorey providing some permanent shade. Limited leaf litter, branches and very infrequent logs provide occasional instream cover.

Comments

The stream cover is sufficient to provide cover in this seasonal waterway. The river may benefit from increasing the extent and diversity of native vegetation in the floodway to improve stream cover.

Habitat diversity

Water flow is unlikely to be permanent in this section. The water is light brown in colour and there are variable levels of sedimentation. The water depth also varies and is shallow in many areas ranging from < 0.2 to 0.8 m. Scattered instream rocks, logs and branches provide limited habitats for aquatic invertebrates. In sections where patchy rushes, sedges and couch are growing down the channel bank, there are localised areas of improved cover. The patchy shrubs and areas of dense understorey provide cover for terrestrial organisms, although it provides reduced habitat diversity. The overstorey provides roosting and nesting sites for birds such as finches, silvereyes, wrens, and magpie larks. Kangaroos, foxes and evidence of rabbits were observed.

Comments

For a foreshore area close to urban development, there was considerable diversity in fauna observed. The presence of shrubland birds such as finches and wrens was surprising, as few were seen or heard along the Chapman River. These animals need to be protected from domestic cats by encouraging owners to keep their pets indoors as much as possible and ensuring that animals have one or two bells to reduce their success as predators.

Enhancing the extent of native vegetation will encourage more native animals to utilise this area for habitat. It is important when undertaking weed control to remember that habitat is being removed.

Other issues

The reserve is not continuous along this section with some properties being excluded. The reserve is also restricted to a narrow corridor, decreasing habitat diversity. Some of the large woody debris is acting as a natural dam deflecting the water flow into vulnerable floodway margins that lack vegetation. Fences do not currently occur along all sections of the reserve. Where the properties are not stocked this is not an issue.

As mentioned above, in the Nanson townsite there is evidence of garden plants and domestic waste being dumped in the river. There is also evidence of the use of the foreshore reserve for walking and bird watching.



Suggestions

Bank Stability

- B Commence a process to control weeds and revegetate the floodway to improve protection for the valley banks from peak flow events.
- B Investigate opportunities to modify the river crossings to minimise changes to low and moderate flow hydrology.
- B Investigate the feasibility of installing small riffles to reduce erosion of the riverbed and banks through the sections with a relatively steep bed.
- B Monitor woody debris and realign if seen to be exacerbating bank erosion.
- B Undertake a foreshore assessment study of Durawah Gully if funding becomes available, as it is a significant contributor to the Chapman River.

Vegetation

- V Eradicate Blackberry from tributary to reduce the threat of creating a significant management issue.
- V Encourage landholders to continue to actively control declared weed species in their properties.
- V Ensure the impact on bank stability is considered before weed control works are undertaken. Consider the potential for weed control matting as an option to reduce weed re-emergence, support plants installed and improve bank stability on steeper gradient banks.
- V Work to control annual grasses and weeds that increase fire risk in the valley, as fire is likely to result in significant topsoil losses.
- V Encourage the formation of a foreshore management group or develop linkage with existing groups to seek funds to provide native plant species for all strata to landholders annually.
- V Hold working bees with the townsfolk and rural landholders in the Nanson townsite to start reducing the populations of Pepper trees and Castor oil. It will be important to designate access points to minimise the formation of tracks that may be susceptible to erosion, focus works away from the banks, and control weeds in sections to minimise disturbance to bank stability and stream cover.
- V Provide information leaflets to townsfolk about the potential impacts of dumping garden waste into river reserves and creating a new weed problem.
- V Control weeds such as Soursob and Buffalo grass around persistent clumps of native rushes and other native relic species to encourage the natural regeneration of these plants.
- V Reinforce the native understorey component, particularly close to the main channel, and focus any additional middlestorey and overstorey on the steep banks or margins of the floodway.

Stream cover

- S Protect native vegetation from disturbance that will reduce its contribution to stream cover.
- S Direct public access to limited points along the foreshore to protect the remnant vegetation providing stream cover.
- S Ensure that weed control activities close to the main channel banks are immediately followed by revegetation works, or alternatively managed as maintenance weed control, should sufficient resources not be available for revegetation.

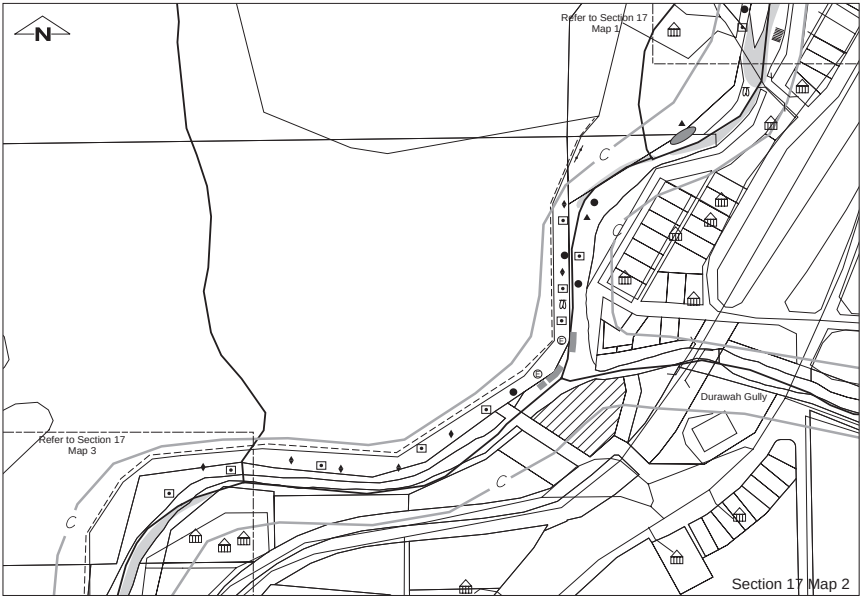
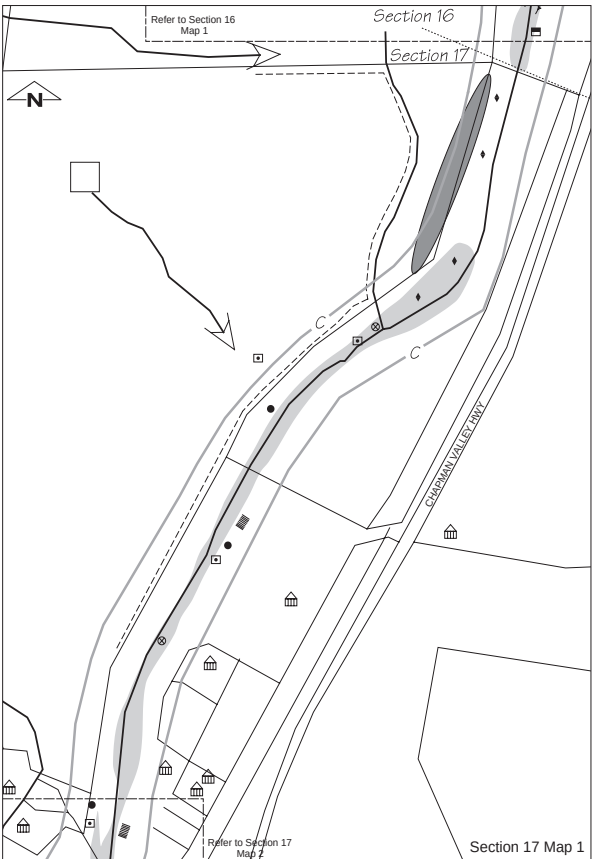
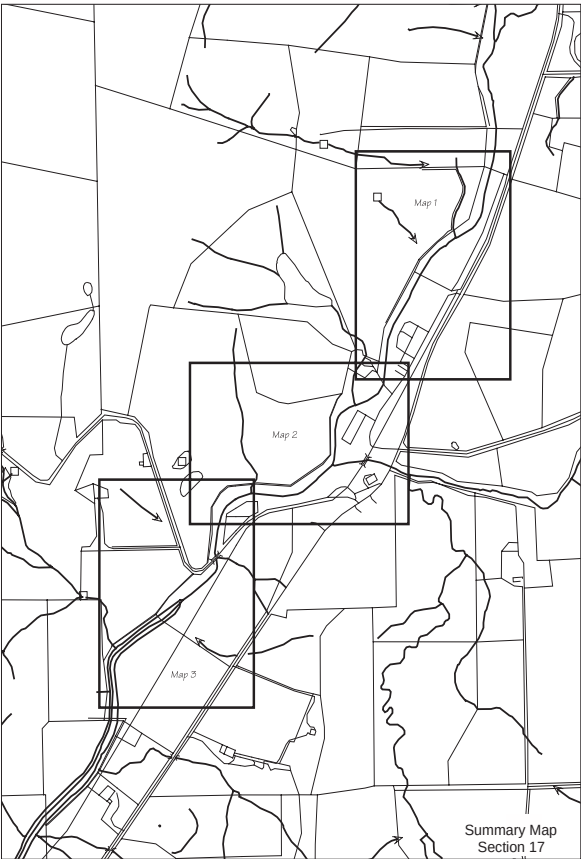
Habitat diversity

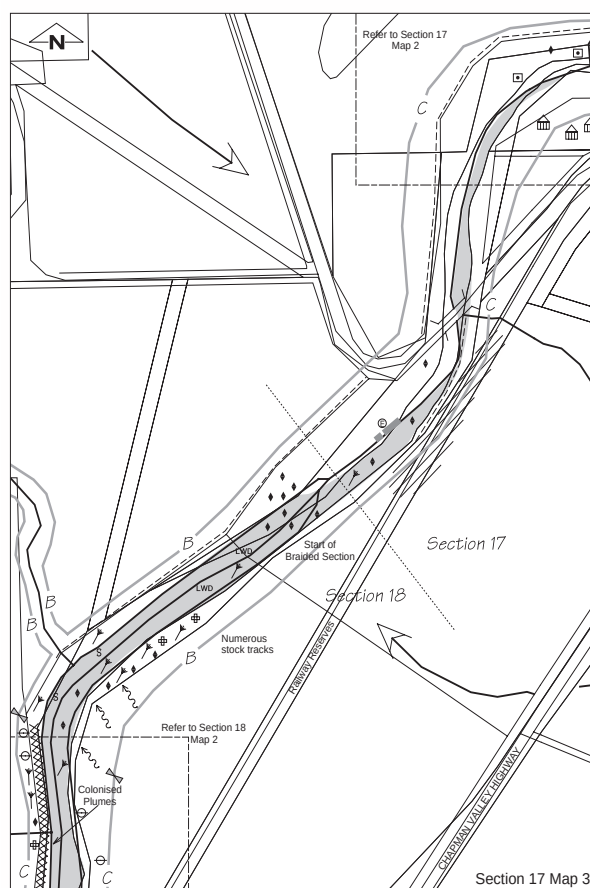
- H Ensure weed control activities occur in islands with areas of vegetation maintained for fauna habitat.
- H Replant areas using low species (understorey) as densely as possible where weed control has been successful. This will reduce the success of weed reinvasion.
- H Work to increase stream cover through instream plantings of rushes and sedges, and increasing the number of trees on the upslope margins of the foreshore.
- H Ensure that assessments of the changes to water depth in the small pools take into consideration habitat for instream fauna.

Other issues

- O Consider the feasibility of developing a small foreshore management plan to define access tracks, possibly provide some small infrastructure and provide a foundation against which funding can be sought.







SECTION 18: CHAPMAN RIVER MAPS 1 – 15

Length of section (m): 20,430m

Recorders' name: N Siemon and T Rebola

Date surveyed: 19 May 2000

Nearest road access: Chapman Valley Hwy and Murphy Yetna Rd

Summary of river health

Bank Stability	Foreshore Vegetation	Stream Cover	Habitat Diversity	Verge Vegetation	Stream Condition
Moderate – B	Moderate – B	Poor – C	Poor – C	Very Poor – D	Poor – C

Bank stability

The main channel is characterised by a braided river form due to significant sediment accumulation over time. Many of the sediment plumes have been colonised by introduced grasses, and occasionally native rushes and sedges. There are four severe off-line blowouts on the floodway margins. Slumping in the braided sections is occasional (5 – 20%) while sedimentation is significant (20 – 50%) in the main channel.

Fourteen tributaries discharge into this section and there is localised severe erosion at some of these junctions. Some of these are causing the water to slow and the dropping out of coarse sediment near the

confluences. There are five significant accumulations of woody debris in this section that if realigned or removed, would reduce damage to the channel banks. A rocky hillside and clay slope is a significant landform feature in this section. There is a 0.5 m step in riverbed height where the substrate changes.

An old railway crossing is impacting on the flow of one tributary, causing erosion between the crossing and the Chapman River.

Comments

The off-line blowouts occurred in areas with minimal vegetation cover on the floodway margins, and insufficient vegetation along the banks to direct the bulk



of the peak flow into the main channel. Where the vegetation is currently evenly spaced, the main channel is braided and more stable. The blowouts are likely to become part of a braided river channel in future fluctuations in the course of river flow. Some of the woody debris is exacerbating erosion and the channel banks would benefit if this debris was realigned or removed. One significant plume has been colonised by perennial grasses, reducing the mobility of this sediment and also impacting on the landform by raising the height of the floodplain.

The large number of tributaries feeding into the Chapman River in this section also contributes water and sediment to the river. Stabilising these landscape features would help the river function.

Where the channel has eroded back to stable clay there is little likelihood of future changes to the left bank of the river.

Vegetation

The overstorey is continuous (> 80% cover) and extends up to 15 m either side of the main river channel. River gum (*Eucalyptus camaldulensis*) and Swamp paperbark (*Melaleuca rhaphiophylla*) are abundant with occasional Swamp sheoak (*Casuarina obesa*). Introduced Castor oil plants (*Ricinus communis*) and two Pepper trees (*Schinus terebinthifolius*) are present periodically. The middlestorey is limited to occasional weeds (5 – 20% cover) such as Black berry nightshade (*Solanum nigrum*). The understorey is continuous (> 80% cover) and is dominated by weeds. Occasional dense stands of native rushes and sedges are present. Spiny flatsedge (*Cyperus gymnocaulos*) and Shore rush (*Juncus kraussii*) are the persisting native species. Frequent weed species include a range of annual grasses, patches of the perennial grass Couch (*Cynodon dactylon*), Lupins (*Lupinus cosentinii* and *L. angustifolius*), Pie melon (*Citrullus lanatus*) and Saffron thistle (*Carthamus lanatus*). There are four patches of verge vegetation in variable condition. The shrub layer is generally intact with occasional York gum (*Eucalyptus loxophleba*). Persistent native grasses such as Silky heads (*Cymbopogon oblectus*), Wallaby grass (*Danthonia setacea*), Foxtail mulga grass (*Neurachne alopecuroides*) and Curly windmill grass (*Enteropogon acicularis*) occur sporadically amongst annual grasses

including Wild oats (*Avena fatua*), Red Natal grass (*Melinis repens*) and a type of Brome (*Bromus* sp.).

Comments

There is minimal evidence of regeneration in some parts of this section. The relatively low numbers of Castor oil and Pepper trees reduce the resources required to control these weeds in this section. If these populations are left unchecked then the resources required are likely to increase exponentially. Some foreshore sections have been cleared to parkland, which minimises the ability of the native vegetation to regenerate. The persisting native verge vegetation although disturbed is important, as these vegetation types are relatively uncommon along the length of the entire Chapman River.

Stream cover

The continuous overstorey and patchy understorey provides some permanent shade along the river channel. Instream cover is also intermittent, as there are very few instream rocks and logs.

Comments

Protecting the long-term survival of the vegetation in this section is important to retain stream cover. Most of the trees are in the same age bracket, and the lack of regeneration means that there will not be replacement trees once the mature plants start dying off. Further, if there is another major flood event there is a chance that many of the plants will die. Management needs to aim at maintaining a sufficient level of natural regeneration at all times. This has implications for stock and pest management.

Habitat diversity

The water is unlikely to be permanent, and is light brown in colour with little suspended sediment. The water depth varies from 0.2 to 0.8 m where there are small scours beneath trees lining the banks. The infrequent instream logs and rocks provide very few habitats for aquatic invertebrates. The lack of dense streamside vegetation also limits suitable habitats for terrestrial invertebrates, frogs and reptiles. The patchy overstorey provides few nesting and roosting sites for birds.



Comments

Few animals were seen or heard during the survey, which was surprising given that there were stands of verge vegetation that in most locations retained relatively diverse bird populations. Some of the tributaries feeding into this section of the river arise in the Northampton Mineral Fields, and the upper parts of one catchment arises in a former tin mine. It may be worth investigating the water quality in the Chapman River to determine whether water quality is limiting instream biota.

Other issues

Surrounding land uses include urban, semi-rural, rural and one intensive landuse. The effluent resulting from the intensive landuse is used to irrigate perennial pastures. There is evidence of stock access along approximately 20 – 40 % of this area and in some places the stock tracks have denuded the banks sufficiently to make them more vulnerable to erosion. There was some dead stock in the foreshore area. There is an informal picnic area with rubbish bins and signs.

Suggestions

Bank Stability

- B Protect remnant vegetation from livestock damage by fencing and monitoring bank stability and vegetation health while grazing is underway.
- B Realign or remove woody debris only where it is acting as a natural dam and exacerbating erosion of the riverbanks or floodway. Any debris could be placed on the verge to provide habitat for fauna.
- B Review the former railway crossing and determine whether a riffle feature to slow water movement under the bridge would help to reduce erosion at the junction of the river and this creek.
- B Work to restore greater understorey vegetation cover in sections that are cleared to parkland, to reduce the potential for blowouts during peak flow events.

Vegetation

- V Encourage landholders to meet their statutory requirements to control declared weed species within their properties.

- V Focus weed control on species occurring in relatively low densities such as Castor oil plants and Pepper trees, by cutting the trees and immediately painting the stump with systemic herbicide.
- V Ensure weed control activities are undertaken in manageable nodes, replacing weeds immediately with native species where stock access can be controlled.
- V Ensure the impact of bank stability is considered before weed control works are undertaken.
- V Spray two metre diameter circles and plant native overstorey and understorey species and fence to protect from livestock if large scale fencing can not be undertaken.
- V Investigate opportunities to provide financial support or material assistance to landholders willing to implement rehabilitation activities.
- V Continue to control Saffron thistle, Lupins and the introduced grasses which all increase fire hazard, after learning to distinguish native grasses from introduced varieties.

Stream cover

- S Support regeneration of overstorey and understorey species to ensure stream cover is provided in the long-term.
- S Continue to control stock access to ensure that sufficient groundcover is maintained all year round.

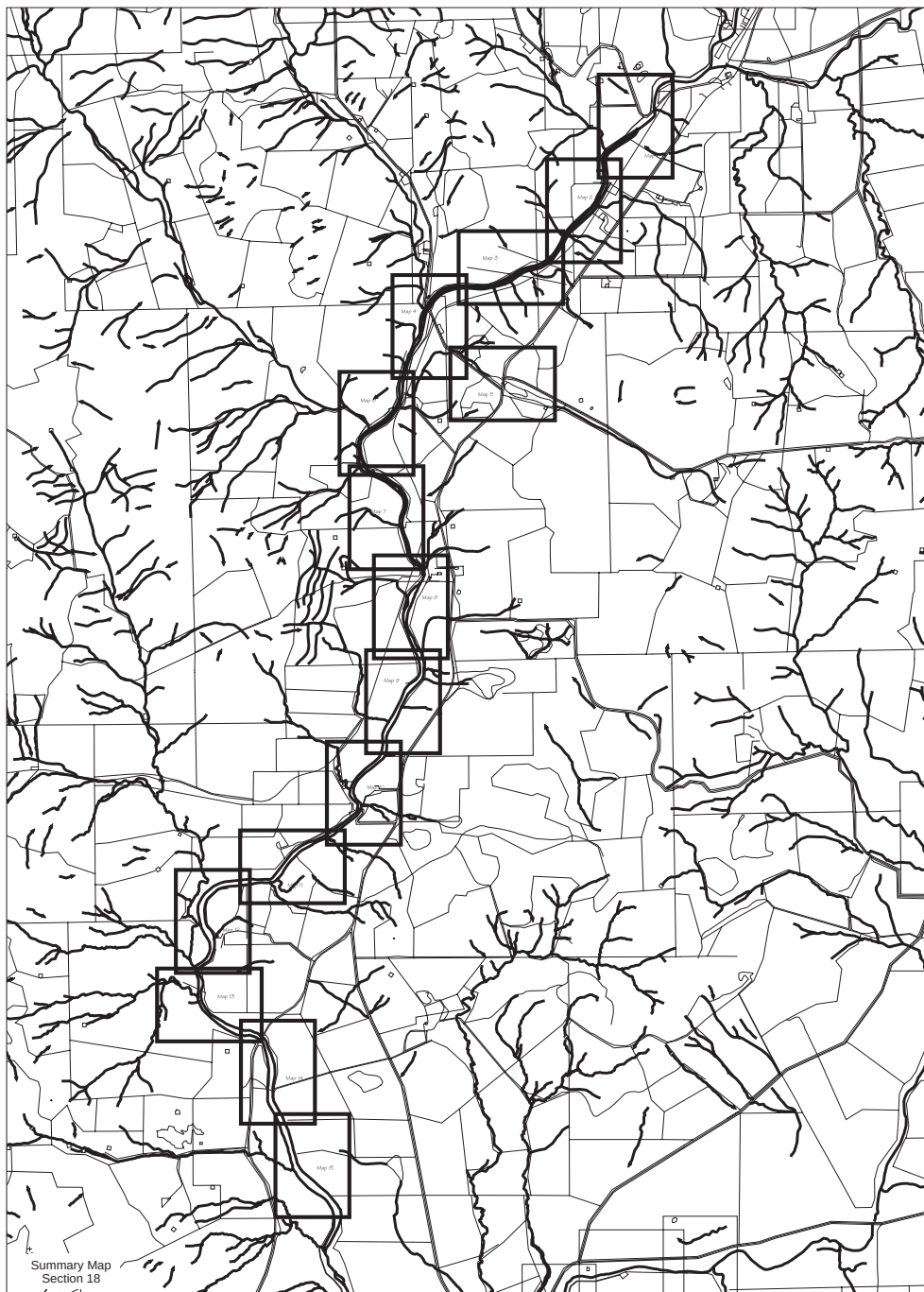
Habitat diversity

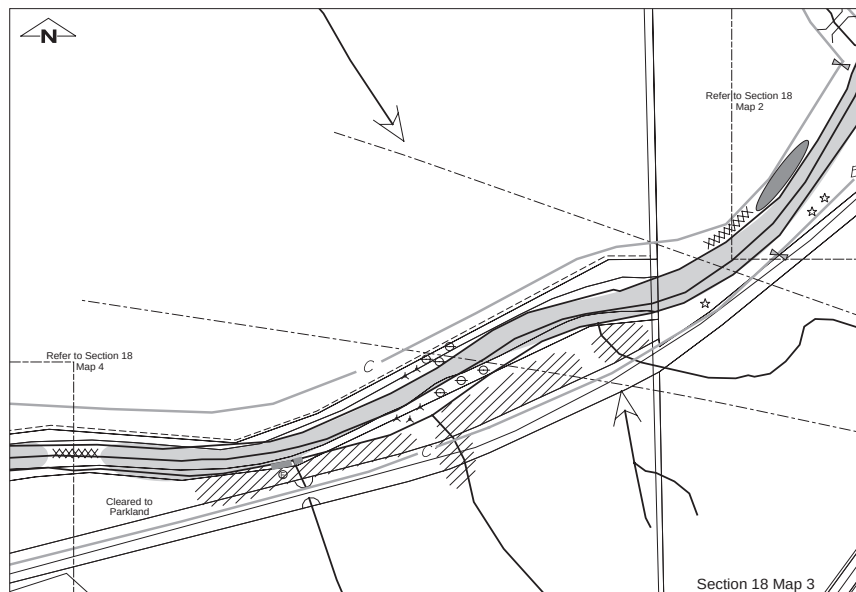
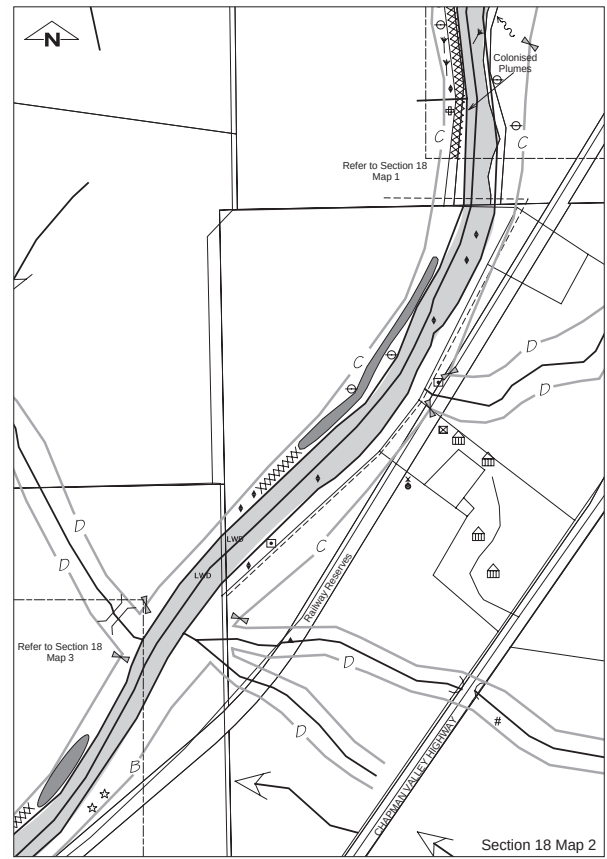
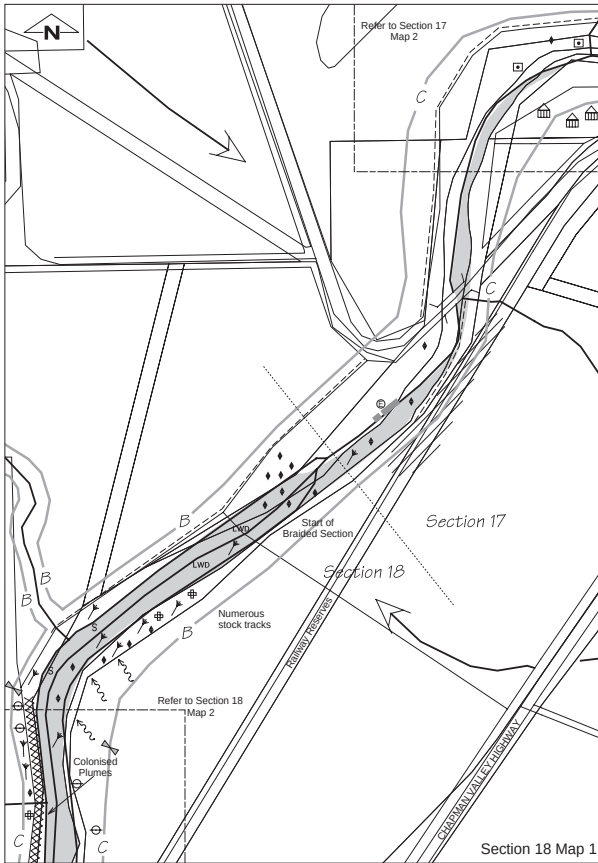
- H Design and implement a water quality monitoring program including physical and biological features to determine if water quality is limiting fauna activity. Testing for heavy metals, herbicides and pesticides in addition to the standard parameters would be useful if the resources can be found. Testing sites along the entire river length would be beneficial.
- H Protect instream detritus, logs and branches where these features do not threaten bank stability.
- H Encourage natural regeneration of the foreshore area by limiting stock access to that required for effective weed control. Monitor for sufficient regeneration, and if inadequate consider planting supplementary tubestock.

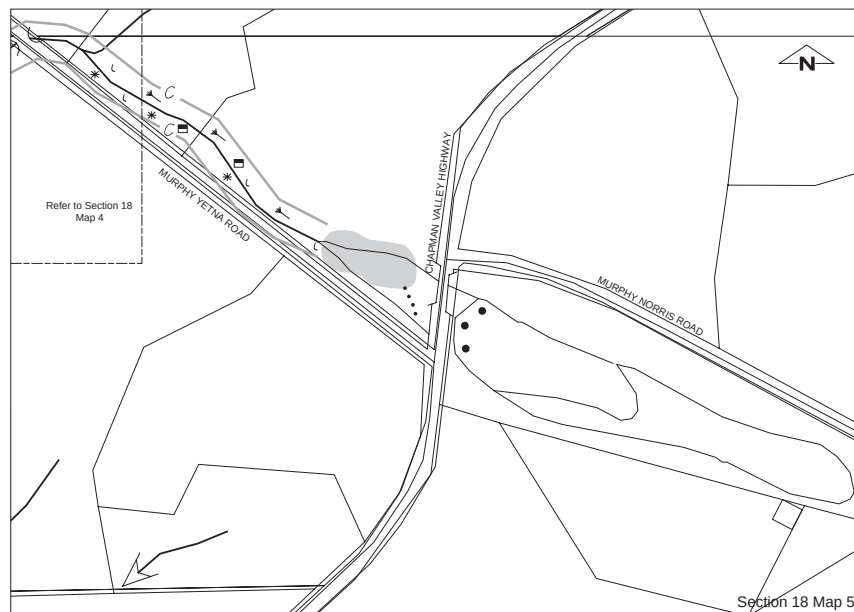
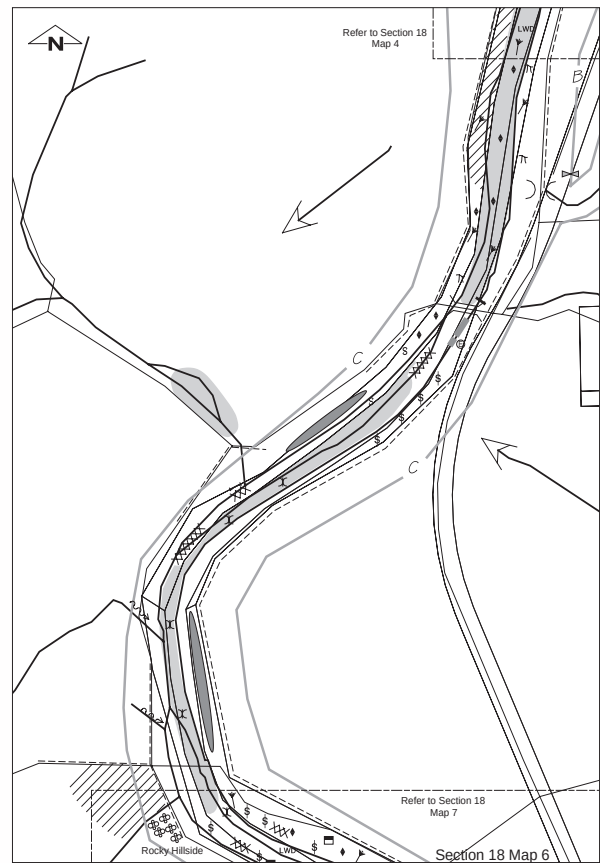
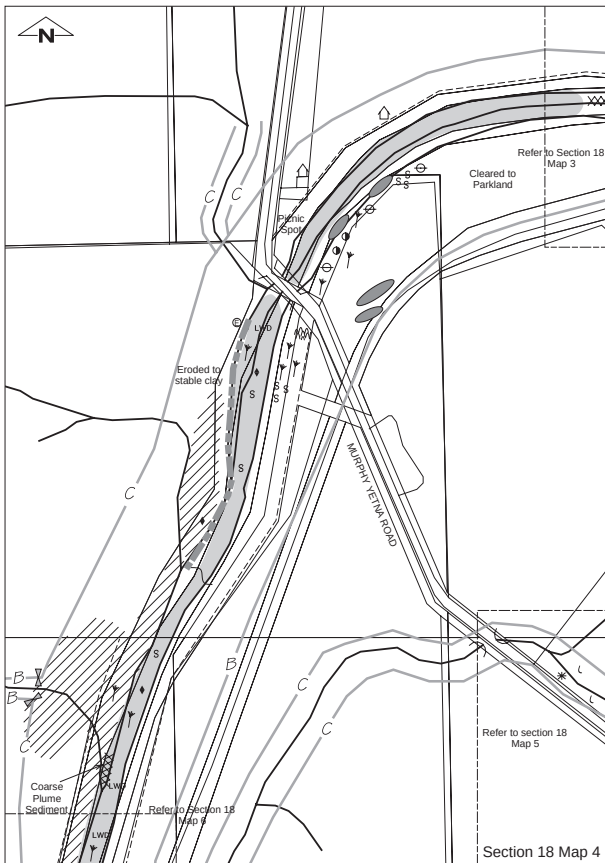


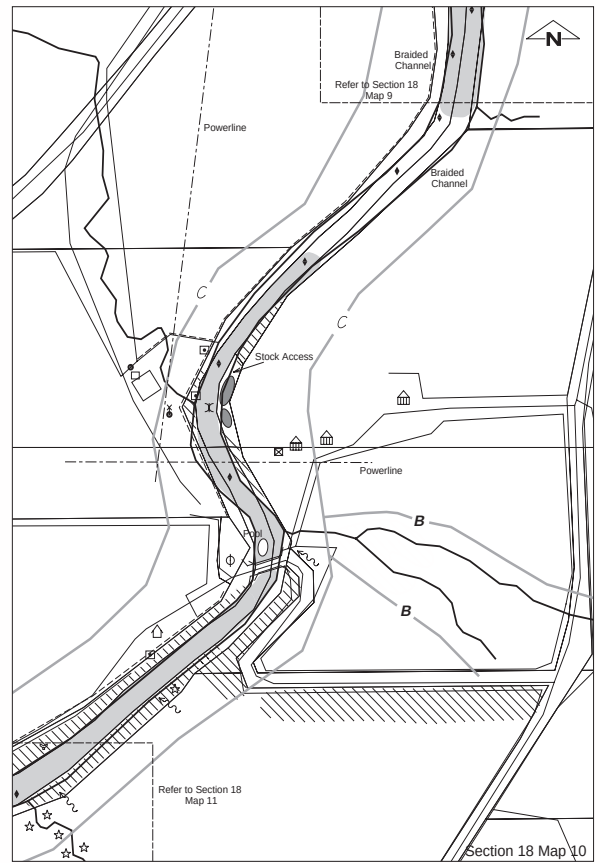
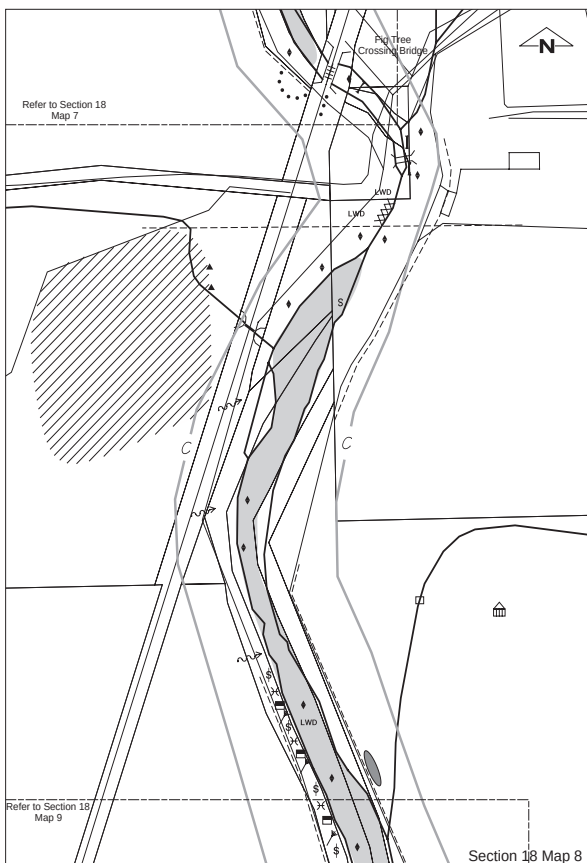
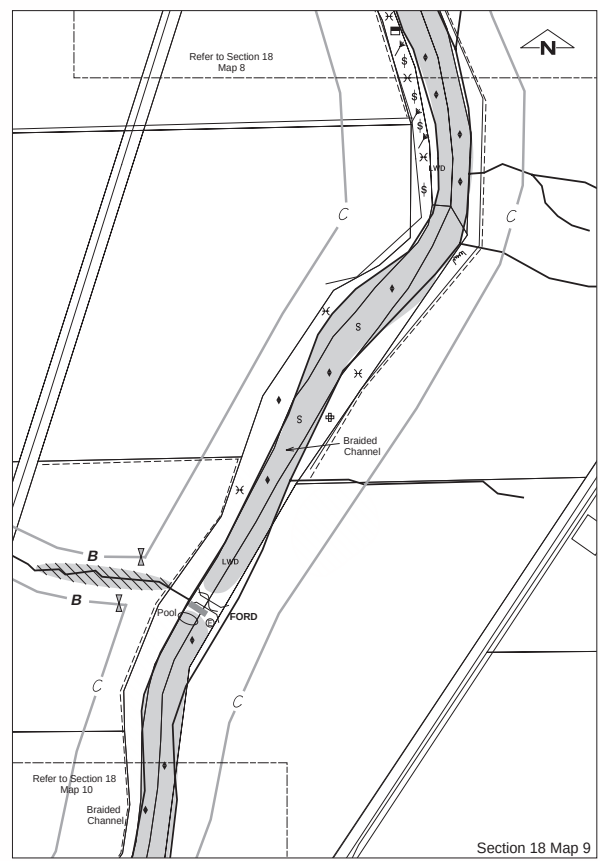
Other issues

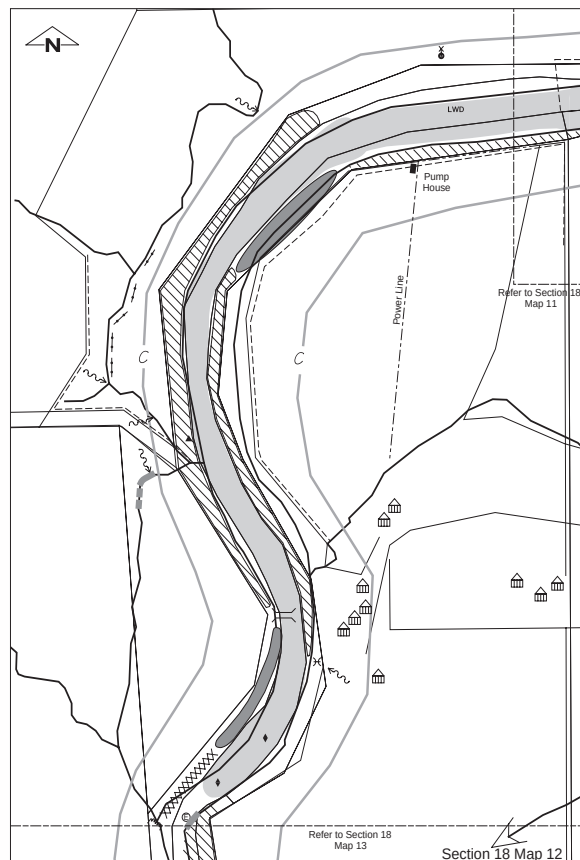
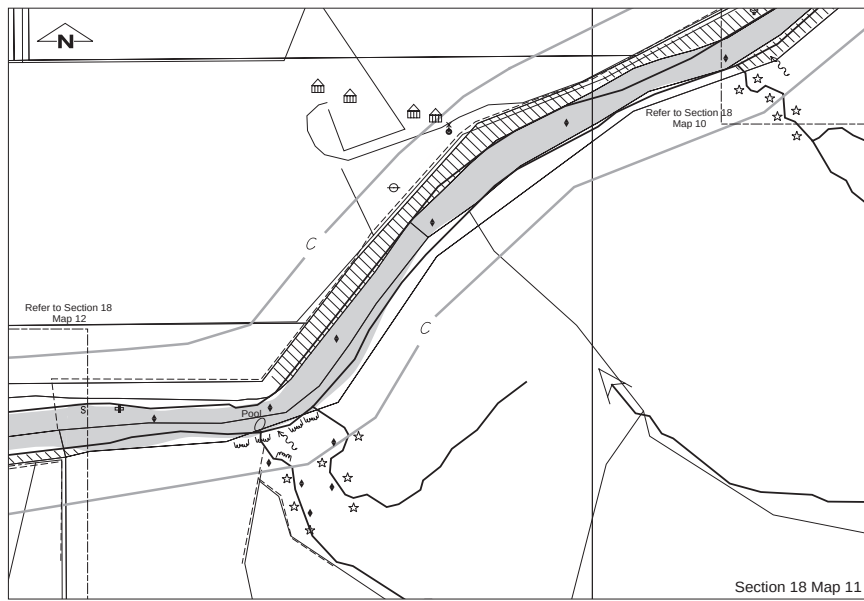
- Ensure rubbish bins in the picnic area are emptied on a regular basis.
- Encourage landholders to bury dead animals or dispose of them away from the river environment as it encourages foxes, feral pigs and other pests to traverse the river reserve.
- Reduce stock access and length of stock grazing in the river paddocks/reserves in sections where stock access tracks are clearly defined, to enable the vegetation to regenerate and protect the banks from future flow events.

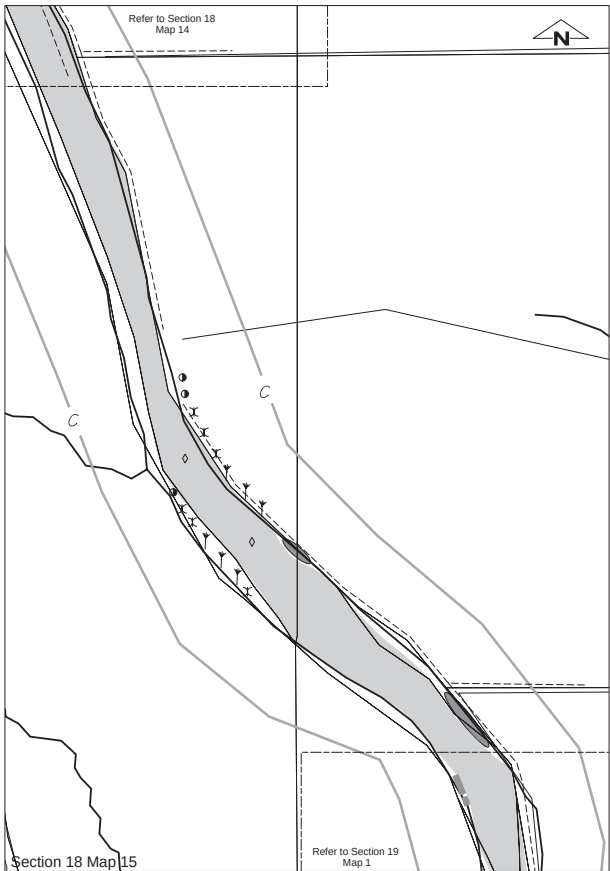
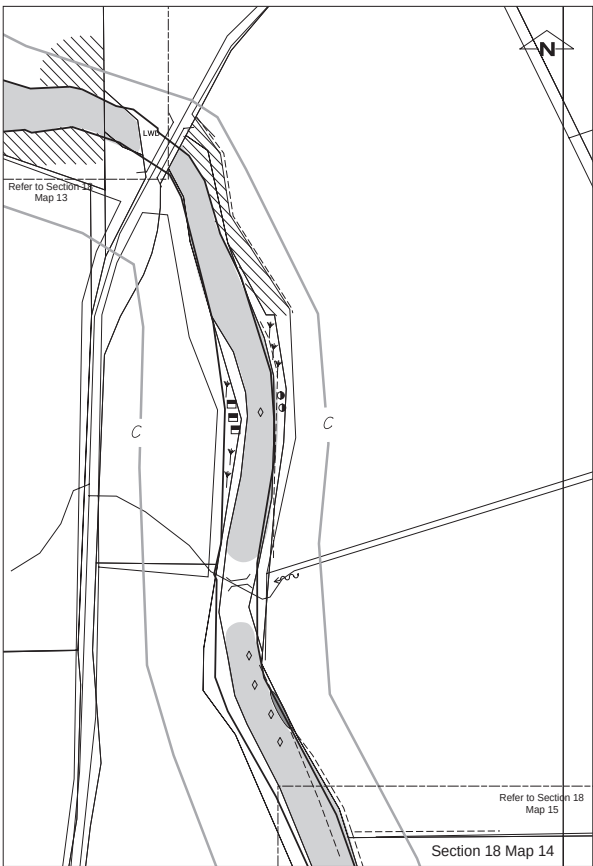
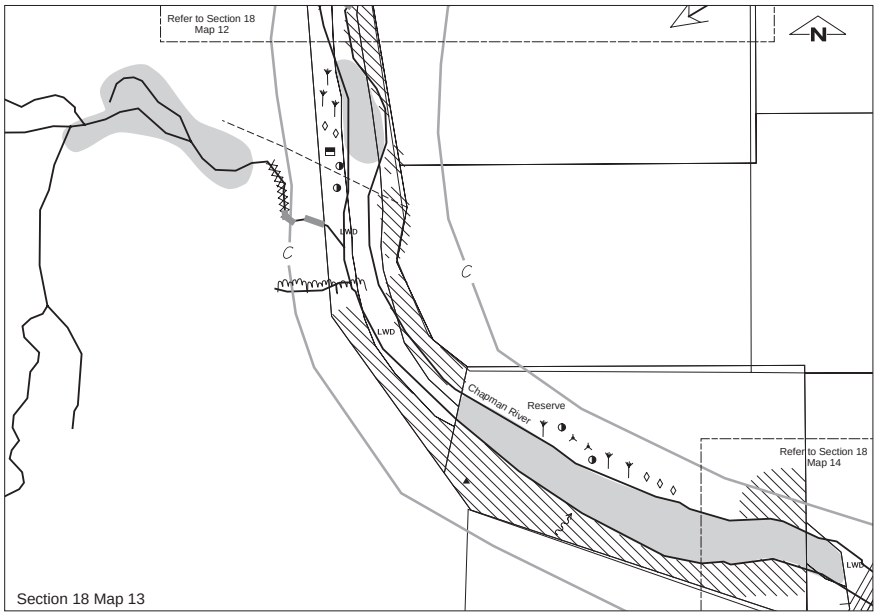












SECTION 19: CHAPMAN RIVER AND CHAPMAN RIVER EAST MAPS 1 – 6**Length of section (m):** 7,000m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 19 May 2000**Nearest road access:** Moonyoonooka Road**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Poor – C	Very Poor – D	Very Poor – D	Very Poor – D	Very Poor – D

Bank stability

The main channel of both Chapman River East and the Chapman River ranges between 12 and > 25 m wide with the foreshore banks rising with the variable gradient of 0.5 – 1.5 m in height. The main channel is partially braided. The left river valley bank on the Chapman River is steep while the right valley bank on the Chapman River East is the steep bank. The erosion is severe as > 50% of the foreshore is affected.

The valley slopes are also eroding with numerous rills. These rills are forming as sheet runoff makes its way to the river. The erosion can be attributed to loss of vegetation due to grazing and trampling of stock in the foreshore area. Clearly defined stock tracks are evident and water preferentially follows these tracks, making the erosion more significant. Extensive areas of both the foreshore and surrounding paddocks were completely denuded at the time of study. The slumping is localised along 5 – 20% of the foreshore. Sedimentation is significant. The main channel is braided due to the large deposits of coarse and fine sediments along 20 – 50% of the channel. Four tributaries feed into this section. There are three formal river crossings in this section.

Comments

The lack of perennial or annual vegetation cover and high levels of stock access have resulted in this section becoming highly unstable and erosion prone. The very steep banks defining the river valley will continue to erode unless there is considerable effort to control water movement down these slopes. The considerable sedimentation observed can be linked to the water slowing as the two rivers meet. Because the instream vegetation is not continuous from Yuna to this point and many tributaries are contributing both water and sediment the rivers tend to carry large amounts of soil during large peak flow events. The sediment that has accumulated in these sections is well-sorted mobile white sand.

Vegetation

The overstorey is limited to isolated patches of Swamp paperbark (*Melaleuca raphiophylla*) and single rows of River gum (*Eucalyptus camaldulensis*). Occasional Swamp sheoak (*Casuarina obesa*) are present infrequently. The middlestorey is limited to occasional Castor oil plants (*Ricinus communis*). The understorey at the time of survey was limited to uncommon clusters of Spiny flatsedge (*Cyperus gymnocaulos*) and native Saltwater couch (*Sporobolus virginicus*). Doublegee seeds (*Emex australis*) were present at the top of the verge, however there was minimal groundcover throughout this section. The diversity of weeds may be greater, however plant identification was limited due to the time of year in which the survey occurred and the level of grazing.

Comments

There is insufficient vegetation within the floodplain, verge and paddocks to protect the soil from erosion processes. The stock levels have resulted in most plants being grazed or trampled, with little groundcover. The paucity of cover was of concern at the time of survey because it was immediately prior to the onset of winter rains and there was insufficient cover to minimise the impact of direct rainfall and runoff. Considerable effort needs to be put into restoring vegetation to the foreshore reserve and beyond if feasible.

Stream cover

There is minimal stream cover within this river section due to a lack of trees, shrubs and groundcovers. The volume of mobile sediment also limits the re-establishment and regeneration of instream vegetation. Occasional woody debris occurs in the main channel, providing cover.



Comments

Stream cover will be difficult to re-establish if the current stocking levels are maintained *ad infinitum*. It is likely that it will take the riverbed, banks and floodplain a considerable length of time to provide habitat in the future, even with substantial changes to current management techniques. Protecting woody debris instream where feasible will provide at least small amounts of cover.

Habitat diversity

There is minimal habitat diversity due to the overall lack of native vegetation, absence of stable pools and mobility of sand in the riverbed. The continual stock movement is resulting in the margins of pools being pushed into the water as the stock drink, filling in the pools and removing habitat for aquatic organisms that are trying to lay eggs or burrow into the riverbed as pools dry up. Trampling is likely to either kill these types of animals, expose their eggs/cysts to the drying effects of voids formed in the soil matrix and/or reduce the amount of time the fauna have to complete their life cycle by increasing the rate of evaporation. The sparse riparian overstorey provides some habitat for woodland birds.

Comments

Reducing stock movement and encouraging regeneration of native vegetation are key requirements for revitalising this foreshore section as habitat for native plants and animals. The current stock and land management practices are not consistent with habitat provision and restoring long-term stability to the river system. It is likely that the course of river flow will change in future years, reducing the usefulness of the floodplain as drought refuge.

Other issues

There are stockyards located at the top of the verge. Faecal material accumulates in these yards, and because of the proximity of the yards to the top of the verge is likely to be washed into the river with the early rains.

Suggestions

Bank Stability

- B Exclude stock from the riparian zone and reduce general stock numbers to allow the land and vegetation to recover.

- B Liaise with landholders to encourage them to install fencing at least 15 m back at the top of the verge.
- B Liaise with Water and Rivers Commission and Agriculture WA to investigate options to stabilise erosion rills.
- B Initiate direct seeding and tree planting projects from top of the verge to the valley floor in manageable nodes.
- B Develop a farm plan that addresses the impact of stock on this unstable environment.

Vegetation

- V Fence off the foreshore reserve and exclude stock until there is sufficient vegetation on the floodplain to protect the channel banks.
- V Investigate opportunities to establish perennial pastures in the paddocks above the verge to try to maintain some vegetation cover all year round.
- V Protect revegetation works from trampling and grazing by stock through fencing off manageable-sized nodes.
- V Work to restore shade tree shelterbelts for stock to reduce their dependence on the foreshore reserve.

Stream cover

- S Protect instream debris where it is not exacerbating erosion, and realign if required.
- S Fence off foreshore by establishing fencing at least 15 m set back from the top of the verge, even if it is beyond the foreshore reserve boundary alignment, to help stabilise the slopes and floodway.
- S Minimise stock access into the foreshore area until there is sufficient vegetation cover to control sheet runoff, minimise the formation of erosion rills and restore some level of habitat function.

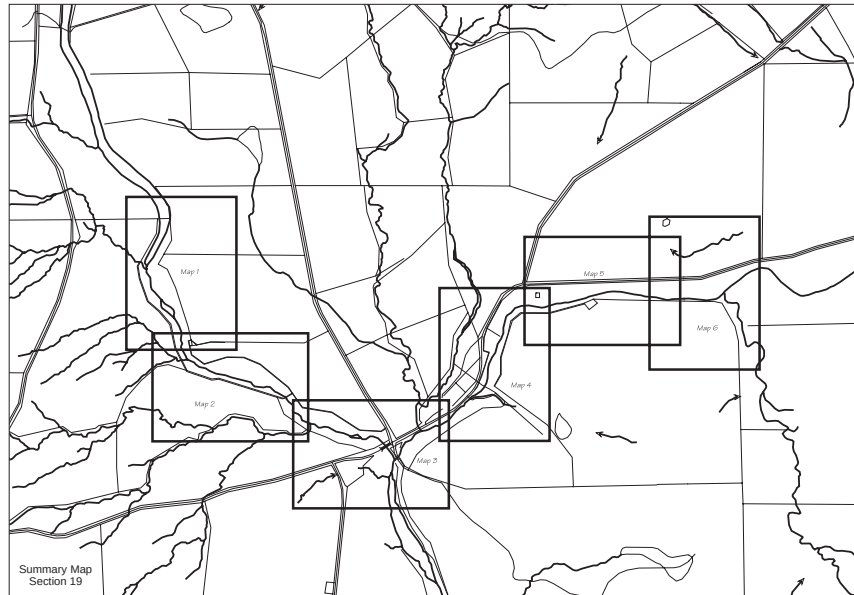
Habitat diversity

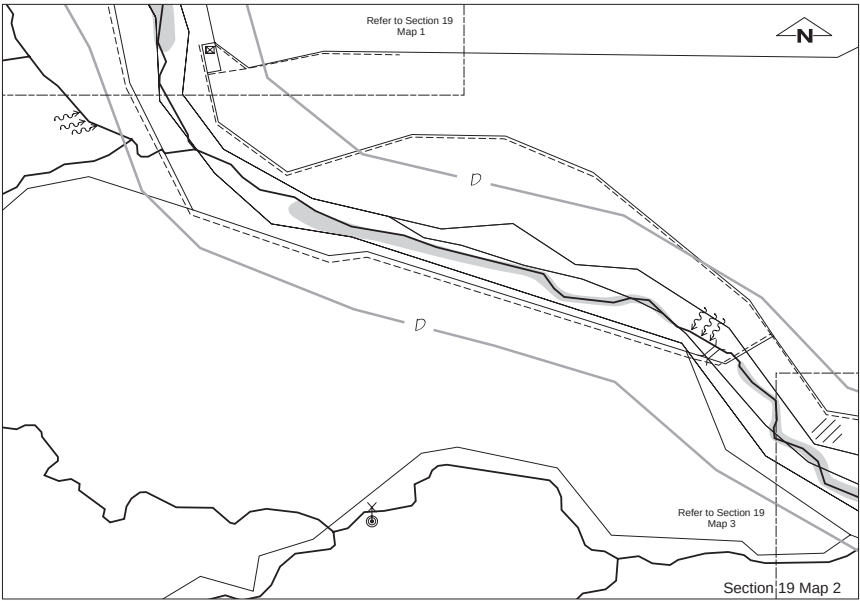
- H Implement management suggestions to restore native vegetation to the riparian zone and the verge, and manage stock access to protect the foreshore from degradation processes.

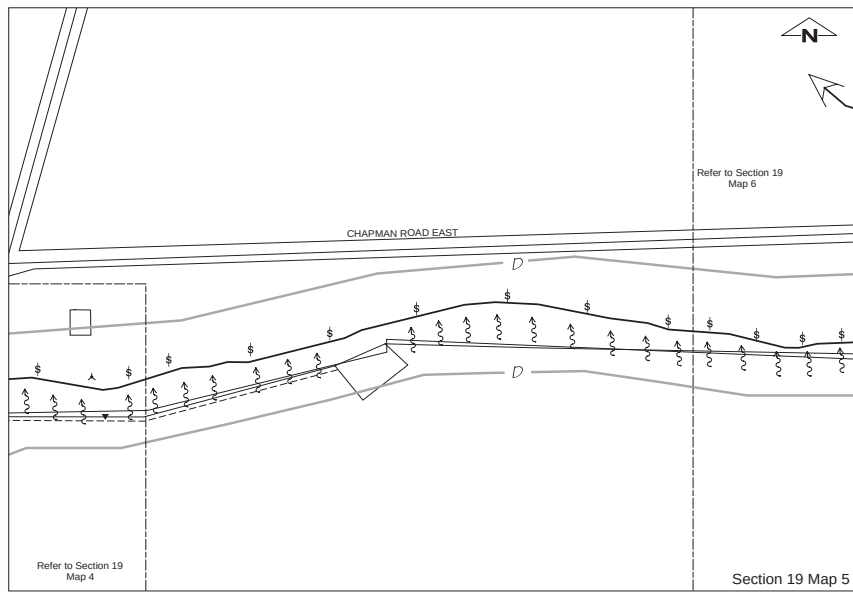
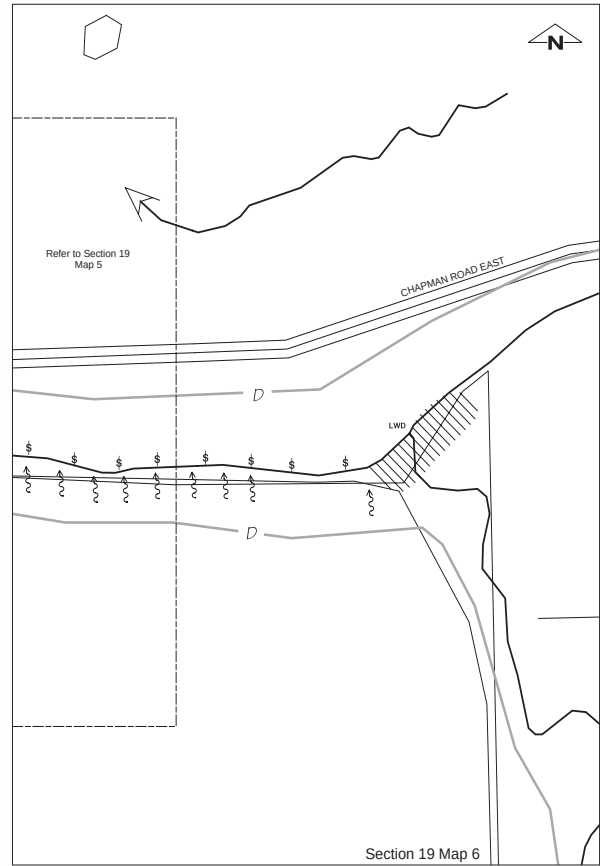
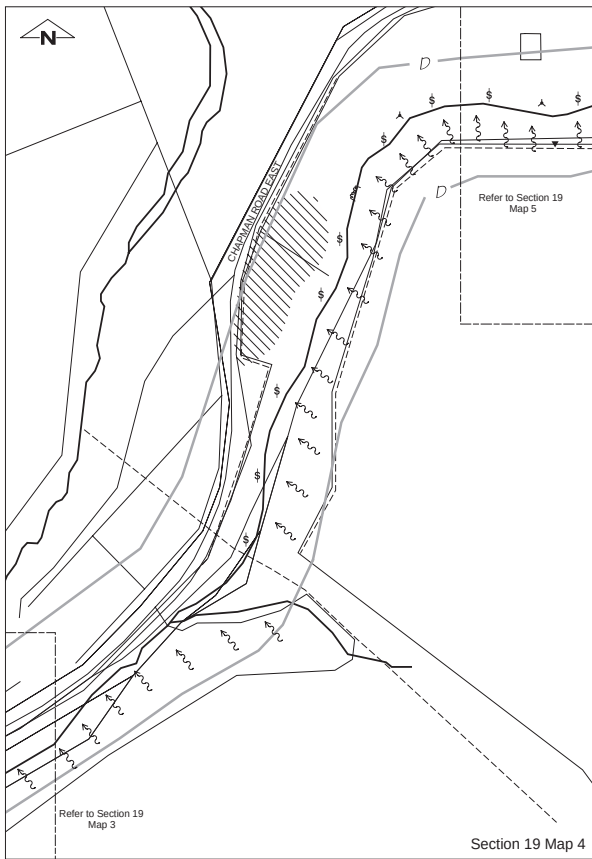


Other issues

- Consider installing traps to direct water flow and faecal material collected in holding yards away from the river.
- Provide all landholders with Water Notes information packs about river health and techniques to protect river function.
- Review foreshore reserve boundaries and encourage changes to land management practices within the reserve zones.







SECTION 20: CHAPMAN RIVER MAPS 1 – 7**Length of section (m):** 8,690m**Recorders' name:** N Siemon and T Rebola**Date surveyed:** 22 May 2000**Nearest road access:** Narratarra Moonyoonooka Road and Giles Rd**Summary of river health**

<i>Bank Stability</i>	<i>Foreshore Vegetation</i>	<i>Stream Cover</i>	<i>Habitat Diversity</i>	<i>Verge Vegetation</i>	<i>Stream Condition</i>
Very Poor – D	Poor – C	Poor – C	Very Poor – D	Poor – C	Poor – C

Bank stability

The main river channel ranges between 6 and 12 m wide where there is a single channel, to 18 m where the channel is braided. There are some sections where the river flows through a series of tight meanders. The foreshore banks rise on a steep gradient to a height of 0.8 - 1.8 m. The valley slopes range from moderate to very steep with extensive erosion rills. Numerous erosion rills are on the left bank. Erosion is occurring along 5 - 20% of the foreshore particularly at the base of trees growing along the foreshore bank, where large woody debris is acting as a natural dam, and on the margins of the floodplain. There are eight blowouts within the floodway of varying size and scale. The largest of these is > 400 m long and 70 m wide, and appears to have been there for many years. Evidence of livestock damage was observed in a small number of sections.

There is little evidence of broadscale bank collapse and slumping though there is localised damage along 5 - 20% of the foreshore. Some of the damage is associated with the very tight meanders causing undercutting and encouraging significant sediment deposition. Sedimentation is also localised along the river channel with deposits evident along 5 - 20% of the main channel. There is one small pool, which appears to be spring fed and permanent. There are six tributaries feeding into the river including Una Brook.

Comments

While many landholders have excluded stock from the foreshore and river valley slopes, others have not. The loss of vegetation cover at the top of the verge is increasing the susceptibility of the valley bank to the formation of erosion rills. The rills are more severe where there is clearly defined stock access. There is some woody debris instream and on the floodway that is exacerbating erosion. This debris could be removed or realigned to help bank stability.

Vegetation

The overstorey is patchy (20 – 80% cover) and is dominated by a mosaic of River gum (*Eucalyptus camaldulensis*) and dense stands of either Swamp paperbark (*Melaleuca raphiophylla*) or Swamp sheoak (*Casuarina obesa*). Castor oil plants (*Ricinus communis*) are abundant. Generally the vegetation extends up to 30 m either side of the main channel, however there are sections with only a single row of trees. There is significant regeneration of River gums (*Eucalyptus camaldulensis*) particularly in blowouts and disturbed areas. The middlestorey is patchy (20 - 80% cover) and is dominated by weeds. Frequent species include Black berry nightshade (*Solanum nigrum*), Lupins (*Lupinus cosentinii* and *L. angustifolius*), Arum lily (*Zantedeschia aethiopica*) and Fleabane (*Conyza bonariensis*). The only native species present is Cumbungi (*Typha domingensis*).

The understorey is continuous (> 80% cover) and is dominated by weeds. Common introduced flowering species include Vetch (*Vicia sativa*), Nasturtium (*Tropeolum* sp.), Soursob (*Oxalis pes-caprae*), Curled dock (*Rumex crispus*), Wild radish (*Raphanus raphanistrum*), Capeweed (*Arctotheca calendula*), Saffron thistle (*Carthamus lanatus*) and Doublegee (*Emex australis*). Other frequent groundcover species include both annual and perennial grasses. Annual Wimmera ryegrass and Drake (*Lolium rigidum* and *L. angustifolius*), Wild oats (*Avena fatua*), Blowfly grass (*Briza maxima*) and Shivery grass (*Briza minor*) are all widespread, while Couch (*Cynodon dactylon*) occurs periodically. The native Spiny flatsedge (*Cyperus gymnaeolus*) occurs sporadically on the riverbank.

Verge vegetation is moderate, consisting of a wide range of Wattle (*Acacia* spp.), *Hakea*, Common baeckea (*Baeckea camphorosmae*) and infrequent Quandong (*Santalum acuminatum*).



Comments

Many landholders have excluded stock from the river foreshore for many years, which is reflected in the relatively low levels of instream erosion and vegetation loss. There is a need for weed control along the entire length, focussing on Castor oil, Arum lily and annual grasses due to increased fire threat. This is one of the few sections of the Chapman River retaining extensive verge vegetation. Increasing vegetation cover where there are erosion rills should be a priority.

Stream cover

The overhanging vegetation provides scattered patches of permanent stream cover. The presence of frequent logs and branches provides some instream cover.

Comments

Maintaining the vegetation cover is a key to providing shade to the watercourse. Many landholders exclude or severely limit stock access, helping to protect these values. Weed control activities may impact on stream cover where weeds provide the major source of shade.

Habitat diversity

It is unlikely that water is permanent along the entire length of this section, but is limited to occasional small pools. At the time of survey the water was light brown in colour and clear. Anecdotal evidence suggests two creeks arising from springs are becoming salty. The depth of the river varies and is relatively shallow 0.2 - 0.8 m. The instream logs, branches and Couch provide good habitats for aquatic invertebrates. Three types of aquatic snails, dragonflies and two types of water beetles were observed. The streamside vegetation provides relatively good habitat for terrestrial invertebrates, frogs and reptiles. The stand of Cumbungi provides suitable habitat for waterbird nesting. The overstorey in the floodway combined with the verge vegetation provides moderately diverse nesting and roosting sites for birds. It is likely that possums occur in the hollows of River gums. Feral pigs are present in the foreshore reserve.

Comments

The dominance of weeds in this section significantly reduces habitat diversity. The extent of vegetation however is relatively good, in some parts providing corridors that allow animal movement.

Other issues

There is considerable evidence of feral pigs in this river section. These animals represent a significant threat to riverbed and bank stability, landholders and their pets. There are ten areas of discarded farm materials either on the main channel or on tributaries. The foreshore reserve appears to be discontinuous along this section with an unclear cadastre around Una Brook. There are two windmills with water tanks. One landholder indicated that they extract water from the river for stock. The foreshore reserve is not clearly identifiable. Not all of the section is fenced. One landholder recently surveyed the foreshore reserve boundary and found it did not reflect the landform at all. Some pegs were set back 30 m into his paddocks and some were in the riverbed. There is a Water and Rivers Commission groundwater monitoring bore close to the confluence of Una Brook with the Chapman River. Locusts were observed.

Suggestions

Bank stability

- B Remove or realign large woody debris where it is acting as a natural dam and exacerbating erosion.
- B Develop management strategies to minimise the formation of erosion rills, and control runoff to slow the continued degradation of these areas.

Vegetation

- V Focus weed control on Saffron thistle, Arum lily, Nasturtium and Castor oil.
- V Encourage private landholders to undertake intensive weed control and revegetation works to encourage natural regeneration within this area, if resources allow.
- V Provide financial support or material assistance to landholders who are willing to implement weed management activities. Encourage the development of a funding application to provide native plant species of all strata. These plants should be made available to landholders annually.
- V Ensure the impact on bank stability is considered before weed control works are undertaken.



- V Cut Castor oil plants 10 cm above base and immediately paint with systemic herbicide.
- V Provide all landholders with a Water Note information pack.
- V Encourage landholders with remnant native verge vegetation to protect this plant community and encourage its long-term survival.

Stream cover

- S Commence localised weed control in the vicinity of native seedlings to maximise their growth rate.
- S Protect instream debris from removal where it is not threatening bank stability.
- S Encourage landholders to continue to manage their foreshore so that > 70% native vegetation cover is present at all times.

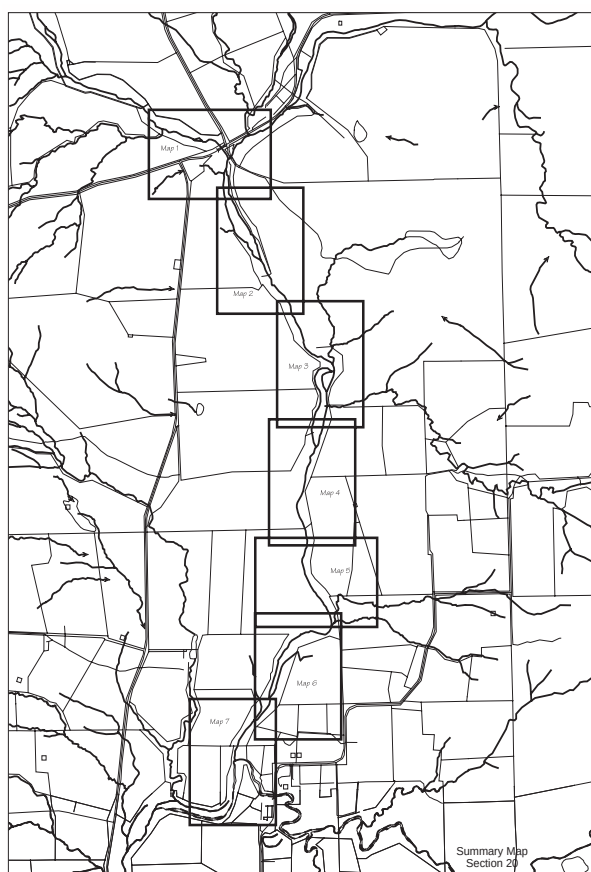
Habitat diversity

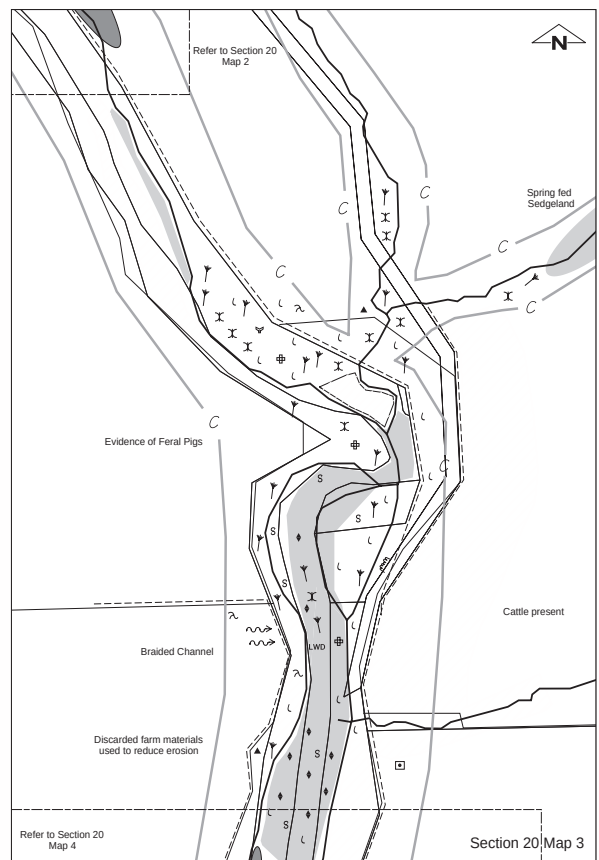
- H Undertake a weed control program, with a focus on encouraging natural regeneration.
- H Assess water quality and undertake invertebrate monitoring through the Ribbons of Blue program.

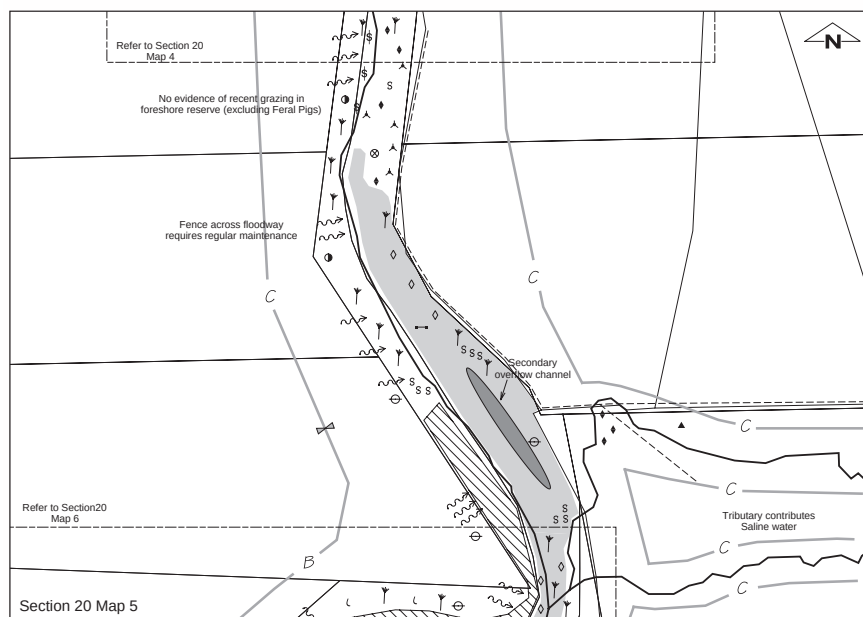
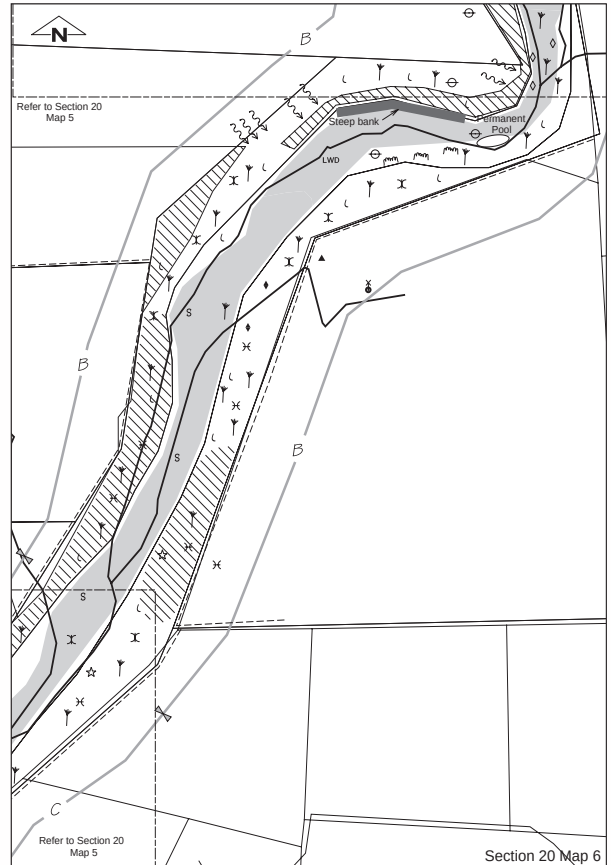
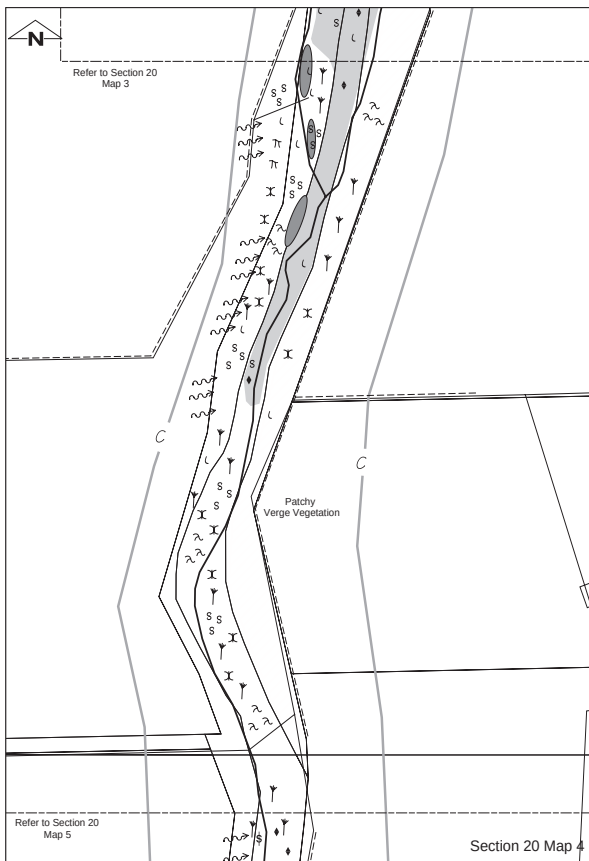
- H Continue to manage stock in a manner that minimises disturbance to the soil and vegetation.
- H Implement feral pig control on a regular basis, aiming for eradication as these animals pose a significant safety threat.

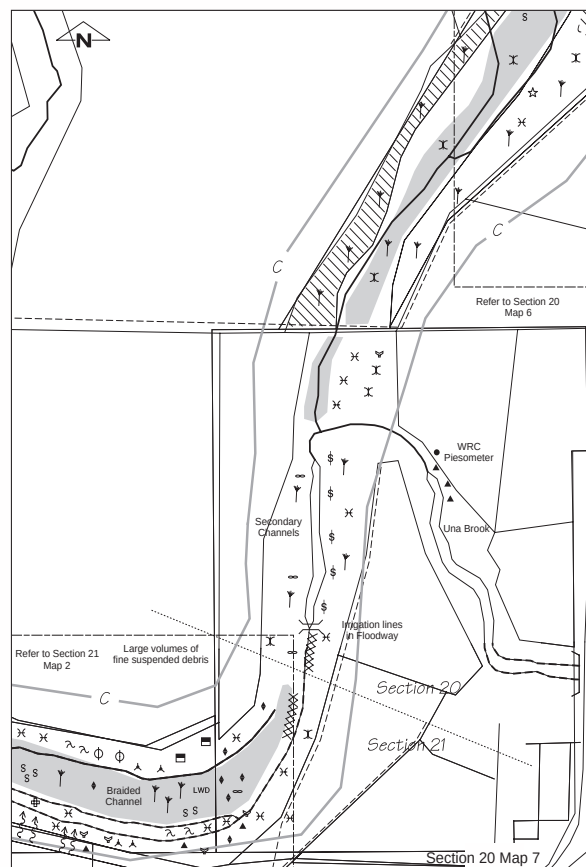
Other issues

- O Develop a strategy to eradicate the feral pigs from the foreshore. All landholders should be involved.
- O Encourage the Water and Rivers Commission and Agriculture WA to investigate changes in salinity of water flowing from the tributaries.
- O Hold CleanUp Australia Day working bees to remove or salvage discarded materials.
- O Survey and define the foreshore reserve boundary. If necessary, realign the reserve boundary to reflect the natural landform, and protect the floodplain environment.
- O Review management of the foreshore reserve and develop options to encourage an agency to take the vesting.









SECTION 21: CHAPMAN RIVER MAPS 1 – 5

Length of section (m): 4,830m

Recorders' name: N Siemon and T Rebola

Date surveyed: 5 October 2000

Nearest road access: Moonyoonooka Road and Narratarra Moonyoonooka Rd

Summary of river health

Bank Stability	Foreshore Vegetation	Stream Cover	Habitat Diversity	Verge Vegetation	Stream Condition
Moderate – B	Moderate – B	Moderate – B	Moderate – B	Moderate – B	Moderate – B

Bank stability

The main river channel ranges from 2 to 18 m wide, with the widest part of the channel being braided due to significant sediment deposition and erosion events. The channel banks rise on a moderate slope and are relatively stable, except in areas where there is some accumulation of woody debris. There are localised sections (5 - 20%) with steep banks that may be susceptible to slumping when waterlogged. The valley banks rise on a moderate to very steep gradient (small cliffs), and are layered. There is some weakness between the layers, and introduced bees have taken advantage of the resulting cracks and nested between the layers of soil. Sedimentation and erosion are localised (5 – 20%) around large woody debris that is

acting as a natural dam. There are numerous blowouts in the floodplain and between the braided channel sections, where vegetation cover is limited. There are four areas of severe erosion rills on the right valley bank, and one significant gully at the downstream end of the section. Discarded farm materials have been used to control water flow and encourage sedimentation within this gully.

Comments

The blowouts in this section are likely to have developed as a combined consequence of pig damage and loss of perennial vegetation cover, increasing the susceptibility of the floodplain to washouts. The river environment is relatively stable and the foreshore alignment generally provides adequate protection for



the soils forming the riverbanks. However, the river environment in this section may be prone to erosion if allowed to become unstable through the continued loss of vegetation or other disturbances (such as the pigs). The small cliffs on the right bank are very steep, and represent a safety hazard following the creation of a subdivision on adjoining land. The course of river flow may change over time as braided sections have sedimentation occur, and new sections erode.

Vegetation

There is a dense continuous canopy providing > 80% cover through the braided section. The right bank retains some sections of excellent floodplain vegetation characterised by Swamp paperbark (*Melaleuca raphiophylla*) with occasional River gums (*Eucalyptus camaldulensis*) over dense stands of Spiny flatsedge (*Cyperus gymnocaulos*) and Shore rush (*Juncus kraussii*). The vegetation quality and extent declines, grading through moderate to poor stands within the floodplain to the left bank. The understorey is continuous and dominated by weeds. There are also patchy dense stands of Bare twig rush (*Baumea juncea*) and Marsh club rush (*Bolboschoenus caldwellii*). There is significant regeneration of River gum (*Eucalyptus camaldulensis*) and Swamp paperbark (*Melaleuca raphiophylla*) in some sections.

Dominant weeds are Castor oil (*Ricinus communis*), Soursob (*Oxalis pes-caprae*), Paterson's curse (*Echium plantagineum*) and Wild oats (*Avena fatua*). There are occasional African boxthorn (*Lycium ferocissimum*).

The limited vegetation on the verge includes occasional York gum (*Eucalyptus loxophleba*), *Pimelea* and *Acacia*, but all are uncommon. There are some small areas of relatively intact shrublands, which should be protected.

Comments

The vegetation diversity is variable with some sections retaining dense homogeneous stands of rushes and sedges beneath the overstorey, but for the most part weeds dominate. Spraying buffers around persisting native plants is likely to be the most effective technique to encourage regeneration of these species and maximise their growth rate. Supporting revegetation works may help on the verge, to enhance the extent

and diversity of the verge vegetation. This could be limited to collecting and spreading seed. Planting dense stands of trees and shrubs on the top of the verge may also discourage landholders buying into the new subdivision from walking through the reserve, and help to keep weeds out. Weed control effort should focus on Castor oil and the African boxthorn, and supporting the natural spread of understorey species.

Stream cover

There are variable levels of stream cover in this section, averaging at moderate. The sections of dense stream cover occur where the emergent plants Marsh club rush and Couch grow in the riverbed and on the banks. The canopy also provides some areas of permanent shade. The instream woody debris provides some cover.

Comments

The stream cover is currently sufficient to provide some cooling of the watercourse and also contribute to localised shading of the bed. With increasing levels of access to the foreshore reserve following the establishment of a subdivision nearby, there is the potential for removal of instream woody debris by children playing. Often this can have minimal impact on the environment, however in the event of a fire in the foreshore reserve, stream cover may be difficult to re-establish.

Habitat diversity

It is likely that water is not permanent along the entire length of this section but is limited to occasional small pools. At the time of survey the water was light brown in colour and clear. The depth of the river varies and is relatively shallow 0.2 - 0.8 m. The instream logs, branches, Marsh club rush and Couch provide good habitats for aquatic invertebrates. Three types of aquatic snails, dragonflies and two types of water beetles were observed. In areas retaining dense streamside vegetation there is relatively good habitat for terrestrial invertebrates, frogs and reptiles. The overstorey in the floodway combined with the verge vegetation provides moderately diverse nesting and roosting sites for birds. Currawong, Magpie larks and Magpies are present. Swallows are breeding in cracks in the steep banks. There is some competition between the swallows and bees that are seeking to use the same space for a hive. Mountain ducks use the areas of open



water and feed on the annual grasses. An unusual beetle, similar to a large ladybird, was observed. It is likely that possums occur in the hollows of River gums. Feral pigs are present in the foreshore reserve. A lone Red kangaroo was utilising this area for habitat at the time of survey.

Comments

Anecdotal evidence indicates that the feral pigs are a significant threat to landholders adjoining the river and also have a major impact on bank stability. The habitat diversity is upgraded because of patchy verge vegetation. These areas are small but have one of the highest diversities in the lower reaches of the Chapman River. The dominance of weeds in this section significantly reduces habitat diversity. The vegetation provides corridors allowing animal movement.

Other issues

There are a number of lengths of irrigation pipe in the floodplain that are likely to be washed away in future flow events if not removed.

The fenceline follows the treeline and does not reflect the width of the floodplain. A second older fence occurs midway from the treeline to valley banks. There is a small private pump station in the floodplain.

Two overhead powerlines are present.

Suggestions

Bank Stability

- B Ensure that weed control works take the impact on bank stability into consideration.
- B Undertake to eradicate feral pigs to reduce disturbance to the vegetation and consequent increased risk to bank stability.
- B Ensure that activities likely to cause disturbance to the soil and vegetation are limited to the verge.
- B Install signs close to the small clay cliff to warn of the danger. This is only necessary due to the presence of a subdivision and the likely higher levels of use of the foreshore area.

Vegetation

- V Spray 2 m diameter circles around persisting native understorey or tree seedlings to enhance their rate of growth. This minimises the risk to bank stability in the event of summer flow events.
- V Cut African boxthorn and Castor oil plants 10 cm above the ground and paint immediately with a systemic herbicide. It may be necessary to remove the bulk of the branches from the African boxthorn to enable access to the main trunk. All cuttings should be removed in tarpaulins to minimise the chance of spreading segments or seeds.
- V Plant tubestock on the top of the verge to discourage recreational users from accessing the foreshore, and also to make weed spread more difficult.
- V Undertake to control Paterson's curse.

Stream cover

- S Ensure that an effective fire control strategy is in place to protect the environmental integrity of this area in the event of fire.
- S Maintain instream woody debris where it is not exacerbating erosion.
- S Monitor natural regeneration within this foreshore section, and if sufficient undertake supplementary plantings of tubestock. Plant establishment may benefit from selective weed control in 1 – 2 m diameter circles around any tubestock.

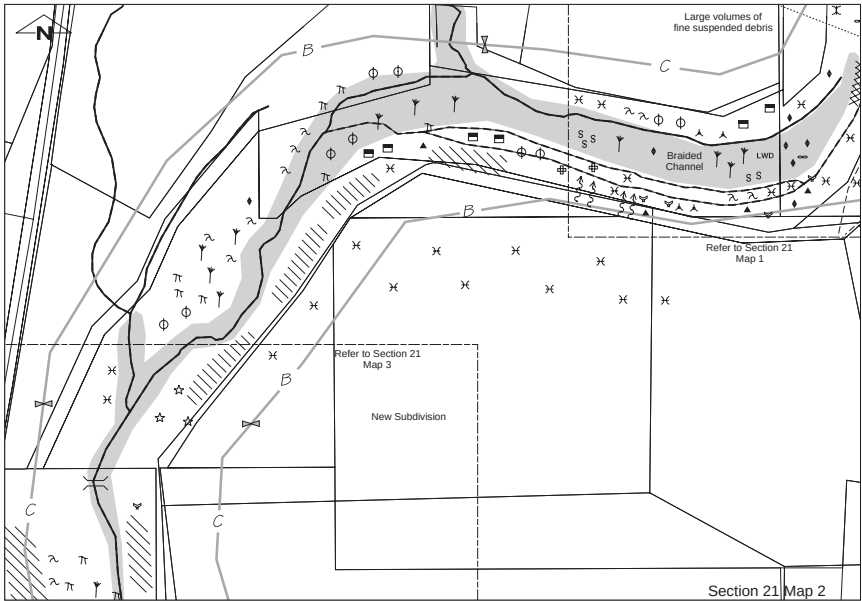
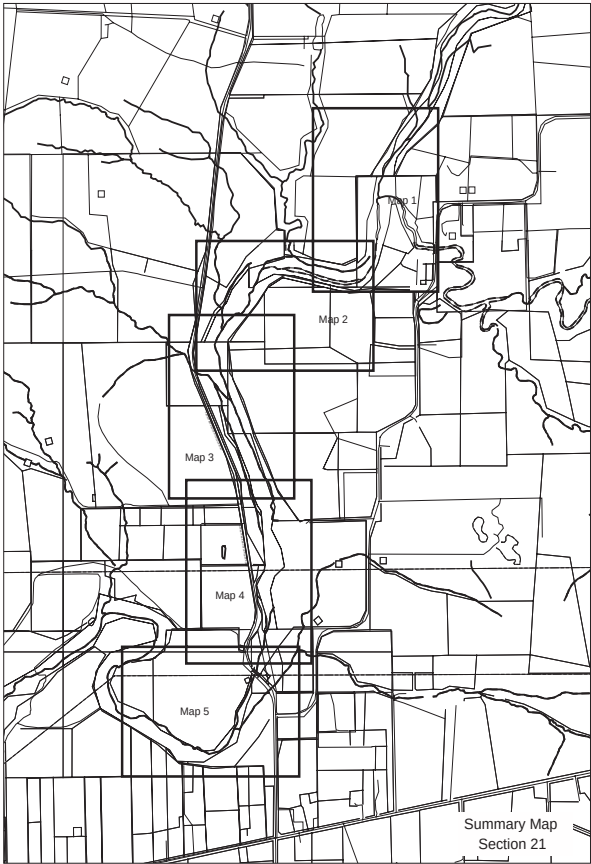
Habitat diversity

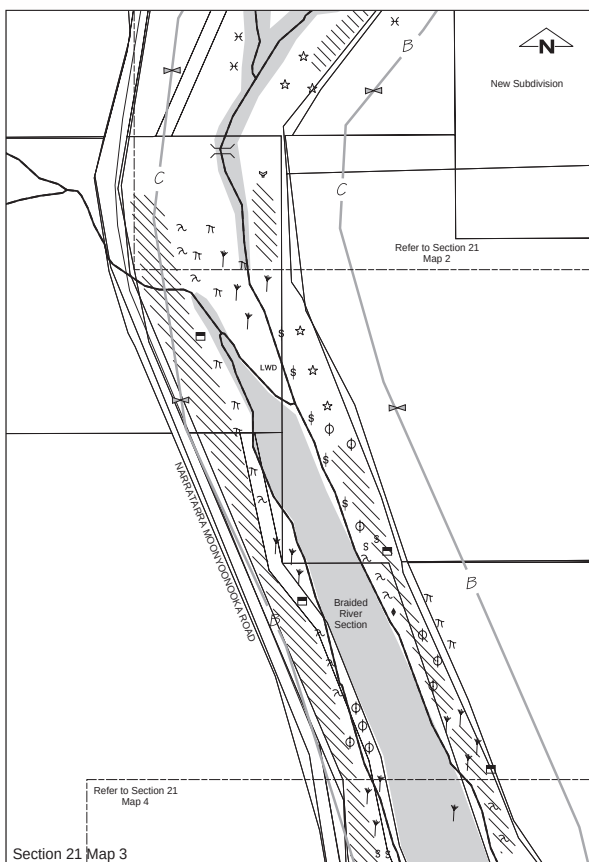
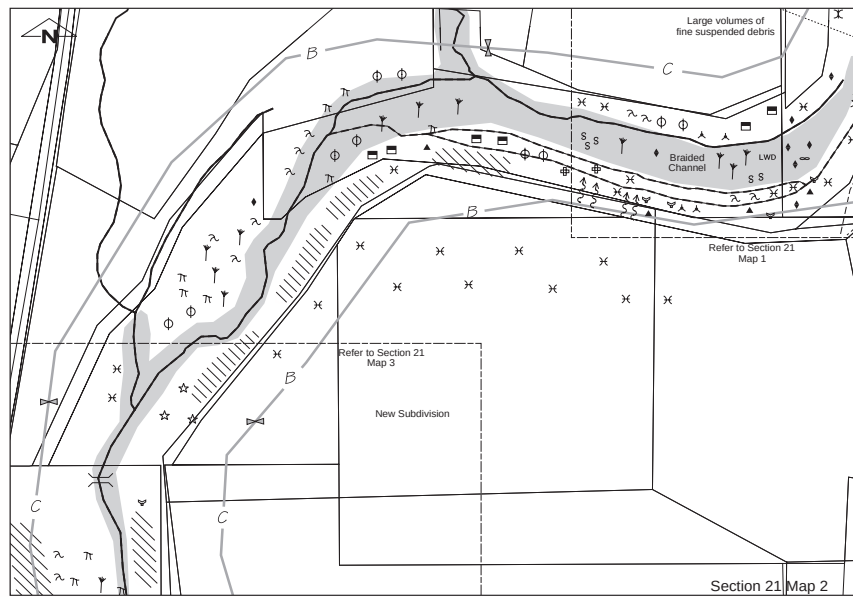
- H Implement feral pig control.
- H Undertake weed control and revegetation activities outlined above.

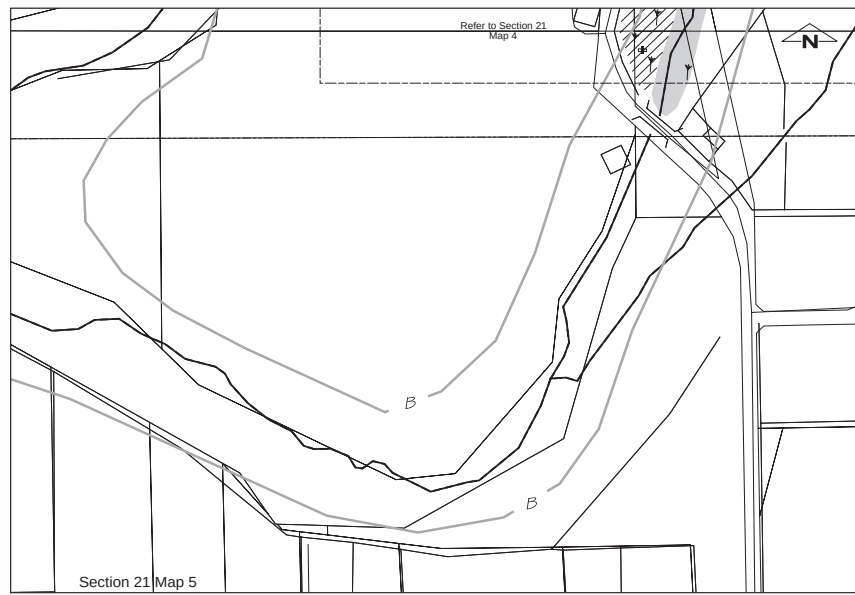
Other issues

- O Consider removing the irrigation lines from floodplain to prevent them being washed away.









6. Common issues

6.1 Rights and responsibilities of owning land adjoining the river and foreshores

Foreshore reserves

Along sections of the Chapman River, Foreshore Reserves have been demarcated, ceded to the Crown and are vested with the local government authority or WRC for on-going management. Any activities or works within foreshore reserves, such as development of access tracks, requires authorisation from the management body.

Riparian rights

The rights of landholders with watercourses through their properties include:

- Domestic and ordinary use of that water;
- Stock watering; and
- The use of the river while ensuring that the flow of the water in the watercourse is not sensibly diminished.

A permit is required from the Water and Rivers Commission if the taking of surface water from the Chapman River will result in interference with the waters, bed or banks of the watercourse.

Obstruction of flow

Landholders cannot convey or discharge, or cause or permit any sludge, mud, earth, gravel, or other matter likely to obstruct the flow of the current to be conveyed or discharged into any surface water or wetland in relation to taking surface water.

6.2 Foreshore reserves

The foreshore reserve extends along much of the river. The reserve boundaries are rarely clearly defined. The current alignment of fencing may not necessarily be consistent with the actual river boundary. Some examples, where landholders applying for subdivisions were required to survey the boundary, showed that sections of reserves lie up to 80 m within existing paddocks, while in other areas the reserve boundary is within the main river channel. The current reserve

boundary alignments do not always correspond with the extent of the floodplain.

The boundaries need to be surveyed to enable fencing in some key locations, rationalisation of reserves to protect foreshore areas for flood mitigation and restoring river functions, and determining an appropriate agency for on-ground river management.

An additional issue requiring resolution is land ownership. Many of the foreshore reserves are unvested vacant Crown land. This means that private landholders are in the best position to contribute to managing the foreshore and river within their property.

It is understood that management is technically the responsibility of the Department of Land Administration where vacant Crown land exists, and there is funding available to support management activities by other bodies. This funding could be sought to contribute to management of the river environment.

Selective use is acceptable, as is weed control within the reserve, provided any activities meet the rules of the river and do not negatively impact on the waterway or its foreshores. For example, overstocking within reserves is contrary to the intention of the reserve, while crash grazing for a three – five week period for weed control is likely to be acceptable. Careful monitoring of any stock within the river system is critical to protect a long-term agreement with any landholder. Abuse of the river system and its reserves may ultimately result in access being denied.

For example, anecdotal evidence collected during the survey also indicates that some landholders exceeded their involvement in river management by spraying for locusts in 1990. Comments were made that frogs have only been heard during the year 2000 in that river section for the first time since the spraying. While frogs provide an effective vocal reminder of their presence, many other animals within this river section would have been affected by the spraying. During the foreshore assessment survey, there was a distinct lack of large predators such as spiders and dragonflies and the diversity was limited. The lack of all levels of the food chain in a river system indicates that all is not well.



General suggestions

- Take advantage of any opportunity to review the current reserve alignment, amend to reflect the natural contours (floodplain margins) and ensure that the boundary is clearly identifiable.
- Remember that foreshore reserves belong to everybody, and that custodianship of the reserve is simply a reflection of proximity.
- Ensure management practices are appropriate for highly sensitive environments.

6.3 Bank stability

Blowouts occurring within the floodway are common along the lower reaches of the Chapman River. Blowouts occur where the river at peak levels locates weakness in the soil and causes erosion. The soil weakness often corresponds with areas lacking good vegetation cover.

Some of the Chapman River obtained a rating for bank stability of Very Good to Good. Sections 1, 12 and 16, show only minor isolated occurrences of bank destabilisation, slumping or sedimentation. These sections corresponded with areas that have been subject to minimal disturbance by stock, fire or other management activities. The extent of regions with these ratings is limited and of concern, as the pressure from accumulating drift sand and scouring will become greater with time.

These sections corresponded either with a granite bed, which is the most stable bed form, and granite rocks throughout the floodway, or low gradient saltmarsh areas. Both zones retain good levels of fringing vegetation, which helps to stabilise the sand moving through the river system, and there are no significant areas of disturbance within the riparian zone.

The remaining river sections are characterised by poor to moderate ratings with a canopy of trees over a chaotic weed assemblage or grassland below. These systems are not sustainable in the long-term.

Points on bank stability

- Feral pigs are one of the greatest threats to bank stability and the direct cause of many of the blowouts seen along both the Chapman and Greenough rivers.

- Feral deer along with farm stock also impact on the stability of sediment in areas, as do native animals.
- Erosion rills on the top of the river valley verge often start as a result of clearing of vegetation by ants or trampling by stock, often next to fencelines.
- Native animals, particularly kangaroos and emus, do less damage to waterholes than stock and feral animals because they have evolved to cope with these conditions.

Large woody debris

During the survey of the study area, a number of characteristics such as significant quantities of large woody debris and suspended woody debris were identified as impacting on the flow characteristics of the river. While this is a normal feature of river systems, the volume of material appears to be greater than in similar river sections throughout Western Australia. Frequent burning of the fringing vegetation encourages trees to drop more branches.

6.4 Salt

The upper reaches of the Chapman and Greenough rivers and many tributaries arise in salt pans. Salt is a natural part of these systems. There are many changes occurring that are increasing the rate at which salt enters the riparian zone, principally where the groundwater table is rising and farmers are constructing drains to remove the water from the property.

One of the predominant causes of the destabilisation of the banks along the 'Very Poor' rated sections was the presence of saline waters, creating salt scalds. These scalds kill off the fringing vegetation, leaving the banks of the waterway prone to the formation of erosion rills and gullies. Further anecdotal evidence and observations indicate that rising groundwater tables have increased the contribution of some springs.

There are some instances of landholders dredging the riverbed and tributaries to drain saline waters to both the Chapman and Greenough Rivers. This not only impacts on the immediate discharge point often causing localised erosion, but also impacts on the river downstream. Continual drainage of saline waters can result in the loss of entire vegetation and fauna communities, where these communities are adapted to occasional exposure to hypersaline waters.



Rising groundwater is certainly an issue and is difficult to address. It is important to remember, however, that the rivers reflect the way in which the catchment is managed. There is a risk that as the river is expected to cope with unusual salt and water loads it will degrade and ultimately function as an unstable drain rather than a river.

Improving land management in the catchment is critical to prevent further impact on this issue.

There are many areas of healthy saltmarsh vegetation particularly in the upper reaches of the Chapman River and central sections of the Greenough River. The foreshore health of these sections is still high where the vegetation is intact. Loss of vegetation as a result of changes to hydrology, particularly damming the water up, is often the first step towards degradation of the river channel.

General suggestions

- Work with Agriculture WA, Water and Rivers Commission and catchment groups to develop catchment management plans that address groundwater and surface water issues.
- Obtain advice and approval from the Water and Rivers Commission before undertaking any works that impact on the bed or banks of a waterway.

6.5 Vegetation

The vegetation along both the Chapman and Greenough rivers is in variable condition, ranging from totally denuded with no vegetation cover, to occasional trees with an understorey dominated by annual grasses and occasional clumps of rushes including Spiny flatsedge (*Cyperus gymnocaulos*) or Shore rush (*Juncus kraussii*). This level of vegetation cover is poor.

An alternative similar community retains only trees with a groundcover of Couch (*Cynodon dactylon*) or the native Saltwater couch (*Sporobolus virginicus*). This type of vegetation provides better bank stability than areas with only annual cover because there is groundcover all year round. In summer, if there is little vegetation cover and a flood event comes through, the damage to the floodplain and channel banks tends to be significantly greater.

The vegetation communities then grade up into trees of all ages with dense perennial rush and sedge cover, with some annual grasses.

The loss of verge vegetation along almost all of the Chapman River and significant lengths of the Greenough River is of great concern, and threatens the long-term survival of many species within the foreshore area. The lack of linkages between the river environment and remnant bushland minimises the chances of recolonisation by many fauna species. Birds are able to fly away, but many ground or tree dwelling animals cannot get around without shelter from dense plants. This is particularly important when it is considered that there are additional predators such as foxes present.

6.5.1 Tax incentives for protecting vegetation

The public benefits of conserving areas of native vegetation that are of high conservation value are greater than the benefits of developing them for production because their biodiversity values are not replaceable through revegetation.

Managing land for conservation is much more expensive than managing land for production and nature conservation is rarely considered an income producing activity (Binning and Young 1997).

The current income tax system acts against nature conservation in two ways:

- (a) Failure of the tax system to recognise activities which are in the community's interest. This occurs because no financial transaction takes place as the goods do not have a market value.
- (b) Failure of the system to recognise negative externalities, such as increased risk of soil degradation, which are not directly related to production.

With the introduction of Section 387-55 of the *Income Tax Assessment Act 1997* there is a case for the public to invest via the tax system in the improvement of water quality, as land degradation is a prime source of water pollution.



Deductions Related to Clearing

Land clearing is a capital expense under current tax arrangements. Applications to clear land need to be approved by the Soil and Land Conservation Commissioner, to ensure that land degradation is not likely as a result of clearing. Generally, additional clearing of land is not approved. Development of farming land in this region has already resulted in the selection of the most arable land, with areas with high management costs generally left intact as bushland.

The clearing of woody weeds is allowable as a deduction under Section 387-55 of the *Income Tax Assessment Act 1997*.

Clarification should be sought from the Australian Taxation Office on the clearing of regrowth which has been re-established for a long period of time or when property has changed ownership.

Western Australia has broadscale controls in agricultural regions through a Memorandum of Understanding between the Commission for Soil and Land Conservation, Environmental Protection Authority, Department of Environmental Protection, Agriculture Western Australia, Department of Conservation and Land Management and the Water and Rivers Commission. As mentioned above, the relationship between State laws and tax laws needs to be understood.

Landcare related deductions:

Section 387-130 – allows a deduction for facilities to conserve or convey water.

Section 387-55 – allows expenditure to be deductible for the following;

- (a) the eradication or extermination of animal or vegetable pests from the land;
- (b) the destruction of weed or plant growth detrimental to the land;
- (c) preventing or combating land degradation, otherwise than by erection of fences on the land ('land degradation' includes not only soil erosion but also other effects detrimental to the land, such as decline of soil fertility or structure; degradation of natural vegetation; deposits of eroded material; or salinisation);

- (d) the erection of fences (including any alteration, extension or addition to fences) on the land to exclude livestock or vermin from areas affected by land degradation (see above) in order to prevent any aggravation of degradation in those areas and to assist in the reclamation of those areas;
- (e) the erection of fences (including any extension, alteration or addition to fences) to prevent land degradation where the fences separate different land classes and are erected in accordance with an approved land management plan in respect of the whole or part of the land;
- (f) the construction on the land of levee banks or similar improvements having like uses; and
- (g) the construction on the land of surface drainage works or sub-surface drainage works for the purpose of controlling salinity or assisting in drainage control (this would include, for example, the sinking of drainage bores and the laying of surface or sub-surface piping in the course of constructing floodwater drainage work (Taxation Ruling T/R 351) – however, the drainage of swamp or low-lying land is not included).

A land management plan must have been prepared or approved by the relevant government department or authority responsible for land conservation and show:

- the land classes;
- the location of fences necessary to separate land classes to prevent land degradation; and
- the kind of fencing and how it would prevent land degradation.

Rebates have been developed for low income earners.

6.6 Weeds

There are a number of serious environmental and agricultural weeds within the Chapman and Greenough river catchments.

Environmental weeds pose a threat to the integrity of remnant vegetation, often increase the fire risk and reduce the ability of the naturally occurring plant communities to survive. This lowered resilience impacts on native animals by removing habitat, reducing the appeal of bushland for these animals and encouraging them to feed in farmed land, and can result in the loss of animals from the system.



Agricultural weeds are often environmental weeds. The cost of weed control within cropped land is massive within Australia. Some landholders within the study area indicated that their herbicide purchases cost up to \$ 300 000 per annum. Weeds affect crop values, can poison stock and reduce the values of animal products such as wool and leather.

In these difficult times, managing weeds before they become a significant problem is critical although many landholders' resources are stretched to the limit. The cost of not controlling weeds when present in small numbers will be significantly greater in future years.

Many of the weeds present in the catchment are 'Declared' under the Agriculture Protection Act. This means that all landholders, no matter what size or zoning, are responsible for the control of these plants on their land. The intention of declaring particular weed species is to ensure the protection of horticultural and agricultural industries. Making weed control the responsibility of every landholder minimises the risk that weeds and pest fauna are building up on one property and spreading to neighbouring land. Even if weeds are considered to be endemic, the legal requirement is to control these plants in an ongoing reduction program. Agriculture protection is everyone's business.

It may be beneficial for the LCDCs, Agriculture WA and Water and Rivers Commission to collate knowledge from landholders about different weed control techniques. This information could possibly be collected between cropping and harvesting, once machinery has been overhauled and there is a lag in on-ground activity.

A number of weeds within the catchment are considered to be management priorities. There is a brief overview of each of these weeds below.

Castor oil plant (*Ricinus communis*) (Priority 3)

This plant is considered to be a substantial problem because of the longevity of the seed, and its toxicity to both native animals and stock. Seed of this plant was removed from an Egyptian tomb after approximately 1200 years, and germinated within days. Minimising seed production is critical to prevent this species from becoming prevalent.

Suggested control: To minimise the risk to bank stability the recommended action is to cut the trunk about 10 cm above the ground and immediately poison the stump by painting a systemic herbicide such as Glyphosate on the cut edge. This needs to be done within about 60 seconds of cutting, otherwise the plant will form a protective skin and not absorb the herbicide. The remainder of the plant should be dragged out of the river environment. If the plant is seeding, it is worthwhile to bag and remove the seed heads to reduce the need for future weed control. For large populations of seedlings, spot spray with Glyphosate 1 in 80.

Fountain grass (*Pennisetum setaceum*) (Priority 3)

This species of plant is becoming an increasing problem within both river catchments, but particularly in the upper reaches of the Chapman River. It is a common roadside weed and causes difficulty for many landholders.

It is considered to be an important weed because it is highly flammable, invasive and not particularly palatable to stock. These features make it able to spread very rapidly. A paddock fire escaped into a foreshore reserve during the survey. The fire crossed the river and the African spear grass on the roadside supported the rapid spread across roads and into neighbouring properties. In another incident, one landholder had a shearing shed burnt down when a paddock with a severe infestation caught fire.

Unpublished data have indicated that the maximum core temperature of this grass can approach that achieved by burning a piece of wood.

Suggested control: Stock can control this species when the plants are small, however are generally unwilling to graze on mature plants. Repeated slashing to prevent seeding can control the extent of populations and eradicate this weed over time. In areas where it occurs on steep banks or access is difficult, manual brushcutting can work but is only feasible in small areas. Alternatively spraying with Fusillade at 4 L / ha before flowering when actively growing is effective but costly, and using broad-spectrum herbicides has varying success levels.

Paterson's curse (*Echium plantagineum*) (Priority 3)

This plant has been established in this region for decades, and has been able to persist due to different levels of control exercised by landholders. This species



is Declared, meaning that landholders are required by law to control this species and work to eradication.

Suggested control: It is possible to remove small populations by hand or use a wick application of Glyphosate or Glyphosate / Roundup 75-100 mL in 15 L water by knapsack. Preventing seed production is again an important technique to control the rate of spread of this species –slashing paddocks during flowering can help to limit seed production and therefore the spread of this plant. Information on the most effective way to control this species should be obtained from landholders who do not currently have it on their properties while their neighbours do. Local knowledge is of enormous benefit with this species.

Doublegee (*Emex australis*) (Priority 3)

This plant has been established in this region for decades, and has been able to persist due to different levels of control exercised by landholders. This species is now a part of the preferred diet of Red-tailed black cockatoos, however it is unknown whether or not the seed is still viable once it has passed through the digestive process of these animals. It is difficult to control as it easily spread on machinery. Undertaking Doublegee counts can be achieved relatively quickly and easily by driving through a paddock, then drawing a 10 cm by 10 cm chalk line on a tyre and counting the number.

Suggested control: Again, removing small populations by hand and destroying plants with seeds is only feasible in small lots. Spraying with Glyphosate / Roundup 75mL in 15 L water in winter and spring has been demonstrated to work. Again, some landholders have had considerable success in controlling this weed and would be in the best position to advise on control techniques.

Saffron thistle (*Carthamus lanatus*)

This plant is widespread throughout both catchments. This species should become a focus for control by all landholders, as it has implications for wool quality if the market picks up and fine grade wool becomes a viable farming option. High grade wool production will be difficult if this species is allowed to spread further.

Suggested control: Preventing flowering is a key to achieving long-term control of this species. Where large populations of this plant occur they are difficult to control as there is poor access to many of the sites.

Other populations occur within the adjoining cropped paddocks. Some landholders have achieved high levels of success in controlling this species, and would be in the best position to advise on control.

Datura (*Datura*)

This plant was located in a few sections along the Greenough River. It is a hallucinogen and toxic to stock and humans.

Suggested control: Hand weed the plants as soon as they are identified. It is the quickest and most time-efficient way to control this plant while the populations are limited to single plants.

Arum lily (*Zantedeschia aethiopica*) (Priority 1)

Arum lilies occur in sections of the Chapman Valley catchment and were identified in the river in two areas. It is important that this species be controlled now before they become more widespread. The current distribution could be reduced and eradicated within five years if action is taken now.

Arum lily control costs the southwest region considerable resources. This species can be toxic to stock and native animals.

Suggested control: Manual removal is feasible, as the populations are currently limited to a few plants. Care should be taken to remove all underground stems, and debris deposited in the resulting hole to minimise the potential for scouring in the next flow event. On dry sites use a Peter lever and Glyphosate 1 in 100 with several applications used between June and October. Glean Ally/Brushoff can also be used 1g in 50 L water plus wetter, using 20 g per ha.

Spot spray when plants are 8 – 12 cm high between April and November. Two months later spray any missed plants. Try to spray before flowering to stop seed set. To avoid problems with frogs and tadpoles in wetland areas use Glyphosate without a surfactant. The herbicide will form a pool at the leaf base and be absorbed into the plant.

Red Natal grass (*Melinis repens*) (Priority 1)

This introduced grass is common along roadsides and railway lines, and is in the early stages of spreading through the Chapman River catchment. It is an effective competitor against native plants, reduces habitat



diversity, increases fire risk and can become a crop weed.

Suggested control: This plant is considered to be relatively easy to control. At 3 to 5 leaf stage, use 1 L / ha of Fusilade, while for mature plants a stronger dose is necessary at 4 L / ha of Fusilade or Targa. The best time to spray is between June and August.

Pie melon (*Citrullus lanatus*) (Priority 3)

This melon is widespread throughout both the Chapman and Greenough Rivers. Some landholders have achieved high levels of success in controlling this plant.

Suggested control: The Kings Park and Botanic Gardens have successfully used 2,4-D amine (500 g/L) at a rate of 20 mL in 10 L of water plus 0.25% wetting agent to control this plant. Spraying while the plant is actively growing is important to maximise the success. Again, discussing management of this weed with landholders who have been successful in eradicating it from their properties is likely to identify the most effective techniques.

6.7 Pest fauna

There are a number of legal requirements associated with owning rural or special rural lands and pest fauna. The owner is responsible for the control of all Declared Animals on their land. Appropriate action must be taken to prevent the build up of rabbit numbers.

Many landholders indicate that it seems pointless to control the animals when there is no active management of the reserves that adjoin their properties. This is a very real and valid concern because there is limited active management of the foreshore reserves. Many landholders are willing to extend their management activities into the reserve, which is the most effective way to link some resources with this land.

The crux of the issue is that most of the reserves are unvested vacant Crown land. It is understood that management is technically the responsibility of the Department of Land Administration where vacant Crown land exists, and there is funding available to support management activities by other bodies.

6.8 Farm plans

Farms, as with any other business, should have a plan. Farm management plans are important to ensure that the land is managed in a way that protects the sustainability of the environmental, financial and social values.

Managing water movement across, through and beneath the surface is one critical component of such plans. Land that is unproductive or difficult to farm, often in the floodplain, could be written off to help restore river function. By restoring vegetation to the floodplain, peak flows can be slowed more consistently and may reduce some of the flood damage. Cropping within the floodplain is a gamble but is very risky. Ultimately, occasionally productive land could be lost and the damage downstream would be considerable. The off-site impacts of rivers are rarely recognised as many landholders have never seen any other properties on the same river.

6.9 Fire

As mentioned above, many tree deaths cannot be attributed to natural attrition. Frequent fires in the floodway result in more branches falling from the River gums, sheoaks and paperbarks, further blocking the river. Usually this blockage occurs downstream from landholders using fire as a management tool, and they do not have an opportunity to see the impact of this work on the river as a continuum.

Fires occur in the riparian zone following paddock fire escapes, deliberate lighting or uncommonly as the result of lightning strikes. There is a strong belief within the local community that clearing the vegetation will make the river flow faster and reduce sedimentation within their immediate area. It is critical to remember that as water flows faster, it has more power and can pick up more sediment. It is also able to spread more widely. As the river collects more sediment, it broadens its river channel and more land is lost. Also, when the water reaches a well-vegetated section, it will bank up upstream and can cause blowouts.

Manual removal of large and fine woody debris is by far the most effective management technique. Often



there are only small numbers of blockages that are causing problems, and often burning does not target the sections that require treatment. Woody debris that is suspended between 1 m and 2.5 m above the main channel is commonly the material that contributes to damage during peak flow events. The material on the ground helps to slow water movement on the margins of the floodway and focus the flow into the main channel, which helps the river to clean itself out. Fires usually result in loss of vegetation and debris to slow the big flows, resulting in blowouts downstream and loss of arable land within the floodway. This allows the river to spread itself out and create what are known as braided sections – or several main channels.

Weeds also impact on the stability of the floodway. Native rushes and sedges tend to be tall cylindrical plants with dense underground stems that help to hold the soil down. These plants also trap leaf litter and other material that provide habitat for native animals. In comparison, plants like the introduced couch (Saltene, standard Couch and others) have limited habitat value but provide cover more than 250 mm deep. During peak flow events, the height and shape of the rushes and sedges enables them to lie down in the stream and allow the water, fully loaded with sand, to pass through. In sections where the dominant plant in the floodway is couch, there is considerable sediment accumulation and the floodway is building up in height.

Comments are often made about vegetation instream causing the water to bank up, which allows it to spread out and drop more sediment. Along a lot of the length of the Chapman River the riverbed is actually incising, digging itself out because there is nothing left to slow the water flow. Instead of digging out and maintaining pools, the riverbed is dropping on long sections.

6.10 Cropping

Farming can be a difficult business from which to make a livelihood. In many situations, gaining as much land as possible for production is a priority. The nature of cropping processes affects on sediment stability, however changing land management practices such as minimal tillage is reducing some of that impact.

Along both the Chapman and Greenough Rivers there are sections where cropping is occurring within 3 m of the low flow channel. This land occurs within the bank full channel and the floodway. Much of the damage to farming land is the direct result of a high rainfall event immediately following furrowing, ploughing or some site preparation. In many instances, luck may be on the side of the landholder and they may gain extra crops, however at other times the river will flow and damage the cropped land.

The bank full channel and floodway are designed to take peak flows for the river, and trying to force the river into one channel is not possible.

Poor riverbank and floodplain stability occurs in all areas where annual grasses and herbs dominate. This is because there are limited deep-rooted plants, little living plant material and insufficient groundcovers to protect the soil from water movement. In the event of summer rain, these plants have often broken down and there is little cover.

Ensuring perennial vegetation cover occurs evenly across and along the rivers is an important part of managing flows. Respecting the natural landform and working beyond the floodway will ultimately protect infrastructure and assets for all landholders along the entire river length. In the long-term, the river may evolve into a braided channel that occupies the entire floodway, and reduce the area of land available for cropping.

General suggestions

- Aim to restore native vegetation to the floodway boundary to protect the bed and banks from erosion, provide improved flood attenuation and control the rate of sediment movement through the river system.
- Consider the risks when cropping within 3 m of the low flow channel, extending beyond each individual property to think about the potential impacts on landholders downstream.
- Obtain information packs from the Water and Rivers Commission and Agriculture WA to learn more about river processes, management and techniques to minimise risk to the land.



6.11 Fence alignment

There are many examples of washed out fences along the length of the rivers. Where property boundaries cross the river it is difficult to manage the fence during the flow events. It may be useful to consider using temporary fences, either electric or ringlock, which are reasonably quick to install and remove in case of a flow event. Monitoring the weather and radio are often sufficient to provide one day's notice of a flow event. Further, the Water and Rivers Commission has developed a flood warning system for the Greenough River to provide information to local ABC radio stations about flow events.

This may seem labour intensive however, as it is unusual for peak flows to occur for any significant duration. In the long-term it is likely to be cheaper and more effective as it will save on the cost of replacing fences annually.

Under the *Rights in Water and Irrigation Act 1914* it is illegal to disrupt the flow of any water body, declared or not. This means that if fencing is used across the river and traps debris, which impacts on water flow, then that contravenes the Act. Common sense needs to apply, however fencing across waterways is not generally recommended.

Fence alignments parallel with the water flow are also often at bank full height, within the floodway and in some situations constructed very close to the low water level. This greatly increases the risk of losing the fence to the river, while possibly only gaining an extra hectare of land. If the fence is at risk of being washed away, so too is the top soil because it means that should the water level reach the areas prepared for cropping, it will have limited resistance to water erosion.

It is important to weigh up the value of locating a fence above peak events and loss of potentially productive land.

Use of trees as strainers can impact on plant health. Further, should a large tree with fences attached be undermined and fall in during a peak flow event, there may be sufficient force in the water to remove long sections of fence during one event. While some landholders try to protect the trees by placing rubber around the wire, when the tree is not mature and is still

actively growing the wire still cuts into the bark. This effectively ringbarks the tree and results in tree death.

As the tree is dying and is stressed it may also drop branches. This contributes to the woody debris load of the river. This woody debris, along with that caused by natural attrition and loss of branches following fire damage, is washed downstream; during peak flows or flood events it crashes into trees along the riverbank. This in turn can knock more branches from living trees, producing more debris. As the amount of debris in the water increases, the impact becomes greater and the river flow can be blocked. This can cause erosion of the riverbanks.

6.12 Stock access

The riparian zone is often used as a summer paddock for stock as it often retains the only shade trees on the property, and may have permanent water and sufficient fodder during the harsh summer months.

Stock camps within the floodway are characterised by denuded unstable sands, loam or clay, large quantities of sheep, cattle or goat droppings and an overall lack of vegetation both instream and on the floodway. The water that will pass through these sections is able to wash away not only the nutrients and bacteria in the livestock droppings, but also the sand and clay that have been loosened by long-term trampling and grazing. This sediment continues to move to the river mouth.

The way in which sediment moves, varies in accordance with the flow characteristics. The Water and Rivers Commission has a publication describing sediment movement in river systems that is easy to read. Many river pools are being filled up, and appear to be unable to self-clean due to the sediment load. To protect summer watering points, it is important to ensure that perennial vegetation cover within the river system is maintained at about 70% cover to minimise the potential for blowouts, erosion and mobilisation of significant quantities of drift sand.

Ultimately, if the processes continue at the current rate, it will become very difficult to water stock in the river. Large amounts of mobile sand are often unstable – with animals sinking in to the substrate and unable to get out, and pools unavailable for drinking water. While pool in-filling is a natural process, the rate is



accelerated by increasing sediment loss from all river sections, not the localised erosion problems experienced in well-vegetated systems.

Anecdotal evidence from many private landholders suggests that water quality has deteriorated in terms of the extent and types of algal blooms within river pools. There is a wide range of algal species in both rivers. Some species are indicative of salinity levels and dominance of freely available nutrients (plants preferring higher nitrogen or phosphorus conditions), and others show changes to water quality in recent times.

The river mouth is a popular holiday location and many people surf and swim in the sheltered waters. While the volume of water may dilute the nutrient levels it may do little to impact on the bacteria. Further, the remains of animals trapped in the loose sediment will be washed downstream. Purely from the point of view of good taste, swimming with decaying animal material is undesirable. Discovering decaying animal material is probably not considered an enjoyable component of any recreational activity.

Because the river is seasonal and does not necessarily conform to a winter flow pattern, it is not realistic to think that any contamination will have broken down significantly prior to any flows. The nature of the river is that any significant rainfall event inland of Talling Peak may result in a flood event. This was seen in both March and May of 1999.

6.13 Grazing

Another key contributor to erosion occurs in sections where there are significant numbers of stock within the river system. Grazing pressure and trampling of the soils is increasing the rate of erosion of some sections of the riverbanks. While low level grazing is an effective weed management tool, long-term stocking with large numbers of animals can result in clearly defined tracks across the floodway and the loss of perennial vegetation across large areas.

Depending on whether the bank is sand or clay, these tracks are compacted or loosened. Both pressures reduce soil cohesion, making them more susceptible to erosion. As these tracks are typically aligned parallel with the riverbanks, the peak flows (which are the flows

that cause the damage) move preferentially along these tracks because there is no vegetation to slow water flow.

This can either result in large sections of the banks collapsing into the river in steep areas, or large plumes of sediments being scoured out of the floodway and deposited either further down the floodway or in the river. This sediment is then washed downstream, giving the river more power to erode other weakened sections of the bank further downstream. And so the process moves on.

As the riverbanks are eroded, large trees can be washed in. While it is natural for some plants to be washed into the river, changes to the river system can result in large numbers of plants falling into the river. More frequent tree deaths occur from ringbarking where trees are used as fenceposts, trampling by stock causing soil loss from around the roots of the trees, use of fire to clear debris and slumping of large areas with trees, all as a result of management practices.

These trees may impact on the river flow depending on the way they fall across the river. As trees fall into the river, they also impact on river health by causing blockages (natural dams). The water is deflected either below or around the dam, causing new erosion in areas lacking vegetation cover.

Loss of perennial vegetation cover is a significant step towards facilitating erosion during any flow event. As both the Chapman and the Greenough rivers respond to substantial rainfall events in any season, summer, autumn, winter and less frequently spring, it is critical that there is vegetation cover along the foreshore all year round. Significant lengths of the foreshores of the Chapman and Greenough Rivers had only annual grass species present or were totally denuded at the time of survey between April and October.

River paddocks are important components of many farms. The presence of foreshore reserves, however, puts the onus on private landholders to ensure that management of the foreshore is consistent with the objectives of the reserve. Stock exclusion is occasionally necessary where stock management practices are inconsistent with the protection of the riverbed, banks and floodplain.

Treating the river foreshore as a sensitive river paddock and monitoring stock impacts are essential components



towards protecting the river's form and function. Some inappropriate stock management practices observed during the foreshore assessment survey include:

- overgrazing,
- allowing stock to die in the river and making no effort to save them,
- not providing shade or shelter for stock elsewhere on the property,
- not monitoring stock for long periods,
- retaining only instream watering points, and
- poor animal husbandry.

These do have a significant impact on foreshore health and reflect poor farm management practices. The farming industry is going through difficult times, and losing sight of managing assets in the best possible manner does not help. The vast majority of landholders in the study area want to protect their future in farming. These people are adapting to changing conditions and are taking an interest in the environment as a whole. Others have an interest, but have been slower to adapt to the dynamic nature of the physical, biological, social

and economic environments, and their inability to adapt is reflected in an increasing rate of degradation of the foreshore.

General suggestions

- Develop river paddocks and manage them as 'sensitive areas' when determining stock rotation.
- Design river paddocks to minimise the chance of stock walking parallel with the riverbanks.
- Monitor the impact of stock on the vegetation and aim to restore or maintain at least 70% perennial vegetation cover at all times of the year.
- Ensure that farm management plans include grazing schedules, recognise surface and groundwater issues and the need to manage these within statutory requirements, and aim to reinvest in improving the land when times are good.
- Develop guidelines for landholders with your local LCDC and the support of Agriculture WA, Water and Rivers Commission and Department of Conservation and Land Management and the local government authority.



7. General recommendations

A number of general recommendations apply to all of the sites. They are listed under the core activities, which will be required for groups to successfully develop and implement rehabilitation strategies.

7.1 Planning

- Determine cadastral boundaries and landowner/manager and ensure that the landholders support the foreshore assessment process, and are involved in the development and implementation of any remedial strategies.
- Collate as much existing information about the focus waterway and catchment as possible.
- Focus initial foreshore assessment survey work in areas where future rehabilitation projects may be undertaken.
- Extend future foreshore assessment work from previously surveyed areas along the foreshore, eventually mapping all sites. Future surveys may also include re-assessment of earlier surveys to assess changes to the environment.
- Create herbariums of native and weed species to teach group members and other interested parties to distinguish between native and introduced plants present in the riparian zone. This could include seedlings.
- Ensure that all works are planned well in advance and that a long-term strategy has been developed and is amended as new information becomes available.
- Ensure that all agencies with statutory responsibilities such as the relevant local government authority, Water Corporation, Water and Rivers Commission and Department of Conservation and Land Management are advised of any works within their management areas, to ensure that the works meet legislative requirements.
- Develop information brochures to increase community awareness of the importance of foreshore areas and to encourage community involvement in managing their own foreshores and surrounding reserves.

- Develop an information brochure for the landholder to suggest methods of improved land management and encourage rehabilitation of the foreshore area.
- Endeavour to obtain funds from outside sources to assist both the group and any private landholders who are willing to implement rehabilitation activities.

7.2 Site preparation

7.2.1 Weed control

- Ensure weed control activities are undertaken in manageable-sized nodes, reinforcing overstorey species and restoring the middlestorey and understorey species once weeds have been eradicated.
- Tag any native plants present to protect them from weed control activities.
- Use a qualified herbicide operator if chemical control is undertaken near waterways.
- Always consider the impacts that weed control will have on habitat, particularly for reptiles and small mammals such as bandicoots. Maintain vegetated corridors within which animals can move until sufficient native plants have re-established.
- Ensure that all weeds are removed from the site to limit re-infestation.
- Create buffers around existing clumps of native vegetation to encourage natural regeneration of existing plants, e.g. spray Fusilade around native rushes to control introduced grasses and enable the clumps of rushes to spread naturally.
- Ensure the impact on bank stability is considered before weed control works are undertaken. Consider potential for use of erosion control matting as an option to reduce weed re-emergence, support plants installed and improve bank stability on steeper gradient banks.

7.2.2 General site preparation

- Encourage landholders throughout the rural and semi-rural catchments to fence off or delineate



waterways and tributaries and implement a broadscale revegetation program.

- Provide financial support or material assistance to landholders willing to implement rehabilitation activities.
- Define access tracks to weed management areas or where there are planting programs, to minimise disturbance and limit damage to existing vegetation and soil.
- Implement intensive weed control activities in manageable-sized nodes where planting will be undertaken.
- Slash flower heads prior to seed ripening to limit reinforcement of the weed seed bank.
- In broadscale areas proposed for future works or in high-risk areas of dense weeds with few native plants where complete removal is inappropriate, ensure either flower removal or repeated slashing occurs prior to seeding.

7.3 Planting out

- Ensure planted areas within streamlines are artificially stabilised and planted in low-flow conditions to enable sufficient time for establishment, to reduce the chance of plants being washed out during peak flows.
- Plant native species only in areas where weeds have been effectively controlled and managed for a preferred minimum of two seasons.
- Encourage landholders to ensure all strata of vegetation, including understorey, middlestorey and overstorey species, are over time included in revegetation works to reinforce bank stability.
- Plant overstorey species initially in highly exposed regions lacking vegetation, to create a level of cover and protection for future plantings.
- Plant emergent and wetland plants in permanent water between September and March, securing those planted in flowing water with 600 mm steel U-shaped pegs.

- Plant in dryland areas in May to July and in seasonally inundated areas in August to September.
- Plant in higher densities than ultimately required to create instant habitat and improve weed exclusion, particularly in the inner urban environments.
- Obtain professional advice about planting densities for each recommended species, to optimise chances of success and re-create a more natural ecosystem.

7.4 Maintenance

- Ensure the works program includes ongoing intensive maintenance of areas where weed control and planting works have previously been undertaken.
- Implement ongoing weed management, before site preparation and planting works in new areas.
- Monitor for any natural regeneration on a regular basis, and undertake weed control around any emerging native plant seedlings.
- Assess the effectiveness of any river restoration works or installation of any products such as hemp matting, and modify as required.

7.5 Monitoring

- Continue to use the proforma to assess changes and improvement to foreshore health over time.
- Assess the effectiveness and relative benefits of different management techniques utilised and update the works program accordingly.
- Document the results and learn from experience.
- Monitor the effectiveness of sustaining interest within the project at both the management and implementation level. Develop techniques to support community groups and individuals in undertaking this work.
- Minimise the potential for burnout by not over-extending limited resources, particularly labour.



7.6 General management suggestions for each foreshore rating

A – Near pristine (Very good)	River sections achieving this rating require minimal maintenance effort including: • Removal or realignment of large and suspended woody debris where it is causing localised erosion. • Eradication of isolated occurrences of weeds. • Maintenance of fencing to exclude livestock and feral animals. • Establishment and maintenance of fire access tracks.
B – Moderate	Management effort required is greater than in A grade foreshore sections and generally relates to: • Eradication of minor weed infestations and ongoing maintenance control of more widespread weeds. The weed control effort should be focussed on establishing buffers around native plants to encourage regeneration. • Monitoring and realignment of woody debris to ensure that natural dams that are exacerbating erosion are realigned to improve flow. Any debris that is not resulting in erosion needs to be left as habitat. • Close stock management is necessary to achieve effective weed control without reducing the values of the persisting native vegetation or the creation of clearly defined tracks.
C – Poor	Management activities are becoming more difficult as the degradation has stepped up an order of magnitude. Potential management activities include: • Using woody debris to direct peak flows back to the main river channel and working to slow flows across the floodway • Revegetating using a combination of direct seeding and tubestock planting on the floodway margins. Planting close to the main channel is unlikely to be successful due to the volumes of mobile sediment and instability of the channel. • Controlling stock access until there is sufficient groundcover to improve bank and floodway stability.
D – Very poor	It is very costly to restore river systems once they degrade to this level. Priorities include: • Re-establishing nodes of vegetation using fast growing species initially then infilling with slower growing plants. All plants need to be protected from peak flow events. • Developing and implementing strategies to slow water flow – possibly using instream large woody debris or riffles/causeways. • Undertaking localised weed control around revegetation works only. • Excluding stock until there is sufficient vegetation cover to protect the channel banks and floodway.



8. Working with government

8.1 Liaison with government agencies

A number of recommendations cited throughout this report require substantial technical assistance or additional funds to implement. Consequently, it may be beyond the scope of many community groups to undertake these projects due to a lack of available resources. Further, in many instances approval from the appropriate authority is required before any works can progress. Liaison with government agencies at the local and State level is an important step in determining if these remedial strategies can be implemented. Therefore, even though these recommendations can often not be addressed immediately, they can become a focus for future works when funds and assistance become available.

8.1.1 Water and Rivers Commission

The Water and Rivers Commission plays an integral role in the management and protection of our waterways. Many of the recommendations suggest that community groups liaise with these agencies to determine opportunities to investigate the following:

- Monitor stream health at a catchment level to assess erosion events, sediment loads, peak flow rates and pollution levels.
- Determine opportunities to retain water upslope when flow rates are high by increasing groundwater use through planting trees or to investigate the feasibility of diverting water flow into holding ponds.
- Assess the potential to minimise the amount of saline water entering waterways by installing upslope interception banks.
- Determine the legality of all off-take pipes, pumps and water containment structures (ponds and dams) located along waterways to investigate the level of water extraction.
- Assess the impact of dams and ponds on stream flow and sedimentation ensuring that these structures meet with stipulated conditions of construction and design and do not impact on stream hydrology or foreshore stability.

8.1.2 Local government authority

Community groups need to establish close links with the local government authorities when aiming to undertake any rehabilitation works on foreshore areas as approval and support is required. It is important to understand the current policies and requirements of these authorities and to undertake works within a framework that complements their own aims for the management of these riparian areas.

Work with the local government authorities to:

- Review current structures that may be exacerbating erosion and address these problems using appropriate water sensitive urban design principles.
- Determine the possibility of constructing where required, crossover points, drainage outfalls, rock spillways and riffle zones that promote the stabilisation of foreshore areas.
- Assess the provision of recreational facilities such as bins to limit rubbish entering the waterway.
- Provide guideways using bollards and woodchip pathways to minimise the trampling of vegetation particularly near revegetation works or valuable remnant vegetation.
- Promote careful management of recreational parks ensuring mowing and other maintenance work does not threaten native plants.
- Encourage the use of appropriate native species in any planting works associated with foreshore areas.
- Assess and limit access to areas if required.
- Implement signage to inform the local community and promote care of the foreshore environment.
- Ensure that any prescribed burns are undertaken in a mosaic pattern to provide sufficient cover and habitat for fauna while the vegetation is regenerating.

8.1.3 Department of Environmental Protection

The primary responsibility of the Department of Environmental Protection is to monitor and protect the



environment. This department will provide information to the community about numerous issues such as stating appropriate guidelines for development proposals, environmental protection and management rules and policy directions, and undertaking assessment of reports of pollution or environmental damage.

Contact the Department of Environmental Protection to assess:

- Potential source points of nutrient or chemical pollutants entering the waterway from surrounding residential, business (such as petrol stations) or rural developments.

8.1.4 Ministry for Planning

The Ministry for Planning is the government agency responsible for landuse planning and therefore the community should liaise with this department (and the Department of Environmental Protection) to ensure:

- Any future subdivisions and residential developments close to foreshore areas have suitable management systems and infrastructure in place, to prevent degradation of the foreshore and stream environments.
- The use of water sensitive urban design principles, to aid in decreasing potential water and sediment loads to waterways when developing drainage infrastructure close to waterways.

8.1.5 Main Roads WA

Main Roads Western Australia manages the road and transport network and associated road reserves. Encourage the Main Roads WA to:

- Install gross pollutant or sand/silt traps on stormwater system outfalls into waterways to collect rubbish and sediment,
- Maintain weed management in road reserves adjacent to riparian areas.

8.1.6 Department of Conservation and Land Management

The Department of Conservation and Land Management is the State government agency that manages our national parks and reserves. Foreshore

areas on reserve land are protected by legislation and managed by the department and therefore approval is required if community groups wish to undertake any works in these areas. CALM also provides a wide range of information and support to community groups. Contact the department to find out information about:

- Western Shield Program to control feral animals;
- Declared and protect fauna and flora;
- Joining the land for Wildlife Scheme; and
- Detection and management of plant diseases.

8.1.7 Agriculture Western Australia (AgWA)

Agriculture Western Australia has a great deal of information that is available to the community including pamphlets and publications on a range of landcare subjects. They also provide a number of services. Liaise with AgWA to:

- Gain advice on the identification and control of pest insects.
- Assess salinity levels in salt affected areas and investigate mechanisms to contain saline runoff upslope away from waterways to protect vegetation from the hypersaline waters.
- Determine if it is appropriate to establish perennial pastures associated with foreshore areas to provide an alternative to landholders that currently allow stock to freely graze these areas. Ensure that the management of such a cropping system prevents the plants from seeding, and that plant fragments are trapped to prevent these species from invading the riparian foreshore.

8.1.8 Fire & Emergency Services Authority of WA

It is essential that community groups ensure that appropriate fire management plans are developed for foreshore areas as these sites are often in close proximity to high-density residential areas and may pose a threat to public safety. Community groups should liaise with the Fire & Emergency Services Authority of WA to ensure a comprehensive plan is maintained. It is important that all associated agencies such as the Department of Conservation and Land Management, the local volunteer fire brigade and the



State Emergency Service are informed of any changes to access to sites. It is also important to ensure that firebreaks are maintained.

8.2 Further Information

The world wide web can provide a wealth of information and useful contacts, following are some URL addresses that may be of use:

The Government of Western Australia:

<http://www.wa.gov.au/>

Water and Rivers Commission:

<http://www.wrc.wa.gov.au/>

Water Corporation:

<http://www.watercorporation.com.au/>

Department of Environmental Protection:

<http://www.environ.wa.gov.au/>

Main Roads WA:

<http://website.mrwa.wa.gov.au/>

Ministry for Planning:

<http://www.planning.wa.gov.au/index.html>

Department of Conservation and Land Management:

<http://www.calm.wa.gov.au/>

Agriculture Western Australia:

<http://www.agric.wa.gov.au/agency/index.htm>

Fire and Emergency Services Western Australia:

<http://www.fire.wa.gov.au/>

WA online:

<http://www.onlinewa.com.au/enhanced/>



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