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Land resource assessment of the Goodar area, Queensland

D. J. Ross and A. J. Crane
Land Use and Fisheries

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

Queensland Government Technical Report

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This publication was prepared for Department of Primary Industries officers. It may be distributed to other interested individuals and organisations.

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Page 4 photograph 2 caption.	Replace Bulla with Billa
Page 7 paragraph 1.	Delete production
Page 7 paragraph 2.	Replace period with periods

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Land Categories	Area (ha)
Class 2 land with minor limitations for wheat, barley, oats, sorghum and cotton	40 331.7
Class 3 land with moderate limitations for wheat, barley, oats, sorghum and cotton	10 147.5
Class 3 land with moderate limitations for wheat, barley, oats and sorghum	15 426.9
Class 3 land with moderate limitations for wheat, barley and oats	64 406.4
Class 3 land with moderate limitations for barley and oats	35 739.0
Class 4 land with severe limitations for wheat, barley and oats	2 1671.1
Class 4 land with severe limitations for barley and oats	6 868.1
Class 4 land with severe limitations for barley	1 381.2

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Land Categories	Area (ha)
Class 1 land with negligible limitations for purple pigeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum	40 402.1
Class 2 land with minor limitations for purple pigeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum	13 887.4
Class 3 land with moderate limitations for purple pigeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum	29 452.7
Class 3 land with moderate limitations for purple pigeon, bambatsi, medics, lucerne and silk sorghum	48 033.0
Class 3 land with moderate limitations for purple pigeon and bambatsi	51 336.7
Class 3 land with moderate limitations for Rhodes, buffel and medics	24 253.9
Class 3 land with moderate limitations for bambatsi	1 446.0

Page 33 Figure 5 (d).	Replace Galmond with Salmond

Summary

The Goodar area is located immediately north of the southern border of Queensland, at Goondiwindi. It occupies some 264 000 ha and is made up of the floodplains of the Macintyre and Weir Rivers, older more elevated alluvial plains, gently undulating rises on sedimentary rocks and a low plateau overlying altered sedimentary rocks. Belah-brigalow forests are the dominant vegetation. The Goodar landscape is typical of large areas of inland southern Queensland.

The major current land uses in the Goodar area are dryland cropping and native pasture supporting sheep and cattle grazing. Properties are typically 2 500 ha and operatea mixed enterprise. The major limitations are soil related, but there can be overriding problems or limitations such as slope or woody weeds. Prolonged drought further complicates the effective land use.

The climate is subhumid with long, hot summers and mild winters. Compared to other areas of Queensland the appreciable winter rains and low evaporation favour winter cereal production. Droughts are a feature of the environment and lead to both crop failure and stock losses. Heat wave conditions and heavy ground frosts also affect agricultural production.

A soil survey and land suitability assessment have been undertaken to provide better information about soils, vegetation, landforms and land use problems. This report describes the land resource and land suitability data for various classes of land. It also describes the soils and landscape units, geology, vegetation and climate of the area as well as the methods used in the survey. The distribution of soils and various classes of land are shown on the accompanying maps. A plant species list and data for 53 soil profiles are appended.

Sixty one soil profile classes have been identified within five broad landscapes. Soils with gradational, duplex and uniform texture profiles occur; most have hardsetting surface horizons, alkaline reaction trends and sodic/saline subsoils. Several soils with acid subsoils not previously recorded were identified. Soil distribution is related to parent material, topography and drainage.

A total of 1 141 unique map areas (UMAs) were delineated. Each has been assessed for its suitability for dryland cropping and sown pastures. The survey area has been categorised according to its cropping and sown pasture versatility. Eight categories of suitable or marginal cropping land and seven categories of suitable sown pasture land were identified. About 30% of the area has been assessed as unsuitable for dryland cropping and sown pastures and described in terms of native pasture productivity. Approximately 5% of the area is suitable for a limited range of sown pastures only.

Land degradation occurs in both grazing and cropping lands. Woody weeds in the form of limebush, brigalow suckers and eucalypt regrowth are the most common form of land degradation. This was followed by water erosion (sheet, rill, gully) and wind erosion to a lesser extent. Water erosion is a major problem on unprotected sloping lands whereas the wind erosion hazard is significant in both cropping and grazing land on susceptible soils. Some potential also exists in undulating topography for seepage salting.

1. Introduction

Land resources of a representative area of Waggamba Shire in southern Queensland, at Goondiwindi, have been examined and assessed for agricultural use. The purpose was to provide better information about soils, vegetation, landform and land use problems. This would then be used with local experience to provide land management recommendations for sustainable land use. Land resource data and an understanding of the limitations of land resources are essential to the management of these lands for various agricultural uses. This report presents the land resource and land suitability data for various classes of land. It describes the soils and landscape units, geology, vegetation and climate as well as the methods used in the survey.

Previous mapping covering the Waggamba Shire was largely broad scale and inadequate to provide information at a level appropriate for more intensive agricultural development. Soil and land attributes were mapped as soil associations (Isbell 1957), as land systems (Galloway *et al.* 1974, Mullins 1980) and as associations of soils (Northcote 1966, Isbell *et al.* 1967).

The pattern of land use in the shire has become more intense in recent years, with a change from predominantly grazing enterprises to mixed farming enterprises and small areas of irrigated cropping. In Waggamba Shire, conversion of pastoral land to cropping has more than doubled over the past two decades, and this land use change is expected to continue. Weston *et al.* (1981) estimated the area of potentially permanently arable land of the shire to be some 585 000 ha, approximately 42%.

The present survey was initiated by the Department of Primary Industries in January 1989 because the existing land resource information was inadequate for planning, extension and research activities in an area of rapid land development and land use change. It was made possible by joint funding through the National Landcare Program. The Goodar land resource survey is part of a continuing program of land resource assessment by Department of Primary Industries, Division of Land Management.

The Goodar survey area was chosen as a representative area of Waggamba Shire because it had land use problems, soil/vegetation land units previously recognised as widespread throughout the Shire (Isbell 1957) and areas of land with potential for agricultural development. The Goodar 1:100 000 map sheet (8941) is located immediately north of the town of Goondiwindi in southern Queensland (Figure 1). The map sheet occupies about 20% of Waggamba Shire, and lies between 150^0 and $150^030'$ east longitude, and 28^0 and $28^030'$ south latitude. The boundaries encompass an area of approximately 264 000 ha. Topographically, the area is mainly composed of the floodplains of the Macintyre and Weir Rivers, with older elevated alluvial plains, gently undulating rises on sedimentary rocks and a low plateau (Figure 2).

The land resource data for this area are stored on computer files and can be accessed by contacting the Manager, Resource Assessment and Planning, Meiers Road, Indooroopilly Qld 4068. These files contain site and UMA (unique map area) data. Each mapped area is given

a sequential number and called a Unique Map Area, abbreviated to UMA. The site data file comprises descriptions of landform, vegetation and soil properties together with measured field pH and slope angle. The UMA data file contains land resource and interpreted information for each mapped area. Land resource attributes include soils, landform, microrelief, vegetation, land degradation and land use. Interpreted information for each UMA are the suitability and limitations to dryland cropping and sown pasture production. The UMA data can be manipulated using a Geographic Information System (ARCINFO software) to produce maps of any desired attribute or combination of attributes.

1.1 Land use

Agricultural production statistics are not available for the Goodar survey area. Regional statistics, and a historical overview of land use for the Waggamba Shire have been compiled by Bourne (1980). More recent statistics have been compiled by Salmond (1991) and are representative of the current land use.

On average, the shire produces 30% of Queensland's wheat, and in most years produces more wheat than any other Queensland shire. In terms of sheep numbers, Waggamba Shire rates seventh on the State's Shire comparison list. In addition to being a large cattle breeding and fattening shire, the area under irrigation is gradually expanding, currently about 13 000 ha.

Dryland cropping, beef cattle and sheep grazing are the major land uses of the area. There are also small areas of irrigated cropping of economic significance. Most properties are mixed enterprises, dominated by dryland cropping with varying proportions of beef cattle and sheep. There are, however, some landholders who rely solely on cropping, or beef cattle grazing, or sheep grazing. A typical property size would be about 2500 ha with almost 1000 ha of cultivation and 100 head of cattle or 2000 sheep.

Wheat is the major crop grown and has been since the early 1960's. Average wheat yields are 1.4 t/ha and high yields in excess of 3 t/ha are achieved in some seasons. The production area of broadacre monoculture wheat exceeds its nearest rival, forage oats by some 150 000 ha each year. Protein levels in wheat have declined to around 11% because more nitrogen has been removed from the system than replaced. The other major winter grain crop is barley with an average yield of 1.5 t/ha.

The major summer crops include grain and forage sorghum, and dryland cotton. Grain sorghum yield is 1.2 t/ha on average, and an average yield of 3.2 t/ha over three years has been achieved at Billa Billa (Gibson *et al.* 1992). Dryland cotton yields have averaged about 2.5 bales/ha, ranging from 1.0 to 4.5 bales/ha (McIntyre *et al.* 1992). The area developed for irrigated cotton (Photograph 1) has gradually increased since gazettal of the Yambocully and Callandoon Creek schemes. Further development has been curtailed by the 1991-94 drought, with very limited water available from high flow pumping. Average yields are 6.5 bales/ha and high yields of 10 bales/ha can be achieved (McCollum and Salmond 1992).

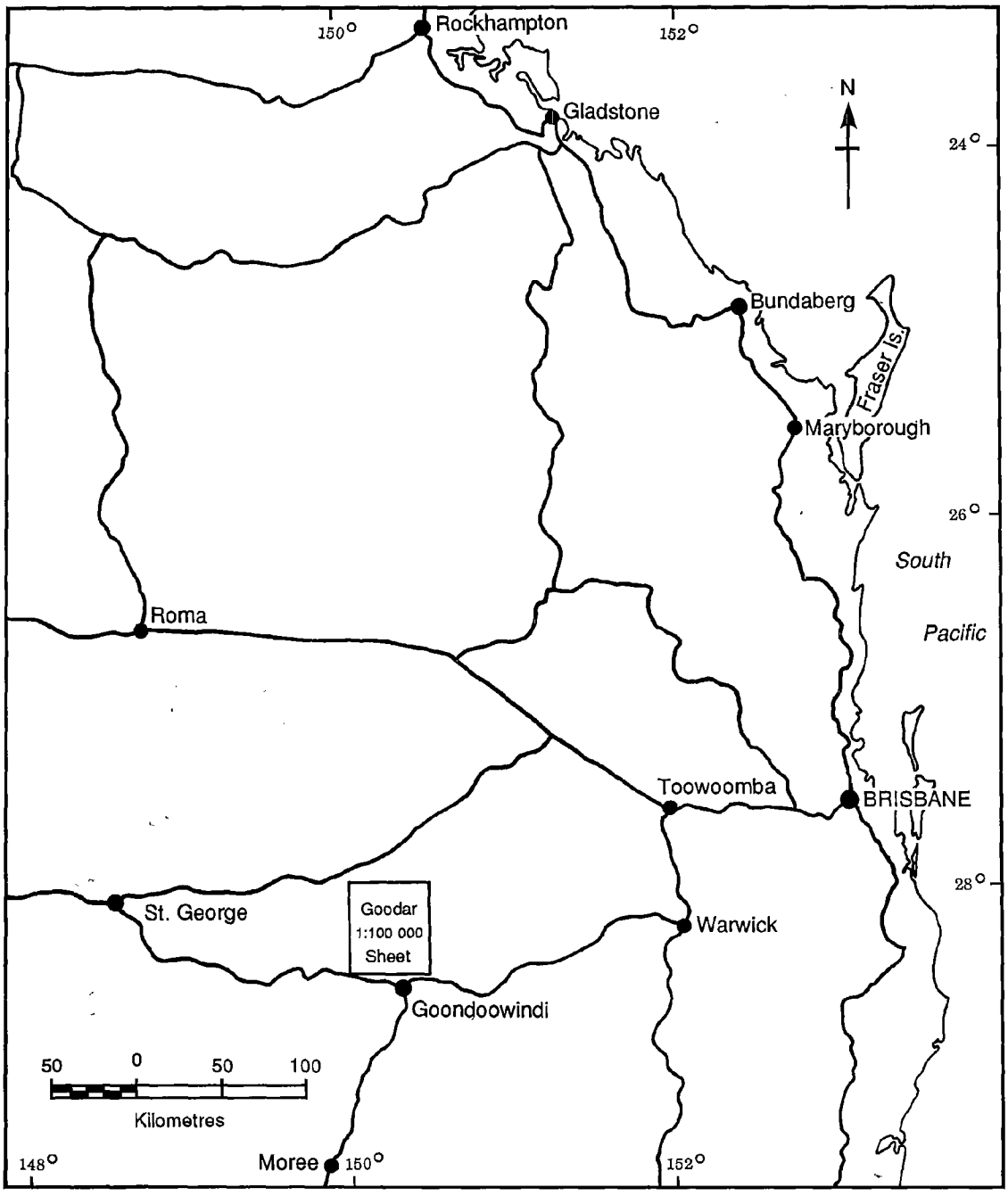
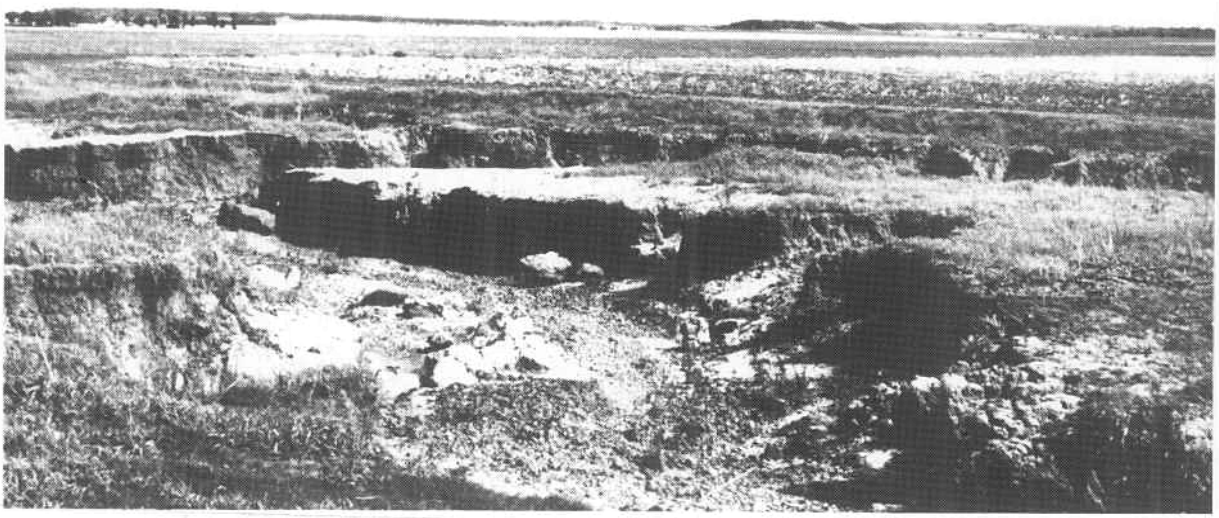


Figure 1. Location of survey area

The main grazing enterprise is breeding and fattening or store production of beef cattle. Cattle breeding and fattening are undertaken by 79% of the Shire's producers. British based breed herds (*Bos taurus*) are dominant because of market suitability and low incidence of internal and external parasites. Beef is produced for the domestic market as well as for the grass-fed and lot-fed export markets. Animal production is largely dependent on native pastures, in particular annual winter medics and summer grasses. Oats is the main forage crop grown for fattening. Several opportunity and large scale feedlots operate within the Shire to provide a grain-fed finished product.

Photograph 1. Irrigated cotton on land plains west of Goondiwindi



Photograph 2. Gully erosion in gently sloping lands unprotected by soil conservation measures, Bulla Billa district

On native pastures within-breed and cross-breed steers at 12 months of age, average 320 kg and 460 kg, respectively. Feedlot growth rates of 1.5-2.1 kg/hd/day are achieved for weaners through to Jap-ox animals. Reproduction rates are 75-95% over a 12 month period, and birth weights are increasing from an average of 32-36 kg with the use of higher growth animals.

Annual medics are a component of most native pastures throughout the area. Mitchell grass* and Queensland bluegrass are the more productive perennial species but have limited distribution. Nut grass is an important component of Mitchell and Queensland bluegrass pastures, occurring as the dominant component in seasonally wet areas. Less productive species include wire, windmill and love grasses. Pasture improvement is not a feature of most grazing enterprises because of high costs and unknown returns (Bertram and Dunlop 1991). Pasture improvement does occur and is usually associated with cultivation for woody weed control (Cockfield 1994).

The Shire produces 5.4% of the State's wool. The wool type is primarily Bulk 79B 22.5μ, the median wool type produced in Australia. Flock woolcuts of 4.62 kg on average exceed the Queensland average woolcut. Merino turnoff, breeding stud rams, and the sale of prime lambs to a lesser extent, are features of the area's sheep enterprise. Wethers are commonly used in cropping land for fallow weed management. Wool production is based on perennial native pastures rather than annual forages which are only used to grow out weaners, culls and cast-for-age sheep for sale.

1.2 Land degradation

Woody weed regrowth, water erosion and wind erosion are the principal forms of land degradation occurring in the area. Secondary salinity, soil structural decline and pasture degradation are also present. The major form of land degradation recorded during the survey was woody weeds (Table 1). This was followed by water erosion and wind erosion to a lesser extent.

Table 1. Occurrence of land degradation

Land degradation type	Percentage of UMAs affected
Woody weeds	24.0
Gully erosion	3.8
Wind erosion	3.0
Sheet erosion	2.8
Rill erosion	2.2
Scald erosion	0.5

* botanical names are listed in Appendix IV

Woody weed regrowth is widespread throughout the survey area. The main problem plant species are limebush, brigalow, false sandlewood, box and cypress pine. The current situation is due largely to a number of factors including the financial position of landholders, frequently ineffective chemical and mechanical control measures, an inadequate plant density to carry fire and long withholding periods of some herbicides (up to 5 years for winter cereals). The regrowth is prominent on grazing properties and on former crop land found to be marginal or unsuitable for cropping. The most effective control measure against brigalow and box suckers and limebush, is cultivation over several seasons. However, limebush is persistent, being known to regenerate in sown pasture land preceded by 15 years of continuous cultivation. Chemical control of limebush is expensive.

More than half of the survey area is essentially flat with little or no water erosion hazard. **Water erosion** (sheet, rill and gully) is common on sloping land (0.5-4%) unprotected by soil conservation measures. Soils of the gently undulating rises on Cretaceous sedimentary rocks are the better cropping soils of the survey area and also the most erodible. Tillage produces very fine soil aggregates which are easily transported by runoff. The low plateau and its remnants are also sloping lands with high erosion risk. Several soils associated with this landscape are of low productivity, with crop stubble providing little erosion protection. Gully erosion is mainly confined to the major drainage lines or where water has been diverted and concentrated (Photograph 2). Sheet erosion is evident in native pastures on sloping land, overgrazed by stock. For effective erosion control on cropping land with slopes >0.5%, contour banks, grassed waterways and the maintenance of crop stubble are essential (Muller 1991).

Wind erosion occurs in both cultivated and grazing land. Strong winds capable of detaching and transporting soil particles are experienced especially during late winter and early spring. Severe wind erosion is associated with drought incidence. During the past three drought years (1991-93), severe wind erosion has been observed several times each year (Photograph 3). All surface soils with high amounts of fine sand or silt, are prone to wind erosion, irrespective of topographic position. An adequate surface cover (30% standing) both in cultivated and grazing land, is the only effective control measure for this form of erosion (P Pearce *pers. comm.).* Wind erosion was recorded in 3% of the mapped areas (Table 1), and is more widespread throughout Waggamba Shire than indicated by Burgess (1991a).

There are no known occurrences of **seepage salting** within the survey area, however, one small area was recorded in the western part of the shire in 1991 (Photograph 4). Areas with potential for secondary salinity are recorded in the UMA database. Measurement of salt profiles for soils under irrigated cotton within the survey area show little downward movement of salts with irrigation water, after 3-5 years of cropping. Watertable monitoring is required in irrigated crop land to determine salt movement. Likewise, there is a need for further work to identify the movement of salts in sloping lands with dryland agriculture. High levels of salts are known to occur at undisturbed sites. However, in adjacent cultivations, there appears to be no accumulation of salts at depth even where hard rock is present. This suggests that there may be lateral movement of salts in the landscape.

Pasture degradation is common on sheep properties. The complete removal of ground cover by sheep during drought facilitates other forms of land degradation including water and wind

erosion. Medic seed eaten by sheep at this time, reduces the medic seed source for subsequent winter herbage. Overgrazing accompanied by intermittent drought is leading to a decrease in the more productive pasture species and an increase in weed numbers and less productive pasture grasses. The sowing of pasture production on poorly structured heavy clay soils has resulted in the decrease in hoop mitchell grass and some land degredation. Sown pasture species have poor establishment and the native mitchell grass has not regenerated.

Soil compaction (degradation of soil structure) can be a problem. Most soils in the area contain low initial organic matter levels and with time become more difficult to work as organic matter declines. Tillage operations which are carried out through necessity when the soil is too wet, result in soil compaction. Soil compaction is difficult to repair on most soils of the district. They do not self-mulch, or crack strongly in dry period and have a low shrink-swell potential, indicated by their clay activity ratio (see Section 3.2). The maintenance of surface cover, controlled movement of machinery (fixed wheel tracks), and the removal of stock from cultivation following rain are essential to avoid and control further soil structure degradation.

Soil compaction (structure degradation) is generally not a problem for winter crops, except in dry years. During wet years the compacted layer wets up and can be penetrated by roots, or the plant responds by producing more roots close to the surface. In dry years, and for summer crops, soil compaction has led to large yield losses or total crop failure. This occurs because poor penetration by plant roots restricts access to stored water, even though the amount of water stored in the subsoil is high.

Photograph 3. Wind erosion on cultivated land unprotected by surface cover, north-east of Goondiwindi

Photograph 4. Seepage salting on the lower slope of a low rise, east of Nindigully

2. Land suitability

2.1 Introduction

A land suitability assessment of the survey area has been made to provide information in a readily useable form for decision-making. Better informed decision-making will lead to minimal land degradation and the sustainable use of land resources in the long-term. This assessment is for dryland cropping and sown pastures only, these being the major expanding land uses in the region. An assessment has not been made for flood irrigated cropping because the extent of the available water resource is unknown. The suitability information is described in Section 2.3-2.5, and produced in map form in the accompanying land suitability map.

The major current land uses in the Goodar area are dryland cropping and grazing sheep and cattle on native pasture. Wheat, barley and forage oats are the major crops. Grain sorghum, cotton and chick pea are minor crops. Forage oats, in this assessment, is considered as part of the crop group because the agronomic requirements are more like annual crops than perennial pastures. Medics and summer grasses are the mainstay of sheep and cattle grazing native pastures. The minor land uses are irrigated cropping and non-irrigated sown pastures. Small areas of barley and oats are irrigated, but cotton is the major irrigated crop. The major sown pastures are silk sorghum, lucerne and purple pigeon grass, whereas medics, buffel and Rhodes grass are minor sown pasture species.

A soil survey of the Goodar area provided the framework for this assessment. During this survey, land attributes other than soils were also recorded and measured for use in the assessment. These land attributes included vegetation, slope and landform. The soil survey was used to provide a framework because the likely problems or limitations to growing crops and pastures are predominantly soil related, but there can be other overriding problems or limitations such as land slope and woody weeds. The soil survey is also useful because it allows for later reinterpretation of land suitability with changing technologies. Vegetation was found to be an inconsistent indicator of land suitability. The assessment required a knowledge of the landscape features and soils.

A suitability classification was constructed from survey information, local landowner and extension staff experience. The suitability classification is based on limitations to production for dryland cropping and sown pastures (Appendix I). Land has been allocated to one of five classes based on its potential to attain optimum production with minimal long-term degradation (Land Resources Branch Staff 1990).

The land suitability classes are:

Class 1 **Suitable land with negligible limitations** which is highly productive requiring only simple management practices to maintain economic production

Class 2 **Suitable land with minor limitations** which either reduce production or require more than simple management practices of Class 1 to maintain economic production

Class 3 **Suitable land with moderate limitations** which either further lower production or require more than those management practices of Class 2 land to maintain economic production

Class 4 **Marginal land with severe limitations** which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long-term

Class 5 **Unsuitable land with extreme limitations** that preclude its use

Within the above suitability classes, land has been grouped on the basis of limitations to show the range of crops and pastures land would support. The soils and land attributes in one of these groupings or units (mapped areas) are similar and are suited to the same suite of crops or sown pastures, require similar management, and have similar productivity and other responses to management. No Class 1 land for dryland cropping is recognised within the study area because all soils have some form of limitation to maximum productivity (Appendix II). In this assessment, there are no groupings within Class 2 land because the soils of this class have few limitations.

The suitability class for each parcel of land mapped (UMA) was determined by rating limitations with increasing severity on a scale of 1 to 5. The limitation rating is known as a subclass and generally the level of the most severe limitation subclass determined the final suitability rating. For example the most severe limitation may have a wetness rating subclass of 3 which would result in a suitability rating of Class 3. The criteria for limitation subclasses are given in Appendix I. In some cases, a number of limitations in combination may downgrade the overall land suitability of an area.

2.2 Limitations to dryland cropping and sown pasture production

The **climate** over the area (see Section 6) presents a major limitation to achieving maximum productivity of land for dryland cropping. There is insufficient rainfall in some years to grow winter and summer crops. Heavy ground frosts damage winter crops while summer crops are affected by high evaporation and temperature. Other than an overriding climatic limitation for the whole area, twelve limitations were identified as restricting the use of land for crops and sown pastures:

Water availability (m). Crop yields and pasture dry matter vary from one soil to another, but they largely depend on an adequate supply of soil moisture at planting and during the growing season. Although rainfall, drainage and evaporation cannot be controlled, the effects of these can. Soils can be managed, for example, to hold more water. However, under dryland conditions at Goondiwindi, soils with a high plant available water capacity (PAWC) consistently outyield soils of low PAWC, other limitations being equal.

Measurements of soil water storage and use at a Billa Billa tillage trial site, have been made by Gibson *et al.* (1992) between 1985 and 1988 inclusive. The results show stored soil water was used more efficiently for grain sorghum production, by reduced blade tillage with stubble

retention. More recently, PAWC has been measured for a range of soils in the Goondiwindi district. The PAWC values ranged from 80 mm for a hardsetting texture contrast soil to 150 mm for a self-mulching cracking clay (E A Gardner *pers. comm.*).

Measured PAWC's were combined with long-term climatic data for Goondiwindi Post Office station to predict wheat yields (Littleboy *et al.* 1989). Figure 2 shows the predicted wheat yield for soils with 50, 75, 100, 125 and 150 mm plant available water capacity. The average wheat yield for the district of 1.4 t/ha (French 1993) has been used to determine a cropping success. On this basis, soils with a PAWC of <75 mm were assigned an extreme (m_5) water availability limitation. A severe (m_4) limitation rating applies to soils with 75-100 mm PAWC. The average wheat yield or better is achieved in 60% of years when soil PAWC exceeds 100 mm (Figure 2), and a moderate (m_3) limitation rating was given to soils with 100-120 mm PAWC. When soil PAWC exceeds 120 mm, the average wheat yield or better is predicted to be achieved in 80% of years, and a minor (m_2) limitation rating applies. Given the climate at Goondiwindi, all soils were considered to have a water availability limitation for dryland cropping.

For sown pasture production a negligible (m_1) water availability limitation was allocated to soils with >120 mm PAWC. Shallow (<30 cm) soils were estimated to have a PAWC of <40 mm, and were assigned an extreme (m_5) water availability limitation. The remaining subclasses (m_2 - m_4) have arbitrary limits.

Soil properties such as rockiness, sodicity and salinity affect the amount of soil water available for plant growth. These were considered as components of the water availability limitation. Where soil distribution is complex within UMAs, the water availability limitation was applied to the co-dominant soil of lowest estimated PAWC.

Nutrient deficiency (nd). Nutrients removed in crop and livestock production must be replaced if profitable land use is to be maintained. Traditionally, winter cereals and grain sorghum have been produced from the district without the use of artificial fertilisers. In recent years, soil deficiency in major plant nutrients particularly nitrogen and phosphorus has been recognised. The level of soil nitrogen can be maintained in cropping soils through legume/pasture rotations, but phosphorus levels can only be maintained through the application of inorganic fertilisers. Low rates of fertiliser, 20-40 kg/ha of di-or mono-ammonium phosphate, are now being used with summer and winter crops. Selected soil samples taken from cropped land during the survey, indicated common element deficiencies to be nitrogen, phosphorus, zinc and sulfur.

Soils were given a nutrient deficiency limitation rating (nd_1-nd_4) based on surface soil fertility, local landholder experience and selected sampling. Subclasses represent increasing deficiencies in combinations of major plant and trace elements. A severe (nd_4) limitation rating has been assigned to soils with the widest range of nutrient deficiencies. These generally include the more easily leached deep sands for which an economic response to the application of fertilisers under dryland conditions is considered unlikely. The same limitation subclass ratings are used for crops and sown pastures because both land uses have similar nutrient requirements.

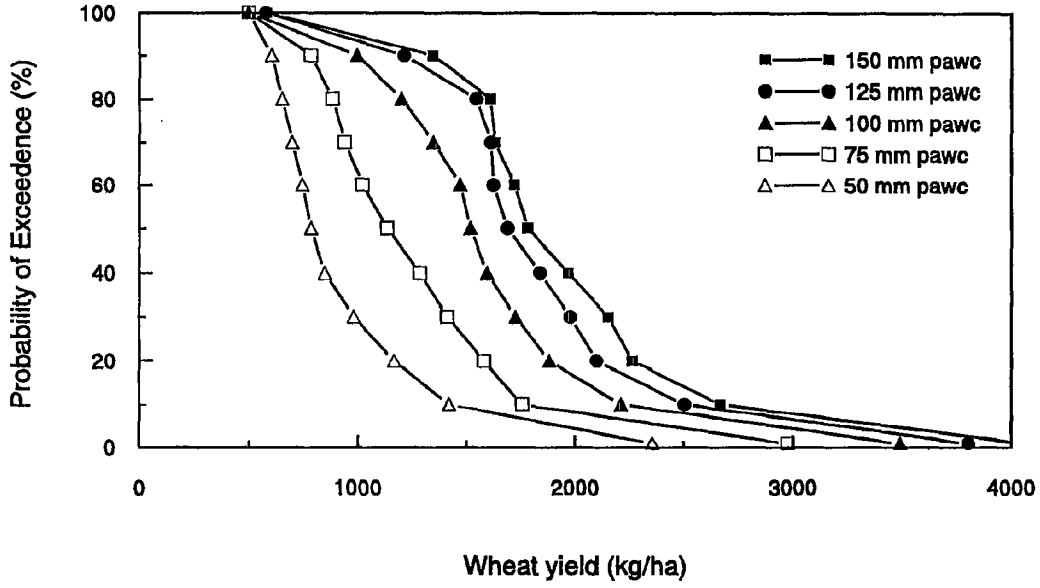


Figure 2. Predicted wheat yield and plant available water capacity (PAWC)

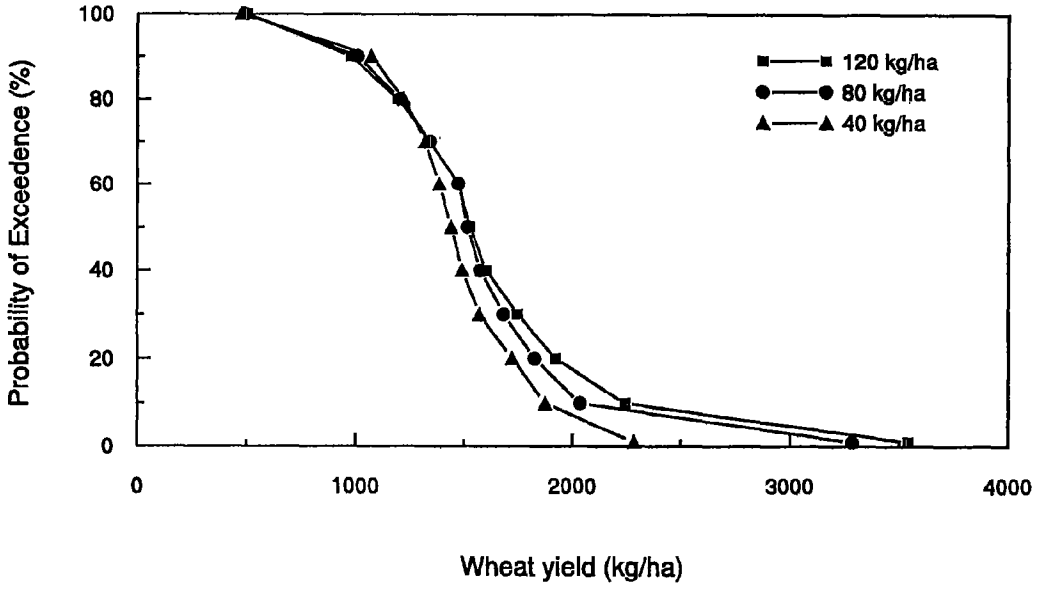


Figure 3. Predicted wheat yield and soil nitrogen

Low levels of grain protein due to nitrogen deficiency can result in potential yield loss and loss of premium payment. Figure 3 shows the predicted wheat yields of a 100 mm PAWC soil with 40, 80 and 120 kg/ha of available soil nitrogen at planting. Available soil nitrogen at 40 kg/ha would be acutely deficient, adequate at 80 kg/ha and possibly non-limiting at 120 kg/ha. By maintaining adequate available soil nitrogen, a yield increase is predicted in 70% of years but this is only substantial (0.5 t/ha) in 5% of years. However, the main benefit will be increased profitability due to high protein levels.

Salinity hazard (ss). The accumulation of high concentrations of soluble salts near or at the soil surface reduces or prevents plant growth. Most cropping soils in the area had high levels of soluble salts (indicated by electrical conductivity measurements >1.0 dS/m) in the subsoil prior to land clearing and cultivation. The depth to high soluble salts has increased with cultivation because of increased infiltration of rainwater into the soil profile. The absence of accumulated salts at depth where hard rock is present suggests lateral movement of salts in the landscape.

Burgess (1991a) suggests that there were no recorded outbreaks of secondary seepage salting in the Waggamba Shire because the water intake areas had predominantly impermeable soils. The first occurrence of seepage salting was recorded in late 1991, outside the survey area. Muller (1991) recommends retaining vegetation on shallow soils in upland areas to prevent potential erosion and salinity problems. Much of the survey area has been cropped continuously for about 30 years. Areas generally take about 50 years before salt outbreaks become evident. For example seepage salting in the adjacent Millmerran Shire.

The salinity hazard limitation (ss) applied to dryland cropping only, is used to identify areas with potential for dryland seepage salting. These areas have been assigned a minor (ss_2) limitation rating. They all occur on scarp-footslope positions in the landscape and are known to have high levels of soluble salts throughout the soil profile. These areas at the present time are restricted mostly to salt tolerant crops, mainly barley. The remaining land has been given a negligible (ss_1) limitation rating and assumed to currently have little or no potential for dryland seepage salting because assessment is beyond the scope of this survey.

Wetness (w). More than one half of the survey area is essentially flat with little or no surface drainage. Ponding of water occurs in melonhole gilgai depressions, the closed depressions of drainage lines and on level plains, especially during winter under low evaporative conditions. Crop and sown pasture production is significantly affected by waterlogging which reduces planting and harvesting opportunities. Differential drying between mounds and wet depressions of melonhole gilgai microrelief prevents plantings of summer crops. Waterlogging of a growing crop or pasture reduces plant growth and subsequent yield by impeding oxygen supply to the plant root system.

Sloping land with no plant or soil features indicating excessive wetness have a negligible wetness (w_1) limitation. A moderate (w_3) limitation has been given to areas dominated by heavy clay soils on level plains. Areas of closed depressions and large melonhole gilgai microrelief have been assigned a severe (w_4) limitation rating. Few sown pasture species are likely to persist in these situations. An extreme (w_5) wetness limitation rating applies to swamps and lagoons.

Flooding (f). The flooding limitation, as distinct from the wetness limitation, is used to identify and downgrade the suitability of land susceptible to erosive flooding resulting from stream channel overflow. Erosive flooding affects crop and sown pasture production by scouring seedbeds, flattening plants and depositing sediment. Infrequent floods which inundate much of the Weir and Macintyre River floodplains are slow flowing and of short duration. Flooding of this nature provides a full profile of soil water and is regarded by landholders as beneficial to crop and pasture production.

Erosive flooding is restricted to the low terraces and channel benches located in the upper reaches of the Weir River, and to the creek flats of tributary streams with a flooding frequency of more than 1 in 10 years. These areas have been assigned a minor (f_2) flood limitation rating while the remaining areas have a negligible rating.

Surface condition (ps). Soils have a characteristic surface condition when undisturbed and dry. This can range from loose or self-mulching to hardsetting or crusting. Surface condition affects crop and sown pasture production by reducing water entry, restricting soil aeration and impeding seedling emergence. Cultivation can modify the natural surface condition by creating surface seals and crusts. Surface seals and crusts can be broken by further cultivation but return to this state with wetting and drying.

Seedling emergence and plant establishment rates are high on fine self-mulching clay soils, and such soils are regarded as having a negligible (ps_1) surface condition limitation. The same limitation rating applies to soils with sand and loamy sand surface textures. Presswheels or rollers are used on the coarse self-mulching clays to improve soil seed contact and reduce surface drying. Soils with this attribute have been given a minor (ps_2) limitation rating. A moderate (ps_3) limitation rating applies to hardsetting surface soils and to heavy clay soils with coarse surface structure.

Soil workability (k). Tillage is carried out for stubble incorporation, weed control, seedbed preparation and planting. Land is considered more suitable for crop production if tillage operations can be undertaken over a wide range of moisture conditions without detrimental effects to the soil profile. If the soil is too wet, excessive rolling resistance results in wheel compaction and soil adhesion. When the soil is too dry, excessive draft energy is required. Planting opportunities can be lost for soils with a narrow `tillage window' or moisture range. Abrasiveness, a component of soil workability, affects implement wear particularly where ironstone gravels are present.

Surface soils with free calcium carbonate and few ironstone gravels, have low soil strength and the widest moisture range for tillage operations. A negligible (k_1) soil workability limitation has been designated to soils with these properties. Soils with loamy and silty hardsetting surfaces have been given a minor (k_2) limitation rating. A moderate (k_3) soil workability limitation has been assigned to medium heavy clay soils lacking free calcium carbonate, and to shallow surfaced texture contrast soils with coarsely structured subsoils. Heavy clay soils with weak surface structure or sodic and saline surface properties have a severe (k_4) soil workability limitation. The severity of the limitation is lower for sown pasture production because tillage operations are performed less frequently.

Gullies (tg). Dissected land due to natural or eroded gullies, water courses and prior stream channels prevent efficient use of large machinery. Gullies extend headward from an incision and develop dissection patterns depending on soil properties and the underlying substrate. Gully pattern in the survey area is mostly meandering, and less commonly straight or dendritic. Machinery operations are less efficient because paddock shape does not conform to gully pattern, and the gullies themselves are a barrier to the passage of machinery.

The limitation has been applied without a specified width to depth ratio, and simply represents the number of gullies per UMA irrespective of size. UMAs with a minor (tg_2) gully limitation are areas which contain between one and five gullies. These areas are usually associated with minor drainage lines. Creek flats, river terraces and meander plains are usually more strongly dissected and most have a moderate (tg_3) limitation rating. The limitation is less severe for sown pasture production because smaller machinery can be used for sowing, harvesting and renovation and machinery operations are less frequent.

Microrelief (tm). Soil microrelief of the melonhole gilgai type is common throughout the survey area. The surface mounds are mostly convex and roughly circular in shape and separated from adjacent mounds by variable concave to flat depressions. Alternatively, the gilgai are concave depressions set in a planar surface. A linear type, where the mounds and depressions are elongated and run downslope, has a restricted occurrence. Other forms of microrelief include small hummocks associated with swamps and biotic microrelief of termite mounds and rabbit warrens. The microrelief limitation is based on restrictions to machinery operations caused by the uneven surface.

Gilgaied land with a vertical interval of <0.3 m has been given a minor (tm_2) microrelief limitation, the restrictions to machinery being largely removed over time by cultivation. Tillage, planting and harvesting operations with wide machinery are restricted to a greater degree with increasing amplitude of microrelief. Where the vertical interval ranges between 0.3 and 1 m, a moderate (tm_3) limitation rating applies. A severe (tm_4) limitation rating has been given to soils with microrelief having a vertical interval of >1 m. The limitation ratings are less severe for sown pasture production because machinery operations are undertaken less frequently.

Rockiness (r). The majority of soils in the area have no gravel or stone throughout the soil profile, due largely to their formation on fine grained transported materials. However, rock outcrop is common on the low escarpment, and surface stone on scarp-footslopes and residual hills. Large amounts of stone and rock outcrop in the plough zone impedes cultivation and damages machinery. The effects of rockiness on abrasion and soil water storage have been taken account of in the soil workability and water availability limitations respectively.

Local experience indicates that coarse fragments up to 60 mm in diameter are abrasive, but do not restrict tillage operations or significantly reduce yields of winter cereals. The rockiness limitation reflects the presence of coarse fragments (>60 mm in diameter) and/or rock outcrop within the plough zone (0-20 cm) depth. A negligible, minor and moderate limitation applies to UMAs with <2%, 2-10% and >10% coarse fragments and/or rock outcrop respectively. Few UMAs were recorded with a severe limitation (>20% rockiness cover) for crop and sown pasture production.

Water erosion (e). Soil material is transported by water in a downslope direction when the storage or water entry capacity of the soil profile is exceeded. Water erosion occurs on both steep slopes and long, very gentle slopes which are seemingly flat. The removal of surface soil by runoff water to lower slope positions is a natural geomorphic process. On agricultural land this process is accelerated, leading to reduced productivity unless control structures and agronomic practices are employed.

The amount of soil loss for a given area is determined by rainfall characteristics, soil properties, land slope and management practices. The relative erodibility of different soils was difficult to establish for the area. Local experience indicates little difference in soil loss between hardsetting texture contrast soils, self-mulching clays and gilgaied clays on sloping land. This suggests that soil loss for the area is strongly influenced by slope properties and management practices.

Slopes in the field are rarely uniform. They are frequently either convex or concave with varying gradient and length. For convenience, the modal slope angle has been used in applying the water erosion limitation for each UMA. The upper slope limits for dryland cropping and sown pastures in the region have been set by Muller (1991) at 6% and 8% respectively. The erosion protection provided by sown pastures on long slopes is greater than that provided by cropping. The water erosion limitation was considered to be negligible (e_1) on slopes of <1% for sown pastures, and <0.5% for dryland cropping. In assessing the water erosion limitation, it is assumed the cropping/pasture management practices outlined by Blacket (1991) are applied.

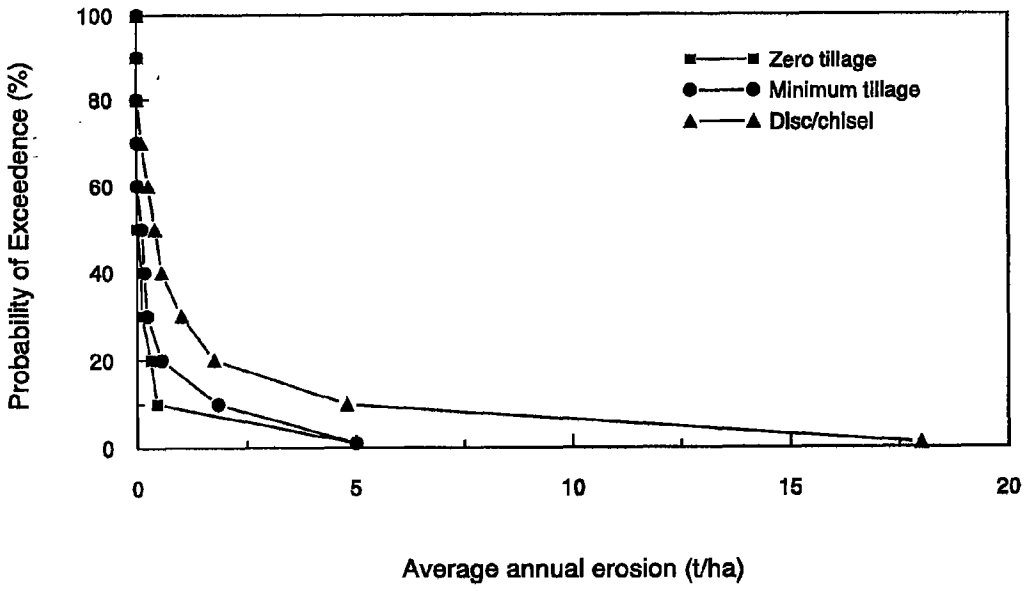


Figure 4. Predicted erosion and tillage practice for a 1% slope

Figure 4 shows the distribution of predicted erosion (Littleboy *et al.* 1989) on a 1% slope for monoculture wheat with three tillage practices (zero, minimum and disc/chisel). Water erosion is lower in all years with zero tillage. There is little difference in erosion between zero and minimum tillage in most years. The potential for soil loss is high with a disc/chisel tillage practice, reflecting the absence of adequate surface cover. Annual erosion in 10% of years for zero, minimum and disc/chisel tillage are <0.5, 2 and 6 t/ha respectively (Figure 4).

Wind erosion (a). Loose material on a bare soil surface will be removed by turbulent surface winds at moderate velocities. Soil tillage for crop and pasture production and the overgrazing of native pastures provide opportunities for soil loss. Excessive tillage causes soil loosening and pulverisation resulting in increased susceptibility of the soil surface to wind erosion. Extended periods of low rainfall, high temperatures, or high wind velocity contribute to the severity of wind erosion.

Erosion by wind removes not only soil particles but also organic matter and plant nutrients, resulting in reduced productivity. Scalding and windsheeting leave the surface bare and extremely difficult to regenerate. Blowing sand can strip and bury the leaves of young seedlings. Damage of this type has occurred with dryland cotton plantings in the region.

The wind erosion limitation was determined for each UMA using a combination of soil properties and landform. Clay surfaced soils have no apparent wind erosion hazard and were given a negligible (a_1) limitation, irrespective of topographic position. Very shallow sandy or loamy soils on ridge crests were assigned an extreme (a_5) limitation. A severe (a_4) wind erosion limitation applies to deep sands with a loose fine surface. The remaining soils have a minor to moderate (a_{2-3}) wind erosion limitation. The limitation is less severe in application for sown pastures because the frequency of tillage and consequent soil surface exposure is considerably less.

Vegetation (v). The regrowth and invasion of woody weed species following clearing for pasture production, reduces the amount of ground cover available to stock. Plants have different mechanisms which permit regeneration when disturbed. For example, eucalypts will grow from surviving stems and roots or establish from surviving seed. Continuous cropping provides effective regrowth control, despite these mechanisms. For sown pastures, the recommended regrowth control after initial clearing is a three year cropping phase or a heavy duty blade ploughing (French 1992). A further cropping phase is required about every ten years to control subsequent regrowth (Blacket 1991).

The vegetation limitation is used to indicate the potential for regrowth and invasion of woody weeds under sown pastures and in grazing land. A negligible (v_1) limitation applies to all UMAs under cultivation, and those with tussock grasslands and isolated trees of coolibah, belah or ironbark. Belah-brigalow plant communities with an understorey of limebush and false sandlewood have been given a minor (v_2) vegetation limitation. A moderate (v_3) limitation has been assigned to most UMAs assessed as unsuitable for crop and sown pasture production. The same limitation rating applies to UMAs where box, false sandlewood, cypress pine, bulloak and acacias are major vegetation components. Similarly to strongly gilgaied clays with limebush and brigalow regrowth.

2.3 Suitability for dryland cropping

Land was assessed as to its suitability for growing wheat, barley, oats, sorghum and cotton using a minimum tillage fallow management technique. Crop suitability was found to vary considerably in the survey area. Some areas are very versatile and are well suited for growing many of these crops. Others because of their limitations are restricted to growing only a few crops, while some areas are marginal for certain crops but totally unsuitable for others.

The survey area has been categorised and mapped according to its cropping versatility. Eight categories of land are described below in terms of their suitability for cropping, limitations, soils, landscapes, current land use and general management requirements. Brief descriptions of soils are provided in the soil map reference and Section 3 of this report. The 8 categories are:

Land Categories	Area (ha)
Class 2 land with minor limitations for wheat, barley, oats, sorghum and cotton	40331.7
Class 3 land with moderate limitations for wheat, barley, oats, sorghum and cotton	10147.5
Class 3 land with moderate limitations for wheat, barley, oats. and sorghum	25574.4
Class 3 land with moderate limitations for wheat, barley and oats	89980.8
Class 3 land with moderate limitations for barley and oats	125719.9
Class 4 land with severe limitations for wheat, barley and oats	21671.1
Class 4 land with severe limitations for barley and oats	28539.2
Class 4 land with severe limitaions for barley	29920.4

Class 2 land with minor limitations for wheat, barley, oats, sorghum and cotton

This land is characterised by moderately well drained soils on gently sloping to undulating rises, and less commonly on very gently undulating plains. The soils are **Mt Carmel, Portreath, Wynhari, Rockwood, Arden, Doolanvale** and **Banool.** These soils have a high plant available water capacity (>120 mm), little or no microrelief, a self-mulching surface layer, and are easy to work over a wide range of moisture conditions. Surface stone (>60 mm in diameter) is present in some mapped areas (UMAs) but is not considered a limitation to machinery operations (<2% of UMA area).

The land is used mainly for wheat, barley and oats, but some chickpea, grain sorghum and cotton are grown. It is suited to cropping for the widest range of crop types.

Limitations to crop production are minor, and include water availability (m_2), nutrient deficiency (nd_{1-2}), water erosion (e_2) and wind erosion (a_{1-2}). Phosphorus deficiency is associated with the **Wynhari** soil, and nitrogen deficiency with **Mt Carmel** and **Portreath** soils which have been cropped continuously for 15-20 years. All of the soils except **Banool** occur on long (>1 km) gentle slopes (0.5-3%), have erodible surface horizons, and are susceptible to water erosion. Soils with clay loamy surface horizons (**Banool, Mt Carmel, Rockwood** and **Portreath**) are susceptible to wind erosion in the absence of surface cover.

Management of the land for crop production requires the control of erosion and the maintenance of soil fertility. This can be achieved by the application of soil conservation practices and structures (Muller 1991), and the application of fertiliser and/or pasture legume rotations (Blacket 1991).

Class 3 land with moderate limitations for wheat, barley, oats, sorghum and cotton

Clay soils are dominant in this unit. They occur on slightly elevated areas of level plains, on gently undulating plains and gently undulating rises. The soils are **Wondalli, Mandama, Bulimba, Teelabar, Undabri** and **Moruya.** All these soils have a high plant available water capacity (>120 mm), but have inherent differences in microrelief, surface condition, soil workability and site drainage.

The land is used mostly for wheat, barley and oats, with some small areas sown to grain sorghum and cotton. Drainage depressions associated with **Bulimba** have been largely converted to waterways for runoff disposal.

Limitations to crop production are moderate in aggregate (resulting in an overall suitability rating of Class 3) and include water availability (m_2), microrelief (tm_2), nutrient deficiency (nd_2), wetness (w_2), surface condition (ps_2) and soil workability (k_2). A wind erosion limitation (a_2) is restricted to the **Moruya** soil. The water erosion limitation (e_2) applies to the **Mandama, Bulimba** and **Moruya** soils only.

Melonhole gilgai and normal gilgai are associated with **Wondalli** and **Mandama.** Gilgai depressions retain water and reduce planting opportunities. The surface condition of **Teelabar** is coarse self-mulching, resulting in poor soil seed contact and plant establishment. This surface condition and its effect also applies to some UMAs dominated by **Mandama.** Nitrogen deficiency is associated with soils of this group cropped continuously for long periods. The moisture range over which tillage operations can be undertaken is slightly restricted in comparison with Class 2 land. The drier and wetter ends of the tillage window are represented by **Moruya** and **Bulimba** respectively.

Land management for crop production requires the maintenance of soil fertility, the control of erosion where applicable, and the prevention of soil structure degradation. Maintenance of fertility can be achieved by the application of fertiliser and/or pasture legume rotations. Soil conservation practices and structures (Muller 1991) need to be implemented where required. Soil structure degradation can be avoided by the controlled movement of machinery (minimising wheel compaction) when the soil is not wet.

Class 3 land with moderate limitations for wheat, barley, oats and sorghum

This land has soil or landform characteristics or a combination of both which would severely affect cotton production such as slopes >2% and melonhole microrelief. The soils are predominantly melonhole gilgaied clays on slopes of gently undulating rises. Gilgaied clays on level plains and soils without microrelief are part of this group. The dominant soils are **Calingunee, Tarewinnabar, Wondalli, Barclay, Doolanvale** and **Banool.** These soils have a high plant available water capacity (>120 mm).

The current land use is predominantly wheat, barley and oats. Some areas have previously been cropped with grain sorghum, with frequently low and erratic yields.

Limitations to crop production are generally moderate, and include water availability (m_{2-3}), nutrient deficiency (nd_{2-3}), microrelief (tm_{2-3}), water erosion (e_{2-3}), and wind erosion (a_2). Where gilgai microrelief is present, (**Calingunee, Wondalli** and **Barclay**), the vertical interval from the mound to depression is usually less than 0.8 m prior to cultivation. Microrelief presents restrictions to tillage, harvesting and planting operations; it also affects the accuracy of surveying for contour banks on slopes. A moderate water erosion hazard occurs on slopes of 1.5 to 3%. Soils with clay loamy surface horizons, **Doolanvale** and **Banool** are susceptible to wind erosion in the absence of surface protection. Nitrogen deficiency is associated with all soils having a long cropping history, whereas phosphorus deficiency is generally restricted to areas of **Wondalli** soil.

In management of this land for crop production, the main objectives are to control erosion, prevent soil structure degradation and maintain soil fertility. This can be achieved by the application of soil conservation practices and structures on sloping land, and the application of fertiliser and/or pasture legume rotations. Soil compaction can be minimised by the controlled movement of machinery. The levelling of melonhole gilgai should be undertaken as a gradual process to prevent exposure of sodic subsoils (see Section 3.2).

Class 3 land with moderate limitations for wheat, barley and oats

Land use requirements for winter crop production are less demanding than those for summer crop production. Consequently a wide range of soils are represented for this crop suitability group, and occur on level plains, gently undulating plains and gently undulating rises. The major soils are **Morilla, Butler, Ibon, Trevanna, Pindari, Oonavale, Barclay, Calingunee, Wondalli** and **Crooked.** They are texture contrast, or uniform clays or a complex unit of both. Plant available water capacity of all soil units is moderate
(100-120 mm).

The land is mainly used for wheat, barley, oats and grazing. Previous attempts at cropping some areas of clay soils for grain sorghum have been unsuccessful because of inadequate PAWC. Where texture contrast soils have been used for cotton production, uneconomic yields were obtained because of inadequate PAWC.

Limitations to winter crop production are moderate, and include water availability (m_3), nutrient deficiency (nd_3), water erosion (e_{2-3}), wind erosion (a_{2-3}), microrelief (tm_3), wetness (w_{2-3}), surface structure (ps_{2-3}), soil workability (k_2) and rockiness (r_2). A rockiness limitation is restricted to the **Ibon** soil. The texture contrast soils **Morilla, Butler, Trevanna, Ibon, Pindari** and **Oonavale** have a minor to moderate wind erosion limitation. They also have a surface condition limitation because of poor soil seed contact and restrictions to emergence. The coarse surface structure of **Barclay** and **Crooked** can similarly reduce crop establishment. All of the soils except **Pindari, Oonavale, Wondalli** and **Crooked,** occur on long gentle slopes (0.5-4%) and are susceptible to water erosion. Melonhole gilgai microrelief associated with **Barclay, Calingunee** and **Wondalli** restricts tillage, planting and harvesting operations. A wetness limitation applies to **Crooked.** All of the soils have nutrient deficiencies and a restricted moisture range for tillage.

Management of this land for crop production requires the maintenance of soil fertility, the prevention of soil structure degradation and the control of erosion. Maintenance of fertility can be achieved by the application of fertiliser and/or pasture legume rotations. Controlling the movement of machinery by fixed wheel tracks will minimise the effects of soil compaction. Erosion control can be achieved by implementing soil conservation structures where necessary, and in applying soil conservation practices.

Class 3 land with moderate limitations for barley and oats

The landform over much of this unit is essentially flat with slow surface drainage. The unit also includes fringing areas of gently undulating rises with better surface drainage. Major soils are **Wilga, Crane, Ukabilla, Murriverie, Bunker, Wondalli, Strathmore, Yambocully** and **Blacket.** Minor soils are **Morilla, Dunlop, Coorang** and **Crooked.** The soils are sodic at shallow depth and difficult to work over a wide range of moisture conditions. Plant available water capacity is low (75-100 mm).

Most of the land is presently used for barley, oats, wheat and grazing. Some areas previously cropped with wheat have produced low and erratic yields because of poor establishment and inadequate PAWC. This unit includes areas of large melonhole gilgai which have been almost completely levelled and are known to be unsuitable for wheat because of exposed saline, sodic and acid subsoils (see Section 3.2). Wheat is more sensitive to these limitations than barley or oats.

Limitations to barley and oats production are moderate, and include water availability (m_3), nutrient deficiency (nd_3), surface condition (ps_{2-3}), soil workability (k_3), wetness (w_{2-3}), microrelief (tm_3), and wind erosion (a_{2-3}). The texture contrast soils **Yambocully, Wilga, Crane, Blacket** and **Ukabilla** are susceptible to wind erosion, especially **Yambocully** which has a silty surface. Most of these soils have a thin surface horizon overlying a heavy clay subsoil. With tillage they behave as "stiff" clays and can be cultivated only over a narrow moisture range. Also, the surface soil structure is coarse and cloddy, slakes with rain, and sets hard when dry, resulting in poor soil seed contact and emergence. These surface soil properties are also characteristic of the uniform clay soils **Murriverie, Bunker, Crooked, Ukabilla, Strathmore** and **Wondalli.** Melonhole gilgai microrelief associated with **Wondalli, Strathmore** and **Bunker** presents restrictions to tillage, harvesting and planting operations.

Land management for crop production requires the prevention of soil structure degradation, care in the levelling of melonhole gilgai, the maintenance of soil fertility, and the control of wind erosion. This can be achieved by the controlled movement of machinery (fixed wheel tracks), minimising the levelling of melonhole gilgai, the application of fertiliser and/or pasture legume rotations, and the maintenance of adequate surface cover respectively.

Class 4 land with severe limitations for wheat, barley and oats

This unit consists of clay soils with large melonhole gilgai on gently undulating plains and on slopes of undulating rises; and hardsetting texture contrast soils on ridges, plateau remnants and gently undulating plains. The soils are **Wondalli, Barclay, Arrowfield, Widgewa, Nareen,**

Kegabilla, Mooroolbark and **Roe.** Low lying areas with **Flinton** soil, and soil complexes are included. The texture contrast soils have a low plant available water capacity (75-100 mm). Clay soils with strongly developed gilgai are estimated to have a moderate plant available water capacity after levelling.

Almost all of the land with large melonhole gilgai is used for grazing. A few small areas are sown to barley and oats. The remaining land without melonhole gilgai is largely used for wheat, barley and oats on a short term basis.

Limitations to winter crop production are severe and comprise microrelief (tm_4), water availability (m_{3-4}), nutrient deficiency (nd_{2-4}), rockiness (r_{2-3}), surface condition (ps_{2-3}), soil workability (k_2), wetness (w_{2-4}), water erosion (e_{2-3}) and wind erosion (a_{2-3}). Where rock outcrop and/or surface stone occur in UMAs dominated by **Arrowfield, Widgewa, Nareen** and **Kegabilla** a rockiness limitation applies. All soils except **Wondalli** and **Barclay** have a wind erosion limitation. **Barclay, Widgewa, Arrowfield, Nareen** and **Kegabilla** have a water erosion limitation on slopes of from 0.5 to 4%. Inherent low fertility is associated with the texture contrast soils, and nitrogen and phosphorus deficiency are likely on levelled mounds of large melonhole gilgai. A severe microrelief limitation rating applies to **Wondalli** and **Barclay** with a vertical interval between 1 and 1.5 m. The texture contrast soils have a narrow tillage window as the surface layer is quick to dry and set hard. The surface condition is usually hardsetting, with a coarse and cloddy surface structure resulting in poor soil seed contact and restrictions to emergence.

Management of this land for crop production requires care in levelling of melonhole gilgai, the control of erosion and the maintenance of soil fertility. This can be achieved by minimising the levelling melonhole gilgai and as a gradual process over time to avoid exposing saline and sodic subsoils. Frequent application of fertiliser is required in conjunction with pasture/legume rotations to maintain soil fertility. Soil conservation practices and structures need to be applied where necessary.

Class 4 land with severe limitations for barley and oats

Texture contrast soils are dominant in this unit. Generally the mapped areas are complex and contain several soils. Some minor soils in these mapped areas have been assessed as unsuitable for cropping (for example **Lanky** in a **Wilga/Lanky** soil complex). The major soils are **Wilga, Oonavale, Mooroolbark** and **Wondalli.** They occur on slightly elevated areas of level plains and very gently undulating plains. Plant available water capacity is low (75-100 mm).

The land is used for barley, oats, wheat and grazing. Where cropping occurs, yields are generally low, particularly for wheat because of its sensitivity to inadequate PAWC and poor establishment conditions.

Limitations to barley and oats production are severe, and include water availability (m_4), microrelief (tm_4), surface conditions (ps_3), soil workability (k_{2-3}), nutrient deficiency (nd_{3-4}), wetness (w_3), wind erosion (a_2), and gullies (tg_2). A gully limitation applies to all UMAs dominated by **Mooroolbark** where natural or eroded gullies restrict the movement of large

machinery. The texture contrast soils are susceptible to wind erosion in the absence of surface cover. UMAs dominated by **Wondalli** usually contain small areas with the vertical interval of melonhole gilgai microrelief greater than 1.5 m.

The soils are difficult to work over a wide range of moisture conditions. Because of poor surface drainage and localised wet areas, cultivation is generally undertaken when the soil is very dry, resulting in the pulverisation of soil structure and a dry seedbed. Cultivation also produces a cloddy surface structure which is difficult to work down to seedbed tilth. Poor soil seed contact is made and germination levels are low. Nitrogen, phosphorus, sulfur and zinc deficiencies are associated with **Oonavale, Lanky** and **Mooroolbark.**

The requirements for land management include the maintenance of soil fertility, soil physical condition, and the control of wind erosion. This can be achieved by the application of fertiliser and/or pasture legume rotations, the provision of adequate surface cover and the controlled movement of machinery (minimising wheel compaction).

Class 4 land with severe limitations for barley

Mandama (sodic variant) is the dominant soil of this unit. The other soils are **Calingunee** and

Mt Carmel. The soils characteristically occur on scarp-footslopes below the low plateau. These soils have a low to very low plant available water capacity (60-80 mm), and are either non-saline and strongly sodic at the surface or saline and strongly sodic at depth.

The land is used mainly for barley, wheat and grazing. Some areas are known to be unsuitable for wheat because of high surface sodicity and salinity and have been sown to improved pasture. Barley is more robust than oats and wheat in establishment and under moisture stress.

Limitations to barley production are severe in combination, and include water availability, (m_4), surface condition (ps_3), soil workability (k_3), nutrient deficiency (nd_3), water erosion (e_{2-3}) and salinity hazard (ss_2). All the UMAs in this unit have been given a salinity hazard limitation, based on topographic position and the presence of high soil salt levels from 0.3 m to below 1.5 m depth. Limited laboratory data indicate nitrogen and phosphorus to be present in very low amounts. The soils are difficult to work. When wet, they are sticky and plastic, and when dry, they are hard. Tillage produces a very coarse and cloddy surface structure. Dense compacted layers are common in cultivated areas. The water erosion hazard is minor to moderate.

Management of the land for crop production requires further assessment for potential salinity hazard. In the absence of this information, the main objectives are to maintain soil fertility, prevent soil structure degradation and erosion. This can be accomplished by adding fertiliser and/or pasture legume rotations, the controlled movement of machinery (fixed wheel tracks) and the application of soil conservation practices and structures.

2.4 Suitability for sown pastures

Land was assessed to grow purple pigeon grass, bambatsi panic, Katambora Rhodes grass, buffel, snail and barrel medics, lucerne and silk sorghum. Sown pasture suitability was found to vary considerably in the survey area. Some areas are very versatile and well suited for growing many of these pasture species. Other areas, because of their limitations, are restricted to growing only a few pasture species.

The survey area has been categorised and mapped according to its sown pasture versatility. Seven categories of land are described below in terms of their suitability for sown pasture production, limitations, soils, landscapes, current land use and general management requirements. The seven categories are:

Land Categories	Area (ha)
Class 1 land with negligible limitations for purple pedgeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum	40402.1
Class 2 land with minor limitations for purple pidgeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum	13887.4
Class 3 land with moderate limitations for purple pidgeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum	29452.7
Class 3 land with moderate limitation for purple pidgeon, bambatsi, medics, lucerne and silk sorghum	77485.7
Class 3 land with moderate limitations for purple pidgeon and bambatsi	128822.5
Class 3 land with moderate limitations for Rhodes, buffel, and medics	53706.7
Class 3 land with moderate limitations for bambitsi	130288.5

Class 1 land with negligible limitations for purple pigeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum

Class 1 land for sown pasture production is essentially Class 2 land for crop production. The unit includes a few isolated areas of land where the production area for the full range of crop types is considered too small. The landform is gently sloping to undulating rises or gently undulating plains. The soils are **Mt Carmel, Portreath, Wynhari, Rockwood, Banool, Arden** and **Doolanvale.** These soils have a high plant available water capacity (>120 mm), little or no microrelief, adequate surface drainage, good seedbed conditions and low soil strength.

The land is used predominantly for crop production. For sown pastures, species are sown as pure stands and include lucerne, silk sorghum and bambatsi. This land is suited to sown pasture production for the widest range of pasture species.

Limitations to sown pasture production are negligible to minor. They are water erosion (e_{1-2}), and nutrient deficiency (nd_{1-2}). The unit although predominantly Class 1 land includes areas with minor (subclass 2) limitations. Soils occurring on long (>1 km) gentle slopes of <1% have been given a negligible water erosion limitation, but where they occur on slopes to 3%, a minor water erosion limitation applies. Nitrogen deficiency is associated with **Mt Carmel** and **Portreath** soils cropped continuously for 15-20 years, and phosphorus deficiency with **Wynhari.**

Management of the land for sown pasture production requires the control of water erosion and the maintenance of soil fertility. This can be achieved by the application of soil conservation practices (maintaining at least 60% pasture ground cover), and soil conservation structures where appropriate. Soil fertility can be maintained on nitrogen deficient soils by adding fertiliser or by the legume component of pastures.

Class 2 land with minor limitations for purple pigeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum

This unit consists mainly of clay soils on level plains, gently undulating plains and gently undulating rises. Major soils are **Teelabar, Undabri, Tarewinnabar, Moruya, Mandama, Wondalli** and **Calingunee**. Minor soils include **Barclay** (alkaline variant), **Doolanvale** and **Banool**. These soils all have a high plant available water capacity, but have restrictions to sown pasture production in terms of microrelief, surface condition and nutrient deficiencies. The unit includes some soils associated with Class 1 land; these have been downgraded because of slightly more severe limitations.

The land is used mostly for crop production. The more common sown pasture species of this unit include lucerne, silk sorghum and purple pigeon. These are usually sown as pure stands.

Limitations to sown pasture production for individual land units are minor. They include water erosion (e_2), nutrient deficiency (nd_2), microrelief (tm_2) and surface condition (ps_2). **Calingunee, Tarewinnabar** and **Mandama** have a minor water erosion limitation on slopes of 1-3%. Nitrogen deficiency is associated with soils of this group which have been cropped continuously for long periods. Melonhole and normal gilgai microrelief associated with **Calingunee, Wondalli, Barclay** (alkaline variant) and **Wondalli** presents minor restrictions to tillage and planting opportunities. The surface condition of **Teelabar** and **Moruya** is coarse self-mulching and hardsetting respectively, resulting in poor soil seed contact for establishment of small seeded pasture species.

Land management for sown pasture production requires the control of water erosion where appropriate and the maintenance of soil fertility. This can be achieved by maintaining a good ground cover, the installation of soil conservation structures where necessary, and the strategic use of fertiliser.

Class 3 land with moderate limitations for purple pigeon, bambatsi, Rhodes, buffel, medics, lucerne and silk sorghum

Texture contrast soils are dominant in this unit. The major soils are **Pindari, Butler, Trevanna, Morilla** and **Nareen**. Minor soils include **Oonavale, Yambocully** and **Yarril**. The unit contains several areas of complex soil units, for example **Arrowfield-Barclay**. The soils occur on a range of landforms from level to gently undulating plains through undulating rises to plateau remnants. Plant available water capacity is moderate (80-100 mm).

Current land use is predominantly winter crop production, however a significant proportion of the unit is used for grazing. Sown pasture species recorded include lucerne, forage sorghum and medics.

Limitations to sown pasture production are generally moderate, and include water availability (m_3), water erosion (e_2), surface condition (ps_{2-3}), soil workability (k_2), nutrient deficiency (nd_{2-3}) and vegetation (v_2). A minor vegetation limitation has been given to all UMAs not under cultivation and containing woody weeds, especially limebush. The soils of this unit all have a minor to moderate nutrient deficiency limitation. Those soils occurring on slopes of 1-3% and 3-6% respectively have a minor and moderate water erosion hazard. Soil surface condition is hardsetting when dry and structure becomes coarse to cloddy with tillage. This results in poor soil seed contact and plant establishment. The moisture range over which tillage operations can be performed for seedbed preparation and renovation is restricted in comparison with Class 1 and 2 land.

The main objectives in managing these soils for sown pasture production are to control erosion and maintain fertility. This can be done by adding fertilisers, maintaining good pasture ground cover, and using soil conservation structures where necessary.

Class 3 land with moderate limitations for purple pigeon, bambatsi, medics, lucerne and silk sorghum

Clay soils represent this unit. They usually have a high clay content, a coarse surface structure, and/or a wetness restriction which reduces the persistence of buffel and Rhodes grass. The major soils are **Wondalli, Barclay, Calingunee, Bulimba, Crooked** and **Goodar.** Minor soils include **Dunlop, Strathmore** and **Ukabilla.** The landform comprises mainly level to gently undulating plains or broad valley floors of the low plateau. Some areas of gently undulating rises also occurs.

The land is largely used for winter crop production but substantial areas are used for grazing. Silk sorghum, purple pigeon, bambatsi and lucerne are the major sown pasture species within this unit. Constructed waterways are commonly sown with Rhodes grass for soil stabilisation.

Limitations to sown pasture production are minor but in combination result in a moderate Class 3 suitability rating. They include wetness (w_2), surface condition (ps_2), microrelief (tm_2), nutrient deficiency (nd_{2-3}), vegetation (v_2) and water erosion (e_2). Melonhole gilgai microrelief associated with **Wondalli, Barclay, Calingunee** and **Strathmore** retains water, restricting tillage and planting opportunities. Drainage depressions associated with **Bulimba** and **Dunlop** pond water for short intervals. The coarse surface structure of **Barclay, Crooked, Ukabilla, Goodar** and **Dunlop** prevents good soil seed contact and reduces plant establishment. Nutrient gathering sites associated with **Bulimba** and **Dunlop** have been assigned a minor nutrient deficiency limitation, whereas most other soils have a moderate limitation. A minor vegetation limitation has been given to all UMAs containing woody weeds of brigalow and limebush. **Calingunee** soil occurring on slopes of 1-3% has a minor water erosion limitation.

Management of this land for sown pasture production requires the control of water erosion and woody weed regrowth, and the maintenance of soil fertility. This can be accomplished by the addition of fertiliser, a crop rotation to control regrowth, and the use of soil conservation structures where necessary.

Class 3 land with moderate limitations for purple pigeon and bambatsi

This unit consists of essentially three groups of soils. The soil groups are: clay soils with large melonhole gilgai (**Wondalli, Barclay, Bunker**); non-gilgaied clay soils with sodic surfaces (**Mandama, Crooked**); and thin surfaced texture contrast soils overlying heavy clay subsoils (**Wilga, Crane, Morilla, Ukabilla, Blacket, Yambocully**). These soils have a moderate plant available water capacity (80-100 mm). The soils generally have a coarse surface structure and successful establishment is achieved by sowing into cereal crop stubble. They also have a wetness limitation which restricts the persistence of buffel, Rhodes and medics, and a water availability restriction to the persistence of silk sorghum and lucerne. The landform is predominantly level to gently undulating plains with minor occurrences of scarp footslopes and undulating rises.

The land is used mainly for grazing, particularly the clay soils with large melonhole gilgai. Extensive areas of non-gilgaied clay soils are used for winter crop production. Sown pasture species include silk sorghum, purple pigeon, bambatsi and lucerne. These are generally sown as pasture mixtures to permit the establishment of species tolerant of differing soil and site conditions.

Limitations to sown pasture production are mostly moderate. These are water availability (m_3), microrelief (tm_3), soil workability (k_2), surface condition (ps_{2-3}), wetness (w_{2-3}), nutrient deficiency (nd_{2-3}) and vegetation (v_{2-3}). **Wondalli, Barclay** and **Bunker** have a moderate microrelief limitation. The vertical interval of melonhole gilgai microrelief associated with these soils is between 1 and 1.5 m. All of the remaining soils of this unit have a coarse surface soil structure with tillage, and are difficult to work over a wide range of moisture conditions. A minor to moderate wetness limitation also applies to all soils of this unit and largely determines the persistence of pasture species. Nitrogen, phosphorus and zinc deficiencies have been recorded in cropped land. A moderate vegetation limitation applies to all land not currently cultivated; such areas have poplar box, or false sandlewood or limebush or brigalow as major vegetation components.

The main concerns of land management for sown pasture production are maintaining soil fertility, and the control of woody weed regrowth and invasion. A practical way to accomplish this is to add fertiliser, use a crop rotation and maintain a good pasture ground cover to reduce woody weed competition. The levelling of melonhole gilgai should be undertaken as a gradual process to prevent exposure of saline, sodic or acid subsoils.

Class 3 land with moderate limitations for Rhodes, buffel and medics

The soils of this unit are characteristically the lighter surfaced (lower clay content) texture contrast soils of the area. Other sown pasture species are not suitable because plant available water capacity is low. Major soils are **Arrowfield, Nareen, Kegabilla, Widgewa, Ibon, Roe, Coorang, Oonavale, Mooroolbark** and **Marella.** The minor soils are **Flinton** and **Salmond.** The landform consists of elevated areas on level plains, gently undulating plains and rises, and ridges and remnants of the low plateau.

Most areas of this land unit are used for grazing but winter crop production occurs in some localities. Sown pasture species recorded were buffel, silk sorghum, purple pigeon, bambatsi and creeping bluegrass.

Limitations to sown pasture production for this restricted pasture group are generally moderate. The limitations include water availability (m_3), surface condition (ps_{2-3}), nutrient deficiency (nd_{3-4}), wind erosion (a_{2-3}), water erosion (a_{2-3}) and vegetation (v_3). A moderate vegetation limitation has been given to UMAs in this unit assessed as unsuitable for crop production, because the potential for regrowth is high in uncropped land. The same limitation applies to UMAs where either poplar box or grey box or false sandlewood or cypress pine or wattles are major vegetation components. Ridge crests and slopes are susceptible to water and wind erosion in the absence of surface cover. Most soils in this group have low soil fertility, with deficiencies in nitrogen, phosphorus, zinc and copper. A moderate surface condition limitation applies. The soils are typically hardsetting when dry and coarse and cloddy when cultivated, resulting in poor soil seed contact and plant establishment.

Land management for sown pasture production requires the maintenance of soil fertility and the control of erosion and woody weeds. This can be achieved by the application of fertiliser, the maintenance of good pasture ground cover and soil conservation structures, and the use of chemicals or a crop rotation respectively.

Class 3 land with moderate limitations for bambatsi

The soils of this unit are associated with drainage depressions (often closed) where surface water ponds for lengthy periods. The land is not suitable for crop production and other sown pasture species because of waterlogging. The major soils are **Bulimba, Dunlop** and **Euroka.** Minor soils are **Callandoon, Crooked, Wilga** and **Wondalli.** Soil moisture and plant nutrients are interpreted as being adequate for pasture production because the areas are water and nutrient gathering sites.

The land is used almost entirely for grazing native pastures. There are, however, a few small areas with sown pasture species of bambatsi and silk sorghum.

Limitations to sown pasture production are moderate to severe. These include wetness (w_3), surface condition (ps_{2-3}), soil workability (k_2), vegetation (v_2) and flooding (f_2). Erosive flooding is confined to UMAs forming major drainage lines that are flooded several times in most years. Potential for woody weed regrowth exists because the land is not suitable for continuous cropping. The coarse surface soil structure of the clay soils of this group reduces the reliability of establishment of small seeded grasses. These soils can be worked for seedbed preparation only over a narrow moisture range, and successful establishment is determined largely by immediate follow-up rainfall.

The main objectives in managing this land for sown pasture production is to prevent erosive flooding and consequent soil loss, and to control woody weed regrowth. This can be achieved by maintaining a good pasture ground cover, and the use of chemical or mechanical methods for regrowth control.

2.5 Suitability/productivity of remaining lands for native pastures

Land assessed as unsuitable for dryland cropping and sown pastures has severe to extreme limitations for these land uses. However, this land can be valuable pasture land and has been divided into three categories on the basis of native pasture productivity, these are described below.

Land suitable for grazing native pasture of high productivity

Macintyre is the only soil in this unit, and occurs on extensive level plains. It is a black or grey heavy clay (surface clay content 67-74%) with a very coarse weakly structured subsoil. Plant available water capacity is moderate. The land is not gullied or susceptible to erosive flooding, has no microrelief, nor has it a wind or water erosion hazard.

The land is used mainly for grazing. Hoop mitchell grass is the dominant native pasture species, but Queensland bluegrass and native medics are also significant components. Some areas adjacent to Yambocully Creek have been developed for flood irrigated cotton. Uneconomic yields have been obtained for wheat, barley, oats, grain sorghum and cotton under dryland conditions. Attempts to establish sown pasture species, namely purple pigeon and bambatsi, under dryland conditions, have also been unsuccessful.

Limitations to dryland crop production and sown pasture production are moderate to severe. These include water availability (m_3), soil workability (k_4), surface condition (ps_3), wetness (w_3) and nutrient deficiency (nd_3). The analyses of surface soil samples show deficiencies in nitrogen, phosphorus and zinc. Prolonged wetness is associated with the absence of surface drainage and the high soil surface clay content. These clays are extremely difficult to work over a wide range of moisture conditions, and are highly susceptible to soil compaction. The soil surface is coarse with tillage and dries rapidly, resulting in poor soil seed contact and plant establishment.

Management of the land for native pasture production requires the maintenance of sward vigour and balance of desirable pasture species. This can be achieved by adjusting stocking rates to a level which avoids damage to the sward and the influx of undesirable species. The use of nitrogen fertiliser or aerially sown medics should be considered as a management option.

Land suitable for grazing native pasture of moderate productivity

Much of this unit is made up of floodplains of the Weir River, Billa Billa Creek, and part of the meander plain of Yambocully Creek. The remaining areas are closed depressions or seasonally wet runon areas, where drainage is not considered feasible. The major soils include **Giddi Giddi, Dunlop, Callandoon** and **Euroka.** The soils commonly have a very thin (<5 cm) pale surface horizon overlying a neutral to acid heavy clay subsoil.

The land is used mostly for grazing. Nut grass is the dominant pasture species, and on slightly elevated areas, Queensland bluegrass, hoop mitchell grass and native medics are major pasture components. Areas adjacent to the Weir River have been developed for flood irrigated cotton. Uneconomic yields have been obtained for wheat, barley, oats and grain sorghum under dryland conditions. Poor establishment and persistence has occurred with purple pigeon and silk sorghum under dryland conditions.

Limitations to dryland crop production and sown pasture production are moderate to severe. These include water availability (m_3), soil workability (k_3), surface condition (ps_3), wetness (w_4), nutrient deficiency (nd_3), vegetation (v_2) and gullies (tg_3). Gullied land associated with the meander plain of Yambocully Creek severely restricts the use of machinery. Because the land is not suitable for dryland cropping, the control of woody weed regrowth, particularly coolibah, is made more difficult. The surface layer of the clay soils of this group contain low amounts of nitrogen and phosphorus. The soils have a restricted workability range, and there is difficulty in achieving a fine surface tilth. Although most of the area is periodically inundated by flood water, the velocity of flow is such that erosive flooding is negligible. However, the resulting wet conditions due to the absence of surface drainage can prevent the movement of machinery for several weeks.

Management of the land for native pasture production requires the control of woody weeds. This can be achieved by adjusting stocking rates to maintain a good ground cover, and chemical or mechanical control methods.

Land suitable for grazing native pasture of low productivity

The main features of the soils of this unit are their very low soil moisture storage and/or high erodibility by wind or water. A large number of soils are included, thirteen are specific to this unit. The unit consists of essentially five groups of soils. The soil groups and associated landforms are: shallow soils on steep scarp slopes (**Minnabilla, Karbullah, Uranilla, Widgewa, Flinton**); hardsetting texture contrast soils of narrow to broad drainage lines (**Bulgar, Lanky, Herden**); deep sands on alluvial ridges and terraces or in relict drainage lines (**Sturt, Bendidee, Wondoogle, Wai Wai, Brendle, Ballin**); clay soils in swamps and closed depressions or on plains (**Euroka, Dunlop, Cooper**); and soil complexes of gullied meander plains (**Yambocully/Crooked, Oonavale/Euroka, Brendle/Euroka**).

Nearly all the land of this unit is used for grazing. A few small areas are cultivated for winter cereals, particularly barley. Sown pasture species include lucerne, purple pigeon, bambatsi and buffel. These have shown little improvement in productivity over native pastures.

Limitations to dryland crop production and sown pasture production are generally severe to extreme. The limitations include water availability (m_{4-5}), nutrient deficiency (nd_{3-4}), water erosion (e_{4-5}), wind erosion (a_{3-5}), wetness (w_5), gullies (tg_3), surface condition (ps_3) and soil workability (k_{3-4}).

The shallow soils on steep scarp slopes **Minnabilla, Karbullah, Uranilla, Widgewa** and **Flinton** have very low plant available water and are highly erodible by wind and water in the absence of surface cover. **Bulgar, Lanky** and **Herden** have low plant available water, restricted workability and a coarse and cloddy surface with tillage. The deep sandy soils **Sturt, Bendidee, Wondoogle, Wai Wai, Brendle** and **Ballin** have very low plant available water and a high fertiliser requirement to correct nutrient deficiencies. They are also easily eroded by wind in the absence of surface cover. Free standing water in swamps and closed depressions (**Euroka** and **Dunlop** soils) precludes crop and sown pasture use. **Cooper** is an intractable saline and sodic heavy clay soil which exhibits a surface crust in an undisturbed state. The soil complexes **Yambocully/Crooked, Oonavale/Euroka** and **Brendle/Euroka** contain numerous gullies restricting the use of standard machinery. Where adjacent to permanent water, these complex areas are frequently overgrazed by stock, and are then highly susceptible to erosion by wind and floodwaters.

The main objectives in managing this land for native pasture production are the retention of as much native vegetation as practical, and where clear-felling has occurred, the control of erosion and woody weeds. This can be achieved by limited clearing where appropriate and the maintenance of a good perennial grass cover. Chemical control of woody weeds will minimise disturbance.

3. Soils

Sixty one soils were recognised and mapped as separate units at soil profile class level (Isbell 1988). The soil mapping units are not pure units of soil profile classes, rather they are complex units, and the relative proportion of the three dominant soils in any mapped area is shown in the UMA database. The soil mapping units are named after the dominant soil profile class and abbreviated in discussion. For example, Minnabilla soil profile class is abbreviated to Minnabilla soil or Minnabilla.

The soils have been classified according to A Factual Key (Northcote 1979) and the Australian great soil groups (Stace *et al.* 1968). Soil profiles sampled for analytical data are classified at great group level in A Classification System for Australian Soils (Isbell 1993) and provisionally placed at subgroup level in Soil Taxonomy (Soil Survey Staff 1975).

Soils with uniform, gradational and duplex (texture contrast) texture profiles occur (Northcote 1979); most have hardsetting surface horizons, alkaline reaction trends and sodic subsoils. There are a number of soils with acid subsoils not previously recorded in the area. Soil distribution is related to parent material, topography and drainage. The soils generally have low amounts of organic matter, nitrogen and phosphorus in the surface horizon. Data for soil descriptions and chemical analyses of 53 profiles are tabulated in Appendix III. Soil distribution is shown on the accompanying soil map and a description of the landscape units and more pronounced soil relationships is given below.

3.1 Soils and landscape units

The soils have been grouped (see Figure 5) on the basis of five broad landscape units: a low plateau, undulating rises, relict alluvial plains, undulating riverine and level riverine plains. This separation is essentially a soil/landform/parent material relationship and is made in general terms to explain the different mapping units and to provide a recognisable framework for extrapolation of soil information to adjoining map sheets. Caution should be used in extending soil information to areas west of the survey boundary as a preliminary examination and previous mapping north of Talwood (Ross 1986) indicate a number of soils not represented in this survey.

Gently undulating plateaus and plateau remnants

The most striking feature of this landscape is its elevation in relation to other landscape units. The low plateau is situated about 30 m in elevation above the gently undulating rises and is bounded by a narrow scarp. The escarpment is stepped in places and has no recognisable pediment slopes or alluvial fans extending out from it. The large amount of altered gravel associated with **Ibon** soil on plateau remnants is interpreted as lag gravel associated with scarp retreat.

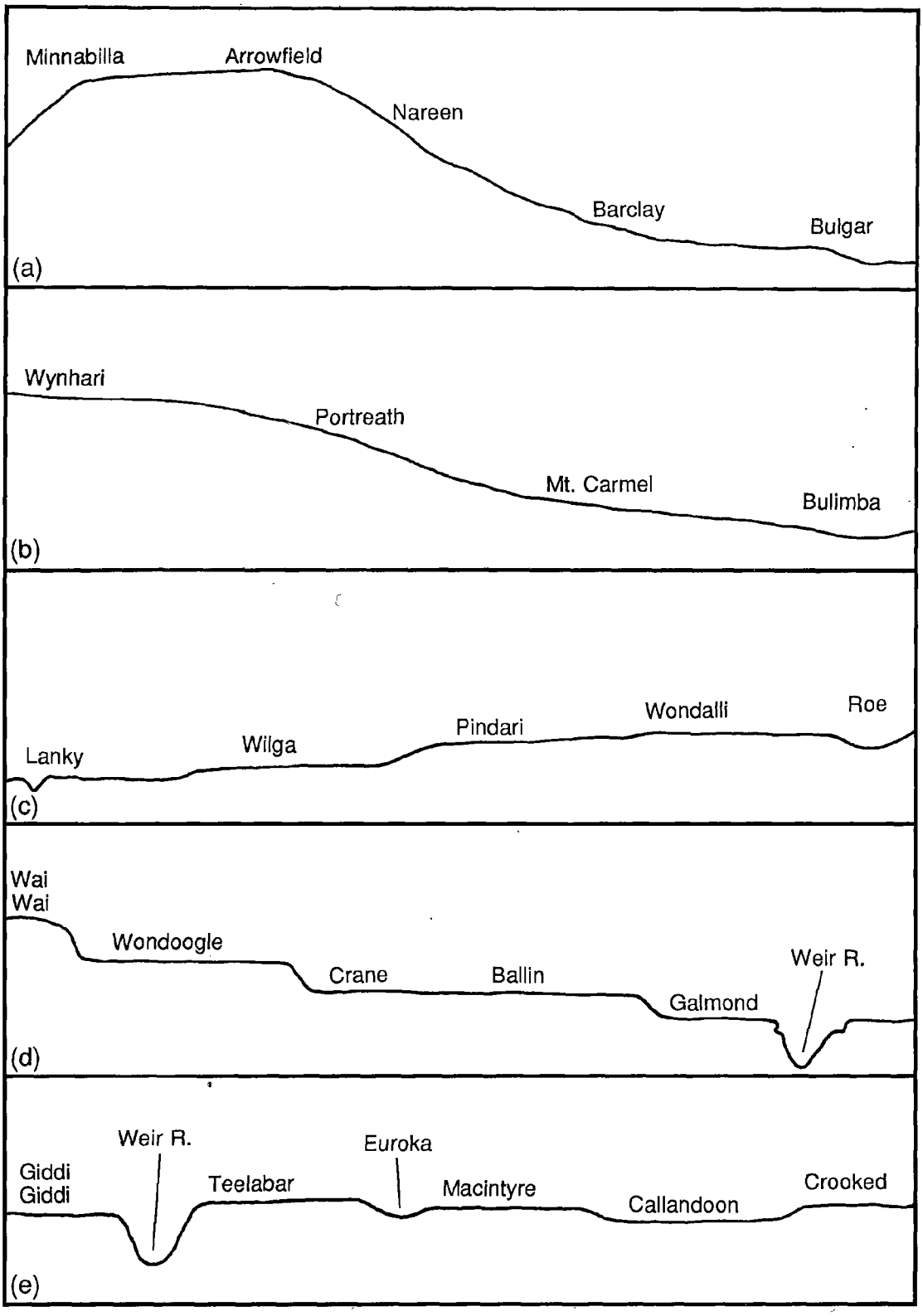


Figure 5 Schematic section across ridges and alluvium.

Shallow gravelly soils, **Minnabilla** and **Karbullah** are dominant on the moderate to steep scarp slopes, but occur elsewhere as minor components of other soil units. Altered rocks underlying **Karbullah** show little evidence of iron enrichment in comparison with **Minnabilla** and other red soils affected by laterific influences.

Beyond the scarp margin, the landscape is predominantly a series of discontinuous ridges separated by narrow to broad plains. The more common soil topo-sequence recorded is shown in Figure 5a. Texture contrast soils are dominant on ridges, mainly **Arrowfield,** but there are occurrences of cracking clay soils formed in the same landscape position. Cracking clay soils with melonhole gilgai (**Barclay** and an alkaline variant) have formed over large areas of these narrow to broad plains. No parent rock was recorded beneath the clay plains to 1.5 m depth, except on side-slopes to the `valley' plains. The geology map shows an elevated area of these clay plains along the northern boundary of the survey area to be of much younger age (Quaternary). This is considered unlikely given its elevated landscape position and degree of dissection.

Very gently undulating rises

The soils of this unit have formed on less weathered parent rocks and comprise most of the more productive cropping soils in the survey area. These more productive soils are characterised by an absence of surface microrelief, a clay loamy to light clay surface horizon overlying a strongly structured subsoil and the presence of free calcium carbonate in the upper subsoil. Subsoil colour varies from red through brown to black, but has little influence on crop performance. Slopes are gentle, generally between 1 and 3% and grade to about 0.5% as the rises merge with very gently undulating plains in a southerly direction.

Most of the Cretaceous surface rocks (sandstones, siltstones and mudstones) west of the Leichhardt Highway are shown on the geology map to be overlain by younger, Quaternary materials. Nearly all the soils in this area are known to be underlain by sandstones and siltstones before 1.5 m depth, except on lower slope positions. However, the substrate of the two major soils, **Mt Carmel** and **Calingunee** east of the Leichhardt Highway is unknown. These soils and others with unknown substrates exhibit pedological development to below 1.5 m depth. No discontinuities were recorded in any soil profiles throughout this landscape unit. There is also no recorded occurrence of mudstone.

The more predictable slope sequence of soils in this unit is illustrated in Figure 5b. Where **Wynhari** overlies sandstone on the crests of rises, the depth to hard rock is moderately shallow (0.5 m). This depth is always greater where the less weathering resistant siltstone occurs. **Portreath** soil developed on similar rock types is predominantly brown in colour in upper and mid-slope positions, while **Mt Carmel** on lower slopes is predominantly black grading with depth to mottled grey and yellow clay. Similar dark colours are associated with **Bulimba** formed in the weathering products of local alluvium.

Very gently undulating relict plains

These are largely melonhole clay plains with numerous drainage lines. The landscape unit is slightly elevated in relation to the very gently undulating riverine plains and distinctly elevated to the level riverine plains. Incision and deposition by two major streams, Commoran and Yarrill Creeks, and their tributaries give rise to a very gently undulating topography.

Several soils in this unit represent prior stream channels, in particular **Mooroolbark, Sturt, Bendidee** and **Roe.** These soils can occur on quite different landform elements but in this survey they have not been separated on the basis of landform element. For example, **Sturt** occurs as the major soil of creek terraces or of drainage depressions, and on low sand ridges. The only major morphological difference in the soil profile between these landform elements, is the presence of a densipan at about 1.5 m depth in drainage depressions.

A complex distribution of soils is typical of most alluvial landscapes because the transported materials on which the soils are formed may be of different origin, and these materials are likely to have been reworked by water and/or wind since deposition. However, a recurring pattern of soil distribution was found between some soils and their relative positions across the alluvium is shown in Figure 5c. The vertical interval of melonhole gilgai microrelief associated with **Wondalli** soil ranges from 0.4 to 2.0 m, and in most instances there is a high proportion of mounds to depressions with the gilgai. These differences and other chemical characteristics between areas, although not shown on the soil map, are shown on the land suitability map.

Very gently undulating riverine plains

This landscape unit represents mainly older fine sandy alluvium of the Weir River, which has been modified by stream channels and possibly wind action to form the present undulating land surface. Alluvial features including terraces, levees, scrolls, and swales occur throughout the unit. Terraces are well developed in the upper reaches of the Weir River where the river is confined by plateau remnants and rises. The terrace sequence which contains the largest number of soils is located on the property `Ballymena' and shown schematically in Figure 5d.

Meander plains with widely spaced and moderately deep stream channels are dominated by texture contrast soils, principally **Yambocully** and **Oonavale**. The associated clay soils in stream channels, depressions and ox-bows have been related to the soil profile classes of the level riverine plains, which have similar soil properties. Sand ridges with **Wai Wai** and **Wondoogle** soils occur intermittently throughout the level clay plains, and are distinctly elevated, up to 8 m, in relation to the surrounding plains. These sand deposits are interpreted as source bordering dunes as they are invariably situated adjacent to meander plains.

Level riverine plains

Extensive flat low-lying clay plains of the Macintyre and Weir Rivers are represented by this unit. Most of the area is inundated by flood water during major floods, but more frequently, flooding in the survey area is restricted to the Weir River floodplain south west of Goodar, and to areas north of Callandoon Creek. The major cracking clay soil **Giddi Giddi** of the Weir River alluvia has a neutral to acid soil reaction trend, while those of the Macintyre River alluvia are alkaline in soil reaction.

The landscape position of **Euroka** is restricted to drainage depressions, meander channels and swamps, periodically inundated. Less obvious topographic differences occur with the remaining cracking clay soils of this unit. Some of these are exaggerated and shown in Figure 5e. **Teelabar** and **Murriverie** are not expected to have a much wider distribution than shown on the accompanying soil map. Both are formed on alluvium at the confluence of the Weir River and Commoran Creek.

3.2 Chemical properties

Soil morphological descriptions and data from chemical and physical analyses of 53 profiles are tabulated in Appendix III. Laboratory data indicate all soils have some undesirable chemical or physical attributes. These attributes include low pH (<5.5), high salinity (EC >1 dS/m), high sodicity (ESP >6) and low fertility (N <0.15%, P <15 mg/kg). Selected attributes associated with land use limitations are described below.

Soil **pH** levels affect plant growth through nutrient availability and the solubility of toxic substances. The major plant nutrients (nitrogen, phosphorus, potassium and calcium) have reduced availability in acid soils. Aluminium and manganese can be present in toxic amounts at low pH. In alkaline soils, the trace elements zinc, iron and copper have reduced availability. Lime is needed to raise soil pH while sulfate of ammonia may lower pH in soils which are excessively alkaline.

Most of the cropping soils have a surface soil (0-10 cm) pH between 6.0 and 9.5. There is no evidence of acidification in the survey area due to current farming practices. The surface pH of **Mt Carmel, Portreath** and **Wynhari** soils is strongly alkaline (>9.0) raising the possibility of trace element deficiencies and increased residual effects with some herbicides. Almost one third of the soils have strongly acid (pH <5.0) lower subsoils. This includes the melonhole gilgaied clays **Barclay, Bunker, Calingunee, Mandama** and **Wondalli** which require care in the levelling of gilgai to prevent exposure of the acid subsoil.

High levels of **sodicity** and **salinity** can explain why soil moisture remains at depth in the soil following harvest. High salinity makes it difficult or impossible for plant roots to absorb water. High sodicity restricts root activity and water uptake. At shallow depth, most soils are sodic (exchangeable sodium percentage >6) and saline (electrical conductivity > 1 dS/m). Others (**Arrowfield, Nareen, Blacket, Banool, Goodar, Mooroolbark, Morilla, Trevanna, Roe, Widgewa** and **Lanky**) are non-saline but sodic to strongly sodic (ESP to 30) at shallow depth. The deep sands (**Sturt, Bendidee, Wai Wai** and **Wondoogle**) and the shallow sandy loams (**Minnabilla** and **Karbullah**) are non-sodic and non-saline.

Paired site data (undisturbed verses cultivation) for **Calingunee, Barclay, Mt Carmel** and **Portreath** shows a decrease in salinity and sodicity with cropping over time. The depth to maximum chloride ion concentration and exchangeable sodium has increased by at least 20 cm after 5 years of continuous cultivation. Numerous electrical conductivity readings show the same trend in salt leaching. However, some areas of levelled gilgaied clays (particularly the mounds) remain highly saline and strongly sodic after 10 years of continuous cropping.

The ratio CEC/clay % is called **clay activity ratio** (CAR). A CAR of >0.8 indicates the dominance of smectite clay minerals in the soil profile (Baker and Eldershaw 1993). These clay minerals shrink and swell readily with wetting and drying while the other major types (illites and kaolinites) have little expansion when water is added. **Tarewinnabar** and **Wynhari** soils have a clay activity ratio of 1.1 and 0.9 respectively, indicating the presence of smectite clays and the ability to reform soil aggregates with changing moisture conditions. All other soils have a clay activity ratio of <0.6, the majority being <0.5. Although the clay soils crack during drying due to their high clay content, large dense blocks formed by compaction remain intact. These have little potential for self repair.

Excluding the sands and shallow sandy loams, levels of plant **nutrients** in the surface (0-10 cm) are generally low for total nitrogen and zinc, and low to medium for extractable phosphorus and copper. A medium level (0.15-0.25%) of total nitrogen was measured in the surface samples of **Banool, Rockwood, Mandama** and **Calingunee.** The surface samples of **Mt Carmel, Moruya, Wynhari, Tarewinnabar, Ukabilla, Arrowfield, Nareen, Crane, Mooroolbark** and **Widgewa** contain very low (<10 mg/kg) levels of extractable phosphorus. Very low levels of zinc (<0.3 mg/kg) were determined in the surface samples of **Mt Carmel, Barclay, Trevanna, Arrowfield, Oonavale, Wilga** and **Widgewa.**

3.3 Correlation

Following extensive field correlation, the relevant soils in the study area were named after those established in the Land Management Manual Waggamba Shire (Burgess 1991a), and in the unpublished Border Rivers survey (Slater, McDonald and Christianos). The soil associations of Isbell (1957) are represented in part by the soil classes of Burgess (1991a) and therefore correlated to the present survey.

Soils that were similar to established soil classes (Table 2) were given the same names. However, 35 soils were sufficiently different from any of the classes and required new names. The very gently undulating relict alluvial plains landscape (Table 2) has poor soil representation in previous studies. Five soils from previous studies (**Flinton shallow, Murra Cul Cul, Tarewinnabar shallow, Oonavale** and **Undabri**) were renamed because the previous definitions were too narrow to accommodate the wide range of properties found in this survey.

Table 2. Correlation with previous soil studies*

Goodar survey	Land Management Manual	Border Rivers survey
Very gently undulating plateaus and plateau remnants on altered Tertiary rocks		
Flinton	Flinton	not applicable
Karbullah	Karbullah	not applicable
Minnabilla	Flinton shallow (?)	not applicable
Uranilla	Uranilla	not applicable
Gently undulating rises on Cretaceous sedimentary rocks		
Arden	Arden	not applicable
Butler	Murra Cul Cul	not applicable
Calingunee	Calingunee	not applicable
Moruya	Moruya	not applicable
Mt Carmel	Mt Carmel	not applicable
Tarewinnabar	Tarewinnabar	not applicable
Ukabilla	Tarewinnabar shallow	not applicable
Wynhari	Wynhari	not applicable
Very gently undulating relict alluvial plains		
Bendidee	Bendidee	not applicable
Wondalli	Wondalli	not applicable
Very gently undulating riverine plains		
Brendle	Oonavale	Brendle (?)
Marella	Marella	no equivalent
Wai Wai	Wai Wai	Wai Wai
Wondoogle	Wondoogle	Wondoogle
Yambocully	Yambocully	Yambocully
Level riverine plains		
Callandoon	no equivalent	Callandoon
Crooked	no equivalent	Crooked
Euroka	no equivalent	Euroka
Giddi Giddi	no equivalent	Giddi Giddi
Macintyre	Undabri	Undabri
Murriverie	no equivalent	Murriverie (?)
Strathmore	no equivalent	Strathmore

* There are 35 additional soils with no equivalent soils from previous studies

4. Vegetation

Remnant vegetation of the Goodar survey area occurs in structural forms ranging from grasslands through woodlands to forests. Aerial photographs taken in 1952 show most of the native vegetation to be cleared and the land used for grazing.

The area has been previously mapped by Isbell (1957) showing cleared land, cultivated land and areas dominated by one of belah, brigalow and brigalow-belah plant communities. A comprehensive description is given in that publication of the major plant communities within four broad structural forms. Description of the communities has been updated by Cooper (1991) using current terminology.

The vegetation description and classification used in the survey is based on the dominant plant species and structural form (Walker and Hopkins 1990). Despite extensive clearing, most properties have shadelines and/or small areas or clumps of vegetation which provide a good indication of the former communities. A list of plant species compiled during the survey is given in Appendix IV. No rare or endangered plants were recorded but a few known to be poisonous to stock were identified. The dominant vegetation species associated with each soil is shown on the accompanying soil map. Most soils support several dominant species.

Land use recommendations, property sales, leasing and purchase are often based on vegetation type. While land use suitability can be predicted for some vegetation types (for example bulloak equates with unsuitable crop land), it can be misleading for others (for example belah equates with marginal (Class 4) crop land through to very versatile (Class 2) crop land).

Belah is the most widespread plant species throughout the survey area. It is supported by a variety of soils, parent materials and landforms. These range from heavy clays on level alluvial plains to shallow hardsetting texture contrast soils on ridges of altered Tertiary rock. Belah grows in association with brigalow, grey box and poplar box. Where melonhole gilgai microrelief is present, belah is invariably the dominant species, not brigalow (see also Isbell 1957).

Tall (15-20 m) mid-dense to closed forests of belah and tall mid-dense layered forests of belah and brigalow occur on the more versatile crop land. However, the same vegetation can be found elsewhere but the land is less versatile for cropping because of limiting soil properties including plant available water, workability and microrelief.

Brigalow is the common co-dominant species within belah forests. Pure stands of tall (12-18 m) mid-dense brigalow forest are rare. The brigalow communities are typically mid-high (8-12 m tall) and mid-dense forests. The soils are saline and sodic at shallow depth and frequently acid in soil reaction. The land is better suited to winter cereal production, particularly barley and oats.

Grey and poplar box communities indicate the presence of soils with low to moderate plant available water and therefore either marginal (Class 4) or suitable land (Class 3) for winter cereal production, only. Poplar box may also indicate unsuitable crop land (Class 5) such as deep sands. Belah is a common component of box communities. These communities occur as tall (12-15 m) woodlands or mid-dense forests.

Elevated sandridges and sandy plains carry closed mid-high forests of cypress pine. The soils have very low plant available water and for this reason alone, are unsuitable for agricultural use. Other tree species which grow on deep sandy soils include bulloak, river red gum and carbeen.

Coolibah is restricted in distribution to the seasonally wet or more frequently flooded clay plains. The species generally indicate unsuitable crop land because of waterlogging especially where lignum, rushes and nut grass are major ground components. Hoop mitchell grass occurs only on slightly elevated (drier) areas indicating highly productive native pasture land.

5. Geology

The geology of the area has been mapped and described by Isbell (1957), and by the Bureau of Mineral Resources as part of a regional reconnaissance of the Great Artesian Basin and the New England Fold Belt (Senior 1972). A description and discussion of the geological history for the area has been presented by Slater (1991). The geological units, landforms and associated soils are given (Table 3).

The oldest outcropping sediments are the Jurassic to Cretaceous Kumbarilla Beds located in the north east corner of the survey area. The unit is comprised of sandstone, siltstone, mudstone and some conglomerate. To the west, the area is dominated by the Rolling Downs Group of Cretaceous age. The group consists of the Grimman Creek Formation and a composite unit of Surat Siltstone and Wallumbilla Formation. Major rock types include lithic sandstone, siltstone and mudstone. The landsurface has been dissected to form a pattern of gently undulating rises.

An unnamed geological formation of Tertiary to Lower Cretaceous age fringes the northern boundary of the survey area. The landform is elevated, gently undulating, and forms a low plateau with moderate to steep scarp slopes. The unit consists of deeply weathered sediments (sandstone, siltstone and mudstone) which are kaolinized, and in part silicified and ferruginized. The area mainly represents the laterite residuals of Isbell (1957), and is referred to in this report as altered tertiary rocks.

The remaining area of the map sheet (about 60%) is Quaternary alluvium of varying age (Qa, Qs), and forms extensive level to very gently undulating plains. This unit consists of alternating layers of clays and sands, with gradations through sandy clays and clayey sands. The sandy material is generally fine or less commonly medium grained, with minor coarse sand, and is dominantly quartzose.

Deep drilling by BHP Minerals in 1991-1992, show the alluvial sequence to have very low amounts of very coarse sands, gravels and boulders. In the southern part of the survey area, north-west of Goondiwindi, deep drilling exposed beds of 'pebbly sands'. These comprise fine to coarse clayey sands with 5-30% pebble content. The pebbles are well-rounded, from 1-10 cm in size, and comprise milky quartz, jasper and silicified lithic clasts (G Toor *pers. comm.*).

There is possibly a widespread laterite horizon underlying the alluvium which may represent a buried Tertiary weathering surface. The 'laterite profile' was observed in excavations for water storage. It is distinguished by a marked change to a light red colour, sometimes accompanied by cemented ironstone. The 'laterite profile' may persist for 2 to >10 metres (G Torr *pers. comm.*). A distinct break beneath unconsolidated materials to an underlying truncated laterite profile, was recorded by Isbell (1957).

The gently undulating rises on Cretaceous sedimentary rocks has been mapped by Senior (1972) comprising three separate formation units, the Kumburilla Beds, Grimman Creek and a composite unit of Surat Siltstone and Wallumbilla. Common lithologies associated with these units are sandstones and siltstones. As a result soils have not been associated exclusively with any one particular formation unit but rather spread across all three units (Table 3).

Table 3 Geological units, landforms and soils

Period	Formation	Lithology	Landform	Soils
Middle Jurassic to Lower Cretaceous	Kumbarilla Beds (JKk)	Sandstone, siltstone, mudstone; some conglomerate	Gently undulating rises	Coorang, Butler, Morilla, Moruya, Rockwood, Mt Carmel, Portreath, Ukabilla, Tarewinnabar, Wynhari, Bulimba, Mandama, Calingunee, Arden
Lower Cretaceous	Surat Siltstone and Wallumbilla (Kl)	Siltstone, mudstone, lithic siltstone, glauconitic and calcareous in part	Gently undulating rises	
Lower Cretaceous	Grimman Creek (Klg)	Lithic sandstone and siltstone, commonly glauconitic and calcareous	Gently undulating rises	
Tertiary to Lower Cretaceous	Unnamed	Deeply weathered sediments, (Kaolinized, in part silicified and ferruginized)	Gently undulating plateaus and plateau remnants	Minnabilla, Karbullah, Flinton, Nareen, Kegabilla, Widgewa, Arrowfield, Ibon, Uranilla, Bulgar, Trevanna, Barclay
Quaternary	Unnamed (Qs)	Sand, soil	Gently undulating plains	Sturt, Bendidee, Roe, Mooroolbark, Lanky, Wilga, Pindari, Yarril, Banool, Dunlop, Wondalli, Bunker, Wondoogle, Wai Wai, Salmond, Brendle, Ballin, Marella, Herden, Blacket, Crane, Oonavale, Yambocully, Doolanvale
Quaternary	Unnamed (Qa)	Alluvium	Level plains	Goodar, Giddi Giddi, Murriverie, Cooper, Callandoon, Euroka, Macintyre, Crooked, Teelabar, Undabri, Strathmore

6. Climate

General climatic conditions prevailing in the area are indicated by three classification systems. The climate is represented by the Köppen system as temperate with uniform rainfall, long hot summers, and mild winters (Dick 1975). According to the Thornthwaite system, the area is subhumid, mesothermal and has a sparse seasonal rainfall (Gentilli 1972). The Growth Index system of Fitzpatrick and Nix (1970), defines the area's climate as suitable for the growth of temperate grasses and legumes.

A combination of relatively reliable winter rainfall, low winter evaporation and suitable cropping soils enables successful winter cereal production in most years. The pattern of seasonal rainfall is unpredictable and drought can occur in any season. Landholders in response have developed diverse farming enterprises to take advantage of favourable seasonal conditions when they occur. Climatic elements which directly influence the success of cropping and pasture systems include rainfall, temperature and evaporation.

6.1 Rainfall

For the Goodar area, the mean annual rainfall lies between 544 and 624 mm (Table 4). Goondiwindi Post Office station has the highest mean annual rainfall, and the longest period of climatic record. The stations Glen Aradale, Burilda and Minnabilla are all located in the northern part of the map sheet area and each have about 30 years of rainfall record. Glen Aradale in the east, receives on average some 50 mm of rainfall less than Burilda and 26 mm less than Minnabilla, located to the west and north west respectively. Rainfall is summer dominant for all stations with approximately 65% falling during the period October to March inclusive.

Table 4. Mean monthly and annual rainfall

Station (Location)	Period of records	Mean rainfall (mm)												
		J	F	M	A	M	J	J	A	S	O	N	D	Annual
Burilda (28 09S 150 09E)	1959-1992	77	64	52	38	44	26	38	32	32	52	63	76	594
Glen Aradale (28 10S 150 27E)	1958-1992	72	52	50	39	38	24	34	35	31	46	54	69	544
Goondiwindi PO (28 33S 150 18E)	1879-1991	79	69	60	39	43	41	42	33	39	49	60	70	624
Minnabilla (28 00S 150 09E)	1961-1990	70	53	49	44	43	31	37	32	32	53	60	65	570

Source: Bureau of Meteorology

A measure of the variability of rainfall is the probability of receiving amounts of rainfall equal to or exceeding certain levels (Figure 6). The high variability of annual rainfall reflects the influence of a variety of rainbearing systems resulting in frontal rain, thunderstorms and rain depressions. Winter rainfall (April to September) is less variable than summer rainfall. Appreciable mid-winter rains can be expected at least once in ten years, and substantial mid-winter rains can occur at least five times in ten years. Low winter evaporation and rainfall intensity improves the effectiveness of winter rainfall.

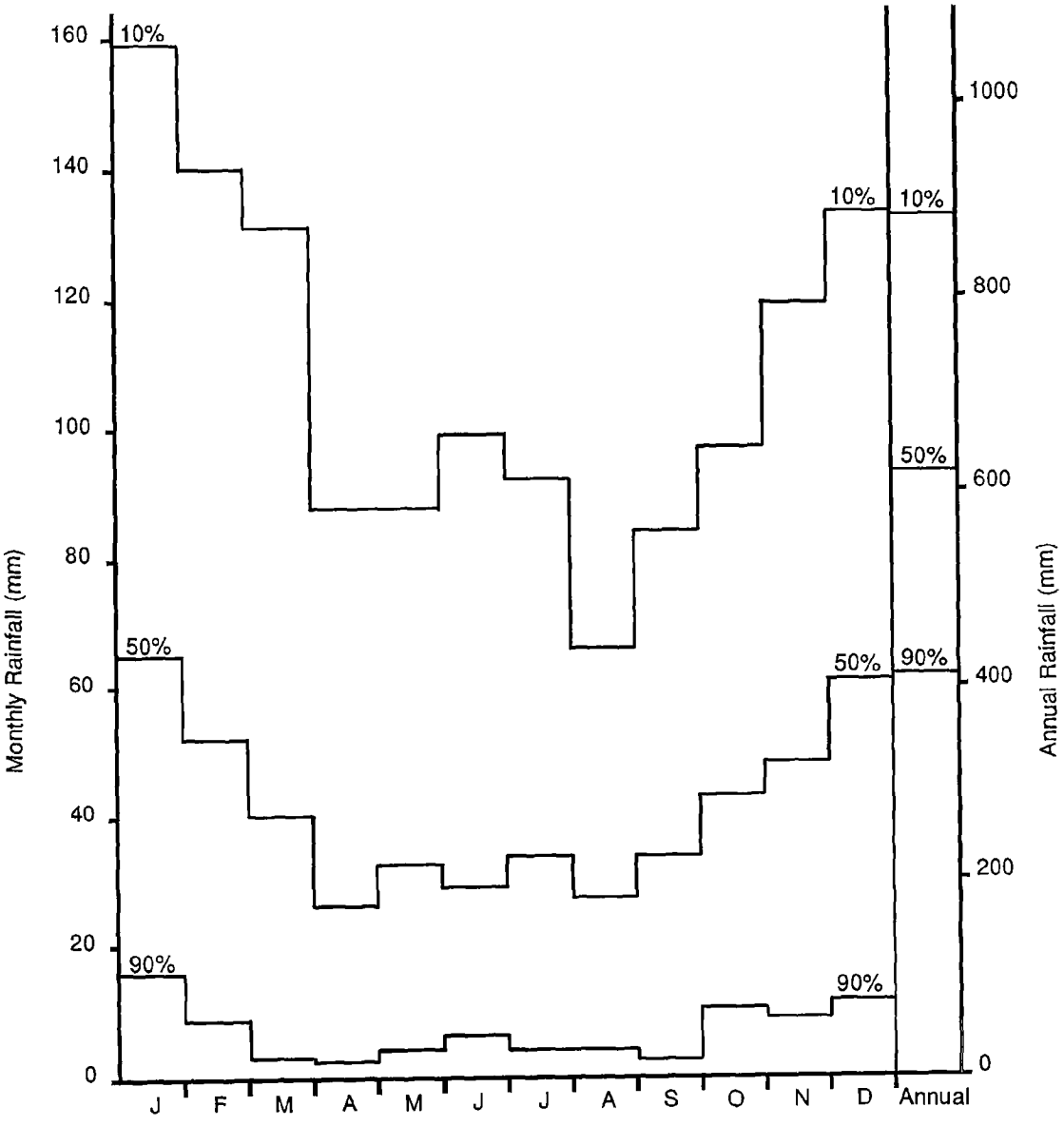


Figure 6 Probability distribution of rainfall for Goondiwindi Post Office station.

7. Survey methods

7.1 Field

The soils were examined initially along twelve transects in order to compile a reference for soil mapping. These transects were selected across the soil associations mapped by Isbell (1957) and different landscape features identified during air-photo interpretation. Transect length ranged from 5 to 50 km, and a total of 390 sites were examined and described. This information was then used to establish preliminary soil profile classes and a provisional map reference.

Soil descriptions were made to a depth of 1.5 m or shallower where hard rock, hard pan or gravel occurred. Undisturbed soil samples for description and analysis were obtained using 50 mm thin walled push tubes, hydraulically driven. A few sites were hand augured where vehicle access was not possible. The soils were described according to the Australian Soil and Land Survey Field Handbook (McDonald *et al.* 1990). Field pH was determined for each soil horizon using a field kit according to the method of Raupach and Tucker (1959); both moist and dry soil colours were referenced to Munsell Soil Colour Charts; slope angle was measured using a Suunto clinometer; electrical conductivity of soil and water samples was determined by using a LCD81 conductivity meter.

During the mapping phase an additional 1241 sites were described. A free survey technique (Reid 1988) was used with the aid of aerial photographs. Soil boundaries were drawn on 1:25 000 scale black and white aerial photographs and later transferred to the Goodar 1:100 000 topographic map for publication. The provisional map reference and soil profile class definitions were updated to accommodate additional information.

7.2 Laboratory

Samples were taken for analysis from 53 sites which represent major soil profile classes, these are described and the analyses reported in Appendix III. At each sampling site, a bulk surface (0-10 cm) sample was collected consisting of 8 to 10 cores. The profiles were sampled in 10 cm increments to 1.5 m depth in most instances, and standard depth samples (Table 6) submitted for analysis. Sampling depth was altered for some profiles in order to sample thin horizons, the upper part of B horizons and to avoid mixing horizons.

The samples were analysed for a standard suite of analyses (Table 6). The methods used are outlined in Interpreting Soil Analyses from Soil Surveys Conducted in Queensland (Baker 1991) and detailed in the Australian Laboratory Handbook of Soil and Water Chemical Methods (Rayment and Higginson 1992).

Table 6. Range of analyses performed at standard sampling depths (after Baker 1991)

Analysis	Bulk	Profile					
	0-100*	0-100	200-300	500-600	800-900	1100-1200	1400-1500
pH, EC, Chloride	x	x	x	x	x	x	x
Exch. cations, CEC		x	x	x	x	x	
Total P, K, S		x	x	x	x	x	
Organic C, Total N	x						
Bicarb. extractable P	x						
Replaceable K	x						
DTPA extr. Fe, Mn, Cu, Zn	x						
Particle size analysis		x	x	x	x	x	
Dispersion ratio		x	x	x	x		
Moisture measurements -							
% Air dry		x	x	x	x	x	
-1500 kPa content		x	x	x	x		

* Profile depths measured in mm

7.3 Data storage

Site and UMA (unique map area) data are computer stored on separate files using the WARIS system (Rosenthal *et al.* 1986). The site data file contains descriptions of landform, vegetation and soil properties, measured field pH and slope, and soil classification. The information was stored for 1631 sites.

The UMA data file contains land resource and interpreted information for 1141 individually mapped areas. Land resource attributes include soil type, landform, microrelief, vegetation and land use. Interpreted data are the UMA's suitability and limitation subclass ratings for dryland cropping and sown pastures.

The data is held on the Land Resource Information System (LRIS) computer files and can be accessed through the Manager, Resource Assessment and Planning, DPI, Meiers Road, Indooroopilly Qld 4068.

7.4 Land evaluation

Soil mapping provided the framework for land evaluation by delineation of areas of similar soils. These areas are termed mapping units, and each occurrence of a mapping unit is termed a unique map area, or UMA. A suitability classification based on limitations to production was developed for dryland cropping and sown pastures. Every UMA was qualitatively assessed for its potential for these land uses.

The limitations to dryland cropping and sown pasture production (see Section 2.2) had been previously identified for the region by Burgess (1991b), and are used in this evaluation. Limitation subclasses (see Appendix I) for the two broad land use categories being evaluated were established following consultation with local extension staff, landholders and observations made during the survey.

The method of land suitability classification is based on guidelines prepared by Land Resources Branch staff (1990). A 5 class system of land suitability was used, the classes are:

Class 1	Suitable land with negligible limitations
Class 2	Suitable land with minor limitations
Class 3	Suitable land with moderate limitations
Class 4	Marginal land with severe limitations
Class 5	Unsuitable land with extreme limitations

Each land use limitation was allocated a subclass rating by matching the land resource attribute data with the established limitation subclasses. Based on the most severe limitation or combination of limitations, each UMA was assigned to one of the five land suitability classes.

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9. References

Baker, D.E. (1991). *Interpreting soil analyses from soil surveys conducted in Queensland.* Department of Primary Industries, Queensland, Bulletin QB91001.

Baker, D.E. and Eldershaw, V.J. (1993). *Interpreting soil analyses for agricultural land use in Queensland.* Department of Primary Industries, Queensland, Project Report QO93014.

Bertram, J.D. and Dunlop, L.B. (1991). Livestock management. In Part A of R.N. Thwaites S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Blacket, D.S. (1991). Agricultural systems. In Part A of R.N. Thwaites and S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Bourne, J. (1980). *Waggamba Shire handbook: an inventory of the agricultural resources and production of Waggamba Shire, Queensland.* Edited by P. Lloyd, Department of Primary Industries, Queensland.

Bruce, R.C. and Rayment, G.F. (1982). *Analytical methods and interpretations used by the Agricultural Chemistry Branch for soil and land use surveys.* Department of Primary Industries, Queensland, Bulletin QB82004.

Burgess, J. (1991a), Land resources: Land resource areas and soils. In Part A of R.N. Thwaites and S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Burgess, J. (1991b). Land evaluation. In Part A of R.N. Thwaites and S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland Training Series QE90014.

Cockfield, G. (1994). *Waggamba Pastures.* Local experiences with the establishment and management of pastures, Waggamba Conservation Committee.

Cooper, P.J. (1991). Vegetation. In Part A of R.N. Thwaites and S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Dick, R.S. (1975). A map of the climates of Australia: according to Koppen's principles of definition. *Queensland Geographical Journal* 3, 33-69.

Fitzpatrick, E.A. and Nix, H.A. (1970), The climatic factor in Australian grassland ecology. In, Moore, R.M. (ed). *Australian Grasslands*, ANU Press, Canberra pp 3-26.

French, A.V. (1992). Woody weeds. In D. Lawrence and A.V. French (eds), *Sown pasture management notes Western Downs and Maranoa*, Department of Primary Industries, Queensland.

French, A.V. (ed) (1993). *Crop management notes: Western Downs and Maranoa 1993-94.* Department of Primary Industries, Queensland.

Galloway, R.W., Gunn, R.H., Pedley, L., Cocks, K.D. and Kaline, J.D. (1974). *Lands of the Balonne-Maranoa area, Queensland.* CSIRO Land Research Series 34, CSIRO, Canberra.

Gentilli, J. (1972). *Australian Climate Patterns.* Nelson, Melbourne.

Gibson, G., Radford, B.J. and Nielsen, R.G.H. (1992). Fallow management, soil water, plant-available soil nitrogen and grain sorghum production in south west Queensland. *Australian Journal of Experimental Agriculture* **32**, 473-82.

Isbell, R.F. (1957). *The soils of the Inglewood - Talwood - Tara - Glenmorgan region, Queensland.* Technical Bulletin 5, Queensland Bureau of Investigation.

Isbell, R.F. (1988), Soil classification. In R.H. Gunn, J.A. Beattie, R.E. Reid and R.H.M. van de Graaff (editors) *Australian soil and land survey handbook, Guidelines for conducting surveys.* Inkata Press, Melbourne.

Isbell, R.F. (1993). *A Classification System for Australian Soils.* 3rd approximation, CSIRO Division of Soils Technical Report 2/93.

Isbell, R.F., Thompson, C.H., Hubble, G.D., Beckmann, G.G. and Paton, T.R. (1967). *Atlas of Australian Soils, Map plus explanatory data for sheet 4, Brisbane-Charleville-Rockhampton-Clermont area.* CSIRO/Melbourne University Press.

Land Resources Branch Staff (1990). *Guidelines for agricultural land evaluation in Queensland.* Department of Primary Industries Queensland, Information Series QI90005.

Littleboy, M., Silburn, D.M., Freebairn, D.F., Woodruff, D.R. and Hammer, G.L. (1989). *PERFECT: A computer simulation model of productivity, erosion, runoff functions to evaluate conservation techniques.* Department of Primary Industries, Queensland, Bulletin QB89005.

McCollum, D. and Salmond, G.S. (eds) (1992). *Irrigation management notes - Border rivers and St George 1992/93.* Department of Primary Industries, Queensland, SQA91009.

McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. (1990). *Australian soil and land survey field handbook.* 2nd edition, Inkata Press, Melbourne.

McIntyre, G., Marshall, J., Rickman, J. and Lucy, M. (1992). *Dryland cotton production Queensland.* Department of Primary Industries, Queensland, SQA92011.

Muller, A.D. (1991). Soil conservation management and planning. In Part A of R.N. Thwaites and S.E. Macnish, S.E. (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Mullins, J.A. (1980). *Land use study for the Millmerran - Moonie - Tara area of Queensland.* Department of Primary Industries Queensland, Division of Land Utilisation, Technical Bulletin 35.

Northcote, K.H. (1966). *Atlas of Australian Soils, Map plus explanatory data for sheet 3, Sydney - Canberra - Bourke - Armidale area.* CSIRO/Melbourne University Press.

Northcote, K.H. (1979). *A factual key for the recognition of Australian soils.* Rellim Technical Publications.

Raupach, M. and Tucker, B.M. (1959). The field determination of soil reaction, *Journal of the Australian Institute of Agricultural Science* **25**, 129-133.

Rayment, G.E., (1983). *Interpretation of soil and plant analytical data for temperate pastures in south-east Queensland.* Department of Primary Industries, Queensland, Bulletin QB83006.

Rayment, G.E. and Higginson, F.R. (1992). *Australian Laboratory Handbook of Soil and Water Chemical Methods.* Inkata Press, Melbourne.

Reid, R.E. (1988). Soil survey specifications. In R.H. Gunn, J.A. Beattie, R.E. Reid and R.H.M. van de Graaff (editors) *Australian soil and land survey handbook, Guidelines for conducting surveys,* Inkata Press, Melbourne.

Rosenthal, K.M., Ahern, C.R. and Cormack, R.S. (1986). WARIS: A computer-based storage and retrieval system for soils and related data. *Australian Journal of Soil Research* **24**, 441-456.

Rosenthal, K.M. and White, B.J. (1980). *Distribution of a rainfall erosion index in Queensland,* Department of Primary Industries, Queensland, Division of Land Utilisation Report 80/8.

Ross, D.J. (1986). *Soils of the Wyncanna woodland experiment centre, Talwood, South Maranoa region, Queensland.* CSIRO, Division of Soils Divisional Report No. 83.

Salmond, G.S. (1991). Waggamba shire land use. In Part A of R.N. Thwaites and S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Senior, D.A. (1972). *St George Queensland, 1:250 000 Geological Series - Explanatory Notes.* Sheet SH/55-4, Bureau of Mineral Resources, Geology and Geophysics and Geological Society of Queensland, Australian Government Publishing Service, Canberra.

Slater, B.K. (1991). Geology. In Part A of R.N. Thwaites and S.E. Macnish (eds), *Land Management Manual Waggamba Shire,* Department of Primary Industries Queensland and Waggamba Conservation Committee, Department of Primary Industries, Queensland, Training Series QE90014.

Soil Survey Staff (1975). *Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys.* USDA Agriculture Handbook 436.

Stace, H.C.T., Hubble, G.D., Brewer, R., Northcote, K.H., Sleeman, J.R., Mulcahy, M.J. and Hallsworth, E.G. (1968). *A handbook of Australian soils.* Rellim Technical Publications.

Walker, J. and Hopkins, M.S. (1990). Vegetation. In R.C. McDonald, R.F. Isbell, J.G. Speight, J. Walker and M.S. Hopkins (editors) *Australian soil and land survey field handbook,* Inkata Press, Melbourne.

Weston, E.J., Harbison, J., Leslie, J.K., Rosenthal, K.M. and Mayer, R.J. (1981). *Assessment of the agricultural and pastoral potential of Queensland.* Department of Primary Industries, Queensland, Agriculture Branch Technical Report 27.

APPENDIX I

LIMITATIONS, SUBCLASSES AND CRITERIA FOR GOODAR SURVEY AREA

WATER AVAILABILITY (m)

Dryland crops

Subclass	
m1	>150 mm (PAWC)
m2	120-150 mm
m3	100-120 mm
m4	75-100 mm
m5	<75 mm

Sown pastures

Subclass	
m1	>120 mm (PAWC)
m2	100-120 mm
m3	80-100 mm
m4	40-80 mm
m5	<40 mm

NUTRIENT DEFICIENCY (nd)

Dryland crops

Subclass	
nd1	nil or unknown
nd2	low P or N
nd3	low P and N
nd4	low P or N and others

(see Bruce and Rayment 1982 for critical limits)

Sown pastures

Subclass	
nd1	nil or unknown
nd2	low P or N
nd3	low P and N
nd4	low P and N and others

(see Rayment 1983 for critical limits)

SALINITY HAZARD (ss)

Dryland crops

Subclass	
ss1	nil or unknown
ss2	potential dryland salting, scarp footslopes with high levels of subsoil salts

WETNESS (w)

Dryland crops		Sown pastures	
Subclass		Subclass	
w1	no plant indicator species or soil features (eg. sedges or mottles)	w1	all sown species persist, sloping no ponding
w2	few plant indicator species or melonhole gilgai VI <50 cm	w2	most sown species persist, flat ponding for short intervals
w3	common plant indicator species or melonhole gilgai VI 50-100 cm	w3	few sown species persist, flat lengthy ponding
w4	many plant indicator species or melonhole gilgai VI >100 cm	w4	bambatsi only
w5	swamps and lagoons (drainage not possible)	w5	no species persist

FLOODING (f)

Dryland crops		Sown pastures	
Subclass		Subclass	
f1	<1:10 years or no flooding	f1	< 1:10 years or no flooding
f2	>1:10 years	f2	> 1:10 years

SURFACE CONDITION (ps)

Dryland crops		Sown pastures	
Subclass		Subclass	
ps1	sands and fine self-mulching clays	ps1	sands and fine self-mulching clays
ps2	coarse self-mulching clays	ps2	coarse self-mulching clays
ps3	other soils hardsetting or crusting	ps3	other soils hardsetting or crusting

WORKABILITY (k)

Dryland crops		Sown pastures	
Subclass		Subclass	
k1	sands and self-mulching clays (free $CaCo_3$ within plough zone)	k1	sands and self-mulching clays (free $CaCo_3$ within plough zone)
k2	hardsetting FSL to ZCL	k2	other soils
k3	medium clays (no free $CaCo_3$)	k3	heavy clays (no free $CaCo_3$)
k4	heavy clays (no free $CaCo_3$)		

GULLIES (tg) (natural and eroded)

Dryland crops		Sown pastures	
Subclass		Subclass	
tg1	no gullies recorded per UMA	tg1	<5 per UMA
tg2	1-5 per UMA	tg2	≥5 per UMA
tg3	>5 per UMA		

MICRORELIEF (tm)

Dryland crops		Sown pasture	
Subclass	vertical interval (m)	Subclass	vertical interval (m)
tm1	0 or <0.1	tm1	0 or <0.3
tm2	0.1 - <0.3	tm2	0.3 - <1.0
tm3	0.3 - <1.0	tm3	1.0 - <1.5
tm4	1.0 - <1.5	tm4	>1.5
tm5	>1.5		

WATER EROSION (e)

Dryland crops

Subclass	slope angle (%)
e1	≤0.5
e2	>0.5 ≤1.5
e3	>1.5 ≤3.0
e4	>3.0 ≤6.0
e5	>6.0

Sown pastures

Subclass	slope angle (%)
e1	≤1.0
e2	>1.0 ≤3.0
e3	>3.0 ≤6.0
e4	>6.0 ≤8.0
e5	>8.0

WIND EROSION (a)

Dryland crops

Subclass	
a1	clays, no apparent erosion hazard
a2	hardsetting medium-coarse sandy or loamy surfaced soils
a3	fine sandy or silty surfaced soils
a4	loose fine sands and loamy fine sands
a5	very shallow sandy or loamy soils on ridge crests

Sown pastures

Subclass	
a1	clays, hardsetting sandy or loamy surfaced soils
a2	loose fine sands, fine sandy or silty surfaced soils
a3	very shallow sandy or loamy soils on ridge crests

ROCKINESS (r)

Dryland crops

Subclass	
r1	<2% of UMA
r2	2-10%
r3	11-20%

Sown pastures

Subclass	
r1	<10% of UMA
r2	10-20%
r3	21-40%

VEGETATION (v)

Dryland crops

not applicable

Sown pastures

Subclass

v1 tussock grassland with isolated trees; coolibah, belah, ironbark; existing cultivation

v2 tall open forest of belah-brigalow; sandalwood, limebush understorey

v3 tall open forest of belah-brigalow; sandalwood, limebush understorey - strongly gilgaied.
tall open forest of box; sandalwood, cypress, bulloak or acacias as understorey.
Unsuitable for cultivation.

APPENDIX II

LIMITATIONS FOR DRYLAND CROPPING AND DOMINANT SUITABILITY CLASS FOR GOODAR SHEET SOILS

Soil	Limitations	Class
Very gently undulating plateaus and plateau remnants on altered Tertiary rocks		
Arrowfield	m_4 nd_3 ps_3 k_2 r_{1-2} e_{2-3} a_{2-3}	4
Barclay	m_{2-3} nd_3 w_{2-3} ps_2 k_2 tm_{3-4} e_2	3
Bulgar	m_5 nd_4 ps_3 k_3 tg_{1-2} e_2 a_2	5
Flinton	m_4 nd_{3-4} ps_3 k_2 r_{1-2} e_{2-5} a_{2-5}	5,4
Ibon	m_4 nd_3 ps_3 k_2 r_2 e_{3-5} a_{2-3}	3,5
Karbullah	m_5 nd_4 ps_3 k_2 r_2 e_{3-5} a_5	5
Kegabilla	m_4 nd_3 ps_3 k_2 r_{1-2} e_{2-3} a_{2-3}	4
Minnabilla	m_5 nd_4 ps_3 k_2 r_{2-3} e_{3-5} a_5	5
Nareen	m_4 nd_3 ps_3 k_2 r_{1-2} e_{2-3} a_{2-3}	4
Trevanna	m_4 nd_3 ps_3 k_2 e_{2-3} a_{2-3}	3
Uranilla	m_5 nd_4 ps_3 k_2 e_{2-3} a_{2-3}	5
Widgewa	m_4 nd_3 ps_3 k_2 r_{1-2} e_{2-3} a_{2-5}	4,5
Gently undulating rises on Cretaceous sedimentary rocks		
Arden	m_2 nd_{1-2} tm_{1-2}	2
Bulimba	m_{2-3} nd_{1-2} w_{2-3} tg_{1-2} e_{1-2}	3
Butler	m_3 nd_2 ps_3 k_2 e_2 a_2	3
Calingunee	m_2 nd_2 ss_{1-2} w_{2-3} tm_{2-3} e_{2-3}	3
Coorang	m_4 nd_3 ps_3 k_{2-3} e_{2-3} a_{2-3}	3
Mandama	m_{2-4} nd_2 ss_{1-2} w_{1-2} ps_{2-3} k_{2-3} tm_{1-2} e_{2-3}	3,4
Morilla	m_{3-4} nd_3 ps_3 k_2 e_{2-3} a_{2-3}	3
Moruya	m_3 nd_2 ps_{2-3} k_2 e_{2-3} a_2	3
Mt Carmel	m_2 nd_2 ss_{1-2} e_{2-3} a_2	2,3
Portreath	m_2 nd_2 e_{2-3} a_2	2
Rockwood	m_2 nd_2 e_{2-3} a_2	2
Tarewinnabar	m_{2-3} nd_2 w_2 r_{1-2} e_{2-3}	3
Ukabilla	m_{3-4} nd_3 w_2 ps_3 k_3 r_{1-2} e_{2-3}	3
Wynhari	m_2 nd_2 e_{2-3}	2
Very gently undulating relict alluvial plains		
Banool	m_2 nd_2 a_2	2,3
Bendidee	m_5 nd_4 e_2 a_{2-4}	5
Bunker	m_4 nd_3 w_3 ps_2 k_3 tm_3	3

Soil	Limitations	Class
Dunlop	m_{2-3} nd_{2-3} w_{2-4} ps_{2-3} k_{2-3} tg_{1-2}	3,5
Lanky	m_{4-5} nd_4 w_2 f_{1-2} ps_3 k_3 a_{1-2}	5
Mooroolbark	m_4 nd_4 f_{1-2} ps_2 k_2 a_{2-3}	4
Pindari	m_{3-4} nd_3 ps_3 k_2 e_{1-2} a_2	3
Roe	m_4 nd_3 ps_2 k_2 a_{2-3}	3,5
Sturt	m_5 nd_4 f_{1-2} tg_{1-2} e_2 a_{2-4}	5
Wilga	m_4 nd_3 w_2 ps_{2-3} k_3 a_{1-2}	3,4
Wondalli	m_{2-4} nd_{2-3} w_{2-4} tm_{2-4}	3,4
Yarril	m_4 nd_3 f_{1-2} ps_3 k_2 tg_{1-2} a_2	3,5
Very gently undulating riverine plains		
Ballin	m_5 nd_4 e_2 a_4	5
Blacket	m_4 nd_3 ps_3 k_2 a_2	3
Brendle	m_5 nd_3 tg_{1-2} a_3	5
Crane	m_4 nd_3 w_2 ps_3 k_2 a_2	3
Doolanvale	m_2 nd_2 a_2	2,3
Herden	m_5 nd_4 ps_3 k_3 a_2	5
Marella	m_4 nd_2 ps_3 k_2 e_2 a_3	5
Oonavale	m_{3-4} nd_3 f_{1-2} ps_3 k_2 tg_{1-2} a_2	3,4
Salmond	m_4 nd_3 w_2 f_{1-2} ps_3 k_2 tg_{1-2} e_2 a_2	5
Wai Wai	m_5 nd_4 e_2 a_4	5
Wondoogle	m_5 nd_4 e_2 a_4	5
Yambocully	m_4 nd_2 f_{1-2} ps_3 k_2 tg_{1-2} a_3	3,5
Level riverine plains		
Callandoon	m_3 nd_2 w_3 ps_3 k_3 tm_2	3,5
Cooper	m_4 nd_2 w_3 ps_3 k_4	5
Crooked	m_{3-4} nd_{2-3} w_{2-3} ps_{2-3} k_3	3
Euroka	m_3 nd_{2-3} w_{4-5} ps_3 k_3 tg_{1-2} tm_{1-2}	5
Giddi Giddi	m_{3-4} nd_2 w_3 ps_3 k_3	5
Goodar	m_3 nd_2 w_2 ps_3 k_2	3
Macintyre	m_{3-4} nd_3 w_3 ps_3 k_4	5
Murriverie	m_4 nd_2 w_2 ps_3 k_3	3
Strathmore	m_{3-4} nd_3 w_{2-3} ps_2 k_2 tm_3	3
Teelabar	m_2 nd_2 w_2 ps_2 k_2	3
Undabri	m_2 nd_2 w_2 ps_2	3

LIMITATIONS FOR SOWN PASTURES AND DOMINANT SUITABILITY CLASS FOR GOODAR SHEET SOILS

Soil	Limitations	Class
Very gently undulating plateaus and plateau remnants on altered Tertiary rocks		
Arrowfield	m_3 nd_3 ps_3 k_2 e_2 v_{1-3}	3
Barclay	m_{1-2} nd_3 w_2 ps_2 k_2 tm_{2-3} e_{1-2} v_2	3,2
Bulgar	m_5 nd_4 ps_3 k_2 tg_{1-2} e_{1-2} v_3	5
Flinton	m_3 nd_{3-4} ps_3 k_2 e_{2-4} a_{2-3} v_{2-3}	3,5
Ibon	m_3 nd_3 ps_3 k_2 e_{2-4} v_{1-3}	3
Karbullah	m_5 nd_4 ps_3 k_2 r_2 e_{2-5} a_3 v_3	5
Kegabilla	m_3 nd_3 ps_3 k_2 e_2 v_{1-3}	3
Minnabilla	m_5 nd_4 ps_3 k_2 r_2 e_{2-5} a_3 v_3	5
Nareen	m_3 nd_3 ps_3 k_2 e_2 v_{1-3}	3
Trevanna	m_3 nd_3 ps_3 k_2 e_2 v_{1-3}	3
Uranilla	m_4 nd_4 ps_3 k_2 e_2 v_3	5
Widgewa	m_3 nd_3 ps_3 k_2 e_2 v_{1-3}	3,5
Gently undulating rises on Cretaceous sedimentary rocks		
Arden	nd_{1-2} v_{1-2}	1
Bulimba	m_{1-2} nd_{1-2} w_2 v_{1-2}	3
Butler	m_3 nd_2 ps_3 k_2 e_{1-2} v_{1-3}	3
Calingunee	nd_2 w_2 tm_2 e_{1-2} v_{1-2}	2
Coorang	m_3 nd_3 ps_3 k_2 e_2 v_{1-3}	3
Mandama	m_{1-3} nd_2 ps_{2-3} k_2 e_{1-2} v_{1-2}	2,3
Morilla	m_{2-3} nd_3 ps_3 k_2 e_2 v_{1-2}	3
Moruya	m_2 nd_2 ps_{2-3} k_2 e_{1-2} v_{1-2}	2
Mt Carmel	nd_2 e_{1-2} v_{1-2}	1
Portreath	nd_2 e_{1-2} v_{1-2}	1
Rockwood	nd_2 e_{1-2} v_{1-2}	1
Tarewinnabar	m_{1-2} nd_2 e_{1-2}	2
Ukabilla	m_{2-3} nd_3 ps_3 k_2 e_{1-2} v_{1-2}	3
Wynhari	nd_2 e_{1-2} v_{1-2}	1
Very gently undulating relict alluvial plains		
Banool	m_{1-2} nd_2 v_{1-2}	1,2
Bendidee	m_4 nd_4 a_3 v_3	5
Bunker	m_3 nd_3 w_2 ps_2 k_2 tm_2 v_{1-3}	3

Soil	Limitations	Class
Dunlop	m_{1-2} nd_{2-3} w_3 ps_{2-3} k_2 tg_{1-2}	3,5
Lanky	m_{3-4} nd_4 f_{1-2} ps_3 k_2 v_3	5
Mooroolbark	m_3 nd_4 f_{1-2} ps_2 k_2 v_{1-3}	3
Pindari	m_{2-3} nd_3 ps_3 k_2 v_{1-3}	3
Roe	m_3 nd_3 ps_2 k_2 a_2 v_{1-3}	3,5
Sturt	m_4 nd_4 f_{1-2} tg_{1-2} a_3 v_3	5
Wilga	m_3 nd_3 ps_{2-3} k_2 v_{1-2}	3
Wondalli	m_{1-3} nd_{2-3} w_{2-3} tm_{2-3} v_{1-3}	3,2
Yarril	m_3 nd_3 f_{1-2} ps_3 k_2 tg_{1-2} v_{1-3}	3,5
Very gently undulating riverine plains		
Ballin	m_4 nd_4 a_3 v_3	5
Blacket	m_3 nd_3 ps_3 k_2 v_3	3
Brendle	m_4 nd_3 tg_{1-2} a_2 v_3	5
Crane	m_3 nd_3 ps_3 k_2 v_{1-3}	3
Doolanvale	m_{1-2} nd_2 v_{1-2}	1,2
Herden	m_4 nd_4 ps_3 k_2 v_3	5
Marella	m_3 nd_2 ps_3 k_2 a_3 v_3	3
Oonavale	m_{2-3} nd_3 f_{1-2} ps_3 k_2 tg_{1-2} v_{1-3}	3
Salmond	m_3 nd_3 f_{1-2} ps_3 k_2 tg_{1-2} v_{2-3}	5
Wai Wai	m_4 nd_4 a_3 v_3	5
Wondoogle	m_4 nd_4 a_3 v_3	5
Yambocully	m_3 nd_2 f_{1-2} ps_3 k_2 tg_{1-2} a_2 v_{1-3}	3,5
Level riverine plains		
Callandoon	m_2 nd_2 w_{2-3} ps_3 k_2 v_{1-2}	3,5
Cooper	m_4 nd_2 w_2 ps_3 k_3 v_3	5
Crooked	m_3 nd_{2-3} w_2 ps_{2-3} k_2 v_2	3
Euroka	m_2 nd_2 w_{3-5} ps_3 k_2 tg_{1-2} v_3	5
Giddi Giddi	m_3 nd_2 w_2 ps_3 k_2 v_3	5
Goodar	m_2 nd_2 ps_3 k_2	3
Macintyre	m_3 nd_3 w_2 ps_3 k_3	5
Murriverie	m_3 nd_2 w_2 ps_3 k_2 v_2	3
Strathmore	m_{2-3} nd_3 w_2 ps_2 k_2 tm_2 v_2	3
Teelebar	nd_2 ps_2	2
Undabri	nd_2 ps_2	2

APPENDIX III

MORPHOLOGICAL AND ANALYTICAL DATA

SOIL PROFILE CLASS: Arrowfield
SITE NO: 491
A.M.G. REFERENCE: 247 000 mE 6 894 800 mN ZONE 56
GREAT SOIL GROUP: Solodic Soil
PRINCIPAL PROFILE FORM: Db1.43
SOIL TAXONOMY UNIT: Udic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Hypocalcic, Subnatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few medium pebbles, subrounded altered substrate material

SUBSTRATE MATERIAL: Altered substrate material
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Crest
LANDFORM PATTERN TYPE: Low plateau
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Eucalyptus pilligaensis, Eucalyptus populnea, Acacia harpophylla, Geijera parviflora, Aristida species, Stipa rudis

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Brown (7.5YR4/3); fine sandy loam; very few small pebbles, subrounded altered substrate material; massive; dry; very firm; common 1-2mm roots. Clear to-
A2e	.08 to .10 m	Dull yellowish orange (10YR7/2) dry; fine sandy loam; few medium pebbles, subrounded altered substrate material; massive; dry; very firm; common <1mm roots. Abrupt to-
B21	.10 to .45 m	Dark brown (10YR3/3); fine sandy medium clay; very few medium pebbles, subrounded altered substrate material; moderate 20-50mm angular blocky; dry; rigid; few <1mm roots. Gradual to-
B22	.45 to .60 m	Dull yellowish brown (10YR5/3); medium clay; moderate 10-20mm angular blocky; dry; moderately strong; very few medium calcareous soft segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m	%	%				m.eq/100g					%			%					m.eq/100g			
	@ 40C	@105C	@ 105C					@ 105C					@ 80C			@ 105C			@ 40C		@ 105C			@ 40C
B 0.10	6.2	.09	.004																					5.1
0.08	5.7	.08	.003	9	56	13	22	13	4.2	3.3	0.5	.52	.026	.149	.032	1.4		6	.46				9	4.5
0.10	5.5	.06	.002																					4.2
0.20	5.8	.09	.004																					4.4
0.30	6.5	.14	.011	8	48	13	31	14	5.6	5.5	1.4	.14	.006	.124	.010	1.8		9	.69				11	5.2
0.60	8.7	.38	.037	7	52	10	34	14	7.4	8.6	3.5	.10	.009	.146	.013	2.1		12	.78				19	7.4

Depth	Org.C (W&B)	Tot.N	Extr. P Acid Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg					m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	2.1	.14	2	.63		52	13	0.4	0.1												

* -1500kPa (-15 bar) using pressure plate apparatus.
Cation exchange capacity (CEC) and Exch. cations extracted with alcoholic 1M NH_4Cl at pH 8.5.

SOIL PROFILE CLASS: Ballin
SITE NO: 360
A.M.G. REFERENCE: 218 900 mE 6 894 800 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dy3.43
SOIL TAXONOMY UNIT: Arenic Haplustalf (?)
AUSTRALIAN SOIL CLASSIFICATION: Eutrophic, Mottled-Mesonatric, Grey Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Alluvium
SLOPE: 1.0 %
LANDFORM ELEMENT TYPE: Terrace
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Allocasuarina leuhmannii, Callitris glaucophylla, Eucalyptus populnea

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .25 m	Dull yellowish brown (10YR5/3); loamy fine sand; massive; dry; moderately weak. Diffuse to-
A2e	.25 to .48 m	Dull yellowish orange (10YR7/2) dry; loamy fine sand; massive; dry; very weak. Sharp to-
B21	.48 to .75 m	Greyish yellow-brown (10YR5/2), yellowish brown (10YR5/6); common medium distinct mottles; light medium clay; strong 50-100mm angular blocky; moderately moist; moderately strong. Gradual to-
B22	.75 to .90 m	Dull yellowish brown (10YR5/4), dark greyish yellow (2.5Y5/2); few fine distinct mottles; light medium clay; strong 20-50mm angular blocky; moderately moist; very strong. Gradual to-
B23	.90 to 1.60 m	Dull yellowish brown (10YR5/3), brown (7.5YR4/4); medium clay; moderate 20-50mm angular blocky; moderately moist; very strong.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*1	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
B 0.10	7.2	.04	.002																			6.3
0.10	7.3	.07	.004	11	80	4	7	5	2.8	.68	.11	.60	.022	.601	.013	.3	2	.47				6.5
0.30	7.3	.03	.003	9	82	4	7	3	2.1	.59	.09	.23	.002	.592	.007	.2	1	.50				6.5
0.60	7.1	.29	.035	6	69	7	23	10	4.8	3.6	1.9	.12	.002	.616	.012	.9	8	.87				5.9
0.90	8.2	.48	.059	2	63	11	28	15	9.0	5.9	3.9	.21	.004	.709	.015	1.4	11	.92				7.2
1.20	8.5	.34	.041	4	70	13	18	15	5.9	5.7	3.8	.23	.001	.633	.010	1.0						7.4
1.50	8.6	.28	.034																			7.3

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.				Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.1	.06	6		.18		7	12	0.1	0.2											

SOIL PROFILE CLASS: Banool
SITE NO: 1127
A.M.G. REFERENCE: 247 300 mE 6 870 700 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Db1.33
SOIL TAXONOMY UNIT: Udic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Sodic, Calcic, Brown Chromosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Casuarina cristata, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting, occasional periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1j	0 to .12 m	Brownish black (10YR3/2); fine sandy clay loam; massive; dry; moderately firm; few medium manganiferous nodules. Clear to-
B21	.12 to .20 m	Greyish yellow-brown (10YR4/2); medium clay; strong 10-20mm angular blocky; dry; very firm; few medium calcareous soft segregations. Clear to
B22	.20 to .65 m	Dull yellowish brown (10YR4/3); medium clay; strong 5-10mm angular blocky; dry; very firm; very few medium calcareous nodules. Gradual to-
B23	.65 to .95 m	Dull yellowish orange (10YR6/3); sandy medium heavy clay; strong 5-10mm angular blocky; moderately moist; moderately firm; few medium manganiferous veins. Diffuse to-
B24	.95 to 1.60 m	Dull yellowish brown (10YR5/3); few medium distinct yellow mottles; sandy medium clay; moderate 5-10mm angular blocky; moderately moist; moderately firm.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	6.5	.13	.004																					5.7
0.10	6.3	.16	.005	20	44	8	28	20	8.6	3.0	.17	1.8	.037	.536	.046	1.8		9	.23					5.5
0.30	8.0	.08	.002	20	35	7	38	22	9.3	6.2	0.4	1.7	.029	.520	.025	1.9		12	.42					6.9
0.60	9.3	.26	.003	21	36	7	35	20	6.7	9.1	2.6	.40	.018	.493	.027	2.1		13	.91					7.9
0.90	9.1	.43	.012	16	35	8	38	21	4.7	8.7	7.0	.21	.018	.484	.038	1.7		16	.99					7.7
1.20	5.6	.47	.020	18	37	8	33	20	3.4	6.4	6.4	.17	.014	.455	.026	1.6								4.6
1.50	5.2	.47	.029																					4.1

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	2.2	.17	109		1.7			86	46	1.2	1.3											

SOIL PROFILE CLASS: Barclay
SITE NO: 470
A.M.G. REFERENCE: 247 300 mE 6 900 100 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic-Endocidic, Self-mulching, Grey Vertosol
TYPE OF MICRORELIEF: Melonhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Low plateau
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Acacia harpophylla, Casuarina cristata

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR5/2); light medium clay; strong 2-5mm granular; dry; moderately weak; common <1mm roots. Abrupt to-
B21	.02 to .40 m	Greyish yellow-brown (10YR5/2); medium clay; strong 10-20mm angular blocky; dry; very firm; common <1mm roots. Gradual to-
B22	.40 to .70 m	Dull yellowish brown (10YR5/3); medium heavy clay; lenticular, parting to moderate 10-20mm angular blocky; moderately moist; very firm; few 1-2mm roots. Diffuse to-
B23	.70 to 1.65 m	Dull yellowish orange (10YR6/3); medium heavy clay; lenticular, parting to moderate 10-20mm angular blocky; moderately moist; very firm; few 1-2mm roots.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2				CaCl2
metres		dS/m	%			%			m.eq/100g					%			%					m.eq/100g			
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C		@ 40C			@ 105C		@ 40C
B 0.10	7.7	.20	.015																					6.7
0.10	7.0	.25	.020	5	36	15	48	26	21	5.4	1.8	1.2	.025	.378	.031	3.2	15		.39				27	6.2
0.30	6.0	.78	.080	3	33	12	55	27	16	6.9	3.0	.44	.007	.302	.019	3.6	17		.57				29	5.4
0.60	5.0	1.4	.166	3	30	11	58	28	11	8.3	5.5	.55	.004	.287	.019	3.0	19		.71				29	4.4
0.90	4.6	1.7	.208	2	29	14	58	30	12	8.7	6.7	.59	.001	.285	.017	3.0	20		.83				31	4.0
1.20	4.5	1.9	.249	2	27	10	60	28	8.8	8.5	7.6	.56	.001	.286	.018	3.3							32	3.9
1.50	4.4	2.1	.282																					3.9

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg			mg/kg				mg/kg				ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C			@ 105C				@ 105C			@ 40C		@ 105C				
B 0.10	1.4	.11	6	1.2			10	23	0.9	0.1											

SOIL PROFILE CLASS: Barclay
SITE NO: 489
A.M.G. REFERENCE: 247 800 mE 6 895 300 mN ZONE 56
GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.34
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Epiacidic, Self-mulching, Brown Vertosol
TYPE OF MICRORELIEF: *Melonhole gilgai*
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 2.0 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Low plateau
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Acacia harpophylla, Geijera parviflora, Aristida species, Stipa species

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Dark brown (10YR3/3); light medium clay; strong 2-5mm granular; dry; loose; common <1mm roots. Sharp to-
B21	.02 to .10 m	Dark brown (10YR3/3); heavy clay; strong 10-20mm angular blocky; moderately moist; moderately firm; common <1mm roots. Clear to-
B22	.10 to .40 m	Dull yellowish brown (10YR4/3); heavy clay; very few small pebbles, altered substrate material; moderate 20-50mm angular blocky; moderately moist; very firm; few 1-2mm roots. Gradual to-
B23	.40 to .80 m	Brown (10YR4/4); heavy clay; very few small pebbles, altered substrate material; moderate 50-100mm lenticular; moderately moist; very firm; few 1-2mm roots. Diffuse to-
B24	.80 to 1.75 m	Brown (7.5YR4/3); heavy clay; very few small pebbles, altered substrate material; moderate 50-100mm lenticular; moderately moist; very firm; few 1-2mm roots.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Exch ECEC Al	Acid		pH CaCl2
metres	@ 40C	dS/m	@105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	5.9	.21	.016																					5.1
0.10	5.9	.31	.025	5	24	7	61	36	17	10	1.8	2.5	.032	.546	.039	4.0		19	.37				33	5.2
0.20	4.9	.48	.048																					4.2
0.30	4.6	.78	.080	3	21	10	67	37	14	12	4.0	1.6	.071	.182	.024	3.9		21	.46				29	3.9
0.60	4.4	1.5	.196	3	20	8	69	36	6.0	11	6.7	1.7	.014	.457	.023	3.8		23	.54				32	3.8
0.90	4.3	1.9	.250	2	17	8	72	37	5.5	12	7.5	1.8	.014	.457	.025	4.6		25	.52				36	3.8
1.20	4.3	2.2	.297	1	13	8	75	39	6.4	11	8.6	2.0	.016	.485	.026	4.1							39	3.8
1.50	4.2	2.3	.338																					3.8

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C			mg/kg @ 105C				mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	2.4	.11	14		1.4			77	15	0.4	0.2											

SOIL PROFILE CLASS: Bendidee
SITE NO: 1201
A.M.G. REFERENCE: 250 000 mE 6 863 100 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dy5.43
SOIL TAXONOMY UNIT: Arenic Haplustalf (?)
AUSTRALIAN SOIL CLASSIFICATION: Melanic, Calcic, Grey Chromosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 1.0 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: Eucalyptus populnea, Callitris glaucophylla, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A1	0 to .35 m	Brownish black (10YR3/1); loamy sand; massive; dry; loose. Clear to-
A2j	.35 to .45 m	Greyish yellow-brown (10YR6/2) dry, greyish yellow-brown (10YR4/2); loamy sand; massive; dry; very weak. Clear to-
B21k	.45 to .90 m	Greyish yellow-brown (10YR5/2); few medium prominent yellow mottles; sandy light medium clay; moderate 10-20mm angular blocky; moist; moderately firm; few medium calcareous soft segregations, very few medium manganiferous nodules.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS %	S %	C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P % @ 80C	K %	S %	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Acid Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
B 0.10	6.4	.04	.001																		
0.10	5.9	.02	.001	43	46	3 9	6	2.6	.69	.09	.48	.085	.428	.056	.3 3	.40					
0.30	6.8	.01	.001	34	54	3 10	5	3.7	.51	.09	.21	.054	.450	.034	.3 2	.43					
0.60	7.8	.03	.001	30	41	1 27	12	9.7	2.3	.16	.52	.035	.528	.023	.8 8	.64					
0.90	8.7	.10	.001	27	45	1 25	10	8.5	2.3	.23	.55	.035	.571	.027	.6 8	.54					

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	1.1	0.1	26	.62			32	20	0.3	1.1											

SOIL PROFILE CLASS: Blacket
SITE NO: 985
A.M.G. REFERENCE: 205 800 mE 6 866 700 mN ZONE 56
GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dd1.43
SOIL TAXONOMY UNIT: Aquic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Subnatric, Black Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Alluvium
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus populnea, Eremophila mitchellii, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .06 m	Greyish yellow-brown (10YR4/2); fine sandy clay loam; massive; dry; moderately firm. Clear to-
A2e	.06 to .09 m	Dull yellowish orange (10YR7/2) dry; fine sandy clay loam; massive; dry; moderately firm. Clear to-
B21	.09 to .50 m	Brownish black (10YR3/1); medium heavy clay; strong 50-100mm columnar, parting to moderate 20-50mm angular blocky; dry; very strong. Gradual to-
B22k	.50 to 1.00 m	Greyish yellow-brown (10YR4/2); medium clay; moderate 20-50mm angular blocky; moderately moist; moderately firm; few medium calcareous concretions. Gradual to-
B23	1.00 to 1.50 m	Brownish grey (10YR5/1); few medium faint brown mottles; medium heavy clay; strong 10-20mm angular blocky; moderately moist; moderately firm; very few manganiferous veins, very few medium calcareous soft segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S % @ 105C	C	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)	Total Elements P	K	S (% @ 80C)	Moistures ADM	33*	1500* (% @ 105C)	Disp.Ratio R1 @ 40C	R2	Exch Al (m.eq/100g @ 105C)	Exch Acid	ECEC	pH CaCl2 @ 40C
metres																						
B 0.10	7.5	.12	.006																			6.4
0.09	7.0	.14	.012	12 43 19	26	20	8.4	3.6	.98	.98	.037	.698	.034	1.5		11	.65					5.8
0.30	7.2	.58	.070	5 23 13	59	37	16	8.5	4.9	.84	.025	.605	.036	3.5		23	.80					5.9
0.60	8.8	1.0	.092	4 13 15	66	43	19	10	8.0	.53	.021	.633	.058	3.8		27	.82					8.0
0.90	8.7	.74	.077	6 22 11	56	28	13	8.0	6.6	.55	.018	.687	.032	3.2		24	.99					7.8
1.20	8.1	.65	.074	8 29 11	48	29	12	7.5	6.0	.72	.017	.820	.031	2.0								7.3
1.50	8.0	.65	.069																			7.2

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B (mg/kg @ 105C)	Extractable SO4S	NO3N	NH4N (mg/kg @ 105C)	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)
metres																					
B 0.10	1.7	0.1	21	1.2			21	20	0.4	.28											

SOIL PROFILE CLASS: Bulimba
SITE NO: 614
A.M.G. REFERENCE: 233 600 mE 6 884 600 mN ZONE 56
GREAT SOIL GROUP: Affinities with grey clay
PRINCIPAL PROFILE FORM: Ug5.16
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous-Endohypersodic, Epipedal, Black Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Alluvium
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus populnea, Acacia pendula, Casuarina cristata, Dichanthium sericeum, Danthonia longifolia

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking, surface flake

HORIZON	DEPTH	DESCRIPTION
A1	0 to .12 m	Brownish black (10YR3/2); medium heavy clay; strong 20-50mm angular blocky; dry; moderately weak. Gradual to-
B21	.12 to .45 m	Brownish black (10YR3/1); heavy clay; moderate 20-50mm angular blocky; moderately moist; moderately firm; very few medium calcareous nodules. Diffuse to-
B22	.45 to .75 m	Brownish grey (10YR4/1); heavy clay; moderate 20-50mm angular blocky; moist; moderately firm; very few medium calcareous nodules. Gradual to-
B23y	.75 to .95 m	Greyish yellow-brown (10YR5/2); medium clay; moderate 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moist; moderately firm; few medium gypseous crystals. Gradual to-
B24	.95 to 1.60 m	Greyish yellow-brown (10YR5/2); common coarse distinct brown mottles; heavy clay; strong 50-100mm lenticular, parting to strong 5-10mm lenticular; moist; moderately firm; very few manganiferous veins.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	7.9	.14	.007										7.0
0.10	7.7	.19	.016	2 50 9 40	26 13 7.8 1.0 1.2	.042 .425 .038	2.2 14	.46					6.9
0.30	7.9	.84	.089	2 28 11 60	39 16 14 4.7 .86	.029 .405 .047	2.8 23	.63					7.3
0.60	8.5	1.4	.149		37 15 15 6.3 .57	.024 .359 .058	1.8 22						7.9
0.90	7.5	3.9	.141		30 14 12 5.7 .44	.023 .349 2.74	2.2 21						7.4
1.20	7.7	1.2	.146		33 11 12 6.0 .43	.020 .362 .066	2.5						7.1
1.50	5.9	1.2	.145										5.4

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.2	.08	14	1.2		14	15 .67 .37				

SOIL PROFILE CLASS: Bunker
SITE NO: 1483
A.M.G. REFERENCE: 242 200 mE 6 875 100 mN ZONE 56
GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.34
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic-Epiacidic, Epipedal, Brown Vertosol
TYPE OF MICRORELIEF: Melonhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Acacia harpophylla, Casuarina cristata, Geijera parviflora, Rhagodia parabolica

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A11	0 to .02 m	Greyish brown (7.5YR4/2); medium clay; moderate 10-20mm angular blocky; dry; moderately firm. Sharp to-
A12	.02 to .11 m	Brown (7.5YR4/3); heavy clay; strong 20-50mm angular blocky; dry; very firm. Clear to-
B21	.11 to .80 m	Dull yellowish brown (10YR4/3); heavy clay; moderate 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moderately moist; moderately strong. Diffuse to-
B22	.80 to 1.60 m	Brown (10YR4/4); heavy clay; moderate 50-100mm lenticular; moderately moist; moderately strong.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	CEC	Exch. Cations Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	5.9	.38	.034											5.2
0.10	5.3	.48	.054	6 23 14 61	35	14 9.5 2.4 1.4	.032 .254 .040	4.7 18	.31		0.1	0.1	29	4.8
0.30	4.9	.79	.103	6 24 12 60	34	9 9.8 5.1 .63	.025 .214 .031	3.9 20	.59		0.5	0.6	28	4.8
0.60	4.6	1.3	.201	6 23 12 62	32	6.7 8.6 7.5 .41	.024 .208 .028	4.7 21	.75		0.6	1.0	29	4.2
0.90	4.5	1.5	.231	7 25 12 58	31	5.8 7.6 7.7 .39	.023 .204 .025	4.4 20	.76		0.9	1.4	29	4.1
1.20	4.4	1.8	.274	5 23 14 62	33	4.5 7.6 8.7 .47	.024 .215 .024	4.6			1.3	1.9	30	4.0
1.50	4.4	1.8	.281											4.0

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	2.5	.15	42	1.5			81	41	.77	.76											

SOIL PROFILE CLASS: Butler
SITE NO: W17
A.M.G. REFERENCE: 234 200 mE 6 886 900 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dd2.43
SOIL TAXONOMY UNIT: Mollic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Gypsic, Mesonatric, Black Sodosol

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 1.5 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Gently undulating rises
VEGETATION: Tall open woodland of poplar box with occasional belah

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few coarse pebbles

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dark brown (10YR3/3) moist; fine sandy clay loam; very few large pebbles, rounded other, strong, dispersed; massive; dry; very firm; few 1-2mm roots. Abrupt to-
A2e	.05 to .08 m	Greyish yellow-brown (10YR5/2) moist, dull yellowish orange (10YR7/2) dry; fine sandy clay loam; massive; dry; very firm; few 1-2mm roots. Sharp to-
B21t	.08 to .27 m	Brownish black (10YR3/2) moist; heavy clay; weak 50-100mm prismatic, parting to strong 10-20mm angular blocky; dry; moderately strong; few 2-5mm roots. Clear to-
B22tk	.27 to .62 m	Brown (7.5YR4/3) moist; heavy clay; very few large pebbles, rounded other, strong, dispersed; moderate 20-50mm polyhedral; dry; moderately strong; very few medium calcareous soft segregations, very few medium calcareous nodules. Gradual to-
B23yn	.62 to .87 m	Dull brown (7.5YR5/4) moist; few medium faint grey mottles; medium clay; very few large pebbles, rounded other, strong, dispersed; moderate 2-5mm polyhedral; dry; very strong; many coarse gypseous crystals, very few coarse manganiferous veins. Clear wavy to-
B24	.87 to 1.50 m	Bright brown (7.5YR5/6) moist; many coarse distinct grey mottles, few medium prominent orange mottles; light medium clay; few medium pebbles, angular tabular sandstone, moderately strong, undisturbed; moderate 5-10mm polyhedral; wet; moderately weak.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C %	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K %	S %	Moistures ADM @ 105C	33* %	1500* %	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
Bulk 0.10	6.9	.13	.007																					
0.10	7.2	.05	.003	4	59	17	19	15	6.8	3.3	.50	.48	.017	.501	.018	1.0		6	.69					
0.30	7.9	.92	.116	2	30	11	57	46	16	19	7.2	.54	.021	.558	.058	2.9		24	.75					
0.60	8.5	1.6	.167	2	34	12	53	40	13	17	8.3	.50	.016	.525	.096	2.9		21	.78					
0.90	7.5	.38	.068	7	20	7	57	34	15	15	8.0	.49	.015	.491	3.25	5.0		22	.97					
1.20	5.8	.24	.007	1	35	14	48	39	11	14	7.5	.54	.019	1.04	.075	2.7								

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
Bulk 0.10	1.8	.13	22	15	.71			47	21	0.5	0.9											

SOIL PROFILE CLASS: Calingunee
SITE NO: W20
A.M.G. REFERENCE: 257 200 mE 6 894 500 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.15
SOIL TAXONOMY UNIT: Sodic Calciustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous-Endoacidic,
Self-mulching, Grey Vertosol

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 2.0 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises
VEGETATION: Tall open forest of brigalow with belah

TYPE OF MICRORELIEF: Melonhole gilgai
VERTICAL INTERVAL: 0.60 m
HORIZONTAL INTERVAL: 10 m
COMPONENT OF MICRORELIEF SAMPLED: Shelf
SURFACE COARSE FRAGMENTS: Few coarse pebbles

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking; weakly to moderately self mulching on mounds and in depressions with a weak surface flake after rain

HORIZON	DEPTH	DESCRIPTION
A11	0 to .05 m	Brownish black (10YR3/2) moist; medium clay; strong 2-5mm angular blocky, parting to strong <2mm granular; dry; moderately weak; common 1-2mm roots. Abrupt to-
A12	.05 to .20 m	Brownish black (10YR3/1) moist; medium heavy clay; few large pebbles, angular quartz, very strong, dispersed, very few large pebbles, angular sandstone, strong; strong 20-50mm angular blocky; moist; moderately weak; common 2-5mm roots. Clear to-
B21k	.20 to .60 m	Greyish yellow-brown (10YR4/2) moist; medium heavy clay; few large pebbles, angular quartz, very strong, dispersed; strong 20-50mm angular blocky; dry; moderately firm; common medium calcareous soft segregations; few 1-2mm roots. Diffuse to-
B22	.60 to 1.50 m	Brown (7.5YR4/3) moist; medium heavy clay; very few large pebbles, angular quartz, very strong, dispersed; moderate 100-200mm lenticular, parting to moderate 50-100mm polyhedral, parting to moderate 10-20mm lenticular; dry; very firm; few 1-2mm roots.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @105C	Cl % @105C	Particle Size CS FS S % @ 105C	C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P % @ 80C	K	S % @ 105C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
Bulk 0.10	7.4	.08	.002													
0.10	6.9	.07	.001	30 24 12 33		29 17 4.4 .24 .45	.064	.561	.049	1.7 13	.32					
0.30	9.1	.30	.007	21 20 8 50		35 24 11 .03 .73	.032	.381	.026	1.8 20	.80					
0.60	8.9	.54	.048	21 18 8 50		30 12 11 7.6 .33	.023	.365	.023	1.5 20	.94					
0.90	5.4	.88	.139	17 17 9 56		33 6.8 9.2 8.4 .30	.021	.363	.018	2.0 20	.94					
1.20	4.9	.80	.128	21 19 11 49		30 4.6 8.1 7.2 .34	.018	.370	.013	1.9						

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
Bulk 0.10	1.7	.18	26 18	.82			33	31	1.0	1.0											

SOIL PROFILE CLASS: Callandoon
SITE NO: 1317
A.M.G. REFERENCE: 209 300 mE 6 849 000 mN ZONE 56
GREAT SOIL GROUP: Affinities with grey clay
PRINCIPAL PROFILE FORM: Ug5.15
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Endocalcareous-
Endohypersodic, Epipedal, Black Vertosol
TYPE OF MICRORELIEF: Normal gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus coolabah

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Brownish black (10YR3/2); medium heavy clay; moderate 10-20mm angular blocky; moist; moderately firm. Sharp to-
A12	.03 to .12 m	Brownish black (10YR3/2); heavy clay; moderate 20-50mm angular blocky; moist; moderately firm. Gradual to-
B21	.12 to .48 m	Brownish black (10YR3/2); heavy clay; moderate 50-100mm lenticular, parting to moderate 5-10mm lenticular; moderately moist; moderately strong. Gradual to-
B22k	.48 to 1.00 m	Dull yellowish brown (10YR4/3); medium heavy clay; moderate 5-10mm lenticular; moist; moderately weak; few medium calcareous concretions. Diffuse to-
B23	1.00 to 1.50 m	Dark brown (10YR3/3); medium clay; strong 5-10mm lenticular; moist; moderately weak; few manganiferous veins.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C (% @ 105C)	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)	Total Elements P	K	S (% @ 80C)	Moistures ADM	33*	1500* (% @ 105C)	Disp.Ratio R1	R2 (@ 40C)	Exch Al (m.eq/100g @ 105C)	Exch Acid	ECEC	pH CaCl2 @ 40C
B 0.10	6.7	.12	.005																					5.6
0.10	7.0	.08	.003	10	9	21	60	38	17	11	1.2	1.1	.048	1.44	.031	3.3	19		.60					5.7
0.30	8.3	.27	.026	6	7	21	65	40	20	12	3.9	.40	.034	1.39	.027	3.7	21		.66					7.3
0.60	8.4	1.0	.089	5	4	28	64	36	16	12	5.5	.43	.043	1.59	.043	3.0	19		.64					7.7
0.90	8.3	.88	.106	3	5	34	57	32	14	11	5.4	.45	.057	1.79	.025	2.8	19		.77					7.6
1.20	8.2	.81	.100	4	6	33	53	31	13	10	5.5	.43	.053	1.80	.022	2.4								7.3
1.50	8.0	.79	.094																					7.2

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B (mg/kg @ 105C)	Extractable SO4S	NO3N	NH4N (mg/kg @ 105C)	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)
B 0.10	1.8	.09	73	1.1			146	30	3.3	.80											

SOIL PROFILE CLASS: Cooper
SITE NO: 932
A.M.G. REFERENCE: 216 000 mE 6 860 300 mN ZONE 56
GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.34
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic-Endoacidic, Epipedal, Brown Vertosol
TYPE OF MICRORELIEF: Crabhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Mid-high isolated trees
DOMINANT SPECIES: Acacia harpophylla, Eucalyptus coolabah

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking, surface crust

HORIZON	DEPTH	DESCRIPTION
A1	0 to .03 m	Dark brown (10YR3/3); heavy clay; moderate 10-20mm angular blocky; dry; moderately strong. Sharp to-
B21	.03 to .30 m	Dark brown (10YR3/3); heavy clay; moderate 50-100mm angular blocky; dry; moderately strong. Gradual to-
B22	.30 to .70 m	Dull yellowish brown (10YR4/3); heavy clay; moderate 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moderately moist; very firm; very few manganiferous veins. Gradual to-
B23	.70 to 1.60 m	Brown (10YR4/4); medium heavy clay; moderate 50-100mm lenticular, parting to moderate 10-20mm lenticular; moderately moist; very firm.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
metres																								
B 0.10	6.2	.56	.073										.057	.631	.037	3.2	20		.43			31		5.5
0.10	6.3	.65	.100	4	11	20	63	39	13	11	2.9	.91	.035	.581	.037	3.4	24		.66			34		5.6
0.30	5.7	1.7	.275	3	9	19	69	39	10	10	6.7	.49	.028	.589	.037	3.8	25		.78			35		5.1
0.60	5.4	2.0	.327	3	9	19	67	38	9	10	7.4	.49	.029	.600	.033	2.3	25		.78			33		5.0
0.90	5.2	2.2	.360	1	7	22	64	37	8.1	10	7.4	.50	.029	.604	.032	2.8						33		4.7
1.20	4.9	2.2	.364	1	7	24	65	35	7.5	9.5	7.5	.50												4.5
1.50	4.7	2.1	.344																					4.3

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn mg/kg @ 105C	Cu mg/kg @ 105C	Zn mg/kg @ 105C	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C
metres																						
B 0.10	1.5	.09		58	.74			57	175	1	.79											

SOIL PROFILE CLASS: Coorang
SITE NO: 1536
A.M.G. REFERENCE: 234 400 mE 6 883 500 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Db1.42
SOIL TAXONOMY UNIT: Udic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Eutrophic, Subnatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few medium pebbles, altered substrate material

SUBSTRATE MATERIAL:
SLOPE: 0.75 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Rises
VEGETATION
STRUCTURAL FORM: Tall open woodland
DOMINANT SPECIES: Eucalyptus populnea, Casuarina cristata, Eremophila mitchellii, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .11 m	Greyish brown (7.5YR4/2); fine sandy clay loam; massive; dry; very firm. Clear to-
A2e	.11 to .14 m	Light brownish grey (7.5YR7/2) dry; fine sandy clay loam; massive; dry; moderately strong. Abrupt to-
B21	.14 to .32 m	Brown (7.5YR4/3); medium heavy clay; moderate 20-50mm angular blocky; dry; very strong. Gradual to-
B22	.32 to .75 m	Greyish yellow-brown (10YR4/2); medium heavy clay; moderate 10-20mm angular blocky; moderately moist; very firm; very few manganiferous veins. Gradual to-
B23	.75 to 1.60 m	Dull yellowish brown (10YR4/3); heavy clay; moderate 20-50mm angular blocky; moderately moist; moderately strong.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C (%) @ 105C	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g) @ 105C	Total Elements P	K	S (%) @ 80C	Moistures ADM	33*	1500* (%) @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al (m.eq/100g) @ 105C	Exch Acid (m.eq/100g) @ 105C	ECEC (m.eq/100g) @ 105C	pH CaCl2 @ 40C
B 0.10	6.7	.08	.009										.039	.178	.032	1.8		6	.41				11	5.7
0.10	6.8	.13	.015	10	57	14	23	14	6.9	3.6	0.5	.50	.039	.178	.032	1.8		6	.41				11	5.9
0.30	6.7	.56	.070	6	40	11	49	28	9.8	8.6	4.0	.20	.024	.164	.047	3.4		16	.68				27	5.9
0.60	7.7	.92	.098	6	40	12	48	29	11	10	5.9	.17	.018	.157	.055	3.4		17	.88				31	6.9
0.90	5.1	1.0	.111	5	39	11	48	25	8.5	7.4	5.4	.16	.016	.169	.056	3.9		17	.77		0.1	0.2	26	4.5
1.20	4.7	.94	.109	5	40	12	48	24	6.0	6.6	5.0	.14	.017	.164	.052	3.5					0.5	0.8	23	4.1
1.50	4.5	.93	.110																					4.0

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B (mg/kg @ 105C)	Extractable SO4S	NO3N	NH4N (mg/kg @ 105C)	P Buff Cap	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)
B 0.10	1.3	.05	10	0.4			18	37	.47	.42											

SOIL PROFILE CLASS: Crane
SITE NO: 824
A.M.G. REFERENCE: 209 800 mE 6 878 300 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Db1.43
SOIL TAXONOMY UNIT: Udic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Subnatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus populnea, Eremocitrus glauca, Dichanthium sericeum, Chloris truncata

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Greyish yellow-brown (10YR4/2); fine sandy clay loam; massive; moderately moist; moderately firm. Sharp to-
A2e	.07 to .09 m	Dull yellowish orange (10YR7/2) dry; fine sandy clay loam; massive; moderately moist; moderately firm. Abrupt to-
B21	.09 to .40 m	Dark brown (10YR3/3); medium heavy clay; moderate 20-50mm angular blocky; dry; very strong. Gradual to-
B22	.40 to .80 m	Dull yellowish brown (10YR4/3); medium heavy clay; moderate 10-20mm angular blocky; dry; moderately strong; very few fine calcareous soft segregations. Gradual to-
B23k	.80 to 1.50 m	Dull yellowish brown (10YR5/4); few medium distinct brown mottles; medium clay; strong 10-20mm angular blocky; dry; moderately strong; few medium calcareous concretions.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	7.4	.10	.004									6.3
0.09	7.2	.08	.003	19 44 15 25	16 10 3.2 .43 .92	.041 .600 .038	1.3 8	.41				6.2
0.30	8.3	.26	.027	10 28 13 52	31 22 6.8 3.6 .60	.031 .510 .033	2.4 18	.58				7.2
0.60	8.7	.90	.111	13 38 12 38	22 14 6.0 4.9 .30	.021 .544 .041	2.0 14	.84				7.8
0.90	9.0	.97	.103	14 36 10 38	22 13 5.9 5.8 .32	.021 .546 .043	2.2 15	.90				8.0
1.20	9.0	.88	.098	13 37 10 37	24 13 5.7 6.0 .30	.021 .543 .031	1.5					8.0
1.50	9.0	.95	.109									8.0

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.3	.09	7	.99			26 16 .54 .25				

SOIL PROFILE CLASS: Crooked
SITE NO: 1309
A.M.G. REFERENCE: 212 400 mE 6 859 000 mN ZONE 56
GREAT SOIL GROUP: Affinities with grey clay
PRINCIPAL PROFILE FORM: Ug5.16
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic, Epipedal, Black Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus coolabah, Alectryon oleifolius

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .06 m	Brownish black (10YR3/2); medium heavy clay; moderate 10-20mm angular blocky; moderately moist; very firm. Clear to-
B21	.06 to .40 m	Brownish black (10YR3/2); medium heavy clay; moderate 20-50mm angular blocky; dry; very strong. Gradual to-
B22	.40 to .80 m	Greyish yellow-brown (10YR4/2); medium heavy clay; strong 50-100mm lenticular, parting to strong 5-10mm lenticular; moderately moist; very firm. Gradual to-
B22	.80 to 1.60 m	Dull yellowish brown (10YR4/3); medium heavy clay; moderate 20-50mm lenticular; moderately strong.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Exch ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g		
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C		@ 40C		@ 105C		@ 40C
B 0.10	7.2	.14	.008																			6.1
0.10	7.5	.12	.007	3	17	23	59	43	17	10	2.6	1.5	.038	.752	.030	3.9	21		.74			6.3
0.30	8.4	.84	.100	1	14	23	62	40	17	9	7.0	.76	.028	.685	.039	2.6	22		.76			7.7
0.60	8.1	1.6	.215	1	13	26	59	32	13	9.0	7.0	.56	.021	.669	.035	2.7	21		.79			7.6
0.90	7.1	1.6	.211	1	15	30	54	30	11	8.5	7.0	.50	.022	.708	.034	2.2	20		.89			6.7
1.20	5.8	1.6	.110	1	12	26	57	32	11	8.8	7.7	.48	.027	.765	.033	2.9						5.4
1.50	5.7	1.6	.211																			5.2

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable		P	Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	2	.14	59	1.2			50	58	1.4	.50											

SOIL PROFILE CLASS: Doolanvale
SITE NO: 825
A.M.G. REFERENCE: 210 500 mE 6 870 000 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Db1.13
SOIL TAXONOMY UNIT: Vertic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Sodic, Calcic, Brown Chromosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Casuarina cristata, Owenia acidula, Eucalyptus populnea

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Greyish yellow-brown (10YR4/2); light sandy clay loam; massive; moist; moderately weak. Abrupt to-
B21	.08 to .40 m	Dull yellowish brown (10YR4/3); medium heavy clay; strong 20-50mm angular blocky; moderately moist; moderately firm. Gradual to-
B22k	.40 to .80 m	Greyish yellow-brown (10YR4/2); medium heavy clay; moderate 20-50mm angular blocky; moderately moist; moderately firm; few medium calcareous soft segregations. Gradual to-
B23	.80 to 1.40 m	Brownish grey (10YR4/1); sandy medium clay; strong 10-20mm angular blocky; dry; moderately strong; very few medium calcareous soft segregations, very few manganiferous veins. Diffuse to-
B24	1.40 to 1.60 m	Greyish yellow-brown (10YR5/2); sandy medium clay; strong 10-20mm angular blocky; dry; moderately strong; very few manganiferous veins.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m	@105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C		@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	6.7	.12	.002																				5.4
0.08	5.6	.13	.001	36	34	9	22	16	5.9	2.3	.13	1.2	.053	.432	.040	1.3	7	.41					4.8
0.30	8.0	.24	.013	27	24	9	42	31	16	8.1	.25	1.1	.040	.420	.034	2.0	15	.48					6.8
0.60	8.8	1.0	.087	29	23	7	41	25	13	9.0	4.8	.29	.020	.334	.059	2.2	14	.74					8.0
0.90	8.9	.88	.080	28	22	8	39	25	12	8.6	5.8	.33	.020	.403	.041	2.4	15	.97					7.8
1.20	8.1	.77	.081	25	22	11	41	28	14	8.5	7.1	.35	.019	.426	.037	2.7							7.2
1.50	7.7	.68	.078																				6.8

Depth	Org.C (W&B)	Tot.N	Extr. P Acid Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C	meq% @105C	mg/kg @ 105C			mg/kg @ 105C				mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	2	.13	60	1.3			59	68	1.3	1.8											

SOIL PROFILE CLASS: Dunlop
SITE NO: 1255
A.M.G. REFERENCE: 237 900 mE 6 856 700 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic-Epicalcareous, Self-mulching, Grey Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.2 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Mid-high isolated trees
DOMINANT SPECIES: Acacia harpophylla, Casuarina cristata, Eucalyptus pilligaensis

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Brownish black (10YR3/1); medium heavy clay; strong 2-5mm granular; dry; moderately weak. Sharp to-
A12	.03 to .10 m	Brownish black (10YR3/1); medium heavy clay; moderate 20-50mm angular blocky; dry; very strong. Clear to-
B21	.10 to .45 m	Brownish grey (10YR4/1); heavy clay; few small pebbles, rounded quartz; moderate 10-20mm angular blocky; dry; very strong; very few fine calcareous soft segregations, very few medium calcareous nodules. Gradual to-
B22	.45 to .90 m	Greyish yellow-brown (10YR4/2); heavy clay; weak 20-50mm lenticular, parting to moderate 10-20mm angular blocky; dry; very strong. Clear to-
B23	.90 to 1.20 m	Greyish yellow-brown (10YR6/2); medium heavy clay; 50-100mm lenticular; moderately moist; moderately strong. Gradual to-
B24	1.20 to 1.50 m	Greyish yellow-brown (10YR6/2); medium heavy clay; moderate 10-20mm angular blocky; moderately moist; moderately strong.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS % @ 105C	S % @ 105C	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	7.2	.12	.007																				5.9
0.10	6.7	.34	.043	11	37	8 44	32	12	7.0	2.9	.98	.042	.548	.045	2.7	15		.53					5.8
0.31	8.7	1.0	.176	8	33	10 50	32	12	8.7	7.4	.49	.031	.498	.048	4.1	18		.89					7.8
0.60	8.6	1.3	.161	6	31	10 55	33	11	9.2	8.9	.44	.022	.498	.047	3.2	19		.95					7.8
0.90	7.5	1.1	.151	4	34	15 52	29	10	7.9	8.6	0.4	.019	.527	.038	4.1	18		.93					6.9
1.20	6.4	.97	.131	6	38	16 45	24	8	6.3	7.0	.35	.017	.539	.036	3.1								5.6
1.50	5.2	.95	.129																				4.5

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn mg/kg @ 105C	Cu mg/kg @ 105C	Zn mg/kg @ 105C	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C
B 0.10	1.7	.07	35	.85			34	68	1.8	.54											

SOIL PROFILE CLASS: Euroka
SITE NO: 997
A.M.G. REFERENCE: 220 200 mE 6 858 200 mN ZONE 56
GREAT SOIL GROUP: Affinities with grey clay
PRINCIPAL PROFILE FORM: Ug3.1
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Endocalcareous-
Endohypersodic, Epipedal, Black Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS:

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Very tall sparse shrubland
DOMINANT SPECIES: Eucalyptus coolabah, Muehlenbeckia cunninghamii

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1e	0 to .07 m	Greyish yellow-brown (10YR5/2); medium clay; moderate 10-20mm angular blocky; moist; moderately firm. Abrupt to-
B21	.07 to .50 m	Brownish black (10YR3/1); heavy clay; moderate 20-50mm angular blocky; moist; very firm. Gradual to-
B22	.50 to 1.15 m	Brownish grey (10YR4/1); medium heavy clay; moderate 50-100mm lenticular; moderately moist; moderately strong; very few medium calcareous soft segregations. Gradual to-
B23	1.15 to 1.50 m	Brownish black (10YR3/2); heavy clay; moderate 50-100mm lenticular, parting to moderate 10-20mm angular blocky; moderately moist; moderately strong; few manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2				CaCl2
metres		dS/m	%		%				m.eq/100g					%			%					m.eq/100g		
	@ 40C		@105C		@ 105C				@ 105C					@ 80C			@ 105C		@ 40C			@ 105C		@ 40C
B 0.10	7.1	.09	.004																					5.8
0.07	6.9	.08	.003	2	19	21	59	37	17	8.7	1.6	1.2	.048	1.26	.035	2.9		21	.72					5.7
0.30	8.7	.22	.017	1	16	20	65	38	22	9.7	4.0	.58	.031	1.21	.026	2.9		22	.84					7.5
0.60	8.3	.87	.101	1	16	22	61	36	18	9.7	6.8	.48	.027	1.22	.033	3.1		22	.82					7.6
0.90	7.7	1.4	.174	1	17	24	58	34	14	9.4	7.4	.35	.026	1.27	.037	3.1		21	.89					7.3
1.20	5.9	1.5	.199	1	13	27	57	35	13	9.2	7.4	.33	.029	1.34	.037	3.6								5.4
1.50	5.7	1.6	.200																					5.2

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.				Extractable			P	Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg				ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.4	.09	33	0.9			47	60	2.0	.43											

SOIL PROFILE CLASS: Giddi Giddi
SITE NO: 905
A.M.G. REFERENCE: 215 300 mE 6 867 900 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug3.2
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Endohypersodic, Epipedal Grey Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus coolabah

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1j	0 to .08 m	Greyish yellow-brown (10YR4/2); medium clay; moderate 10-20mm angular blocky; dry; moderately strong. Clear to-
B21	.08 to .40 m	Brownish grey (10YR4/1); medium heavy clay; moderate 20-50mm angular blocky; dry; moderately strong. Gradual to-
B22	.40 to .90 m	Dark brown (10YR3/3); medium heavy clay; 50-100mm lenticular parting to moderate 20-50mm angular blocky; moderately moist; very firm. Gradual to-
B23	.90 to 1.50 m	Dull yellowish brown (10YR4/3); medium clay; strong 10-20mm angular blocky; moderately moist; moderately firm; very few manganiferous veins.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	% @105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	6.4	.08	.006	2	11	24	59	34	13	9.1	1.8	1.0	.071	.710	.044	3.6	22		.56			26		5.0
0.08	6.4	.09	.004	2	12	20	66	40	14	10	4.7	.40	.039	.550	.037	2.5	23		.69			30		4.9
0.30	5.8	.60	.081	1	13	21	66	40	13	10	7.1	.40	.031	.552	.045	3.0	24		.62			34		5.3
0.60	7.1	1.4	.197	1	22	19	57	36	13	11	7.3	.39	.023	.567	.044	3.4	26		.87			35		6.6
0.90	7.0	1.2	.174	1	27	22	48	30	10	8.9	6.7	.37	.022	.605	.033	3.1						33		6.3
1.20	5.7	1.2	.180																					4.9
1.50																								

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	Fe	DTPA-extr. Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C			mg/kg @ 105C				mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	1.8	.11	45		.78			115	56	.82	.98											

SOIL PROFILE CLASS: Goodar
SITE NO: 933
A.M.G. REFERENCE: 217 300 mE 6 872 700 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Uf3
SOIL TAXONOMY UNIT: Udic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Sodic, Eutrophic, Grey Dermosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Level plain <9m
VEGETATION
STRUCTURAL FORM: Mid-high isolated trees
DOMINANT SPECIES: Eucalyptus coolabah, Eucalyptus populnea, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Greyish yellow-brown (10YR4/2); silty light clay; moderate 10-20mm angular blocky; moderately moist; moderately firm. Clear to-
A2j	.08 to .10 m	Greyish yellow-brown (10YR6/2) dry; silty light clay; moderate 10-20mm angular blocky; dry; very firm. Sharp to-
B21	.10 to .60 m	Brownish black (10YR3/2); medium heavy clay; moderate 20-50mm angular blocky; dry; moderately strong. Gradual to-
B22	.60 to 1.20 m	Greyish yellow-brown (10YR4/2); medium clay; moderate 10-20mm angular blocky; moderately moist; very firm. Gradual to-
B23	1.20 to 1.60 m	Dark brown (10YR3/3); medium clay; strong 10-20mm angular blocky; moderately moist; moderately firm; very few manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33* 1500*	R1	R2	Al Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%			m.eq/100g	
	@ 40C		@105C	@ 105C				@ 105C					@ 80C			@ 105C		@ 40C		@ 105C	@ 40C
B 0.10	6.5	.12	.004										.056	.759	.036	2.6	15	.53			5.4
0.10	6.4	.07	.001	7	32	26	37	24	11	5.2	.50	.77	.040	.628	.030	2.3	22	.57		16	5.3
0.30	6.5	.24	.028	2	20	22	58	38	18	8.8	2.5	.29	.040	.680	.040	2.3	20	.57		28	5.4
0.60	7.5	.46	.053	2	31	21	48	32	16	8.7	2.8	.26	.037	.694	.031	2.4	19	.68		28	6.7
0.90	7.3	.39	.046	3	36	21	40	28	13	7.3	3.0	.24	.036	.680	.031	2.6				25	6.4
1.20	6.5	.39	.045	3	39	19	37	29	12	6.9	2.9	.19								24	5.5
1.50	6.6	.35	.040																		5.5

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.5	.11	64	.71			45	29	.38	.43											

SOIL PROFILE CLASS: Karbullah
SITE NO: W23
A.M.G. REFERENCE: 246 600 mE 6 890 800 mN ZONE 56
GREAT SOIL GROUP: Lithosol
PRINCIPAL PROFILE FORM: Uc1.24
SOIL TAXONOMY UNIT: Lithic Ustorthent
AUSTRALIAN SOIL CLASSIFICATION: Paralithic, Leptic Rudosol

SUBSTRATE MATERIAL: Deeply weathered sedimentary rocks
SLOPE: 15 %
LANDFORM ELEMENT TYPE: Hillcrest
LANDFORM PATTERN TYPE: Undulating to rolling rises and low hills
VEGETATION: Tall woodland of silver leaved ironbark, narrow leaved ironbark, poplar box and cypress pine

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Many cobbles

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Firm to hardsetting

HORIZON	DEPTH	DESCRIPTION
A11	0 to .12 m	Brownish black (10YR2/2) moist; sandy loam; abundant cobbles, subangular sandstone, moderately strong, undisturbed; massive; dry; moderately weak; few <1mm roots. Clear smooth to-
A12	.12 to .35 m	Brownish black (10YR2/3) moist, brownish grey (10YR6/1) dry; loamy sand; abundant cobbles, subangular sandstone, moderately strong, undisturbed; massive; dry; moderately firm. Abrupt smooth to-
C	.35 to .45 m	Weathered sandstone and siltstone.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33* 1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C	@ 40C
0.10	6.3	.02	.001	20	62	3	10	8	3.5	.84	.05	.31	.016	.140	.023	0.4	4	.34				
0.30	6.6	.03	.001	29	52	7	10	6	2.6	.87	.06	.35	.008	.092	.018	0.3	4	.62				

SOIL PROFILE CLASS: Lanky
SITE NO: 463
A.M.G. REFERENCE: 252 600 mE 6 884 600 mN ZONE 56
GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dy2.43
SOIL TAXONOMY UNIT: Typic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Mesonatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus populnea, Casuarina cristata, Allocasuarina leuhmannii, Eremophila mitchellii, Chloris species, Aristida species

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Brown (7.5YR4/3); sandy loam; massive; dry; moderately firm; common <1mm roots. Abrupt to-
A2e	.08 to .10 m	Light grey (10YR8/2) dry; sandy loam; massive; dry; moderately firm; common <1mm roots. Clear irregular to-
B21	.10 to .35 m	Dull yellowish brown (10YR5/4), dull yellowish brown (10YR4/3); very few medium distinct brown mottles; sandy medium clay; very few medium pebbles, subrounded altered substrate material; strong 100-200mm columnar; dry; very strong; few <1mm roots. Gradual to-
B22k	.35 to .80 m	Brown (10YR4/4); sandy light medium clay; moderate 20-50mm angular blocky; moderately moist; moderately strong; few medium calcareous concretions; few 1-2mm roots. Diffuse to-
B23	.80 to 1.50 m	Dull yellowish orange (10YR6/3), greyish yellow-brown (10YR6/2); common coarse distinct mottles; sandy light medium clay; moderate 20-50mm angular blocky; moderately moist; moderately strong; very few medium manganiferous soft segregations.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al @ 105C	Exch Acid @ 105C	ECEC m.eq/100g @ 105C	pH CaCl2 @ 40C
B 0.10	6.8	.04	.001										6.0
0.08	6.8	.04	.001	21 47 13 19	13 5.0 2.7 .31 .58	.041 .202 .018	1.2	7	.67				5.6
0.10	6.9	.04	.002	20 50 15 17	10 3.7 2.5 .54 .44	.019 .173 .014	.80	5	.59				5.5
0.30	6.5	.28	.031	24 38 10 32	16 4.9 4.7 3.1 .19	.004 .173 .015	1.3	11	.81				5.3
0.60	9.2	.63	.053	20 40 9 33	17 7.5 7.0 5.7 .15	.004 .194 .024	1.9	13	.76				8.0
0.90	9.2	.67	.057	14 35 13 42	23 8.1 8.4 7.1 .19	.005 .236 .022	3.3	15	.83				7.9
1.20	5.7	.60	.066	13 35 12 40	17 5.3 6.2 5.8 .14	.001 .205 .025	2.1						4.7
1.50	5.2	.53	.053										4.2

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.5	.09	11	.28			29 62 0.6 0.9				

SOIL PROFILE CLASS: Macintyre
SITE NO: W13
A.M.G. REFERENCE: 224 400 mE 6 850 600 mN ZONE 56
GREAT SOIL GROUP: Affinities with grey clay
PRINCIPAL PROFILE FORM: Ug5.16
SOIL TAXONOMY UNIT: Chromic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Endocalcareous, Epipedal, Grey Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Clay alluvium
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Level alluvial plain
VEGETATION: Tussock grassland of hoop mitchell grass and Queensland bluegrass with occasional coolibah

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking; hardsetting or weakly self mulching with a weak surface flake after rain

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Brownish black (10YR3/2) moist; heavy clay; strong 5-10mm angular blocky largest peds; dry; very weak.
A12	.01 to .10 m	Brownish black (10YR3/2) moist; heavy clay; strong 50-100mm angular blocky; dry; very strong; common 1-2mm roots. Clear to-
B21	.10 to .70 m	Greyish yellow-brown (10YR4/2) moist; heavy clay; weak 20-50mm lenticular, parting to moderate 10-20mm lenticular; moist; moderately firm; few 1-2mm roots. clear wavy to-
B22k	.70 to 1.05 m	Greyish yellow-brown (10YR4/2) moist; heavy clay; moderate 20-50mm polyhedral, parting to moderate 10-20mm polyhedral largest peds; dry; very strong; very few medium calcareous soft segregations. Gradual wavy to-
B23k	1.05 to 1.50 m	Dull yellowish brown (10YR4/3) moist; heavy clay; moderate 20-50mm polyhedral, parting to moderate 10-20mm polyhedral; dry; moderately strong; very few medium calcareous soft segregations.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g	Ca m.eq/100g	Mg m.eq/100g	Na m.eq/100g	K m.eq/100g @ 105C	Total Elements P %	K %	S % @ 80C	Moistures ADM % @ 105C	33* %	1500* %	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
Bulk 0.10	7.2	.08	.001																					
0.10	7.6	.06	.001	1	8	23	67	45	21	15	1.2	1.1	.024	1.25	.016	3.8								
0.30	8.3	.07	.001	1	8	24	67	46	23	16	2.5	.62	.019	1.21	.013	3.9		21	.60					
0.60	8.6	.10	.003	1	8	23	69	47	23	16	3.0	.59	.018	1.21	.013	3.7		22	.64					
0.90	8.6	.35	.035	1	6	23	70	45	23	17	4.5	.61	.018	1.25	.019	3.4		21	.67					
1.20	8.4	.39	.046	1	10	23	64	41	18	14	3.5	.20	.025	1.48	.012	3.2		20	.77					

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg	DTPA-extr. Fe mg/kg @ 105C	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
Bulk 0.10	0.9	.08	15	12	1.1			43	43	1.5	0.5											

SOIL PROFILE CLASS: Mandama
SITE NO: 596
A.M.G. REFERENCE: 234 700 mE 6 893 800 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.25
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Epihypersodic-Endoacidic Self-mulching, Grey Vertosol
TYPE OF MICRORELIEF: Normal gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Scarp footslope
LANDFORM PATTERN TYPE: Escarpment
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Acacia Harpophylla, Casuarina cristata, Eremophila mitchellii, Geijera parviflora, Chloris species, Sporobolus caroli

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Brownish black (10YR3/2); medium clay; strong 10-20mm angular blocky; dry; very firm. Clear to-
B21k	.05 to .41 m	Brownish grey (10YR4/1); medium heavy clay; 50-100mm lenticular, parting to strong 10-20mm angular blocky; dry; very firm; few fine calcareous soft segregations. Gradual to-
B22	.41 to .80 m	Greyish yellow-brown (10YR4/2); medium heavy clay; 50-100mm lenticular; moderately moist; very firm. Diffuse to-
B23	.80 to 1.65 m	Brown (10YR4/4); medium heavy clay; 50-100mm lenticular; moist; moderately firm.

Depth metres	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS %	S %	C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P % @ 80C	K %	S %	Moistures ADM 33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	7.2	.20	.005																			6.3
0.10	7.6	.12	.002	3	33	11 51	36	20	10	1.2	2.6	.045	.805	.045	2.7	21	.29					6.7
0.30	9.2	.58	.048	2	27	11 55	35	15	16	6.7	1.1	.032	.627	.049	2.2	25	.71					8.1
0.60	8.3	1.3	.146	2	27	11 55	36	10	15	9.8	.76	.025	.551	.066	2.4	24	.79					7.7
0.90	5.1	1.6	.201	2	25	8 65	33	6	10	8.9	.50	.023	.512	.065	1.7	22	.62					4.4
1.20	4.6	1.5	.200	1	22	9 64	34	4.8	9.4	8.4	.47	.022	.513	.054	2.2							4.0
1.50	4.5	1.4	.186																			3.8

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	Fe	DTPA-extr. Mn mg/kg @ 105C	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	3.9	.29	53	3.2			32	27	.81	2											

SOIL PROFILE CLASS: Marella
SITE NO: W22
A.M.G. REFERENCE: 210 300 mE 6 867 800 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Db3.33
SOIL TAXONOMY UNIT: Aridic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Hypocalcic, Subnatric, Brown Sodosol

SUBSTRATE MATERIAL: Fine sandy alluvium
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Mid slope
LANDFORM PATTERN TYPE: Gently undulating rises
VEGETATION: Tall open forest of cypress pine and poplar box

TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .35 m	Brownish black (7.5YR3/2) moist; sandy loam; massive; moist; moderately weak; common 1-2mm roots. Clear smooth to-
A2j	.35 to .55 m	Dark brown (7.5YR3/4) moist, dry sporadically bleached; light sandy clay loam; massive; moist; moderately weak; few 1-2mm roots. Abrupt smooth to-
B21t	.55 to .84 m	Dull reddish brown (7.5YR4/4) moist; light medium clay; moderate 20-50mm prismatic, parting to moderate 10-20mm angular blocky; moderately moist; moderately firm. Abrupt smooth to-
B22	.84 to 1.20 m	Brown (7.5YR4/3) moist, dull yellowish orange (10YR6/4) dry; fine sandy clay loam; weak 20-50mm prismatic, parting to strong 10-20mm angular blocky, parting to weak 5-10mm cast; moderately moist; very firm; few fine manganiferous veins; few 1-2mm roots. Clear wavy to-
B23	1.20 to 1.50 m	Brown (7.5YR4/4) moist, dull yellowish orange (10YR7/4) dry; fine sandy clay loam; weak 20-50mm prismatic, parting to moderate 10-20mm polyhedral; dry; very firm; very few medium calcareous soft segregations.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S % @ 105C	C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid	ECEC	pH CaCl2 @ 40C
Bulk 0.10	7.6	.11	.001											
0.10	7.3	.03	.001	16 59 13	13	10 6.8 1.4 .56 .79	.067 .677 .013	0.7 5	.56					
0.30	7.6	.02	.001	16 58 11	14	10 5.9 1.7 1.3 .26	.032 .656 .012	0.6 6	.68					
0.60	8.0	.02	.001	16 51 10	22	14 8.3 2.8 1.6 .44	.018 .630 .009	0.8 9	.72					
0.90	8.5	.02	.001	12 50 12	25	16 10 4.3 1.0 .54	.020 .639 .009	1.2 10	.40					
1.20	8.9	.11	.001	6 59 13	19	15 8.4 4.3 .04 .50	.017 .665 .010	1.0						

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
Bulk 0.10	1.2	.09	129 63	.77			17 50 0.4 0.9				

SOIL PROFILE CLASS: Minnabilla
SITE NO: 493
A.M.G. REFERENCE: 247 600 mE 6 892 600 mN ZONE 56
GREAT SOIL GROUP: Lithosol
PRINCIPAL PROFILE FORM: Uc5.21
SOIL TAXONOMY UNIT: Dystric Ustochrept
AUSTRALIAN SOIL CLASSIFICATION: Paralithic, Leptic Rudosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few medium pebbles, altered substrate material

SUBSTRATE MATERIAL: Altered sandstone
SLOPE: 1.0 %
LANDFORM ELEMENT TYPE: Crest
LANDFORM PATTERN TYPE: Low plateau
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus crebra, Callitris glaucophylla, Eucalyptus exserta, Bursaria incana, Acacia sparsiflora, Aristida benthamii, Aristida species

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A11	0 to .12 m	Dark reddish brown (5YR3/3); loamy sand; few medium pebbles, altered substrate material; massive; dry; moderately weak; few <1mm roots. Clear to-
A12	.12 to .25 m	Dull reddish brown (5YR4/3); sandy loam; few medium pebbles, altered substrate material; massive; few very fine macropores; dry; moderately weak; few <1mm roots.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC	1:5 Soil/Water Cl	Particle Size CS	Particle Size FS	Particle Size S	Particle Size C	Exch. Cations CEC	Exch. Cations Ca	Exch. Cations Mg	Exch. Cations Na	Exch. Cations K	Total Elements P	Total Elements K	Total Elements S	Moistures ADM	Moistures 33*	Moistures 1500*	Disp.Ratio R1	Disp.Ratio R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m	@105C		%			m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	5.2	.03	.001																					4.2
0.12	5.7	.04	.001	23	51	11	3	13	2.9	1.2	.09	1.5	.053	.219	.029	1.5		7	.45				5	4.4
0.25	5.0	.04	.001					11	2.4	0.8	.09	.86											3	3.9

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Extr. P Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	DTPA-extr. Mn	DTPA-extr. Cu	DTPA-extr. Zn	DTPA-extr. B	Extractable SO4S	Extractable NO3N	Extractable NH4N	P Buff Cap	P Equil	Alternative Cations CEC	Alternative Cations Ca	Alternative Cations Mg	Alternative Cations Na	Alternative Cations K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	1.9	.09		1.1	0.5			60	24	0.2	.05											

SOIL PROFILE CLASS: Mooroolbark
SITE NO: 1275
A.M.G. REFERENCE: 238 700 mE 6 859 100 mN ZONE 56
GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dr2.43
SOIL TAXONOMY UNIT: Typic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Mesonatric, Red Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Mid-high isolated trees
DOMINANT SPECIES: Eucalyptus populnea, Allocasuarina leuhmannii, Callitris glaucophylla, Eremophila mitchellii

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .12 m	Dark reddish brown (5YR3/4); fine sandy loam; massive; dry; moderately firm. Clear to-
A2e	.12 to .21 m	Dull orange (7.5YR7/3) dry; fine sandy loam; massive; dry; moderately firm. Abrupt to-
B21	.21 to .32 m	Dull reddish brown (2.5YR4/4); medium clay; moderate 50-100mm columnar; dry; very strong; few fine manganiferous veins. Clear to-
B22	.32 to .65 m	Dark reddish brown (5YR3/4); medium clay; strong 10-20mm angular blocky; moist; moderately firm; very few medium calcareous concretions. Gradual to-
B23	.65 to 1.20 m	Greyish yellow-brown (10YR5/2); medium clay; moderate 10-20mm angular blocky; moist; moderately firm; very few medium calcareous concretions, few fine manganiferous veins. Gradual to-
B24	1.20 to 1.60 m	Greyish yellow-brown (10YR6/2); medium clay; moderate 10-20mm angular blocky; moist; moderately firm; few fine manganiferous veins.

Depth	1:5 Soil/Water pH	1:5 Soil/Water EC dS/m @ 40C	1:5 Soil/Water Cl % @105C	Particle Size CS	FS	S	C (%) @ 105C	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)	Total Elements P	K	S (% @ 80C)	Moistures ADM	33*	1500* (% @ 105C)	Disp.Ratio R1 @ 40C	Disp.Ratio R2	Exch Al	Exch Acid (m.eq/100g @ 105C)	ECEC	pH CaCl2 @ 40C
metres																								
B 0.10	7.1	.05	.001																					6.0
0.10	7.2	.05	.001	11	64	13	15	9	5.5	1.8	.12	1.5	.041	.653	.030	0.8		4	.58					6.0
0.31	8.2	.13	.014	8	49	9	34	16	7.6	5.2	3.1	.35	.021	.590	.021	1.5		11	.69					6.7
0.60	9.2	.55	.063	6	44	9	42	24	6.3	8.1	7.0	.54	.022	.598	.027	2.6		17	.93					8.0
0.90	9.5	.75	.068	7	50	12	35	20	7.3	7.5	6.7	.52	.017	.587	.043	2.4		14	.91					8.2
1.20	9.5	.72	.065	6	55	10	33	19	6.0	7.3	6.6	.48	.016	.658	.041	2.4								8.1
1.50	8.8	.52	.066																					7.6

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Extr. P Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	DTPA-extr. Mn mg/kg @ 105C	DTPA-extr. Cu mg/kg @ 105C	DTPA-extr. Zn mg/kg @ 105C	DTPA-extr. B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	Extractable NO3N mg/kg @ 105C	Extractable NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L @ 105C	Alternative Cations CEC m.eq/100g @ 105C	Alternative Cations Ca m.eq/100g @ 105C	Alternative Cations Mg m.eq/100g @ 105C	Alternative Cations Na m.eq/100g @ 105C	Alternative Cations K m.eq/100g @ 105C
metres																						
B 0.10	1.8	.07		9	1.3			13	37	.39	.39											

SOIL PROFILE CLASS: Morilla
SITE NO: 427
A.M.G. REFERENCE: 253 500 mE 6 896 600 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dd1.33
SOIL TAXONOMY UNIT: Udic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Eutrophic, Mesonatric, Black Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Small pebbles, rounded

SUBSTRATE MATERIAL:
SLOPE 3.0 %
LANDFORM ELEMENT TYPE: Scarp footslope
LANDFORM PATTERN TYPE: Escarpment
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Acacia harpophylla, Geijera parviflora, Stipa scabra, Chloris species

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Greyish yellow-brown (10YR4/2); sandy clay loam; few medium pebbles,; massive parting to moderate 5-10mm subangular blocky; dry; moderately firm; many <1mm roots. Abrupt to-
B21	.10 to .70 m	Brownish black (10YR3/2); medium clay; few small pebbles,; moderate 20-50mm angular blocky parting to moderate 10-20mm angular blocky; dry; moderately strong; very few fine manganiferous soft segregations; few <1mm roots. Gradual to-
B22	.70 to 1.20 m	Dull yellowish brown (10YR4/3); medium clay; few small pebbles,; moderate 20-50mm angular blocky; moderately moist; moderately strong. Gradual to-
B3	1.20 to 1.60 m	Brown (7.5YR4/3); sandy medium clay; few small pebbles,; weak 20-50mm angular blocky; moderately moist; moderately strong.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	dS/m @ 40C	% @105C		% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	6.8	.10	.005																					6.0
0.10	6.8	.09	.004	32	38	7	26	17	9.2	3.7	.60	1.3	.046	.400	.032	1.5		7	.38					5.9
0.20	8.6	.31	.036																					7.7
0.30	8.7	.57	.080	24	32	6	39	27	9.6	9.0	6.0	.28	.016	.323	.019	2.5		14	.87					7.9
0.60	9.0	.80	.088	24	33	6	36	25	6.2	9.3	7.0	.19	.012	.324	.016	2.3		14	.98					7.9
0.90	5.6	.57	.074	32	32	4	32	18	3.0	6.6	5.7	.12	.003	.317	.007	1.9		6	1.0					4.5
1.20	5.1	.59	.075	33	31	5	31	19	2.9	7.0	6.2	.13	.002	.336	.007	2.1								4.1
1.50	5.0	.58	.074																					3.9

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	1.2	.13	13		.90			26	30	0.5	0.9											

SOIL PROFILE CLASS: Moruya
SITE NO: W18
A.M.G. REFERENCE: 224 800 mE 6 879 800 mN ZONE 56
GREAT SOIL GROUP: Red brown earth
PRINCIPAL PROFILE FORM: Dr2.43
SOIL TAXONOMY UNIT: Typic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Bleached-Sodic, Calcic, Red Chromosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 2.0 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating rises
VEGETATION: Tall open forest of belah with poplar box

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Dark brown (7.5YR3/3) moist; loam, fine sandy; massive; dry; moderately weak; common <1mm roots. Abrupt to-
A2e	.07 to .14 m	Dull reddish brown (5YR4/4) moist, dull orange (5YR7/4) dry; clay loam, fine sandy; massive; dry; moderately firm; common 1-2mm roots. Sharp to-
B21t	.14 to .50 m	Dark reddish brown (5YR3/4) moist; medium clay; moderate 100-200mm prismatic, parting to strong 20-50mm angular blocky; dry; moderately strong; very few medium calcareous soft segregations; few 1-2mm roots. Clear to-
B22tk	.50 to .80 m	Reddish brown (5YR4/6) moist; medium clay; moderate 20-50mm angular blocky, parting to moderate 5-10mm polyhedral; dry; very firm; very few medium calcareous nodules, common medium calcareous soft segregations. Clear to-
B23n	.80 to 1.50 m	Dull reddish brown (5YR5/4) moist; very few fine distinct red mottles, very few fine distinct grey mottles; light medium clay; moderate 10-20mm polyhedral, parting to moderate 5-10mm polyhedral, parting to weak 5-10mm cast; dry; moderately strong; very few medium manganiferous veins.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM	33*	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
Bulk 0.10	8.1	.11	.001																					
0.10	8.0	.10	.001	10	56	17	18	15	10	1.0	.07	.80	.029	.217	.038	1.1		6	.56					
0.30	8.8	.13	.001	5	41	13	40	24	15	4.9	1.4	.65	.014	.206	.035	1.8		15	.53					
0.60	9.4	.23	.003	4	42	13	41	27	12	7.3	5.0	.56	.013	.193	.021	2.0		17	.87					
0.90	9.0	.25	.036	4	41	13	40	29	10	7.6	8.6	.37	.012	.163	.034	2.2		17	1.0					
1.20	5.6	.92	.118	4	41	14	41	22	7.3	6.0	7.9	1.0	.009	.123	.070	1.9								

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
Bulk 0.10	1.3	.11	15	7	.89			10	23	0.5	0.6											

SOIL PROFILE CLASS: Mt. Carmel
SITE NO: W26
A.M.G. REFERENCE: 239 400 mE 6 882 800 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Dd1.33
SOIL TAXONOMY UNIT: Udic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Subnatric, Black Sodosol
TYPE OF MICRORELIEF: Crabhole gilgai
VERTICAL INTERVAL: 0.10 m
HORIZONTAL INTERVAL: 7 m
COMPONENT OF MICRORELIEF SAMPLED: Shelf
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 1.0 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating rises
VEGETATION: Tall open forest of belah with occasional brigalow

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hard setting, occasional periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .06 m	Dark brown (10YR3/3) moist; clay loam; massive parting to weak 10-20mm angular blocky; dry; moderately firm. Abrupt to-
A2j	.06 to .07 m	Brownish black (10YR3/2) moist, dull yellowish orange (10YR7/2) dry, dry sporadically bleached; massive; dry; very firm. Abrupt to-
B21	.07 to .18 m	Brownish black (10YR3/2) moist; heavy clay; strong 20-50mm angular blocky parting to moderate 5-10mm angular blocky; dry; moderately strong. Clear wavy to-
B22k	.18 to .35 m	Brownish black (10YR3/2) moist; medium heavy clay; strong 20-50mm angular blocky, parting to moderate 10-20mm angular blocky; dry; very strong; common medium calcareous soft segregations. Gradual wavy to-
B23	.35 to .55 m	Greyish yellow-brown (10YR4/2) moist; heavy clay; very few medium pebbles, subangular jasper, strong, dispersed; weak 20-50mm angular blocky, parting to moderate 10-20mm angular blocky; dry; very strong. Diffuse to-
B24	.55 to 1.50 m	Dull yellowish brown (10YR5/3) moist; medium heavy clay; weak 20-50mm angular blocky, parting to moderate 10-20mm polyhedral; moderately moist; moderately strong.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m	@105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
Bulk 0.10	7.3	.08	.005																					
0.10	7.4	.18	.022	5	40	12	42	24	16	4.9	2.3	.86	.024	.325	.022	3.9		15	.58					
0.30	8.7	.83	.098	5	31	13	53	32	18	7.5	5.7	.76	.019	.326	.036	5.5		20	.78					
0.60	7.1	.82	.107	4	34	15	47	27	12	6.6	6.3	.50	.013	.277	.037	4.6		21	.99					
0.90	5.0	.84	.094	3	30	16	50	28	9.3	5.8	6.8	.38	.012	.244	.042	4.0		22	.98					
1.20	4.8	.80	.091	2	26	14	56	30	8.9	6.2	7.2	.31	.011	.218	.038	4.5								

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
Bulk 0.10	1.5	.10	9	3	.96			12	30	0.6	0.2											

SOIL PROFILE CLASS: Murriverie
SITE NO: 1360
A.M.G. REFERENCE: 225 300 mE 6 858 200 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic-Endosodic, Epipedal, Grey Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus coolabah, Acacia harpophylla, Casuarina cristata

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .01 m	Brownish grey (10YR4/1); medium heavy clay; moderate 20-50mm angular blocky; dry; moderately strong. Clear to-
B21	.11 to .40 m	Greyish yellow-brown (10YR4/2); heavy clay; moderate 20-50mm lenticular; moderately moist; moderately strong. Gradual to-
B22	.40 to 1.00 m	Greyish yellow-brown (10YR5/2); heavy clay; moderate 50-100mm lenticular; moderately moist; moderately strong; very few manganiferous veins. Gradual to-
B23	1.00 to 1.50 m	Greyish yellow-brown (10YR6/2); heavy clay; weak 50-100mm lenticular; moderately moist; moderately strong.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC m.eq/100g @ 105C	pH CaCl2 @ 40C
metres																	
B 0.10	7.8	.53	.061														
0.10	7.2	.37	.045	2 25 17 58	31 15 12 2.8 1.4	.035	.822	.033	2.9		19	.59					
0.30	6.6	1.5	.240	1 20 15 66	33 12 11 6.5 .49	.026	.798	.033	1.8		22	.80					
0.60	5.6	1.8	.299	1 19 15 66	31 9.3 9.6 6.9 .45	.022	.796	.030	2.1		23	.88					
0.90	5.2	1.9	.312	1 20 15 63	29 7.8 8.8 6.9 .46	.021	.773	.029	1.9		22	.91					
1.20	4.9	2.0	.324	1 21 15 62	27 7.5 8.1 6.8 .43	.022	.754	.029	2.4								
1.50	4.7	2.1	.342														

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
metres																					
B 0.10	1.7	.09	39	1.1			14	14	1.5	.50											

SOIL PROFILE CLASS: Nareen
SITE NO: 465
A.M.G. REFERENCE: 252 300 mE 6 900 000 mN ZONE 56
GREAT SOIL GROUP: Soloth
PRINCIPAL PROFILE FORM: Dd1.41
SOIL TAXONOMY UNIT: Ultic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Bleached, Natric, Black Kurosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Siltstone
SLOPE: 1.0 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Low plateau
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Eucalyptus pilligaensis, Casuarina cristata, Eucalyptus crebra, Eremophila mitchellii, Acacia deanei, Aristida species, Chloris species

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Greyish yellow-brown (10YR4/2); fine sandy loam; very few medium pebbles, angular siltstone; massive; dry; very firm; common <1mm roots. Clear to-
A2e	.08 to .12 m	Greyish yellow-brown (10YR5/2), dull yellowish orange (10YR7/2) dry; fine sandy loam; very few medium pebbles, angular siltstone; massive; dry; very firm; common <1mm roots. Clear to-
B21	.12 to .50 m	Brownish black (10YR3/2); medium heavy clay; moderate 20-50mm angular blocky; moderately moist; moderately strong; common <1mm roots. Gradual to-
B22	.50 to .80 m	Dark brown (10YR3/3); medium heavy clay; moderate 5-10mm polyhedral; moderately moist; very firm; few <1mm roots. Clear to-
B3	.80 to .90 m	Brownish black (10YR2/2); medium heavy clay; common medium pebbles, angular siltstone; weak 5-10mm polyhedral; moist; moderately firm.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2	Al Acid	CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g	
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C		@ 40C		@ 105C	@ 40C
B 0.10	6.4	.07	.003																		5.2
0.10	5.7	.09	.004	10	49	15	20	14	5.4	3.5	.46	1.2	.025	.207	.033	2.2		8	.48		10	4.6
0.16	5.5	.07	.004																			4.2
0.30	5.2	.12	.008	6	35	12	48	19	2.6	6.6	1.9	.21	.007	.157	.008	2.1		14	.52		10	3.8
0.60	4.9	.36	.034	5	32	12	51	21	1.7	6.6	3.6	.12	.004	.156	.019	2.5		15	.55		12	3.8
0.90	4.8	.66	.068	14	28	10	48	23	1.8	7.5	5.9	.27	.001	.141	.023	3.0		18	.69		15	3.8

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr	DTPA-extr.				Extractable			P	Alternative Cations				
	(W&B)		Acid	Bicarb.	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil ug/L	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg	mg/kg					mg/kg					m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C	@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	2.4	.11	5		.63		54	29	0.2	0.4											

SOIL PROFILE CLASS: Oonavale
SITE NO: 987
A.M.G. REFERENCE: 206 900 mE 6 865 300 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Db1.43
SOIL TAXONOMY UNIT: Udic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Mesonatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus populnea, Eremophila mitchellii, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Brown (7.5YR4/3); fine sandy clay loam; massive; dry; moderately firm. Clear to-
A2e	.10 to .13 m	Light brownish grey (7.5YR7/2) dry; fine sandy clay loam; massive; dry; moderately firm. Abrupt to-
B21	.13 to .48 m	Dull yellowish brown (10YR4/3); medium heavy clay; moderate 20-50mm angular blocky; dry; moderately strong; very few manganiferous veins. Gradual to-
B22k	.48 to 1.00 m	Dull yellowish brown (10YR5/3); medium clay; strong 10-20mm angular blocky; moderately moist; moderately firm; few medium calcareous soft segregations. Diffuse to-
B23	1.00 to 1.60 m	Greyish yellow-brown (10YR5/2); very few medium distinct orange mottles; medium clay; moderate 20-50mm angular blocky; moderately moist; very firm.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	6.7	.06	.003										5.8
0.10	6.4	.03	.001	10 50 21 21	12 3.9 2.7 .16 .73	.054 .679 .031	1.4 8	.61					5.1
0.30	6.6	.05	.063	4 33 16 49	31 9.0 7.7 4.9 .64	.022 .639 .027	2.7 20	.82					5.6
0.60	8.7	1.0	.117	3 30 19 48	31 12 9.1 6.7 .66	.022 .640 .045	2.1 19	.85					7.8
0.90	8.1	.90	.109	1 40 22 37	24 8.7 7.0 5.4 .56	.020 .655 .032	1.9 18	.93					7.4
1.20	6.3	.96	.120	4 27 21 45	28 8.1 7.0 5.8 .53	.020 .645 .031	2.3						5.6
1.50	5.3	.91	.112										4.5

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
B 0.10	1.9	.11	21	.85			11 1.9 .33 0.1				

SOIL PROFILE CLASS: Pindari
SITE NO: 558
A.M.G. REFERENCE: 247 300 mE 6 854 200 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dy2.33
SOIL TAXONOMY UNIT: Udic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Subnatric, Grey Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus pilligaensis, Acacia harpophylla, Eremophila mitchellii, Geijera parviflora, Chloris truncata, Aristida species

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1j	0 to .13 m	Brown (7.5YR4/3); fine sandy clay loam; very few small pebbles, quartz; massive; dry; moderately weak. Abrupt to-
B21	.13 to .35 m	Greyish yellow-brown (10YR4/2); medium clay; very few small pebbles, quartz; moderate 50-100mm angular blocky, parting to strong 10-20mm angular blocky; dry; moderately strong. Gradual to-
B22k	.35 to .70 m	Dull yellowish brown (10YR5/4); medium clay; very few small pebbles, quartz; strong 20-50mm angular blocky; moderately moist; moderately firm; few fine calcareous soft segregations. Gradual to-
B23	.70 to 1.00 m	Dull yellowish brown (10YR5/3); medium clay; very few small pebbles, quartz; moderate 20-50mm angular blocky; moderately moist; moderately firm; very few fine calcareous soft segregations. Gradual to-
B24	1.00 to 1.55 m	Greyish yellow-brown (10YR6/2); medium clay; few small pebbles, quartz; moderate 20-50mm angular blocky; dry; moderately strong.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2				CaCl2
metres		dS/m	%			%			m.eq/100g					%			%					m.eq/100g			
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C		@ 40C			@ 105C		@ 40C
B 0.10	6.6	.08	.002																					5.6
0.10	7.1	.13	.003	18	46	16	23	17	17	2.2	.70	1.2	.076	.686	.036	0.9		7	.47					6.4
0.30	8.0	.08	.002	13	37	11	38	25	16	7.2	2.8	.57	.012	.626	.019	1.9		14	.47					6.7
0.60	9.0	.25	.018	12	34	14	42	27	8.1	8.1	7.0	.22	.006	.595	.018	2.5		17	.71					7.8
0.90	9.0	.93	.080	11	34	14	42	26	7.0	8.3	8.9	.20	.002	.571	.040	2.2		17	.90					7.9
1.20	5.5	.91	.103	11	37	15	38	24	4.9	6.4	7.0	.33	.001	.594	.033	2.0								4.7
1.50	5.1	.82	.097																					4.3

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil ug/L	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg			@ 40C		m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C					@ 105C				
B 0.10	1.7	.11	37	.70		38	48	0.5	6.7												

SOIL PROFILE CLASS: Portreath
SITE NO: 564
A.M.G. REFERENCE: 227 800 mE 6 880 600 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Dd1.33
SOIL TAXONOMY UNIT: Vertic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Vertic, Subnatric, Black Sodosol
TYPE OF MICRORELIEF: Crabhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Rises
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting, occasional periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Brownish black (10YR3/2); clay loam; massive largest peds, parting to moderate 20-50mm angular blocky next size peds; dry; moderately weak. Sharp to-
A2e	.10 to .12 m	Dull yellowish orange (10YR7/2) dry; clay loam; massive largest peds, parting to moderate 20-50mm angular blocky next size peds; dry; moderately weak. Sharp to-
B21k	.12 to .30 m	Brownish black (10YR3/2); medium heavy clay; strong 10-20mm angular blocky; dry; moderately firm; few medium calcareous soft segregations. Gradual to-
B22	.30 to .65 m	Brownish grey (10YR4/1); heavy clay; 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moderately moist; very firm. Gradual to-
B23	.65 to 1.50 m	Brown (10YR4/4); heavy clay; 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moderately moist; very firm. Gradual to-
B24	1.50 to 1.65 m	Reddish brown (5YR4/6); heavy clay; 50-100mm lenticular, parting to moderate 10-20mm angular blocky; moist; moderately firm.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	7.1	.09	.004																					6.2
0.10	6.6	.06	.001	5	56	14	25	22	12	3.6	.12	.98	.057	.331	.047	1.8		11	.35					5.5
0.30	9.1	.44	.036	3	39	10	50	32	19	8.3	4.6	1.3	.029	.318	.030	5.9		22	.47					8.0
0.60	6.6	1.3	.132	2	32	11	54	34	15	10	9.0	.70	.025	.291	.057	7.6		26	.93					6.0
0.90	5.0	1.2	.155	2	30	13	54	33	10	7.5	8.1	.40	.021	.245	.048	4.1		22	.85					4.3
1.20	4.8	1.1	.153	1	26	11	58	35	11	7.7	8.2	.26	.022	.242	.045	5.2								4.1
1.50	4.6	1.3	.161																					3.9

Depth	Org.C (W&B)	Tot.N	Extr. P Acid Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C	meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	1.8	.14	14	1			23	33	.63	.65											

SOIL PROFILE CLASS: Rockwood
SITE NO: 565
A.M.G. REFERENCE: 227 900 mE 6 884 400 mN ZONE 56
GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Dr2.13
SOIL TAXONOMY UNIT: Vertic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Vertic, Subnatric, Red Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 2.0 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Rises
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Acacia harpophylla, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting, occasional periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dark reddish brown (5YR3/2); fine sandy clay loam; moderate 20-50mm angular blocky; dry; very firm. Abrupt to-
B21k	.10 to .45 m	Dull reddish brown (5YR4/4); medium clay; strong 10-20mm angular blocky; moderately moist; very firm; few medium calcareous soft segregations. Gradual to-
B22	.45 to 1.00 m	Dark reddish brown (5YR3/4); medium heavy clay; 50-100mm lenticular, parting to strong 10-20mm angular blocky; moist; moderately firm; very few medium calcareous soft segregations. Gradual to-
B23	1.00 to 1.35 m	Brown (10YR4/4); medium heavy clay; 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moist; moderately firm; few manganiferous veins. Gradual to-
B24	1.35 to 1.65 m	Dull yellowish brown (10YR5/3); medium heavy clay; few medium pebbles, angular; 50-100mm lenticular, parting to moderate 20-50mm angular blocky; moist; moderately firm.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C % @ 105C	CEC	Exch. Cations Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P % @ 80C	K %	S %	Moistures ADM	33*	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	7.2	.10	.002																					6.3
0.10	7.1	.09	.003	6	60	4	31	22	15	3.7	.23	1.6	.059	.515	.052	1.4	11		.26					6.3
0.30	9.1	.28	.010	5	47	2	48	30	22	7.8	2.3	1.3	.029	.381	.033	4.6	16		.68					7.9
0.60	8.8	1.3	.151	5	40	7	50	33	18	9.6	6.0	.17	.021	.267	.055	6.0	19		.73					8.0
0.90	8.9	1.2	.149	6	40	9	45	32	16	9.6	6.5	.17	.020	.277	.055	5.2	18		.61					8.1
1.20	8.8	1.1	.134	4	42	9	45	33	16	9.7	7.5	.19	.019	.272	.039	4.4								7.8
1.50	5.6	1.0	.134																					4.8

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S	NO3N	NH4N mg/kg @ 105C	Buff Cap @ 40C	P Equil ug/L @ 40C	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
B 0.10	2.7	.22		56	1.4			17	21	.43	.65											

SOIL PROFILE CLASS: Roe
SITE NO: 1167
A.M.G. REFERENCE: 240 400 mE 6 864 000 mN ZONE 56
GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Db3.43
SOIL TAXONOMY UNIT: Aquic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Subnatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Mid-high open woodland
DOMINANT SPECIES: Eucalyptus populnea, Eucalyptus pilligaensis, Eremophila mitchellii, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .08 m	Brownish black (10YR3/2); loamy sand; massive; dry; very weak. Abrupt to-
A12	.08 to .13 m	Brownish black (7.5YR3/2); loamy sand; massive; dry; very weak. Clear to-
A2e	.13 to .18 m	Greyish yellow-brown (10YR4/2), greyish yellow-brown (10YR7/2) dry; loamy sand; massive; dry; very weak. Abrupt irregular to-
B21	.18 to .32 m	Brownish black (10YR3/2); sandy medium clay; moderate 20-50mm columnar; dry; very strong. Clear to-
B22	.32 to .68 m	Brown (10YR4/4); sandy medium clay; strong 10-20mm angular blocky; dry; moderately strong; very few medium calcareous nodules, very few fine manganiferous veins. Diffuse to-
B23	.68 to .90 m	Greyish yellow-brown (10YR6/2); many medium distinct orange mottles; sandy medium clay; strong 5-10mm angular blocky; dry; moderately strong; very few medium calcareous nodules. Gradual to-
B24	.90 to 1.30 m	Greyish yellow-brown (10YR5/2); sandy clay; moderate 10-20mm angular blocky; dry; very strong; very few medium calcareous nodules.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C %	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K %	S %	Moistures ADM % @ 105C	33* %	1500* %	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	6.6	.11	.003																					5.4
0.10	6.0	.07	.003	35	47	5	12	9	3.7	1.3	.09	.79	.042	.348	.033	0.8		3	.36					4.9
0.30	6.8	.15	.009	28	40	4	30	14	6.0	4.2	1.9	.53	.019	.358	.024	1.7		9	.80					5.5
0.60	9.3	.41	.029	27	39	5	32	16	7.0	6.2	4.0	.27	.020	.399	.025	2.1		11	.91					7.9
0.90	9.5	.64	.057	26	41	6	31	16	5.2	6.7	5.0	.27	.017	.389	.031	2.1		11	.88					8.2
1.20	9.5	.65	.070	30	44	4	26	14	2.3	5.6	4.9	.28	.015	.420	.025	2.1								8.1

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn	Cu	Zn	B	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
B 0.10	1.7	.07	30	1.8			75	38	.55	.61											

SOIL PROFILE CLASS: Strathmore
SITE NO: 826
A.M.G. REFERENCE: 211 200 mE 6 879 400 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous-Epihypersodic, Self-mulching, Grey Vertosol
TYPE OF MICRORELIEF: Melonhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Mid-high woodland
DOMINANT SPECIES: Casuarina cristata, Sporobolis disjunctus

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Greyish yellow-brown (10YR4/2); medium clay; strong 10-20mm angular blocky; moderately moist; moderately firm. Clear to-
B21k	.08 to .50 m	Brownish grey (10YR4/1); medium heavy clay; strong 20-50mm angular blocky; moderately moist; moderately firm; few medium calcareous nodules. Gradual to-
B22y	.50 to 1.00 m	Greyish yellow-brown (10YR5/2); medium heavy clay; moderate 50-100mm lenticular parting to moderate 10-20mm lenticular; moderately moist; very firm; very few fine gypseous crystals. Gradual to-
B23	1.00 to 1.60 m	Dull yellowish brown (10YR5/3); medium heavy clay; moderate 50-100mm lenticular; moderately moist; very firm; very few manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2				CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g			
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C		@ 40C
B 0.10	8.3	.34	.024																				7.4
0.08	8.0	.19	.006	12	44	12	34	26	18	4.8	1.1	1	.036	.591	.036	2.0	12	.45					7.2
0.30	9.0	1.0	.137	8	35	16	46	27	17	6.3	7.3	.60	.026	.516	.057	2.7	17	.81					8.1
0.60	8.8	1.8	.204	9	36	11	45	26	13	7.1	8.3	.59	.021	.513	.081	2.8	17	.86					8.0
0.90	7.6	1.5	.212	8	36	15	42	26	10	6.5	7.9	.57	.020	.509	.043	1.5	17	.97					6.9
1.20	5.4	1.5	.207	8	36	13	41	23	8.5	5.5	7.0	.47	.018	.502	.044	1.9							4.8
1.50	5.1	1.4	.189																				4.5

Depth	Org.C	Tot.N	Extr. P	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	P Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
	(W&B)		Acid Bicarb.																		
metres	%	%	mg/kg	meq%	mg/kg			mg/kg					mg/kg					m.eq/100g			
	@ 105C	@ 105C	@ 105C	@105C	@ 105C			@ 105C					@ 105C		@ 40C			@ 105C			
B 0.10	0.8	.06	19	.75			15	14	.59	.27											

SOIL PROFILE CLASS: Sturt
SITE NO: 557
A.M.G. REFERENCE: 240 300 mE 6 863 700 mN ZONE 56
GREAT SOIL GROUP: Earthy sand
PRINCIPAL PROFILE FORM: Uc2.34
SOIL TAXONOMY UNIT: Ustic Quartzipsamment
AUSTRALIAN SOIL CLASSIFICATION: Basic, Regolithic, Bleached-Leptic Tenosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Callitris glaucopylla, Eucalyptus dealbata, Allocasuarina leuhmannii, Aristida species, Dichanthium sericeum

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A11	0 to .10 m	Greyish yellow-brown (10YR4/2); loamy sand; massive; dry; loose. Clear to-
A12	.10 to .25 m	Dull yellowish brown (10YR4/3); loamy sand; massive; dry; very weak. Clear to-
A21	.25 to .90 m	Dull orange (7.5YR6/4), light brownish grey (7.5YR7/2) dry; sand; massive; dry; very weak. Clear to-
A22	.90 to 1.20 m	Dull orange (7.5YR6/4); sand; massive; moist; very weak; very few coarse ferruginous concretions. Abrupt to-
D	1.20 to 1.30 m	Greyish yellow-brown (10YR6/2); few medium distinct yellow mottles; sandy clay loam; moist; moderately strong; massive continuous very strongly cemented.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* % @ 105C	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2 @ 40C	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
B 0.10	6.5	.04	.001																					5.8
0.10	6.6	.01	.001	52	43	3	5	4	2.4	.52	.09	.14	.009	.209	.009	.2		2	.93					5.5
0.25	6.5	.01	.001	48	47	2	5	4	1.8	.31	.09	.12	.001	.209	.004	.2		1	.94					5.2
0.60	6.1	.01	.001	41	54	2	4	1	0.5	.31	.09	.06	.001	.238	.002	.1		1	.99					5.0
0.90	6.1	.01	.001	37	58	3	4	.1	0.5	.44	.09	.08	.001	.258	.002	.1		1	.86					5.0
1.20	6.8	.01	.001	38	58	1	4	.6	0.2	.35	.09	.10	.001	.245	.001	.1								6.3
1.30	7.2	.12	.012																					5.9

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe mg/kg @ 105C	Mn mg/kg @ 105C	Cu mg/kg @ 105C	Zn mg/kg @ 105C	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N mg/kg @ 105C	NH4N mg/kg @ 105C	P Buff Cap @ 40C	Equil ug/L @ 40C	Alternative Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C
B 0.10	1	.05		11	.06			8	14	0.1	0.4											

SOIL PROFILE CLASS: Sturt
SITE NO: 1202
A.M.G. REFERENCE: 250 600 mE 6 865 000 mN ZONE 56
GREAT SOIL GROUP: Earthy sand
PRINCIPAL PROFILE FORM: Uc3.21
SOIL TAXONOMY UNIT: Ustic Quartzipsamment
AUSTRALIAN SOIL CLASSIFICATION: Regolithic, Leptic Rudosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Plain
VEGETATION
STRUCTURAL FORM: Mid-high isolated trees
DOMINANT SPECIES: Callitris glaucophylla, Eucalyptus populnea

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Soft

HORIZON	DEPTH	DESCRIPTION
A11	0 to .60 m	Brownish black (10YR3/1); loamy sand; massive; dry; loose. Clear to-
A12	.60 to 1.05 m	Greyish yellow-brown (10YR4/2); loamy sand; massive; moist; moderately weak. Clear to-
A2j	1.05 to 1.20 m	Greyish yellow-brown (10YR6/2) dry, greyish yellow-brown (10YR4/2); loamy sand; single grain; moist; moderately weak. Clear to-
D	1.20 to 1.50 m	Greyish yellow-brown (10YR5/2); common medium prominent yellow mottles; sandy medium clay; massive; moist; moderately firm; very few fine manganiferous veins.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C (%) @ 105C	Exch. Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)	Total Elements P	K	S (% @ 80C)	Moistures ADM 33*	1500* (% @ 105C)	Disp.Ratio R1 @ 40C	R2	Exch Al	Exch Acid (m.eq/100g @ 105C)	ECEC	pH CaCl2 @ 40C
B 0.10	6.3	.02	.001																				
0.10	6.1	.02	.001	45	47	1	7	4	1.5	.39	.09	.37	.067	.303	.046	.4	2	.65					
0.30	6.2	.02	.001	40	53	2	7	3	1.7	.45	.09	.22	.054	.291	.038	.2	2	.60					
0.60	6.6	.03	.001	43	50	2	7	2	1.9	.43	.09	.37	.025	.314	.021	.1	2	.60					
0.90	7.1	.02	.001	40	55	2	4	1	1.6	.40	.09	.16	.022	.293	.019	.2	1	.87					
1.20	7.7	.03	.001	41	54	3	3	1	1.1	.39	.09	.01	.019	.319	.019	.1							
1.50	7.2	.15	.012																				

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P	DTPA-extr. Fe	Mn	Cu	Zn	B (mg/kg @ 105C)	Extractable SO4S	NO3N	NH4N (mg/kg @ 105C)	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K (m.eq/100g @ 105C)
B 0.10	0.4	.03	8	.29			21	10	0.2	.16											

SOIL PROFILE CLASS: Tarewinnabar
SITE NO: W15
A.M.G. REFERENCE: 221 300 mE 6 890 000 mN ZONE 56
GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.12
SOIL TAXONOMY UNIT: Typic Calciustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous, Self-mulching, Black Vertosol

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 3.0 %
LANDFORM ELEMENT TYPE: Lower slope
LANDFORM PATTERN TYPE: Gently undulating to undulating rises
VEGETATION: Tussock grassland of Queensland bluegrass

TYPE OF MICRORELIEF: Linear gilgai
VERTICAL INTERVAL: .15 m
HORIZONTAL INTERVAL: 8 m
COMPONENT OF MICRORELIEF SAMPLED: Mound
SURFACE COARSE FRAGMENTS: Very few stones

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking; moderately to strongly self mulching with a weak surface flake after rain

HORIZON	DEPTH	DESCRIPTION
A11	0 to .02 m	Brownish black (10YR3/2) moist; medium heavy clay; strong 5-10mm granular, parting to strong 2-5mm granular; dry; moderately weak; few 1-2mm roots. Abrupt to-
A12	.02 to .06 m	Brownish black (10YR3/2) moist; medium heavy clay; moderate 20-50mm angular blocky; moist; moderately weak; common 1-2mm roots. Clear to-
B21	.06 to .45 m	Brownish black (10YR3/1) moist; heavy clay; moderate 20-50mm angular blocky; moist; moderately weak; very few medium calcareous nodules; common 1-2mm roots. Gradual to-
B22k	.45 to .92 m	Brownish black (10YR3/1) moist; heavy clay; moderate 50-100mm lenticular; dry; moderately strong; common medium calcareous nodules; common 1-2mm roots. Gradual to-
BC	.92 to 1.01 m	Weathered sandstone and siltstone.

Depth (metres)	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P K S % @ 80C	Moistures ADM 33* 1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
Bulk 0.10	8.2	.11	.001										
0.10	7.7	.07	.001	7 36 11 46	52 38 6.8 .30 1.1	.027 .539 .029	4.2 21	.39					
0.30	8.6	.09	.001	5 32 13 52	58 45 6.9 1.3 .52	.017 .474 .019	4.3 24	.40					
0.60	8.7	.18	.006	4 29 12 54	62 45 8.8 2.8 .57	.014 .492 .018	4.7 26	.53					
0.90	8.6	.27	.017	4 25 12 57	64 45 10 3.4 .62	.015 .512 .017	5.3 27	.56					

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Extr. P Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	CaCl2 Extr P mg/kg @ 105C	DTPA-extr. Fe Mn Cu Zn B mg/kg @ 105C	Extractable SO4S NO3N NH4N mg/kg @ 105C	P Buff Cap @ 40C	P Equil ug/L	Alternative Cations CEC Ca Mg Na K m.eq/100g @ 105C
Bulk 0.10	0.9	.07	24	3	.71			16 11 0.6 0.3				

SOIL PROFILE CLASS: Teelabar
SITE NO: 1355
A.M.G. REFERENCE: 226 200 mE 6 856 600 mN ZONE 56
GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.16
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous-Endohypersodic, Self-mulching, Black Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.25 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Casuarina cristata, Eucalyptus coolabah

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Self-mulching, Surface flake

HORIZON	DEPTH	DESCRIPTION
A11	0 to .03 m	Brownish black (10YR3/2); coarse sandy medium clay; few small pebbles, quartz; strong 2-5mm granular; dry; very weak. Sharp to-
A12	.03 to .10 m	Brownish black (10YR3/2); coarse sandy medium heavy clay; few small pebbles, quartz; strong 10-20mm angular blocky; moderately moist; very firm. Clear to-
B21k	.10 to .40 m	Brownish black (10YR3/2); coarse sandy medium heavy clay; few small pebbles, quartz; moderate 50-100mm lenticular, parting to moderate 5-10mm lenticular; moderately moist; very firm; few medium calcareous soft segregations. Gradual to-
B22	.40 to 1.20 m	Brownish grey (10YR4/1); coarse sandy heavy clay; few small pebbles, quartz; moderate 50-100mm lenticular; moist; moderately firm; few medium calcareous concretions. Gradual to-
B3	1.20 to 1.50 m	Greyish yellow-brown (10YR5/2); coarse sandy light clay; common small pebbles, quartz; weak 50-100mm lenticular; moist; moderately firm; very few medium calcareous concretions.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres	@ 40C	dS/m	% @105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	7.6	.13	.004																					
0.10	8.1	.15	.001	29	9	8	54	32	22	10	.74	1.7	.055	1.27	.037	2.6		17	.59					
0.30	9.0	.41	.027	23	8	8	63	33	18	12	4.2	.70	.036	1.07	.031	2.4		21	.73					
0.60	8.6	1.1	.129	22	7	8	63	33	15	12	6.0	.73	.026	1.05	.034	2.0		21	.89					
0.90	8.4	1.2	.162	24	7	11	56	31	14	12	6.3	.42	.023	1.12	.032	2.5		19	.94					
1.20	7.9	1.1	.165	26	7	8	56	29	12	11	5.8	.45	.022	1.20	.036	2.2								
1.50	8.8	.75	.097																					

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C		m.eq/100g @ 105C				
B 0.10	1.7	.11	54		1.2			23	13	1.7	.55											

SOIL PROFILE CLASS: Trevanna
SITE NO: 416
A.M.G. REFERENCE: 247 900 mE 6 885 100 mN ZONE 56
GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Db1.43
SOIL TAXONOMY UNIT: Typic Natrustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Mesonatric, Brown Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Sandstone
SLOPE: 2.5 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Rises
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Eucalyptus populnea, Eremophila mitchellii, Enteropogon ramosus, Stipa scabra

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Brownish black (7.5YR3/2); fine sandy loam; massive; dry; moderately firm; common <1mm roots. Clear to-
A2e	.10 to .13 m	Light brownish grey (7.5YR7/2) dry; fine sandy loam; very few medium pebbles, altered substrate material; massive; few fine macropores; dry; moderately firm; few <1mm roots. Clear to-
B21	.13 to .48 m	Brown (7.5YR4/4); medium clay; very few small pebbles, altered substrate material; strong 50-100mm columnar parting to moderate 10-20mm angular blocky; dry; moderately strong. Gradual to-
B22k	.48 to .90 m	Brown (7.5YR4/6); medium clay; moderate 10-20mm angular blocky; moist; moderately firm; few medium calcareous concretions. Gradual to-
B23	.90 to 1.40 m	Greyish brown (7.5YR5/2); few medium distinct brown mottles; medium clay; moderate 10-20mm angular blocky; moist; moderately firm; few manganiferous veins.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Exch ECEC		pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2	Al	Acid	CaCl2
metres		dS/m	%		%			m.eq/100g						%			%				m.eq/100g		
	@ 40C		@105C		@ 105C			@ 105C					@ 80C			@ 105C			@ 40C		@ 105C		@ 40C
B 0.10	6.5	.04	.001																				5.5
0.10	7.0	.06	.003	31	49	6	15	11	5.8	1.4	.36	.62	.030	.149	.037	1.0		4	.40				6.4
0.13	7.5	.06	.002																				6.5
0.20	8.1	.28	.022																				7.3
0.30	8.9	.38	.039	20	35	7	42	22	6.8	7.5	4.2	.45	.011	.177	.026	2.5		14	.93				7.9
0.60	9.3	.65	.058	24	38	6	34	18	5.0	8	6.5	.15	.007	.142	.048	2.4		12	.93				8.2
0.90	8.9	.59	.080	20	35	7	41	26	4.7	10	10	.17	.006	.161	.025	3.2		15	.97				7.8
1.20	7.8	.47	.071	22	35	5	39	24	3.5	10	9.7	.15	.007	.144	.026	3.1							6.5

Depth	Org.C	Tot.N	Extr. P		HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid	Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.3	0.1	10		.66		26	27	0.4	0.2												

SOIL PROFILE CLASS: Ukabilla
SITE NO: W16
A.M.G. REFERENCE: 221 500 mE 6 889 700 mN ZONE 56
GREAT SOIL GROUP: Red clay
PRINCIPAL PROFILE FORM: Ug5.37
SOIL TAXONOMY UNIT: Leptic Calciustert
AUSTRALIAN SOIL CLASSIFICATION: Endocalcareous, Epipedal Brown Vertosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few stones

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 3.0 %
LANDFORM ELEMENT TYPE: Upper slope
LANDFORM PATTERN TYPE: Gently undulating to undulating rises
VEGETATION: Tall open woodland of silver leaved ironbark and poplar box

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking; hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dark brown (7.5YR3/3) moist; light medium clay; moderate 20-50mm angular blocky; moderately moist; moderately firm; common 1-2mm roots. Clear to-
B21	.10 to .35 m	Dark reddish brown (5YR3/4) moist; medium clay; moderate 10-20mm angular blocky; moist; moderately firm; common <1mm roots. Clear to-
B22k	.35 to .60 m	Dark brown (10YR3/3) moist; medium clay; moderate 10-20mm angular blocky; moist; moderately weak; common medium calcareous nodules. Clear to-
BC	.60 to .71 m	Weathered sandstone and siltstone.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2				CaCl2
metres		ds/m	%			%			m.eq/100g					%			%					m.eq/100g		
	@ 40C	@105C		@ 105C				@ 105C					@ 80C			@ 105C			@ 40C		@ 105C			@ 40C
Bulk 0.10	7.1	.04	.001																					
0.10	7.0	.04	.001	11	46	11	31	31	16	7.0	.32	.82	.026	.680	.029	2.5		14	.45					
0.30	7.4	.03	.001	6	37	10	48	40	25	9.4	.60	.50	.022	.570	.028	3.8		21	.35					
0.60	8.1	.06	.002	8	34	10	48	49	32	13	.78	.40	.025	.577	.023	4.4		21	.33					

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr	DTPA-extr.					Extractable			P	Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg			@ 40C	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C					@ 105C				
Bulk 0.10	1.5	.13	7	5	.77		22	47	0.6	0.4											

SOIL PROFILE CLASS: Widgewa
SITE NO: 1392
A.M.G. REFERENCE: 240 500 mE 6 897 600 mN ZONE 56
GREAT SOIL GROUP: Soloth
PRINCIPAL PROFILE FORM: Dr3.41
SOIL TAXONOMY UNIT: Ultic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Eutrophic, Mottled-Subnatric, Red Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: Very few medium pebbles, altered substrate material

SUBSTRATE MATERIAL: Altered substrate material
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Crest
LANDFORM PATTERN TYPE: Rises
VEGETATION
STRUCTURAL FORM: Site cleared
DOMINANT SPECIES:

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .16 m	Dark reddish brown (5YR3/2); fine sandy clay loam; few small pebbles, altered substrate material; massive; moderately moist; moderately firm. Clear to-
A2e	.16 to .21 m	Light brownish grey (5YR7/2) dry; sandy clay loam; few small pebbles, altered substrate material; massive; moderately moist; moderately firm. Abrupt to-
B2	.21 to .50 m	Reddish brown (2.5YR4/6); common medium distinct grey mottles; medium clay; very few small pebbles, altered substrate material; moderate 20-50mm angular blocky; moist; moderately firm. Clear to-
B3	.50 to .60 m	Dull reddish brown (5YR4/4); very few medium distinct mottles; coarse sandy medium clay; common large pebbles, altered substrate material; weak 10-20mm polyhedral; moist; moderately weak.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m	%		%			m.eq/100g					%			%						m.eq/100g		
	@ 40C	@105C		@ 105C				@ 105C					@ 80C			@ 105C			@ 40C			@ 105C		@ 40C
B 0.10	5.7	.13	.010																					
0.10	5.9	.04	.001	13	53	10	25	15	5.2	1.8	.14	.80	.045	.221	.040	1.0		8	.58					
0.31	5.6	.07	.002	14	28	9	42	16	3.0	4.0	1.8	.22	.023	.202	.025	1.1		14	.54					
0.60	4.9	.23	.014	9	42	6	52	26	2.6	6.6	4.3	.72	.020	.185	.064	1.6		18	.48					

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg				ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	2.3	.15	5		.69			59	14	.28	.24											

SOIL PROFILE CLASS: Wilga
SITE NO: 426
A.M.G. REFERENCE: 251 600 mE 6 889 600 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dd1.43
SOIL TAXONOMY UNIT: Udic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Hypocalcic, Mesonatric, Black Sodosol
TYPE OF MICRORELIEF: Crabhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Eucalyptus populnea, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR4/2); fine sandy loam; massive; dry; very firm; common <1mm roots. Sharp to-
A2e	.02 to .04 m	Greyish yellow-brown (10YR5/2), dull yellowish orange (10YR7/2) dry; fine sandy loam; massive; dry; very firm; very few medium manganiferous nodules; common <1mm roots. Abrupt to-
B21	.04 to .40 m	Brownish black (10YR3/2); medium heavy clay; very few small pebbles, quartz; moderate 20-50mm angular blocky; dry; moderately strong; very few fine calcareous soft segregations; few <1mm roots. Gradual to-
B22	.40 to .80 m	Greyish yellow-brown (10YR4/2); medium heavy clay; very few small pebbles, quartz; moderate 10-20mm angular blocky; moderately moist; very firm; few medium manganiferous soft segregations; few <1mm roots. Diffuse to-
B23	.80 to 1.50 m	Dull yellowish brown (10YR4/3); medium heavy clay; moderate 10-20mm angular blocky; moderately moist; very firm.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS	FS	S	C % @ 105C	Exch. Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 105C	S % @ 105C	Moistures ADM	33*	1500* % @ 105C	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
metres																								
B 0.10	7.1	.20	.017																					6.2
0.04	6.9	.11	.005	22	38	21	19						.052	.224	.038	2.1		9	.44					6.1
0.20	7.0	.45	.062																					6.0
0.30	7.1	.86	.102	10	26	16	51	35	13	11	7.5	.70	.011	.214	.029	5.1		20	.91					6.5
0.60	8.1	1.0	.122	9	25	13	54	32	13	13	8.5	.25	.006	.198	.016	4.5		21	.98					7.3
0.90	5.2	.84	.102	9	26	9	54	29	8.0	8.1	7.1	.17	.004	.190	.023	3.9		19	1.0					4.5
1.20	4.9	.80	.098	8	24	15	54	30	7.4	7.0	7.1	.16	.004	.183	.017	4.3								4.1
1.50	4.7	.78	.093																					3.9

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid mg/kg @ 105C	Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P mg/kg @ 105C	DTPA-extr. Fe	Mn	Cu	Zn	B mg/kg @ 105C	Extractable SO4S mg/kg @ 105C	NO3N	NH4N	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K m.eq/100g @ 105C
metres																						
B 0.10	1.5	.12		18	.90			22	40	0.6	0.3											

SOIL PROFILE CLASS: Wilga
SITE NO: 1206
A.M.G. REFERENCE: 250 800 mE 6 865 700 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Db1.13
SOIL TAXONOMY UNIT: Udic Haplustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Mesonatric, Black Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Drainage depression
LANDFORM PATTERN TYPE: Plain
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus populnea

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Brownish black (7.5YR3/2); loam, fine sandy; massive; moist; moderately weak. Clear irregular to-
B21	.15 to .25 m	Brownish black (7.5YR3/2); medium clay; moderate 10-20mm angular blocky; moist; very firm. Gradual to-
B22	.25 to .80 m	Brown (7.5YR4/3); light medium clay; strong 10-20mm angular blocky; moist; moderately firm; very few fine calcareous soft segregations, very few fine calcareous nodules. Diffuse to-
B23k	.80 to 1.50 m	Dull yellowish orange (10YR6/3); medium clay; strong 5-10mm angular blocky; moist; moderately firm; few medium calcareous soft segregations.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures			Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM	33*	1500*	R1	R2				CaCl2
metres		dS/m	%			%			m.eq/100g					%			%					m.eq/100g		
	@ 40C		@105C	@ 105C				@ 105C					@ 80C			@ 105C			@ 40C		@ 105C			@ 40C
B 0.10	7.4	.04	.001																					
0.10	7.5	.04	.001	9	55	11	25	16	9.7	3.2	0.4	1	.043	.685	.031	0.6		9	.48					
0.30	9.2	.22	.003	7	48	10	38	19	12	5.6	3.1	.78	.027	.672	.024	0.8		14	.68					
0.60	9.4	.83	.065	5	43	14	40	19	6	8.0	6.2	.66	.023	.668	.047	1.2		16	.92					
0.90	9.2	1.4	.151	4	44	13	41	20	4.3	9.2	7.2	.66	.019	.698	.053	1.2		17	.99					
1.20	8.7	1.3	.150	3	41	17	39	19	3.1	9.6	7.8	.69	.017	.712	.050	1.3								
1.50	8.0	1.1	.131																					

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr	DTPA-extr.				Extractable			P	Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff Cap	Equil ug/L	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg					m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	0.9	.08	8	1.1			20	22	1.1	.21											

SOIL PROFILE CLASS: Wondalli
SITE NO: 239
A.M.G. REFERENCE: 235 900 mE 6 854 000 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.28
SOIL TAXONOMY UNIT: Halic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Episodic-Endoacidic, Self-mulching, Grey Vertosol
TYPE OF MICRORELIEF: Melonhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 1.0 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Acacia harpophylla, Geijera parviflora, Eremophila mitchellii

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Self-mulching, periodic cracking

HORIZON	DEPTH	DESCRIPTION
A1	0 to .02 m	Greyish yellow-brown (10YR4/2); light medium clay; strong 2-5mm granular; moist; very weak; common <1mm roots. Abrupt to-
B21	.02 to .10 m	Dark greyish yellow (2.5Y4/2); medium heavy clay; strong 5-10mm angular blocky; moist; moderately firm; very few medium calcareous soft segregations; few <1mm roots. Gradual to-
B22	.10 to .50 m	Greyish yellow-brown (10YR5/2); medium heavy clay; strong 50-100mm lenticular parting to 2-5mm lenticular; moist; moderately weak; very few medium calcareous soft segregations; few <1mm roots. Diffuse to-
B23	.50 to 1.60 m	Greyish yellow-brown (10YR6/2); medium heavy clay; strong 50-100mm lenticular; moist; moderately weak; very few manganiferous veins; few <1mm roots.

Depth	1:5 Soil/Water pH @ 40C	EC dS/m @ 40C	Cl % @105C	Particle Size CS %	FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM % @ 105C	33* %	1500* %	Disp.Ratio R1 @ 40C	R2	Exch Al m.eq/100g @ 105C	Exch Acid m.eq/100g @ 105C	ECEC	pH CaCl2 @ 40C
metres																								
B 0.10	7.1	.23	.020																					6.1
0.10	7.2	.38	.043	7	25	17	55	36	14	9.2	5.6	1.8	.019	.751	.035	4.6		20	.81					6.4
0.20	7.1	.99	.120																					6.7
0.30	7.8	1.6	.204	4	22	15	61	34	11	12	13	1.4	.009	.727	.038	5.3		21	.91					7.2
0.60	5.8	4.1	.302	4	22	14	63	32	9.1	9.6	12	1.0	.005	.688	.367	5.5		22	.90					5.6
0.90	5.3	2.5	.333	2	20	13	65	34	7.6	8.6	12	1.0	.004	.698	.042	5.1		23	1.0					4.8
1.20	5.1	2.3	.313	3	21	15	62	35	6.7	7.1	11	.96	.005	.700	.038	5.0								4.6
1.50	4.9	2.2	.303																					4.5

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. P Acid Bicarb. mg/kg @ 105C	HCl K meq% @105C	CaCl2 Extr K mg/kg @ 105C	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S mg/kg	NO3N mg/kg	NH4N mg/kg	P Buff Cap @ 40C	Equil ug/L	Alternative Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K
metres																					
B 0.10	1.6	.14	14	1.0			20	36	0.9	0.4											

SOIL PROFILE CLASS: Wondalli
SITE NO: 293
A.M.G. REFERENCE: 247 500 mE 6 855 800 mN ZONE 56
GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Sodic Haplustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous-Endohypersodic, Self-mulching, Grey Vertosol
TYPE OF MICRORELIEF: Melonhole gilgai
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE:
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall open forest
DOMINANT SPECIES: Casuarina cristata, Acacia harpophylla, Chloris ventricosa

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking, self-mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dull yellowish brown (10YR4/3); medium clay; strong 5-10mm angular blocky; dry; moderately strong. Clear to-
B21k	.10 to .60 m	Brownish grey (10YR4/1); medium heavy clay; moderate 10-20mm angular blocky, parting to strong 2-5mm angular blocky; moderately moist; very firm; few fine calcareous soft segregations. Diffuse to-
B22k	.60 to 1.10 m	Brownish grey (10YR5/1); medium heavy clay; moderate 10-20mm angular blocky, parting to strong 2-5mm angular blocky; moderately moist; moderately firm; few medium calcareous soft segregations, few manganiferous veins. Diffuse to-
B23	1.10 to 1.50 m	Greyish yellow-brown (10YR5/2); medium heavy clay; moderate 20-50mm angular blocky; moderately moist; moderately firm.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Exch ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2	Al	CaCl2
metres		dS/m	%		%				m.eq/100g					%			%			Acid	
	@ 40C		@105C		@ 105C				@ 105C					@ 80C			@ 105C	@ 40C		@ 105C	@ 40C
B 0.10	8.1	.18	.002																		7.5
0.10	8.0	.08	.003	6	41	14	42	28	26	4.7	1.0	1.9	.040	.995	.031	2.6	16	.51			7.0
0.30	8.6	.46	.034	4	29	15	54	37	28	7.6	4.7	1.4	.022	.961	.029	3.5	24	.46			7.6
0.60	8.4	1.5	.061	3	34	17	53	30	21	9.9	6.3	1.6	.012	.911	.148	3.6	21	.63			8.0
0.90	9.0	.90	.079	4	36	17	49	30	13	9.1	6.8	1.5	.005	.899	.038	2.9	21	.76			8.0
1.20	8.5	.97	.102	3	29	16	53	29	12	8.9	7.5	1.4	.002	.886	.033	3.3					7.8
1.50	7.8	1.1	.118																		7.0

Depth	Org.C	Tot.N	Extr. P	HCl	CaCl2 Extr		DTPA-extr.					Extractable			P		Alternative Cations				
	(W&B)		Acid Bicarb.	K	K	P	Fe	Mn	Cu	Zn	B	SO4S	NO3N	NH4N	Buff	Equil	CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg			Cap	ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1.9	.17	16	1.2		9	16	0.7	0.8												

SOIL PROFILE CLASS: Wondoogle
SITE NO: 358
A.M.G. REFERENCE: 218 700 mE 6 895 800 mN ZONE 56
GREAT SOIL GROUP: Earthy sand
PRINCIPAL PROFILE FORM: Uc5.21
SOIL TAXONOMY UNIT: Ustic Quartzipsamment
AUSTRALIAN SOIL CLASSIFICATION: Basic, Stratic Rudosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Sand
SLOPE: 0 %
LANDFORM ELEMENT TYPE: Terrace
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall woodland
DOMINANT SPECIES: Eucalyptus dealbata, Allocasuarina leuhmannii, Callitris glaucophylla

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A11	0 to .18 m	Brown (10YR4/4); loamy fine sand; massive; moist; very weak. Diffuse to-
A12	.18 to .30 m	Dull yellowish brown (10YR5/4); loamy fine sand; massive; moist; very weak. Diffuse to-
C	.30 to 1.65 m	Brown (10YR4/4); loamy fine sand; massive; moist; very weak.

Depth	1:5 Soil/Water			Particle Size				Exch. Cations					Total Elements			Moistures		Disp.Ratio		Exch Al	Exch Acid	ECEC	pH
	pH	EC	Cl	CS	FS	S	C	CEC	Ca	Mg	Na	K	P	K	S	ADM 33*	1500*	R1	R2				CaCl2
metres		dS/m	%			%			m.eq/100g					%			%				m.eq/100g			
	@ 40C		@105C			@ 105C			@ 105C					@ 80C			@ 105C	@ 40C			@ 105C		@ 40C
B 0.10	7.0	.02	.001										.023	.567	.014	.2	2	.99					5.9
0.10	6.9	.02	.001	26	67	1	7	4	4.9	.60	.09	.29	.008	.574	.007	.3	2	.71					5.8
0.30	6.1	.01	.001	17	77	2	6	2	1.5	.31	.09	.13	.001	.575	.005	.2	2	.71					5.2
0.60	6.5	.01	.001	21	73	3	5	2	3.4	.31	.09	.20	.001	.613	.004	.2	1	.69					5.4
0.90	6.6	.01	.001	14	81	4	4	2	1.3	.31	.09	.16	.001	.613	.003	.2							5.7
1.20	6.6	.01	.001	12	83	1	4	2	3.1	.40	.09	.31											6.0
1.50	6.8	.01	.001																				6.0

Depth	Org.C (W&B)	Tot.N	Extr. P Acid Bicarb.	HCl K	CaCl2 Extr K	CaCl2 Extr P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	P Equil ug/L	Alternative Cations CEC	Ca	Mg	Na	K
metres	%	%	mg/kg	meq%	mg/kg		mg/kg					mg/kg					m.eq/100g				
	@ 105C	@ 105C	@ 105C	@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
B 0.10	1	.05	7	.12		7	10	0.1	0.3												

SOIL PROFILE CLASS: Wynhari
SITE NO: W14
A.M.G. REFERENCE: 218 900 mE 6 878 300 mN ZONE 56
GREAT SOIL GROUP: Brown clay
PRINCIPAL PROFILE FORM: Ug5.32
SOIL TAXONOMY UNIT: Sodic Calciustert
AUSTRALIAN SOIL CLASSIFICATION: Epicalcareous-Epihypersodic, Self-mulching, Brown Vertosol
TYPE OF MICRORELIEF: Crabhole gilgai
VERTICAL INTERVAL: 0.15 m
HORIZONTAL INTERVAL: 9 m
COMPONENT OF MICRORELIEF SAMPLED: Shelf
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL: Labile sedimentary rocks
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Crest
LANDFORM PATTERN TYPE: Gently undulating rises
VEGETATION: Tall open forest of belah with occasional brigalow

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Periodic cracking and self mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Dark brown (10YR3/3) moist; light medium clay; moderate 10-20mm angular blocky, parting to moderate <2mm granular; moderately moist; moderately firm; common 1-2mm roots. Abrupt to-
B21	.05 to .36 m	Dark brown (10YR3/3) moist; medium heavy clay; moderate 20-50mm angular blocky, parting to moderate 10-20mm angular blocky; moist; moderately firm; few medium calcareous nodules; few >5mm roots. Clear to-
B22k	.36 to .98 m	Dull yellowish brown (10YR5/3) moist; few medium faint grey mottles; medium heavy clay; moderate 20-50mm polyhedral, parting to moderate 10-20mm polyhedral; moderately moist; very firm; many coarse calcareous soft segregations, common medium calcareous nodules; few 1-2mm roots. Abrupt to-
BC	.98 to 1.23 m	Weathered sandstone and siltstone, very few coarse calcareous soft segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m	%	%				m.eq/100g					%			%							
	@ 40C	@105C	@ 105C					@ 105C					@ 80C			@ 105C		@ 40C		@ 105C			@ 40C
Bulk 0.10	8.2	.16	.002																				
0.10	8.4	.13	.001	9	40	16	37	40	30	4.4	.49	1.1	.028	.409	.029	2.8	15	.39					
0.30	9.2	.41	.014	6	35	14	47	43	26	8.8	7.3	.54	.015	.326	.042	3.3	21	.79					
0.60	8.8	.82	.055	7	33	15	45	44	24	9.8	9.0	.48	.013	.321	.060	3.0	20	.74					
0.90	8.7	1.0	.079	3	28	14	52	49	25	10	10	.50	.009	.373	.047	3.6	23	.93					

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	%	%	mg/kg		meq%	mg/kg		mg/kg					mg/kg				ug/L	m.eq/100g				
	@ 105C	@ 105C	@ 105C		@105C	@ 105C		@ 105C					@ 105C			@ 40C		@ 105C				
Bulk 0.10	1.2	.11	15	9	.86			17	23	0.8	0.4											

SOIL PROFILE CLASS: Yambocully
SITE NO: 1324
A.M.G. REFERENCE: 212 700 mE 6 860 300 mN ZONE 56
GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dd1.33
SOIL TAXONOMY UNIT: Udic Paleustalf
AUSTRALIAN SOIL CLASSIFICATION: Calcic, Mesonatric, Black Sodosol
TYPE OF MICRORELIEF: No microrelief
SURFACE COARSE FRAGMENTS: No coarse fragments

SUBSTRATE MATERIAL:
SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Plain
LANDFORM PATTERN TYPE: Alluvial plain
VEGETATION
STRUCTURAL FORM: Tall isolated trees
DOMINANT SPECIES: Eucalyptus populnea, Casuarina cristata, Allectryon oleifolius, Eremophila mitchellii, Geijera parviflora

PROFILE MORPHOLOGY:

CONDITION OF UNDISTURBED SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .06 m	Greyish brown (7.5YR4/2); silty clay loam; massive; moist; moderately weak. Sharp to-
A2j	.06 to .08 m	Greyish brown (7.5YR6/2) dry; silty clay loam; massive; moist; moderately weak. Abrupt irregular to-
B21	.08 to .23 m	Brownish black (10YR3/2); medium clay; moderate 20-50mm angular blocky; moderately moist; very firm. Gradual to-
B22k	.23 to .75 m	Greyish yellow-brown (10YR4/2); medium heavy clay; moderate 20-50mm angular blocky; moderately moist; very firm; few medium calcareous soft segregations. Gradual to-
B23k	.75 to 1.20 m	Greyish yellow-brown (10YR5/2); few medium faint brown mottles; medium clay; strong 10-20mm angular blocky; moderately moist; moderately firm; few medium calcareous soft segregations. Gradual to-
B24	1.20 to 1.60 m	Greyish yellow-brown (10YR4/2); medium heavy clay; weak 50-100mm lenticular parting to moderate 20-50mm angular blocky; moderately moist; very firm; very few medium calcareous soft segregations, very few manganiferous veins.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	33*	1500*	Disp.Ratio R1	R2	Exch Al	Exch Acid	ECEC	pH CaCl2
metres		dS/m @ 40C	% @105C	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C			@ 40C		m.eq/100g @ 105C			@ 40C
B 0.10	7.0	.09	.003																					5.7
0.08	6.5	.06	.001	8	48	20	25	19	7.3	3.7	.35	1.6	.082	.771	.039	1.8		9	.59					5.3
0.33	9.0	1.0	.096	4	31	16	52	32	11	9.0	7.3	1.7	.026	.720	.040	2.7		19	.85					8.0
0.60	9.0	1.3	.101	4	32	17	47	23	8.4	8.6	8.3	1.3	.022	.698	.056	2.6		19	.94					8.1
0.90	9.1	1.2	.123	4	42	18	38	21	.18	6.4	6.4	.78	.200	.687	.043	1.9		17	.99					9.0
1.20	8.9	1.1	.104	1	32	20	45	23	.18	6.8	8.0	.68	.200	.678	.038	2.1								7.9
1.50	8.1	1.0	.103																					7.3

Depth	Org.C (W&B)	Tot.N	Extr. P Acid	Bicarb.	HCl K	CaCl2 Extr K	P	DTPA-extr. Fe	Mn	Cu	Zn	B	Extractable SO4S	NO3N	NH4N	P Buff Cap	Equil	Alternative Cations CEC	Ca	Mg	Na	K
metres	% @ 105C	% @ 105C	mg/kg @ 105C		meq% @105C	mg/kg @ 105C		mg/kg @ 105C					mg/kg @ 105C			@ 40C	ug/L	m.eq/100g @ 105C				
B 0.10	1.6	0.1	75		1.6			47	84	.82	1.1											

APPENDIX IV

LIST OF PLANT SPECIES

	Botanical name	Common name
	Acacia burrowii	currawong
	A. crassa subsp. *crassa*	-
	A. deanei	green wattle
	A. decora	pretty wattle
	A. excelsa	ironweed
	A. harpophylla	brigalow
	A. leptostachya	-
	A. pendula	myall
	A. salicina	Sally wattle
	A. sparsiflora	a lancewood
	Agrostis avenacea var. *avenacea*	blown grass
	Alectryon oleifolius	boonaree
	Allocasuarina luehmannii	bull oak
	Alopecurus geniculatus	marsh foxtail
	Alphitonia excelsa	red ash
	Alstonia constricta	bitter bark
	Ancistrachne uncinulata	hooky grass
	Angophora leiocarpa	rusty gum
	A. floribunda	rough bark apple
	Aristida benthamii	a wiregrass
	A. blakei	-
	A. caput-medusae	many headed wire grass
	A. leptopoda	white speargrass
	Astrebla elymoides	hoop mitchell grass
	Atalaya hemiglauca	whitewood
	Atriplex sp.	saltbush
	Baeckea jucunda	-
	Bothriochloa decipiens	pitted bluegrass
	Brachychiton populneus subsp. *trilobus*	kurrajong
	Bursaria incana	prickly pine
	Callitris glaucophylla	cypress pine
	Canthium odoratum	sweet susie
	Capparis mitchellii	wild orange or bumble
	Casurina cristata	belah
*	*Cenchrus ciliaris*	buffel grass
*	*C. incertus*	spiny burrgrass
	Chloris truncata	windmill grass
	C. ventricosa	tall chloris
	Chrysocephalum apiculatum	yellow buttons
	Critesion murinum subsp. *leporinum*	barley grass
	Cryptandra armata	a cryptandra
	Cymbopogon refractus	barb wire grass
	Cyperus rotundus	nut grass
	Dactyloctenium radulans	button grass
	Danthonia longifolia	long leaved wallaby grass
	Dichanthium sericeum subsp. *sericeum*	Queensland bluegrass
	Digitaria leucostachya	-
	D. orbata	-

	Diplachne fusca	brown beetle grass
	Dodonaea viscosa subsp. *angustifolia*	-
	D. viscosa subsp. *angustissima*	sticky hop bush
	Einadia hastatia	berry saltbush
	Eleocharis plana	-
	Enchylaena tomentosa var.*tomentosa*	ruby saltbush
	Enneapogon gracilis	slender nineawn
	E. lindleyanus	bottle washer
	Enteropogon ramosus	-
	Eragrostis cumingii	a love grass
*	*E. curvula*	African lovegrass
	E. elongata	clustered lovegrass
	E. lacunaria	purple lovegrass
	E. minor	smaller stink grass
	Eremocitrus glauca	limebush
	Eremophila maculata	fuchsia bush
	E. mitchellii	false sandalwood
	Eriochloa crebra	spring grass or cup grass
	Eriostemon angustifolius	-
	Eryngium plantagineum	-
	Eucalyptus camaldulensis	river red gum
	E. chloroclada sens. lat.	-
	E. coolabah	coolibah
	E. crebra	narrow leaved ironbark
	E. crebra-coolabah	hybrid
	E. dealbata	tumbledown gum
	E. dolichocarpa	bloodwood
	E. exserta	Queensland peppermint
	E. largiflorens	black box
	E. melanophloia	silver leaved ironbark
	E. pilligaensis	grey box
	E. populnea	poplar box
	E. tereticornis	Queensland blue gum
	E. tessellaris	carbeen or Moreton Bay ash
	Eulalia fulva	brown top
	Fimbristylis dichotoma	common fringerush
	Flindersia maculosa	leopardwood
	Geijera parviflora	wilga
	Hakea lorea	a needlewood hakea
	Harrisia species	harrisia cactus
	Heteropogon contortus	bunch spear grass, black spear grass
	Juncus aridicola	tussock rush
	Leptochloa digitata	umbrella canegrass
	Lomandra leucocephala	a mat-rush
	Maireana microphylla	-
	Melaleuca lanceolata	western tea tree
	M. uncinata	broom honey myrtle
*	*Melinis repens*	red natal grass
	Muehlenbeckia cunninghamii	lignum
	Myoporum acuminatum	boobialla water bush
	M. deserti	Ellangowan poison bush
	Owenia acidula	emu apple
	Panicum buncei	-
	P. effusum var. *effusum*	hairy panic
	P. laevinode	-
	P. subxerophilum	gilgai grass
	Pareneurachne muelleri	-

Paspalidium jubiflorum	Warrego grass
Perotis rara	comet grass
Phebalium glandulosum subsp. *glandulosum*	-
Pimelea trichostachya	pimelea
Rhagodia parabolica	mealy saltbush
R. spinescens	spiny saltbush
Sclerolaena birchii	a galvanised burr
S. glabra	a galvanised burr
Senna artemisioides subsp. *filifolia*	desert cassia
S. coronilloides	-
Sesbania cannabina	sesbania pea
Setaria surgens	-
Sporobolus caroli	yakka grass
S. disjunctus	-
Stipa rudis	-
S. scabra subsp. *scabra*	rough speargrass
S. verticillata	slender bamboo grass
Triodia mitchellii	buck spinifex
Triraphis mollis	purple plume grass
Urochloa mosambicensis	sabi grass
U. panicoides var. *panicoides*	liverseed grass
Zygophyllum apiculatum	gallweed

* (Exotic Species)