

# North East Pastoral District Plan

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## **SUMMARY**

The North East Pastoral Soil Conservation District covers 34,500 km<sup>2</sup> of semi-arid land in the central eastern part of South Australia. Population density is very low with no major towns. The dominant land use is sheep pastoralism, with 64 moderate sized properties, most of which are held under Pastoral leases. In the far south west of the District are a few perpetual leasehold properties. The arid climate and low fertility soils make other forms of agriculture unviable.

The District is divided eastwest through the centre by the low hills of the Olary Spur which support quite diverse vegetation types. South of the Spur, the undulating plains support a range of mallee and black oak communities, usually with chenopod understorey. North of the hills are the extensive plains dominated by saltbush and bluebush with occasional groves of black oak and low dunes with hophushes, mulga and umbrella bush.

The main land management issues in the District revolve around the pastoral land use and include the maintenance of native pastures in good condition, control of pest plants and animals, and control of wind and water erosion.

This Plan outlines the District in terms of its physical characteristics, identifies and describes the range of management issues, and makes recommendations for appropriate practices to maintain the current land uses and manage the natural resources in a sustainable manner.

This document provides an overview of the District and useful information for all land managers, and includes a 3 year program of activities aimed at enhancing the sustainability of the current land uses and conserving the resource base.

## INTRODUCTION

### ***THE NORTH EAST PASTORAL SOIL CONSERVATION BOARD***

The North East Pastoral Soil Conservation Board was formed in 1991. The Board consists of seven land managers who live within the District and have suitable knowledge of, and experience in land management.

The current (1997\*) and foundation members of the North East Pastoral Soil Conservation Board are:

*Richard Gloster (Chair)	Mulyungarie Station	Ph 08 8091 1614
*Garry Shephard (Secretary)	Manunda Station	Ph 08 8650 5988
*Shan Murray (Treasurer)	Oak Park Station	Ph 08 8650 5040
*Maurice Francis	Oulnina Station	Ph 08 8650 5901
Will Crawford	Weekeroo Station	Ph 08 8650 5390
*Keith Treloar	Wiawera Station	Ph 08 8091 1526
Alan Bartholomaeus	Pine Creek Station	Ph 08 8091 1618
*Greg Treloar	Yarramba Station	Ph 08 8091 1622
*Gloria Tiver	Netley Gap Station	Ph 08 8650 5938

The current Board wishes to acknowledge the substantial contribution made by Alan Bart and Will Crawford to the formulation of this plan.

The Manunda Creek Catchment Group is a Landcare group supported by the North East Pastoral Soil Conservation Board and incorporated under the neighbouring Eastern Districts SCB. This group is testing mechanical and chemical methods for controlling the weeds boxthorn and pepper tree.



*Some of the 1997 Board members: from left; Shannon Murray, Richard Gloster, Gloria Tiver, Greg Treloar and Keith Treloar at the historic Mannahill railway siding*

### ***DUTY OF CARE***

The Board feels that all people have the responsibility to care for soil, vegetation, water and other natural resources.

The *Soil Conservation and Land Care Act 1989* provides that it is the duty of all landholders to take all reasonable steps to prevent degradation of land.

Degradation of land means a decline in the quality of soil, vegetation, water and other natural resources of the land resulting from various activities or failure to take appropriate action to prevent that degradation.

## **THE ROLE OF THE BOARD**

The role of the Board is one of education, coordination and cooperation, and is directed towards preventing land degradation through responsible land management. Other aspects of the Board's role are to:

- develop community awareness and understanding of land conservation issues;
- promote the principle that land must be used within its capability;
- develop and support community projects for land conservation and rehabilitation;
- provide advice and assistance to landholders on land conservation and rehabilitation;
- seek landholder cooperation to ensure land is not degraded;
- implement the provisions of the *Soil Conservation and Land Care Act 1989* ;
- prepare District Plans and Three Year Programs;
- approve property plans.

## **AIMS OF THE BOARD**

- Promote ecologically and economically sustainable land uses in the District.
- Help each property manager in this District to develop property management plans which are consistent with economically and ecologically sustainable land management.
- Collect, collate and make available historical information and local knowledge about total land management.
- Provide advice on land management to land managers and Government agencies where requested.
- Be a voice, network link and responsible mediation body on land use and management issues for the North East Pastoral community to the Government and community of SA and Australia.
- Encourage liaison between the Pastoral Management Branch of DEHAA, the Pastoral Board, and land managers.

## **AIMS OF THE DISTRICT PLAN**

This District Plan has been developed as required by section 36 of the *Soil Conservation and Land Care Act 1989* to:

- describe the District including; vegetation types, land capability and land uses;
- describe the existing and potential soil and vegetation degradation problems;
- identify the land management options best suited to prevent those problems and to rehabilitate degraded land.

## **COMMUNITY CONSULTATION**

This draft District Plan has been prepared by the Board with the comments of local land managers in mind. This document has been released in draft form for a 90 day period during which comments on its content were sought from the community.

## ***REVIEW***

This District Plan will be reviewed every three years when concerns and guidelines presented in this plan will be updated. Ongoing consultation with the community is recognised by the Board as necessary to maintain the relevance of this plan and the Board's activities to the current land management issues within the District.

# DESCRIPTION OF THE DISTRICT

## ***INTRODUCTION***

The North East Pastoral Soil Conservation District consists of 34,500 square kilometres of natural pasture land. The district lies between 240 and 500 km northeast of Adelaide and 50 to 290 km west of Broken Hill. The eastern boundary of the District is the New South Wales / South Australian border. The dingo proof fence forms the northern boundary of the District and makes possible the dominant land use, pastoral sheep grazing ([Figure 1](#)).

The Barrier Highway connecting Adelaide and Sydney passes through the middle of the District. The east-west railway line runs alongside the highway and is primarily used to transport ore from Broken Hill to the smelters at Port Pirie. The famous Indian Pacific passenger service also uses this line.

Several small towns exist along the highway but there is no major town in the District. There are no shopping centres, high schools or kindergartens, and no medical facilities in the District. The Royal Flying Doctor Service provides clinics and emergency services to the District. The only rural school is at Yunta.

There are 64 pastoral enterprises within the District. Land tenure includes pastoral lease, perpetual lease and freehold. The population of the District is approximately 400 - 500 people plus itinerants (miners / roo shooters).

The dominant land use in the District is pastoral grazing of sheep for the production of wool and lambs. The District contains some of the best country in South Australia and the world for medium to strong wool production with high production per sheep and disease free flocks. Some cattle are also grazed within the District and gold and uranium mining are past and/or present land uses.

The most dominant landscape feature in the District is the Olary Spur, which runs in a northeasterly direction through the centre of the region. Approximately 40% of the District lies in the Murray Darling Basin; most of this area south of the Barrier Highway. The remainder lies within the Frome Drainage Basin, with streams flowing north into Lake Frome.

Vegetation and soils of the District are very diverse due to complex geology and a variety of landforms. Vegetation types include woodlands, low shrublands and grasslands with chenopod species, *Maireana* spp. (bluebush), *Atriplex* spp. (saltbush) being common to or dominant in most communities. *Casuarina pauper* (black oak), *Acacia aneura* (mulga) and *Myoporum platycarpum* (false sandalwood) are the most common timber species, with lesser amounts of *Eucalyptus* spp. (eucalypts) and *Callitris glaucophylla* (northern cypress pine). Grasslands are dominated by perennial and/or annual species. Soil types include uniform sands and clays (cracking and non-cracking), duplex and gradational soils, and skeletal stony loams (most being calcareous to some degree). Saline soils are also common.



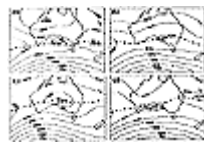
**Figure 1** Location of the North East Pastoral Soil Conservation District



## CLIMATE

The North East Pastoral Soil Conservation District has an arid climate with hot to extremely hot, very dry summers, and cool to mild, dry winters. Rainfall is low and unreliable, characterised by extremely infrequent heavy falls. There is no seasonal pattern over most of the District, although in the southwest (where the highest average annual totals occur), winter rains show less variability than summer falls.

Seasonal variation of the weather is controlled by the location of large-scale high pressure systems which are part of the global sub-tropical ridge ([Figure 2](#)). During the warmer part of the year (November to March), the ridge is located south of the District and the prevailing surface winds are from the southern quadrant. During autumn the ridge generally moves north and remains over the continent from April until September.



**Figure 2.** The average mean sea level pressure pattern for a) January, b) April, c) July, and d) October. (Units are in hectopascals.) The subtropical ridge (-----), south of the continent in summer, moves northwards in April and is located just north of the District in winter. (Source: National Meteorological Operations Centre, Bureau of Meteorology.)

During winter the North East Pastoral District is south of the ridge axis, and winds generally have a westerly component (north north-west to south south-west). Weak orographic lifting by the Benda Ranges and Olary Spur produce slightly higher average rainfalls over the elevated ground. The uplands, which consist of a series of ridges, generally aligned northeast / southwest, influence temperatures (especially daily minima) and may cause localised wind effects. On winter nights cold air may accumulate in valleys and depressions.

## WINDS

While large scale pressure features ([Figure 2](#)) determine the broad scale wind flow, topography can have a marked effect on local wind speed and direction, particularly overnight and early in the morning, when stable conditions allow localised wind regimes to be set up. Surface wind observations are available from Yunta and Broken Hill.

In summer (December to February) winds are generally light to moderate and the prevailing airstream is from the south to southeast.

In autumn winds are frequently light and more variable, but still show a southeast to southwest tendency. Through the cooler months (late May to August), westerly and even northerly winds are common. During spring, winds are again variable in direction but the strongest winds are generally from the northerly and westerly quadrants.

The observed occurrence of strong winds (41 to 62 kph) is shown in [Table 1](#). In general the most frequent strong winds occur during the period from late winter through spring, while a relative lull occurs during April and May. Gales (> 62 kph) are uncommon, but the highest monthly frequency occurs during the period September and October.

**Table 1.** The average number of days per month that strong winds are observed at the meteorological observation sites of Yunta and the Broken Hill Royal Flying Doctor Service (RFDS). Some allowance has been made for the short record at Broken Hill.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Yunta	1	1	1	1	1	1	2	2	3	3	2	1
Broken Hill RFDS	1	1	1	1	<1	1	1	1	2	2	1	1

## RAINFALL

Rainfall across the District is unreliable with no marked seasonality. Average annual rainfall ranges from 250 mm in the west to less than 175 mm on the plains in the far northeast. Tables of monthly mean and median rainfalls, together with the mean number of rain days for selected Stations are at [Appendix A](#).

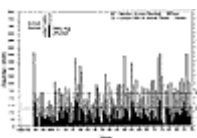
Widespread significant rainfall is infrequent, but is most likely to result from tropical inflow in summer (from the north or northeast), or from slow moving cut-off low pressure systems, or northwest cloud bands at any time of the year. These latter systems, which originate over the northeast Indian Ocean, are associated with a well established northwesterly flow aloft, but at mean sea level easterly, northeasterly, or even light variable winds, may prevail.

Rainfall in the warmer months is highly erratic, and most often in the form of heavy showers, associated with thunderstorms. It is in this season that extreme falls may occur. The intrusion of copious moist air, associated with a trough extending from the tropics in some years, can produce prolonged widespread rain. Extreme rainfall records for selected Stations are shown in [Table 2](#).

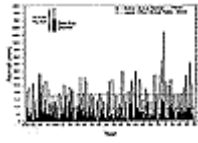
The historical rainfall record for selected Stations (Figs 3 - 7), highlight the rainfall variability and show:

- annual, and May to August totals for each year since records commenced
- the annual median for each Station (line M)
- the lowest 10% of annual falls on record (line D)

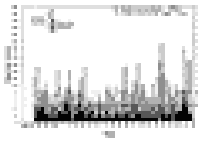
Tables of annual and monthly decile values for these Stations are in [Appendix B](#). Decile tables can be used to estimate the probability (or chance) of rainfall totals exceeding a given threshold over a specific period. For example, the Decile 1 value identifies the lowest 10% of annual falls on record. The Decile 5 value, (also known as the median) delineates the lowest 50% of observed falls. In the southwest of the District the annual Decile 1 value is near 120 mm and the Decile 5 value is around 225 mm. Based on this historic record from Yunta for example (Fig 3), landholders can expect that on average, one year in ten the rainfall will be less than 120 mm. In 50 percent of years the expectation is that the annual rainfall will be less than 225 mm. In the northeast of the District (Fig 7), the one in ten expectation is an annual total less than 75 mm, and the five in ten expectation is a total less than 150 mm. Decile values give an indication of rainfall reliability.



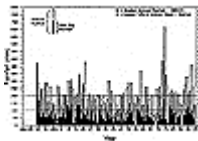
**Figure 3** The historical rainfall record for Yunta (Station No 20026) at 32° 35'S, 139° 33'E (elevation 303.0m).



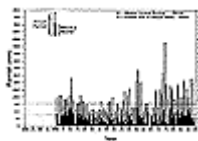
**Figure 4** The historical rainfall record for Curnamona (Station No. 20004), at 31° 39'S, 139° 33'E, (elevation 90.0m).



**Figure 5** The historical rainfall record for Mutooroo (Station No 20017), at 32° 27'S 140° 55'E, (elevation 183.0m).



**Figure 6** The historical rainfall record for Mannahill (Station No 200173), at 32° 26'S 139° 59'E, (elevation 371.0m).



**Figure 7** The historical rainfall record for Mulyungarie (Station No 20016), at 31° 33'S, 140° 47'E, (elevation 90.0m).

**Table 2.** Extreme daily falls (9am to 9am) recorded at selected sites across the District.

Station	Station Number	Highest daily fall (mm)	Date	Period of Records (number of full years)
<b>Boolcoomatta Station</b>	20001	197	3 Feb 1950	1882 - 1993 (68)

<b>Curnamona</b>	20004	154	17 Feb 1950	1881 - 1993 (82)
<b>Winnininnie Station</b>	20024	149	13 Dec 1975	1891 -1993 (71)
<b>Paratoo</b>	20021	145	29 Jan 1911	1880 -1993 (82)
<b>Olary</b>	20019	140	14 Mar 1989	1928 - 1993 (39)
<b>Mount Victor 2</b>	20052	132	14 Jan 1974	1971 -1992 (21)
<b>Kalability</b>	20007	128	17 Mar 1950	1920 - 1979 (43)
<b>Panaramitee</b>	20020	126	17 Mar 1950	1901 - 1993 (63)
<b>Tepco Station</b>	20053	121	21 Oct 1938	1928 -1993 (52)
<b>Koonamore</b>	20010	114	2 Jan 1889	1888 - 1993 (72)
<b>Yunta</b>	20026	112	17 Mar 1950	1888 - 1993 (103)
<b>Lilydale Station</b>	20012	101	14 Mar 1989	1899 -1993 (60)

## **METEOROLOGICAL DROUGHT YEARS**

The term drought refers to an acute water shortage. Although the amount of available water depends largely upon storage (in the soil, in artesian basins and in dams and reservoirs) and in losses from evaporation, the best single indicator of water availability is rainfall. Gibbs and Maher (1967) showed that the years with an annual total in the first decile range (ie. the lowest 10% of falls on record) correspond well with droughts recorded in other sources. Using these guide and rainfall records from a number of Stations, 11 years since 1900 are identified as those in which drought affected extensive areas of the District. These years are 1902, 1922, 1927, 1940, 1943, 1944, 1948, 1965, 1967, 1977, and 1982.

Some droughts such as those at the turn of the century, in the late 1920s, and the early 40s, lasted beyond 12 months over large areas of the District, and the widespread drought of 1982 did not break until the second half of 1983.

More rigorous methods of analysis, (eg. as used in Drought Review Australia) will identify slightly different drought periods to those identified above, including those of shorter duration.

## **POTENTIAL EVAPORATION**

Evaporation is dependent on sunshine, temperature, humidity and wind. For any given latitude evaporation rates are generally lower on the uplands where cooler daytime temperatures occur, but persistently windy conditions around exposed ridges can counter this effect.

Evaporation values used by the Bureau of Meteorology are based upon daily rates measured by a Class 'A' Evaporimeter (fitted with bird guard). These potential evaporation values representing the amount of evaporation possible given unlimited water supply. The only routine observations representative of the area are those taken at Umberumberka Reservoir (near Broken Hill) for the period 1974 to 1985.

Average annual evaporation ranges from 2,500 mm in the south of the district to 2,800 mm in the north. [Table 3](#) shows the average monthly evaporation for the mid-season months.

**Table 3.** Average monthly evaporation estimates for the mid-season months. Estimates are to the nearest 25 mm.

	January	April	July	October
North	425	200	75	275
South	350	175	75	225

## TEMPERATURE

Temperatures are influenced by elevation and other features of the local environment. For example, maximum temperatures are reduced by around 1.0°C on average, for every 100 m increase in elevation. Minimum temperatures are also reduced at elevated sites, but cold air drainage into local depressions will also affect minimum temperature distributions.

Climatological charts of mean maximum and minimum temperatures across the District for the mid-season months, January, April, July and October are available from the Bureau of Meteorology (1988). Observed daily temperatures are available from Yunta (elevation 303 m) and the three observing sites at Broken Hill. Data from the RFDS site (elevation 252 m), has been used in this section, taking into account the shortness of record. [Figure 8](#) shows the monthly mean maximum and mean minimum temperatures for Yunta and the RFDS. The 86 percentile for maximum temperature, and the 14 percentile for minimum temperature are also shown. These give an envelope within which daily temperatures can be expected to fall on 86% of occasions or, on average, on six out of seven days. In other words, daily maximum temperatures exceed the 86 percentile on average, one day in seven, and similarly, minimum temperatures fall below the 14 percentile on average, one day in seven.

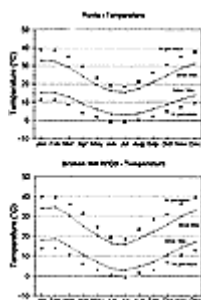
In the hotter part of the year (November to March) average daily maximum temperatures exceed 28°C, and during January and February average over 32°C. Average minimum temperatures for the period November to March are in the low to mid teens on the uplands, and the mid to high teens over lower areas. The mildest (warmest) overnight temperatures occur in January and February.

For the cooler months, (April to October), average maximum daily temperatures range from around 25°C in April and October to near 15°C in winter. In elevated areas average minimum temperatures are less than 10°C and dip to around 3°C or lower in July. At Yunta daily minimum temperatures below zero have been recorded in each month between April and October. In the north, average minimum temperatures range from the low teens in April and October to around 5°C in July, and below zero temperatures are most likely to occur in the period June to August. Yunta is regularly cited as one of the coldest towns in South Australia.

## FROST

Frosts occur in the cooler part of the year, generally on calm, clear nights when there is little moisture in the air. The frequency of frost is dependent on local surface features (including vegetation and soil moisture) and topography. Some locations, such as hollows and depressions especially in elevated areas, are more prone to frost than others. Frost is reported when ice deposits are observed or, when the ground surface temperature falls below -0.9°C - whether or not ice is observed. A minimum temperature of less than 2.2°C is a good

indicator of ground frost, while temperatures below zero indicate a heavy frost. It is this criterion which has been used to assess the frequency of frost occurrence across the District. Actual observations of white frost (ice deposits) may occur less frequently (depending on the availability of moisture). At the elevated site of Yunta, frosts have been reported throughout the period from April to November, while at Broken Hill RFDS they have been observed from April to September. On average, Yunta experiences 46 frost-days per year, with the highest frequency (10 to 12 per month) during the winter months, June to August.



**Figure 8.** Mean monthly maximum and minimum temperatures (solid lines) for Yunta and Broken Hill RFDS. The 86 percentile for maximum temperatures (square symbols) and the 14 percentile for minimum temperatures (oval symbols) are also shown. On one day in seven the maximum (minimum) temperature will exceed (not exceed) these limits.

At the RFDS site, on average 35 frost days occur each year, with the highest frequency in June and July (10 to 12 per month). The average number of days per month when the minimum temperature falls to or below, the thresholds of 2.2°C, and 0°C at the Yunta and RFDS sites are given in [Appendix C](#). It is worth comparing these sites with the residential observation site at Broken Hill. While isolated frosts have been observed in all months from May to October at this sheltered, watered site, they are most commonly restricted to the winter months, when on average, 2 frost days per month occur.

## SUNSHINE HOURS

Across the District, the annual average bright sunshine per day is 8.5 hours. It varies from 10.5 hours in January to around 7 hours in the north, and 6.5 hours in the south during July.

Appendices A, B and C contain detailed rainfall and temperature data from recording Stations in the District.

## DATA AVAILABILITY

This climatic description was prepared by the Bureau of Meteorology for the North East Pastoral Soil Conservation Board.

Weather and climate observations are available from Yunta and Broken Hill (three sites). Many more rainfall observations are undertaken by a volunteer network, and records are available from 45 observing sites in the District, although not all these are part of the national rainfall observation network in operation today. All climate and rainfall observations are quality controlled and archived in the national climate data-bank, and made available to researchers and other interested users.

More information is available from:

Bureau of Meteorology

Phone (08) 8366 2222

25 College Road (or PO Box 421)

Fax (08) 8366 2293

Kent Town, South Australia 5071

E-mail [climate.sa@bom.gov.au](mailto:climate.sa@bom.gov.au)

## GEOLOGY

This region consists of a series of low ranges, trending generally northeasterly, bounded to the north and south by the Curnamona and Murray Plains respectively ([Figure 9](#)).

Two major groups of rocks make up the ranges. The majority of the area is occupied by outcrops of sedimentary rocks 540 to 850 million years old (Adelaidean age). These rocks include quartzite, sandstone, siltstone, shale, glacial tillite, limestone and dolomite. The more resistant of these rocks such as quartzite, sandstone and tillite tend to form the more prominent outcrops and ranges. Softer, more easily eroded rocks such as shales tend to form subdued outcrop areas and broad valleys and plains filled with younger soil and sediments. The distribution of the rocks has been affected by their deformation into broad folds by tectonic forces within the earth. The ranges are also cut by major sand and gravel filled creek systems draining north to the Curnamona Plain and the Lake Frome area and south to the Murray Plains.

To the northeast in the Olary - Kalabity region, an older group of basement rocks (1,700 to 1,580 million years BP) forms low but rugged ranges and outcrops. These rocks were much more affected by heat and pressure (metamorphism) and much more deformed than the younger Adelaidean rocks. Rock types include schist, gneiss and large areas of granite which tend to form the higher hills. Again, areas of more easily eroded rocks often form sediment filled valleys and plains. Rocks of this age are similar to those which host the Broken Hill mines in NSW. Both groups of rocks have numerous small occurrences of copper, lead, zinc, gold and other minerals and the region is the subject of continuing mineral exploration by mining companies and the Department of Mines and Energy (MESA), a group within Primary Industries and Resources South Australia (PIRSA).

To the north and south of the ranges the rocks are covered by increasing depths of younger soil and sediment of Tertiary and Quaternary age (60 million years old to present day). These sediments include sand, clay and gravel derived from the ranges. The surface soil is commonly red-brown sandy clay often containing white calcrete (limestone). Coarser sand and gravel can be found close to the rock outcrop areas. Red-brown, fine dune sand is common further north on the Curnamona Plain.



**Figure 9** Geology of the North East Pastoral Soil Conservation District

## **WATER RESOURCES**

### ***HYDROGEOLOGY***

Groundwater can be found throughout the North East Pastoral Soil Conservation District. Although its quantity and quality vary considerably, reasonable stock quality groundwater (below 14,000 mg / L) is quite widespread.

In the hard rock areas of the Olary Spur, groundwater occurs in joints and fractures, with large supplies obtainable from the harder and brittle sandstones compared to the softer shales. The quality and quantity of these groundwater supplies is good and is the main source of water for stock.

In the sediment-filled watercourses and valleys, groundwater is stored between the individual grains of gravel, sand or silt. Better quality groundwater (below 5,000 mg / L) can be found where surface water collects and percolates underground.

To the south of the ranges, marginal stock water (10,000 - 14,000 mg / L) can be found in the sediments of the Murray Basin at a depth of about 100 m below ground. To the north, beneath the Curnamona Plains, suitable stock supplies are rare due to the high salinities, and little information is available. Uranium exploration near Honeymoon, at Kalkaroo discovered ancient buried river valleys which contained good supplies, however the water was too radioactive and saline for stock use.

The Great Artesian Basin does not provide groundwater resources within this District, its southern margin reaching only as far as the southern part of Quinyambie, about 30 km from the northern boundary of the District.

Some high flows of good quality sub-artesian water are available in the northern section of Mulyungarie.

### **SURFACE WATER**

The landscape of the District determines the presence and quality of water resources. The Olary Spur provides the catchment and storage for most groundwater suitable for stock in the District.

Dams are the major water supply outside the Olary Spur. Geomorphology and soil types significantly affect water capture and storage. Dams in the red-brown clay soils are more effective than those sited on the loamy yellow-brown soils. The supply and quality of bore water in the plains to the north and south of the Olary Spur is low, and used for supplementary supplies in dry seasons. These bores often do not supply enough flow to pipe water to several water points.

Roaded catchments have the potential to increase runoff to dams. Dam drains need to be surveyed and maintained to ensure that channelled runoff does not cause erosion.

Vegetation growth around dam catchments needs managing to ensure adequate runoff, and at the same time to ensure there is sufficient cover to prevent soil erosion. It is necessary to obtain approval to clear vegetation for dams, roaded catchments, and drains from the Native Vegetation Council.

The cost of harvesting, storing and distributing water is a major concern in the pastoral industry, and has implications with respect to overall grazing management practices. The high cost of improvements to the water distribution networks on properties creates limitations to expansion and development, and limits the choices for positioning of water points. Another aspect of this is that inevitably, parts of some paddocks sustain a lower overall grazing



pressure and can be maintained in good condition more easily. This poses questions about the balance between overdevelopment through improvements to maximise production and maintenance of optimum vegetation cover and composition for sustainable production in the long term.

## **VEGETATION ASSOCIATIONS**

The native vegetation of the District has been modified, in most places quite significantly from that which occurred before European settlement, which brought with it the introduction of pastoral land use and a large variety of "weed" species. Preferential grazing pressure from domestic stock, rabbits, goats and kangaroos, coupled with the inevitable periodic droughts and floods have had a major role in bringing about these changes.

A vegetation map at a scale of approximately 1:500,000 showing the current distribution of vegetation in the District is included in a pocket inside the back cover of this Plan.

The following descriptions cover the range of vegetation associations known to exist in the District. They have been simplified appropriate to the scale of mapping, and grouped into structural categories such as *woodland*, *mallee*, *shrubland*, *low shrubland* and *grassland* to assist interpretation and understanding, and are an expansion of the legend on the vegetation map. This scale of vegetation mapping cannot provide accurate detail at paddock level. It is intended for use at a regional scale, with the generalised groupings relating to the dominant vegetation types. More comprehensive vegetation information is available in the Biological Survey Reports produced by Playfair and Robinson (1997) and Forward and Robinson (1996).

### **WOODLAND**

#### ***Casuarina pauper* (black oak) Low woodland over mixed chenopod shrubs and grasses on loamy plains and footslopes.**

This community ranges in structure from an open forest to a low open woodland on a range of sandy loam to clay loam soils mainly in the southern part of the District. It is dominated by *C. pauper* (black oak), and groves of *Alectryon oleifolius* (bullock bush) and *Myoporum platycarpum* (false sandalwood) are also common in the overstorey. The understorey varies, sometimes of low diversity ranging from dense chenopods to virtually bare ground. *Atriplex vesicaria* (bladder saltbush), *Enchylaena tomentosa* (ruby saltbush), *Senna artemisioides* (desert sennas) and *Rhagodia spinescens* (spiny saltbush) are often prominent. In the north of the District, *Acacia aneura* (mulga) commonly occurs in this association, sometimes in homogeneous groves. *Maireana sedifolia* (pearl bluebush) is the second most dominant species of this community where it occurs on the southern plains.

#### ***Eucalyptus camaldulensis* (river red gum) Open woodland over sparse shrubs and grasses in watercourses.**

Throughout the District, sandy ephemeral creeklines and major drainage lines are lined with *E. camaldulensis* (river red gum). *E. largiflorens* (river box) also often occurs, most commonly in the north of the region. A variety of understorey species occur, generally consisting of sparse shrubs and tussock grasses in the hills, or annual and introduced species on the plains, but often including *Maireana pyramidata* (blackbush), *Rhagodia spinescens* (spiny saltbush), *Acacia victoriae* (elegant wattle), and introduced herbs and grasses. In the southwest of the District, *E. porosa* (mallee box) lines some watercourses. There is strong evidence that *E. camaldulensis* (river red gum) woodlands are establishing on the southern plains in creeks that drain central and eastern parts of the ranges.

#### ***Eucalyptus largiflorens* (river box) Open low woodland over sparse chenopod shrubs and grasses in drainage lines and runoff areas.**

Woodlands or low woodlands which are either sparse or very sparse, dominated by *E. largiflorens* (river box). The understorey is usually very sparse, and often composed almost completely of introduced species and annuals. There is usually no middle shrub layer. In the north of the District, this association has an understorey dominated by *Eragrostis setifolia* (neverfail), with some *Eremophila maculata* (spotted emubush) and *Eremophila longifolia* (weeping emubush). On Mulyungarie, there are significant stands of *Atriplex nummularia* (Old man saltbush).

***Eucalyptus porosa* (mallee box) Open low woodland over mixed shrubs on low hills.**

Occurs only on some hills, ridges and hillslopes in the far west and south-west of the District; the understorey is variable but often contains *Enchylaena tomentosa* (ruby saltbush), *Rhagodia parabolica* (mealy saltbush), various shrubs and ridge-top species such as *Cassinia laevis* (curry bush), *Olearia decurrens* (clammy daisy bush) and *Solanum petrophilum* (rock nightshade).

***Callitris glaucophylla* (northern cypress pine) Low woodland over sparse grasses and herbs on hillslopes and flats.**

*C. glaucophylla* (northern cypress pine) low woodlands occur in the ranges of the District, usually in gullies and on southern slopes. Other associated overstorey species include *Eucalyptus gracilis* (yorrell), *E. socialis* (beaked mallee) and *Alectryon oleifolius* (bullock bush) with *Rhagodia parabolica* (mealy saltbush), *R. spinescens* (spiny saltbush), *Dodonaea* spp. (hopbushes), *Cassinia laevis* (curry bush), *Ptilotus obovatus* (silver mulla mulla) and *Maireana pyramidata* (blackbush) in the understorey.

In the far north of the District on the NSW border, this association occurs, interspersed with very open *Acacia aneura* (mulga) woodlands and mixed shrublands on low rises and plains.

***Acacia aneura* (mulga) Very open low woodland over mixed herbs, daisies, and grasses on swales and low dunes.**

This community is very variable and ranges from very low open woodland to very open herbland. Very open grassland is also present. There are usually no significant middle level shrubs. *A. aneura* (mulga) is widespread through this community although it is often very sparse. *Enneapogon avenaceus* (bottlewashers), *Salsola kali* (roly-poly), annual daisies and *Atriplex* spp. (saltbushes) are common in the understorey.

***Acacia aneura* (mulga) Very open low woodland over sparse herbs and grasses on sandy plains and rises.**

This community is a very low woodland, or a very low open woodland dominated by *A. aneura* (mulga) or occasionally *Alectryon oleifolius* (bullock bush). The understorey is open, and mainly comprised of annual grasses and herbs. The introduced species *Brassica tournefortii* (long-fruited wild turnip) and *Schismus barbatus* (Arabian grass) are common ground covers.

## **MALLEE**

***Eucalyptus gracilis* (yorrell) / *Eucalyptus oleosa* (red mallee) / *Eucalyptus socialis* (beaked mallee) Open tree mallee over sparse mixed chenopod shrubs and grasses on loamy plains and swales.**

*E. gracilis* (yorrell) and / or *E. oleosa* (red mallee) dominate the upperstorey with *E. socialis* (beaked mallee) in the area south of Mannahill and Yunta. The understorey comprises *Zygophyllum* spp. (twinleafs), *Enchylaena tomentosa* (ruby saltbush) and a variety of middle level shrubs, including *Grevillea huegelii* (comb grevillea), *Olearia muelleri* (Mueller's daisy bush), *Senna artemisioides* (desert sennas) and chenopod shrubs.

***Eucalyptus socialis* (beaked mallee) Open tree mallee over very sparse chenopod shrubs, twinleaves and grasses on calcareous or shaly low hills and rises.**

This community is a low woodland, or open low woodland dominated by *E. socialis* (beaked mallee) mainly in calcareous or shaly hills of the central west of the District. *E. gracilis* (yorrell), *Myoporum platycarpum* (false sandalwood) and *Alectryon oleifolius* (bullock bush) are also sometimes present in the overstorey. The understorey is usually very sparse, and characterised by small chenopod shrubs, daisies and grasses and *Zygophyllum* spp. (twinleaves).

***Eucalyptus socialis* (beaked mallee) / *Eucalyptus dumosa* (white mallee) Open tree mallee over *Triodia* spp. (spinifex) and mixed shrubs on loamy sands and low dunes.**

The presence of *Triodia* spp. (spinifex) is common in this vegetation type predominantly on sand or loamy-sand low dunes in the south-western part of the District. *E. socialis* (beaked mallee) and / or *E. dumosa* (white mallee) dominate the upperstorey with *E. leptophylla* (narrow-leaf red mallee) and *E. incrassata* (ridge-fruit mallee) also occurring in the south. Other understorey species include *Eremophila glabra* (tarbush) and mixed shrubs, sometimes with chenopods in the lower shrub layer.

***Eucalyptus socialis* (beaked mallee) / *Eucalyptus gracilis* (yorrell) Open tree mallee over sparse chenopod shrubs and grasses on loams and skeletal soils in low hills and rises.**

The overstorey of *E. socialis* (beaked mallee) and / or *E. gracilis* (yorrell) may also include scattered *Callitris glaucophylla* (northern cypress pine) and *Myoporum platycarpum* (false sandalwood) with understorey species being predominantly low chenopods, grasses, spinifex and hobbushes. This vegetation type is found in the low hills and rises of the central southern ranges of the District.

## **SHRUBLAND**

***Acacia ligulata* (umbrella bush / marpoo) Open shrubland over very sparse herbs and grasses on dunes and sandy rises.**

This is a tall open shrubland dominated by *A. ligulata* (umbrella bush) and only occurring on the dunes in the far north of the District. *Callitris glaucophylla* (northern cypress pine), *Casuarina pauper* (blackoak) and *Alectryon oleifolius* (bullock bush) are present sometimes as emergents and sometimes form dense stands. The understorey is usually very sparse with occasional tussock grasses and annual herbs.

***Acacia* spp. (wattles / mulgas) / *Dodonaea* spp. (hobbushes) / *Eremophila* spp. (emubushes) / *Senna* spp. (sennas) Open shrubland over mixed shrubs, grasses and herbs in rocky hills and on sandy rises in the plains.**

This vegetation type is extremely diverse in its species mix, which is closely linked with the geology and soil texture upon which it grows.

This community is an open to dense tall shrubland dominated by *E. sturtii* (turpentine), *E. duttonii* (Harlequin fuchsia-bush), or *S. artemisioides* (desert sennas). *Rhagodia spinescens* (spiny saltbush) is usually present, often with *D. microzyga* (brilliant hobbush) as middle level shrubs and *Sclerolaena obliquicuspis* (limestone copperburr) and *Enneapogon avenaceus* (bottlewashers) in the ground layer.

Often, on low dunes and sandy rises, this group comprises a tall shrubland varying from open, to closed. *D. viscosa* (sticky hobbush) is the principal dominant species, with *E. sturtii*

(turpentine), *Casuarina pauper* (blackoak) and *S. artemisioides* (desert sennas) also locally dominant. The understorey is composed of low chenopod shrubs.

This vegetation type occurs in large patches but more usually as part of a mosaic with chenopod shrublands.

*D. viscosa* (sticky hopbush), *S. artemisioides* (desert sennas), *E. sturtii* (turpentine) and *Acacia victoriae* (elegant wattle) often occur in disturbed areas such as around dams, homesteads or yards, with the latter particularly favouring watercourses and drainage lines.

***Acacia victoriae* (elegant wattle) Tall open shrubland over *Maireana pyramidata* (blackbush) / *Rhagodia spinescens* (spiny saltbush), herbs and grasses in creeks, floodplains and plains.**

This community is usually a tall open shrubland, or tall very open shrubland dominated by *A. victoriae* (elegant wattle) occurring along minor drainage lines, river terraces and sometimes the plains. Occasionally it forms a closed shrubland. Chenopods, mainly *M. pyramidata* (blackbush) and *R. spinescens* (spiny saltbush) are prominent in the understorey. *Malvastrum americanum* (spiky malvastrum), an introduced species, is common in this community along the eastern edge of the Flinders Ranges.

***Eragrostis australasica* (canegrass) / *Muehlenbeckia florulenta* (lignum) / *Halosarcia* spp. (samphires) Shrubland on swamps, depressions and claypans.**

Exclusively found on claypans, scalds and depression areas, this vegetation type is dominated by *E. australasica* (canegrass), *M. florulenta* (lignum), and occasionally *Chenopodium nitrariaceum* (nitre goosefoot) or *Nitraria billardiarei* (nitrebush) and *Halosarcia* spp. (samphires) in more saline areas. Other plants growing in this association include *Maireana aphylla* (cottonbush), *Sclerolaena brachyptera* (short-winged copperburr), *M. pyramidata* (blackbush) and other *Sclerolaena* spp. (bindyis).

In highly saline areas this community is a low shrubland of minimal diversity, of variable density. *H. indica* (brown-headed samphire) is the most common dominant. Only a few annual species are found with samphire, most commonly *Atriplex holocarpa* (pop saltbush).

## LOW SHRUBLAND

***Maireana sedifolia* (pearl bluebush) ± *Maireana pyramidata* (blackbush) Open low shrubland over grasses on stony rises and low hills.**

A low, open shrubland often dominated by *M. sedifolia* (pearl bluebush). *Eriochiton sclerolaenoides* (woolly fruit copperburr) and *M. pyramidata* (blackbush) can also be locally dominant. Occasionally tall shrubs of *Senna* sp. or trees of *Casuarina pauper* (black oak) occur as sparse emergents.

Shrub cover in this vegetation type ranges from very open to mid-dense. Very open forms include other chenopod species such as *Sclerolaena obliquicuspis* (limestone copperburr), *E. sclerolaenoides* and *Enchylaena tomentosa* (ruby saltbush) and native grasses. Denser stands are often quite species-poor with only a herbaceous ground cover, often of *Carrichtera annua* (Ward's weed).

Further north, this association seems to be replaced by *Atriplex vesicaria* (bladder saltbush) / *M. astrotricha* (low bluebush) or *M. pyramidata* (blackbush) low shrublands, with some of the latter appearing to be degraded former *M. sedifolia* (pearl bluebush) areas.

***Maireana pyramidata* (blackbush) / *Maireana aphylla* (cottonbush) ± *Nitraria billardiarei* (nitrebush) Open low shrubland over herbs in drainage lines, runon areas and flats.**

This community is a shrubland, ranging from tall, to low and open. It is dominated by *M. pyramidata* (blackbush). In some locations it is represented by mono-specific stands of *M. pyramidata* (blackbush), and in other instances it may have shrubs of *Dodonaea* spp. (hop-bushes), *Senna* spp. (sennas), *Eremophila* spp. (emubushes) or *Acacia* spp. (wattles / mulgas) present. Introduced herbs and grasses are prominent in the understorey.

This vegetation type is abundant throughout the District, where it occurs on loamy to clay soils on plains and floodplains, predominantly in low lying areas, and occasionally on low stony hills in the north.

In some areas, this community varies from a closed, to an open shrubland, dominated by *M. aphylla* (cottonbush). *Rhagodia spinescens* (spiny saltbush) and a number of swamp habitat species such as *Muehlenbeckia florulenta* (lignum) are also found in the overstorey. The grasses *Eragrostis setifolia* (neverfail) and *Enneapogon avenaceus* (bottlewashers) are common understorey species.

In watercourses, drainage lines and floodouts, this association often includes *N. billardierei* (nitrebush), *M. aphylla* (cottonbush), *Acacia victoriae* (elegant wattle), and introduced herbs.

It is commonly believed that *M. pyramidata* (blackbush) shrublands indicate degraded former *M. sedifolia* (pearl bluebush) and *M. astrotricha* (low bluebush) areas through preferential grazing, and in severely altered areas either through grazing pressure or catastrophic flooding, *N. billardierei* (nitrebush) can become dominant.

***Maireana astrotricha* (low bluebush) ± *Atriplex vesicaria* (bladder saltbush) Open low shrubland over herbs and grasses on plains and low rises.**

The structure varies from a low shrubland to a low very open shrubland, and is dominated by *M. astrotricha* (low bluebush) on undulating plains and rises in the north and northwest of the District. Other chenopods are also present, including *A. vesicaria* (bladder saltbush) at varying densities. *Sclerolaena diacantha* (two-spined copperburr) and *S. obliquicuspis* (limestone copperburr) are prominent also. Small groves of *Casuarina pauper* (blackoak) are scattered throughout the community.

***Atriplex vesicaria* (bladder saltbush) ± *Maireana astrotricha* (low bluebush) Open low shrubland over herbs and grasses on plains and low rises.**

These shrublands are distributed widely through the northern parts of the District in plains, rises and low hills, on loamy and clay loam soils, and vary from low shrubland to low open shrubland. *Sclerolaena* spp. (copperburrs) and daisies are prominent in the understorey. Grasses can be seasonally very common. North of the highway, they often occur in areas characterised by gravel patches or patterned ground (gilgais), especially with quartz or ironstone gravels. *Maireana sedifolia* (pearl bluebush) seems to occur on what appear to be rises of deeper soils between such areas. Associated species in this vegetation type are *M. pyramidata* (blackbush), *S. obliquicuspis* (limestone copperburr) and *M. sedifolia* (pearl bluebush). This association also often occurs as understorey in mallee and black oak communities.

***Atriplex vesicaria* (bladder saltbush) Very open low shrubland over daisies, herbs and grasses on low dunes and sandy rises.**

The structure of this community varies from low open shrubland to (rarely) tall shrubland, but it is predominantly low and dominated by *A. vesicaria* (bladder saltbush) with other chenopods. *Acacia ligulata* (umbrella bush / marpoo) or *Senna artemisioides* (desert sennas) are occasionally present as emergents. The understorey is rich in daisies with *Senecio lautus* (variable groundsel) and *Rhodanthe* spp. (everlastings) being very common.

***Gunniopsis quadrifida* (Sturt's pigface) Very open low shrubland over herbs and grasses on low sandy rises and plains.**

This community ranges from a low very open, to a low medium dense shrubland, and occurs only in the far northeast of the District. *Maireana astrotricha* (low bluebush) and *Rhagodia spinescens* (spiny saltbush) are common dominant shrubs. *G. quadrifida* (Sturt's pigface) is often locally dominant and is an indicator of this community. Occasionally tall shrubs of *Eremophila sturtii* (turpentine) or *Senna* sp., or *Acacia aneura* (mulga) are present as emergents or overstorey.

***Sida petrophila* (rock sida) / *Ptilotus obovatus* (silver mulla mulla) Very open low shrubland over grasses and herbs with occasional emergent shrubs or trees on stony low hills.**

Spread throughout the District, this vegetation type grows on rocky ridge tops. Co-existing species include *Enchylaena tomentosa* (ruby saltbush), *Oxalis perennans* (native soursob), *Prostanthera striatiflora* (striated mintbush), *Chenopodium curvispicatum* (cottony goosefoot), the native ferns *Cheilanthes lasiophylla* and *C. sieberi* in sheltered crevices, grasses, low chenopods and occasionally larger shrubs such as *Dodonaea* spp. (hop-bushes) and *Cassinia* spp. (curry bushes).

This is very low woodland, to very low open woodland where the dominant overstorey species is *Acacia aneura* (mulga). The understorey varies from dense shrubs, to very open herbs and grasses depending on the grazing pressure which has occurred at the site.

Isolated trees sometimes occur on these ridges, such as *Eucalyptus porosa* (mallee box) in the northwest and *A. aneura* (mulga) and occasionally *E. gracilis* (yorrell) and *E. socialis* (beaked mallee) in the low hills of the Olary Spur.

## **GRASSLAND**

**Mixed open grassland / herbland of varied dominants; *Danthonia* spp. (wallaby grasses), *Stipa* spp. (spear grasses), *Asphodelus fistulosus* (Onion weed), *Carrichtera annua* (Ward's weed), or *Sclerolaena* spp. (bindyis) often with sparse emergent trees or shrubs on plains, rises and low hills.**

This vegetation type is common and extremely variable, scattered throughout the District on many landform types. It includes very open to mid-dense grasslands, herblands and very low chenopod shrublands. The grasslands are sometimes dominated by the native *Danthonia* spp. (wallaby grasses) and *Stipa* spp. (spear grasses) and in localised areas *Enneapogon intermedius*, *E. avenaceus* (tall and common bottlewashers) and *Stipa scabra* group (rough spear grass), *S. acrocliliata* or *S. elegantissima* (elegant spear grass). In some areas particularly in the south of the District, introduced grasses, particularly *Critesion murinum* (barley grass) and *Bromus rubens* (red brome grass) dominate large areas. The herblands are often dominated by introduced annuals, like *Carrichtera annua* (Ward's weed), *Asphodelus fistulosus* (Onion weed), *Marrubium vulgare* (Horehound), *Salvia verbenaca* (wild sage), but also include natives such as *Erodium* spp. (stork's bills) and *Tetragonia tetragonoides* (New Zealand spinach), as well as some introduced grass species. They occur in disturbed areas around dams, yards, buildings, watercourses and drainage lines.

This community is sometimes a low open, or low very open shrubland dominated by *Sclerolaena divaricata* (poverty bush) or an open low shrubland dominated by *S. obliquicuspis* (limestone copperburr), or herbfield dominated by various introduced species including *A. fistulosus* (Onion weed) and *C. annua* (Ward's weed).

A mixture of emergent trees and shrubs is also a significant part of this vegetation type. Most commonly the trees are *Myoporum platycarpum* (false sandalwood) and *Alectryon oleifolius* (bullock bush) but also include isolated *Casuarina pauper* (black oak), *Eucalyptus* spp.

(mallees) and *Acacia aneura* (mulga), the latter particularly in the north. *Maireana pyramidata* (blackbush) also frequently occurs in conjunction with this association.

On shaly hills, this vegetation type varies from a very open shrubland, commonly consisting of *Acacia tetragonophylla* (dead finish), *A. victoriae* (elegant wattle), *A. aneura* (mulga) and *Eremophila freelingii* (rock fuchsia-bush) over sparse low shrubs of *Senna* spp. (sennas) and *Dodonaea lobulata* (lobed hop-bush) with *Solanum* spp. (nightshades) and *Enneapogon* spp. (bottleshwashers) in the ground layer, to an open to very open tussock grassland with very sparse emergent shrubs. This structural variation occurs within a similar suite of species, but with differing densities.

## **BARREN LAND**

Significant areas devoid of any vegetation cover have been mapped as barren land.

## **LAND USE**

### **ABORIGINAL**

Prior to settlement by pastoralists, Aboriginal people occupied some areas of the District on a temporary basis during good seasons. The lack of permanent water in the area prevented permanent occupation.

The major traditional Aboriginal group of the area were the Ngadjuri (Tindale, 1974), who occupied the Central Mount Lofty Ranges and the areas around Roberstown and Mannahill in the east. At the time of white arrival in the area, the Ngadjuri were involved in aggressive exchanges with the Murray River groups near Morgan. Descendants of the Ngadjuri apparently lived a traditional existence as late as 1905 in the Quorn area to the northwest of Peterborough (Long *et al.*, 1995).

In the Olary area, part of Ngadjuri territory, more than a hundred thousand engravings are estimated to exist, and the area around these hills was an abutment of four different groups of Aboriginal people. This made the area a very significant gathering place for ceremonial and social interaction such as trade. Records show that Aboriginal people left the area in 1892 for 'sanctuary at Poolamacca' in the Barrier Ranges, NSW. During the late 19<sup>th</sup> century, the area carried a European population of miners, prospectors, and sheep station staff well in excess of the present day's. Conflict over water and game supplies may well have driven the Aboriginal groups back to their heartlands (Hobbs, 1992).

### **PASTORAL**

The establishment of the South Australian colony in 1836 was followed by rapid settlement of the land. The inland was regarded as a huge untapped resource but it lacked water suitable for domestic and stock use. Few of the early grazing licences issued under the Waste Lands Act of 1842 extended beyond the 250 mm rainfall line which now defines the southern margin of the pastoral land.

Early grazing of the rangelands took advantage of wet seasons by herding stock out into the unsettled areas after heavy rain and retreating to established properties as the country dried out.

### **Leases**

The first pastoral leases were issued in 1851 with a 14 year term. This short term was to prevent any land suitable for subdivision for agriculture being tied up for pastoral purposes.

The short term leases also discouraged extensive 'improvement', for which pastoralists would have to be compensated when the land was resumed for subsequent lease / sale.

Since 1899 most pastoral leases have been for 42 years.

In the early days the Government tried to encourage development by setting minimum stock numbers and set spending on improvements. The current policy is towards maximum stocking rates and conservation of resources to ensure sustainable yield from the land.

## ***Legislation Affecting Pastoral Tenure and Land Management***

The first Pastoral Act was passed in 1893 and established three classes of land depending on its distance from a railhead. Amendments to this Act in 1895 created a Pastoral Board which administered all unoccupied land under consideration for leases, and all abandoned leases.

In 1897 a Royal Commission was held on the condition of the pastoral lands and to report on the action which should be taken by Parliament to induce the occupation and development of the pastoral lands. The Commission recommended that the land classification system be abolished and new lease terms and conditions be introduced. The term of 42 years grew out of this report, but for some time afterwards, 21 year leases were still issued, though gradually 42 year leases replaced 21 year leases.

In 1926 another Commission of Inquiry was appointed to report on tenure, land classification and any conditions that would be imposed with any alteration of tenure. A new classification of lands was recommended, with the value based on average rainfall, proximity to rail or seaports, and accessibility to markets.

Despite evidence of stock causing land degradation since 1861, it was not until 1939 that the *Pastoral Act 1936* was amended to include a provision for the Pastoral Board to limit the number of stock on a lease where the land was likely to be permanently damaged if the stock remained. This amendment was also incorporated under the *Soil Conservation Act 1939* following reports of soil erosion on the pastoral lands. Included in the amendments were provisions for the control of inappropriate stocking levels and a reduction in the requirement for a minimum stocking level. This amendment also allowed the Pastoral Board to place a maximum stocking rate in the lease covenants.

This was the first period where overgrazing by stock had been recognised as a major cause of land degradation. Up until this time degradation was attributed to rabbits and drought (Tynan 1992).

*The Pastoral Land Management and Conservation Act 1989* is the latest legislation affecting the pastoral lands. This Act places emphasis on the maintenance or improvement of the condition of the land, and provides several avenues for the prevention of land degradation, including destocking when the Pastoral Board considers there is a likelihood of damage from stock grazing, or from any other cause.

Amendments to the *Pastoral Land Management and Conservation Act 1989* have been delayed until the situation regarding land claims under the *Native Title Act 1993* have been clarified. Appendices E and F contain background information regarding the implications of provisions of the *Native Title Act 1993* and recent High Court decisions.

These amendments will recognise the 407,000 square kilometres of pastoral lease in South Australia as *rangelands*. The Pastoral Board will be expanded to an 8 member Rangeland Board. Amendments will cover tenure security, resource monitoring, multiple use demands, diversification opportunities, the aspirations of Aboriginal people and the travel interests of the greater Australian community.



## **Development of the Pastoral Industry**

Some of the significant eras in the development of the pastoral industry in this District are briefly outlined below:

### **1850 – 1890**

Establishment of the large pastoral runs (Oulnina, Outalpa etc.), reliant on high labour inputs (shepherds etc.) and sparse water points, often springs or other 'natural' waters.

### **1890 – 1910**

Increased subdivision of the large runs into paddocks as fencing became more common and more reliance on use of wells, dams and bores, rather than springs and other natural supplies.

### **1910 - 1940**

Carve-up and sale of the large runs into smaller properties, (eg. Oulnina – 1911, the beginnings of the current property boundaries). Period of high stocking during reconstruction years following World War 1.

### **1946**

The dog fence legislation became enacted. The dingo-proof fence, while not an absolute barrier to dogs due to maintenance difficulty, made it possible to maintain the sheep industry south of the fence.

### **1940 – 1970**

Increasing intensive developments, with creation of smaller paddocks into current station layout. Reconstruction after World War 2 brought high wool prices encouraging high stocking rates, though not as high as previous rates. Stocking rates generally declined in the later 1960s. First successful attempts at extensive rabbit control.

### **1970 -2000**

Extensive redevelopment of stations through desire to get water away from historically used waters, greatly facilitated through use of polypipe, but also necessitated through replacement of fences etc. erected early in

1940 –1970 development period. Ethos of land management changed from developmental considerations mainly to production with conservation.

It was realised very early that this District was exceptionally good sheep country, in terms of wool per head, effective lambing and healthy disease free stock.

The pioneers found expansion slow and difficult because of the lack of reliable water supplies. They had to learn how to establish and manage waters and to handle the unfamiliar pastures. A few disastrous droughts showed that if stock routes dried out, stock could not be moved back to safer country.

Pastoralists have continued to use their experience to improve management, and ongoing research continues to build up knowledge and expertise. Individual pastoralists have carried out many projects in attempts to regenerate degraded land, and Government agencies have also undertaken trials and research.

In 1982 the Department of Agriculture began the Mannahill - Olary project, with the aim of promoting re-establishment of perennial plants using mechanical soil treatments and sensible management strategies. This project treated 6,000 hectares on 17 properties with contour furrows or disc pitting and created nation-wide interest.

### **History of the Main Resource: Vegetation**

The pastoral country is noted for dramatic short-term changes in vegetation as the rainfall comes and goes. There have been some significant events which have had long term effects.

#### **1850 - 70**

When the country was first stocked, perennial bush was thinned and pruned by grazing stock and replaced by a greater density of grasses and herbs. The resulting improved pasture, with good water supply and dingo numbers controlled, allowed the build up of both stock and kangaroo numbers. The perception at the time was that the land seemed to carry the total grazing pressure well.

Droving was the only way to transport stock to and from market and shearing sheds. Very large mobs of stock moving along the official Travelling Stock Routes as well as unofficial routes, was a major cause of severe degradation of these areas. This degradation is still visible today, particularly from the air, in aerial photographs and satellite imagery. Mobs of 10,000 sheep would be driven along these routes at weekly intervals denuding the vegetation and pulverising the soil. Pastoral lessees were obliged to let travelling stock pass through.

#### **1880 - 90**

Rabbits spread throughout the District. Their grazing pressure prevented regeneration of trees and perennial bush. Drought and financial depression on top of the uncontrollable grazing pressure of rabbits caused widespread soil erosion.

There were huge demands on timber for firewood and fencing, and also to fuel steam engines for water pumps. Many thousands of tons of timber were cut for the Broken Hill mines from as far away as Mannahill.

By 1910 woodcutters were required to obtain a licence and only dead timber was permitted to be taken.

#### **1950 - 51**

Myxomatosis almost eradicated the rabbits. Coinciding with good seasons, this caused a massive increase in all plant life. Young trees became established for the first time in 60 years.

Kangaroo numbers immediately rose but steadied as the meat industry developed. The good seasons and a boom in wool prices pushed sheep numbers up. The rabbit industry disappeared for a few years until rabbits began to develop immunity to myxomatosis.

#### **1971 - 75**

Flood rains, mainly in summer brought on significant plant growth. With rabbit numbers still only moderate, there was a huge regeneration of trees, woody shrubs, blackbush, nitrebush and a heavy growth of summer grasses. This was followed by bushfires.

Kangaroo numbers ran out of control and goats increased and spread to new country.

#### **1995 - 96**

Rabbit Calicivirus Disease (RCD) escaped from the Wardang Island experimental station in October, and by the end of 1995 had spread into the North East Soil Conservation District, wiping out a large percentage of the adult rabbits. Many young rabbits, although immune to RCD, were killed by myxomatosis, which is still effective in places. As the summer of 1995 - 96 advanced, the spread of RCD slowed. In March 1996 reports of the virus were confirmed in central Victoria and a nation-wide release took place in October 1996.

## 1997

An exceptional flood in February 1997 significantly altered the vegetation characteristics of some areas, changing the courses of the creeks, removing vegetation and damaging many property improvements over large areas in the District.

## **Present Situation**

The dominant land use continues to be the grazing of sheep and some cattle on native vegetation. At present any other land uses require the approval of the Pastoral Board.

Some of the biggest challenges to pastoral land management are the low, variable and unpredictable rainfall, recurring severe droughts, feral animals (particularly rabbits and goats), and the spread of noxious weeds.

Efficiency of sheep-based products is improving, yielding increased returns. Improved technology and management strategies include the availability and use of polyethylene pipe, better machinery and vehicles (including stock transports), portable yards, better fencing products, UHF radios, telecommunications, and information availability. These technologies have enabled graziers to breed and maintain better flocks with fewer sheep producing more wool and lambs.

The practical, financial and political factors which continue to affect the pastoral industry are:

- Uncertainty of land tenure:
  - Currently (1997), amendments are pending to *the Pastoral Land Management and Conservation Act 1989*. The process has been delayed by the uncertainty regarding native title claims over pastoral leases. The amendments, if passed, provide for perpetual lease and hence better security of tenure.
  - A considerable part of the North East Pastoral Soil Conservation District area lies within the Lake Eyre / Lake Frome catchment, currently under assessment for World Heritage listing. Implications of any resulting management plan on the pastoral industry are unknown.
- Fluctuating commodity prices and terms of trade. The future of the wool industry since the Reserve Price Plan finally collapsed is uncertain.
- The taxation system is not designed for the long-term financial requirements of pastoralists with highly variable income.
- Lobbying of Governments must be continued to have financial requirements recognised as an industry problem rather than having financial hardship treated as a welfare matter.
- The kangaroo industry for meat and skins has the potential to grow. Lessees need to be able to manage kangaroos to ensure grazing pressure is sustainable. The third broad aim of the South Australian Kangaroo Management Program is 'to mitigate damage to vegetation and the pastoral industry caused by high populations of kangaroos'. This program enables lessees to become more involved in marketing the products from kangaroos harvested from their lease.

- The feral goat industry will continue until the numbers are reduced through the policy of eradication.
- The rabbit industry collapsed following the Rabbit Calicivirus Disease outbreak in the District in 1995.

## **MINING**

Many different minerals have been mined along the Olary Spur in many small operations. Gold at Teetulpa, Waukaringa, Wadnaminga, copper at Mutooroo and Dome Rock and uranium at Radium Hill, Crocker's Well and Honeymoon were some operations.

Radium Hill was a large producer of uranium. Infrastructure to the mine and the service town of 1,200 people included a railway branch line, powerline and water pipeline line. Production began in 1951. The mine closed, the town was dismantled, and assets sold in 1961.

Exploration for minerals in the District fluctuates as new methods become available or taxation concessions change.

With the decreasing production from Broken Hill, there has been a large exploration effort since 1995 as the SA, NSW and Federal Governments have cooperated with exploration companies to locate ore bodies similar to the Broken Hill lode in the District.

### **Present Situation**

No mines of any significance are currently operating. Extraction leases are obtainable.

## **TOURISM**

Tourism has a low profile in this District. While tourist numbers have increased overall in the outback, this area lies between the big tourist attractions of Broken Hill, the Riverland, the Flinders Ranges and Coopers Creek.

### **Present Situation**

The potential for eco-tourism is quite good. There is a wide variety of animals, birds, reptiles, plants and minerals to be studied. Some Station properties (such as Wompinnie and Bulloo Creek) are developing this potential with some success. Eco-tourism ventures also include pastoral demonstrations such as shearing, or other historically related aspects such as leather and iron work or horse handling. Old mining methods are potential subjects also.

## **LAND USE OPPORTUNITIES**

The quality of the underground water (high sodium and magnesium content) and the sodium content of the soil restricts opportunities for arid land horticulture. Most bores have a restricted supply and would not produce quantities adequate for the irrigation of commercial crops.

Emu, ostrich and alpaca enterprises would involve feedlotting during at least part of the year. Feedlotting would require overstocking the feedlot areas and their consequent denudation. Fencing and infrastructure costs for establishing these industries are high. With the price of the products and the cost of husbandry, these industries are unlikely to be profitable. Under current legislation, only the stocking of cattle and sheep have automatic approval. There is provision for stocking of any animal, but Ministerial or Pastoral Board approval is required.

Kangaroo harvesting, when done by pastoralists using their own allocation under the Kangaroo Management Program administered by DEHAA, provides supplementary income for pastoral enterprises.

The current policy of the Soil Board is for goat eradication precluding goat husbandry as a potential land use.

Yabby farming in dams is a seasonal enterprise and can provide a reasonable income. There are technical problems which need to be resolved to increase the success of this opportunity.

Fish farming may also be possible but commercial viability would need to be assessed.

## **INFRASTRUCTURE AND SERVICES**

### **TRANSPORT**

The first transport through the North East provided services to miners and pastoralists in the Barrier Ranges, Broken Hill and Silverton. Drovers and freight wagons used the old road which followed the most reliable waters from Terowie through Winnininnie, Mannahill, Mingary and Cockburn. Stage coaches ran as far as Boolcomatta in 1878.

As motor traffic replaced horses and bullocks the main road to Broken Hill ran from Burra along the Peg Line through Lilydale and Mutooroo to Cockburn. Later a road was established through Quondong, Oakbank, Mutooroo and Cockburn.

The railway line from Peterborough to Cockburn was completed in 1887. The road through Mutooroo was still preferred until the rough washed out track along the railway line was upgraded with bridges and culverts during the 1930s. This became the Barrier Highway and was sealed all the way by the late 1960s.

The railway was converted to standard gauge in the mid 1970s (from 3 feet, 6 inches to 4 feet, 8½ inches) but all railway Stations between Broken Hill and Peterborough have been closed and railway stock trucking yards dismantled. Only a few maintenance gangs for rail and road are left in the area.

Today stock and wool are moved to market by motor transport. Motorcycles, four-wheel-drive vehicles and aeroplanes have long since replaced the horse for mustering or checking waters.

An unsealed tourist road runs north from Yunta to the Flinders Ranges and south from Yunta to the Riverland. Mail roads through the area have been improved and maintained since 1946, firstly by the Engineering and Water Supply Department, and in recent years by the Department of Transport.

### **COMMUNICATIONS**

A weekly mail service delivered mailbags to each Station along with correspondence school lessons, newspapers, magazines, stores and supplies. The arrival of the mail truck was, in the early days, the big event of the week.

The Ding's ran a carrier service in the outback which included several mail runs. The first two-way radio network in the District was set up by Harry Ding of Yunta. Ding's were able to provide a service to the Stations equipping trucks with radios before the RFDS extended into South Australia.

Telephones were installed from town to town in the early 1900s, and the majority of Stations were connected to their nearest town by the mid 1920s. From about 1935, homesteads not on the phone could apply for a Flying Doctor Pedal Wireless. The South Australian Railways had its own telegraph line linking the five towns and six fettlers cottages between Paratoo and Cockburn.

Radio links and underground cables have now replaced the overhead wires and automatic exchanges with fax and computer facilities replacing the manual exchanges at Yunta, Mannahill, Olary, Mingary and Cockburn. A coaxial cable and a microwave link run alongside the railway carrying local, interstate and international communications. In early 1996 fibre optic cables were installed along the same route. Mobile telephone networks cover some of the District and satellite telephones and services are available.

UHF radio is widely used by the transport and pastoral industries and television can be received from Broken Hill, Port Pirie or by satellite dish.

## **EDUCATION**

The population of the area has dropped dramatically as the number of pastoral and railway workers dwindle. Some large Stations, mining townships and the five railway towns all had their own schools in the past. Yunta is the only school operating in the District; some children from the Cockburn area go to school in Broken Hill.

Children living on Stations receive lessons and tuition from the Open Access College and the School of the Air.

Secondary school students usually attend a school with boarding facilities. Secondary schooling is also available through the Open Access College.

## ***OTHER SERVICES***

### **Water**

The four towns Cockburn, Olary, Mannahill and Yunta have water storage dams and supply systems operated by Water SA (formerly the Engineering and Water Supply Department). When the dams which provide these water supplies become dry, water is carted by rail to augment supply. This water supply service provided by Water SA costs the consumer four times the price of water in Adelaide.

All pastoral Stations provide and maintain their own water storage and supply systems.

### **Electricity**

Cockburn is supplied with electrical power from the Broken Hill grid. Olary has a private power supply and the Office of Energy has supplied the power for Mannahill and Yunta since 01/07/97.

### **Community Services**

There are police Stations at Yunta, Mannahill and Cockburn with one officer at each.

Fire trucks and State Emergency Service vehicles are stationed at Yunta and Cockburn.

Ambulance services to the District are stationed at Yunta, Broken Hill and Peterborough. The Royal Flying Doctor Service base at Broken Hill holds regular clinics at several locations in the District. Clinics are provided on request.

## **LAND TENURE**

There are several types of land tenure in the North East Pastoral Soil Conservation District, each affected and managed by different State legislation. The major classes of tenure are freehold and leasehold.

The forms of tenure occurring within the District include:

- Pastoral Lease
- Perpetual Lease
- Freehold Land
- Miscellaneous Leases
- Reserves
- Unallotted Crown Land
- Mining and Mineral Exploration Leases

## **PASTORAL LEASE**

Pastoral leasehold land is Crown Land leased under the *Pastoral Land Management and Conservation Act 1989* for a 42 year renewable term. A 14 year extension of term of pastoral leases may be offered by the Board in the last year of each 14 year period of the term and after an assessment of the condition of the land by the Pastoral Board. The lease may include land management conditions providing for the following matters:

- the species of animals depastured on the land;
- maximum stocking levels for the lease;
- the purposes to which the land is put;
- maintenance of existing fencing and constructed stock watering points; and
- rehabilitation of degraded land.

The Pastoral Board may vary the land management conditions on a lease, if the lease has been assessed as required by the Act, and notice is given to the lessee in writing at least 4 months before the variation takes effect.

Pastoral lessees must obtain permission from the Pastoral Board to increase stock numbers beyond the maximum set for the lease, to take stock on agistment or to change land use. Pastoral leases are subject to inspection by Pastoral Inspectors and to land condition assessment.

## **PERPETUAL LEASE**

Perpetual leases are leases issued by the crown entitling the lessee, the lessee's heirs and assigns, to use a particular area of land for a specific purpose, usually agriculture, forever.

There are 25 or so different types of perpetual lease, all having different covenants and conditions. In many cases the covenants and conditions are outdated (eg. erect no brush fences), or have been superseded by other legislation (eg. control of weeds and rabbits). The rental on perpetual leases is generally fixed and not subject to review; most rentals are less than \$25 per annum.

The payment of an annual rental and the need to obtain approvals to effect transactions on a perpetual lease appears to be the only real difference between perpetual leasehold and

freehold titles, but the Crown retains a residual 15% interest on the land value of perpetual leases.

Marginal Lands Perpetual Leases are issued under the *Marginal Lands Act 1940*. Covenants on these leases require the following conservation practices:

- to reserve 5 acres in every 250 acres for the growth of timber which shall not be destroyed;
- to set apart and keep reserved for the purpose of preventing soil erosion areas covered with natural scrub growth, not to exceed one tenth of the area of the lease;
- to destroy and keep the lease free of vermin.

The current government policy on the administration of Perpetual Leases includes the following provisions:

"To treat perpetual leasehold land as freehold recognising the financial interest of Government and within the constraint that perpetual leaseholders are tenants."

"Perpetual leases of all types will be subject to the provisions of the *Soil Conservation and Land Care Act 1989* as if they were held in freehold title."

## **FREEHOLD LAND**

The land is held in fee simple, the interest in the land can be inherited. Properties in the townships of Yunta, Olary, Mannahill and Cockburn are freehold. Some small sections within perpetual and pastoral leasehold areas are also freehold.

## **MISCELLANEOUS LEASES**

Miscellaneous leases are issued for less than 21 years for a variety of purposes and on whatever terms and conditions the relevant Minister deems appropriate.

## **RESERVES**

There are several types of reserves created under various Acts generally for specific public purposes. They can be placed under the care, control and management of Government, or incorporated under community bodies or, they can become the responsibility of a particular body by virtue of the Act under which they were created (eg. National Parks).

Some of the purposes of reserves include:

- recreation, water and conservation reserves;
- public utilities, eg. railways, cemeteries, roads, stock routes or municipal buildings;
- parklands and sanctuaries.

Reserves cannot be transferred or mortgaged but may sometimes be leased by the managing authority. Reserves under the *Crown Lands Act 1929* may revert to the Crown if they are no longer used or required for the purposes of the reservation.

## **UNALLOTTED CROWN LAND**

Unallotted Crown land in this State is confined to areas of waterfront both river and sea, and reverted reserves. Crown land is public land and the public is entitled to access, and may camp on it on a temporary basis.



## **MINING AND MINERAL EXTRACTION LEASES**

These leases are agreements between the lessees and the Government which give the lessees the right to mine or explore for minerals in accordance with the *Mining Act 1971* and the *Mines and Works Inspection Act 1920*.

The term of the lease is usually 1 or 2 years for exploration, and 7 years for production, with entitlement to renewal provided the lessee complies with the lease conditions, covenants and the legislation. Where mining lease applications cover pastoral leasehold land, negotiation with the pastoralist is necessary. [Appendix G](#) contains guidelines for maintaining good relations between pastoralists and mining exploration companies.

One of the conditions of leases is that the miner prepares a plan identifying how the mining will progress, and the methods and timing of the rehabilitation of the site.

Rights and obligations of miners and pastoral lessees are briefly outlined in the Land Management section on p.65.

**Regardless of the form of tenure  
the *Soil Conservation and Land Care Act 1989*  
gives all land managers  
the common responsibility of sustainable land management.**

## ***THE DOG FENCE***

The Dog Fence forms the northern perimeter of the District. The Dog Fence is administered under the *Dog Fence Act 1946* and is important to the survival of the sheep industry throughout South Australia.

Pastoral occupation of the arid lands was well established by the 1860s and sheep flocks had grown to hundreds of thousands. Dingoes quickly became a major problem for the management of these flocks and shepherds were used to keep deaths under control. It was realised very soon that some form of dingo proof fencing was required if sheep production was to be maintained. Individual landholders began fencing and gradually cooperatives, later called Vermin Districts, developed to patrol and maintain the dingo - proof cells which evolved.

The idea of a continuous fence running from the NSW border to the Great Australian Bight was formalised in 1946 by the *Dog Fence Act*, which also established the Dog Fence Board to administer, patrol and organise maintenance of the fence.

A new system is currently being put in place where pastoralists are no longer required to maintain their sections of the Dog Fence. Local Dog Fence Boards are being set up to undertake the day to day management of the various sections of the fence in South Australia. The local Boards use contractors who conduct fortnightly patrols to monitor and maintain the Dog Fence.

A fence supervisor inspects the entire 2,230 km four times per year. The cost of maintaining the Dog Fence in South Australia is met through a levy on all property holdings larger than 10 km<sup>2</sup> south of the fence and is subsidised dollar for dollar by the State Government.



*The Dog Fence runs along the northern boundary of the District.*

Electrification of some sections in other parts of the state has had promising results. Future management in this District may include this as a tool.

## **LAND MANAGEMENT**

The following issues and their importance in the sustainable management of the land resource are discussed in this section:

### **RANGELAND CONDITION**

Rangeland condition is the '*health*' of the plant and soil resources relative to their potential in a particular land type and climatic environment.

In the North East Pastoral Soil Conservation District the production of sheep and cattle is wholly dependent on native vegetation as the grazing resource. The sustainable management of the land must therefore aim to conserve the condition of the rangeland, which includes the density and diversity of the vegetation, and its ability to respond to seasonal influences, (eg, put on fresh growth and set seed in response to rain; provide adequate root stock to reshoot after drought).

Plants can be used as indicators of rangeland condition or the 'health' of the vegetation or pasture. The grazing impact on palatable species needs to be managed so that these species are maintained in the pasture. Where the mixture of species is altered, degradation of the plant community has occurred.

Alterations to the soil resource which result in a decline in the quality and condition of the soil is called soil degradation. Soil degradation in the pastoral areas is accelerated (compared with natural) wind or water erosion, most often resulting from removal of the vegetation and/or stone or lichen soil surface cover. Accelerated erosion includes gullying, soil drift and scalding, and results in the loss of nutrients and top soil. Where the soil environment is changed the plant community will also change. Weeds are likely to establish in degraded areas and production will often be decreased in the long term.

Changes in rangeland condition may occur over short or long periods and may be reversible, irreversible and detrimental or advantageous to long term productivity. Rangeland condition is often a reflection of past management. In some areas the vegetation has been converted where one vegetation type has been replaced by another in response to land management. These converted vegetation types may be stable and productive.

### **MANAGEMENT OF RANGELAND CONDITION**

The management of the vegetation resource is the key to the health of rangelands. Vegetation:

- protects the soil from erosion;
- provides pasture for stock and native animals;
- provides habitat for wildlife and contributes to biodiversity.

Perennial shrubs and trees provide year round protection to the soil. Stock need to be managed to ensure that the mix and density of perennials is maintained and, in degraded areas, improved. The condition of the vegetation needs to be monitored closely and managed to allow for seed set and seedling establishment. Management of the vegetation resource needs also to recognise the stresses of drought; in very dry seasons annual plant cover and a proportion of the perennial cover will die and be removed by wind. During drought, the vegetation resource needs to be spared the additional stress of stock and feral animal grazing.

*To manage the health of the vegetation resource total grazing pressure needs to be managed through:*

- stocking paddocks with numbers appropriate to the condition of the vegetation and season, and destocking paddocks before vegetation is damaged beyond its ability to 'come back';
- controlling or eradicating feral animals;
- placing waters and fences to encourage even spread of grazing pressure;
- monitoring vegetation and stock condition continually;
- selling cull and older stock at correct time.

*Indicators of loss of rangeland condition resulting from high grazing pressure are:*

- loss of the more palatable perennial species and/or, remaining perennial species in poor condition;
- replacement of perennial species with annual and ephemeral species;
- replacement of palatable species with less palatable species, eg. replacement of bladder saltbush or bluebush with nitrebush;
- invasion of weedy shrubs eg. hopbush, turpentine;
- bare unstable soil surfaces with associated water and wind erosion;
- increased grazing of less palatable species.

Grazing pressure is highest where stock congregate, such as watering points, yards, around shearing sheds, dam catchments and 'camping' areas. Poorly positioned waters are a major cause of poor rangeland condition.

Degradation of rangelands has occurred since pastoralism was established in the District. On most leases degradation is a historic problem due to past stock management practices, a lack of infrastructure (water and fences), and little understanding of the carrying capacity of the land by both government and land managers.

Rangeland degradation is visible along old stock routes, areas cleared for cropping, old waters, around current waters and shearing sheds, in rabbit and goat infested areas and areas historically overgrazed. In some areas, past overgrazing has contributed to increased runoff and the accelerated erosion of watercourses.

Some areas are considered sacrifice areas. Sacrifice areas are acceptably small areas of degradation associated with stock management and husbandry infrastructure such as near waters and in holding yards.

Degradation problems of the future are more likely to be related to infestations of introduced and woody weeds rather than to erosion issues.

## **Stock management**

Stock management is the most effective means available to pastoralists for the management of native pasture resources. Stock grazing and watering patterns are managed through the placement of water points and fencing.

Factors which need to be considered when determining the stocking regime for each paddock, or on each water are:

- water supply;
- feed supply;
- soil, land and vegetation type;
- vegetation condition;

- season;
- fencing and water location;
- total grazing pressure.

### **Water**

Sheep typically consume 7 - 8 litres of water per day and cattle consume up to 60 litres per day. Stock usually drink at least once every two days and in dry seasons once or twice per day. To prevent stress to the vegetation and compaction of soils near waters it is important that the stock can obtain a drink as quickly as possible so they do not wait around the water point to drink.

Cattle require better quality water than sheep. Dry beef cattle will tolerate up to 10,000 ppm salts and adult dry sheep up to 13,000 ppm salts. Lactating stock, lambs and calves require water in the 5 - 6,000 ppm range or better.

Wethers are generally run on the poorer quality waters as they can tolerate a higher salt content than breeding ewes. Saline water reduces the distance stock will walk for feed hence reducing the grazing radius (or watered area) of the paddock. Ewes and lambs require better quality water to maintain condition, and if placed on poor quality water will stay around the water point putting pressure on the nearby vegetation and will break up the soil surface. In these situations, stock numbers need to be adjusted accordingly.

Water quality and availability are the biggest limiting factor in the ability of rangelands to carry stock.

### **Feed**

*Annual feed* - The timing and amount of rainfall determines the type and quantity of annual feed. Winter rains produce annual herbs, and winter growing grasses. Summer rains promote the growth of summer grasses.

The annual grasses and herbs provide the bulk of nutritious, palatable feed. These more palatable annual species are selected in preference to perennial vegetation by stock. As the quantity of annual vegetation diminishes, stock turn to the perennial vegetation for feed. Whilst stock are grazing mainly on green feed their requirement for water is reduced. Dry annual trefoil and clover provide nutritious feed for many months.

*Perennial feed* - Many perennial bush species of shrublands are palatable to stock. These include bladder saltbush, low bluebush, pearl bluebush and black bluebush. Stock grazing on perennial bush require more and fresher water because, although quite nutritious, perennial bush is high in salts.

Perennial grasses such as Mitchell grass and neverfail, and native millet which occur in gilgais and some creeks, are a valuable source of feed when green. These grasses are of low nutritional value when dry.

### **Soil, land and vegetation type**

The carrying capacity of the land type must be considered when placing stock in paddocks. Land types vary in their productivity and resilience. Highly productive and resilient land types such as the saltbush plains can sustain higher stocking rates than less productive and / or more erodible land types such as the mallee.

The age and experience of the stock must also be considered when placing stock in paddocks. Sheep which know a particular paddock and the location of the waters in the paddock require less attention than sheep new to a paddock. Dry sheep, wethers, and older more experienced

sheep are generally located in larger and rougher paddocks, ewes and lambs in the more productive paddocks.

### ***Vegetation Condition***

The condition of the vegetation and soil resource within a paddock must be considered in planning paddock management. The objectives of sustainable management of soils and vegetation are to:

- maintain vegetation diversity and density
- allow bush and grasses to seed, and to ensure future recruitment and establishment of perennials and annuals
- prevent soil erosion by maintaining soil surface cover
- ensure sustainable pastoralism into the future

Monitoring the condition of the vegetation is the best way of determining whether management strategies are achieving these objectives. The simplest method of monitoring is by establishing a photopoint ie. photographing a marked site and keeping notes about the plants present, season and stock movements. The site is marked so that future monitoring can be done at the same sites thereby establishing a long-term record of changes in condition.

### ***Season***

The season in which rain falls will affect the type of plant growth. Summer rainfalls promote the growth of mostly perennial grasses and a quick response by annuals on sandy soils. Annuals may however be quickly 'cut off' by dry winds. Above average summer and autumn rains with follow-up rain promote germination and growth of perennial shrub and tree species. In these seasons grazing management should ensure that these seedlings become established. Annual herbs and spear grass are the main feed species which grow in response to winter rains. After good spring rains spear grass will germinate in high density on loamy soils creating management problems such as fire hazards and seed in wool and sheeps eyes etc.

The season and intensity of rainfall will determine whether or not there is sufficient runoff to fill dams. Summer thunderstorms are the best runoff producing (dam filling) rains.

Seasons are very variable in the District. Good seasons occur when average rainfalls occur during the winter months (April - September). In such seasons, there is a good supply of feed. However, properties which rely on dam water also require enough runoff producing rains to fill dams. These are chiefly summer rains. Ideally good winter rains should be followed by summer thunderstorms which provide this runoff to fill dams. Perennial species have the opportunity to grow and set seed whilst stock concentrate on the fresh green feed.

Dry seasons and drought occur regularly in the region. The onset of a dry season can be slow and difficult to determine. However damage to vegetation and soils can be severe and long term, if areas are carrying too many stock as the season dries off. It is essential to prevent damage to the vegetation resource by assessing carrying capacity and adjusting grazing pressure as the dry season progresses.

### ***Fencing and water location***

Stock numbers in a paddock need to take into account the location of water points in relation to fences. Waters located centrally in paddocks offer a 360° grazing radius and therefore a greater grazing radius than a water located on, or near a fence, or, in the corner of a paddock.

Water needs to be located to encourage the even grazing of a paddock. Sheep walk 6 - 7 km from water and tend to graze into the wind, which is predominantly from the southern quarter. Waters are therefore best located north of the centre of paddocks. Location of water points on southern fencelines may lead to overgrazing of the southern end of the paddock, unless stocking rates are adjusted to the grazing radius utilised by stock.

The paddock stocking rate needs to be determined on the carrying capacity of the land types which occur within 7 km of the water. When stock are using moisture from green feed and/or puddles, stock numbers can be based on the size of the paddocks and its carrying capacity.

When planning fencing projects, consideration should be given to land type and land productivity. Fencing to land type can be a useful tool in managing stock grazing patterns to, for example, avoid overgrazing of favoured country.

### ***Stock handling facilities***

Portable crutching trailers help alleviate the problem of stock concentrations in holding paddocks and along droving routes. Portable crutching facilities can be taken to the sheep and allow the whole operation of mustering, crutching and releasing to be undertaken in the same day. This reduces the impact of these operations on the vegetation and soil resource.

The ideal location for the shearing shed is in the centre of the property. Many existing wool sheds are not well located. In the past wool sheds were located in close proximity to reliable water supply and roads.

### **The productivity trade-off**

Experienced pastoralists in the District describe the 'productivity trade-off' as stock quantity versus stock quality. The ideal distribution of waters and fences provides 6 - 7 km grazing radius from centrally located waters. This reduces the walking distance for stock between grazing areas and water. In turn the stock return higher wool cut, weight gain and lambing percentages. Disciplined culling and breeding from good stock maintain stock quality.

### **Stock marketing**

The natural increase in stock numbers needs to be quit each year on average. In better years there are more options for the sale of stock than in poor years, where prices may be low and the temptation is to hold stock too long into the dry spell.

Sale of stock is more flexible now than in the past with lambs, old and young wethers and caste for age ewes each having their own market share, and with greatly improved transport facilities.

### **Revegetation**

The establishment of vegetation on previously degraded areas is accelerating. This revegetation has been facilitated by increased seed source. Perennial shrubs flower and set seed more often as a result of reduced grazing pressure brought about by changed management practices which encourage spread of grazing pressure, ie. through distributing waters and fencing.

This trend in improved vegetation condition and revegetation is graphically shown by the following photographs taken at Primary Industries revegetation sites on Manunda Station.

Previous pastoral inspectors and Pastoral Board Members took many pictures on Stations in the Central Ranges over the period 1940 to 1970. Relocating these photo sites has illustrated the passive nature of change in these parts of the District. Furthermore, earlier attempts at

relocating these photos in the period 1975 to 1980, shows that the greater portion of these changes has occurred since 1976.

Notable vegetation changes recorded include:


- establishment of *Nitraria billardierei* (nitrebush) open low shrubland on bare, undulating plains with saline soils;
- establishment of *Atriplex vesicaria* (bladder saltbush) low shrubland on plains of non-saline loamy yellow-brown soils and on stony soils of lower parts of hillslopes;
- establishment of *Maireana pyramidata* (blackbush) low shrubland on alluvial plains and floodplains with well drained sandy loam soils and on lower slopes of hills.

During assessment of the North East Pastoral District, many photopoints established in the 1970s and 1980s were revisited. Common observations of these areas included the spread of woody shrubs, *Dodonaea viscosa* ssp. *angustissima* (narrow-leaf hop-bush) and *Senna artemisioides* (desert senna) on sandy soils, *Eremophila sturtii* (turpentine) on loamy soils and *Dodonaea lobulata* (lobe-leaf hop-bush) on rocky soils. In highly degraded areas, transformations of patchy covers of *Atriplex vesicaria* (bladder saltbush) into continuous covers of *Atriplex* spp. (saltbushes) and the invasion and establishment of *Maireana pyramidata* (blackbush) which abundantly continues into both degraded and stable communities.



*Maireana sedifolia* (pearl bluebush) is also regenerating as a result of both passive and active revegetation.

Observations regarding the impact of available seed arise through a number of factors, the contribution of each being difficult to identify:

- regular population control of rabbits since 1956 by myxomatosis;
- less stock being carried on stations, and being carried more evenly over properties;
- exceptional rainfall events recorded in 1956, 1973 74, 1987 and 1989.

 file unavailable 

*Site SC41 - 10 March 1983.*

 file unavailable 

*Natural regeneration at SC41 after 4 years.*





*Mechanical Revegetation - contour ripping at site SC48, 9 May, 1983.*



*Mechanical Revegetation – SC48 after 4 years – 24 April, 1987.*

## **PASTURE TYPES - PRODUCTION INDICATORS AND REHABILITATION**

Pasture types are the main vegetation associations identified from a pastoral viewpoint. The pasture types discussed here are also used by Pastoral Management Branch, DEHAA in determining the Land Condition Index (LCI) during lease assessment. Indicative stock carrying capacities and rehabilitation measures are suggested for these pasture types.

The pasture types fall into two broad categories: chenopod shrublands and low woodlands. Within these categories are several distinct pasture types. The dominant pasture types occurring in the District are:

### **CHENOPOD SHRUBLANDS**

- Low bluebush (*Maireana astrotricha*) and bladder saltbush (*Atriplex vesicaria*) plains.
- Bladder saltbush (*Atriplex vesicaria*) plains, low hills and salty country.
- Pearl bluebush (*Maireana sedifolia*) and bladder saltbush (*Atriplex vesicaria*) on calcareous plains and hills.
- Blackbush (*Maireana pyramidata*) plains and watercourses.

### **LOW WOODLANDS**

- Mulga (*Acacia aneura*) woodlands on deep sands and dunes.

- Mulga (*Acacia aneura*), Black oak (*Casuarina pauper*), False sandalwood (*Myoporum platycarpum*) low open woodlands on hills.
- Mallee (*Eucalyptus* spp.) on calcareous soils, deep sands and dunes and rocky hills.

Following are details of these pasture types which include:

**Description** - a description of the pasture type and its variants common within the District (including the vegetation types shown on the vegetation map and described in the vegetation associations section).

**Occurrence** - the land systems, topography and position in the landscape in which the pasture type occurs.

**Soils** - a description of the major soil types on which the pasture type occurs.

**Stages of Degradation** - the species which occur in various condition states and their pastoral value.

**Carrying Capacity** - carrying capacity as an indication of the land capability of the pasture type. The indicative carrying capacity of each pasture type has been given a **low, moderate or high** capacity within the District, in the range of **5 - 15 sheep / km<sup>2</sup>**. It assumes fair to good pasture condition, and cannot be specific because of the wide range of seasonal and land conditions, and improvements. Actual stocking rates must be in accordance with the relevant tenure provisions, and, on a paddock by paddock basis at any time, must be adjusted according to:

- pasture condition,
- water quality and quantity,
- preceding and current climatic conditions.

**Rehabilitation** - appropriate grazing management, mechanical rehabilitation and pasture improvement strategies where relevant or where information on likely effectiveness is available.

## **Low bluebush and Bladder saltbush (*Maireana astrotricha* and *Atriplex vesicaria*) plains**

### **Description**

Low bluebush and bladder saltbush pasture type is the most important and widespread in the District and includes both the low bluebush / bladder saltbush communities shown on the vegetation map.

### **Largely treeless plains with duplex soils.**

Bladder saltbush and low bluebush density is naturally high. Other perennial bushes such as *M. aphylla* (cottonbush), *M. pyramidata* (blackbush) and *Gunniopsis quadrifida* (Sturt's pigface / starbush) are common in parts. Small scalds and claypans commonly occur.

### **Patterned plains**

*Pebbled patterned plains* consist of quartz gibber covered areas between vegetated areas. Bladder saltbush and low bluebush occur in high densities in the vegetated patches and

blackbush is also common. This variety of the low bluebush, bladder saltbush pasture type occurs on broad rises to the east and in the northern outwash areas of the Olary Spur.

Patterned plains *with bare clay flats between vegetated areas dominated by bladder saltbush and Sclerolaena spp. (bindyis).*

### **Flats or lower ground with gilgai self-mulching clay loam soils**

Support sparse bladder saltbush and occasional low bluebush with annuals and bindyis.

Most areas with modified vegetation now supporting ephemeral vegetation or *Nitraria billardieri* (nitrebush) was originally this pasture type.

### **Occurrence**

This pasture type was originally very extensive across the eastern parts of the Olary Spur. Large areas have been altered to other pasture types since the removal of the perennial bush by preferential grazing. It also occurs extensively on the outwash plains and low rises to the north of the ranges, but its occurrence south of the ranges is patchy.

### **Soils**

There are two main soil types:

- Duplex or texture contrast soils - sandy loam over clay, which are calcareous at depth without a massive calcrete layer occurring on the treeless and patterned plains.
- Deep self-mulching clay loams often with gilgai.

### **Stages of Degradation**

#### **Good condition Indicators of good condition are:**

- Shrubland of bladder saltbush and low bluebush dense to sparse depending on soil type.
- Shrubs may be lightly grazed. No significant bush death evident.
- Scalds appear natural without dead bush remains or signs of recent soil loss.
- Regeneration of low bluebush, bladder saltbush and other palatable perennial species if present, indicates good condition.

#### **Fair Condition Indicators of declining condition are:**

- Heavily grazed stands of bush with increasing density of blackbush or Sturt's pigface (more than occasional plants).
- Accelerated (grazing induced) scalding evidenced by dead bush remains.

#### **Poor Condition Indicators of poor condition are:**

- Only isolated remnants of bladder saltbush or low bluebush remain.

- Increaser shrub species such as cottonbush, blackbush and Sturt's pigface are grazed, and density is being reduced.
- Extensive bindyi dominated areas.
- Soil scalding and / or drifting and dead bush remains evident.

In the past severely degraded areas of this pasture type have been colonised by ephemerals and/or nitrebush.

### ***Carrying capacity***

This pasture type is the most productive in the District. The indicative carrying capacity is high, even in average years.

It is generally in fair to good condition throughout the District. In dry seasons, country in declining or poor condition may need stocking rates reduced to moderate to prevent overgrazing.

### ***Rehabilitation***

The effectiveness and ease of re-establishment of the perennial component of this pasture type depends on the soil type and condition of topsoil.

Shrubs will re-establish on duplex (texture contrast) soils where the sandy top soil is still largely intact, grazing pressure is low and, there is a seed source within 50 metres.

Before perennials can be re-established it is necessary for a seed source to be available when suitable rainfall occurs. Seed may be provided by seeding shrubs within 50 metres of the site or by direct seeding. Seed of many chenopod shrubs is only viable for 12 months or less. Bladder saltbush and blackbush are the most successful local perennials for rehabilitation programs. They provide soil surface protection and fodder and seed is readily available or easily harvested. These species establish more readily than low bluebush or pearl bluebush.

On scalded areas, or where most topsoil is gone, increasing retention of water on the site can usually restore an annual herbaceous cover. This may be achieved by constructing contour furrows and/or banks using a winged ripper tyne. These furrows collect and control water runoff and flow. Disc pitting is only recommended where slopes are less than 1% and the surface soils are non-dispersive. Ripping must be surveyed to avoid gully erosion.

Rehabilitation projects over the last 10 or so years have been successful in assisting the establishment of ground cover. However this cover is often weedy. The establishment of perennial bush of pastoral value is slow and inconsistent. Blackbush is a useful coloniser of scalded areas previously dominated by this pasture type. The self-mulching clay loams are much more difficult to rehabilitate.

Examples of successful long-term regeneration of areas of this pasture type are to be found on Panaramitee and Teetulpa Stations, near Yunta.

## **Bladder saltbush (*Atriplex vesicaria*) plains, low hills and salty country**

### ***Description***

This pasture type is typified by areas near the Barrier Highway between Yunta and Cockburn, often supporting a mixed bladder saltbush and *Halosarcia* spp. (samphire) dominated shrubland. It is included with the bladder saltbush ± low bluebush community, and includes the bladder saltbush very open low shrubland over daisies on the vegetation map.

Bladder saltbush is the dominant shrub on the saline plains associated with small saltlakes and swamps, and extends onto the low sandy rises in the central north of the District.

### **Occurrence**

Bladder saltbush dominated plains are extensive throughout the central area of the Olary Spur.

This pasture type occurs in patches scattered throughout the District, particularly in the valleys of the central ranges. Typical examples of this pasture type occur on Maldorky and Eringa Stations.

### **Soils**

There are two main soil types:

- Duplex or texture contrast soils - sand over clay.
- Deeper sand or sandy loam, usually over saline or calcareous clay loams.

### **Stages of Degradation**

#### **Good condition Indicators of good condition are:**

- bladder saltbush ungrazed or lightly grazed with no indication of reduced bush density,
- palatable perennial grasses may occur in an ungrazed or lightly grazed state,
- no evidence of significant bush death,
- presence of young bladder saltbush plants.

#### **Fair Condition Indicators of declining condition are:**

- bladder saltbush heavily grazed with reduced bush density,
- significant bush death apparent,
- less palatable shrubs such as *Maireana pyramidata* (blackbush) and *Atriplex stipitata* (bitter saltbush) increasing in abundance and ungrazed,
- *Sclerolaena* spp. (bindyis) more abundant.

#### **Poor Condition Indicators of poor condition are:**

- palatable shrubs such as bladder saltbush and palatable perennial grasses absent,

- increaser shrub species such as blackbush and *Gunniopsis quadrifida* (Sturt's pigface) are grazed and their density is being reduced,
- plant cover dominated by bindyi and annuals,
- unpalatable perennial shrubs such as samphires and *Maireana tomentosa* (woolly bluebush) and *Nitraria billardierei* (nitrebush) dominate.

Degradation of this pasture type to poor condition often results in extensive soil drift or deflation.

Through a process referred to as secondary succession, many of the areas originally vegetated with bladder saltbush dominant pasture have been colonised by blackbush after a run of above average seasons. Blackbush has a preference for disturbed sites and has the ability to establish, produce abundant seed and colonise such areas.

### ***Carrying capacity***

The indicative carrying capacity for the saltbush plains is moderate to high.

To achieve rehabilitation of this pasture type in poor condition, a low to moderate stocking rate is recommended.

### ***Rehabilitation***

The effectiveness and ease of re-establishment of the perennial component of this pasture type depends on the condition of top soil and the availability of suitable seed and the seeding regime of the existing shrubs.

There are many examples of successfully revegetated areas of this pasture type. Disc pitting is the most often used and cost-effective mechanical treatment on flat or near flat land (less than 1% slope).

Mechanically treated areas need to be stocked very carefully as the soils are often dispersive and erodible when without plant protection. Stock management needs to consider the preference given to this pasture type by stock as it occurs adjacent to and in watercourses and floodout areas.

Over many years moderate overgrazing of this pasture type has led to replacement of bladder saltbush with blackbush and short-lived perennials. The establishment of bladder saltbush for seed reserves by mechanical or other means will assist in reversing this trend.

## **Pearl bluebush and bladder saltbush (*Maireana sedifolia* and *Atriplex vesicaria*) on calcareous plains and hills**

### ***Description***

Shrublands dominated by pearl bluebush occur on flats with shallow limestone pans or sheet limestone and on higher ground and low hills where soils are limy at depth.

This pasture type occurs with or without *Casuarina pauper* (black oak), *Acacia aneura* (mulga), or *Eucalyptus* spp. (mallee) as overstorey, and is shown on the vegetation map as pearl bluebush ± blackbush open low shrubland ± black oak low woodland.

## **Occurrence**

Pearl bluebush dominated pastures occur extensively south of the Barrier Highway and throughout the low hills of the Olary Spur and as far north as Koonamore. In much of the area south of the Barrier highway, the areas shown on the vegetation map as black oak are actually this pasture type with a significant overstorey of black oak.

## **Soils**

Sandy or silty calcareous loams with calcrete or limestone pans or rubble at generally less than 45 cm depth.

## **Stages of Degradation**

### **Good condition Indicators of good condition are:**

- dense stands of pearl bluebush,
- no signs of bush death,
- juvenile bluebush present,
- bladder saltbush present.

### **Fair Condition Indicators of declining condition are:**

- pearl bluebush stands less dense,
- no pearl bluebush or bladder saltbush juveniles present,
- bluebush and bladder saltbush obviously grazed,
- increase in density of blackbush, *Sclerolaena* spp. (bindyis) and *Dissocarpus paradoxus* (cannonball).

### **Poor Condition Indicators of poor condition include:**

- sparse pearl bluebush,
- pearl bluebush plants grazed to half their natural size and/or bush death evident,
- blackbush also obviously grazed,
- abundance of bindyis and cannonballs,
- bladder saltbush absent,
- grazed *Atriplex stipitata* (bitter saltbush) is an indicator in southern parts of the District.

*Eremophila sturtii* (turpentine) will increase in density in areas where its seed is present and soil is disturbed by grazing pressure or by mechanical treatments.

Floods such as in 1989 have resulted in significant bush death in this pasture type.

### **Carrying Capacity**

The indicative carrying capacity for this pasture type is moderate.

Where this pasture type is in poor condition, or to achieve rehabilitation, the stocking rate needs to be reduced by up to half (to very low) depending on season and location of water points.

### **Rehabilitation**

Contour ripping together with grazing management (stock, goats and rabbits), and the provision of viable seed has been demonstrated to be an effective method of re-establishing this pasture type on calcareous soils. Viable seed may be available from nearby (< 50 m) seeding shrubs to facilitate natural regeneration, or by direct seeding.

Where woody weeds such as turpentine and *Senna* spp. (senna) are present, mechanical treatment will encourage their growth. The Board does not recommend mechanical disturbance of the soil in these situations.

## **Blackbush (*Maireana pyramidata*) plains and watercourses.**

### **Description**

Blackbush dominated shrublands, often with *M. aphylla* (cottonbush) and *Nitraria billardieri* (nitrebush), and in some places *Atriplex vesicaria* (bladder saltbush). A sparse overstorey of *Acacia victoriae* (prickly wattle), woody shrubs or *Casuarina pauper* (black oak) is sometimes present.

### **Occurrence**

This pasture type is scattered throughout the District and occurs where broad flats or ill-defined watercourses are adjacent to hills or rises supporting *Maireana sedifolia* (pearl bluebush).

### **Soils**

The soils which support this pasture type are variable. They include gradational soils of sandy or loamy texture, sandy duplex soils and deep alluvial soils of loamy texture. Generally, there is calcareous subsoil.

### **Stages of Degradation**

#### **Good condition Indicators of good condition are:**

- bladder saltbush present and only lightly grazed,
- diverse and abundant range of ephemerals after rain,
- *Dissocarpus paradoxus* (cannonball) not a dominant component of herbage,



- palatable overstorey species have some foliage within grazing reach.

**Fair Condition Indicators of declining condition are:**

- absence or much reduced density of bladder saltbush,
- cannonballs dominant in ephemeral herbage,
- prominent browse-line on palatable overstorey species,
- some healthy *Atriplex stipitata* (bitter saltbush) may occur.

**Poor Condition Indicators of poor condition are:**

- blackbush grazed hard and no regeneration evident,
- blackbush removed and replaced by bitter saltbush which is also grazed,
- the area is dominated by nitrebush with or without mounding due to soil drift in the past,
- prominent browse-line on any palatable overstorey species.

### ***Carrying Capacity***

The indicative carrying capacity for this pasture type is moderate to high, but depends on the adjacent pasture types and season. The ephemeral feed which grows between the bush is often the dominant stock fodder.

### ***Rehabilitation***

In areas where soils are largely intact, nitrebush will be progressively replaced over the long term by more desirable species such as blackbush, *Enchylaena tomentosa* (ruby saltbush) and bladder saltbush. Grazing pressures from stock, goats and rabbits need to be low to ensure palatable species have the opportunity to become established.

Rehabilitation trials of extensive areas colonised by nitrebush have been undertaken by the Central Flinders Ranges Soil Conservation Board. Mounds and nitrebush were levelled by bulldozer, the site direct seeded, and nitrebush regrowth sprayed with a suitable herbicide. While this can be spectacularly effective where there is adequate rabbit control, the cost and difficulty of this style of operation make it impractical in many situations.

## **Mulga (*Acacia aneura*) woodlands on sands and dunes.**

### ***Description***

Open mulga woodlands and open treed plains on deep sands of swales and flats in low dunes or sandy rises.

*Acacia ligulata* (marpoo / umbrella bush) and *Dodonaea viscosa* (sticky hop-bush) with a grassy understorey also occur in conjunction with this pasture type.

### ***Soils***

Deep alkaline red sands, gradational soils and sandy loams.

### **Occurrence**

Extensive in the northern extremities of the District on Mulyungarie and Benagerie Stations.

### **Stages of Degradation**

#### **Good condition Indicators of good condition are:**

- no obvious browse line on mulga,
- regeneration of palatable shrubs and trees evident,
- perennial palatable shrubs and grasses intact,
- no woody shrub increase or recent soil movement.

#### **Fair Condition Indicators of declining condition are:**

- mulga regeneration grazed,
- adult mulga have prominent browse line,
- palatable shrubs missing or heavily grazed,
- increase in density of woody shrubs,
- evidence of soil erosion.

#### **Poor Condition Indicators of poor condition are:**

- no mulga regeneration evident and mulga mature and senescent,
- no feed from palatable perennial shrubs within grazing reach,
- significant woody shrub encroachment is often present eg. hop-bush, *Senna artemisioides* (desert senna), *Eremophila sturtii* (turpentine),
- weedy annual growth such as *Brassica tournefortii* (wild turnip) and *Salsola kali* (roly-poly) often dominate,
- extensive surface soil movement may be evident.

### **Carrying Capacity**

This pasture type is generally stocked with cattle. The indicative carrying capacity for this pasture type is moderate, depending on season.

### **Rehabilitation**

Re-establishing perennials on sandy soils is often difficult to achieve without risking significant soil erosion.

Where vegetation has been removed by overgrazing or fire, judicious stock management coupled with effective rabbit or feral animal control is recommended in order to achieve regrowth of ground cover and shrubs.

The control of woody weeds by heavy grazing or mechanical removal is not feasible. Various methods such as blade ploughing, rolling and burning have been tested in western NSW where the problem is much worse. These methods have not been found cost-effective, and their success depends on the age and species composition of stands of woody shrubs.

Where woody weed invasion is becoming a problem, conservative grazing regimes and feral animal control need to be used to encourage species which compete with woody weeds, or have pastoral value.

## **Mallee (*Eucalyptus* spp.) on calcareous soils, deep sands and dunes.**

### ***Description***

This pasture type has an overstorey dominated by mallee species *Eucalyptus socialis* (beaked mallee) and *E. gracilis* (yorrell). On sandy soils other woodland species such as *Myoporum platycarpum* (false sandalwood), *Casuarina pauper* (black oak) and *Acacia* spp. (wattle species) are also present. *Atriplex stipitata* (bitter saltbush) or *Atriplex vesicaria* (bladder saltbush) understorey is often present except on deep sands where spinifex is common.

### ***Occurrence***

This pasture type occurs extensively in the Benda Range and southwest of the District. Its occurrence is patchy in the Olary Spur and uncommon in the central parts of the District. Four mixtures of mallee species are shown on the vegetation map.

### ***Soils***

The soils supporting this pasture type are calcareous. There is a large variety of soils ranging from skeletal soils over dolomite in the hills to sand over calcrete at varying depths in the south of the District.

### ***Stages of Degradation***

**Good condition** Indicators of good condition are:

- the growth and seed set of palatable species is not suppressed.

**Fair Condition** Indicators of declining condition are:

- palatable species are showing signs of suppression,
- defined graze line is present on palatable shrubs and trees,
- increase in woody weeds.

**Poor** Indicators of poor condition are:

### Condition

- absence of palatable vegetation within grazing reach is an indication of poor condition,
- abundance of woody shrub invaders, such as *Eremophila sturtii* (turpentine) or *Senna artemisioides* (desert senna),
- soil drift or surface scour may also be evident.

### Carrying Capacity

Sheep will generally avoid mallee with spinifex understorey except after a fire when new growth is soft and palatable. After a burn and follow up rains the stocking rate can be increased for up to two years to moderate levels. Where mallee occurs with virtually no understorey, the carrying capacity is nil.

### Rehabilitation

Management of total grazing pressure is the best way to encourage seeding and establishment of the palatable component of this pasture type. Bladder saltbush, bitter saltbush and *Enchylaena tomentosa* (ruby saltbush) are species which colonise the calcareous mallee soils readily if total grazing pressure is managed.

## **Mulga (*Acacia aneura*), black oak (*Casuarina pauper*), false sandalwood (*Myoporum platycarpum*) low open woodlands on hills.**

### Description

This pasture type describes the vegetation of the rough, prominent hills of the Olary Spur. It includes variable open woodlands, open country and low scrub.

### Occurrence

The mulga-dominated examples are restricted to the hills of the Olary Spur such as the Oulnina Park Ranges, the granite hills of Plumbago, and the skeletal hills of Tikalina and Outalpa.

### Soils

Soils are skeletal and calcareous, well drained with gravelly subsoils. Gypsum occurs low in the profile on the deeper soils.

### Stages of Degradation

#### **Good condition Indicators of good condition are:**

- palatable trees or shrubs, eg. mulga, *Eremophila glabra* (red-flowered emu-bush) are healthy,
- regeneration and regrowth is only lightly grazed,

- reasonably continuous and diverse ground cover.

**Fair Condition Indicators of declining condition are:**

- the growth of palatable shrubs and trees is suppressed,
- less palatable species such as black oak and *Prostanthera striatiflora* (striated mintbush) are lightly grazed,
- ground cover is less dense and diversity is reduced,
- some soil movement evident, larger gullies stable.

**Poor Condition Indicators of poor condition are:**

- absence of palatable vegetation within grazing reach,
- less preferred species grazed hard,
- soil surface largely bare with evidence of instability such as gullying or sheeting of erodible soils.

### ***Carrying Capacity***

The indicative carrying capacity for this pasture type is very low. This pasture type occurs in isolated patches, and is not stocked as a single pasture type.

When in good condition it provides good stock feed at the indicative stocking rate.

### ***Rehabilitation***

Much of the vegetation of this type has been modified and denuded by the total grazing pressure of rabbits, goats, kangaroos, euros and stock.

The control of rabbits and goats is the most effective method for rehabilitation of this pasture type.

From 1950 to 1965, rabbits were controlled within a 3 km radius of Radium Hill. This is now the only location within the District where any significant quantity of regenerating mulga exists, and demonstrates the significant impact of rabbits on mulga regeneration, and the value of rabbit control.

## ***RABBITS***

The spread of rabbits into the District is poorly documented. Rabbits had reached areas north and west of the District by 1879, Beltana in 1886, Lake Callabonna in 1888 (Stodart and Parer, 1940) Pine Creek in 1892 and Erudina in 1889.

Rabbits have successfully spread throughout the temperate regions of the country. Their spread and successful establishment has been attributed to their ability to survive most seasons without free water, their capacity to breed and the use of warrens to provide protection from predators and climatic extremes.

Where plants containing at least 60% moisture content are available rabbits do not require free water to drink. When their feed dries off rabbits need free water to make use of the dry feed. At this stage, they may begin to strip bark from shrubs for moisture. Under food and water stress, rabbits respond by eating less food, lose weight and dehydrate. Rabbits may lose up to 50% of their body weight through food and moisture stress before dying. The rabbit's ability to tolerate such severe weight loss explains why a few rabbits manage to survive even the most severe droughts. To maintain populations, rabbits require a high quality diet with 40% fibre and at least 10 - 12% crude protein to assist reproduction. They have small manoeuvrable mouthparts which allow them to be selective feeders and to graze plants to ground level (Linton, 1991 - 1996).

Rabbits will breed as soon as conditions are favourable, and stop breeding once conditions deteriorate. Actively growing green grass is the trigger for breeding, providing vitamins required to stimulate reproductive activity. A litter typically consists of 3 - 7 young. The gestation period is four weeks, and young females are sexually mature between 3 and 10 months. Females can become pregnant again immediately after birth. It is not unusual for populations to increase five-fold during an average breeding season.

Warrens are an important factor in the survival of the rabbit as they provide protection from extremes in climate and from predators. Litters of young are protected in the warren and stay underground for the first 21 days of life (Linton, 1991 - 1996).

Rabbits form social groups centred on the warren and individuals rarely move far from that home warren. Outside the breeding season, rabbits may roam within a home range of 300 - 600 m, usually in search of food. This range may increase as food becomes scarce. During breeding, movement is restricted by territorial fighting.

The grazing pressure of rabbits cannot be managed. The impacts of rabbits are:

- even low numbers of rabbits suppress regeneration of perennials and can contribute to the replacement of a perennial plant community with an annual or ephemeral plant community or, an increase in the density of less palatable species;
- warrens and associated grazing by rabbits denude areas, leading to increased erosion especially in sandy country;
- 12 rabbits graze the equivalent of one dry sheep (DSE) or 2 warrens per DSE based on an average warren population of 5 - 6 rabbits. The grazing impact of rabbits is significant and reduces the sustainable stock carrying capacity;
- rabbits provide a food source for dingoes, cats and foxes enabling these animals to reach high numbers which then impact on wildlife and livestock.

The public perception of rabbits is of cute, soft, furry animals, family pets and 'Easter Bunny' a symbol of new life. Most Australians do not understand the enormous cost to production and the environment caused by rabbits

## **Distribution of rabbits**

The larger populations of rabbits occur in the calcareous soils and along watercourses. Warrens in calcareous soils have stable air temperatures providing a good refuge from climatic extremes. Watercourses are a relatively reliable moisture source.

## **Control**

### ***Mechanical control***

Warren destruction is the key to rabbit control because rabbits rarely breed away from a warren. Control is most effective when rabbit numbers are low. Warren destruction is the most

effective form of rabbit control and is recommended in 'harder' country, which is more productive. In sandy country, control is more difficult, as reopening rates are usually higher.

Rabbits are difficult and expensive to control. The results of the rabbit control trial on Morialpa Station indicate that warrens generally need to be cross ripped using powerful machinery (D6 bulldozer), with tynes which will rip to at least 90 cm and spaced no more than 50 cm apart. Ripping needs to extend two metres beyond the edge of the warren to ensure destruction of the entire warren structure. Single pass ripping can be successful with winged boots. The whole ripping program or blocks of ripping need to be completed in as short a time as possible. For this reason, a contractor dedicated to the job is often the best option, as down time caused by distractions to other responsibilities and machinery breakdown are kept to a minimum.

Work should be done in summer or during a dry spell when rabbit numbers are low to take advantage of:

- dry, friable soil which readily collapses into the warren;
- low rabbits numbers and less likelihood of warrens being re-opened;
- heat; rabbits without the shelter of their warrens tend to be in poorer condition as they have no refuge from heat and dehydration, and are more vulnerable to predation.

Warrens that have been reopened must be re-ripped or fumigated to ensure the effectiveness of the ripping program. The complete destruction of all warrens and all warren structure is vital for effective long-term rabbit control.

### ***Biological Control***

Biological control of rabbits is often seen as the only real opportunity for rabbit control in the extensive areas of the rangelands. Myxomatosis killed very large proportions of the rabbit population when it was first introduced to the Broken Hill region in 1950, and by culture from the then Department of Agriculture in 1956 in the Olary area. Myxomatosis is still effective at reducing rabbit numbers in the rangelands. There was little regeneration of trees in the District from the time rabbits became established but when myxomatosis reduced the rabbit population there was a tremendous vegetation growth response.

The Spanish rabbit flea which, it is hoped will be a more efficient vector for spreading myxomatosis in the hotter drier regions of Australia has been released extensively throughout the District.

The rabbit calicivirus disease (RCD) escaped from quarantine trials on Wardang Island in October 1995. The second outbreak of RCD was detected in the Yunta area, the first was on Yorke Peninsula. The virus spread north and west throughout most of the District and into New South Wales near Broken Hill before its progress slowed. The spread was rapid and patchy. It was difficult to anticipate where it would appear next and how it was being spread. Scientists believed the most likely vectors were mobile insects such as the common bush fly.

One year after RCD escaped from Wardang Island it spread over most of SA, NSW, and WA. Studies are now being carried out to determine:

- the spread and recurrence of RCD in different land systems,
- the effect of rabbit predators (foxes and cats) on populations of alternative food sources (eg. native mammals, lizards and birds), following the decline in rabbit numbers,
- the effects of myxomatosis on RCD,
- the development of resistance to RCD in rabbits,
- the impact of reduced rabbit populations on the health of vegetation,
- the cost of rabbit eradication for broad areas.

Rabbit Calicivirus was officially released at Wagga in early October 1996, and in South Australia a week later at Turretfield and in the southeast of the state.

Indicators of the presence of RCD include:

- a dramatic drop in rabbit numbers,
- few dead rabbits on the surface,
- increased activity of foxes and hawks,
- rabbits appear 'tame' above ground,
- very young rabbits moving about on their own,
- a strong smell and blowflies coming from warrens.

The impact of the reduced rabbit population resulting from the RCD out break may include:

- regeneration of plants including perennials,
- increase in populations of insects and herbivores such as kangaroos, small mammals, birds, reptiles and feral goats,
- decrease in populations of predators of the rabbit such as foxes, cats, wedge tail eagles and dingoes.

Calicivirus has the potential to substantially reduce rabbit numbers. It must be understood however, that no biological control measure completely kills its host and that the rabbit will still be a pest. It is necessary to take advantage of the low rabbit numbers caused by disease and season, whether it be myxomatosis or calicivirus, to destroy rabbit warrens according to a plan that considers the productivity of the land and the costs and benefits of such a program.



*Rabbits reached plague proportions as recently as 1990 in the sandy country.*

## **GOATS**

Goats are hardy and well adapted to the topography and climate of the North East Soil Conservation District. Goats will eat almost any plant and have the ability to browse up to 2 metres from the ground and to ringbark trees. Goats contribute to grazing pressure and are particularly difficult to control. They are very mobile, thrive in rugged and inaccessible terrain and are drought tolerant. They have a high reproductive rate. Female feral goats may breed at as young as 3 months old. Typically, a nanny gives birth to two kids every 8 months. The goat population can thus increase by up to 75% in one year particularly in good seasons.

Goats increase the grazing pressure and compete with stock for feed and stock water hence stock condition and production are reduced. The destruction of vegetation by goats and the damage to soil structure by their hard hooves increases susceptibility of the soil to erosion.



Goats are generally free of disease and parasites, but they are susceptible to exotic animal diseases, including foot and mouth disease. In the event of a disease outbreak, goat populations will make it very much more difficult to contain the disease. Goats are a declared pest in South Australia.

Goats mustered and trucked to abattoirs can fetch up to \$30 per head. This price pays for the mustering and trucking operation and provides a reasonable profit for effort. The prices fetched for goats fluctuate and so does the impetus for their muster and control.

**It appears that goat mustering operations occur more frequently when prices are high. This suggests that not all land managers are committed to goat control and eventual eradication, and that goats are regarded by some as owned by the pastoral community and a resource rather than an environmental pest.** Goats are both a threat to the sustainability of the region and a financial resource. It has been demonstrated that goats remaining after a mustering operation cost the pastoralist more to keep than to remove from the property when competition between sheep and goats, ecological, management and social considerations are accounted for (Pastoral Lands Notes 1994).

Goats became a problem in the District in the late 1940s when the milk and meat herds of the railway gangs were released and became feral. Their population has increased since that time and their population and impact on soils and vegetation is now a significant resource management problem.

An indication of the distribution and population of goats within the District is gained from the results of the aerial surveys conducted by the DEHAA. [Table 4](#) gives the raw data from these surveys where goat sightings are counted for each half degree block (equivalent to 1:100,000 map sheets). These sightings are likely to underestimate the true densities, and mobbing and clumping may distort annual trends. The survey provides an index of goat densities and reflects the real changes in abundance and distribution over a number of years.

However, the Board believes that these results do not reflect the decrease in the goat population as a result of mustering.

**Table 4** Density of goats per km<sup>2</sup> in each half degree block within the North East Soil Conservation District.

MAP SHEET NAME	1989	1990	1991	1992	1993	1994	1995
Mingary	No data	2.4	No data	No data	No data	0.7	0.1
Olary	1.0	4.3	4.2	1.2	3.3	0.8	3.1
Winnininnie	0.3	0.3	No data	0.8	No data	No data	No data
Koonamore	No data	No data	No data	No data	0.1	No data	No data
Oakvale	No data	4.2	3.1	0.7	3.3	3.5	3.2
Anabama	10.5	4.0	6.7	2.7	2.8	2.8	4.9

Yunta	4.0	14.0	2.7	3.9	4.0	6.4	1.6
Paratoo	No data	0.4	0.2	No data	0.4	No data	No data
Canopus	1.3	3.6	0.9	2.3	3.9	2.2	2.2
Lilydale	1.8	6.0	8.1	2.7	3.8	7.1	5.9
Murkaby	0.5	0.6	1.2	1.8	1.2	4.3	2.6
Caroona	0.3	2.4	1.2	0.2	No data	No data	0.3

## CONTROL

The goats' need for water in dry times and their herd instinct is exploited for their control. The most common methods of dealing with goats are to muster or trap herds on waters during dry times when there is limited free water, and truck goats caught for sale. Goats are very mobile and smart. They are difficult to muster and learn from experience, making it difficult to muster escapees. Where numbers are low they are often shot on sight.

In inaccessible and difficult terrain, helicopter mustering and follow up shooting by the Hunting and Conservation Branch of the Sporting Shooters Association has been shown to be successful and economic in other Soil Conservation Districts. Some managers make it a policy to shoot or kill any goats on sight as part of day-to-day Station management.

**All goats located need to be removed or shot, none should be 'let go for later'.**

Although profitable sale of mustered goats is encouraged, the cessation of mustering when it becomes non-profitable is discouraged. Goats are a proclaimed pest species under the *Animal and Plant Control Act 1986*. Section 44(1) of this Act makes it an offence to release goats, the penalty for releasing goats being \$2,000 or 6 months imprisonment.

To improve the efficiency of mustering and trapping goats:

- their capture needs to be coordinated between neighbours and,
- time needs to be dedicated to a thorough and planned operation.

Goat control needs to be coordinated across property boundaries to be successful. Goats are not hindered by fences and neither should their control and management. Throughout the Soil Conservation District goat control coordination cells have been defined and a coordinator of each cell nominated. To maximise goat control effort and to enable records to be kept of goat culls, culling costs and relative efficiencies, the Board asks landholders to discuss and report the goat control activities with the assigned cell coordinator.

## KANGAROOS

Permanent water and the Dog Proof Fence have provided optimum conditions for kangaroos, allowing an increase in population reducing the necessity for kangaroos to migrate, and restricting their movement north into the cattle country. The population still moves about within the District but is more stable.

The availability of water has enabled kangaroos to use more country on a more continuous basis. Kangaroos increase the grazing pressure and competition for food and water and damage fences.

Red kangaroo and western grey kangaroo numbers have been monitored by aerial survey in the North East Pastoral Soil Conservation District since 1978. Ground-based surveys were conducted during the same period including intensive line transects conducted on foot to determine euro densities in hilly areas. In addition, preliminary work has commenced on determining the status of the Yellow-footed rock-wallaby, a vulnerable species that occurs in low numbers in some rocky hills in the District.

Aerial survey figures supplied by DEHAA indicate an average red kangaroo density of 12.3 kangaroos / km<sup>2</sup> over the 19 years of population surveys, and an average western grey population of 0.7 kangaroos / km<sup>2</sup>. Euro densities in their optimum habitat within the region have averaged approximately 22.0 euros / km<sup>2</sup> based on line transects surveyed on foot.

The current control practice is to issue culling permits on the basis of the District average for red kangaroo densities. Due to the variation in land systems within the District and the associated variability in species make up and densities, DEHAA has been asked to issue permits on the basis of half degree block survey information.

Grey kangaroos are not indigenous to most of this District and the Board believes their distribution needs to be limited to their natural habitat. To manage their population sustainably, it is necessary that the natural habitat range and sustainable population density for this species be determined. Their population should not be permitted to build up within the District. DEHAA surveys consistently under-estimate their population. DEHAA has been asked to reassess the population estimates of western grey kangaroos on the basis of current research, and to implement a culling strategy to limit the density of this species to sustainable populations within their indigenous habitat and to limit their population outside this range.

Euro densities in the hill country are a particular concern and DEHAA has been asked to examine management options to lower the average density of this species to a sustainable population within its indigenous range. Research will be required to determine the range, sustainable population within this range, and to enable the management of this species.

Once the indigenous range of western grey kangaroos and euros has been identified, populations of these species outside their range need to be limited.

## MANAGEMENT

Management objectives proposed under the South Australian Kangaroo Management Program:

**Objective** To harvest red kangaroos and euros as a sustainable resource.

**1**

**Action** A sustainable use harvest quota of 15% for red kangaroos and 15% for Euros of the estimated populations on each property will be issued each year based on survey results of the previous year. Permits are issued in whole at the beginning of each calendar year.

This approach seeks to achieve the prevention of a build up of very high numbers of kangaroos, facilitate the development of a kangaroo harvesting industry capable of sustaining the required harvest and where possible enable economic return to landholders from kangaroo harvesting.

**Objective** To avoid excessive increases in red kangaroo and euro numbers and  
**2** concentration of excessively large numbers of these species on dwindling food and water resources during the onset of drought.

**Action** Encourage the use of the sustainable harvest across the whole of the District on

an annual basis. This should avoid rapid increases in numbers under most conditions.

An additional kangaroo harvesting quota may be sought in years where kangaroo densities are above average and the sustainable use quota is likely to be fully utilised before the end of the year. The additional quota will be allocated from the land management component of the annual South Australian kangaroo harvesting quota.

The land management component of the South Australian kangaroo harvesting quota is available to lower unusually high kangaroo numbers, or address specific land management issues identified at a regional level.

In years where drought conditions are developing, the Board, in consultation with DEHAA, will seek to achieve a lowering of kangaroo densities in the region. This will be done through additional kangaroo harvesting quotas or 'shoot and let lie' permits when conditions are severe and the kangaroo industry is unable to take the required numbers.

**Objective** Restrict the occurrence of the western grey kangaroo to very low levels.

**3**

Action DEHAA has been asked to develop a strategy to lower the density of this species to insignificant numbers outside their indigenous range and to sustainable populations within their range.

**Objective** Restrict the grazing impact of euros in the less accessible hill country to help lower the overall grazing impact in these areas.

**4**

Action DEHAA has been asked to develop a strategy to lower the density of this species to insignificant numbers outside their indigenous range and to sustainable populations within their range.

**Objective** Protect isolated colonies of Yellow-footed Rock-wallabies within the District.

**5**

Action Monitor the outcome of efforts to assist the recovery of remnant colonies of this species in the District.

A healthy working relationship between the Soil Board and the Wildlife Management Branch (DEHAA) currently exists, and has been beneficial to the ongoing issue of kangaroo population management in the District.

This Board feels that Pastoral Management Branch needs to provide support to pastoralists on the issue of management of total grazing pressure and in this instance the management of the grazing impact of artificially high populations of kangaroos.

## ***OTHER PEST ANIMALS***

Cats, foxes and dingoes are pest animal species which occur within the District. These animals need to be controlled on an ongoing basis and with the intent of eradication. Baits are used for cat and fox control, and baits are available through the Animal and Plant Control Commission (APCC) officer at the PIRSA Port Augusta Office.

Emu populations can increase and become a pest to pastoral production at times. Pastoralists are not able to control their numbers and therefore their grazing impact is unchecked.

Emus feed on the fruits of many shrub species, which in return require ingestion by emus for germination. For this reason emus are an important species to many plants for propagation. Emus may also spread weeds in this way. A permit to destroy emus may be obtained from DEHAA where their control is warranted for sustainable land management.

Little corellas and galahs can also be pests at times. In large flocks they will settle in trees and strip the leaves off, causing significant damage.

Locusts, army worms, caterpillars, and rutherghen bugs can at times occur in plague proportions and strip leaves from large areas of vegetation. Christmas beetles can cause tree decline when, in plague proportions, they destroy tree roots.

## **SCALDING**

Scalds are bare areas produced by the removal of the surface soil by wind and/or water erosion and are a natural part of most landscapes. The result is exposure of the more clayey subsoil which is, or becomes, relatively impermeable to water. Scalds are a typical erosion form of texture contrast soils in semi-arid and arid regions.

Scalds result from the removal of protective plant cover (eg. by high grazing pressure, hailstorm, or drought), followed by removal of topsoil by high intensity rainfall and / or strong winds. Scalds should not be confused with natural claypans which are areas where water lies for extended periods following major rainfall events.

Scalds are difficult to revegetate due to the lack of topsoil, low permeability and often saline surface.

Texture contrast and calcareous soils are susceptible to scalding. The pasture types in which texture contrast soils occur to a significant extent are:

- low bluebush and bladder saltbush plains;
- pearl bluebush and bladder saltbush on calcareous plains and hills;
- blackbush plains and watercourses.

## **LAND MANAGEMENT AND REHABILITATION**

To prevent scalds from developing on susceptible soils, plant cover needs to be maintained. Plant cover protects the soil from the erosive actions of water and wind and provides niches for the accumulation of organic matter, wind blown soil and seeds. Perennial bush species provide the best soil protection because they are present in dry times when the soil is most vulnerable to erosion.

Scalds have a smooth, crusty and often saline surface which is unsuitable for seed lodgement and germination and seedling establishment. A successful revegetation program alters the environment to provide conditions suitable for seed germination and plant growth.

To rehabilitate scalds:

- assess the expected benefit against cost,
- control runoff,
- reduce wind velocity at the soil surface,
- provide adequate moisture for seed germination and seedling establishment,
- select suitable sites for seed germination and growth,
- provide seed for the site by:
  - a source of mature bushes of appropriate species within 50 metres, or
  - direct seeding.

These needs can be met by mechanically altering the site. Furrowing and water ponding have been shown to be successful treatments for reclaiming scalds. Disc-pitting has been tested extensively with varying degrees of success.

Over much of the District, the instances of scalding are reducing. Numerous instances are on the northern and valley plains in the Central Ranges and on the southern plains where former

extensive scalds have been reduced to fragmented bare areas. Bindyi (*Sclerolaena* spp.), waterweed (*Osteocarpum acropterum*) and annual grasses, in particular are the main colonisers. Salt copperburr (*S. ventricosa*) grows in places where soils are slightly saline and short-winged copperburr (*S. brachyptera*) on clayey surfaces. Waterweed is most common in areas where water erosion has caused scalding. Some of the bladder saltbush regeneration in the District has occurred on previously scalded soil surfaces.

The success of rehabilitation projects in the arid zone is highly dependent on seasonal and soil factors, as well as technique. Trials and research are continuing and more is being learned all the time. Greening Australia, PIRSA (State Flora), and a variety of private revegetation contractors can provide advice on the current practices.

## **WIND EROSION**

Wind erosion will occur where soil surface protection is low, and soil particles are light enough to be moved by wind (drift) to which nutrients and soil particles are attached.

The major cost of wind erosion to the land manager is the loss of fine soil particles, to which nutrients are attached and, organic matter. The loss of the most productive part of the soil reduces the productivity of the site and increases its susceptibility to further erosion. The sand blasting effect of eroding soil may damage plants, particularly seedlings.

Soil loss by wind erosion is most likely to occur in areas where vegetation has been removed. Vegetation may be removed by stock and feral animal grazing, fire and hail storm (small isolated patches).

The sandy soils of the sand plain and sand dune areas are more prone to drift. The sandy loams of the texture contrast soils are prone to wind and water erosion.

Significant drift occurred in the recent past and its effects can still be seen. Linear mounds mark the position of old fencelines where drift accumulated. Sandy mounds can be found on the leeward side of extensively scalded areas or on the windward side of obstacles such as ridges, hills and rises, where it has collected, in many instances on the southwest margins. *Maireana aphylla* (nitrebush) mounds on plains are generally formed through soil particle capture. Many of the past drifts are now fixed by weedy plants such as *Eremophila sturtii* (turpentine), *Dodonaea viscosa* ssp. *angustissima* (narrow-leaf hopbush) and *Asphodelus fistulosus* (onion weed) or other natives like *Acacia ligulata* (umbrella bush), *A. burkittii* (pin-bush wattle), *Olearia pimeleoides* (showy daisy-bush) or *Aristida* spp. (kerosene grasses).

Powdery soils with sandy loam or fine sandy loam textures are also susceptible to wind erosion when pulverised by stock trampling. This is probably the cause of much past drift and risk of such erosion is probably considerably reduced today, mainly because stock are not concentrated in the way they were previously.

In areas of dune systems, the eruption of blow-outs, sand movement etc. is to some degree a natural occurrence.

Drought is the biggest single contributing factor to wind erosion in the District. After drought the soil remains bare until sufficient rains provide moisture for germination, and for resprout of perennial shrubs, trees and grasses.

## **LAND MANAGEMENT AND REHABILITATION**

Prevention of erosion is cost-effective and much easier than revegetation after erosion has occurred.

Measures for the prevention of wind erosion include:

- maintaining or increasing the density of perennial vegetation cover,
- maximising grass and litter cover on sandy soils by maintaining annual pastures,
- avoid placing access tracks and water points on sandy soils,
- managing fire affected areas to ensure maximum recruitment of plants and establishment of perennial plants in the longer term,
- controlling or eradicating rabbits, and
- maintaining the lichen crust on soil surface.

To revegetate areas where wind erosion has occurred, it is necessary to restrict grazing pressure. Providing a seed source and nutrient traps in the form of dead timber or rough soil surface will contribute to the establishment of vegetation.

Where there are small areas of drift on soils with a heavy subsoil, ripping and roughening the soil surface at right angles to the prevailing wind will reduce the wind velocity and hence the potential for erosion. This practice is not recommended on deep sands.

## **WATER EROSION**

Water erosion is a process where soil particles are detached and transported by the action of rainfall or overland flow. There are several forms of water erosion:

- *Splash erosion* is the detachment of soil particles by the impact of raindrops. The loosened particles are then more susceptible to transportation by runoff.
- *Sheet erosion* is the removal of a fairly uniform layer of soil from the land surface by raindrop splash and/or runoff.
- *Wave / Ripple erosion* is caused when water collects in low-lying flat areas (scalds) and under the action of strong winds, wave ripples form which erode the scald margins.
- *Rill erosion* is the removal of soil from the land surface whereby numerous small channels up to about 30 cm deep, are formed.
- *Gully erosion* may be caused by the concentration of runoff with sufficient volume and velocity to cut large channels or, by the dispersal of subsoils causing the collapse of the surface soil forming gullies.

Extensive gullies can form on quite gentle slopes on susceptible soil types.

Creek systems are a naturally eroding system; high intensity rainfall events will generate flows that erode the riparian zone.

The potential for water erosion will be increased by management practices which:

- breakdown soil structure into fine readily transportable particles, eg. by stock trampling, vehicle movements,
- remove protective vegetation, lichen crust, stone cover or mulch cover,
- create furrows or tracks up and down slopes.

Sheet, rill and gully erosion have occurred on the foot slopes of ranges where soil surface cover has been reduced or removed.

## **LAND MANAGEMENT AND REHABILITATION**

Water erosion is difficult to control. Re-establishment of vegetation by reducing the grazing pressure (stock management, rabbit, goat and kangaroo control) is showing benefits. There are areas where pearl bluebush and black bluebush and bladder saltbush are re-establishing as a result of reduced grazing pressure.

Measures for the prevention of water erosion include:

- maintaining or increasing the density of perennial vegetation cover,
- maximising grass and litter cover on sandy soils by maintaining annual pastures,
- avoid placing access tracks and water points on sandy soils,
- managing fire affected areas to ensure maximum recruitment of plants and establishment of perennial plants in the longer term,
- controlling or eradicating rabbits, and
- maintaining the lichen crust on soil surface.

Water control banks and contour furrows are also successful measures where finances permit their construction. It is essential that these structures be properly surveyed to prevent concentration and channelling of flow.

## ***FIRE***

Fires occur rarely in the region. The infrequency of fires is due to the prevalence of chenopod communities throughout the District. *Atriplex* spp. (saltbush) and *Maireana* spp. (bluebush) do not burn readily, and only when grasses are abundant do fires spread, once started. The main impact of fire is the loss of vegetation cover which may lead to soil erosion.

Large bushfires tend to occur after exceptional years (greater than 525 mm rainfall), when high fuel loads generally of spear grasses, are ignited often by lightning and fanned by hot dry winds.

There is little documentation and research done on the fire regime and its effect on the plant communities of this region.

Some species resprout from their base or from epicormic buds, whilst others regenerate from viable seed in the soil after wildfires. Many *Acacia* seeds are assisted in their germination by fire.

A good example of the effects of fire exists on Curnamona in the bluebush / saltbush plains where chenopod shrub death was complete and subsequent regeneration was dominated by bindyis and native grasses.

## ***CONTROL AND MANAGEMENT***

Fires occurring in the District are attended by the CFS and local people. In inaccessible country fires are left to burn out. Because of the fire and communications equipment now available wildfires don't get out of control as much as they have in the past.

The management of fire affected areas requires that stock numbers in the paddock need to be reduced in proportion to the area burned. It also requires that plants which regenerate or germinate after rainfall are maintained and allowed to establish to limit soil erosion. Grazing management of these areas is a balance between lowering stock numbers and managing the impact of kangaroos by stock grazing. The first feed to grow is the sweetest and if sheep don't eat it, kangaroos will.

Grading of firebreaks in conjunction with fence lines and roads can be beneficial to the control of fires when they occur.



⚠ file unavailable ⚠

*Basal resprout of Eucalyptus spp. six years after fire.*

## INTRODUCED WEEDS

Introduced plants that are considered weeds in the pastoral context include Onion weed, Wards weed, Salvation Jane, Horehound, Statice (winged sea lavender), Bathurst burr, African rue, Noogoora burr, Mesquite and African boxthorn.

Wards weed, Salvation Jane, Horehound and Bathurst burr are all eaten by stock and although not preferred pasture, these species provide both soil surface cover and / or stock feed particularly in the areas cleared in the past for cropping and which now support volunteer (compared with native) pastures.

Weed species can be introduced in many ways including:

- deliberate introduction as stock feed or soil stabilisation, eg. Salvation Jane,
- introduction as garden species, eg. pepper tree and prickly pear,
- accidental introduction of burr weeds such as Noogoora burr or, in an animals stomach, eg. Wards weed and mimosa bush in stock, and African boxthorn in birds,
- accidental introduction on vehicles of any seed,
- accidental introduction of seed in imported goods, eg. African rue in camel pack saddles, seed in imported hay,
- natural dispersal will spread weeds, eg. seed can be transported downstream by water.

The colonisation and naturalisation of weeds depends on their ability to grow and propagate in the region in successive seasons and their ability to withstand drought. Disturbance is a key factor in arid areas. The greater the disturbance (prolonged, repeated, intense), the greater the invasion and, the poorer the native vegetation community. Disturbance in the arid zone is a natural phenomenon - drought, flood, fire, wind storm, an emu pad - but the types and scale of disturbance have increased greatly since European settlement (Michelmore 1995).

## WEED CONTROL STRATEGIES

Due to the relatively low productive value of pastoral land and normally high costs of weed control, it is important to control new infestations of weeds as soon as possible.

Identify new plants first. Many desirable native plants can remain dormant for many years and then 'reappear' as a 'new' plant. If any new plants cannot be identified then post specimens of leaves, flowers, and seed pods / fruits to PIRSA Port Augusta for identification. Wrap the specimen in newspaper, NOT plastic, before posting.

Some of the plants mentioned here are proclaimed under the *Animal and Plant Control Act 1986*. This legislation outlines a variety of control measures and requirements for certain plants. For further information and to obtain copies of Pastoral Lands Notes on weeds, contact the Animal and Plant Control Adviser, PIRSA Port Augusta.



*Significant areas in the southern part of the District are affected by Onion weed infestation.*

## **WOODY SHRUB INCREASE**

Grazing and agricultural practices in the pioneering days of the District caused the removal of palatable perennial plants from some areas, and led to an increase in density of some species of woody shrubs. These include *Callitris* spp. (native pines), *Dodonaea* spp. (hopbushes), *Eremophila sturtii* (turpentine), and *Senna* spp. (Sennas). These species are considered weeds because they are unpalatable and tend to grow in thickets which prohibit establishment of other plants and make mustering difficult. These woody species are native to the area.

Experience interstate indicates that these species increase where the vegetation and soils have been disturbed or where there is a lack of competition for soil moisture from grasses. The exceptional rainfall of 1973 - 74 provided high soil moisture conditions suitable for the establishment of woody shrubs. Rabbits formerly controlled woody shrub growth but since the decline in rabbit numbers due to the introduction of myxomatosis in the 1950s, the pressure on woody shrubs has decreased. Heavy grazing before the 1973 - 74 wet season created conditions suitable for the establishment of woody shrubs. In these situations, the growth of woody shrub seedlings is not limited by competition and shrubs may establish in high densities.

The increase in density of woody shrubs is not an extensive problem in this District, although it is of concern in some areas. The Board supports the idea that the situation be monitored, and that an understanding of the factors leading to woody shrub increase be gained. Research into the ecology and management of these species needs to be undertaken in the near future.

To prevent an increase in woody shrubs it is necessary to stock country so that the density of palatable perennial bush species is not reduced and soil stability is maintained.

It is very tempting to treat the symptoms of this problem rather than the cause. Destroying woody shrubs is not the entire solution to the problem. Soil needs to be stabilised and a good cover of vigorous deep-rooted plants is necessary.

Approval from the Native Vegetation Council and the Pastoral Board on pastoral leasehold land are required before removing native vegetation including woody shrub infestations.

The soil and landform associations of these weedy shrub invaders are applicable in this District:

- *Dodonaea viscosa* (hop-bushes) sandspreads on sand plains in the northeast.
- *Dodonaea lobulata* (lobe-leaved hop-bush) crests and slopes of rocky, stony hills with skeletal soils.

- *Olearia pimeleoides* (showy daisy-bush) on stony hillslopes and in shallow sandspreads on northern plains and central range valleys.
- *Senna artemisioides* spp. (desert sennas) in a variety of land types, including sandspreads of the northern plains, plains with sandy loam topsoils and calcareous plains of southern black oak woodlands.
- *Eremophila sturtii* (turpentine) lower lying plains with firm sandy-loam to loamy topsoils in the east of the District, in the west on old drifts and shallow sandy topsoils over firm subsoils.
- *Acacia burkittii* (pin-bush wattle) on old soil drifts in the west of the District and in runoff areas of the southern black oak plains.
- *Eremophila duttonii* (Harlequin fuchsia-bush) on sandy plains over firm subsoils in the northwest of the District.
- *Callitris glaucophylla* (northern cypress pine) on dunes and sandspreads in the northeast of the District and on hillslopes and valleys in the far west of the District.

The futility of destroying weedy shrubs, without providing perennial cover, cannot be emphasised enough.



*Woody shrub invasion in sandy country near Mount Victor.*

## **CONSERVATION AND BIODIVERSITY**

There are no proclaimed National Parks and Wildlife Reserves in this Soil Conservation District.

The strength of this District is its biodiversity and its ability to respond to the seasons. Biological diversity is higher in the low hills of the Olary Spur, due to the more complex geology and higher rainfall. Grazing pressure over extended periods has depleted the understorey of the mallee communities in the south, reducing their value as habitat for some native species of birds, small mammals and reptiles. Preferential grazing of the more palatable plants has altered the composition of the native pastures throughout the District. Protecting and enhancing this biodiversity is the key to the future viability of the pastoral industry in the District.

Privately initiated on-property conservation provides the opportunity for a potentially large and effective conservation strategy for pastoral lands in the District. It is a widely held view that long term survival of many vertebrates will only be possible if active management of animal and plant diversity by landholders and managers occurs. Adequate pest plant and animal control is a form of habitat management contributing to biodiversity maintenance. Land managers also contribute to conservation at paddock level. Areas remote from water points can provide habitat as good or better than what may be protected in reserves, and appropriate land management (in terms of paddock size, stock numbers and water point location) can achieve maintenance of biodiversity to some degree. There is biodiversity value in undisturbed pastoral land. A balance is required between the provision of additional water points and the consequential impact on wildlife.

Some individual property managers have reserved paddocks for conservation purposes. The Koonamore Vegetation Reserve, a 5 km<sup>2</sup> area of mulga and saltbush, has been managed for research and conservation purposes since its acquisition by the University of Adelaide in 1926.

A number of plant species found in the District have conservation significance. The most important of these is the purple wood wattle (*Acacia carnei*), which is rated vulnerable nationally. It grows in association with the blackbush (*Maireana pyramidata*) low open shrubland community where it forms dense thickets by suckering. Typically these thickets are on sandy rises and mounds formed by the shrubs capturing windblown sand.



Small groves are scattered throughout the District. In the south, it grows along the valley of Pine Creek between Mutooroo homestead and Corella Outstation south of Cockburn. A large population grows near the Barrier Highway near the old Mingary rail siding and along the adjacent creek banks. It is also scattered along the drainage line which runs south of Mulyungarie homestead toward Cockburn, and extending onto the plains in the northeastern portion of Boolcoomata Station. Further north, in an atypical situation, it occurs on the northern boundary of Mulyungarie Station in native pine woodland on sand dunes. Near Bimbowrie Station the species is growing along the valley floor south-east of the homestead, and westwards on the flood plains south of Plumbago homestead, and toward Four Brothers homestead. South of Plumbago, it is growing on sandy hill footslopes on soils derived from the adjacent hills which support mulga and rock sida. Further west on Curnamona Station it grows on small sandy rises in the low bluebush open shrubland community.

Hairy bluebush (*Maireana pentagona*) and slender soft-horns (*Malococera gracilis*), respectively rated rare and uncommon in South Australia, are also found in the District.

Other plant species of conservation significance in the District are nealie (*Acacia loderi*) occurring on the black oak / bluebush plains in the south of Mutooroo Station and camel poison (*Codonocarpus pyramidalis*) which grows on rocky crests of hills on Outalpa, Bimbowrie and Minburra Stations.

The Yellow-footed rock wallaby (*Petrogale xanthopus*) occurs only in three areas in South Australia: the Flinders Ranges (the most extensive populations), the Gawler Ranges and the Olary Hills (north of the Barrier Highway). The same subspecies also occurs in one area in western NSW. The range of this subspecies has declined by greater than 50% and continues to be threatened by competition with goats and rabbits, and predation by foxes.

In the Olary Spur area, rock-wallabies are known historically from south of the Barrier Highway. Skeletal remains have been found at Anabama Hill where there were reported sightings up to 1960. Copley and Alexander (in press) describe the current status and distribution of these threatened animals based on extensive survey and monitoring work undertaken since 1980. The known colonies in the Olary Spur north of Bimbowrie have been increasing in response to becoming central to an integrated pest control program since 1992 (pers. comm. P. Alexander).

 file unavailable 

*The Yellow-footed Rock-wallaby has made a significant recovery in the Olary Spur through integrated pest management around key colonies.*

The Department of Environment, Heritage and Aboriginal Affairs and the Animal and Plant Control Commission are jointly conducting research on the effects on rangeland condition and livestock production of reducing the numbers of rabbits, feral goats and kangaroos in the Olary Spur. This project, which began in April 1995, is being conducted in four study areas on

portions of five pastoral leases in the North East Pastoral District and involves the cooperation of pastoralists and the Soil Board. It is planned that the study will run for many years in order to accumulate significant data on any changes which may occur. The herbivore control program involves kangaroo harvesting by local shooters, pastoralists mustering and shooting goats, and the ripping of rabbit warrens. Herbivore densities are monitored and plant biomass and floristic composition are being measured twice a year, while wool production and lambing percentages are being recorded on an annual basis. The improved understanding of the benefits and costs of controlling vertebrate pests and kangaroos could lead to a reassessment of management practices and policy regarding domestic and wild grazing mammals in rangelands.

In the two years which the project has been operating, significant reductions in target herbivores (kangaroos, goats and rabbits) have been achieved. Despite the presence of RCD in the area the rabbit warren ripping program went ahead and there has been little sign of warren re-openings or rabbit activity at these sites. Kangaroo populations have been reduced by approximately 50% in the targeted areas.

It is expected that many years of monitoring will be required before any changes of rangeland vegetation can be directly related to altered herbivore densities. (pers. comm. N. Neagle).

## **ABORIGINAL HERITAGE AND CULTURE**

Due respect by all land managers and visitors should be given to all Aboriginal heritage sites and sites of cultural importance.

The Soil Conservation Board believes that land managers respect sites and ensure that such sites are not desecrated. Before development takes place near, or on, known sites of aboriginal cultural importance relevant government departments should be contacted for advice as required by the *Aboriginal Heritage Act*.

Recently Native Title legislation has been altered and some landmark High Court decisions made relating to pastoral use of land and how it is affected by Aboriginal land claims. This situation is still unresolved, and the current understanding of the implications with regard to pastoralism are described in Appendices E and F.

## **TOURISM AND RECREATION**

Different forms of tourism have different effects on the land. Bushwalkers and camel safaris leave very little sign of passage. Drivers of conventional vehicles usually stay on outback tracks. During recent years, public access to inland areas has been progressively restricted or closed for a variety of reasons including environmental abuse and safety concerns. The remaining areas are under increasing pressure as users of the land are forced to share this resource. Although many respect the environment, a small percentage of uneducated users can cause significant impact.

Vehicles are usually welcomed on pastoral leasehold land. However, when they are driven improperly in the wrong places or at the wrong times, vehicles can seriously damage vegetation, disturb wildlife, scar the landscape, create soil erosion and water pollution, or damage costly facilities. Unless people learn to use vehicles in appropriate ways, more and more land will be closed to their use.

The vast majority of those involved in outdoor recreation are not affiliated with any organisation. As a result, most involved learn about it by trial and error. This lack of knowledge leads to the continuing repetition of damaging actions and problems for land managers. These can be minimised by:

- travelling only where permitted;

- respecting the rights of others to enjoy their activities undisturbed;
- education about the land you wish to visit;
- avoiding damage and / or disturbance to watercourses, wetlands, wildlife, livestock and;
- avoiding steep terrain.

Most visitors to the District come from regions where the climate is less harsh and they are not familiar with the local environment. A lack of knowledge can damage local vegetation, endanger wildlife and disrupt pastoral activities. In some cases wilful action leads to littering, pollution of waters, shooting of wildlife and livestock, illegal fishing and / or serious damage to land and roads.

## **RUBBISH DISPOSAL**

As a general rule there has been little effect other than isolated dumping of rubbish by campers. A good rule for all visitors is **"If you bring it in - take it out again"**.

Overall the impact of tourism is minimal and not a soil conservation problem in this District.

## **PROPERTY MANAGEMENT PLANNING**

Landcare practices are often tied to income, which in turn is affected by commodity prices, tax liability, and tax deductibility. A land manager with no tax liability through low income, gives low priorities to landcare programs.

The inability to control prices of produce, general market variability and increasing costs of production are management risks currently of major concern to many pastoralists. While these risks themselves are not new, enterprise profit margins are now so small that there is no tolerance to sub-optimal management.

To address these risk management problems, farm business management training can assist pastoralists develop a sustainable and viable business.

Property Management Planning offers a challenging and productive approach to pastoral enterprise management. It also provides a forum for exchange of ideas between land managers. A primary production management process integrates personal goals with animal production, economics, marketing and natural resources management. Once implemented a good property management plan results in the development of a sustainable and viable pastoral business.

The State and Federal Governments are promoting Property Management Planning (PMP) in a number of ways. For pastoralists in the North East Pastoral Soil Conservation District there is a PMP facilitator located at the Port Augusta PIRSA office. The facilitator's role is to assist groups of pastoralists in developing their own plans.

Funds are also available under the Farm Plan Grant scheme. Under this scheme up to \$3,000 is available to assist producers to develop their own property management plan. The grant is utilised in two stages:

1. Up to \$1,500 is available to review all aspects of the business including landcare issues.
2. Any remaining funds from first stage plus an additional \$1,500 is then available to further plan issues identified as requiring more work.

Applications are made to the Rural Finance and Development Group, PIRSA (toll free 1800 182 235).

The Pastoral Property Management Planning process offered through PIRSA works through six steps, the result of which will be an effective Property Management Plan for your property and business. The steps, and the sorts of activities which make up a plan are:

#### *Setting directions*

- set personal and business goals
- identify strengths, weaknesses, opportunities and threats

#### *Natural resources and property layout*

- stocktake of the property's soil, vegetation and water resources and existing property layout
- discuss climatic variability
- develop general plans for sustainable grazing management

#### *Human resources and business position*

- identify the people involved in the business and their skills
- equity, cash flow and net profit/loss
- identify and discuss business structures

#### *Enterprise evaluation*

- livestock performance indicators

#### *Enterprise planning*

- methods for assessing proposed management changes, diversification etc

#### *Business planning*

- estate and retirement planning
- identify short, medium and long term objectives
- plan monitoring and business controls

## **PASTORAL LEASE ASSESSMENT**

The Pastoral Management Branch (DEHAA), in accordance with the provisions of the *Pastoral Land Management and Conservation Act 1989* undertakes assessments of pastoral leasehold lands. This assessment process includes the establishment of permanent photographic monitoring points, Land System mapping and in the cattle country, a grazing gradient analysis centred on specific watering points. In the North East Pastoral District, this process is expected to be complete by late 1998, with about 850 monitoring sites (photopoints) being established (usually one per set-stocking paddock) over the 37 pastoral runs. These assessments are only undertaken on land under pastoral tenure (p.29), as required by the legislation, but assessment of non-pastoral leasehold lands can be undertaken by arrangement.

Assessment, being the evaluation of condition, includes the establishment of monitoring points, the description of paddock characteristics and condition and sampling for the Land Condition Index, using the criteria detailed earlier in the section on Pasture Types. It also includes assessment of grazing capacity of a lease, which is then used to set a stocking maximum for the lease.

Monitoring is primarily aimed at establishing condition trend at paddock, station and district levels. To derive district level trends, reference sites will be established in representative landscapes within the district, at the cessation of the current assessment phase. On a lease, monitoring sites can be of two types, the most common being a "representative" site. These are usually placed about 1.5 – 2 km from water points in country representative of the landscape and condition around the water point. Vegetation attributes such as plant density, cover and frequency may be measured along marked transects for future quantitative comparison. Other sites could be termed "issue" sites because they are created to monitor certain issues, for example, soil erosion, woody shrub invasion, and other issues usually related to paddock condition. Conservation issues may arise where threatened or endangered plants require monitoring. "Issue" type sites are usually placed within 2 km of a water point.

This information, including the paddock descriptions, land management issues, tenure, stock, and rainfall details, forms an Assessment Report. This Assessment Report is part of an ongoing monitoring program of all Pastoral Leases in South Australia. Following the initial assessment, it is intended that all leases will be revisited at least every 3 years (some leases more frequently) by a Pastoral Inspector working with a Rangelands Officer. This will involve the traditional pastoral inspection, as well as a detailed review of the issues identified in the Assessment Report. In addition to the Assessment Report, all information and photographs collected at photopoints is provided to the lessee, or manager, in a Photopoint Manual. Lessees or managers are encouraged to use these monitoring points and rephotograph them periodically. The Pastoral Management Branch, in collaboration with Soil Boards is examining means of involving lessees and managers in future lease assessment and monitoring. An updated Paddock Plan and a Land Systems (or land type) map is also produced as an aid to management planning.

## **INFRASTRUCTURE CONSTRUCTION AND MAINTENANCE**

Planners, builders and managers need to adopt a pro-active approach to infrastructure development, construction and maintenance with the aim of minimising impacts on resources such as soils, vegetation and water by:

- ensuring that such activities do not cause soil erosion
- controlling and where possible eradicating weeds and pest animals
- disposing of all wastes safely and appropriately
- ensuring that activities do not degrade vegetation

## **MINING AND EXPLORATION**

There is extensive exploration for minerals in the District. To date negotiations between lessees and mineral exploration licence holders have generally been acceptable and to mutual benefit. The Board endorses the conditions which Mines and Energy SA impose on exploration through various Acts.

Good relations between landholders and those involved in mineral exploration are based on each party understanding the interests of the other, and whilst the *Mining Act 1971* enables mining companies and prospectors to access the land for exploration purposes, it also recognises the rights of landowners.

A clearly set down procedure must be adhered to:

- First a *Miners Right* must be obtained
- A *Notice of Entry* must be served on the landowner (lessee) at least 21 days prior to entering on the land, or a written agreement with the landowner entered into giving consent to enter
- After pegging, the *Mineral Claim* must be registered within 30 days
- A *Mining Lease* applied for within 12 months, before production can begin



- Annual rental on a *Mining Lease* is \$22 per hectare
- A *Bond on the Mining Lease may be required*. The amount of the bond will depend on the type of proposed operations
- Royalty payments need to be made on all extracted minerals

The Act lays down clear obligations for the explorer to notify and consult with landowners, to repair damage to improvements, to reinstate disturbed areas and to pay compensation for financial loss, hardship or inconvenience.

Fossickers (those who gather minerals as a recreation and do not disturb the land or water with machinery or explosives) are not subject to the *Mining Act 1971* and can only enter the land with the owner's permission.

The landowner and the explorer are both obliged to care for the land and use its resources in a sustainable way. This can only be achieved if each party knows what the other is doing and can integrate their management practices.

The exploration company should aim to:

- establish and maintain close liaison with the owner and occupier of the land on which exploration is conducted
- avoid damage to improvements (including water supplies), and carefully manage activities in relation to their effects on vegetation and land
- avoid interference with crops, livestock and other economic activities on the property
- avoid disturbance to the owner's house and other amenities from noise, dust and other nuisances
- rectify damage to the property or improvements without delay
- pay compensation promptly
- ensure that all employees and contractors know of and comply with the company's obligations and commitments.

The landowner's (lessee's) contribution to a good working relationship is to:

- respond with minimum delay to requests for information or to notices issued under the Mining Act
- advise the explorer of any changes to previously agreed stock or management programs
- respect the confidential nature of exploration and refrain from discussing the results of the work with others

Any human activity has some effect on the environment. In the past, most people saw land and the environment as a relatively limitless resource. In many cases, little or no attention was given to the question of ongoing land use after mining activities. More recently, other land values and the value of the environment have been better recognised. This has led to a situation where no land is subject to major disturbance by mining without planning for its restoration or later use for other purposes. In addition, the actual extent of the disturbance can be minimised by careful planning and strict controls. Where all or most of the material extracted is removed from the site, restoration may be aimed at smoothing the final contours and reducing the visual impact with vegetation.

The community measures the minerals industry by the standard of its environmental management. To maintain the support of the community for mining, the minerals industry must demonstrate high standards of environmental management, backed by a commitment to continual improvement.

Modern living demands a steady, assured supply of minerals and metals, resources which must be removed from the ground. While mining activity disturbs the local environment, it is essentially a temporary use of land.

There has been a growing community awareness of the importance of environmental protection and conservation. This awareness is shared by the minerals industry, which contributed to the development of the National Conservation Strategy for Australia. The industry has also embraced the concept of sustainable development which emerged from the work of the UN's World Commission on Environment and Development, and which calls for a balance between conservation and development.

Many factors must be considered in the implementation of sound environmental policies to achieve a balance between economic necessities and ecological goals. Land use planning in relation to mining can be complicated. This is particularly so today as most new deposits are found in areas with a pre-existing land use. Mineral deposits may be found after other land use decisions have already been made.

There is also the question of relative permanence. Some mining operations continue in a particular area for decades while others may disturb an area for only a short time. No matter how long the operation continues, disturbance can be minimised by careful planning and strict supervision.

Today, two land use changes occur where mining takes place. The first involves disturbance caused by surface mining and the construction of buildings, plant and roads. The second is the return of the land from mining to its original or some other agreed use.

Previously no budgetary provisions were made for rehabilitating the land. Today, all small-scale mining operations must prepare a Declaration of Environmental Factors (DEF) prior to receiving government approval to mine. The DEF outlines appropriate and workable plans for all aspects of the environmental management of a mine. Adequate funds must be set aside by the company in advance for this environmental work to be done.

Environmental Guidelines for Mineral Exploration Activities are set out in MESA Information Sheet E8, and cover access, drilling operations, campsites, excavations and waste management.

Today, the mining industry considers final rehabilitation of the landscape to be part of the total mining operation. Therefore plans and budgets are made in advance for long-term environmental programs. With rehabilitation costs frequently exceeding \$10,000 per hectare, companies are anxious to ensure their programs are environmentally acceptable and are recognised by the community as such. Rehabilitation does not cease with earthworks, planting and seeding. The effectiveness of the rehabilitation program can only be determined by comprehensive monitoring.

The four common stages of a rehabilitation program are:

- Determination of the future land use of the disturbed area - ie. rehabilitation for what future use?
- Earthworks to prevent erosion and measures to maximise surface suitability for plant growth;
- Establishment of vegetation by tubestock planting, direct seeding or techniques to conserve topsoil seed sources;
- Monitoring and research to ensure the desired long-term ecological outcomes are attained.

The Soil Conservation Board will act as negotiator and arbitrator in the establishment of conditions and requirements for the rehabilitation of exploration and mining sites, and

supports the environmental objectives and guidelines published by MESA (Information Sheets E6, E8, E9 and E10).

# THREE YEAR PROGRAM

## ***AIMS OF THE SOIL CONSERVATION BOARD***

- Promote and eventually achieve ecologically and economically sustainable land use in the District.
- Help each property manager in this District to develop property management plans which are consistent with achieving economically and ecologically sustainable land management.
- Collect, collate and make available historical information and local knowledge about total land management.
- Provide advice on land management to land managers and Government agencies where requested.
- Be a voice, network link and responsible mediation body on land use and management issues for the North East Pastoral community to the Government and community of SA and Australia.
- Encourage liaison between the Pastoral Management Branch of DEHAA, the Pastoral Board, and land managers.

## ***GOALS AND STRATEGIES TO MEET AIMS***

**GOAL:** Optimise the productivity of the land.

### **STRATEGIES:**

- Encourage coordinated and planned programs for the eradication of goats and rabbits.
- Encourage pastoralists to revegetate low productivity areas by demonstrating methods and benefits of revegetation.
- Encourage a planned approach to water distribution and fencing improvements through Property Management Planning.
- Investigate within the requirements of the Pastoral and Land Management Act, pasture species to increase pasture productivity.
- Liaise with DEHAA to establish research activities into the indigenous range and sustainable populations of western grey kangaroos and euros within the District.
- Support and facilitate research into ecology and management of invasive woody shrubs.

**TIME FRAME:** Ongoing

**GOAL:** Eradicate goats from the North East Pastoral Soil Conservation District.

### **STRATEGIES:**

- Promote the ethic that goats need to be eradicated by:
  - peer pressure,
  - information dissemination including field days, fact sheets and/or information evenings,
  - supporting research into eradication methods.
- Soil Conservation Board to contribute to funding submission to assist DEHAA with the collection of **more reliable and accurate goat population data.**

**TIME FRAME:** Ongoing

**GOAL: Eradicate rabbits to increase productivity and improve rangeland condition.**

**STRATEGIES:**

- Encourage land managers to plan and implement rabbit control programs on their properties.
- Support the development of biological control methods by assisting with trials and experiments.
- Demonstrate, monitor and publicise the economic and ecological impact of rabbits.
- Identify priority areas for rabbit control.

**TIME FRAME:** 1998 (Release of RCD) / Ongoing

**GOAL: Promote Property Management Planning to land managers in the District.**

**STRATEGIES:**

- Invite a speaker to:
  - relate the content and process of the Property Management Planning program,
  - discuss with the Board and North East Pastoral community the value of the Property Management Plan.
- **Promote and support land condition monitoring as a management tool.**

**TIME FRAME:** 1998

**GOAL: Reduce the extent of eroded and eroding areas**

**STRATEGIES:**

- Increase awareness of the types and mechanisms of erosion and preventative and control measures by arranging and holding field days and distributing appropriate fact sheets.
- Establish a demonstration project focussing on gully and scald erosion. This trial needs to demonstrate mechanisms for controlling runoff and methods for encouraging productive species without **creating a woody shrub problem.**

**TIME FRAME:** Ongoing

**GOAL: Increase knowledge and understanding of the North East Pastoral Soil Conservation Board's role and its activities**

**STRATEGIES:**

- Publish articles for local and statewide press.
- Promote the Board's activities by radio interviews and events notices.
- Hold annual information sharing meetings for local and invited people.
- Distribute leaflets about the Board at field days outside the District.
- Promote the Board and its activities by erecting displays at local race meetings and social events.

**TIME FRAME:** Ongoing

**GOAL: Create mechanisms for open communication with Pastoral Board and Pastoral Management Branch, DEHAA.**

**STRATEGIES:**

- Invite Pastoral Board and Pastoral Management Branch personnel to field days and other Board activities.
- Arrange joint annual meetings of the North East Pastoral Soil Conservation Board and the Pastoral Board to discuss common issues and activities.

**TIME FRAME:** Ongoing

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# GLOSSARY

**ALLUVIAL SOIL** A soil developed from Alluvium.

**ALLUVIUM** An extensive stream laid deposit which may include gravel, sand, silt and clay. Typically forming floodplains that develop alluvial soils.

**ANNUAL PLANT** Plants which germinate, flower and seed in one season or year, eg. button grass, fairy grass. (See perennial plant).

**ARID** Refers to climates or regions which lack sufficient rainfall for crop production or extensive sown pastures. Usually defined as a climate with annual average rainfall less than 250 mm (10 inches).

**CALCRETE** any cemented terrestrial carbonate accumulation that may vary significantly in morphology and degree of cementation.

**CARRYING CAPACITY** An estimation of the long term stocking rate land can support without a decline in the sustainability or condition of the vegetation and soil resource.

**CHENOPOD** A plant which is a member of the drought and salt tolerant Chenopodiaceae family (eg. saltbush, bluebush, bindyi).

**CONDITION** The condition or 'health' of plant and soil resources, relative to their potential. Condition is determined by comparing similar sites under different grazing impacts.

**COVER** The proportion of ground surface covered by plants, litter and stone (usually expressed as a percentage). Cover is one of the most important factors in reducing soil erosion.

**DECREASER PLANTS** Plants which are preferred by stock and which decrease in density and are eventually eliminated from zones of high grazing pressure. Bladder saltbush and Mitchell grass are decreaser plants. (See indicator plants).

**DEFLATION** Decrease in soil surface level through wind or water erosion.

**DEGRADATION** Degradation of land is the decline in the quality of the natural resources of the land resulting from human activities on the land.

**DESTOCKING** The removal of stock from a grazing area, generally to reduce the grazing pressure on the area and often to provide the vegetation in the area an opportunity to resprout, seed or recruit.

**DOG FENCE** Vermin proof fence designed to keep dingoes out of the sheep country.

The idea of a continuous fence running from the NSW border to the Great Australian Bight was formalised in 1946 by the Dog Fence Act, which also established the Dog Fence Board to administer, patrol and organise maintenance of the fence.

A new system is currently being put in place where pastoralists are no longer required to maintain their sections of the Dog Fence. Local Dog Fence Boards were recently set up to undertake the day to day management of the various sections of the fence in South Australia. Contractors to these Local Boards, for maintenance and monitoring, conduct fortnightly patrols.

A fence supervisor inspects the entire 2,230 km four times per year. The cost of maintaining the Dog Fence in South Australia is met through a levy on all property holdings larger than 10 km<sup>2</sup> south of the fence and is subsidised dollar for dollar by the State Government.

**DIRECT SEEDING** Application of seed directly into the area in which the seedlings are to germinate and grow to maturity.

**DISPERSIVE** When water is applied to the surface of some soils, the forces which bond the soil particles together are almost completely destroyed, causing the surface "clods" to break down completely. Soils which behave in this way, losing their structure, and becoming unstable when wet are termed dispersive.

**DOLOMITE** Rock consisting chiefly of the mineral of the same name, calcium magnesium carbonate.

**DOMINANT SPECIES** The tallest plant species present at a site. There must be several individuals of the plant present at the site for it to be the dominant species.

**DUPLEX SOIL** A soil in which there is a sharp change in soil texture between the A horizon (topsoil) and B horizon (subsoil). In the pastoral areas these soils are common and are prone to scalding.

**ECOLOGY** The study of relationships between living organisms and their environment.

**EPICORMIC** of buds, shoots or flowers, borne on the old wood of trees (applied especially to shoots arising from dormant buds after injury or fire).

**EPHEMERAL** short-lived.

**GILGAI** Micro-relief associated with some clayey soils consisting of depressions and / or hummocks of varying size, shape and frequency. Gilgai depression formation and / or maintenance is a continuing long-term process in which the shrinking and swelling of deep subsoils with changes in moisture content causes the redistribution of soil. Gilgai is an aboriginal word meaning small waterhole.

**GRADATIONAL SOIL** A soil in which there is a gradual change in soil texture from the A horizon (surface soil) to the B & C horizons (subsoil).

**GROUND COVER** Material which protects the soil from erosion. Ground cover can include plants, stone, plant litter and lichen.

**GULLIES** An open incised erosion channel in the landscape greater than 30 cm deep. The main factor contributing to the formation of gullies is the concentration of surface runoff; gullies are often associated with drainage lines.

**GYPSUM** A naturally occurring soft crystalline material containing approximately 23% calcium and 18% sulphur. Gypsum is commonly used to improve soil structure and reduce crusting in hard setting clays.

**INCREASER PLANTS** Plants which are not preferred by stock for grazing and which increase in density and eventually dominate zones of high grazing pressure (replacing decreaser plants). Poverty bush, silvertails and sandhill wattle can be increaser plants in some situations. (See increaser plants, indicator plants, invader plants).

**INDICATOR PLANTS** Plants of which can be used to indicate levels of range condition through their occurrence or abundance for a particular soil - vegetation association. (See increaser plants, decreaser plants).

**INFILTRATION** The downward movement of water into the soil. Factors affecting infiltration include soil structure, soil surface and plant density.

**INVADER PLANTS** Plants which establish, and subsequently dominate, sites on which they were formerly scarce or absent. The invasion usually occurs after, or as a result of, soil disturbance, for example, vegetation clearance, fire or high grazing pressure. (See increaser plants).

**LAND CAPABILITY** The ability of land to sustain a type and intensity of use permanently, or for specified periods under specific management.

**LAND CONDITION INDEX** An index which provides an objective estimate of the relative overall condition of all the leases in a Soil Conservation Board District. (Previously known as the Weighted Average Condition (WAC) index). A manual developed for each Soil Conservation District which provides criteria and photographic standards for assessing the condition (good, fair, poor) of each pasture type and component within the district.

**LANDFORM** Any of the various features that comprise the surface character of land.

**LAND SYSTEM** An area of land distinct from surrounding areas with a relatively uniform climate and throughout which there is a recurring pattern of topography, geology, soils and vegetation. Land systems are most commonly delineated on a map. (See vegetation association).

**LAND TYPE** see Land System

**LIMESTONE PANS** a "pan" of sedimentary rock consisting predominantly of calcium carbonate.

**MECHANICAL REHABILITATION** The rehabilitation of degraded land using mechanical implements such as opposed disc ploughs and pitter planters.

**MONITORING** Collection and comparison of information to determine type, extent and cause of change.

**OROGRAPHIC LIFTING** Upward movement of air as it passes over areas of higher terrain (hills or mountains).

**PERENNIAL PLANT** A plant whose life cycle extends for more than two years (bladder saltbush). Some perennials, such as grasses and herbs, have above-ground parts which die off in unfavourable seasons leaving an underground structure, such as a bulb or rhizome, to produce new growth when the season is favourable, (eg. Mitchell grass). (See annual plant).

**PHOTOPOINT** A photopoint is a marked site from which photographs are taken to monitor change over time. Photopoints are set up as part of the pastoral lease assessment process. At these sites vegetation condition is usually also monitored.

**PLANT DENSITY** The number of plants in a defined area. Usually expressed as plants per unit area.

**RANGELAND** Land used for extensive grazing of sheep, cattle or other domestic stock. Rangeland vegetation is typically native or naturalised pasture and the country in general does not have the capability to sustainably support the economic production of crops. (See land capability, sustainable use).

**RANGELAND CONDITION** Describes the current condition of rangeland in relation to the potential condition of the particular area for the extensive grazing of domestic stock. (See condition trend, sustainable use).

**REGENERATION** The re-establishment of native pastures by self-seeding and growth.

**REHABILITATION** The treatment of degraded or disturbed land to achieve an agreed level of capability and stability, preferably at least equal to that which existed prior to degradation or disturbance. Rehabilitation may involve cultivation, earthworks, direct seeding etc. (See mechanical rehabilitation, land capability.)

**REVEGETATION** The re-establishment of plants on an area where the vegetation has previously been depleted, often to provide protection against soil erosion. (See regeneration, direct seeding.)

**RUN-OFF** The portion of precipitation not absorbed into or detained upon the soil and which becomes surface flow.

**SCALD** A bare area produced by the removal of the surface soil by wind and / or water erosion or salination. The result is exposure of the more clayey subsoil which is, or becomes, relatively impermeable to water. Scalds are a typical erosion form of duplex soils in the semi-arid and arid regions. Scalds are difficult to revegetate due to the lack of topsoil, low permeability, and often saline surface.

## **SECONDARY SUCCESSION**

**SEMI-ARID** Refers to climates or regions which lack sufficient rainfall for regular crop production. Usually defined as a climate with annual rainfall greater than 250 mm but less than 375 mm.

**SKELETAL SOIL** A shallow soil showing minimal profile development and dominated by the presence of weathering rock and rock fragments. Such soils are typically found on steep slopes and exposed hillslopes.

**SOIL EROSION** The detachment and transportation of soil and its deposition at another site by wind, water or gravitational effects.

**Natural erosion** Erosion occurring under natural environmental conditions, undisturbed by humans.

**Accelerated erosion** Erosion which is attributable to the influence of human activities. See also scald, hummocking and pedestalling.

**Water erosion** An erosion process in which soil is detached and transported from the land by the action of rainfall, runoff and seepage. Types of water erosion include:

**Splash erosion** The spattering of soil particles caused by the impact of raindrops on the soil; an important component of sheet erosion.

**Sheet erosion** The removal of a fairly uniform layer of soil from the land surface by wind and raindrop splash and / or runoff. No rills are formed.

**Rill erosion** The removal of runoff from the land surface whereby numerous small channels are formed. Rills are defined as small channels up to 30 cm deep.

**Gully erosion** The removal of soil by water whereby large incised channels (> 30 cm deep) are formed. The severity of gully erosion may be recorded as minor, moderate, severe or very

severe. Gully erosion processes may include the removal of soil from the land surface by concentrated runoff or the dispersion of unstable subsoils.

**Stream bank erosion** The removal of soil from stream banks by the direct action of stream flow and/or wind /wave action. Typically occurs during periods of high flow.

**Wind erosion** The removal and transportation of soil by wind. (See sheet erosion).

**SOIL TEXTURE** The coarseness (sand content) or fineness (clay content) of soil.

**SUSTAINABLE USE** The use of the resource, (eg. pastoral land), in such a manner that the productivity and quality of the resource is maintained indefinitely.

**TEXTURE CONTRAST SOIL** Texture contrast soils are soils with a sharp change in texture between the topsoil (A horizon) and the subsoil (B or C horizons). Topsoils are generally light sandy or loamy textured, and subsoils are clayey.

**VEGETATION ASSOCIATION** A stable plant community of definite composition presenting a uniform appearance and growing in more or less uniform habitat conditions.

**VEGETATION CONDITION** Refers to the condition, composition and density of the plants in an area. (See plant density).

**WEED** Plants growing out of place. In a pastoral context weeds may be undesirable plants or increaser species which grow where desirable or decreaser plants have been removed. (See increaser plants, invader plants).

**WOODY WEEDS** Trees or shrubs which have increased in density to a point where productivity or management is adversely affected. (See increaser plants, invader plants).

# APPENDIX A

## MEAN AND MEDIAN RAINFALL FOR SELECTED STATIONS

**Curnamona Station** : 020004 31° 39'S 139° 33'E Elev 90M  
Means and Medians for the period 1881 to 1993 using all available data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<b>Mean Rainfall (mm)</b>	21.0	17.2	14.6	14.9	20.1	16.5	11.7	13.3	12.7	15.9	14.7	17.4	188.6
<b>Median Rainfall (mm)</b>	6.4	5.6	3.8	5.1	10.9	10.9	7.8	11.4	5.0	8.9	8.2	8.0	175.8
<b>Mean No. of Raindays</b>	1	1	1	1	2	2	2	2	2	2	2	1	19

**Yunta Station** : 020026 32° 35'S 139° 33'E Elev 303M  
Means and Medians for the period 1888 to 1993 using all available data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<b>Mean Rainfall (mm)</b>	21.0	20.6	15.7	16.0	23.1	21.8	17.0	19.0	18.3	22.5	19.7	21.7	238.0
<b>Median Rainfall (mm)</b>	10.4	5.9	6.8	8.0	13.2	15.8	14.0	17.0	10.9	16.8	11.8	14.3	226.6
<b>Mean No. of Raindays</b>	3	2	2	3	4	5	5	5	4	4	3	3	43

**Mutooroo Station** : 020017 32° 27'S 140° 55'E Elev 183M  
Means and Medians for the period 1887 to 1993 using all available data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<b>Mean Rainfall (mm)</b>	21.1	18.0	17.3	17.0	20.3	16.4	13.5	14.3	15.2	22.4	15.9	18.6	208.8
<b>Median Rainfall (mm)</b>	7.5	8.6	7.2	7.1	11.4	12.2	8.7	10.8	8.8	15.3	10.2	7.3	192.7
<b>Mean No. of Raindays</b>	2	2	1	2	2	3	2	2	2	3	2	2	25

**Mannahill Station** : 020013 32° 26'S 139° 59'E Elev 371M  
Means and Medians for the period 1889 to 1993 using all available data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<b>Mean Rainfall (mm)</b>	21.1	17.9	14.8	14.5	19.4	19.0	14.5	17.3	15.5	21.3	16.1	18.8	209.0
<b>Median Rainfall (mm)</b>	7.2	6.0	4.8	6.9	11.2	13.3	11.1	14.0	9.4	13.7	10.7	8.7	200.2
<b>Mean No. of Raindays</b>	2	1	2	2	3	4	4	4	3	3	2	2	32

**Mulyungarie Station** : 020016 31° 33'S 140° 47'E Elev 90M

Means and Medians for the period 1901 to 1993 using all available data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<b>Mean Rainfall (mm)</b>	15.9	15.9	14.3	11.5	16.9	13.4	13.4	11.5	12.1	15.0	12.0	15.2	167.3
<b>Median Rainfall (mm)</b>	5.2	4.1	3.8	3.8	10.9	7.7	9.1	8.4	5.6	9.5	7.0	3.8	154.0
<b>Mean No. of Raindays</b>	1	1	1	1	2	2	2	2	1	2	1	1	17

**Boolcoomatta Station** : 019061 31° 58'S 140° 32'E Elev 200M  
Means and Medians for the period 1882 to 1993 using all available data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
<b>Mean Rainfall (mm)</b>	17.7	20.2	15.1	11.4	21.2	19.2	12.1	13.4	12.3	16.9	13.8	14.9	185.3
<b>Median Rainfall (mm)</b>	3.0	6.7	4.2	3.9	9.1	12.2	7.0	9.4	6.4	9.6	4.9	3.3	172.1
<b>Mean No. of Raindays</b>	1	1	1	1	2	2	1	2	1	2	1	1	16

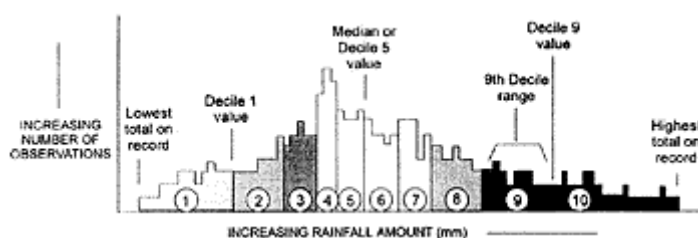
# APPENDIX B

## EXPLANATION OF RAINFALL DECILES

Most people are familiar with the term mean or average rainfall. It is calculated by adding rainfall totals over a long period and dividing by the number of years of records. However, as there may be a large number of years of low rainfall and a few years of high rainfall, the mean can give a misleading impression of the rainfall regime. This is particularly so in the drier parts of Australia and in the drier months of the year.

The median gives a better guide to rainfall. It represents the middle value of all observations. In other words, in 50% of years the rainfall exceeds the median and in 50% of years it is less than the median.

Deciles are an extension of this idea. All rainfalls received (for a year or a particular month or a series of months) are ranked in order from lowest to highest. The lowest 10 per cent are delineated by the decile 1 value, and belong to decile range 1 (see figure below). The next 10 per cent are in decile range 2, and so on, the highest 10 per cent being in decile range 10. The median is equivalent to the decile 5 value. Decile ranges shown in tables and in maps give a better indication of how dry or wet the month or year has been than does the departure from the 'mean' or 'average'.



Decile range	Extent of range	description
1	Lowest 10% of records	Very much below average
2	2nd lowest 10% of records	Much below average
3	3rd lowest 10% of records	Below average
4, 5, 6, 7	Middle 40% of records	Average
8	3rd highest 10% of records	Above average
9	2nd highest 10% of records	Much above average
10	Highest 10% of records	Very much above average

Source: Bureau of Meteorology May 1995

### Rainfall Deciles for Yunta

Deciles	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
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<b>low</b>	0	0	0	0	0	0	0	0	0	0	0	0	<b>80</b>
<b>1</b>	0	0	0	0	2	3	2	3	2	2	0	0	<b>125</b>
<b>2</b>	1	0	0	2	3	5	4	7	4	4	3	2	<b>154</b>
<b>3</b>	2	1	1	2	7	8	7	10	5	8	5	4	<b>184</b>
<b>4</b>	6	3	3	5	11	13	11	13	7	11	7	8	<b>211</b>
<b>median 5</b>	10	6	7	8	13	16	14	17	11	17	12	14	<b>227</b>
<b>6</b>	17	10	10	11	18	24	18	19	16	20	16	21	<b>251</b>
<b>7</b>	20	16	15	17	28	28	22	23	24	29	24	26	<b>269</b>
<b>8</b>	33	41	26	25	40	35	27	30	32	38	34	37	<b>299</b>
<b>9</b>	65	68	45	47	60	49	37	40	44	56	53	57	<b>353</b>
<b>high</b>	177	147	146	116	123	71	72	58	97	99	114	154	<b>514</b>
<b>Years</b>	<b>105</b>	<b>105</b>	<b>105</b>	<b>105</b>	<b>105</b>	<b>104</b>	<b>104</b>	<b>105</b>	<b>104</b>	<b>105</b>	<b>106</b>	<b>106</b>	<b>103</b>

### Rainfall Deciles for Curnamona

<b>Decile</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>low</b>	0	0	0	0	0	0	0	0	0	0	0	0	<b>45</b>
<b>1</b>	0	0	0	0	0	0	0	0	0	0	0	0	<b>86</b>
<b>2</b>	0	0	0	0	0	1	0	1	2	2	0	0	<b>126</b>
<b>3</b>	0	0	0	0	4	4	2	5	4	4	1	0	<b>138</b>
<b>4</b>	3	0	0	2	7	8	5	8	6	6	4	4	<b>162</b>
<b>median 5</b>	6	6	4	5	11	11	8	11	9	9	8	8	<b>176</b>
<b>6</b>	13	12	7	9	16	14	12	14	13	13	10	12	<b>190</b>
<b>7</b>	27	21	13	16	25	18	16	16	19	19	15	18	<b>214</b>
<b>8</b>	43	34	23	23	36	30	22	18	28	28	24	25	<b>253</b>
<b>9</b>	63	55	43	42	61	41	31	32	47	47	40	52	<b>301</b>
<b>high</b>	133	165	187	175	112	83	66	72	76	76	115	162	<b>616</b>
<b>Years</b>	<b>113</b>	<b>113</b>	<b>112</b>	<b>113</b>	<b>113</b>	<b>113</b>	<b>113</b>	<b>113</b>	<b>113</b>	<b>113</b>	<b>113</b>	<b>112</b>	<b>111</b>

### Rainfall Deciles for Mutooroo

<b>Decile</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>	<b>Annual</b>
<b>low</b>	0	0	0	0	0	0	0	0	0	0	0	0	<b>24</b>
<b>1</b>	0	0	0	0	0	0	0	0	0	1	0	0	<b>110</b>
<b>2</b>	0	0	0	0	2	2	1	4	4	4	0	0	<b>136</b>
<b>3</b>	2	1	1	2	5	5	3	5	5	9	1	2	<b>162</b>
<b>4</b>	4	4	4	3	8	8	5	8	6	12	5	5	<b>173</b>
<b>median 5</b>	8	9	7	7	11	12	9	11	9	15	10	7	<b>193</b>
<b>6</b>	11	11	12	13	19	16	13	14	15	18	14	13	<b>217</b>
<b>7</b>	23	16	16	19	27	21	19	16	17	24	19	18	<b>232</b>
<b>8</b>	37	32	25	26	35	26	26	21	23	39	28	34	<b>265</b>
<b>9</b>	77	45	45	51	54	43	35	36	45	54	43	56	<b>358</b>
<b>high</b>	146	176	202	147	91	71	68	67	73	143	128	156	<b>540</b>

Years	107	107	106	106	107	107	107	107	107	107	107	106	105
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### Rainfall Deciles for Mannahill

Decile	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
low	0	0	0	0	0	0	0	0	0	0	0	0	50
1	0	0	0	0	1	1	1	3	1	1	0	0	104
2	0	0	0	0	3	4	3	7	3	4	1	0	138
3	3	0	1	3	6	7	5	9	4	7	4	4	156
4	5	4	3	5	8	9	9	11	7	10	7	6	184
median	7	6	5	7	11	13	11	14	9	14	11	9	200
5													
6	14	13	10	10	20	18	15	17	14	21	13	14	212
7	23	18	13	15	23	25	20	19	19	25	17	20	238
8	41	34	20	20	31	31	24	25	26	33	25	27	266
9	65	56	44	42	49	44	31	38	37	50	39	56	307
high	149	143	171	147	140	92	71	64	81	102	113	122	667
Years	104	104	103	103	104	102	103	103	103	103	103	102	101

### Rainfall Deciles for Mulyungarie

Decile	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
low	0	0	0	0	0	0	0	0	0	0	0	0	36
1	0	0	0	0	0	0	0	0	0	0	0	0	75
2	0	0	0	0	0	1	2	0	0	1	0	0	98
3	0	0	0	0	4	4	4	2	1	5	0	0	116
4	3	0	1	2	7	5	7	4	2	7	2	0	129
median	5	4	4	4	11	8	9	8	6	10	7	4	154
5													
6	10	9	8	6	15	11	13	10	8	12	10	8	172
7	18	17	11	12	20	15	17	16	12	16	13	13	196
8	29	31	17	17	29	24	26	21	23	24	20	31	215
9	45	51	54	29	44	33	31	31	38	47	28	52	287
high	147	116	157	200	90	70	66	55	68	89	144	102	578
Years	93	93	93	93	93	92	92	93	92	92	93	92	91

Example:

*What is the frequency of receiving an annual total in excess of 125mm at a) Mulyungarie, and b) Yunta?*

a) At **Mulyungarie** the Decile 4 value is 129mm. In four out of ten years the annual rainfall is less than 129mm, or in six years in ten it exceeds 125mm.

b) At **Yunta**, 125mm is the Decile 1 value. Here, in 90% of years (nine in ten) the annual rainfall exceeds 125mm.

# APPENDIX C

## TEMPERATURE DATA FOR YUNTA & BROKEN HILL RFDS

### Yunta (1951 - 1993)

	Minim um(°C)		Maxim um(°C)		Average number of days				
	Extreme	Mean	Mean	Extreme	>40°C	>35°C	>30°C	<2.3°C	<=0°C
Jan	5.0	15.2	32.9	47.3	3	11	20	0	0
Feb	6.4	15.1	32.3	44.8	2	10	18	0	0
Mar	3.4	12.7	29.1	42.3	0	5	14	0	0
Apr	-1.1	8.9	24.3	38.2	0	0	4	1	0
May	-4.9	5.9	19.2	30.0	0	0	0	6	3
Jun	-6.0	3.5	15.9	24.9	0	0	0	10	6
Jul	-7.7	3.0	15.4	26.1	0	0	0	12	7
Aug	-5.4	3.7	17.3	30.1	0	0	0	10	5
Sep	-2.3	6.0	21.0	36.7	0	0	1	6	2
Oct	-1.0	8.7	24.7	40.0	0	1	5	1	0
Nov	1.1	11.3	28.7	43.0	1	4	12	0	0
Dec	2.8	13.7	31.3	44.2	1	8	17	0	0

### Broken Hill RFDS (1979 - 1985)

	Minim um(°C)		Maxim um(°C)		Average number of days				
	Extreme	Mean	Mean	Extreme	>40°C	>35°C	>30°C	<2.3°C	<=0°C
Jan	7.0	18.0	33.9	43.8	4	13	22	0	0
Feb	10.5	18.6	34.6	43.8	3	14	21	0	0
Mar	5.5	14.9	30.3	40.6	1	5	14	0	0
Apr	1.6	10.5	24.8	36.2	0	1	5	0	0
May	0.4	7.0	20.4	29.7	0	0	0	3	0
Jun	-4.5	3.5	16.4	24.1	0	0	0	11	3
Jul	-6.6	2.8	15.7	25.8	0	0	0	13	8
Aug	-2.4	4.8	18.9	29.6	0	0	0	7	2
Sep	-0.2	7.0	22.4	36.0	0	0	2	2	0
Oct	2.8	10.6	25.8	36.4	0	1	6	0	0
Nov	5.3	14.4	30.1	42.0	1	6	14	0	0
Dec	8.5	16.9	32.8	42.5	3	11	20	0	0

## APPENDIX D

[SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES \(A - F\)](#)

[SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES \(G - L\)](#)

[SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES \(M - Q\)](#)

[SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES \(R - Z\)](#)

### (A - F) SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES OCCURRING IN THE NORTH EAST PASTORAL SOIL CONSERVATION DISTRICT

These are the accepted botanical names and preferred common names from the South Australian Environmental Database current at 17/5/95

Botanical Name	Common Name
<i>Abutilon fraseri</i>	dwarf lantern-flower
<i>Abutilon halophilum</i>	plains lantern-flower
<i>Abutilon leucopetalum</i>	desert lantern-flower, desert Chinese-lantern
<i>Abutilon malvaefolium</i>	mallow lantern-flower, scrambling lantern-flower
<i>Abutilon otocarpum</i>	desert lantern-flower, desert Chinese lantern
<i>Acacia aneura</i> var. <i>aneura</i>	mulga, narrow-leaf mulga
<i>Acacia argyrophylla</i>	silver mulga-bush, silver mulga
<i>Acacia ayersiana</i> var. <i>latifolia</i>	broad-leaf mulga
<i>Acacia barattensis</i>	Baratta wattle
<i>Acacia beckleri</i>	Beckler's rock wattle, Barrier Range wattle
<i>Acacia burkittii</i>	pin-bush wattle, Burkitt's wattle
<i>Acacia calamifolia</i>	wallowa
<i>Acacia carnei</i>	needle wattle, purple-wood wattle
<i>Acacia cibaria</i>	turpentine mulga, umbrella mulga
<i>Acacia colletioides</i>	wait-a-while, spine bush
<i>Acacia continua</i>	thorn wattle
<i>Acacia farnesiana</i>	sweet acacia, mimosa bush

<i>Acacia hakeoides</i>	hakea wattle, western black wattle
<i>Acacia havilandii</i>	needle wattle, Haviland's wattle
<i>Acacia ligulata</i>	umbrella bush, dune wattle
<i>Acacia loderi</i>	nealie, eastern myall
<i>Acacia murrayana</i>	colony wattle, Murray's wattle
<i>Acacia nyssophylla</i>	wait-a-while, spine bush
<i>Acacia oswaldii</i>	umbrella wattle, Oswald's wattle
<i>Acacia paradoxa</i>	kangaroo thorn, hedge wattle
<i>Acacia pravifolia</i>	coil-pod wattle, range wattle
<i>Acacia pycnantha</i>	golden wattle
<i>Acacia salicina</i>	Broughton willow
<i>Acacia tetragonophylla</i>	dead finish, kurara
<i>Acacia victoriae</i> ssp. <i>victoriae</i>	elegant wattle, bramble wattle
<i>Acacia wilhelmiana</i>	dwarf nealie, Wilhelm's wattle
* <i>Acetosa vesicaria</i>	rosy dock, wild hops
<i>Actinobole uliginosum</i>	flannel cudweed, cotton weed
<i>Adriana klotzschii</i>	coast bitterbush
* <i>Agave americana</i> var. <i>americana</i>	century plant, American aloe
<i>Agrostis avenacea</i>	blown grass, fairy grass
<i>Agrostis avenacea</i> var. <i>avenacea</i>	blown grass, fairy grass
<i>Agrostis avenacea</i> var. <i>perennis</i>	blown grass, fairy grass
<i>Ajuga australis</i> form A	Australian bugle, austral bugle
<i>Alectryon oleifolius</i> ssp. <i>canescens</i>	bullock bush, cattle bush
<i>Allocasuarina muelleriana</i> ssp. <i>muelleriana</i>	common oakbush, slaty oak-bush
<i>Allocasuarina verticillata</i>	drooping sheoak
* <i>Alopecurus geniculatus</i>	marsh fox-tail
<i>Alternanthera denticulata</i>	lesser joyweed
<i>Alternanthera nodiflora</i>	common joyweed
* <i>Alyssum linifolium</i>	flax-leaf alyssum

<i>Amaranthus grandiflorus</i>	large-flower amaranth
<i>Amaranthus mitchellii</i>	Boggabri weed
<i>Amyema linophyllum</i> ssp. <i>orientale</i>	casuarina mistletoe, black oak mistletoe
<i>Amyema maidenii</i> ssp. <i>maidenii</i>	pale-leaf mistletoe
<i>Amyema miquelii</i>	box mistletoe
<i>Amyema miraculosum</i> ssp. <i>boormanii</i>	fleshy mistletoe
<i>Amyema preissii</i>	wire-leaf mistletoe
* <i>Anagallis arvensis</i>	pimpernel, blue pimpernel
* <i>Anagallis minima</i>	chaffweed
* <i>Anchusa arvensis</i> ssp. <i>arvensis</i>	
<i>Anemocarpa podolepidium</i>	rock everlasting
<i>Angianthus brachypappus</i>	spreading cup-flower
<i>Angianthus tomentosus</i>	hairy cup-flower, hairy angianthus
<i>Apium prostratum</i> ssp. <i>prostratum</i>	native celery
<i>Apium prostratum</i> ssp. <i>prostratum</i> var. <i>filiforme</i>	native celery, sea celery
<i>Arabidella filifolia</i>	
<i>Arabidella glaucescens</i>	
<i>Arabidella nasturtium</i>	yellow cress
<i>Arabidella procumbens</i>	creeping cress
<i>Arabidella trisecta</i>	shrubby cress, native stock
* <i>Argemone subfusiformis</i> ssp. <i>subfusiformis</i>	
<i>Aristida anthoxanthoides</i>	yellow threeawn, pale wire-grass
<i>Aristida arida</i>	
<i>Aristida behriana</i>	brush wire-grass
<i>Aristida contorta</i>	mulga grass, kerosene grass
<i>Aristida holathera</i> var. <i>holathera</i>	
<i>Aristida latifolia</i>	feathertop wiregrass

<i>Aristida nitidula</i>	brush threeawn, small brush wire-grass
<i>Aristida strigosa</i>	rough threeawn, rough wire-grass
<i>Arthropodium minus</i>	small vanilla-lily
* <i>Arundo donax</i>	Spanish reed, bamboo
<i>Asperula conferta</i>	common woodruff
* <i>Asphodelus fistulosus</i>	onion weed, wild onion
* <i>Aster subulatus</i>	wild aster, bushy starwort
<i>Asteridea athrixioides forma athrixioides</i>	wirewort
* <i>Astragalus hamosus</i>	milk-vetch, yellow milk-vetch
* <i>Astragalus sesameus</i>	purple milk-vetch
<i>Astrebla lappacea</i>	curly Mitchell grass, wheat Mitchell
<i>Astrebla pectinata</i>	barley Mitchell grass
<i>Astroloma humifusum</i>	native cranberry, cranberry heath
<i>Atalaya hemiglauca</i>	whitewood
<i>Atriplex acutibractea</i> ssp. <i>acutibractea</i>	
<i>Atriplex acutiloba</i>	
<i>Atriplex angulata</i>	fan saltbush, angular saltbush
<i>Atriplex cordifolia</i>	
<i>Atriplex eardleyae</i>	small saltbush
<i>Atriplex eichleri</i>	
<i>Atriplex holocarpa</i>	pop saltbush
<i>Atriplex intermedia</i>	
<i>Atriplex limbata</i>	spreading saltbush
<i>Atriplex lindleyi</i>	
<i>Atriplex lindleyi</i> ssp. <i>conduplicata</i>	
<i>Atriplex lindleyi</i> ssp. <i>inflata</i>	
<i>Atriplex lindleyi</i> ssp. <i>lindleyi</i>	
<i>Atriplex lindleyi</i> ssp. <i>quadripartita</i>	

<i>Atriplex lobativalvis</i>	
<i>Atriplex nummularia</i> ssp. <i>nummularia</i>	old-man saltbush
<i>Atriplex pseudocampanulata</i>	mealy saltmarsh
<i>Atriplex semibaccata</i>	berry saltbush, creeping saltbush
<i>Atriplex spongiosa</i>	pop saltbush
<i>Atriplex stipitata</i>	mallee saltbush, kidney saltbush, bitter saltbush
<i>Atriplex velutinella</i>	sandhill saltbush
<i>Atriplex vesicaria</i>	bladder saltbush
<i>Atriplex vesicaria</i> ssp. <i>calcicola</i>	
<i>Atriplex vesicaria</i> ssp. <i>macrocystidia</i>	
* <i>Avena barbata/fatua</i>	wild oat
* <i>Avena fatua</i>	wild oat, black oat
<i>Baeckea crassifolia</i>	desert baeckea, desert heath-myrtle
<i>Bergia trimeria</i>	small water-fire
<i>Beyeria lechenaultii</i>	pale turpentine bush, felted wallaby-bush
<i>Blennodia canescens</i>	native stock, wild stock
<i>Blennodia pterosperma</i>	wild stock
<i>Boerhavia coccinea</i>	
<i>Boerhavia dominii</i>	
<i>Boerhavia schomburgkiana</i>	
<i>Bothriochloa macra</i>	red-leg grass
<i>Brachycome campylocarpa</i>	large white daisy
<i>Brachycome ciliaris</i>	variable daisy
<i>Brachycome ciliaris</i> var. <i>brachyglossa</i>	rayless variable-daisy
<i>Brachycome ciliaris</i> var. <i>ciliaris</i>	variable daisy
<i>Brachycome ciliaris</i> var. <i>lanuginosa</i>	wooly variable daisy
<i>Brachycome debilis</i>	weak daisy



<i>Brachycome dentata</i>	
<i>Brachycome eriogona</i>	
<i>Brachycome goniocarpa</i>	dwarf daisy
<i>Brachycome iberidifolia</i>	Swan River daisy
<i>Brachycome lineariloba</i>	hard-headed daisy
<i>Brachycome perpusilla</i>	tiny daisy, rayless daisy
<i>Bracteantha bracteata</i>	golden everlasting
* <i>Brassica tournefortii</i>	long-fruited wild turnip, wild turnip
<i>Bromus arenarius</i>	sand brome
* <i>Bromus catharticus</i>	prairie grass, rescue grass
* <i>Bromus rubens</i>	red brome
* <i>Buglossoides arvensis</i>	sheepweed, corn gromwell
<i>Bulbine alata</i>	winged bulbine-lily, winged leek-lily
<i>Bulbine semibarbata</i>	annual bulbine-lily, annual leek-lily
<i>Bursaria spinosa</i>	sweet bursaria, South Australian Christmas bush
<i>Caladenia toxochila</i>	bow-lip spider-orchid
<i>Calandrinia eremaea</i>	small purslane
<i>Calandrinia ptychosperma</i>	creeping parakeelya
* <i>Calendula arvensis</i>	field marigold, wild marigold
<i>Callistemon teretifolius</i>	needle bottlebrush
<i>Callitris glaucophylla</i>	white cypress-pine, northern cypress-pine
<i>Callitris preissii</i>	southern cypress pine, native pine
<i>Calocephalus platycephalus</i>	billybuttons, western beauty-heads
<i>Calotis cymbacantha</i>	showy burr-daisy
<i>Calotis erinacea</i>	tangled burr-daisy
<i>Calotis hispidula</i>	bogan flea, hairy burr-daisy
<i>Calotis lappulacea</i>	yellow burr-daisy
<i>Calotis latiuscula</i>	leafy burr-daisy

<i>Calotis multicaulis</i>	woolly-headed burr-daisy
<i>Calotis plumulifera</i>	wooly-headed burr-daisy
<i>Calotis porphyroglossa</i>	channel burr-daisy
<i>Calytrix tetragona</i>	common fringe-myrtle
<i>Capparis mitchellii</i>	native orange, wild orange
* <i>Capsella bursapastoris</i>	shepherd's purse
* <i>Carrichtera annua</i>	Wards weed
* <i>Carthamus lanatus</i>	saffron thistle, woolly star-thistle
<i>Cassinia laevis</i>	curry bush, cough-bush
<i>Casuarina pauper</i>	black oak, belah
* <i>Cenchrus ciliaris</i>	buffel grass, black buffel grass
* <i>Centaurea melitensis</i>	Maltese cockspur, cockspur thistle
* <i>Centaurium spicatum</i>	spike centaury
<i>Centipeda cunninghamii</i>	common sneezeweed
<i>Centipeda thespidioides</i>	desert sneezeweed
<i>Centrolepis drummondiana</i>	
<i>Centrolepis eremica</i>	
<i>Cheilanthes distans</i>	bristly cloak-fern
<i>Cheilanthes lasiophylla</i>	woolly cloak-fern
<i>Cheilanthes sieberi</i> ssp. <i>sieberi</i>	Sieber's rock-fern, mulga fern
<i>Chenopodium auricomum</i>	golden goosefoot, Queensland bluebrush
<i>Chenopodium cristatum</i>	crested goosefoot
<i>Chenopodium curvispicatum</i>	cottony goosefoot, white goosefoot
<i>Chenopodium desertorum</i>	desert goosefoot
<i>Chenopodium desertorum</i> ssp. <i>anidiophyllum</i>	mallee goosefoot
<i>Chenopodium desertorum</i> ssp. <i>desertorum</i>	desert goosefoot, frosted goosefoot
<i>Chenopodium desertorum</i> ssp. <i>rectum</i>	erect goosefoot
<i>Chenopodium melanocarpum</i> forma <i>melanocarpum</i>	black crumbweed, black-fruit goosefoot

<i>*Chenopodium murale</i>	nettle-leaf goosefoot, sowbane
<i>Chenopodium nitriaceum</i>	nitre goosefoot
<i>Chenopodium pumilio</i>	clammy goosefoot, small crumbweed
<i>Chenopodium truncatum</i>	
<i>Chloris pectinata</i>	comb chloris, comb windmill grass
<i>Chloris truncata</i>	windmill grass
<i>Chrysocephalum apiculatum</i>	common everlasting
<i>Chrysocephalum pterochaetum</i>	
<i>Chrysocephalum semicalvum</i> ssp. <i>semicalvum</i>	hill everlasting
<i>Chrysocephalum semipapposum</i>	clustered everlasting, yellow buttons
<i>*Cirsium vulgare</i>	spear thistle
<i>*Citrullus lanatus</i>	bitter melon, camel melon
<i>Clematis microphylla</i>	small-leaved clematis
<i>Codonocarpus pyramidalis</i>	slender bell-fruit, camel poison
<i>Commicarpus australis</i>	
<i>*Conium maculatum</i>	hemlock
<i>Convolvulus erubescens</i>	Australian bindweed
<i>Convolvulus eyreanus</i>	
<i>Convolvulus microsepalus</i>	
<i>Convolvulus remotus</i>	
<i>*Conyza bonariensis</i>	flaxleaf fleabane, tall fleabane
<i>Correa glabra</i>	smooth correa, rock correa
<i>Craspedia chrysantha</i>	golden billybuttons, yellow drumsticks
<i>Craspedia glauca</i>	batchelor buttons, common billybuttons
<i>Craspedia pleiocephala</i>	soft billybuttons
<i>Crassula colorata</i>	
<i>Crassula colorata</i> var. <i>acuminata</i>	dense stonecrop, dense crassula
<i>Crassula colorata</i> var. <i>colorata</i>	dense stonecrop, dense crassula
<i>Crassula colorata/sieberana</i>	

<i>Crassula sieberiana</i> ssp. <i>tetramera</i>	Australian crassula, Australian stonecrop
<i>Cratystylis conocephala</i>	bluebush daisy, greybush
<i>Cressa cretica</i>	rosinweed
<i>Crinum flaccidum</i>	Darling lily, Murray Lily
* <i>Critesion murinum</i>	
* <i>Critesion murinum</i> ssp. <i>glaucum</i>	northern barley-grass
* <i>Critesion murinum</i> ssp. <i>leporinum</i>	barley-grass, common foxtail
<i>Crotalaria eremaea</i> ssp. <i>eremaea</i>	bluebush pea, loose-flowered rattlepod
<i>Cryptandra amara</i> var. <i>longiflora</i>	long-flower cryptandra, bell-flower cryptandra
* <i>Cucumis myriocarpus</i>	paddy melon
<i>Cuscuta victoriana</i>	
<i>Cymbopogon ambiguus</i>	lemon-scented grass
<i>Cymbopogon obtectus</i>	silky-heads
* <i>Cynara cardunculus</i>	artichoke thistle, cardoon
* <i>Cynodon dactylon</i>	couch-grass, Bermuda grass
<i>Cyperus alterniflorus</i>	umbrella sedge
<i>Cyperus bulbosus</i>	nalgoo
<i>Cyperus difformis</i>	variable flat-sedge, dirty Dora
<i>Cyperus gilesii</i>	
<i>Cyperus gymnocaulos</i>	spiny flat-sedge, spiny sedge
<i>Cyperus rigidellus</i>	flat-sedge
<i>Cyperus squarrosus</i>	bearded flat-sedge
<i>Dactyloctenium radulans</i>	button grass, finger grass
<i>Danthonia caespitosa</i>	common wallaby-grass, white-top
<i>Danthonia setacea</i> var. <i>setacea</i>	small-flower wallaby-grass, bristly wallaby-grass
* <i>Datura ferox</i>	fierce thornapple, long-spine thornapple
* <i>Datura innoxia</i>	downy thornapple, recurved thornapple

<i>*Datura leichhardtii</i>	native thornapple
<i>*Datura stramonium</i>	common thornapple, purple-flowered thornapple
<i>Daucus glochidiatus</i>	native carrot, Australian carrot
<i>Daviesia genistifolia</i>	broom bitter-pea
<i>Daviesia stricta</i>	Flinders Ranges bitter-pea
<i>Derwentia decorosa</i>	showy speedwell, rock speedweel
<i>Dianella revoluta</i> var. <i>revoluta</i>	black-anther flax-lily, spreading flax-lily
<i>Dichanthium sericeum</i>	
<i>Dichanthium sericeum</i> ssp. <i>humilius</i>	dwarf blue-grass
<i>Dichanthium sericeum</i> ssp. <i>sericeum</i>	silky blue-grass, Queensland blue-grass
<i>Digitaria ammophila</i>	spider grass, silky umbrella-grass
<i>Digitaria brownii</i>	cotton grass, cotton panic-grass
<i>Digitaria coenicola</i>	spider grass, finger panic-grass
<i>Dimorphocoma minutula</i>	
<i>Diplachne fusca</i>	brown beetle-grass, pale beetle-grass
<i>*Diplotaxis muralis</i> var. <i>muralis</i>	wall rocket
<i>*Diplotaxis tenuifolia</i>	Lincoln weed, sand rocket
<i>Disphyma crassifolium</i> ssp. <i>clavellatum</i>	round-leaf pigface, rounded noon-flower
<i>Dissocarpus biflorus</i> var. <i>biflorus</i>	twin-horned copperburr, bassia
<i>Dissocarpus paradoxus</i>	cannon balls
<i>*Dittrichia graveolens</i>	stinkwort, stink-weed
<i>Dodonaea baueri</i>	crinkled hop-bush
<i>Dodonaea lobulata</i>	lobe-leaved hop-bush, lobed hop-bush
<i>Dodonaea microzyga</i> var. <i>microzyga</i>	brilliant hop-bush
<i>Dodonaea viscosa</i>	
<i>Dodonaea viscosa</i> ssp. <i>angustissima</i>	narrow-leaved hop-bush, slender hop-bush
<i>Dodonaea viscosa</i> ssp. <i>spatulata</i>	sticky hop-bush, akeake

<i>Duboisia hopwoodii</i>	pituri, pitcheri
<i>Dysphania glomulifera</i>	
<i>Dysphania glomulifera</i> ssp. <i>eremaea</i>	
<i>Dysphania glomulifera</i> ssp. <i>glomulifera</i>	
<i>Dysphania plantaginella</i>	
<i>Dysphania platycarpa</i>	
<i>Dysphania simulans</i>	erect crumbweed
* <i>Echinochloa crus-galli</i>	barnyard grass
* <i>Echinochloa utilis</i>	Japanese millet
* <i>Echium plantagineum</i>	Salvation Jane, Patersons curse
* <i>Echium vulgare</i>	vipers bugloss
<i>Einadia nutans</i>	
<i>Einadia nutans</i> ssp. <i>nutans</i>	climbing saltbush, nodding saltbush
<i>Einadia nutans</i> ssp. <i>oxycarpa</i>	
<i>Elachanthus glaber</i>	
<i>Elachanthus pusillus</i>	elachanth
<i>Eleocharis pallens</i>	pale spike-rush
<i>Elymus scabrus</i> var. <i>scabrus</i>	native wheat-grass
<i>Embadium uncinatum</i>	
* <i>Emex australis</i>	three-cornered jack, spiny emex
<i>Enchylaena tomentosa</i> var. <i>tomentosa</i>	ruby saltbush, barrier saltbush
<i>Enneapogon avenaceus</i>	common bottle-washers
<i>Enneapogon caerulescens</i> var. <i>caerulescens</i>	
<i>Enneapogon cylindricus</i>	jointed nineawn, jointed bottle-washers
<i>Enneapogon nigricans</i>	black-heads
<i>Enneapogon polyphyllus</i>	leafy nineawn, limestone bottle-washers
<i>Enteropogon acicularis</i>	umbrella grass, curly windmill grass
<i>Enteropogon ramosus</i>	

<i>Epaltes australis</i>	spreading nut-heads
<i>Eragrostis australasica</i>	cane-grass
* <i>Eragrostis barrelieri</i>	pitted lovegrass
* <i>Eragrostis cilianensis</i>	stinkgrass
<i>Eragrostis dielsii</i> var. <i>dielsii</i>	mulka grass, mulka
<i>Eragrostis eriopoda</i>	woollybutt, naked woollybutt
<i>Eragrostis falcata</i>	sickle lovegrass
<i>Eragrostis lacunaria</i>	purple lovegrass
<i>Eragrostis laniflora</i>	hairy-flowered woollybutt
<i>Eragrostis leptocarpa</i>	drooping lovegrass
* <i>Eragrostis minor</i>	smaller stinkgrass, small stinkgrass
<i>Eragrostis parviflora</i>	weeping lovegrass
* <i>Eragrostis pergracilis</i>	
<i>Eragrostis setifolia</i>	narrow-leaved neverfail, neverfail
* <i>Eragrostis tenellula</i>	
<i>Eragrostis xerophila</i>	knotty-butt neverfail
<i>Eremophila alternifolia</i>	narrow-leaved fuchsia-bush, native honeysuckle
<i>Eremophila deserti</i>	
<i>Eremophila duttonii</i>	Harlequin fuchsia-bush, Budda
<i>Eremophila freelingii</i>	limestone fuchsia, rock fuchsia-bush
<i>Eremophila glabra</i> ssp. <i>glabra</i>	tar bush, common emubush
<i>Eremophila latrobei</i> ssp. <i>glabra</i>	crimson turkey-bush, native fuchsia
<i>Eremophila longifolia</i>	berrigan, weeping emubush
<i>Eremophila maculata</i> var. <i>maculata</i>	spotted emubush, fuchsia bush
<i>Eremophila oppositifolia</i> var. <i>oppositifolia</i>	weeooka, twin-leaved emubush
<i>Eremophila scoparia</i>	broom emubush, Scotia bush
<i>Eremophila serrulata</i>	green fuchsia-bush
<i>Eremophila sturtii</i>	turpentine bush, turpentine
<i>Eriachne mucronata</i>	mountain wanderrie, mountain

	wanderrie grass
<i>Eriachne pulchella</i>	pretty wanderrie grass
<i>Eriochiton sclerolaenoides</i>	
<i>Eriochlamys behrii</i>	woolly mantle
<i>Eriochloa australiensis</i>	Australian cupgrass
<i>Eriochloa pseudoacrotricha</i>	perennial cupgrass, early spring grass
<i>Eriostemon linearis</i>	narrow-leaved wax-flower
<i>Erodiophyllum elderi</i>	Koonamore daisy
* <i>Erodium aureum</i>	
* <i>Erodium cicutarium</i>	common storks bill, common herons bill
<i>Erodium crinitum</i>	blue storks bill, blue herons bill
<i>Erodium crinitum/cygnorum</i>	
<i>Erodium cygnorum</i> ssp. <i>glandulosum</i>	
<i>Eucalyptus</i> aff. <i>viridis</i>	green mallee
<i>Eucalyptus camaldulensis</i>	river red gum
<i>Eucalyptus camaldulensis</i> var. <i>camaldulensis</i>	river red gum, red gum
<i>Eucalyptus camaldulensis</i> var. <i>obtusa</i>	northern river red gum
<i>Eucalyptus coolabah</i> ssp. <i>arida</i>	
<i>Eucalyptus dumosa</i>	white mallee, dumosa mallee
<i>Eucalyptus flindersii</i>	Flinders mallee
<i>Eucalyptus gillii</i>	curly mallee
<i>Eucalyptus gracilis</i>	yorrell, white mallee
<i>Eucalyptus intertexta</i>	gum-barked coolibah
<i>Eucalyptus largiflorens</i>	river box, black box
<i>Eucalyptus leptophylla</i>	narrow-leaf red mallee
<i>Eucalyptus oleosa</i>	red mallee, acorn mallee
<i>Eucalyptus porosa</i>	mallee box, black mallee box



<i>Eucalyptus sideroxylon</i> ssp. <i>sideroxylon</i>	
<i>Eucalyptus socialis</i>	beaked red mallee, red mallee
<i>Euchiton sphaericus</i>	Japanese cudweed
<i>Eulalia aurea</i>	sugar-grass, silky browntop
<i>Euphorbia australis</i>	caustic weed, hairy caustic weed
<i>Euphorbia drummondii</i>	caustic weed, flat spurge
<i>Euphorbia parvicaruncula</i>	rough-seeded spurge
<i>Euphorbia stevenii</i>	bottletree caustic, bottletree spurge
<i>Euphorbia tannensis</i> ssp. <i>eremophila</i>	bottle tree caustic, caustic bush
<i>Euphorbia wheeleri</i>	Wheelers spurge
<i>Evolvulus alsinoides</i> var. <i>decumbens</i>	tropical speedwell
<i>Exocarpos aphyllus</i>	leafless ballart, leafless cherry
<i>Fimbristylis dichotoma</i>	common fringe-rush, eight-days grass
<i>Flaveria australasica</i>	yellow twin-stem
<i>Frankenia crispa</i>	hoary sea-heath
<i>Frankenia cupularis</i>	
<i>Frankenia serpyllifolia</i>	thyme sea-heath, clustered sea-heath

## G - L) SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES OCCURRING IN THE NORTH EAST PASTORAL SOIL CONSERVATION DISTRICT

These are the accepted botanical names and preferred common names from the South Australian Environmental Database current at 17/5/95

Botanical Name	Common Name
<i>Galium gaudichaudii</i>	rough bedstraw
<i>Galium migrans</i>	
* <i>Galium spurium</i> ssp. <i>ibicinum</i>	bedstraw
* <i>Galium tricornutum</i>	three-horned bedstraw, rough corn bedstraw
<i>Geijera parviflora</i>	wilga
<i>Geococcus pusillus</i>	earth cress
<i>Geranium solanderi</i> var. <i>solanderi</i>	native geranium, austral cranes bill
<i>Gilesia biniflora</i>	western tar-vine
* <i>Glaucium corniculatum</i> var. <i>corniculatum</i>	bristly horned-poppy, red horned-poppy
<i>Glinus lotoides</i>	hairy carpet-weed
<i>Glossostigma cleistanthum</i>	
<i>Glossostigma diandrum</i>	
<i>Glycine canescens</i>	silky glycine
<i>Glycyrrhiza acanthocarpa</i>	native liquorice, southern liquorice
* <i>Gnaphalium polycaulon</i>	
<i>Gnephosis arachnoidea</i>	
<i>Gnephosis eriocarpa</i>	native camomile
<i>Gnephosis tenuissima</i>	dwarf cup-flower, dwarf angianthus
<i>Gonocarpus elatus</i>	hill raspwort, raspwort
<i>Gonocarpus tetragynus</i>	small-leaf raspwort, common raspwort
<i>Goodenia albiflora</i>	white goodenia
<i>Goodenia berardiana</i>	
<i>Goodenia calcarata</i>	streaked goodenia
<i>Goodenia cycloptera</i>	serrated goodenia

<i>Goodenia fascicularis</i>	silky goodenia, mallee goodenia
<i>Goodenia havilandii</i>	hill goodenia
<i>Goodenia lunata</i>	stiff goodenia, hairy goodenia
<i>Goodenia pinnatifida</i>	cut-leaf goodenia, scrambled eggs
<i>Goodenia pusilliflora</i>	small-flower goodenia
<i>Goodenia vernicosa</i>	wavy goodenia
<i>Goodia lotifolia</i> var. <i>lotifolia</i>	golden-tip, western golden-tip
<i>Gossypium sturtianum</i> var. <i>sturtianum</i>	Sturts desert rose
<i>Grevillea huegelii</i>	comb grevillea, comb spider-flower
<i>Grevillea nematophylla</i>	water bush
<i>Grevillea striata</i>	beefwood
<i>Gunniopsis papillata</i>	twin-leaved pigface
<i>Gunniopsis quadrifida</i>	Sturts pigface
* <i>Gypsophila tubulosa</i>	annual chalkwort, austral chalkwort
<i>Haeckeria punctulata</i>	
<i>Hakea ednieana</i>	Flinders Ranges corkwood, corkbark
<i>Hakea leucoptera</i>	silver needlewood, needle bush
<i>Halgania cyanea</i>	rough blue-flower, rough halgania
<i>Haloragis aspera</i>	rough raspwort
<i>Halosarcia halocnemoides</i> ssp. <i>halocnemoides</i>	grey samphire, grey glasswort
<i>Halosarcia indica</i>	
<i>Halosarcia indica</i> ssp. <i>bidens</i>	
<i>Halosarcia indica</i> ssp. <i>leiostachya</i>	brown-head samphire, brown-head glasswort
<i>Halosarcia nitida</i>	
<i>Halosarcia pergranulata</i>	
<i>Halosarcia pergranulata</i> ssp. <i>divaricata</i>	
<i>Halosarcia pergranulata</i> ssp. <i>pergranulata</i>	

<i>Halosarcia pluriflora</i>	
<i>Halosarcia pterygosperma</i> ssp. <i>pterygosperma</i>	
<i>Hardenbergia violacea</i>	native lilac, purple coral-pea
<i>Harmsiodoxa blennodioides</i>	hairypod cress, May smocks
<i>Harmsiodoxa brevipes</i> var. <i>brevipes</i>	short cress
* <i>Helianthus annuus</i>	sunflower, common sunflower
* <i>Heliotropium curassavicum</i>	smooth heliotrope
* <i>Heliotropium europaeum</i>	potato weed, common heliotrope
* <i>Heliotropium supinum</i>	prostrate heliotrope, spreading heliotrope
* <i>Herniaria cinerea</i>	rupturewort, herniaria
<i>Hibiscus krichauffianus</i>	velvet-leaf hibiscus
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	hill hibiscus
<i>Hyalosperma glutinosum</i> ssp. <i>glutinosum</i>	golden sunray
<i>Hyalosperma semisterile</i>	orange sunray
<i>Hybanthus monopetalus</i>	slender violet, slender violet-bush
<i>Hydrocotyle callicarpa</i>	tiny pennywort
<i>Hydrocotyle trachycarpa</i>	wild parsley
* <i>Hymenolobus procumbens</i>	oval purse
* <i>Hyparrhenia hirta</i>	Tambookie grass
<i>Hypericum gramineum</i>	small St Johns wort
* <i>Hypochaeris glabra</i>	smooth catsear
<i>Hypoxis glabella</i> var. <i>glabella</i>	tiny star
<i>Indigofera australis</i> var. <i>australis</i>	Australian indigo, hill indigo
<i>Indigofera longibractea</i>	
<i>Iseilema membranaceum</i>	small Flinders-grass
<i>Isoetes muelleri</i>	quillwort
<i>Isoetopsis graminifolia</i>	grass cushion, grass buttons
<i>Isolepis australiensis</i>	

<i>Isolepis congrua</i>	
<i>Isotoma petraea</i>	rock isotome
<i>Ixiochlamys nana</i>	small fuzzweed
<i>Ixiolaena chloroleuca</i>	
<i>Ixiolaena leptolepis</i>	stalked ixiolaena, stalked plover-daisy
<i>Ixiolaena tomentosa</i>	woolly ixiolaena, woolly plover-daisy
<i>Jasminum didymum</i> ssp. <i>lineare</i>	native jasmine, desert jasmine
<i>Juncus aridicola</i>	tussock rush
<i>Juncus bufonius</i>	toad rush
<i>Juncus subsecundus</i>	finger rush
<i>Kippistia suaedifolia</i>	fleshy minuria
<i>Galium gaudichaudii</i>	rough bedstraw
<i>Galium migrans</i>	
* <i>Galium spurium</i> ssp. <i>ibicinum</i>	bedstraw
* <i>Galium tricornutum</i>	three-horned bedstraw, rough corn bedstraw
<i>Geijera parviflora</i>	wilga
<i>Geococcus pusillus</i>	earth cress
<i>Geranium solanderi</i> var. <i>solanderi</i>	native geranium, austral cranes bill
<i>Gilesia biniflora</i>	western tar-vine
* <i>Glaucium corniculatum</i> var. <i>corniculatum</i>	bristly horned-poppy, red horned-poppy
<i>Glinus lotoides</i>	hairy carpet-weed
<i>Glossostigma cleistanthum</i>	
<i>Glossostigma diandrum</i>	
<i>Glycine canescens</i>	silky glycine
<i>Glycyrrhiza acanthocarpa</i>	native liquorice, southern liquorice
* <i>Gnaphalium polycaulon</i>	
<i>Gnephosis arachnoidea</i>	
<i>Gnephosis eriocarpa</i>	native camomile

<i>Gnephosis tenuissima</i>	dwarf cup-flower, dwarf angianthus
<i>Gonocarpus elatus</i>	hill raspwort, raspwort
<i>Gonocarpus tetragynus</i>	small-leaf raspwort, common raspwort
<i>Goodenia albiflora</i>	white goodenia
<i>Goodenia berardiana</i>	
<i>Goodenia calcarata</i>	streaked goodenia
<i>Goodenia cycloptera</i>	serrated goodenia
<i>Goodenia fascicularis</i>	silky goodenia, mallee goodenia
<i>Goodenia havilandii</i>	hill goodenia
<i>Goodenia lunata</i>	stiff goodenia, hairy goodenia
<i>Goodenia pinnatifida</i>	cut-leaf goodenia, scrambled eggs
<i>Goodenia pusilliflora</i>	small-flower goodenia
<i>Goodenia vernicosa</i>	wavy goodenia
<i>Goodia lotifolia</i> var. <i>lotifolia</i>	golden-tip, western golden-tip
<i>Gossypium sturtianum</i> var. <i>sturtianum</i>	Sturts desert rose
<i>Grevillea huegelii</i>	comb grevillea, comb spider-flower
<i>Grevillea nematophylla</i>	water bush
<i>Grevillea striata</i>	beefwood
<i>Gunniopsis papillata</i>	twin-leaved pigface
<i>Gunniopsis quadrifida</i>	Sturts pigface
* <i>Gypsophila tubulosa</i>	annual chalkwort, austral chalkwort
<i>Haeckeria punctulata</i>	
<i>Hakea ednieana</i>	Flinders Ranges corkwood, corkbark
<i>Hakea leucoptera</i>	silver needlewood, needle bush
<i>Halgania cyanea</i>	rough blue-flower, rough halgania
<i>Haloragis aspera</i>	rough raspwort
<i>Halosarcia halocnemoides</i> ssp. <i>halocnemoides</i>	grey samphire, grey glasswort
<i>Halosarcia indica</i>	

<i>Halosarcia indica</i> ssp. <i>bidens</i>	
<i>Halosarcia indica</i> ssp. <i>leiostachya</i>	brown-head samphire, brown-head glasswort
<i>Halosarcia nitida</i>	
<i>Halosarcia pergranulata</i>	
<i>Halosarcia pergranulata</i> ssp. <i>divaricata</i>	
<i>Halosarcia pergranulata</i> ssp. <i>pergranulata</i>	
<i>Halosarcia pluriflora</i>	
<i>Halosarcia pterygosperma</i> ssp. <i>pterygosperma</i>	
<i>Hardenbergia violacea</i>	native lilac, purple coral-pea
<i>Harmsiodoxa blennodioides</i>	hairypod cress, May smocks
<i>Harmsiodoxa brevipes</i> var. <i>brevipes</i>	short cress
* <i>Helianthus annuus</i>	sunflower, common sunflower
* <i>Heliotropium curassavicum</i>	smooth heliotrope
* <i>Heliotropium europaeum</i>	potato weed, common heliotrope
* <i>Heliotropium supinum</i>	prostrate heliotrope, spreading heliotrope
* <i>Herniaria cinerea</i>	rupturewort, herniaria
<i>Hibiscus krichauffianus</i>	velvet-leaf hibiscus
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	hill hibiscus
<i>Hyalosperma glutinosum</i> ssp. <i>glutinosum</i>	golden sunray
<i>Hyalosperma semisterile</i>	orange sunray
<i>Hybanthus monopetalus</i>	slender violet, slender violet-bush
<i>Hydrocotyle callicarpa</i>	tiny pennywort
<i>Hydrocotyle trachycarpa</i>	wild parsley
* <i>Hymenolobus procumbens</i>	oval purse
* <i>Hyparrhenia hirta</i>	Tambookie grass
<i>Hypericum gramineum</i>	small St Johns wort
* <i>Hypochaeris glabra</i>	smooth catsear

<i>Hypoxis glabella</i> var. <i>glabella</i>	tiny star
<i>Indigofera australis</i> var. <i>australis</i>	Australian indigo, hill indigo
<i>Indigofera longibractea</i>	
<i>Iseilema membranaceum</i>	small Flinders-grass
<i>Isoetes muelleri</i>	quillwort
<i>Isoetopsis graminifolia</i>	grass cushion, grass buttons
<i>Isolepis australiensis</i>	
<i>Isolepis congrua</i>	
<i>Isotoma petraea</i>	rock isotome
<i>Ixiochlamys nana</i>	small fuzzweed
<i>Ixiolaena chloroleuca</i>	
<i>Ixiolaena leptolepis</i>	stalked ixiolaena, stalked plover-daisy
<i>Ixiolaena tomentosa</i>	woolly ixiolaena, woolly plover-daisy
<i>Jasminum didymum</i> ssp. <i>lineare</i>	native jasmine, desert jasmine
<i>Juncus aridicola</i>	tussock rush
<i>Juncus bufonius</i>	toad rush
<i>Juncus subsecundus</i>	finger rush
<i>Kippistia suaedifolia</i>	fleshy minuria
* <i>Limonium lobatum</i>	winged sea-lavender
<i>Limosella curdieana</i> var. "Long-pedicelled"(W.R.Barker 3577)	large mudwort
<i>Limosella curdieana</i> var. "curdieana"	large mudwort
<i>Linum marginale</i>	native flax, wild flax
<i>Logania nuda</i>	leafless logania, bare logania
* <i>Lolium rigidum</i>	Wimmera ryegrass, annual ryegrass
<i>Lomandra effusa</i>	scented mat-rush, iron-grass
<i>Lomandra leucocephala</i> ssp. <i>robusta</i>	woolly mat-rush, woolly-head mat-rush
<i>Lomandra multiflora</i> ssp. <i>dura</i>	hard mat-rush, iron-grass



<i>Lotus australis</i>	Australian trefoil, austral trefoil
<i>Lotus cruentus</i>	redflower lotus, red birds-foot trefoil
<i>Lycium australe</i>	Australian boxthorn
* <i>Lycium ferocissimum</i>	African boxthorn
<i>Lysiana exocarpi</i> ssp. <i>exocarpi</i>	Harlequin mistletoe
<i>Lythrum wilsonii</i>	

## APPENDIX D

### (M - Q) SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES OCCURRING IN THE NORTH EAST PASTORAL SOIL CONSERVATION DISTRICT

These are the accepted botanical names and preferred common names from the South Australian Environmental Database current at 17/5/95

Botanical Name	Common Name
<i>Maireana aphylla</i>	cotton-bush, leafless bluebush
<i>Maireana appressa</i>	
<i>Maireana astrotricha</i>	grey bluebush, low bluebush
<i>Maireana brevifolia</i>	short-leaf bluebush, Yanga bush
<i>Maireana campanulata</i>	bell-fruit bluebush
<i>Maireana carnosa</i>	cottony bluebush
<i>Maireana ciliata</i>	hairy fissure-weed, fissure-weed
<i>Maireana coronata</i>	crown fissure-weed
<i>Maireana erioclada</i>	rosy bluebush, fleshy bluebush
<i>Maireana georgei</i>	satiny bluebush
<i>Maireana integra</i>	
<i>Maireana lobiflora</i>	lobed bluebush
<i>Maireana microcarpa</i>	swamp bluebush, small-fruit bluebush
<i>Maireana oppositifolia</i>	salt bluebush, heathy bluebush
<i>Maireana ovata</i>	
<i>Maireana pentatropis</i>	erect bluebush
<i>Maireana pyramidata</i>	black bluebush, shrubby bluebush
<i>Maireana sedifolia</i>	pearl bluebush, hoary bluebush
<i>Maireana spongiocarpa</i>	
<i>Maireana trichoptera</i>	mallee bluebush, spike bluebush
<i>Maireana triptera</i>	three-wing bluebush
<i>Maireana turbinata</i>	top-fruit bluebush
<i>Malacocera albolanata</i>	woolly soft-horns

<i>Malacocera gracilis</i>	slender soft-horns
<i>Malacocera tricornis</i>	goat-head, soft horns
* <i>Malus sylvestris</i>	apple, wild crab apple
* <i>Malva parviflora</i>	marshmallow, small-flowered marshmallow
<i>Malvastrum americanum</i>	malvastrum, spiked malvastrum
* <i>Marrubium vulgare</i>	horehound
<i>Marsdenia australis</i>	native pear, austral doubah
<i>Marsilea drummondii</i>	common nardoo
<i>Marsilea hirsuta</i>	short-fruit nardoo
* <i>Medicago minima</i> var. <i>minima</i>	small burr-medic, woolly burr-medic
* <i>Medicago polymorpha</i> var. <i>polymorpha</i>	toothed medic, burr-medic
<i>Melaleuca glomerata</i>	inland paper-bark, white tea-tree
<i>Melaleuca lanceolata</i>	dryland tea-tree, black tea-tree
<i>Melhania oblongifolia</i>	velvet hibiscus
<i>Menkea australis</i>	fairy spectacles
<i>Menkea crassa</i>	
<i>Microseris lanceolata</i>	yam daisy, murnong
<i>Microtis frutetorum</i>	
<i>Millotia greevesii</i> ssp. <i>greevesii</i> var. <i>greevesii</i>	creeping millotia
<i>Millotia macrocarpa</i>	
<i>Millotia myosotidifolia</i>	broad-leaf millotia
<i>Millotia perpusilla</i>	tiny bow-flower
* <i>Minuartia mediterranea</i>	slender sandwort, fine-leaved sandwort
<i>Minuria annua</i>	annual minuria
<i>Minuria cunninghamii</i>	bush minuria
<i>Minuria denticulata</i>	woolly minuria
<i>Minuria integerrima</i>	smooth minuria
<i>Minuria leptophylla</i>	minnie daisy

<i>Minuria rigida</i>	
<i>Mollugo cerviana</i>	wire-stem chickweed
<i>Monachather paradoxa</i>	bandicoot grass
<i>Muehlenbeckia coccoloboides</i>	
<i>Muehlenbeckia diclina</i> ssp. <i>diclina</i>	weeping lignum, slender lignum
<i>Muehlenbeckia florulenta</i>	lignum, tangled lignum
<i>Myoporum montanum</i>	native myrtle, western boobialla
<i>Myoporum platycarpum</i>	false sandalwood
<i>Myoporum platycarpum</i> ssp. <i>perbellum</i>	mallee sandalwood, sugarwood
<i>Myoporum platycarpum</i> ssp. <i>platycarpum</i>	false sandalwood, sugarwood
* <i>Myosurus minimus</i> var. <i>australis</i>	mousetail
<i>Myriocephalus pluriflorus</i>	
<i>Myriocephalus rhizocephalus</i> var. <i>rhizocephalus</i>	woolly heads
<i>Myriophyllum verrucosum</i>	red water-milfoil
<i>Neurachne alopecuroidea</i>	fox-tail mulga-grass
* <i>Nicotiana glauca</i>	tree tobacco, tobacco bush
<i>Nicotiana goodspeedii</i>	small-flower tobacco
<i>Nicotiana simulans</i>	
<i>Nicotiana velutina</i>	velvet tobacco
<i>Nitraria billardierei</i>	nitre-bush, Dillon bush
<i>Olearia ciliata</i> var. <i>ciliata</i>	fringed daisy-bush
<i>Olearia decurrens</i>	clammy daisy-bush
<i>Olearia floribunda</i> var. <i>floribunda</i>	heath daisy-bush
<i>Olearia muelleri</i>	Mueller's daisy-bush
<i>Olearia passerinoides</i> ssp. <i>passerinoides</i>	feather daisy-bush
<i>Olearia picridifolia</i>	rasp daisy-bush
<i>Olearia pimeleoides</i> ssp. <i>pimeleoides</i>	pimelea daisy-bush, showy daisy-bush
<i>Olearia subspicata</i>	spiked daisy-bush, shrubby daisy-bush

<i>Omphalolappula concava</i>	burr stickseed
* <i>Onopordum acaulon</i>	stemless thistle, stemless onopordium
<i>Ophioglossum lusitanicum</i>	austral adders tongue
<i>Ophioglossum polyphyllum</i>	large adders tongue
* <i>Opuntia vulgaris</i>	drooping prickly pear, prickly pear
<i>Orobanche cernua</i> var. <i>australiana</i>	Australian broomrape
<i>Osteocarpum acropterum</i>	bonefruit
<i>Osteocarpum acropterum</i> var. <i>acropterum</i>	small-wing bonefruit, water weed
<i>Osteocarpum acropterum</i> var. <i>deminutum</i>	wingless bonefruit, water weed
<i>Osteocarpum dipterocarpum</i>	two-wing bonefruit
<i>Othonna gregorii</i>	fleshy groundsel
<i>Oxalis perennans</i>	native sorrel, native sour-sob
<i>Oxychloris scariosa</i>	
<i>Ozothamnus scaber</i>	rough bush-everlasting
<i>Pachymitus cardaminoides</i>	sand cress
<i>Panicum decompositum</i> var. <i>decompositum</i>	native millet, windmill grass
<i>Panicum effusum</i> var. <i>effusum</i>	hairy panic
<i>Panicum laevinode</i>	
* <i>Panicum miliaceum</i>	common millet, broom millet
* <i>Papaver hybridum</i>	rough poppy
<i>Paraceterach reynoldsii</i>	scaly rock-fern
<i>Paractaenum novae-hollandiae</i> ssp. <i>reversum</i>	barbed wire grass, reverse grass
<i>Parietaria cardiostegia</i>	smooth nettle, pellitory
<i>Parietaria debilis</i>	smooth nettle, shade pellitory
<i>Paspalidium basicladum</i>	
<i>Paspalidium clementii</i>	Clements paspalidium
<i>Paspalidium constrictum</i>	knotty-butt paspalidium, box grass

<i>*Peganum harmala</i>	African rue
<i>*Pentzia incana</i>	African sheep bush
<i>Peplidium foecundum</i>	dwarf peplidium
<i>Persicaria lapathifolia</i>	pale knotweed, pink knotweed
<i>*Phalaris minor</i>	lesser canary-grass, annual canary grass
<i>*Phalaris paradoxa</i>	paradoxa canary-grass, paradoxa grass
<i>Phlegmatospermum cochlearinum</i>	downy cress
<i>Phragmites australis</i>	common reed, bamboo reed
<i>Phyllanthus lacunarius</i>	Caraweena clover
<i>Phyllanthus saxosus</i>	rock spurge
<i>Pimelea micrantha</i>	silky riceflower, curved riceflower
<i>Pimelea microcephala</i> ssp. <i>microcephala</i>	mallee riceflower, shrubby riceflower
<i>Pimelea petrophila</i>	rock riceflower
<i>Pimelea simplex</i>	desert riceflower
<i>Pimelea simplex</i> ssp. <i>continua</i>	desert riceflower
<i>Pimelea simplex</i> ssp. <i>simplex</i>	desert riceflower
<i>Pimelea stricta</i>	erect riceflower, gaunt riceflower
<i>Pimelea trichostachya</i>	spiked riceflower, annual riceflower
<i>Pittosporum phylliraeoides</i> var. <i>microcarpa</i>	native apricot, weeping pittosporum
<i>Plagiobothrys plurisepaleus</i>	white rochelia, white forget-me-not
<i>*Plantago coronopus</i> ssp. <i>coronopus</i>	bucks-horn plantain
<i>Plantago drummondii</i>	sago weed, dark sago-weed
<i>*Plantago scabra</i>	rough plantain
<i>Plectranthus intraterraneus</i>	inland plectranth, purple mintbush
<i>Pleurosorus rutifolius</i>	blanket fern
<i>Pleurosorus subglandulosus</i>	clubbed blanket fern
<i>Pluchea dentex</i>	bowl daisy
<i>Pluchea rubelliflora</i>	
<i>Poa fordeana</i>	Forde's poa, sweet swamp-grass

<i>Podolepis canescens</i>	grey copper-wire daisy, bright podolepis
<i>Podolepis capillaris</i>	wiry podolepis, invisible plant
<i>Polycalymma stuartii</i>	poached-egg daisy, poached eggs
* <i>Polycarpon tetraphyllum</i>	four-leaf allseed, allseed
* <i>Polygonum aviculare</i>	wireweed, prostrate knotweed
<i>Polygonum plebeium</i>	small knotweed
* <i>Polypogon maritimus</i>	coast beard-grass
* <i>Polypogon monspeliensis</i>	annual beard-grass
* <i>Polypogon viridis</i>	water bent
<i>Pomax umbellata</i>	pomax
<i>Portulaca oleracea</i>	common purslane, munyeroo
<i>Potamogeton ochreatus</i>	blunt pondweed
<i>Prasophyllum odoratum</i>	scented leek-orchid
* <i>Prosopis juliflora</i>	mesquite
<i>Prostanthera striatiflora</i>	striated mintbush, jockeys cap
<i>Pseudognaphalium luteoalbum</i>	cudweed, Jersey cudweed
* <i>Psilocaulon tenue</i>	match-head plant, wiry noon-flower
<i>Psoralea australasica</i>	verbine scurf-pea, tall verbine
<i>Psoralea cinerea</i>	annual scurf-pea, annual verbine
<i>Psoralea parva</i>	small scurf-pea, small psoralea
<i>Pterocaulon sphacelatum</i>	apple-bush, fruit-salad plant
<i>Pterostylis aff. excelsa</i>	dryland green-hood
<i>Pterostylis biseta</i>	two-bristle green-hood, veined green-hood
<i>Pterostylis mutica</i>	midget green-hood
<i>Pterostylis robusta</i>	large shell-orchid, large striped green-hood
<i>Pterostylis rufa group</i>	green-hood
<i>Ptilotus astrolasius</i> var. <i>astrolasius</i>	
<i>Ptilotus exaltatus</i> var. <i>exaltatus</i>	tall mulla mulla, pink mulla mulla
<i>Ptilotus gaudichaudii</i> var. <i>parviflorus</i>	paper foxtail

<i>Ptilotus helipteroides</i> var. <i>helipteroides</i>	hairy mulla mulla, woolly tails
<i>Ptilotus nobilis</i> var. <i>nobilis</i>	yellow tails, regal foxtail
<i>Ptilotus obovatus</i> var. <i>obovatus</i>	silver mulla mulla, silver bush
<i>Ptilotus polystachyus</i> var. <i>polystachyus</i>	long-tails



## APPENDIX D

### (R - Z) SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES OCCURRING IN THE NORTH EAST PASTORAL SOIL CONSERVATION DISTRICT

These are the accepted botanical names and preferred common names from the South Australian Environmental Database current at 17/5/95

Botanical Name	Common Name
<i>Ranunculus hamatosetosus</i>	hill buttercup
<i>Ranunculus pentandrus</i> var. <i>platycarpus</i>	smooth buttercup, inland buttercup
<i>Ranunculus pumilio</i>	ferny buttercup
<i>Ranunculus pumilio</i> var. <i>politus</i>	smooth-fruit ferny buttercup, small-flower buttercup
<i>Ranunculus pumilio</i> var. <i>pumilio</i>	ferny buttercup, small-flower buttercup
* <i>Reichardia tingitana</i>	false sowthistle, reichardia
* <i>Reseda luteola</i>	wild mignonette, weld
<i>Rhagodia parabolica</i>	mealy saltbush, fragrant saltbush
<i>Rhagodia spinescens</i>	spiny saltbush, thorny saltbush
<i>Rhagodia ulicina</i>	intricate saltbush
<i>Rhodanthe corymbiflora</i>	white cluster everlasting, grey everlasting
<i>Rhodanthe floribunda</i>	white paper-daisy, large white sunray
<i>Rhodanthe microglossa</i>	small everlasting, clustered sunray
<i>Rhodanthe moschata</i>	musk daisy
<i>Rhodanthe polygalifolia</i>	milkwort everlasting, brilliant sunray
<i>Rhodanthe pygmaea</i>	pigmy sunray
<i>Rhodanthe stricta</i>	slender everlasting, slender sunray
<i>Rhodanthe stuartiana</i>	clay everlasting, clay sunray
<i>Rhodanthe troedelii</i>	
<i>Rhodanthe uniflora</i>	woolly sunray
<i>Rhynchosia minima</i>	rhynchosia, ryncho
* <i>Ricinus communis</i>	castor oil plant

<i>*Rostraria cristata</i>	annual cats tail
<i>*Rostraria pumila</i>	tiny bristle-grass
<i>Rumex brownii</i>	hooked dock, slender dock
<i>*Rumex crispus</i>	curled dock
<i>Rumex crystallinus</i>	shiny dock, glistening dock
<i>Rumex dumosus</i> var. <i>dumosus</i>	wiry dock
<i>Rumex tenax</i>	
<i>Rutidosis helichrysoides</i>	grey wrinklewort
<i>Rutidosis multiflora</i>	small wrinklewort
<i>*Sagina apetala</i>	annual pearlwort, common pearlwort
<i>*Salix babylonica</i>	weeping willow, willow
<i>Salsola kali</i>	prickly saltwort, roly-poly
<i>*Salvia reflexa</i>	mintweed
<i>*Salvia verbenaca</i> form A	wild sage
<i>*Salvia verbenaca</i> form B	wild sage
<i>Samolus repens</i>	creeping brookweed
<i>Santalum acuminatum</i>	quandong, native peach
<i>Santalum lanceolatum</i>	plumbush, northern sandalwood
<i>Santalum spicatum</i>	sandalwood
<i>Sarcostemma viminalis</i> ssp. <i>australe</i>	caustic bush, caustic vine
<i>Sarcozona praecox</i>	sarcozona
<i>Sauropus ramosissimus</i>	
<i>Sauropus rigens</i>	stiff spurge
<i>Sauropus trachyspermus</i>	slender spurge, dwarf spurge
<i>Scaevola collaris</i>	
<i>Scaevola humilis</i>	inland fanflower
<i>Scaevola parvibarbata</i>	small-beard fanflower
<i>Scaevola spinescens</i>	spiny fanflower, prickly fanflower

<i>*Schinus areira</i>	pepper-tree
<i>*Schismus barbatus</i>	Arabian grass, mulga grass
<i>Schoenia ramosissima</i>	dainty everlasting
<i>Schoenoplectus litoralis</i>	shore club-rush
<i>Schoenoplectus litoralis/validus</i>	club-rush
<i>Schoenoplectus pungens</i>	sharp-leaf club-rush, American club-rush
<i>Scleranthus pungens</i>	prickly knawel
<i>Scleroblitum atriplicinum</i>	purple goosefoot, starry goosefoot
<i>Sclerolaena bicornis</i>	goathead bindyi, goathead burr
<i>Sclerolaena brachyptera</i>	short-wing bindyi, short-wing copperburr
<i>Sclerolaena constricta</i>	
<i>Sclerolaena convexula</i>	tall bindyi, tall copperburr
<i>Sclerolaena cuneata</i>	tangled bindyi, poverty-bush
<i>Sclerolaena decurrens</i>	green bindyi, green copperburr
<i>Sclerolaena diacantha</i>	grey bindyi, grey copperburr
<i>Sclerolaena divaricata</i>	tangled bindyi, poverty-bush
<i>Sclerolaena eriacantha</i>	silky bindyi, silky copperburr
<i>Sclerolaena intricata</i>	tangled bindyi, poverty-bush
<i>Sclerolaena lanicuspis</i>	spinach bindyi, woolly bindyi
<i>Sclerolaena limbata</i>	pearl bindyi, pearl copperburr
<i>Sclerolaena longicuspis</i>	long-spine bindyi, long-spine poverty-bush
<i>Sclerolaena obliquicuspis</i>	oblique-spined bindyi, limestone copperburr
<i>Sclerolaena parviflora</i>	small-flower bindyi, mallee bindyi
<i>Sclerolaena patenticuspis</i>	spear-fruit bindyi, spear-fruit copperburr
<i>Sclerolaena tatei</i>	Tate's bindyi
<i>Sclerolaena uniflora</i>	grey bindyi
<i>Sclerolaena ventricosa</i>	salt bindyi, salt copperbush
<i>Sclerostegia disarticulata</i>	
<i>Sclerostegia tenuis</i>	slender glasswort

<i>Senecio anethifolius</i>	feathery groundsel
<i>Senecio cunninghamii</i> var. <i>cunninghamii</i>	shrubby groundsel, bushy groundsel
<i>Senecio cunninghamii</i> var. <i>serratus</i>	shrubby groundsel
<i>Senecio glossanthus</i>	annual groundsel, slender groundsel
<i>Senecio lautus</i>	variable groundsel, fireweed
<i>Senecio magnificus</i>	showy groundsel, tall yellowtop
<i>Senecio quadridentatus</i>	cotton groundsel, cotton fireweed
<i>Senecio runcinifolius</i>	thistle-leaf groundsel
<i>Senna artemisioides</i> nothosp. <i>artemisioides</i>	silver senna, silver cassia
<i>Senna artemisioides</i> nothosp. <i>coriacea</i>	desert senna, desert cassia
<i>Senna artemisioides</i> nothosp. <i>sturtii</i>	grey desert senna, grey cassia
<i>Senna artemisioides</i>	desert senna, desert cassia
<i>Senna artemisioides</i> ssp. <i>alicia</i>	
<i>Senna artemisioides</i> ssp. <i>filifolia</i>	fine-leaf desert senna, desert cassia
<i>Senna artemisioides</i> ssp. <i>helmsii</i>	blunt-leaf desert senna, crinkled cassia
<i>Senna artemisioides</i> ssp. <i>oligophylla</i>	limestone cassia
<i>Senna artemisioides</i> ssp. <i>petiolaris</i>	flat-stalk senna
<i>Senna artemisioides</i> ssp. <i>quadrifolia</i>	desert senna
<i>Senna artemisioides</i> ssp. <i>zygophylla</i>	desert senna, desert cassia
<i>Senna cardiosperma</i> ssp. <i>gawlerensis</i>	Gawler Ranges senna
<i>Setaria dielsii</i>	Diels pigeon-grass
* <i>Setaria italica</i>	foxtail millet, Italian millet
<i>Sida ammophila</i>	sand sida
<i>Sida corrugata</i>	corrugated sida
<i>Sida corrugata</i> var. <i>A</i>	
<i>Sida corrugata</i> var. <i>angustifolia</i>	corrugated sida, variable sida
<i>Sida fibulifera</i>	pin sida

<i>Sida intricata</i>	twiggy sida
<i>Sida petrophila</i>	rock sida
<i>Sida phaeotricha</i>	hill sida
<i>Sida trichopoda</i>	high sida, narrow-leaved sida
<i>Sigesbeckia australiensis</i>	
* <i>Silene apetala</i>	mallee catchfly
* <i>Silene nocturna</i>	Mediterranean catchfly
* <i>Silybum marianum</i>	variegated thistle
* <i>Sisymbrium erysimoides</i>	smooth mustard
* <i>Sisymbrium irio</i>	London rocket
* <i>Sisymbrium orientale</i>	wild mustard, Indian hedge mustard
<i>Solanum chenopodium</i>	goosefoot potato-bush
<i>Solanum coactiliferum</i>	tomato-bush, western nightshade
<i>Solanum ellipticum</i>	velvet potato-bush, potato-bush
<i>Solanum esuriale</i>	quena
<i>Solanum ferocissimum</i>	spiny potato-bush
* <i>Solanum nigrum</i>	black nightshade, black-berry nightshade
<i>Solanum petrophilum</i>	rock nightshade
<i>Solanum quadriloculatum</i>	tomato bush, wild tomato
<i>Solanum sturtianum</i>	Sturt's nightshade, Thargomindah nightshade
* <i>Sonchus asper</i> ssp. <i>glaucescens</i>	
* <i>Sonchus oleraceus</i>	common sow-thistle, milk thistle
* <i>Sorghum halepense</i>	Johnson grass
* <i>Spergularia diandra</i>	lesser sand-spurrey, small sand-spurrey
* <i>Spergularia marina</i>	salt sand-spurrey
* <i>Spergularia rubra</i>	red-spurrey, sand spurrey
<i>Sporobolus actinocladus</i>	ray grass, katoora
<i>Sporobolus caroli</i>	yakka grass
<i>Spyridium phlebophyllum</i>	inland spyridium

<i>Stackhousia muricata</i> ssp. "Perennial"(W.R.Barker 3641)	yellow candles, western candles
<i>Stemodia florulenta</i>	bluerod
<i>Stenopetalum lineare</i>	narrow thread-petal
<i>Stipa acrociliata</i>	spear grass
<i>Stipa blackii</i>	crested spear-grass
<i>Stipa densiflora</i>	foxtail spear-grass
<i>Stipa drummondii</i>	cottony spear-grass
<i>Stipa elegantissima</i>	elegant spear-grass, feather spear-grass
<i>Stipa eremophila</i>	desert spear-grass
<i>Stipa lanata</i>	
<i>Stipa nitida</i>	Balcarra grass
<i>Stipa nodosa</i>	smooth spear-grass
<i>Stipa platychaeta</i>	flat-awn spear-grass
<i>Stipa scabra</i> ssp. <i>scabra</i>	rough spear-grass
<i>Stipa scabra</i> group	falcate-awn spear-grass
<i>Stipa trichophylla</i>	
<i>Stipa tuckeri</i>	Tucker's spear-grass
<i>Streptoglossa adscendens</i>	desert daisy
<i>Streptoglossa liatroides</i>	Wertaloona daisy
<i>Stuartina hamata</i>	
<i>Stuartina muelleri</i>	spoon cudweed
<i>Swainsona fissimontana</i>	Broken Hill pea
<i>Swainsona flavicarinata</i>	yellow-keel swainson-pea
<i>Swainsona formosa</i>	Sturt pea, Sturts desert-pea
<i>Swainsona murrayana</i>	Murray swainson-pea
<i>Swainsona murrayana</i> ssp. <i>eciliata</i>	Murray swainson-pea
<i>Swainsona murrayana</i> ssp. <i>murrayana</i>	Murray swainson-pea, slender Darling pea
<i>Swainsona oligophylla</i>	

<i>Swainsona phacoides</i> ssp. <i>phacoides</i>	dwarf swainson-pea, lilac Darling pea
<i>Swainsona procumbens</i>	Broughton pea, Tatiara pea
<i>Swainsona pyrophila</i>	yellow swainson-pea, yellow Darling pea
<i>Swainsona stipularis</i>	orange swainson-pea, orange Darling pea
<i>Swainsona swainsonioides</i>	downy swainson-pea, downy Darling pea
<i>Swainsona tephrotricha</i>	bushy-haired swainson-pea, bushy-haired swainsona
<i>Swainsona viridis</i>	creeping Darling pea
<i>Synaptantha tillaeacea</i>	
<i>Templetonia aculeata</i>	spiny mallee-pea
<i>Templetonia egena</i>	broombush templetonia, desert broombush
<i>Tephrosia sphaerospora</i>	mulga trefoil
<i>Tetragonia eremaea</i>	desert spinach
<i>Tetragonia tetragonioides</i>	New Zealand spinach
<i>Teucrium albicaule</i>	
<i>Teucrium racemosum</i>	grey germander
<i>Teucrium sessiliflorum</i>	mallee germander, camel bush
<i>Themeda triandra</i>	kangaroo grass
<i>Thyridolepis mitchelliana</i>	window mulga-grass, mulga-grass
<i>Thysanotus baueri</i>	mallee fringe-lily
<i>Trachymene glaucifolia</i>	blue parsnip, wild parsnip
<i>Tragus australianus</i>	burr grass, small burr grass
<i>Trianthema triquetra</i>	red spinach, small hogweed
* <i>Tribulus terrestris</i>	caltrop, cat-head
<i>Trichanthodium skirrophorum</i>	woolly yellow-heads, woolly gnephis
<i>Trichodesma zeylanicum</i>	camel bush, cattle bush
<i>Triglochin calcitrapum</i>	spurred arrowgrass
<i>Triglochin centrocarpum</i>	dwarf arrowgrass
<i>Trigonella suavissima</i>	sweet fenugreek, Cooper clover

<i>Triodia irritans complex</i>	spinifex, porcupine grass
<i>Triodia scariosa</i> ssp. <i>scariosa</i>	spinifex, porcupine grass
<i>Tripogon loliiformis</i>	five-minute grass, rye beetle-grass
<i>Triptilodiscus pygmaeus</i>	small yellow-heads
<i>Triraphis mollis</i>	purple heads, purple plume grass
<i>Urochloa gilesii</i> ssp. <i>gilesii</i>	
<i>Urochloa praetervisa</i>	large armgrass
* <i>Urtica urens</i>	small nettle, stinging nettle
<i>Velleia arguta</i>	spur velleia
<i>Velleia paradoxa</i>	spur velleia
* <i>Verbena officinalis</i>	common verbena
* <i>Verbena supina</i>	trailing verbena
* <i>Vicia monantha</i>	spurred vetch, one-flower vetch
* <i>Vicia sativa</i> ssp. <i>nigra</i>	narrow-leaved vetch
<i>Vittadinia blackii</i>	narrow-leaf New Holland daisy, western New Holland daisy
<i>Vittadinia cervicularis</i> var. <i>cervicularis</i>	waisted New Holland daisy
<i>Vittadinia cuneata</i>	New Holland daisy
<i>Vittadinia cuneata</i> var. <i>cuneata</i> forma <i>cuneata</i>	New Holland daisy, fuzzweed
<i>Vittadinia cuneata</i> var. <i>morrisii</i>	New Holland daisy, fuzzweed
<i>Vittadinia dissecta</i> var. <i>hirta</i>	dissected New Holland daisy, common New Holland daisy
<i>Vittadinia eremaea</i>	desert New Holland daisy
<i>Vittadinia gracilis</i>	woolly New Holland daisy
<i>Vittadinia pterochaeta</i>	rough New Holland daisy, fuzzweed
<i>Vittadinia sulcata</i>	
* <i>Vulpia myuros</i> forma <i>myuros</i>	rats tail fescue, silver grass
<i>Wahlenbergia communis</i>	tufted bluebell
<i>Wahlenbergia gracilentia</i>	annual bluebell



<i>Wahlenbergia stricta</i> ssp. <i>stricta</i>	tall bluebell
<i>Wahlenbergia tumidifructa</i>	swollen-fruit bluebell
<i>Waitzia acuminata</i> var. <i>acuminata</i>	orange immortelle
<i>Westringia rigida</i>	stiff westringia, stiff western rosemary
<i>Wurmbea centralis</i>	inland star-lily
<i>Wurmbea dioica</i> ssp. <i>dioica</i>	early star-lily, early Nancy
* <i>Xanthium occidentale</i>	Noogoora burr
* <i>Xanthium spinosum</i>	Bathurst burr
<i>Xanthorrhoea quadrangulata</i>	rock grass-tree, Mount Lofty grass-tree
<i>Zygochloa paradoxa</i>	sandhill cane-grass
<i>Zygophyllum ammophilum</i>	sand twinleaf
<i>Zygophyllum angustifolium</i>	scrambling twinleaf
<i>Zygophyllum apiculatum</i>	common twinleaf, pointed twinleaf
<i>Zygophyllum aurantiacum</i>	shrubby twinleaf
<i>Zygophyllum billardierei</i>	coast twinleaf
<i>Zygophyllum compressum</i>	rabbit-ears twinleaf
<i>Zygophyllum confluens</i>	
<i>Zygophyllum crenatum</i>	notched twinleaf, lobed twinleaf
<i>Zygophyllum eremaeum</i>	pale-flower shrubby twin-leaf, climbing twinleaf
<i>Zygophyllum howittii</i>	clasping twinleaf
<i>Zygophyllum humillimum</i>	small-fruit twinleaf
<i>Zygophyllum iodocarpum</i>	violet twinleaf
<i>Zygophyllum ovatum</i>	dwarf twinleaf
<i>Zygophyllum prismatothecum</i>	square-fruit twinleaf

# APPENDIX E

## A PLAIN ENGLISH GUIDE TO THE NATIVE TITLE ACT 1993

The following is a short guide to the main features of the Native Title Act 1993 (the Act). It is not legal advice, only a lawyer can give you a legal opinion about the Act.

The Native Title Act 1993 became law on 1 January 1994.

It is important to remember that the Act is only a beginning. Native title will be explored and developed by courts, tribunals, governments and legislatures across Australia.

### Summary of the Act

The Native Title Act:

- recognises native title rights
- contains some basic principles about native title in Australia
- allows governments ways in which they can:
  - 'validate' or make legal past acts such as leases which native title might have made invalid
  - do things in the future and still protect native title rights
  - lets people get 'compensation' or something in return for loss of native title (generally money) if this happens because past acts have been made legal, or because of future acts
  - puts conditions on future acts which affect native title land and waters
  - contains a process for:
    - finding out about who has native title rights
    - finding out which people might get compensation; and
    - making decisions about whether governments can make future grants, such as grants of mining leases, or do acts over native title land and waters; and
    - creates a Land Fund with money to help Aboriginal and Torres Strait Islander peoples acquire and manage land.

The Aboriginal and Torres Strait Islander Commission (ATSIC) has other booklets which help understand the National Native Title Tribunal and Federal Court processes.

### Main Features of the Act

*This part of the guide goes through the main sections of the Act and explains what they mean.*

#### The Commonwealth approach to native title

##### Recognition of native title

The main purpose of the Act is to recognise and protect native title (see sections 3 and 10).

Native title is the rights and interests in land and waters that Aboriginal and Torres Strait Islander peoples have under their traditional laws and customs and that are recognised by the common law (section 223).

##### Determination of native title

The Act contains a process for 'determining' or deciding about whether or not native title exists and what rights and interests native title holders have (see sections 13 and 61).

A determination of native title under the Act will decide whether the people who have title have 'exclusive possession'. Exclusive possession means they are the only people who have any rights to the land. If they do not have exclusive possession the person who makes the determination may say what kind of rights the titleholders have (section 225).

The traditions of Aboriginal and Torres Strait Islander peoples can change with time and sometimes people stop following a tradition. Therefore, the Act says that native title rights can change or even finish. The Act gives a way to change determinations where circumstances have changed (sections 13 and 61).

Section 12 says that what the common law of Australia says about native title is now Commonwealth law. Native title is subject to the general laws of Australia such as State or Territory laws. Those laws can apply to native title land or waters unless the Act says they cannot (section 8).

However, people may be able to hunt, fish and do other things that are part of their native title rights without a licence or permit when other people need a licence or permit to do those things (section 211).

Some people who have land might want to find out if anyone has native title rights to that land. These people are 'non-claimants', they do not want to claim native title for themselves. The Act allows non-claimants with an interest in land to ask for a determination about native title (sections 61 and 67). If no one opposes a non-claimant application, future acts over the land or waters are valid (section 24).

The Act also says that there will be two public registers: The Register of Native Title Claims where people can register a claim for native title (Part 7) and The National Native Title Register for native title determinations.

### **(Part 8) Protection of native title**

The Act gives a lot of protection to native title.

The Act says that native title is only 'extinguished' or wiped out in a few cases where it is necessary to make past acts legal.

Some future acts of governments can affect native title. The 'non-extinguishment principle' will apply to most future acts (section 238). This means that those acts will not extinguish native title. If there is a conflict between the rights and interests under native title and those granted by a government, the act or grant will win. But once the interests are finished native title can again have full effect. The non-extinguishment principle will not apply when people choose to give up their native title (section 21) or a government compulsorily acquires native title land (section 23(3)b)) and pays compensation. In those cases native title is 'extinguished' or lost forever.

### **Bodies Corporate**

The Act recognises that native title rights are mainly group or community rights. It is likely that a number of people will be able to show that they have native title rights to a particular area. The people who have title will change over time.

To take this into account the Act says there are two ways to organise control of native title:

1. Native title can be held in trust by a company controlled by those who are the native title holders from time to time (see sections 56 and 57); and
2. A company can represent the native title holders and act as their agent (sections 57 and 58).

In both cases, it is the native titleholders who get the full benefit of their native title rights.

The companies will provide a practical and legal point of contact for people who want to deal with native titleholders.

### **Representative Aboriginal and Torres Strait Islander bodies**

The Act says that some Aboriginal and Torres Strait Islander organisations may be named as representative Aboriginal and Torres Strait Islander bodies (Representative Bodies) to help people make native title claims (section 202). They will help with applications to determine native title and compensation; and negotiations and proceedings.

The Representative Bodies may be able to get financial help from the Commonwealth or ATSIC (section 203).

The Minister for Aboriginal and Torres Strait Islander Affairs made a Determination that came into effect from 1 January 1994 that named some existing organisations as Representative Bodies. People claiming native title or compensation do not have to use a representative body.

### **Special measure under the Racial Discrimination Convention**

The Act is a special measure under Article 1(4) of the Racial Discrimination Convention and section 8 of the Racial Discrimination Act (RDA). It gives important benefits to Aboriginal and Torres Strait Islander peoples. The Act does not affect the operation of the RDA (section 7), but all past acts made valid by the Native Title Act are made certain by section 7(2).

### **The Land Acquisition Fund**

The Act recognises that many Aboriginal and Torres Strait Islander peoples will not be able to secure native title and to benefit directly from the High Court decision in the Mabo case. So that those people can get some benefit from the High Court decision in the Mabo case the Act establishes a 'National Aboriginal and Torres Strait Islander Land Fund' (section 201). The fund began operation on 1 July 1994.

The purpose of the Fund (section 201(2)) is to help Aboriginal and Torres Strait Islander peoples:

1. to acquire land; and
2. to manage the acquired land in a way that provides economic, environmental, social or cultural benefits to them.

### **Existing rights**

The Act does not affect rights held under Commonwealth land rights legislation such as the Aboriginal Land Rights (Northern Territory) Act 1976 (section 210).

Governments can confirm (section 212(2)): existing ownership of natural resources; existing rights to water; that existing fishing rights override native title rights; and existing access to beaches and public places.

However, the confirmation will not affect the ability of native titleholders to continue to exercise any rights they might still have (section 212(3)).

### **Validation of past acts**

Section 14 of the Act validates past Commonwealth acts and section 19 lets States and Territories validate their past acts on the same terms.

The Act does not stop States and Territories from attempting to validate their past acts on their own terms. However, they would do so at their own risk and they might find that their actions are not legal.

### **Effect of validation on native title**

Past acts which are or can be validated include the making of legislation, the grant of a lease, licence or permit and the exercise of executive power by governments, in relation to native title land or waters.

When a past act or grant is validated it will only extinguish native title where there has been what the Act calls a Category A past act (sections 15 (1)(a) and (b) and 229). A Category A past act is a grant of freehold or of a commercial, agricultural, pastoral or residential lease (defined in sections 246 to 249) or the construction of a public work (defined in section 253).

A Category B past act is a grant of a leasehold interest, which is not covered by Category A, and is not a mining lease. When a Category B past act is validated it will only extinguish native title rights that cannot co-exist with the rights and interests granted under that act (sections 15(1)(c) and 230).

The Act does not extinguish native title in cases where: a freehold or leasehold grant ended before 1 January 1994; the grant which is validated was made under legislation for the benefit of Aboriginal or Torres Strait Islander peoples; or a validated leasehold grant was held on 1 January 1994 under land rights legislation (sections 229(2), (3) and 230).

Category C past acts are mining leases and Category D past acts are all other grants including licences and permits. Commonwealth validation of Categories C and D past acts (sections 15(1)(d), 231 and 232) will not extinguish native title and the non-extinguishment principle (defined in section 238) will apply to the native title.

In particular, mining leases validated by the Act and those validated by States and Territories under the Act will not extinguish native title.

The only acts that can be validated are: legislation passed before 1 July 1993; other acts and grants made before 1 January 1994; and some acts that will take place in the future where those acts are linked to acts done in the past. These include the exercise of options and legally enforceable rights or the extension or renewal of grants made in the past (see the definition of 'past act' in section 228).

### **Protection of reservations**

The validation exercise will not affect any reservations or conditions for the benefit of Aboriginal or Torres Strait Islander peoples contained in any past grant or legislation, or any other right or interest Aboriginal or Torres Strait Islander peoples may hold arising under law or by usage (section 16).

Any extinguishment of native title that happens where a pastoral lease is validated does not give anyone the right to remove Aboriginal peoples from that land (section 15(2)).

## **Entitlement to compensation for validation**

In the small number of cases where it is necessary to make acts legal by validating, native titleholders are entitled to compensation for the loss of native title.

Native titleholders are entitled to compensation for the effect of the validation of past acts on their rights when the Act extinguishes native title, for example, by the validation of a freehold grant:

- compensation to native title holders will be on just terms (sections 17, 20 and 51); 'impairs' or takes away some rights of native title but does not extinguish it on onshore land, for example by the validation of a mining lease over land
- compensation will be paid to native title holders where freeholders would have received compensation and this will be assessed in the same way as it is for freeholders (sections 17, 20, and 51(3), and the definition of the 'similar compensable interest test' in section 240); or impairs native title and the grant or act could not have been done over freehold land, or where the grant or act was over an offshore place
- compensation to native title holders will be on just terms (sections 17, 20 and 51).

The Act gives Commonwealth rights to compensation, even for the effect of State and Territory validations. These Commonwealth rights can be followed up in the National Native Title Tribunal (NNTT) and the Federal Court. States and Territories may also provide rights to compensation and a process for following up those rights (section 20(4)).

When a court or tribunal makes a decision about giving people compensation under this Act they must take into account any compensation already given by a State or Territory under their own laws (section 49(b)). In practice, this means that people will not get double compensation.

Compensation is payable to native titleholders by: the Commonwealth Government for acts it has validated (section 17(4)), or a State or Territory government if it validates an act (section 20(3)).

Native titleholders also have a right to compensation for the effect of invalid acts where a State or Territory has not acted to validate those acts (Section 20(2)).

If the RDA gives native titleholders a right to compensation, instead of making a grant or act invalid, they can claim compensation under the Native Title Act.

## **Non-monetary compensation**

Native title holders can negotiate non-monetary compensation for the loss of their native title. This could include other property or goods and services (sections 51(6) and 79).

In special circumstances, the Commonwealth Minister may tell the NNTT to consider the effects of validation of particular past acts on Aboriginal and Torres Strait Islander peoples. The Minister can also tell the NNTT to consider the different kinds of compensation (section 137).

## **The future regime**

The Commonwealth also knows that it is very important to have a process that will allow future grants and actions over lands and waters that are or might be affected by native title. Therefore, native title is recognised and made part of the national land management system.

## **Future acts that can be done**

The Act says that future acts that affect native title can be done legally if they are 'permissible future acts' (defined in section 235).

It is important to recognise that the Act makes a distinction between 'offshore' and 'onshore' places. These terms are defined in section 253. An 'onshore place' is land or waters located within the limits of a State or Territory. The waters off the coast of a State or a Territory (known as the coastal waters) are not included in this definition. They are 'offshore' places, which also includes any land (for example, reefs and islands) or waters to which the Act extends that are not within the limits of a State or Territory.

All future acts in offshore places are 'permissible' and can be done even if that place is subject to native title (section 235(8)(a)).

In the case of onshore places, the Act says that where an act can be done over ordinary title land then that act is also permitted over native title land (section 235(5)). 'Ordinary title land' means either freehold or, in the Australian Capital Territory and Jervis Bay, leasehold (section 253).

There is also a test for where an act is proposed over onshore native title waters such as lakes, rivers and harbours. An act can be done to those waters if it could be done to the waters if the land beside or surrounding them was ordinary title land (section 235(5)).

New legislation will only be permissible if it affects native title holders in the same way that it affects ordinary title holders or if it does not put native title holders in a worse position than ordinary title holders (section 235(2)).

### **Commencement of 'permissible future act' test**

From 1 July 1993, new legislation must satisfy the 'permissible future act' test. Other acts and grants must satisfy the test from 1 January 1994.

However, the Act will validate some acts and grants that will take place after these dates as part of the process for validating 'past acts'. Those acts and grants will not need to satisfy the permissible future act test (sections 228(3), (4) and (9), and 233(1)(b)).

### **Exceptions to 'permissible future act' test**

When a non-claimant application is made over a piece of land and no native title claim is made to that land then any act over that land before a court or tribunal makes any determination of native title is valid (section 24).

Renewals of existing interests flowing from a legally enforceable right can occur without negotiation even if the renewals are over native title land or waters (section 25).

Other renewals or extensions of valid existing commercial, agricultural, pastoral or residential leases are permissible future acts (section 235(7)).

### **Grant of mining interest permitted**

An example of a permissible future act is the grant of a mining interest. A mining interest means the right to do something to do with mining either exploring or actually mining. Where a government can grant a mining interest over freehold land it can also make the same grant over native title land.

Other permissible future acts are those made under general Compulsory Acquisition Acts (see definition in section 253).

## **Future extinguishment**

In the future governments can only extinguish native title: if the native titleholders agree (section 21); or by using land for a purpose which it was acquired under a Compulsory Acquisition Act (section 23(3) and section 11).

## **Compensation for future acts**

Native titleholders will be entitled to 'just terms compensation' for any future extinguishment of their rights and interests. Just terms means something that is fair given the circumstances of a particular case. Each different case will have different just terms compensation.

Where an act only impairs the native title rights: onshore, native title holders can get compensation in the same way that ordinary title holders could (sections 23(4) and 51(3)); or offshore, the native title holders can get just terms compensation (sections 23(4) and 51(1)).

The Act provides a Commonwealth right to compensation for extinguishment of native title where it occurs because of a Compulsory Acquisition Act or for onshore impairment. However, this is only when native titleholders do not have a right to compensation given by a State or Territory law (section 23(3)(c), (4)(b)(ii)(c)).

## **Procedural rights for future acts**

In the case of all future acts other than 'low impact future acts', native title holders are entitled to the same procedural rights as holders of ordinary title, such as the right to be notified and to object (sections 23(6) and 253).

## **Right to negotiate**

The Act recognises the special attachment that Aboriginal and Torres Strait Islander peoples have to their land.

It makes sure that registered native title holders and registered native title claimants have a right to negotiate before certain 'permissible future acts' happen (see Subdivision B of Division 3 of Part 2 for more detail about this). The right to negotiate applies to acts to do with mining, the compulsory acquisition of native title to make a grant to a third party and any other acts approved by the Commonwealth Minister (see section 26).

The right to negotiate does not apply if there are no registered native title holders or registered native title claimants within two months of notification of the proposed act (sections 28(1)(a) and 30). In this case, the act can go ahead in the normal way.

Certain types of grants, which have minimal effect on native title, can be excluded from the right to negotiate (sections 26(3) and (6)). Also, if a particular act will not involve major disturbance to native title land, the right to negotiate may not apply (sections 32 and 237).

The right to negotiate is not a 'veto' or right to reject. If the parties cannot come to an agreement after negotiation then any party can apply for a decision to the NNTT or the recognised State or Territory body, called the 'arbitral' or decision making body (section 27). The arbitral body will make a decision about whether or not the act may go ahead and if so on what conditions (section 35).

When it makes its the decision the arbitral body must take into account a number of things, such as the way in which the proposed act might affect the way of life, culture and traditions of the native title holders. It must also consider how important the act is to the economy of Australia and the relevant State or Territory (section 39).



Where there is a State or Territory arbitral body, a State or Territory Minister may override the determination in the interest of the State or Territory (section 42(1), (3)). If the NNTT is the arbitral body, the Commonwealth Minister may override the decision in the national or State or Territory interest (section 42(2), (3)). The relevant Minister may set conditions on which the act may go ahead.

### **State and Territory bodies and processes for right to negotiate**

Where a State or Territory body complies with the relevant criteria and the Commonwealth Minister has recognised it, that body will be the arbitral body for the State or Territory (sections 27 and 251). The Act also has a way in which a State or Territory system, which has an equivalent right to negotiate, can be approved (section 43). Where there are such State or Territory systems then the Commonwealth system for determining whether acts may go ahead will not operate.

### **Low impact future act**

Certain future acts are defined as 'low impact future acts' (section 234). These include the grant of minor licences and permits (such as for beekeeping). Those acts can go ahead before native title is determined. However, they do not extinguish native title and there is no need to pay compensation. The acts may not continue if native title is later determined to exist (sections 23 and 235(8)(b)) unless the native titleholders agree that they can continue.

### **Surrender of native title**

Land which was held traditionally could not be bought and sold. Therefore, native titleholders cannot 'alienate' or give up their title except to governments. They can give up their title to the relevant government in exchange for 'statutory' title such as freehold or leasehold (section 21(1)(a)). Native titleholders can also agree to any acts taking place over their land (section 21(1)(b)). Negotiations of agreements on a local or regional basis can happen if appropriate (Preamble and section 21(4)).

### **Pastoral leases held by native titleholders**

The Act says that Aboriginal and Torres Strait Islander people who have a pastoral lease over an area of land may also be able to claim native title over that land, where they have maintained traditional links with it. Any determination that native title exists is on the basis that the pastoral lease remains valid and operative but the native title holders receive the benefit of the protection given by the Act (section 47).

### **Future acts where native title is not known**

A government can do an act in an area where it has applied to the NNTT for a determination of whether native title exists and no claims to native title are lodged within a specified time (sections 24 and 67). If the NNTT finds that native title does exist the act is not invalidated. However, the native titleholders would be able to get compensation.

### **The Tribunal and Court process**

The Act establishes a new body called the National Native Title Tribunal and gives the Federal Court jurisdiction in native title matters (see Part 6 of the Act). This is to provide the most effective means of dealing with native title issues.

## **GLOSSARY AND ABBREVIATIONS**

**Act:** with a capital 'A' means the Native Title Act 1993, with a lower case 'a' means 'an act'

**acts:** means acts done by governments, people or organisations, such as the granting of a mining lease, or the making of legislation

**Representative Aboriginal and Torres Strait Islander Bodies (Representative Bodies):** Aboriginal and Torres Strait Islander organisations which can help Aboriginal and Torres Strait Islander people making native title claims. They are determined by the Minister for Aboriginal and Torres Strait Islander Affairs under the Act

**arbitral body:** a body which can decide whether acts may go ahead over native title land, for example, the NNTT

**ATSIC:** the Aboriginal and Torres Strait Islander Commission

**common law:** laws which are made by courts; not legislation

**compensation:** something you get in return when something you own is lost, taken or given away

**compulsorily acquire:** to take without giving anyone a choice. Only governments can take land by compulsory acquisition and only with a good reason

**determine:** to make a decision. A determination is a final decision. However, a person can appeal against a determination of a tribunal or court made under the Native Title Act

**extinguish:** to take away forever

**freehold:** the highest form of land title granted by governments

**grants:** a legal right to a piece of land which is given by governments

**impair:** to take away some rights

**interest in land:** any legal right to have or use a piece of land

**just terms compensation:** compensation that is fair based on each different case. Courts and tribunals will decide this if parties cannot agree

**leasehold:** temporary land title, generally giving a right to exclude others, that may be for a long or short period of time

**legislation:** laws which are made by Commonwealth or State parliaments or Territory legislatures

**mining interest:** the right to do things such as explore, prospect or mine

**National Aboriginal and Torres Strait Islander Land Fund:** a fund which began operation on 1 July 1994 and will assist Aboriginal and Torres Strait Islander peoples to purchase and manage land

**National Native Title Register:** a public list of native title determinations

**NNTT:** the National Native Title Tribunal. The tribunal which may hear native title claims from all over Australia

**non-claimants:** people or organisations who have an interest in land and do not want to or cannot make a native title claim but want to ask for a determination about native title for the land in which they have an interest

**non-extinguishment principle:** a principle in the Act. Where this applies to acts and grants they do not extinguish native title. The act or grant can have effect but when its period of operation has ended, native title may again have full effect

**permissible future acts:** acts which the Act allows people or organisations to do over native title land

**public work:** something which is built by a government, for example, a school, a road or a dam

**RDA:** the Racial Discrimination Act 1975

**Register of Native Title Claims:** a public list of native title claims

**statutory:** something that is done under legislation

**title to land:** a legal right to some kind of ownership or use of a piece of land

**title holders:** the people or group of people which has title to an area of land

**traditions:** the customs and laws etc. of people which have been passed down through generations. Traditions can change over time or be given up

**validate:** to make legal

*Source: Native Title and Land Rights Branch ATSIC January 1997*

# APPENDIX F

## A PLAIN ENGLISH GUIDE TO THE WIK CASE

### What is the Wik Case?

On 30 June 1993 (before the Native Title Act became law in December 1993) the Wik Peoples made a claim for native title in the Federal Court of Australia to land on Cape York Peninsula in Queensland.

The Thayorre People joined the action, claiming native title rights to an area partly overlapping the Wik Peoples' claim. The land claimed by the Wik Peoples and the Thayorre People included land where two pastoral leases were granted by the Queensland Government.

One pastoral lease of 1119 square miles (2830 square km), originally granted in 1945, continues to be a pastoral lease. The current lease was granted in 1975 and expires in the year 2004. It has never been permanently occupied or fenced. In 1988 it was reported that it carried only 100 unbranded cattle.

The other pastoral lease was 535 square miles (1385 km<sup>2</sup>). It was first granted in 1915. It was forfeited and replaced by another pastoral lease in 1919 and forfeited again in 1920. In fact, it was never occupied as a pastoral lease. Aboriginal people, however, have been in continuous occupation of the area. About 300 were recorded as being present in 1919. In 1922, the area became an Aboriginal Reserve and remains so today.

The Wik Peoples and the Thayorre People argued that native title co-existed with the pastoral leases.

On 29 January 1996, Justice Drummond in the Federal Court made a decision that the claim of the Wik and Thayorre Peoples could not succeed over the areas as they were subject to pastoral leases. The Judge's reason was that he considered that the grant of pastoral leases under Queensland law extinguished any native title rights.

The Wik People went to the High Court to appeal that decision. The Appeal was against answers which Justice Drummond had given to several legal questions.

The most important of those questions related to the two pastoral leases. The question asked in the case of each pastoral lease was:

*"Does the pastoral lease confer rights to exclusive possession on the grantee (ie. the pastoralist)?"*

### What did the High Court say?

The High Court said that:

Native title can only be extinguished by a written law or an act of the Government, which shows a clear and plain intention to extinguish native title. The Statute creating pastoral leases in Queensland did not show an intention to extinguish native title. Pastoral leases come from Australian Statute Law, not from English common law. Pastoral leases were created in Australia to meet the special needs of the emerging Australian pastoral industry in circumstances unknown in England. The pastoral leases did not give exclusive possession to the pastoralists. (Exclusive possession means not having to share the land with others). The grant of a pastoral lease does not necessarily extinguish all native title rights. Native title

rights could continue at the same time that the land was subject to a pastoral lease. Where there is conflict in the exercise of those rights, native title rights were subordinate to those of the pastoral lease holder.

### **What didn't the High Court say?**

The High Court did not make a decision in the Wik Case about what native title rights the Wik Peoples or the Thayorre People have.

The High Court did not decide on the actual native title rights of the Wik and Thayorre Peoples because of the way in which the case got to the High Court. It was an appeal from a decision of Justice Drummond who had made his decision before hearing any of the evidence of the Wik Peoples' claim to native title.

### **When will the Native Title Rights of the Wik and Thayorre peoples be decided?**

Now that the High Court has said that Justice Drummond was wrong on these questions, the Wik Peoples are able to go back to the Federal Court and present evidence to prove their native title rights.

The High Court in the Mabo Case said that native title rights must be proved, by evidence of the customs and traditions of the native title claimants. Those customs and traditions may be different in different parts of Australia.

The Federal Court can decide what the native title rights are of the Wik Peoples and which of those rights can co-exist with the pastoral lease. Alternatively, the Queensland Government could sit down with the Aboriginal people and negotiate an agreement using the procedures of the Native Title Act. Such an agreement could recognise the rights of everybody, thus avoiding expensive litigation.

### **What Native Title Rights may co-exist with Pastoral Leases?**

The only native title rights that can co-exist with the rights of a pastoralist holding a lease are those that are not inconsistent with the rights of the pastoralist. If an agreement cannot be reached between the relevant parties the Federal Court can make a final determination on native title and compare the native title rights with the rights under the pastoral lease. It may be; for example, that rights to visit sacred sites, hold ceremonies and collect native foods will not be seen as inconsistent with the pastoralists' rights.

### **What Native Title Rights may not co-exist with Pastoral Leases?**

A native titleholder could not exclude the holder of a pastoral lease from the area of the pastoral lease or restrict pastoralists from using the lease area for pastoral purposes. •A native titleholder could not, therefore, have full beneficial ownership of the land at the same time as it is the subject of a pastoral lease. A native titleholder would not be able to do anything which interfered with:

- the ability of the pastoralist's livestock to take advantage of the pasture and water sources on the land;
- the pastoralist's privacy on the homestead,
- the pastoralist's right to build fences, gates, windmills and other improvements to the land.

### **Are Pastoral Leases Affected ?**

The High Court made it very clear that none of the rights of the pastoral leases are taken away by co-existing native title rights. Where there is any inconsistency with a pastoralist's rights, the pastoralist's rights override native title.

The High Court in the Wik Case confirmed its view in the Mabo Case that Governments have power to grant valid pastoral leases. Indeed, the Native Title Act 1993 validated any grants of pastoral leases, which might have been invalid because of native title.

### **What rights do Pastoralists have?**

The High Court confirmed that a pastoral lease gives the pastoralist the right to use the land for pastoral purposes. The Court said that pastoral purposes would include:

- Raising livestock
- Establishing fences, yards, bores, dams, mills and accommodation.

The Court said that a pastoral lessee's rights are defined by the relevant State Statute.

An example of a relevant State Statute is the Land Act of WA. It gives a pastoral lessee the natural surface of the land for pastoral purposes. It does not give general rights to soil or timber but gives specific rights to:

- take soil and timber for domestic purposes
- take soil and timber for the construction of airstrips, roads, buildings, fences, stockyards or other improvements on the land
- sow and cultivate non-indigenous pasture species with the approval of the State Minister.

The High Court points out that pastoral leases in Queensland are subject to statutory provisions which define the right of a pastoralist, (as they are in the other parts of Australia) including conditions:

- Requiring that the land be developed, improved or enclosed by fencing
- Requiring the destruction of noxious plants and the control of vermin
- Prohibiting the destruction of trees
- Making leases subject to rights granted under mining legislation, petroleum legislation and forestry legislation
- Keeping for the government the power to allow other persons to enter the land to take soil or timber or for "any purpose"
- Giving drovers and others the right to pass through pastoral leases and use pastures while passing through.

These provisions are generally limited by the Statute to protect the privacy of the homestead and gardens and paddocks under cultivation.

In other States such as Western Australia, South Australia and the Northern Territory, Statutes provide that Aboriginal people have a right to enter pastoral leases in order to live off the land in their traditional manner. Those provisions also have limitations which protect improved parts of properties.

### **What about where the Government has to approve certain acts on pastoral leases ?**

Some statutory provisions stop pastoralists carrying out certain activities on pastoral leases except with State Government approval. Those activities are exceptional.

If the Government's approval is required to a certain act, the Government may need to take into account the Native Title Act 1993 before giving approval. The extent to which any provisions of the Act apply will require further investigation.

### **Are there any economic consequences for pastoralists ?**

Pastoralists' perceptions of their rights under their leases may have changed as a result of the Wik decision, but they retain the same legal interest as was their legal entitlement prior to the decision. Accordingly, there is no legal impact on:

- The value of the pastoral lease
- The value of the security which the pastoral lease may provide for borrowing money.

Moreover, as restated by the industry recently, financial institutions base their valuations of pastoral leases for security for a loan on its capacity to carry stock (and hence its ability to generate income), the equipment owned by the pastoralist and improvements (houses, fences, dams, yards etc). All these things are unaffected by the Wik decision. Typically, a pastoralist would use the livestock on the land as security for a loan. This is known as a stock mortgage. Again, these arrangements are unaffected by the Wik decision.

There are also no compensation obligations on pastoralists flowing from the Wik decision. Pastoralists are entitled, in the exercise of their rights to use the land for pastoral purposes, to progressively develop areas of the pastoral property for use for pastoral purposes by building fences, cultivating pastures, creating dams or building houses for workers etc. If the pastoralists' acts have the effect of extinguishing or impairing the exercise of co-existing native title rights; those acts are validated by the Native Title Act because they are authorised by statute law. Any compensation payable because of that extinguishment or impairment would be payable by the Government which made that law.

### **How are miners affected?**

Since the commencement of the Native Title Act on 1 January 1994, the grant of mining tenements over land where native title may still exist has to go through a right to negotiate process. This involves governments notifying native titleholders of its intention to grant the mining tenement, allowing the native titleholders a short time to register their claim and, if it is registered, negotiations between the native titleholders, the mining company and the Government. If no agreement can be reached, then the National Native Title Tribunal or a similar State body decides if exploration or mining can go ahead and on what conditions. There are also mechanisms to avoid or fast track this process in some situations.

All grants of mining tenements on pastoral leases since 1 January 1994 should have gone through the right to negotiate process as the question of the continued existence of native title on pastoral leases was not resolved by the Mabo case or the Native Title Act. In finding that some native title rights may coexist with pastoral leases the Wik case confirms the need for governments to use the right to negotiate process.

If native title claims are made over pastoral leases upon which mining tenements existed prior to the Native Title Act, the native title rights are subject to the rights of miners to continue mining. In those instances, the right to negotiate process under the Act will not apply.

However, if a government granted mining tenements on pastoral leases after the Native Title Act without going through the right to negotiate process, those mining tenements could prove to be invalid.

DISCLAIMER: This is general information only and should not be relied upon as legal advice.

*Source: Native Title and Land Rights Branch ATSIC January 1997*

# APPENDIX G

## ESTABLISHING AND MAINTAINING GOOD RELATIONS BETWEEN LANDHOLDERS AND MINERAL EXPLORERS

### Preparations prior to entry onto land

- Either the Project Officer or an appropriately qualified person should be appointed as a Liaison Officer who is responsible for liaison throughout the life of the program. This person must be given that specific responsibility in their duties and should preferably have a knowledge of the agricultural and/or pastoral sector and an affinity for people on the land.
- The Liaison Officer shall be responsible to the company and should be familiar with all aspects and requirements of the project.
- The Liaison Officer should be authorised to make agreements and arrangements on behalf of the company.
- All project personnel, including contractors, should be briefed on company policy and be aware of and comply with the tenement conditions and agreements made with the owner and occupier.
- The Liaison Officer should make direct contact to discuss the exploration program with the landholder (the person who has an interest in the land by way of freehold title, leasehold interest or holds land under some form of dedicated reservation, i.e. park, road reserve, easement, etc.) before exploration commences.
- If possible, the field program should be made flexible enough to fit in with the often more rigid timetable of the landholder, e.g. harvesting, mustering, lambing.
- The landholder should be informed of the Liaison Officer's responsibilities and who the Liaison Officer reports to in the company.
- The company should make the Liaison Officer or other appropriate person available to discuss reasonable requests from the local community for information on the project management plan and commitments.
- The Liaison Officer should ask the landholder about:
  - the location of special features of the property including the location of known Aboriginal or European heritage sites
  - the existence of any Heritage Agreements or management plans approved under the Pastoral Land Management and Conservation Act, the Soil Conservation and Land Care Act, and any other statutory obligations
  - the preference for reinstatement of disturbed areas
  - the future use of drillholes which intersect useable groundwater.
- Wherever practical, serve notices required under the Act personally and use the opportunity to explain the program and establish a working relationship.
- Supply the landholder with the tenement number and conditions attached to it.
- Provide the landholder with the Liaison Officer's business and after hours telephone numbers.
- The explorer should consult with the traditional Aboriginal custodians of the land to avoid disturbance of any significant Aboriginal sites. The Department of State Aboriginal Affairs can advise on the relevant groups or contact persons. MESA can further advise and assist companies if required.

Do not leave landholder liaison to contractors. Make sure that the contractor knows and abides by the terms of the agreements with the landowner and others with an interest in the land.

### ACTIONS UPON FIRST ARRIVING ON THE LAND



- Upon arrival at the property, introductions should be made immediately at the homestead.
- Provide the landholder with comprehensive details of the exploration program. In particular, the following details should be provided:
  - proposed location of fieldwork (include a map)
  - extent and type of operations to be conducted description of vehicles to be used names of personnel involved, including contractors who will do the work living arrangements, particularly if a campsite is required.
- The explorer should request the following details from the landholder:
  - access
  - suitable campsites
  - landholder's planned work program
  - updates on the explorer's map, i.e. fences, gates, bores, dams, etc.
  - permission for use of water.
- Agreements between the landholder and explorer should be simple, and clearly identify what has been agreed to between the two parties. It is preferable that agreements are in writing, as verbal agreements can lead to misunderstandings. If agreements are made verbally, all parties should have a witness present.
- Regular meetings between the Liaison Officer and landowner should be arranged to discuss progress, performance and agreements.
- The outcome of these discussions should be that the owner, occupier and mining company understand each others needs, and how they can be fulfilled.
- Where possible, allow the landholder the opportunity of quoting for any contract work that may become available. Try to employ local people wherever possible but be aware of the need for all contractors to carry adequate public liability and third party insurance.

## LAND CARE

In addition to agreed arrangements with the landholder, the planning and conduct of operations should be based on the *Statement of Environmental Objectives for Mineral Exploration* (Information Sheet E9), issued by MESA.

- Reduce any vegetation clearance to the absolute minimum. Unavoidable track clearing and construction should be undertaken in a manner acceptable to the landholder.
- Be mindful of initiating weed infestations and outbreaks of disease. Thoroughly clean vehicles before moving into new areas.
- No pets or firearms should be taken onto the property without the express permission of the landholder.
- If a campsite is required, prior agreement with the landholder on preferred locations should be reached. However, the campsite should be positioned at least 400 m away from watering points, drainage lines, Under no circumstances should chemicals or their containers be dumped where they could enter surface or groundwater systems. All hazardous rubbish should be removed and placed in authorised waste disposal depots. General rubbish should be dumped, taken to a local tip or buried on written advice from the landholder.
- Fuel stores and vehicle servicing areas should be located and used in a manner which does not permanently contaminate soil or pollute water.

## PROPERTY INFRASTRUCTURE

- If an explorer needs to cut a fence, consult with the landowner for alternatives. However, if a fence is cut, stock-proof gates must be installed and removed if requested by the landowner. Permanent repairs must be effected as soon as practicable.
- Report any damage of gates, fences, roads, crops etc. to the landholder (even if the explorer is not responsible). Where necessary, discuss any arrangement for repairs. Temporary repairs should be completed without delay.

- When the ground is wet, vehicle movements should be curtailed. Any track damage caused by vehicle movements in wet conditions should be repaired as soon as conditions dry out.
- The explorer should ensure that declared equipment is used only under competent supervision. The supervisor should be fully aware of the company's environmental policy and negotiate Vocational matters with the landholder.

## GOOD HOUSEKEEPING

- Have crews carry rubbish containers and avoid littering at all times.
- Where several days are to elapse between the various operational phases of the survey, have any temporary gates checked for stock security.
- Appropriate fire suppression equipment should be carried and accessible at all times.
- Fire risks should be minimised by siting fuel dumps, generators and similar equipment on suitably cleared areas.
- Regulations pursuant to appropriate fire legislation should be adhered to. Talk to the local Country Fire Service officers if in any doubt.
- Have a fire fighting plan or procedures; fire fighting equipment should be supplied, installed and properly maintained in the camp.
- Personnel should be trained and fire drills carried out.

## MANAGEMENT OF EXPLORATION ACTIVITIES

- Keep the landholder fully informed of the progress of the exploration program.
- The explorer should find out where stock are located on a regular basis to avoid disturbance.
- Be mindful of the possibility of discovering sites of scientific or heritage significance. Aboriginal sites should be reported to the Department of State Aboriginal Affairs (see the Aboriginal Heritage Act 1988, Sections 20 and 23).
- Reduce speed near homesteads, watering points and grazing stock to reduce dust and disturbance.
- Be aware of hazards to health and safety to stock and people from cables, drill casing, excavations etc., and take actions to prevent potential hazards.
- Advise the landholder if any blasting is to occur.
- When using helicopters or low-flying aircraft, advise the landholder of their proposed use, the area of use and the times of such flights. Discuss with the landholder the planned stock program, eg. lambing and mustering, and ensure that the pilots are instructed to use the aircraft so as to cause minimal disturbance to stock.

## REINSTATEMENT OF DISTURBED AREAS

- The company should prepare and implement a program which complies with tenement conditions, best practice and the reasonable needs of the landholder.
- The Liaison Officer should visit sites of major disturbance with the landholder after reinstatement has been completed and attend to any reasonable requests for further work.
- Where soil compaction has occurred, offer to rehabilitate the site to the landholder's satisfaction.
- Unless otherwise requested by the landholder, all drillholes should be backfilled immediately on completion, cuttings raked over and octa-plugs put in place. If drillholes are required to remain open temporarily, install casing to prevent injury to stock and small animals from falling in. Backfill costeans and other excavations as soon as they are no longer required.
- Permanent survey markers should be placed where they will not hinder farm management. Temporary markers, pegs, tags and flagging tape should be made from biodegradable materials or removed.

## ACTIONS TO BE UNDERTAKEN UPON PROGRAM COMPLETION

- The Liaison Officer should invite the landholder to inspect the work area when the project is complete and carry out any reasonable requests for reinstatement of the land.
- Undertake any agreed restoration without undue delay and promptly pay in full any agreed compensation which is due to the landholder under the Mining Act or an agreement between the parties.
- Make a final inspection of all roads, gates, fence lines, campsites, drillsites, trenches, etc. to ensure that all areas are free of rubbish and left in a condition that is safe to stock and free of hazards to people.

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