CALM
SOIL CONSERVATION SERVICE

Wantiool Land and Water Management Plan

Prepared for the Wantiool Landcare Group, Junee NSW

Acknowledgments

Land and Water Management Plan and Report:

K A Emery

Department of Conservation and Land Management

23 - 33 Bridge Street, Sydney

Descriptions and recommendations for Native Vegetation Re-establishment:

P L Smith

Department of Conservation and Land Management

23 - 33 Bridge Street, Sydney

The preparation of the Wantiool Land and Water Management Plan was funded by Salt Action (a joint NSW Government program involving NSW Agriculture, EPA, CaLM and DWR) and the NSW Department of Conservation and Land Management (CaLM).

ISBN 0 7310 3207 1

Incorporates: the Soil Conservation Service, the Crown Lands Service, Forestry Policy Unit, Land Information Centre, Land Titles Office, Valuer-General's Office.

Contents

Summary

In a co-operative project with the NSW Department of Conservation and Land Management (CaLM), the members of the Wantiool Landcare Group at Junee have developed a catchment management plan to treat the land degradation problems within their area.

The management plan has three separate components to it:

1. the physical plan, detailing the management requirements to treat dryland salinity, tree decline, water quality issues in Wantiool Creek and eroded areas;
2. a report, describing in more detail, the land management recommendations;
3. a strategy plan to implement the land management recommendations.

The recommendations are very comprehensive and appear to be overwhelming. It is not the intention of the catchment plan that these changes are to be implemented immediately. Rather, they set the framework for landholders to plan a course of action, often in conjunction with their neighbours, to treat common problems, or problems aggravated by changes in one part of the catchment but having effects elsewhere in the catchment. Government departments such as CaLM, Department of Water Resources and NSW Agriculture are available to assist in the planning of such work.

The recommendations will enable the Wantiool Landcare Group to target and make a case for financial assistance to carry out some of the works that have a significant community benefit.

Major land degradation problems

In the Wantiool Area, the major land degradation problems are:

- salt outbreaks and rising salty groundwaters
- soil erosion on cropping lands and bare pastures
- soil acidity
- tree decline
- water quality aspects of Wantiool Creek.

Land management recommendations

Whereas the report makes five sets of recommendations in relation to the treatments of land degradation problems or specific land use features, in reality, many of them are interrelated. Treatments for one form of land degradation can have a beneficial effect in treating other forms of land degradation.

Landholders should not act in isolation to some of the major problems occurring in the Landcare Area. Joint action is needed to treat these problems because individual actions will be only partly successful.

Landholders are recommended to prepare plans of their properties, in a group approach with their neighbours, using CaLM's Property Planning criteria.

This will ensure that all the issues of land degradation on an individual property are considered together. As a result the proposed treatments can be planned in such a way that they will be effective in treating more than one form of land degradation.

As part of the property planning process there is a need for landholders to work together in groups so that some of the major problems such as waterlogging and dryland salinity, stream pollution and tree decline can be treated on a sub-catchment basis. For example, tree planting programs can be easily integrated between neighbours to take advantage of the existing stands of trees, the Crown Road reserves, funding grants and the costs of avoiding unnecessary duplication in fencing and site preparation.

An integrated approach to land management using property plans as the basic planning documents is essential to the long term successful treatment of land degradation in the Wantiool Landcare Area.

Several maps were prepared for public display. The Land Management Map has been scanned and is named LM_Wantiool_Management.pdf"

Introduction

Dryland salinity and the rising levels of groundwater in the Wantiool Landcare Area are of increasing concern to all landholders, particularly those owning land on the lower sloping country. Although the salt outbreaks are at an early stage of development and still covered by vegetation and the areas of land lost to all production are relatively small at the moment, the rapid rises in the levels of salty groundwaters indicate that the problems will increase extensively over the next few years.

The Wantiool Landcare Group joined with the Department of Conservation and Land Management (CaLM) to undertake a project to:

i. Assess the extent of land degradation in the Landcare area.
   The problems identified included sheet, rill and gully erosion, dryland salinity and water logging, soil acidity, and tree decline;
ii. To report upon the conditon of the land;
iii. To develop the appropriate land management programs to treat these problems on an integrated and group approach.

1. Natural resource inventory

To prepare the management plan it was necessary to compile an inventory of the natural resources of the area. Data collected for the inventory included:

- slope
- terrain type
- existing land use
- tree distribution, tree density and tree regeneration
- the present of rock outcrop
- land degradation: sheet, rill and gully erosion, dryland salinity, streambank erosion, soil acidity.

The Landcare members mapped a series of features for their properties onto photocopies of the Junee 1:50 000 topographic sheet. This information showed the following features:

- cropping areas, and areas of native, improved and annual pastures;
- wet areas and sites that have become salty;
- sites with rock outcrop;
- different soil types;
- remaining stands of trees;
- property boundaries and ownership titles.

All this information has been used to form an extensive data base for the Landcare area to enable the Landcare Group to create its own catchment plan. Other information that has been mapped by officers of CaLM include slope categories, terrain types, soil erosion features and areas of Crown land.

The majority of the data was obtained by examining three dimensional images of aerial photographs using a stereoscope. Each feature was described according to set classes and mapped onto a 1:25,000 Landsat image. Field checking was undertaken to verify the mapping and to record any changes in land use and tree cover that may have occurred between the time of aerial photography and the date of field checking. Information prepared by Landcare members was used to verify some of the patterns in the aerial photographs.

Other data were obtained from existing published material. Soil acidity information was obtained from soil test records held by landholders or included within property plans prepared by Mr J Salmon of CaLM at Temora. Water salinity readings were also taken from property planning information available for "Ballengoarrah", "Glen Cairn" and "Kameruka". Soils information was interpreted by correlating field observations, previous reports and profile descriptions within CaLM's Soil Data System to geology, slope and terrain units.

2. Storage of information

All maps prepared for the study have been stored on CaLM's computer-based geographic information system (GIS). The property ownership information provided by members of the Wantiool Landcare Group has also been stored in the system. The data are stored in digital or disk format and can be reproduced at any scale.

The scale of the final maps is 1:25,000. The accuracies of these maps are only guaranteed for scales of 1:25,000 or smaller.

3. The Landsat image as a base map

A 1:25 000 Landsat image was used for the base map owing to the absence of a suitable scale topographic map. The scale of the Junee topographic map is 1:50,000, which is considered to be too small to provide the detail required.

The satellite scene used is dated 15 May, 1991. Bands 2,4, and 7 were used to provide the final base map. Whilst the aerial photographs were used mainly to provide the natural resource information, the satellite image was used to identify recent land use changes, such as newly established tree lots and current cropping patterns.

A separate image, compiled from bands 2,4 and 6 was used to identify sites affected by waterlogging and/or dryland salinity. Because the scene was taken at the end of a relatively dry season, the higher levels of near infrared reflectivity are associated with green pastures along watercourses and around house paddocks. In this image they appear as a green-yellow colour. When topographic features of the landscape are included as part of the interpretation to eliminate areas of green growth around house paddocks and under trees, there remains a very good correlation between the green-yellow colour in the image and lands affected by waterlogging and early stages of dryland salinity.

The image was also used to make some decisions in relation to land management in the area. Landholders identified groups of mature trees from the images and used some of these areas to target areas of natural regeneration.

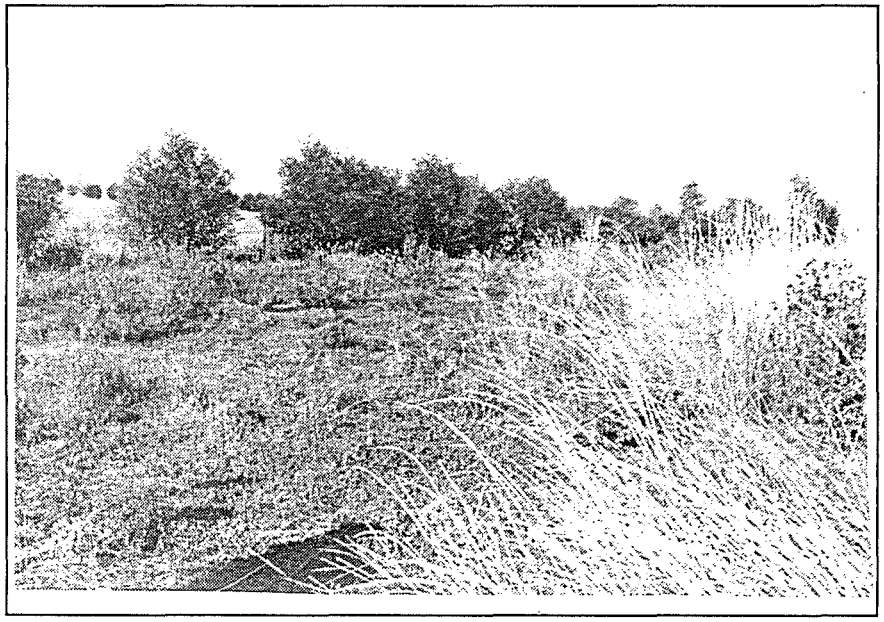
4. Land management recommendations

These recommendations have been developed in a series of workshops by the members of the Landcare Group and officers of CaLM from an assessment of the land capability, soil erosion, soil acidity, and tree cover data. They detail the land management practices needing to be carried out to:

i. deal with the problems of salting, soil erosion, water quality of Wantiool Creek and tree decline
ii. improve the productivity of agricultural lands and reduce the rate of soil acidity
iii. improve the overall appearance of the landscape.

Because of the large number of recommendations made, it is envisaged that this is a long-term plan, the implementation of which may extend well into the next century. Continual revision of the plan is required to make it a living document that will serve the needs of the Wantiool Group.

It is suggested that the Wantiool Landcare Group formally reviews the plan and its recommendations and strategies every two years to ensure that the proposals meet the objectives of the group.



A salt reclamation project on "Wirega" using Tall Wheat Grass, Strawberry clover and trees established from tubestock.

3. The Landsat image as a base map

A 1:25 000 Landsat image was used for the base map owing to the absence of a suitable scale topographic map. The scale of the Junee topographic map is 1:50,000, which is considered to be too small to provide the detail required.

The satellite scene used is dated 15 May, 1991. Bands 2,4, and 7 were used to provide the final base map. Whilst the aerial photographs were used mainly to provide the natural resource information, the satellite image was used to identify recent land use changes, such as newly established tree lots and current cropping patterns.

A separate image, compiled from bands 2,4 and 6 was used to identify sites affected by waterlogging and/or dryland salinity. Because the scene was taken at the end of a relatively dry season, the higher levels of near infrared reflectivity are associated with green pastures along watercourses and around house paddocks. In this image they appear as a green-yellow colour. When topographic features of the landscape are included as part of the interpretation to eliminate areas of green growth around house paddocks and under trees, there remains a very good correlation between the green-yellow colour in the image and lands affected by waterlogging and early stages of dryland salinity.

The image was also used to make some decisions in relation to land management in the area. Landholders identified groups of mature trees from the images and used some of these areas to target areas of natural regeneration.

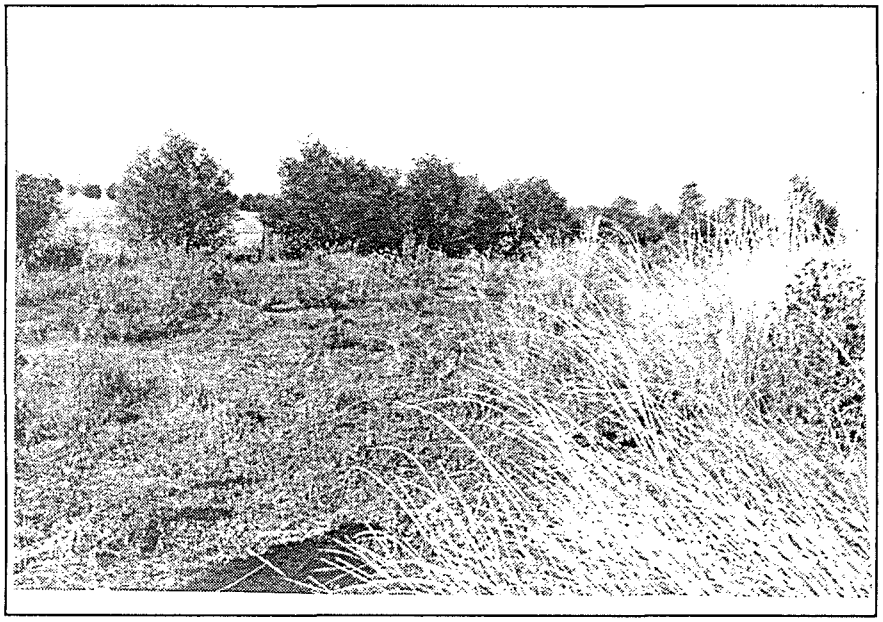
4. Land management recommendations

These recommendations have been developed in a series of workshops by the members of the Landcare Group and officers of CaLM from an assessment of the land capability, soil erosion, soil acidity, and tree cover data. They detail the land management practices needing to be carried out to:

i. deal with the problems of salting, soil erosion, water quality of Wantiool Creek and tree decline
ii. improve the productivity of agricultural lands and reduce the rate of soil acidity
iii. improve the overall appearance of the landscape.

Because of the large number of recommendations made, it is envisaged that this is a long-term plan, the implementation of which may extend well into the next century. Continual revision of the plan is required to make it a living document that will serve the needs of the Wantiool Group.

It is suggested that the Wantiool Landcare Group formally reviews the plan and its recommendations and strategies every two years to ensure that the proposals meet the objectives of the group.



A salt reclamation project on "Wirega" using Tall Wheat Grass, Strawberry clover and trees established from tubestock.

When wet, the subsoil expands, filling the vertical cracks that can be seen when the soil is dry. As a result, the soils are impermeable, which explains why water ponds on these soils for a long time after rain.

Vegetation: The main vegetation community in the Wantiool Landcare area is the White Box community *(Eucalyptus albens)*. Other common tree species in this community are Yellow Box *(E. melliodora)*, Grey Box *(E. microcarpa)* Red Gum *(E. blakelyi)* and Apple Box *(E. bridgesiana)*. Evidence suggests that the dominant grasses were once *Themeda triandra* (Kangaroo Grass) along with *Poa australis* (Tussock Grass) and *Stipa aristiglumis* (Plains Grass).

However, under grazing the main species are *Stipa falcata* (Spear Grass) and *Danthonia spp.* with *Bothriochloa decipiens* (Pitted Blue Grass) becoming very common particularly on overgrazed country.

Most of the area has been cleared for grazing and cropping.

Table 1 - Summary of catchment information		
		Area (ha)
Area of Landcare Group		14,604
Slope classes:	0 < 10%	13,049
	10 to 33%	1,548
	> 33%	7
Terrain units:	Drainage depression	823
	Floodplain	180
	Footslope	2,628
	Stream channel	265
Land uses:	cultivated land	3057
	grazing land	11438
	road reserve	311
Principal soil types:	Red earth	
	Red podzolic	
	Yellow solonetzic	
	Yellow podzolic	
Original vegetation type:	White Box (Eucalyptus albens) community	

Climatic data

Rainfall: Rainfall is generally winter dominant. The average annual rainfall is 536 mm, with August and October having the highest average falls of 49 mm and 53 mm respectively. Generally the winter and early spring months have the most reliable rainfall.

Temperatures: Similar to Wagga and would follow the same pattern. July is the coldest month and January/February the warmest.

Growing seasons: Because the climate is winter rainfall dominant and there is not enough effective summer rainfall for summer growing crops, the area is best suited for cropping of winter cereals, grain legumes and oilseeds, and production of cool season annual and perennial pastures.

Table 2 - Summary of climatic features	
Average annual rainfall	536 m
Wettest months	August and October
Coldest month	July
Warmest months	January and February

Land degradation

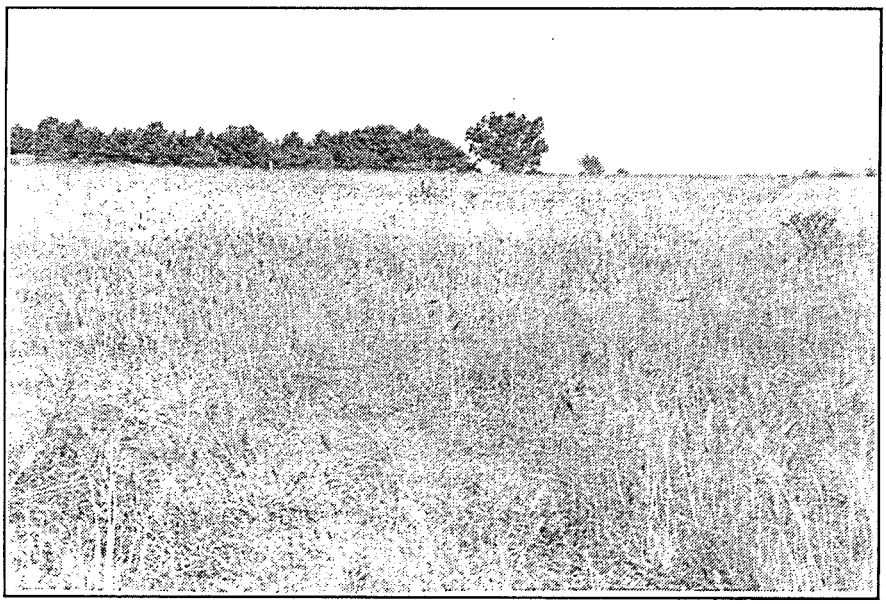
The major land degradation problems in the Wantiool Landcare Area are:

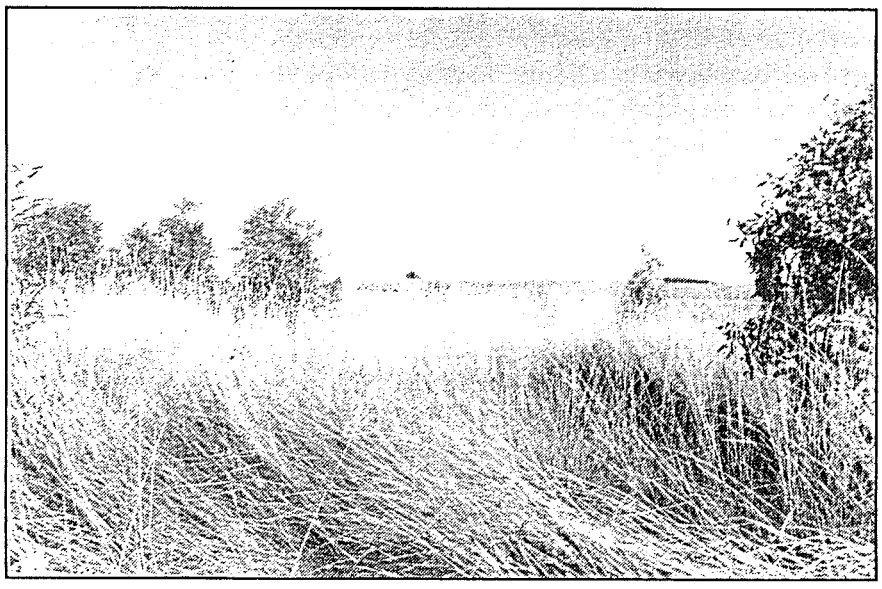
1. Salt outbreaks and rising salty groundwater;
2. Soil erosion on cropping lands and bare pastures;
3. Soil acidity;
4. Tree decline;
5. Water quality aspects of Wantiool Creek.

Each of these features is described in more detail in the land management sections of this report. A summary of the relevant statistical information is given in table 3 on the next page.

Table 3 - Summary of land degradation information		
Sheet and rill erosion:	Area (ha)	% of total area
minor	2,110	14.5
moderate	1,028	7
severe	93	0.6
Salt outbreaks:		
early stages of development	324	2.2
minor to moderate salt scalds	99	0.7
severe salt scalds	5	<0.1
Tree decline:		
area with undisturbed canopy and shrub layer	41	0.3
area with dense canopies but little understorey	259	1.5
area with canopy over>10%	600	4.1

Salt levels in surface water	
minimum level	0.4 dS/m
maximum level	8 dS/m
Soil acidity: soil pH levels (in calcium chloride solution)	**4.0 - 5.2**
Gully erosion:	Lengths (m)
minor gully erosion	945
moderate gully erosion	5,593
severe gully erosion	443
severe gully erosion with salt in floor	761
Total	7,742
Length of fencing required to treat salt outbreaks	
on footslopes and drainage depressions	106,712
in drainage lines	44,043
Total	150,755





Pastures being used to control salinity (top) Consol lovegrass and Tall Wheat Grass (at right).

Land degradation issues and management recommendations

1. Salt outbreaks and rising groundwaters

Description

These are waterlogged areas where salt has accumulated in the soil surface, or waterlogged areas which are likely to become salty.

Three stages of salt outbreaks have been recognised in this survey. They range from sites which are almost comepletely bare of vegetation to those which are at an early stage of salting. These developing scalds are characterised by the loss of clovers and the dominance of salt tolerant grassess such as barley grass, couch and annual beard grass.

Some of the tables used in this section of the report have been taken from the publication *"Dryland Salinity, Introductory Extension Notes"* by Scott Taylor and published by the Department of Conservation and Land Management in 1991.

Extent of problem

In a total catchment situation, the current problems of dryland salinity are serious, occupying 2.93% of the total Landcare area. However, because the salt outbreaks are in the early stages of development, and the areas affected are expanding rapidly, the problems will get worse.

Of a total area of 428 ha identified as having a salt problem, 5 ha are affected by severe salt scalds, 99 ha by minor to moderate scalds, with the remaining 324 ha in the early stages of development as salt scalds. Salt outbreaks occur in drainage depressions and on footslopes (340 ha) or as salt affected areas within the major creek lines (88 ha). In the drainage lines, an indicator species for a salt problem is cumbungi. Although cumbungi also grows in fresh water, it will however, tolerate higher levels of salt than other wetland species.

The main salt outbreaks are within Wantiool Creek and the properties that drain into it from the north and west. Smaller patches of salt occur on the properties on the eastern side of Wantiool Creek and in the catchment of Jeralgambeth Creek which drains from "Ballengoarrah" through "Lynton" and "Hazeldene". Rock Creek which drains through Junee also has severe salt problems with increasing outbreaks in the town areas of Junee.

Units for measuring salt levels in water are decisiemens per metre (dS/m). To convert dS/m to parts per million (ppm) or milligrams per litre (mg/L) multiply dS/m by 640.

Salt levels in the soil or runoff water are unknown except for information collected as part of the property plans prepared by Mr J Salmon of CaLM for "Kameruka", "Glen Cairn" and "Ballengoarrah". Salt conductivity levels in the water on "Kameruka" ranged from 1.6 to 7.2 dS/m mainly clustering in the 1.5-2.9 dS/m range. For "Glen Cairn" the range is 1.1 to 6.6 dS/m clustering around 2.5-3.5 dS/m. At "Ballengoarrah", the range is 0.4 to 8 dS/m, with no apparent clustering of values.

The significance of these salt readings is defined by The Australian Water Resources Council as:

< 0.8	dS/m	not saline
0.8-1.6	dS/m	marginal
1.6-4.8	dS/m	brackish
>4.8	dS/m	saline.

Another important aspect is that salt level measurements are often taken in running water. In the soil, the salt concentrations are often higher.

Maximum levels of water salinity for livestock before production declines are:

Source/use	Reading (dS/m)
Sheep	15.7
Beef Cattle	11.4
Horses	7.8
Pigs	4.1
Poultry	4.1

Water salinity levels for various uses are:

Source/use	Reading (dS/m)
Distilled water	0
Desirable limit for humans	0.83
Lucerne yield reduced by 10%	2.2
Absolute limit for humans	2.5
Limit for mixing herbicide sprays	4.69
Limit for poultry	5.8
Limit for pigs	6.6
Limit for horses	11.6
Limit for beef cattle	16.6
Limit for adult sheep on dry feed	23.0
Sea Water	50.0
Dead Sea	550.0

Stock on green pastures are more tolerant of higher levels of salt than those on dry feed. Plants with a high salt content reduce the tolerance of livestock to salty drinking water.

Within the Landcare area, the main concern is the likelihood of the problem getting worse. The lands that will be affected next by salting are those already identified on the catchment plan as having a seasonal or permanent problem with waterlogging. They are the lowest sites in the landscape and as a consequence are the first to be affected by rises in groundwater.

There is a total of 556 ha of waterlogged land, which is 3.81% of the Landcare Group area. Combined with the areas of existing salt, 6.74% of the Landcare area has serious problems with excess water. Thus 1 ha in 15 ha has, or is under threat from, salt.

In the longer term the threat is even wider. Some 72 ha of low level salinity occur on footslope areas, which are slightly above the drainage depressions in the landscape. With a total area of 609 ha of footslope country with slopes less than 2% gradient, the potential problem expands by another 4.2% to 1 ha in 9 ha.

There is no information on groundwater pressures, levels, qualities and processes for the Landcare area and this is a major barrier to developing a more comprehensive series of land management recommendations. It is essential that the Department of Water Resources be contacted and asked if they could provide such information. Alternative sources of help could be the universities.

Recommendations

- Contact the Department of Water Resources or other organisations such as Charles Sturt University or the University of New South Wales and find out what assistance they can give in providing information on groundwater pressures, levels, qualities and processes for the Landcare area. Depending on the quality of the lower groundwaters, pumping may be an option to lower groundwater pressures and levels.
- Fence off all outbreaks. Stock are to be strictly managed to ensure that ground cover is not depleted. Unfenced outbreaks attract grazing stock, which camp on the sites and lick the surface for the salt. Wet areas are puddled, destroying the surface structure and making the whole site unsuitable for plant growth.
- Fence at least 50 m away from the current edge of the salt patch. This will accommodate any immediate expansion in salting and will enable a greater range of treatments around the affected sites.
- Channels are not to be used to drain salty water from the site if the salt concentration of the water exceeds 2.5 dS/m.
- Install a series of piezometers to monitor changes in water pressure levels with changes in cropping and pasture management practices.
- Surface run-on water from the slopes above the discharge area should be diverted away to a safe disposal site.
- Sow bare areas with salt tolerant grasses such as tall wheat grass or puccinellia. In outbreaks where salt concentrations are lower, strawberry clover can be used.
- Salt tolerant trees can be planted, using soil mounding techniques within or above the salt outbreaks, to help use some of the surplus water and to improve the appearance around the outbreak.

From the land management classes, statistics were obtained from the GIS to give the total perimeter of salt management sites. The perimeter figures can then be used to estimate the lengths of fencing required to manage the salt areas. Fencing of the salt outbreaks which occur in the drainage depressions and on the footslopes will require 106 700 metres of fencing. To fence out the salt affected areas within drainage lines will require an additional 44 000 metres of fencing.

Strategies of the Landcare Group for implementation of recommendations

- All members attending the workshop on 31 August, 1993 agreed that they will not clear any remaining blocks of native trees or native shrubs.
- Employ a consultant by February, 1994 to assess the groundwater condition of the Wantiool Catchment.

- Commence mid October 1993 and complete by February, 1994 a literature review of relevant pasture and crop management practices and relevant tree species for the Wantiool Catchment.
- Property plans to be completed for all properties within the Landcare Group by December, 1995.
- Fence out all salt scalds: with external financial assistance, complete by December, 1996: without financial assistance, complete by December 2000.
- By 1995 prepare a five year project for the management of native vegetation in the Landcare area. Features to be looked at include:
  - management of existing stands of native vegetation
  - re-establish blocks and corridors of native trees in the Wantiool Catchment by natural regeneration or by replanting,
  - seek external support for components of the project by incorporating habitat and wildlife values.

2. Soil acidity

The tables used in this text, and some of the interpretations, are taken from the publication *"What Do All the Numbers Mean?"* edited by P.A. Hazelton and B.W. Murphy and published by the Department of Conservation and Land Management in 1992. Other interpretations have been provided by D. Dight of CaLM's Gunnedah Research Centre.

Description

Soils are considered to have an acid problem when the pH of the top soil layers fall below 5.0 (when tested in calcium chloride solution). Some soils, however, have pH's less than 5.0 in the natural state. Whilst these soils are acid, it is not considered to be a land degradation problem, and there are no practical methods for treating these soils.

Soil pH is tested in either distilled water or calcium chloride solution and the results are different depending upon the method used. As a general rule, soil pH in water is between 0.5 to 1.0 unit higher than the measurements in calcium chloride. This conversion is a general guide only and is dependent on the types of soil in the upper and lower horizons.

Acidity ranges (when tested in water) defined by the Queensland Department of Primary Industries are:

pH	Rating
>9.0	Very strongly alkaline
9.0-8.5	Strongly alkaline
8.4-7.9	Moderately alkaline
7.8-7.4	Mildly alkaline
7.3-6.6	Neutral
6.5-6.1	Slightly acid
6.0-5.6	Moderately acid
5.5-5.1	Strongly acid
5.0-4.5	Very strongly acid
<4.5	Extremely acid

Plant sensitivities to acid soils vary. The critical pH values (in calcium chloride) below which yields decline are:

Soil pH (in calcium chloride)	Sensitive plants
4.3-4.7	barrel medic
	canola
	lucerne
4.1-4.5	sensitive wheat
	sensitive phalaris
4.0-4.3	barley
	tolerant wheat
	tolerant phalaris
	subterranean clover
	cocksfoot
	perennial ryegrass
4.0-4.2	lupins
	triticale
	oats

With soil acidity, a critical factor is the increasing availability of aluminium in more acid soils. At high levels, aluminium is toxic to most crops and pastures. There are two critical measurements in identifying the potential aluminium problem.

One is the exchangeable aluminium, and any figure above 5% will have an aluminium problem. However, this is qualified by the amount of aluminium available. If there is less than 1 MEQ% of aluminium, then there is not enough aluminium in the soil to be a problem.

For pasture establishment, the following recommendations are made:

Soil pH (in water)

Above 6.0	Lime or molybdenum (Mo) not usually required
5.5-6.0	Consider using Mo. Lime not usually needed
4.5-5.5	Use Mo. Lime pellet legume seed
4.0-4.5	Use Mo. Lime pellet legume seed. Use lime-super or sow seed into a band of lime
<4.0	Use Mo. Lime pellet legume seed. Use lime-super or sow seed into a band of lime. Apply lime to raise soil pH.

Paddock strips may be used to test for lime responses. This involves adding lime to one or several small strips in a paddock. The responses to lime may then be observed.

Extent of problem

The assessment of soil acidity in the Wantiool Landcare area is based upon soil test results provided for "Hazeldene", "Caithness", "Wirega", "Claris Park", "Glen Cairn", "Ballengoarrah" and "Kameruka". As stated above, the results have to be read with an understanding of the method of measurement, because some were done in water and others in calcium chloride.

For most areas tested, there is a soil acidity problem. Soil-water pH values for top soils range form 4.8 to 6.0, with similar values in the subsoils. Calcium chloride values are approximately 0.8 units lower, giving a range of 4.0 to 5.2. This is reasonably consistent across all the properties analysed, even though they were done at different time and by different companies or individuals.

Aluminium percentage values vary from 2 to 13%. However, in all cases the total aluminium available is well below 1 MEQ% and there should not be any problems. Further soils testing would confirm or refute this statement.

All soils will therefore requiring liming to raise the soil pH and/or to prevent the problem from occurring or getting worse. Individual landholders should have tests done on their major paddocks to work out more precisely how much lime they should apply. An alternative is to use acid tolerant crops, and whilst effective it limits the flexibility of crop options.

It is essential that the soil acidity problems be corrected before the other programs of establishing perennial pastures and tree planting are undertaken to control the rising groundwaters.

Recommendations

- Test the pH levels in all paddocks to a depth of 40 cm to identify the acidity problems in the surface soil and subsoil.
- Use acid tolerant crops and varieties in rotations to maintain production.
- Use the "Lime-it" model to apply sufficient lime to the soil to take the pH above 5.0 as tested in calcium chloride solution.
- Use reduced tillage systems for cropping.
- Include perennial grasses in improved pastures.
- In a pasture/cropping situation, include annual grasses in the ley phase of the rotation to take advantage of the nitrogen being produced by clovers.
- Plant crops earlier to utilise more free nitrogen in the soil and to reduce leaching.

Strategies of the Landcare Group for implementation of recommendations

- By November, 1993 request NSW Agriculture to conduct a workshop on soil acidity for members of the Landcare Group, preferably in February, 1994. By February 1994, prepare notes for members listing suitable crop and pasture species for various levels of soil acidity.
- By April 1996, test the pH levels in all cropping country to a depth of 40 cm.
- Prior to the establishment of perennial pastures on waterlogged soils, test the pH levels in all soils.
- By March 1994, seek assistance with soil tests from Charles Sturt University, corporate sponsorship from fertiliser, or the use of the science laboratories at local high schools.

3. Soil Erosion

Description

Three types of soil erosion occur within the Landcare area - sheet, rill and gully erosion.

Sheet and rill erosion occur when the soil is left bare during periods of high intensity storms. Cropping lands are most susceptible, although research has shown that pasture lands are also susceptible when the ground cover levels fall below 70%. All the land management recommendations in this report which are concerned with retaining good ground cover conditions quote this figure of 70%.

Sheet and rill erosion ratings are listed as minor, moderate and severe. These have been determined on the basis of an estimated annual average soil loss from any point in a paddock using the Universal Soil Loss Equation. The sheet and rill erosion ratings therefore have the following estimated annual soil loss rates:

minor	1 - 5 tonnes /ha/yr
moderate	5 - 10 tonnes /ha/yr
severe	>10 tonnes /ha/yr

Extent of Problem

Areas of land affected by sheet and rill erosion are:

	Area (ha)
minor	2,110
moderate	1,028
severe	93

Minor levels of sheet and rill erosion occur on cropping lands on slopes less than 5% and on pasture lands with slopes greater than 20%. Moderate sheet and rill erosion rates occur over all cropping lands with slopes between 5% and 10% and the severe levels occur when slopes greater than 10% are cultivated.

Gully erosion is of minor importance in the catchment, with a total length of 7 742 m, within four categories. The gullies of major concern would be those which have salt seeps within them. All other gullies can be treated by individual landholders. Gully erosion statistics are:

	Lengths (m)
minor gully erosion	945
moderate gully erosion	5,593
severe gully erosion	443
severe gully erosion with salt in floor	761
Total	7,742

Recommendations

Land management recommendations for the prevention and control of soil erosion on the different land capability classes are:

- spread stock watering points to ensure an even grazing pattern with stock movement across the slope
- on paddocks sown to improved pastures:
  - use direct drilling techniques
  - remove stock when the ground cover falls below 70% of the total area
  - use perennial pastures wherever possible
  - carry out weed control

For Rural Land Capability Classes II and III, which are used for cropping:

- use reduced tillage or direct drilling techniques for crop sowing whenever practicable
- when cultivating, use tyned implements instead of disc implements
- cultivate across the slope, not up and down the slope
- cultivate at a ground speed of less than 7 km/ hour to reduce damage to the soil structure
- if areas have been cropped for an extended period and a hard pan exists, then deep rill the soil to at least 30 cm to break up hard pans
- if the surface soil structure in a paddock is degraded, test the soil to determine if gypsum is required.

For Rural Land Capability Classes III and V:

- on lands which are actively eroding, construct graded banks with safe disposal outlets into stable drainage lines or depressions or waterways, to control surface run off and reduce the movement of soil from the paddock
- on slopes less than 6% gradient construct broad-based graded banks to reduce erosion, maintain production and to reduce weeds
- on slopes between 6% and 10% gradient, a peak type bank or modified bank is recommended
- annual maintenance of all erosion control earthworks is essential to repair minor wash-outs in channels and waterways and to rebuild slumped or washed-out areas on banks.

For Rural Land Capability Classes IV, V and VI:
- retain native pastures to provide a source of feed during prolonged dry periods, but try and maintain a ground cover of at least 70%
- for all pastures, remove stock when ground cover is reduced to 70%
- apply fertiliser as required and carry out weed and vermin control to maintain pasture productive condition.

Strategies of the Landcare Group for implementation of recommendations:

- no specific strategies; implementation of recommendations left to individual landholders.

4. Tree decline

Description

The widespread clearing of the native forests towards the end of the last century, and the current situation where the remaining mature trees are starting to die, result in an inadequate tree cover over the whole of the Wantiool Landcare area.

The clearing of the native forests has resulted in, or contributed to, a series of land degradation problems, including:

- increasing levels of groundwater
- soil erosion
- loss of shade and shelter to pastures, crops and livestock
- loss of habitat for insect eating birds
- decline in the general appearance of properties.

The extensive clearing in the district is now known to be the direct cause of the rising levels of groundwater in the low lying parts of the Landcare area. The re-establishment of a suitable level of cover is one method to help lower the amount of water entering the system. At the same time, the tree planting or tree regeneration programs will have a direct and important bearing on the treatment of other land degradation problems.

Tree planting alone will not lower the groundwater levels. Replanting programs will need to be carried out in conjunction with improvements to perennial pastures and changed cropping practices.

Extent of Problem

There are very few stands of native trees remaining in the Wantiool Landcare Area. Those stands that do remain are usually in a stressed condition, with no regrowth apparent except in isolated circumstances.

Over the total Landcare area, the amount of trees with a canopy cover (that is, the amount of ground shaded by the tree's canopy) greater than 10% totals 600 ha. This represents 4.1% of the total land area in the Landcare group.

The figures are even more bleak when it is realised that only 41 ha in 14 604 ha have a reasonably intact canopy and shrub layer. This represents 0.3% of the total land area. Almost all of these sites occur along the public road reserves, which remain as the only source of seed for understorey species in the district. A further 218 ha (1.5%) in the Landcare area have stands of trees with dense canopies but little understorey. Included in this figure are some of the tree lots that have been established by individual landholders.

In a total catchment approach, the desirable native forest cover is approximately 15%. This has been based upon observations, general opinions amongst landholders, calculations from optimum windbreak spacings and the needs of wildlife. Over the 14 604 ha in the Wantiool Landcare Group, this would represent 2 191 ha.

There is a shortfall of 2 068 ha for full canopy cover, and 1 591 ha if the figure of 600 ha (see above) is accepted as representing a base resource for future regeneration projects.

Landholders' proposals

Proposed tree replanting or tree regeneration plans indicated by landholders on the catchment plan include:

Type of Planting	Area (ha)
• tree lots	804
• tree lots as part of drainage line management	63
• natural regeneration sites	86
• wildlife corridors along road	39
Total	992

With the proposed plantings, the tree lots already established, and the areas of good tree cover along public roads, there will be a total area of 1 274 ha of tree cover in the Landcare area. If all the proposals of the Landcare Group are implemented then the Landcare Group is well on the way to getting a good forest cover back into the catchment. It can be brought up to the desirable levels by increasing plantings on those properties where they are below average.

Other tree plantings are proposed in the land management recommendations for salt affected land and for areas along the main drainage line and its tributaries. These plantings are not included in the figures above, because the plantings will cover only a proportion of the individual land units.

One feature in most of the proposals drawn up by landholders is the dependence upon replanting of trees. Only 86 ha, out of a total of 992 ha, are proposed to be established by closing off areas and letting natural regeneration take place. It would be worthwhile for group members to look at extending the areas of natural regeneration, particularly for sites where there are still some mature and reasonably healthy trees. The first sites that could be targeted are the steeper lands, those sites where there is a fair amount of rock at or close to the surface, and those areas that have not been regularly fertilised.

Another aspect to be considered in these catchment proposals is the question of creating wildlife corridors. If the Group wishes to follow up this issue, then it will need to reconsider the expansion and location of the tree planting.

Recommendations

- All Landcare group members to review at regular intervals the tree lot proposals to determine if they wish to change the proposals. Individuals should discuss their proposals with their neighbours to work out if they can develop ideas that will give better results and save time, money and effort.
- Group members to look at extending the areas of natural regeneration, particularly for sites where there are still some mature and reasonably healthy trees.
- Consider expanding the plantings along Wantiool Creek, targeting external funds to provide some assistance.
- Look at the potential for agroforestry in some of the tree lot proposals. Species may be selected for on-farm uses, firewood, specialty timbers or for stock fodder.

Strategies of the Landcare Group for implementation of recommendations

- Complete the tree replanting programs as shown on the catchment plan by December, 2008. This equates to a rate of treatment of approximately 3 ha per landholder per year.
- By February 1994 complete a plan for the implementation of a project to establish wildlife corridors with funds obtained from the Natural Resources Management Strategy.
- Request the Department of Conservation and Land Management to carry out an assessment of the remaining Crown roads in the area by March, 1994 and assess their suitability for use in creating part of a tree corridor across the Landcare area.

5. Water quality in Wantiool Creek

Wantiool Creek has a series of land degradation problems, warranting further studies and treatment. The main problems are:

- salinity
- nutrient enrichment from fertilisers and animal manure
- areas of erosion.

Salt in Wantiool Creek originates from the flows entering the creek from its tributaries. No information is available to state whether there are any seepages within the bed or its banks of the creek and no measurements were made of salt levels in the creek because of the high flows occurring at the time of field survey. However, the stands of cumbungi along most of the drainage line indicate a low level of salinity in the stream.

There is no point undertaking treatments for salt in the creek and its tributaries until programmes are implemented to treat the source of the salt.

The increase in nutrient levels in NSW river systems is now acknowledged as a major cause of water pollution.

Of particular concern is the increase in phosphorus levels in the water and its effects on the growth of river weeds and algae. Bule-green algae outbreaks have increased over the last few years in all NSW river systems where low flows have occurred.

The Landcare Group lies at the head of one tributary to the Murrumbidgee River, this is a direct source of nutrients into the drainage system. The main source of phosphorus is from superphosphate, but sheep and cattle manure are also significant sources.

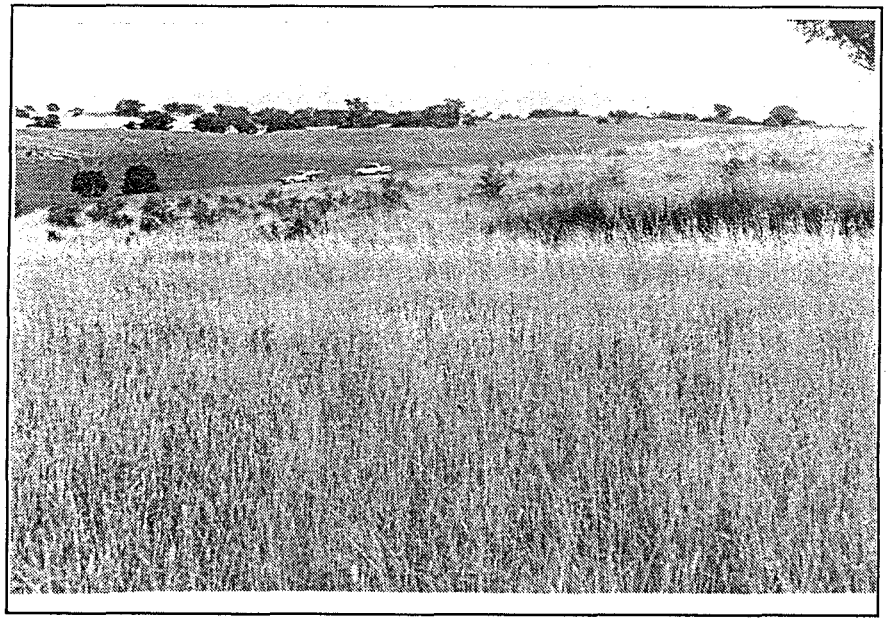
There is an opportunity for the Landcare group to develop innovative land management practices to reduce the flow of nutrients such as phosphorus from their lands into the Murrumbidgee system.

Areas of soil erosion along Wantiool Creek are few and small in size. However, these bare sites contribute sediment to the creek and discolour the water. In addition, nutrients are attached to the clay particles and are another source of nutrient pollution in Wantiool Creek. Treatments will be required on the eroded sites to re-establish ground cover and stabilise the soil. Stock access to the creek will also need to be considered to ensure that unstable and potentially unstable sites are not used for watering points.

One advantage of the cumbungi in Wantiool Creek is that any sediment from the creek banks is contained within the stream. The cumbungi asts as a very thick screen to slow the flow of water, trap the sediments and stabilise them by growing through them.

Recommendations

- Prepare a management plan for the entire length of the main stream, at a scale of 1:750, to identify the land management treatments required along the creek on each of the properties.
- Restrict stock to most parts of the stream and preferably, restrict completely, by installing off-creek watering systems.
- Avoid cropping within 20 m of either bank of the creek, and reduce th elevel of fertilisers used in these areas. Establish perennial pastures in this buffer zone and ensure that there are no direct applications of fertilisers into the creek, avoiding all aerial applications within the zone.
- Fence out critical areas of the stream and plant to trees or perennial pastures. Stock are only to graze these areas when there is a need to reduce the fire hazard.



Direct seeded trees in a pasture paddock in the Wantiool district.

Appendix 1
How the management plan was prepared

The management plan was put together jointly by landholders and officers of CaLM in a series of workshops held at Junee.

The natural resource information held in computer form on CaLM's geographic information system formed the basis for the development of the final plan. Natural resource attributes critical in making land capability and land management decisions were printed out as a series of overlays.

Some of the attributes were printed initially as individual maps to enable discussions with landholders on how to use and read maps and of the importance of each natural resource attribute in making decisions on land capability or land management. Thus separate slope and terrain maps were initially produced. Initial decisions on land capability and land management were made using only the slope map and slope classes, but later modified when terrain and soils information were overlaid onto the slope map.

Once the relationships between slope, terrain, soils and land capability and land management were decided, a combined map of slope/terrain was used, rather than using two separate maps.

Using other maps which showed waterlogged areas, salt outbreaks, tree cover and rock outcrops, landholders developed the first draft of a catchment plan. Proposals for tree lots, windbreaks, connecting corridors and shelter belts were also drawn onto the plan.

Some of the land management proposals were aggregated to ensure that not too many recommendations which were very similar in content but with slight differences appeared on the map. Too many classes would make the land management map too difficult to read.

The majority of the recommendations for the land management map were derived from the resource inventory. Those management proposals such as tree planting proposals and paddocks to be returned to native pastures, which were based on the preferences of individual landholders and independent of the existing resource information, were separately digitised and added to the land management map.

The draft land management plan was reconsidered by the Landcare group in August, 1993. As well as the plan for the whole catchment, "screen dumps" of the land management plan were produced for each property and given to landholders. Additional concepts such as natural regeneration vs. tree planting, wildlife corridors and management of Crown and Shire lands were discussed in this workshop. Modifications subsequently made by landholders were digitised into the GIS and a final map produced.

Appendix 2
How individual land management recommendations were put together

Salt affected and waterlogged lands

Most landholders identified the need to fence out the waterlogged and salt affected lands and to apply special treatments.

Treatments may vary slightly. Some landholders may prefer to use the salt tolerant grasses, whilst others may prefer to try saltbushes or trees, or a combination of any three of these. Whatever method is preferred, they have been grouped together under the one recommendation.

Some landholders showed the areas to be fenced out. The information that was mapped from aerial photographs and incorporated into the data base, was used to define the boundaries of these units on the land management map. Within the legend, the need to fence out these areas was stated. Accordingly, fences around salt outbreaks are not shown on the land management map. The length of fencing required around salt outbreaks was calculated simply by measuring the total perimeter of the salt outbreaks.

Tree lots

The tree lots more than one year old, and shown in red, are taken from the information mapped from aerial photographs. Where tree lots were established after the completion of the mapping, they are included in the legend that reads **"Recently established or proposed".**

The areas of trees along the shire road have also been extracted from the data base.

Alluvial land and principal drainage lines

These were also extracted from the data base. The alluvial areas were not mentioned specifically by landholders, but some of the management plans targeted these areas as being important, so it was applied right across the Landcare area.

The Wantiool Creek and its principal tributaries were separated because the Landcare Group has sought funding for tree planting along Wantiool Creek and its tributaries from the "Green River Banks" project. It was therefore identified as a separate unit from the resource information, because the maintenance of waterways is developing as a critical issue and it's important to know the areas that landholders should be targeting.

Steeper sloping land

This was identified only by one or two landholders as being a separate land management feature. However, these lands are important to highlight right across the Landcare area because they are lands too steep for cultivation for any type of regular cropping, although they can be cultivated for the establishment of a pasture.

These have been identified directly from the data base, by selecting all lands with slopes greater than 10%.

Native pasture and eroded areas

These were taken directly from landholders' plans.

Pasture and cropping area

These are all the lands left after taking out the land types listed above. They have the potential for some cropping, providing soils are reasonably deep and not too much rock in the surface layers. In individual sub-catchments where outbreaks of waterlogging and dryland salinity are high, cropping rotations will need to be changed to increase the length of time under perennial pastures. On the individual plans, these lands were shown under a range of options, e.g., crop/pasture rotation, annual pastures, lucerne or phalaris, but they all logically fall into this one group.

Appendix 3
Rural land capability classification

The natural resource information and the land degradation information have been used to develop a rural land capability classification for the area. Whilst a rural land capability map has not been prepared, the principles of land capability have been used extensively in the development of the land management plan.

Land capability classes

There are four main categories of land within the land capability classification.

Category 1: Classes I, II and III

The first category represents land capable of frequent cropping, using tillage practices involving a series of workings or the preferred techniques of reduced tillage. It includes land where the soils are sufficiently deep and which have a structure and texture which will not break down under tillage within the limits defined; are free of salts likely to reduce or inhibit plant growth; relatively free of large stone or in-site rock so as not to restrict the use of farm machinery; and which have good profile drainage but a sufficient water-holding capacity to meet the requirements of the crop.

Category 2: Classes IV and V

The second category includes land capable only of infrequent growing of crops when using tillage practices involving a series of soil workings. This land is best used for grazing but it can occasionally be tilled for different types of crops or for pasture establishment or renewal. However, because of site factors such as climate, soil type, slope, topographic location or drainage, it is not capable of repeated cultivations.

Category 3: Class VI

Grazing land which is not capable of tillage operations makes up a third category. It includes lands having a series of physical or chemical constraints which limit productivity. Physical constraints may include soil properties such as depth, stoniness, erodibility or drainage, or site features such as slope, landform elements, rock outcrops and erosion hazards. Chemical limitations include both deficiencies and toxic levels of all nutrients.

Category 4: Classes VII and VIII

A final category includes land considered unsuited for any type of cropping or grazing because of its physical limitations. These may physically restrict production and will result in an extreme soil erosion hazard if general land clearing takes place.

The general criteria in determining the land capability classes for the Wantiool Area are:

Class VII - land best left under trees or replanted to trees. Includes all land with one or more of the following features:

- slopes greater than 33% with shallow soils or rock outcrop
- all deep gullies, drainage lines and streams
- swamps and waterbodies
- severely gullied drainage lines which can only be treated by fencing off, excluding stock, and planting trees and pastures
- shallow soils, less than 10 cm deep, on slopes above 10% and less that 33%.

Class VI - lower quality grazing land which should not be cultivated. It incorporates:

- the salt affected lands on the valley flats
- all remaining areas of shallow soils, less than 10 cm deep, which mainly occur on ridge tops
- slopes between 20% and 33%
- drainage depressions which are seasonally or permanently wet or waterlogged.

Classes IV and V - better quality grazing land which can be cultivated for the establishment of perennial pastures. Some areas can be used to grow an occasional crop when soil and seasonal conditions are right. However, due to groundwater problems the total length of time under crop should be less than the time under pasture.

Class IV and V lands include:

- all sloping lands with slope gradients 10% to 20% on red earth and red podzolic soils
- all low sloping lands, with slope gradients less than 20% and soil depths between 10 and 50 cm
- all drainage depressions that currently do not have a waterlogging problem but the soils are yellow solonetzic or yellow podzolic
- areas with severe erosion problems caused by current cropping practices. These lands should be sown to a perennial pasture.

The lands to the south of Wantiool Road, with slopes less than 10% and soils either red podzolics or red earths were traditionally classified as Land Capability Classes II or III. This was the case in 1985 when the area was mapped as Class II or Class III as part of a land capability survey of the Eastern and Central Divisions of NSW.

With the increasing problems of rising water tables and dryland salinity plus the problem of low soil pH, this classification can no longer be justified. Accordingly, all areas in the Wantiool Creek catchment and the catchment of Rock Creek, that were previously classified as Land Capability Classes II or III are now downgraded to Class IV. The same applies for the lands within the catchment of Jeralgambeth Creek through "Ballengoarrah", "Lynton" and "Hazeldene", where rising groundwater levels are occurring.

Classes II and III - these are the remaining areas of land on slopes less than 10% with red podzolic or red earth soils. Rising water tables and dryland salinity are not apparent at this stage. If these situations change, however, then it will be necessary to downgrade the capability of the land.

Appendix 4
Remnant vegetation of the Wantiool Landcare Area.

The native vegetation of the Junee area has been significantly altered from that which existed prior to European settlement. This alteration has been to such an extent that remnant native vegetation occupies less than 2% of the original area. These small remnants are almost completely restricted to the linear areas of Public Land, such as, road reserves and roadside corridors. Even these small areas have been subjected to considerable disturbance through grazing, timber harvesting, roadworks and drainage, introduced species and altered fire regimes. This disturbance has been so complete that none of the remnants is likely to be a good example of the original flora.

To further compound this problem little is known of the botanical composition of the forests and woodlands of the inland slopes prior to the period of large scale clearing. Nevertheless the following is considered to be a reasonable approximation of what the original vegetation would have been like.

The original vegetation consisted of grassy open forests and woodlands dominated by White Box associated with Grey Box and Blakleys Red Gum. On the better soils along the alluvial flats Yellow Box and Blakleys Red Gum would have been prevalent. On the poorer shallow soils Apple Box and possibly Tumbledown Red Gum would have dominated.

The understorey would have consisted of an open shrub layer of various Acacia species such as Varnish Wattle, Box Leaved Wattle and Western Silver Wattle and pea flowers such as *Eutaxia*. On drier, rocky or poor soil areas Callitris pine and lightwood would have been dominant as small trees or tall shrubs. This shrub layer would have been patchy with dense clumps and isolated shrubs separated by open areas of grasses and other small plants. Within this shrub layer varying densities of regenerating eucalypts and other tree species such as Bulloak would have been common.

The ground layer was probably dominated by tall perennial grasses, Kangaroo Grass being the most common, and other plants such as the Matt Rushes, Paper Daisies and Flax Lilies. The best example of what the original vegetation may have been like can be found along the Illabo Road just south of the railway line.

Table 1.1 gives the list of species found during the preparation of the land and water management plan. This list is by no means exhaustive and many of the species that occur in the herb layer have not been identified. Table 1.2 is a list of the species found in the White Box community in the 1950's. It is interesting to note that many of these species have not been found in this study.

The massive alteration of the original vegetation has had a severe impact on the regional wildlife. None of the remnants that exist is large enough to support viable populations of the vertebrate species dependent on native bushland. The result of this is that the majority of the original fauna would be locally extinct.

Many of these species can have beneficial values for farm productivity such as insect control. For example Dr. Hugh Ford of the University of New England has found that in healthy woodland, bird species alone consume up to 50 to 70% of the insects produced in one year. Other species such as magpies, kestrels, ibis, flycatchers and crows consume large numbers of scarabs, crickets, grasshoppers, caterpillars and other herbivorous insects. Birds are not the only beneficial group; mammals such as the sugar glider can consume up to 15 scarabs per hour per night and a colony of common bent winged bats can consume up to 200kg of insects per night, while one echidna can consume up to 120 scarabs per day. All of these species mentioned are dependent on the maintenance of remnant vegetation to a greater or lesser degree.

The treelots and windbreaks that are likley to be established as a result of this plan will not be enough to provide adequate habitat to re-establish the original fauna. Nevertheless any rehabilitated area of native vegetation will provide habitat for a number of species particlarly birds and more mobile mammals such as echidnas.

If nothing is done the existing flora and fauna will most probably decline with further losses of the species that still remain. The existing remnants are at risk of losing their tree canopy through the various forms of "dieback" and with the existing grazing management there is little probability of adequate regeneration of tree or shrub species. If these remnants disappear then the last semblance of the original landscape will be lost and with it most of its wildlife.

Suggestions for native vegetation management

- Protect all existing remnants from further disturbance (fence).
- Use existing remnants as a seed source.
- Target regeneration effort on expanding existing remnants.
- When creating new habitat try to make areas as large and as close to square as possible.
- Aim to have some areas of dense shrubs or regenerating trees to provide habitat for small birds.
- Try to promote natural regeneration where possible.
- Where regeneration of understorey species is not possible then supplementary planting should be incorporated.

- If two areas of remnant timber occur close together try to incorporate both in the one area.
- Use areas with rocks and boulders as these provide shelter for small animals such as lizards.
- Where possible include old fallen logs for the same reason.
- Try to have a number of plant species in the understorey as this will provide variety in food resources.

Table 1.2
Potential species list from earlier studies of the Junee Area

Chielanthes tenuifolia
Ophioglossum coriaceum
Marsilia drummondii (Nardoo)
Callitris endlicheri (Black Cypress)
Carex inversa (Knob Sedge)
Juncus bufonius (Toad Rush)
Juncus polyanthemus (A Rush)
Anguillaria dioica (Early Nancy)
Bulbine bulbosa (Native Leek)
Dianella laevis (A Flax Lily)
Dichopogon strictus (Chocolate Lily)
Lomandra dura (A Matt Rush)
Lomandra longifolio (Spiny Matt Rush)
Lomandra multiflora (Many Flowered Matt Rush)
Tricoryne elatior (Yellow Rush-lily)
Casuarina stricta (Drooping She Oak)
Exacarpos cupressiformis (Brush Cherry)
Amyema miquelii (A Mistletoe)
Rumex brownii (Swamp dock (weed))
Sclerolaena atriplicinuum (Lambs Tongue)
Maireana enchylaenoides (A Blue Bush)
Rhagodia nutans (Climbing Saltbush)
Bursaria spinosa (Sweet Bursaria)
Alternanthera denticulata
Boerhavia diffusa (Tah Vine)
Acacia paradoxa (Hedge Wattle)
Acacia baileyana (Cootamundra Wattle)
Acacia buxifolio (Box Leaved Wattle)
Acacia decurrens (Early Black Wattle)
Acacia implexa (Lightwood)
Acacia montana (Malle Wattle)
Acacia pycnantha (Golden Wattle)
Acacia rubida (Red Stem Wattle)
Glycine clandestina (Twining Glycine)
Glycine tomentella (Rusty Glycine)
Glycine tabacina (Variable Glycine)
Hardenbergia violacea (Native sarsaparilla)
Oxalis corniculata (Creeping Oxalis)
Linum marginale (Native Flax)
Geijera parviflora (Wilga)
Euphorbia drummondii (Caustic Weed)
Stackhousia monogyna (Creamy Candles)
Brachychiton populneus (Kurrajong)
Dodonea cuneata (Wedge leaf Hop Bush)
Eucalyptus albens (White Box)
Eucalyptus dealbata (Tumbledown Red Gum)
Eucalyptus nortonii (Long Leaved box)
Eucalyptus goniocalyx (Long Leaved Box)
Eucalyptus macrorhyncha (Red Stringy Bark)
Eucalyptus melliodora (Yellow Box)
Eucalyptus bridgesiana (Apple Box)
Eucalyptus microcarpa (Grey Box)
Epilobium cinereum (Willow Herb)
Haloragis sp (Raspwort)
Daucus glochidiatus (Australian Carrot)
Eryngium rostratum
Hydrocotyle laxiflora (Stinking Pennywort)
Lissanthe strigosa (Peach Heath)
Wahlenbergia spp. (Blue Bells)
Goodenia hederacea (Forest Guinea Flower)
Goodenia pinnatifida (Scrambled Eggs)
Velleia paradoxa (Spur Velleia)
Centipeda cunninghamii (Common Sneezeweed)
Helichrysum apiculatum (Yellow Buttons)
H. Semipapposum (Clustered Everlasting)

Table 1.3
Other possible local species

Kunzea parvifolia (Violet Kunzea) - rocky seepage areas
Leptospermum juniperinum (Prickly Tea-tree) - poorly drained soils
Callistemon paludosus (River Bottlebrush) - riverbanks - open rocky areas
Calytrix tetragona (Common Fringe-Myrtle) - rocky areas gravel and sandy beds
Brachyloma daphnoides (Daphne Heath) - poorer dry rocky or sandy hillslopes
Cassinia longifolia (Shiny Cassinia) - shallow soils rocky outcrops
Acacia doratoxylon (Currawang) - well drained rocky ridges and slopes

Wantiool Landcare Group - Species found in this study				
Species	Common name	Propogation	Form	Flower
Acacia decora	Western Silver Wattle	Seed or cuttings	Shrubs	Aug - Oct
Acacia buxifolia	Box Leaved Wattle	Seed or cutting	Shrubs	July - Dec
Acacia deanei	Deanei's Wattle	Seed	Tall shrubs	
Acacia flexifolia	Bent Leaved Wattle	Seed or cuttings	Shrubs	May - Nov
Acacia hakeoides	Hakea Wattle	Seed or cuttings	Shrubs	June - Sept
Acacia difformis	A Wattle	Cutting	Shrubs	June - Sept
Acacia vericifua	Varnish Wattle	Seed or cuttings	Shrubs	
Acacia implexia	Lightwood	Seed or cuttings	Tall shrubs	Dec - Mar
Acacia rubida	Red Stem Wattle			Aug - Nov
Indigofea adesmiifolis		Seed or cuttings	Shrubs	
Cassinia aculeata	Dogwood	Seed or cuttings	Shrubs	
Casuarina luehmanni	Bulloake	Seed	Tree	
Myporum debile		Cuttings	Prostrate	
Dianella revoluta	A Lily	Seed or division	Tall herbs	
Helichrysum apiculatun	Yellow Buttons	Cuttings		
Acacia decora	Western Silver Wattle	Seed or cuttings	Shrubs	Aug - Oct
Helechrysum semipapposum	Elastered Evelasting	Seed		
Dodonea cuneata	Wedge Leaved Hop Bush		Shrubs	
Dichopogon strictus	Chocolate Lily	Division or rhisomes	Herbs	
Brachychiton populneus	Kurrajong	Seed	Tree	
Eutaxia microphylla	A Pea Flower	Cuttings or Scarified seed	Low shrubs	Aug - Sept
Themeda triandra	Kangaroo Grass	Seed	Grass	
Lomandra lougiflia	Spiny Matt Rush		Tall herbs	
Lomandra multiflora	Many Flowered Matt Rush		Tall herbs	

Further readings:

Breckwoldt, R. (1983) *Wildlife in the Home Paddock,* Angus and Robertson, Sydney.

Davidson, R. and Davidson, S., (1992) *Bushland on Farms: do you have a choice?,* AGPS, Canberra.

Johnston, P.J.M. and Don, A.R., (1990) *Grow you own Wildlife: how to improve your local environment,* Greening Australia, Sydney.

- If two areas of remnant timber occur close together try to incorporate both in the one area.
- Use areas with rocks and boulders as these provide shelter for small animals such as lizards.
- Where possible include old fallen logs for the same reason.
- Try to have a number of plant species in the understorey as this will provide variety in food resources.

Table 1.2
Potential species list from earlier studies of the Junee Area

Chielanthes tenuifolia
Ophioglossum coriaceum
Marsilia drummondii (Nardoo)
Callitris endlicheri (Black Cypress)
Carex inversa (Knob Sedge)
Juncus bufonius (Toad Rush)
Juncus polyanthemus (A Rush)
Anguillaria dioica (Early Nancy)
Bulbine bulbosa (Native Leek)
Dianella laevis (A Flax Lily)
Dichopogon strictus (Chocolate Lily)
Lomandra dura (A Matt Rush)
Lomandra longifolio (Spiny Matt Rush)
Lomandra multiflora (Many Flowered Matt Rush)
Tricoryne elatior (Yellow Rush-lily)
Casuarina stricta (Drooping She Oak)
Exacarpos cupressiformis (Brush Cherry)
Amyema miquelii (A Mistletoe)
Rumex brownii (Swamp dock (weed))
Sclerolaena atriplicinuum (Lambs Tongue)
Maireana enchylaenoides (A Blue Bush)
Rhagodia nutans (Climbing Saltbush)
Bursaria spinosa (Sweet Bursaria)
Alternanthera denticulata
Boerhavia diffusa (Tah Vine)
Acacia paradoxa (Hedge Wattle)
Acacia baileyana (Cootamundra Wattle)
Acacia buxifolio (Box Leaved Wattle)
Acacia decurrens (Early Black Wattle)
Acacia implexa (Lightwood)
Acacia montana (Malle Wattle)
Acacia pycnantha (Golden Wattle)
Acacia rubida (Red Stem Wattle)
Glycine clandestina (Twining Glycine)
Glycine tomentella (Rusty Glycine)
Glycine tabacina (Variable Glycine)
Hardenbergia violacea (Native sarsaparilla)
Oxalis corniculata (Creeping Oxalis)
Linum marginale (Native Flax)
Geijera parviflora (Wilga)
Euphorbia drummondii (Caustic Weed)
Stackhousia monogyna (Creamy Candles)
Brachychiton populneus (Kurrajong)
Dodonea cuneata (Wedge leaf Hop Bush)
Eucalyptus albens (White Box)
Eucalyptus dealbata (Tumbledown Red Gum)
Eucalyptus nortonii (Long Leaved box)
Eucalyptus goniocalyx (Long Leaved Box)
Eucalyptus macrorhyncha (Red Stringy Bark)
Eucalyptus melliodora (Yellow Box)
Eucalyptus bridgesiana (Apple Box)
Eucalyptus microcarpa (Grey Box)
Epilobium cinereum (Willow Herb)
Haloragis sp (Raspwort)
Daucus glochidiatus (Australian Carrot)
Eryngium rostratum
Hydrocotyle laxiflora (Stinking Pennywort)
Lissanthe strigosa (Peach Heath)
Wahlenbergia spp. (Blue Bells)
Goodenia hederacea (Forest Guinea Flower)
Goodenia pinnatifida (Scrambled Eggs)
Velleia paradoxa (Spur Velleia)
Centipeda cunninghamii (Common Sneezeweed)
Helichrysum apiculatum (Yellow Buttons)
H. Semipapposum (Clustered Everlasting)

Table 1.3
Other possible local species

Kunzea parvifolia (Violet Kunzea) - rocky seepage areas
Leptospermum juniperinum (Prickly Tea-tree) - poorly drained soils
Callistemon paludosus (River Bottlebrush) - riverbanks - open rocky areas
Calytrix tetragona (Common Fringe-Myrtle) - rocky areas gravel and sandy beds
Brachyloma daphnoides (Daphne Heath) - poorer dry rocky or sandy hillslopes
Cassinia longifolia (Shiny Cassinia) - shallow soils rocky outcrops
Acacia doratoxylon (Currawang) - well drained rocky ridges and slopes