DEPARTMENT OF THE INTERIOR

REPORT ON THE LAND UNITS OF THE KATHERINE-DOUGLAS AREA, N.T. 1970

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FIG. 1—SURVEY AREA
Showing Map Sheet Numbers
REPORT ON THE LAND UNITS OF THE KATHERINE-DOUGLAS AREA

Introduction

The area with which this report is concerned is part of the Tipperary area as defined by CSIRO (1965). The actual area surveyed is shown in Figure 1. Throughout this report frequent references are made to the work of CSIRO. This present work is not meant to supersede CSIRO's report, but to elaborate on it. In fact it is hoped that readers of this report will be familiar with the CSIRO work.

Survey work was conducted in the dry seasons of 1968 and 1969. Final interpretation and mapping were carried out on aerial photographs at a scale of four inches to one mile. This was then reduced and transposed to base maps at a scale of 1:50,000 compiled by the National Mapping Division of the Department of National Development and supplied through the Lands and Survey Branch, N.T. Administration.

By using the Land Systems map of the area it was possible to identify the areas of higher potential and to separate them from the more marginal lands. It followed as a result of this initial separation that field survey work was concentrated in these better areas. Little field work was done on the areas of lower potential except where tracks happened to be conveniently placed. The mapping of these areas has proceeded mainly by photo-interpretation and with the aid of the descriptions in the Land Systems report.

The survey procedure that was followed was first to make a thorough preliminary study of the aerial photographs. Secondly, particular sites were selected for study in the field. Then the survey party went out into the field to inspect and record the soils, vegetation and topography at each of these sites. This information was then used in the final interpretation of the aerial photographs.

The final mapping units that have been defined are 'land units'. In order to be able to use these maps and this report effectively it is important to understand what is meant by a land unit. The CSIRO land systems were defined as areas with a recurring pattern of topography, soils and vegetation. Each land system was described in terms of its component parts, which were described as land units. These land units were not mapped, although an effort was made to estimate their proportions. The object of the present survey was to map these land units and to describe them in greater detail. It soon became apparent, however, that it would not be possible to map the actual land units described by CSIRO. These were often too generalised, too small or not readily definable, either on the ground or on the aerial photographs. This is not to say that the CSIRO units were invalid. They have been useful as a foundation on which to base the proposed land unit classification, but were not suitable as mapping units.

The land units proposed here are the end point of an essentially pragmatic approach to the problem of land classification. Each unit, while representing a more or less uniform assemblage of data on topography, soils and vegetation, is also
designed to be informative as to the potential or capability of the land represented. Hooper (1970) has discussed the concept of land units at greater length.

Some of the land units are essentially very uniform with the same topography, soil and vegetation throughout. Others, particularly those representing land of lower potential, are very variable or in other words, contain many components, no one of which is intrinsically any more useful than another.

A land unit therefore is an area of land which exhibits a uniform photo-pattern on the aerial photographs. It contains similar soils, vegetation and topography elements throughout, but minor variation in any of these is allowable. It may contain areas of different land units as components too small to be mappable. The limitations to land use and the land use potential of a land unit are usually but not necessarily similar throughout.

This pragmatic approach to land classification has led to the production of a workable number of units. There could have been many more but their inclusion would have led to a totally unreadable map. The authors therefore make no apologies for what might appear to be inconsistencies in mapping and classification. Land either defies compartmentalism or it can be compartmentalised *ad nauseam*. The authors hope they have struck a happy and usable medium.

**References**


Typical view of part of the Daly Basin
The Daly River flows strongly even at the end of the dry season.

The Daly River has changed its course leaving frequent billabongs along its length.
LAND USE AND LIMITATIONS TO MORE INTENSIVE DEVELOPMENT

At present the only agriculture practised in the Katherine-Douglas area is on a few small farms along the Katherine River levee, one small area on the Edith River, and a few small blocks of land near the station homesteads. CSIRO operates a research station at Katherine and the N.T. Administration has an experimental farm near Katherine and another, the Douglas/Daly Experimental Station, on the Douglas River. The bulk of the area is either vacant Crown land or is held under pastoral lease for extensive cattle 'ranching'. The cattle stations, however, are radically changing their methods of operation. Fences are being erected and areas are being sown to Townsville Stylo so that the production of beef cattle is now following semi-intensive lines. This attitude has followed the increase in prices paid for beef by the local abattoirs, and the overall injection of capital into these cattle stations.

Whilst continuing research by CSIRO and the N.T. Administration shows that it is possible to produce good yields of cash crops, such as peanuts and grain sorghum, particularly on the Red Earths, the present unavailability and unpredictability of markets mitigates against the production of such crops. It is likely therefore that the production of beef will remain the only profitable enterprise for the area in the foreseeable future, with limited areas being brought into arable use mainly for the production of fodder reserves.

Research on Townsville Stylo shows that this useful legume can be introduced onto almost any soil type but that the yields can be expected to vary greatly, and that the problems involved in stocking can be very different. The question asked by a property owner therefore is not, ‘Where can I sow some improved pasture?’ but ‘Where should I sow some improved pasture to obtain maximum returns?’

In defining and mapping land units we have endeavoured to place objective limitations ratings on each unit, and by reference to these limitations to propose a suitable land use for each unit. The limitations that have been considered are relief and micro-relief, soil depth, graveliness, stoniness, rockiness, erodibility, flooding, inundation, drainage, permeability, available soil water storage capacity, topsoil consistency, soil reaction, clearing difficulty and weediness.

It will be appreciated that many of these limitations interact. Thus steep rugged country (severe relief limitation) will also have a severe rock limitation, will be extremely erodible and will have little or no depth of soil. Thus with a unit such as 2a the severe relief limitation overrides all other limitations. Similarly a unit such as 3a with a severe rock limitation is likely to have very shallow soil. A unit such as 7a1 with a serious inundation limitation will also be very poorly drained. A unit such as 5d, with soils with slow permeability will also be poorly drained. Unit 5b with a severe gravel limitation will have soil with a very low waterholding capacity.

It is hoped that the mapping of land units and the description of their soils and vegetation together with the notes on their main limitations will help station owners in the planning and development of their properties. Long-term management decisions are made on the basis of economic considerations. Opportunity costs have always to be considered. This land unit mapping should provide the factual basis on which such long-term decisions can be made. Among the many uses that can be made of the land unit maps are:

1. The selection of cropping areas
2. The selection of most suitable areas for improved pasture
(3) The selection of areas suitable for irrigation
(4) The selection of areas of native pastures for dry season feed
(5) The siting of station tracks, fence lines and buildings
(6) The selection of areas with suitable timber for fence posts
(7) Finding supplies of sand and gravel
(8) Finding cattle and horse camps.

Throughout the following section the heading ‘Occurrence’ refers to the CSIRO land systems in which the land unit most commonly occurs. The term ‘Land Category’ refers to an assessment of the capability of the unit. It is essentially a subjective assessment based on field data and experimental evidence, and as such it is liable to alteration as new evidence becomes available. Land categorisation has been developed with present agricultural and pastoral management systems in mind. Others may follow and the land categories may have to be changed but the mapped information (Land Units) will remain unchanged. The land categories 1–8 are briefly:

1. Arable with only slight limitations: suitable for cash crops
2. Arable with moderate limitations: suitable for cash crops
3. Arable with definite limitations: more suitable for fodder crops than cash crops
4. Marginally arable with serious limitations: more suitable for improved pasture
5. Non-arable: suitable for permanent improved pasture
6. Non-arable: marginally improvable grazing land
7. Unimprovable rough grazing land
8. Land unsuitable for pastoral production.
DESCRIPTION OF LAND UNITS

1. High level plateaux

1a

OCCURRENCE: Mainly Mullaman; some Yujullowan.

TOPOGRAPHY: Flat to gently sloping with marginal rocky slopes up to 10%.

SOILS: Generally shallow Cockatoo and Lateritic Podzolics with frequent outcrop of laterite or sandstone.

VEGETATION: Open forest (E. miniata, E. tetradonta, E. bleeseri); frequently dense understory shrubs; and Spinifex/annual Sorghum.

LIMITATIONS: Rocky, shallow soils.

POTENTIAL LAND USE: Mainly inaccessible; very limited rough grazing; watershed protection.

LAND CATEGORY: 7.

1b

OCCURRENCE: Budbudjong and Kimbyan.

TOPOGRAPHY: Massive limestone ridges with frequent rocky sinks.

SOILS: Very poorly developed Red Earths; large areas of bare rock surface.

VEGETATION: Mainly deciduous non-Eucalypt low woodland and scrub; sparse grasses.

LIMITATIONS: Extremely rocky.

POTENTIAL LAND USE: Inaccessible areas; recreation; wildlife refuges.

LAND CATEGORY: 8.

2. Rugged terrain

2a

OCCURRENCE: Mullaman, Yujullowan, Woggaman, Chinaman and Jindara.

TOPOGRAPHY: Rugged terrain with slopes in general greater than 40%; boulder strewn slopes and rocky crests.

SOILS: Very shallow or skeletal with outcrop

VEGETATION: Very variable, but general occurrence of E. dichromophloia and, in lower rainfall areas, E. umbrawarrensis and Lancewood; Spinifex and annual Sorghum.

LIMITATIONS: Shallow rocky soils.

POTENTIAL LAND USE: Usually inaccessible; watershed protection; catchment reserves; wildlife refuges; unsuitable for pastoral production.

LAND CATEGORY: 8.

2b

As for 2a but slopes 15-40%.

2c

OCCURRENCE: Mullaman, Yujullowan, Woggaman, Chinaman, Jindara, Beemla and Claravale.

TOPOGRAPHY: Hilly terrain with slopes 5-15%; rocky and boulder strewn.

SOILS: Generally shallow or skeletal.

VEGETATION: As for 2a.

LIMITATIONS: Shallow, rocky soils; very erodible situations.

POTENTIAL LAND USE: Limited rough grazing.

LAND CATEGORY: 7.

3. Flat to gently undulating terrain

3a

OCCURRENCE: Mainly Woggaman, Jindara and Claravale.

TOPOGRAPHY: Gently undulating crests and upper slopes up to 5%.

SOILS: Either very shallow and gravelly, or sandy with frequent exposures of sandstone or laterite.

VEGETATION: Frequently dense low woodland or tall shrubland on the shallow gravelly soils, and open forest on the rocky sandy soils; mainly Spinifex and annual Sorghum.

LIMITATIONS: Shallow soils, rocky, poor waterholding capacity; frequently erodible.

POTENTIAL LAND USE: Poor rough grazing.

LAND CATEGORY: 7.

3b

As for 3a but slopes 15-40%.

3c

OCCURRENCE: Kimbyan, Tagoman and Budbudjong.

TOPOGRAPHY: Very gentle slopes less than 2% on Kimbyan and Budbudjong; undulating and dissected terrain on Tagoman; severe limestone pavement or outcrop on Kimbyan and Budbudjong; frequent linear outcrops of intermixed limestone and sandstone on Tagoman.

SOILS: Small pockets of very shallow Red Earths; some Florina.

VEGETATION: Low woodland (E. tectifica, E. foelscheana) with frequently a well-developed understory of Hakea arborescens and Cochlospermum fraseri; mixed annual Sorghum and perennial grasses.

LIMITATIONS: Severe rock outcrop; shallow soils in small pockets, highly erodible on Tagoman.

POTENTIAL LAND USE: Very limited rough grazing; severely restricted accessibility.

LAND CATEGORY: 7.
3b
In general similar to 3a. Rock outcrop less severe on Kimbyan and Budbudjong or terrain more gentle and less dissected on Tagoman. Areas are trafficable with difficulty. Areas without rock are generally more extensive and the soils deeper. Suitable for rough grazing with small areas suitable for improved pasture.
LAND CATEGORY: 6.

3c
OCCURRENCE: As 3a.
TOPOGRAPHY: Flat to gently sloping (less than 2%) with scattered limestone pavement or outcrop.
SOILS: Loamy Red Earths, deep with minor outcrop, or shallow (12-18 in deep) with small amounts of surface stone and gravel.
VEGETATION: Low woodland (E. foelscheana) with few shrubs; grasses dominated by tall perennials, mainly Sehima.
LIMITATIONS: Slight rock; soils sometimes shallow (hence poor waterholding capacity); generally slightly erodible on Tagoman where slopes are greater than 1%.
POTENTIAL LAND USE: Improved pastures with high carrying capacity; often arable but more suitable for forage crops than for cash crops.
LAND CATEGORY: 3.

3d
OCCURRENCE: Extensive on Kimbyan, small areas on Tagoman, Jindara, Douglas and Wriggley.
TOPOGRAPHY: Flat to gently sloping (less than 2%) with indistinct drainage floors.
SOILS: Tippera with small inclusions of Florina, or Tindall associated with Tindall limestones; soils mainly more than 5 ft deep.
VEGETATION: Very uniform low woodland (E. tectifica, E. foelscheana on Tippera soils; E. oligantha on Tindall) with uniform perennial grasses (Sehima and Themeda).
Drainage floors characteristically with taller trees (including E. tetradonta, E. miniata and E. bigalerita) and dense sucker regrowth with the addition to the grasses of Heteropogon contortus and Coelorhachis.
Patches of Florina are characterised by more open trees, scattered understory species notably Grevillea heliosperma and Terminalia ferdinandiana, and more mixed and poorer grasses including Chrysopogon fallax.
LIMITATIONS: Slight erosion on slopes greater than 0.5%, more severe on drainage floors; dense hard surface with low permeability; narrow available moisture range.
POTENTIAL LAND USE: Arable; suitable for cash cropping; not easily ploughed when dry; continuous cultivation leads to insidious sheet erosion.
LAND CATEGORY: 1 with minor 4 (Florina components) and 6 (drainage floors).

3d1
OCCURRENCE: Douglas and Kimbyan in the north of the area.
TOPOGRAPHY: As 3d.
SOILS: Tindall, usually at least 5 ft deep; with subsoil concretions with high manganese content.
VEGETATION: Dense low woodland to tall shrubland with perennial grasses; same species as 3d.
LIMITATIONS: As 3d and in addition a probable nutrient imbalance.
POTENTIAL LAND USE: As 3d depending on severity of the nutrient disorder.
LAND CATEGORY: 2.

3d2
OCCURRENCE: Jindara in the north of the area.
TOPOGRAPHY: Lower slopes and drainage floors; undulating with short and variable slopes.
SOILS: Emu, often shallow.
VEGETATION: As 3d on lower slopes; E. miniata open forest with perennial grasses including Coelorhachis and Heteropogon triticeus on drainage floors.
LIMITATIONS: Very erodible; small, scattered areas.
POTENTIAL LAND USE: Native pastures and grassed waterways with controlled grazing.
LAND CATEGORY: 6.

3e
OCCURRENCE: Tagoman and Jindara; very limited in extent.
TOPOGRAPHY: Undulating terrain with slopes up to 5%; generally at distinct breaks of slope or at heads of drainage systems; frequently used by cattle and horses for camp sites.
SOILS: Loamy Red Earths usually shallow and eroded.
VEGETATION: Low very open woodland with many dead trees; sparse perennial grasses
and Brachyachne, frequent bare areas and gullies.

LIMITATIONS: Very erodible; small, scattered areas.

POTENTIAL LAND USE: Rough grazing; possibly improvable.

LAND CATEGORY: 6.

3f

OCCURRENCE: Kimbyan, in particular adjoining major river alluvials.

TOPOGRAPHY: Almost flat (less than 1%).

SOILS: Elliott, usually deep with slight internal drainage impedances.

VEGETATION: Woodland, rather taller than on 3d, otherwise similar with frequent occurrence of E. patellaris; dense perennial grasses usually dominated by Themeda.

LIMITATIONS: Slow subsoil permeability causes poorer drainage than 3d.

POTENTIAL LAND USE: Arable, suitable for cash cropping although water tolerant varieties may be required, lower yields may be expected on locally waterlogged areas; some areas may be untrafficable during wet periods.

LAND CATEGORY: 2.

4a1

OCCURRENCE: Blain, Kimbyan and Wriggley.

TOPOGRAPHY: Long gentle slopes up to 2%; and broad drainage floors; scattered rock outcrop or pavement, normally limestone.

SOILS: Usually deep Sandy Red Earths with firm surface horizons of sandy loam to sandy clay loam (Oolooloo with some Venn).

VEGETATION: Low woodland to woodland with E. tetradonta and Terminalia grandiflora on Blain and Wriggley and as 3d on Kimbyan; perennial grasses.

LIMITATIONS: Subject to erosion particularly under conditions of continuous cultivation; probable compaction and surface sealing problems.

POTENTIAL LAND USE: Arable; crop responses expected to be similar to 3d.

LAND CATEGORY: 1.

4a2

OCCURRENCE: Blain and Wriggley.

TOPOGRAPHY: Long gentle slopes up to 2%; occasional sandstone outcrop.

SOILS: Deep Sandy Red Earths with soft surface horizons of sand to loamy sand (Blain with some Venn).

VEGETATION: Low woodland to woodland with E. tetradonta and Terminalia grandiflora and dominant annual Sorghum.

LIMITATIONS: Subject to severe erosion; seeding establishment difficulties due to low waterholding capacity of topsoil and surface sealing.

POTENTIAL LAND USE: Mainly suitable for improved pastures; generally non-arable; probably suitable for forestry purposes.

LAND CATEGORY: 5.

4c

OCCURRENCE: Blain and Claravale; mainly close to major rivers and creeks.

TOPOGRAPHY: Gently undulating terrain often adjoining, or at least close to river
backplains, slopes up to 3%; often slight limestone outcrop at breaks of slope.

SOILS: Deep Sandy Red Earths with sand or loamy sand surfaces (Venn with some Blain).

VEGETATION: Woodland to open forest dominated by Ironwood, *E. tetradonta* and *E. papuana*; large well-formed trees, rather widely spaced with much Bauhinia under-story; mixed perennial grasses and annual Sorghum.

LIMITATIONS: Subject to severe erosion if cultivated; probable water stress and surface sealing problems; slight rock.

POTENTIAL LAND USE: Improved pastures with selective clearing; proximity to perennial waters and their content of excellent shade trees makes these areas most valuable for grazing.

LAND CATEGORY: 5.

4c1

OCCURRENCE: Kimbyan; mainly adjacent to Daly river below its junction with Stray Creek.

TOPOGRAPHY: Gently undulating terrain adjoining river backplains or old river channels, slopes up to 5%; some ferruginous outcrops at breaks of slope.

SOILS: Deep Sandy Red Earths with sand to sandy loam surfaces (Venn, with some Blain).

VEGETATION: Open forest dominated by *E. papuana* and *Gyrocarpus americanus*, large well-formed trees rather widely spaced, with some Ironwood, Kurrajong, *Canarium* and *Acacia*. Mixed perennial grasses and annual Sorghum, and *Hyptis*.

LIMITATIONS: Subject to severe erosion if cultivated; probable water stress and surface sealing problems; slight rock.

POTENTIAL LAND USE: Improved pastures on lower slopes with selective clearing; proximity to perennial waters and their content of excellent shade trees increases the value of these areas for grazing.

LAND CATEGORY: 5.

4d

OCCURRENCE: Claravale and to a small extent Blain.

TOPOGRAPHY: Upper and middle slopes in undulating terrain; slopes up to 5%, occasionally up to 8%.

SOILS: Mainly deep Earthy Sands (Cockatoo), sometimes light Sandy Red Earths (Blain) and Siliceous Sands (Cypress); often occurs in association with Claravale soils.

VEGETATION: Open forest dominated by *E. tetradonta* and *E. miniata* with a frequently very dense shrub layer of *Acacia* and *Petalostigma*; pastures dominated by annual Sorghum and Spinifex.

LIMITATIONS: Severe water stress; very loose sandy surface; highly erodible under intensive use.

POTENTIAL LAND USE: Mainly rough grazing; possibly suitable for forestry; particularly in the south.

LAND CATEGORY: 6.

5a

OCCURRENCE: Claravale, Beemla; small areas in Jindara and Woggaman.

TOPOGRAPHY: Mainly crests and upper slopes up to 4%; frequent outcrops on crests (quartzite on Beemla, and laterite on Claravale).

SOILS: Lateritic Podzolics (Claravale); some Cockatoo and Claravale.

VEGETATION: Open forest usually dominated by *E. miniata* with Spinifex and annual Sorghum pasture and frequently a well-developed shrub layer; vegetation generally lower and more open on Jindara.

LIMITATIONS: Very low waterholding capacity; erodible on slopes steeper than 1% if the surface is disturbed; very loose soil surface; very infertile.

POTENTIAL LAND USE: Mainly rough grazing; some slight improvement might be possible on flatter areas; lacking natural stock waters.

LAND CATEGORY: 6.

5b

OCCURRENCE: Claravale, Jindara and Woggaman.

TOPOGRAPHY: Crests and upper slopes, sometimes containing minor drainage lines; frequent laterite outcrop.
SOILS: Lateritic Podzolics (shallow Clara vale). 

VEGETATION: Woodland, dominated often exclusively by *E. bleeseri* with very poor Spinifex dominated pastures with much of the low shrub *Petalostigma haplocladum*.

LIMITATIONS: Very shallow, gravelly and drought affected soils; subject to high amounts of sheetwash and very erodible if disturbed.

POTENTIAL LAND USE: Very poor rough grazing; unimprovable; useful source of gravel.

LAND CATEGORY: 7.

5c 

_occurrence_: Claravale and Beemla; rarely Banyan.

_TOPOGRAPHY_: Either valley floors or low-lying seepage areas in sandy country; frequently abutt drainage lines or back-plains.

_SOILS_: Siliceous Sands (Stray), alluvial Red Earths (Umbrawarra) and Yellow Podzolics (Douglas), the latter on flattest areas.

_VEGETATION_: Scattered tall *E. polycarpa* with extensive open treeless areas. In drainage floors dense *Melaleuca* and *Grevillea pteridifolia* scrub. In the outwash areas scattered *G. pteridifolia* and *Verticordia*, short annual grasses and low sedges.

LIMITATIONS: Very wet and untrafficable in the wet season; highly erodible if disturbed.

POTENTIAL LAND USE: Very poor rough grazing, though may provide a green pick later in the dry season than most areas; may be improvable in parts but drainage floors should be treated as grassed waterways.

LAND CATEGORY: 6, and 7 in drainage floors.

5d 

_occurrence_: Mainly Jindara; minor occurrence in Wriggley and Woggaman.

_TOPOGRAPHY_: Undulating terrain; slopes generally less than 3%.

_SOILS_: Rather variable but typically Lateritic Podzolics (Jindare) and Yellow Podzolics (Ejong); frequent pig wallows.

_VEGETATION_: Rather open woodland with a wide range of species; scattered shrubs (*Grevillea heliosperma, Petalostigma*); pastures dominated by annual Sorghum with some perennials.

LIMITATIONS: Impeded drainage; wet and untrafficable in the wet season; low water-holding capacity; very erodible if disturbed.

POTENTIAL LAND USE: Non-arable but mainly suitable for improved pastures for dry season use.

LAND CATEGORY: 5.

5e 

_occurrence_: Kimbyan, Wriggley and Douglas.

_TOPOGRAPHY_: Generally rather flat (slopes less than 1%).

_SOILS_: Yellow Podzolics (Florina and some Ejong); often associated with areas of Tippera; frequent pig wallows.

_VEGETATION_: Similar to the low woodland of 3d; both trees and perennial grasses have a more uneven appearance; scattered shrubs (*Grevillea heliosperma* and *Terminalia ferdinandiana*) may also be present.

LIMITATIONS: Impeded drainage; boggy in the wet season.

POTENTIAL LAND USE: May be arable but poor drainage could make cultivation difficult and lower yields, good improved pastures.

LAND CATEGORY: 4.

5f1 

_occurrence_: Woggaman and Beemla.

_TOPOGRAPHY_: Undulating terrain; slopes less than 4%; intense drainage pattern.

_SOILS_: Variable, shallow and poorly drained Yellow Podzolics (mainly Ejong, some Lateritic Podzolics).

_VEGETATION_: Tall shrubland with scattered low emergent trees (*E. latifolia, E. tectifica, E. alba, E. tetradonta*); shrub species very variable and mixed; mainly rather poor annual Sorghum pastures.

LIMITATIONS: Very shallow, droughty and poorly drained soils of low fertility, very erodible if disturbed.

POTENTIAL LAND USE: Very marginal country often well supplied with large creeks with almost perennial waterholes, such that low quality improved pastures could be considered with careful stock management.

LAND CATEGORY: 6.

5f2 

_occurrence_: Woggaman.

_TOPOGRAPHY_: Lower slopes and drainage floors associated with 5f1.

_SOILS_: As 5f1 but seriously affected by waterlogging.

_VEGETATION_: Dense tall shrubland; characteristically *Grevillea pteridifolia* and *Melaleuca viridiflora*.

LIMITATIONS: As 5f1 with very serious waterlogging.

POTENTIAL LAND USE: Very poor rough grazing at best.

LAND CATEGORY: 7.

5g 

_occurrence_: Jindara; often lower slopes of Mullaman.
TOPOGRAPHY: Undulating terrain, slopes of up to 4%; frequent unchannelled drainage floors.

SOILS: Yellow Podzolics (Ejong with some Florina); usually with very dense low pointed termitaria.

VEGETATION: Rather open low woodland (E. tectifica, E. latifolia) with low uneven perennial grasses (Chrysopogon fallax and Themeda).

LIMITATIONS: Seriously impeded drainage; moderate to severe erosion risk; probable low waterholding capacity.

POTENTIAL LAND USE: Mainly suitable for improved pastures.

LAND CATEGORY: 5.

6a

OCCURRENCE: Chinaman and Woggaman.

TOPOGRAPHY: Undulating terrain; slopes up to 5%, rarely to 10%; generally associated with rugged terrain.

SOILS: Grey and Brown Clays (Banyan and Cununurra) with surface stone.

VEGETATION: Mainly Sorghum plumosum grassland with scattered trees; small patches of Terminalia platyptera and T. canescens shrubland.

LIMITATIONS: High erodible, stony and strongly gilgaied.

POTENTIAL LAND USE: Rough grazing.

LAND CATEGORY: 7.

6b

OCCURRENCE: Kimbyan and Budbudjong.

TOPOGRAPHY: Small internal drainage depressions; almost flat; often at the base of massive limestone ridges.

SOILS: Grey and Brown Clays (Banyan with moderate to severe limestone outcrop or pavement.

VEGETATION: Perennial grassland with scattered trees.

LIMITATIONS: Moderate to severe rock; severe gilgai; very wet.

POTENTIAL LAND USE: Limited rough grazing.

LAND CATEGORY: 7.

6c

OCCURRENCE: Douglas.

TOPOGRAPHY: Almost flat plains with endoreic drainage; ponded in the wet season.

SOILS: Grey and Brown Clays (Banyan and Cununurra), usually the more poorly drained series.

VEGETATION: Tall shrubland dominated by Melaleuca and Terminalia platyptera; tall perennial grasses, with sedges in depressions.

LIMITATIONS: Strongly gilgaied; very poorly drained; periodically subjected to shallow inundation.

POTENTIAL LAND USE: Limited dry-season rough grazing.

LAND CATEGORY: 7.

4. Tributary creeks, drainage floors and back plains

7a1

OCCURRENCE: Banyan, Green Ant; as drainage lines, may traverse many other land systems.

TOPOGRAPHY: Major river backplains or tributary drainage flats.

SOILS: Grey and Brown Clays (Banyan with some Cununurra and Coolibah).

VEGETATION: Open woodland dominated by E. microtheca with frontage grasses mainly on the Daly River backplains; elsewhere either grassland (predominantly frontage grasses) or very open woodland (E. papuana and Terminalia carpentariae).

LIMITATIONS: Poor drainage; inundated for long periods during the wet season; subject to occasional flooding; moderate to severe gilgai; usually alkaline subsoils; possibly saline.

POTENTIAL LAND USE: At present only rough grazing; pasture improvement given suitable pasture species may be practicable in the future; irrigated pastures may be possible but further study is required.

LAND CATEGORY: 6.

7a2

OCCURRENCE: Banyan, Green Ant; as drainage lines, may traverse other land systems.

TOPOGRAPHY: Slightly elevated areas of major river backplains, and drainage floors in the lower reaches of some tributary creeks.

SOILS: Grey and Brown Clays (Coolibah with some Banyan).

VEGETATION: Woodland (E. tectifica, E. grandifolia and Tristania) with perennial grasses; increasing E. papuana and weed species close to main rivers; tributary drainage floors have very scattered trees (E. papuana) with very dense perennial grasses usually dominated by Themeda.

LIMITATIONS: Poor drainage; isolated at times by floodwaters.

POTENTIAL LAND USE: Marginally arable; suitable for improved pastures used in conjunction with native pastures of 7a1.

LAND CATEGORY: 4.
7a3

OCCURRENCE: Green Ant, Banyan, usually associated with Kimbyan.

TOPOGRAPHY: Almost flat plains up to one mile wide; scattered limestone outcrop.

SOILS: Rendzinas (Ingrid and Phillips), some Cuunurra.

VEGETATION: Either grassland (*Sorghum plumosum*), or very open woodland with large scattered *Tristania suaveolens*.

LIMITATIONS: Impeded drainage and periods of inundation; often shallow and possibly droughty; very high pH.

POTENTIAL LAND USE: Rough grazing; may be improvable with pasture species able to tolerate waterlogging and alkaline conditions.

LAND CATEGORY: 6.

7b

OCCURRENCE: Woggaman; as drainage lines, may traverse other land systems.

TOPOGRAPHY: Drainage lines with transverse slopes up to 1%; may be channelled but the channel is small and well defined; occasional small high-level plains.

SOILS: Gleyed Podzolics (Marrakai) and Yellow Podzolics (Ejong) with minor Solodics, generally shallow with a well-developed hard pan.

VEGETATION: Either open woodland (*E. tectifica, E. latifolia*) or *Melaleuca* shrubland with short annual *Sorghum* and *Eriachne* pastures.

LIMITATIONS: Severely impeded internal drainage; surface water flow; highly erodible if disturbed.

POTENTIAL LAND USE: Permanent grassed waterways with strictly controlled grazing.

LAND CATEGORY: 7, with some 6 (high level plains).

7c

OCCURRENCE: Woggaman, Claravale.

TOPOGRAPHY: Ill-defined depositional drainage lines; rare channels, intermittent and ill-defined.

SOILS: Immature and unstable sandy alluvium with small areas of Marrakai, Ejong and Douglas.

VEGETATION: Extremely variable; frequent occurrence of *Melaleuca* scrub and frontage grasses.

LIMITATIONS: Highly erodible and prone to flooding and flood deposition.

POTENTIAL LAND USE: Strictly controlled rough grazing; permanent grassed waterways.

LAND CATEGORY: 7.

7d

OCCURRENCE: Tagoman, Kimbyan, Jindara and Douglas.

TOPOGRAPHY: Broad drainage flats or seasonally ponded areas with very slight slopes; rarely channelled.

SOILS: Loamy Red Earths (Tippera) with alluvial and colluvial surface horizons.

VEGETATIONS: Woodland (*E. papuana, E. grandifolia, E. foelscheana*) with dense perennial grasses (*Themeda, Coelorhachis*).

LIMITATIONS: Highly erodible if disturbed; subject to periods of surface water flow.

POTENTIAL LAND USE: Grassed waterways; useful grazing which should be strictly controlled; should not be cleared or cultivated.

LAND CATEGORY: 6.

7d1

OCCURRENCE: Douglas, Green Ant, sometimes Kimbyan.

TOPOGRAPHY: Broad drainage flats or temporarily ponded areas with very slight slopes; rarely channelled.

SOILS: Yellow Earths (Elliott series 2) with alluvial and colluvial surface horizons.

VEGETATION: Very open woodland, usually dominated by *E. papuana* with local thickets of *Tristania*; mixed annual *Sorghum* and *Themeda* with local swamp grasses.

LIMITATIONS: Erodible if disturbed, especially where subject to periods of surface water flow.

POTENTIAL LAND USE: Grassed waterways; useful grazing which should be strictly controlled; should not be cleared or cultivated.

LAND CATEGORY: 6.

7e

Major creeks and severely gullied tributaries; contain permanent and ephemeral water supplies; severe risk of erosion, particularly headward gullying, at access points; careful control and regulation of stock numbers at these watering points is necessary.

LAND CATEGORY: 8.

5. Major river alluvials

8a

OCCURRENCE: Banyan, Karaman.

TOPOGRAPHY: Younger river levees with back slopes up to 6% where the levee is narrow, 2-3% where wider; rarely over 200 yds wide.
SOILS: Alluvial Red Earths (Manbulloo and Daly); occasional rock (quartzite) outcrop indicates shallow soils in areas traversing sandy land systems.

VEGETATION: Variable woodland or open forest with *E. papuana* a frequent species; generally short annual grasses infested more or less badly with weeds (*Hyptis, Acanthospermum*).

LIMITATIONS: Weeds; high erosion risk on steeper slopes, stream bank erosion on river side of unit; low waterholding capacity; frequent risk of isolation by floodwaters.

POTENTIAL LAND USE: These soils offer scope for spray irrigation of fruit and vegetable crops or pastures; normal erosion control measures must be considered even on moderately sloping areas.

LAND CATEGORY: 3.

8b

OCCURRENCE: Banyan.

TOPOGRAPHY: Younger river levees with backslopes rarely in excess of 2%; up to half a mile wide.

SOILS: Alluvial Red Earths (Katherine, Edith); deep.

VEGETATION: Variable woodland frequently with *E. papuana*; mixed perennial and short annual grasses with frequent bare patches; more or less badly infested with weed species.

LIMITATIONS: Weeds; slight erosion risk, with stream bank erosion; occasional flooding possible.

POTENTIAL LAND USE: Arable for crops or pastures and suitable for irrigation.

LAND CATEGORY: 1.

8c

OCCURRENCE: Banyan, Karaman.

TOPOGRAPHY: Low-lying areas behind the younger levees, older levees, or minor drainage floors within the younger levees; slopes generally very slight.

SOILS: Alluvial Red Earths (Belbowie, or poorly drained phases of Katherine and Edith).

VEGETATION: Woodland (*E. foelscheana, E. patellaris*) with dense perennial grasses (*Themeda*).

LIMITATIONS: Drainage impedance; flooding and possibly periods of inundation; levee drainage floors highly erodible.

POTENTIAL LAND USE: Arable if extensive and flat, but more suited for fodder crops or improved pasture; irrigation might be considered but some form of artificial drainage would be necessary; levee drainage lines should be left as grassed waterways.

LAND CATEGORY: 3 and 4 with some 6 (levee drainage floors).

8d

Swamps, more or less permanent, either paperbark or freshwater mangrove with *Eleocharis* and *Oryza*. These areas should be considered as refuges for waterfowl or watering places for stock.

LAND CATEGORY: 7.

8e

All severely eroded areas associated with the major river alluvials. These are usually deep and active gully systems which require careful protection, particularly from stock using them for access to water.

LAND CATEGORY: 8.
2b: Typical of rugged country in the southern half of the area with Lancewood and E. dichromophloia and exposed laterite

2d: Massive limestone ridge. Cycas sp. is commonly found in these situations
Ja: Severe limestone pavement renders this unit almost useless

3a: Severe limestone pavement renders this unit almost useless

Jd: Tippera soil supporting a strong perennial pasture and E. foelscheana–E. tectifera woodland

3d: Tippera soil supporting a strong perennial pasture and E. foelscheana–E. tectifera woodland

20
3d: Areas of Tindall soil often carry a uniform stand of E. oligantha

3d2: Emu soil in a low-lying area near Jindara. Note the presence of tall E. miniata and dense tall perennial grasses
3c: Very open woodland with frequent dead and dying trees and an almost bare sheet-eroded surface are characteristic of this unit.

4a1: Woodland and perennial grasses differentiate this unit from 4b1

4b2: Open forest with dominant E. tetradonta and annual Sorghum
4c: E. papuana and Ironwood are characteristic of this Unit

4dl: Small patches of Cypress Pine are found in the southern part of the area

5a: Claravale soils usually carry E. miniata and Spinifex

5b: Uniform E. bleeseri is typical of shallow and very gravelly Claravale soils; these are very erodible when disturbed
5c: Sandy drainage floors and seepage areas carry an open vegetation with tall E. polycarpa and Grevillea pteridifolia

5d: The mixed and untidy nature of the vegetation is typical. Note also the soft surface of the Jindara soil
5f1: Tall shrubland and the pale pointed termitaria often distinguish this unit

7a1: E. microtheca and swamp grasses on a Banyan soil

7a3: A uniform stand of Tristania on a black calcareous soil
8e: Much of the frontage country along the major rivers is severely eroded
GEOMORPHOLOGY


The geomorphology of the Daly Basin has been described by Wright (1965). He postulates two main periods of lateritization. These have resulted in the formation of the Bradshaw and the Maranboy laterite surfaces with their associated weathering profiles.

Wright's Bradshaw surface which appears to coincide with the more extensive Tennant Creek surface of Hays (1967), is preserved as plateau summits in some parts of the survey area. These plateaux now represent the major relief of the basin. The profile described by Wright consists of between 10 and 20 ft of pisolithic laterite, overlying up to 40 ft of mottled zone and 100 ft of pallid zone. Deep weathering has extended through the Cretaceous rocks into the underlying Cambrian sediments of the Daly River Group. These are now the most extensive rocks in the area.

Associated with the deep weathering has been strong silicification, resulting in the formation of porcelanite and quartzite in the lower parts of the profile. The silicification has controlled the degree of resistance to erosion offered by the lower parts of the weathering zones (Mabbutt, 1965).

The Maranboy surface is the second laterite surface, formed on stripped portions of the pallid zone of the Bradshaw profile (Wright 1965). It has been associated with reweathering and some desilicification of parts of the Bradshaw pallid zone. The dissection of the Maranboy surface to form the Tipperary surface is also described by Wright. It has now been extensively stripped by removal of the softer de-silicified materials, but survives locally as small plateau remnants.

The flat laterite plateau surfaces have been mapped in Mullaman land system by CSIRO (1965). They are not extensive and because they are surrounded by steep scarps are usually inaccessible. The periods of deep weathering associated with the formation of laterites have extensively modified the Cambrian sediments of the Daly River Group. Low hills and relict ridges of resistant silicified rocks are now exposed due to dissection of the laterite surfaces. Quartzites survive mainly in Yujullowan, Claravale, Beemla, and Blain land systems, and porcelanite is chiefly exposed in Claravale and Kimbyan land systems in the central part of the basin. Accumulations of detrital laterite often accompany the siliceous exposures and in Claravale land system especially both quartzite and detrital laterite contribute to the parent material of the soils.

The rocks occurring in Woggaman land system are often soft and fine-textured and appear to be strongly pre-weathered. These could be remnants of the desilicified parts of the Maranboy weathering profile which are described by Wright (1965) as powdery, or crumbly and honeycombed. These rocks are exposed in deeply incised cuttings along Dead Horse Creek. They weather easily to medium textured soils which are invariably structureless and poorly drained, and have an unusual quality of stickiness. The clay in these soils seems to be readily dispersed and transported and the claypans that often occur in them are probably the result of clay illuviation. It is likely also that transported clay from Woggaman land system has contributed to the formation of the large cracking clay plains along the Daly River.

Wright (1965) describes three substages of river rejuvenation in the Daly Basin after the formation of the Tipperary surface. The first was probably due to a geological uplift. This resulted in the removal by erosion of much weathered colluvial material from hill slopes which had become less stable as a result of a change to a drier climate.
FIG. 2  GEOLOGY OF THE SURVEY AREA
(Bureau of Mineral Resources, Geology & Geophysics, Dept. of National Development 1967.)

REFERENCE

CAINZOIC
C  Alluvium, soil, swamp deposits, sand and ferruginous gravel

MESOZOIC
Klo  Mullaman Beds
Klo  Ooloo Limestone
Klo  Jinduckin Formation
Klo  Tindall Limestone
Klo  Antrim Plateau Volcanics

PALAEOZOIC
Oloji  Ooloo Limestone
Oloji  Jinduckin Formation
Cto  Antrim Plateau Volcanics

PROTEROZOIC
Bty  Buldiva Sandstone
Bty  (a) Stray Creek Sandstone Member
Bto  (b) Depot Creek Sandstone Member
Cto  Cullen Granite

--- Boundary between Palaeozoic rocks

SCALE

0  10  25 m.
Alluvial banks and plains were then deposited along the major rivers. The second substage was thought by Wright to have been caused by a change to a wetter climate. During this substage extensive younger levees and river backplains were formed from flood deposits and laid down on top of the older levees. Increased run-off and drainage rejuvenation associated with a further climatic change brought about Wright's third substage. Entrenchment of the major rivers occurred during this substage. The Daly River is now deeply entrenched and is cutting into bedrock in many areas.

Observations of the major rivers now indicate that there may be a greater gradient of the river beds where they traverse areas composed predominantly of sandstone, as water depths are less in these areas and water velocities seem greater. Conversely, in areas where bars of more resistant rocks (silicified limestone) occur, the river is less deeply entrenched and its velocity seems lower. The former situation would be liable to much less frequent flooding over the levees as the river could carry much more water between banks; consequently the younger levees in sandstone dominated areas (Blain and Claravale land systems) are small. These levees are also sandier, probably due to the increase in competence of the rivers at times of high flood.

The Daly River has meandered across a broad area downstream from its junction with Stray Creek and old river courses are still evident. Bordering the old river courses are low almost flat medium to heavy textured levees. Where the river has not changed its course the younger levees overlie the older ones. Hence the older levees sometimes occur as a margin on the land side of the new ones. They are mapped as land unit 8c. The younger levees are extensive along the Katherine and Ferguson rivers, but they occur only as thin strips along most of the Daly River. They show little evidence of active aggradation, but they may suffer erratic flood deposition or erosion during rare high floods.

The older levees are flanked by large areas of floodplain which now consist of gilgaied cracking clay soils. These floodplains particularly upstream from Stray Creek seem to have formed mainly by the deposition of fine material from local runoff water, rather than from floodwater from the Daly River. The river when in flood would impede the flow of the local runoff water and cause it to pond on these areas. When the water level in the river drops the ponded rainwater can escape quickly into the river, and as it does so it causes local severe gully erosion. These eroded areas are mapped as land unit 8c.

Alluvial material has entered the Daly Basin in the past through gorges in the scarp between Jindara and the Douglas River. Several of these gorges are cut right through the scarp and although they do not now carry major watercourses, there are extensive areas of alluvial soils in linear bands below them. It is likely that the streams feeding these gorges have been captured behind the scarp by the Douglas River or Stray Creek. The capture would have occurred prior to the re-exposure of the Cullen granites to the north-east, as no granite-derived alluvia are to be found on these old levees. The levees of the Douglas River, however, are strongly layered—probably due to the erosion of Cretaceous sediments in the catchment followed by the abrupt exposure and erosion of the Cullen granites.

The Cambrian sediments of the Daly River Group have been described by Randal (1962) and Mabbutt (1965). Mabbutt estimates that unweathered country rock is exposed over only 20% of the Daly Basin, with weathered rocks over another 25%. The rest of the basin, he estimates, is covered by river alluvia (10%), sandy colluvial/alluvial mantles (25%), or laterite detritus (20%).

Where country rock is exposed it is predominantly limestone and some elements of a karst topography are evident, especially in the south of the area in Budbudjong.
land system. Endoreic drainage occurs through a series of caves and sink-holes. Ridges of exposed limestone containing small caves are fairly common. Because of the resistant nature of the limestones—which are silicified—and the rather harsh climate of the area, the limestones are often exposed at the surface or covered by a thin mantle of soil only. Runoff from the bigger exposures results in impeded drainage around their bases and increased solution of the limestone. This tends to accentuate the relief of the ridges (Wright 1965).

The major strike of the Daly Basin is controlled by the Pine Creek Geosyncline, and is in a north-west/south-east direction. Exposures of rock and minor land-form elements indicate this strike quite strongly throughout the survey area. Local geology has controlled the soils to a high degree, and land units often tend to be linear, and oriented in sympathy with the major strike.

In some areas, notably in Jindara and Tagoman land systems, the sediments are a sequence of thinly interbedded sandstones, siltstones and limestones and these are tilted (if not folded) at several degrees of dip. The terrain is finely dissected and undulating and several sediments may outcrop sequentially on the one slope. The sediments concerned in Tagoman land system are mainly limestones and siltstones with some sandstone, but in Jindara land system they are sandstones and siltstones with some limestone. In each case the land units are small and tend to be linear as they are strongly geologically oriented. Soil patterns particularly in Jindara land system appear complicated, as a soil auger sunk to 5 ft may penetrate several of the thin sediments. Polygenetic soils and intergrades between soils are common.

Blain land system is formed on the extensive colluvial/alluvial mantle referred to by Wright (1965) and Mabbutt (1965). These deposits appear to be almost horizontal and fairly thick with the result that the soils formed on them tend to be uniform over large areas and the land units mapped are commonly large. Most of the deposits are arenaceous and the soils formed on them are sandy in texture.

Kimbyan land system may not have so simple an origin. The nature of the soils occurring here varies closely with the geological boundaries defined by the Bureau of Mineral Resources (1967). (Fig. 2) (See section on soils.) The Kimbyan plains characteristically have frequent exposures of Cambrian limestones either as pavement, floaters or massive outcrops. The massive outcrop becomes most pronounced along the edge of the basin in the south where it has been mapped as Budbudjong land system.

Blain and Kimbyan land systems are extensive in the survey area and contain many of the land units of greatest agricultural potential.

The surveyed portion of the Daly Basin has been protected from dissection to some extent by the nature of its north-eastern boundary. Much of the catchment of the Daly River extends outside the Daly Basin, but drainage from the upper catchment can only enter the surveyed area via a few main rivers—the Douglas, Fergusson/Edith and Katherine rivers and Stray Creek.

Near Katherine, the Antrim Plateau volcanics form a low drainage divide between the basin and the Arnhem Land escarpment. (Fig. 2). Much of the run-off from Arnhem Land is channelled into creeks behind these volcanics and hence into the Katherine River, before it reaches the basin.

Further north near the Edith and Fergusson Rivers, the boundary of the basin is the Eight Mile Creek on the edge of the Cullen granites. This granite is rugged and drains almost completely into the Cullen, Edith, or Fergusson Rivers before they enter the basin.
From below Jindaree to beyond the Douglas River a prominent ridge forms the north-eastern boundary of the basin. (Fig. 2). This ridge consists of the Stray Creek and Depot Creek members of the Buldiva sandstones and is very hard and erosion resistant. Drainage from the country behind it is intercepted before it enters the basin by the Douglas River or Stray Creek.

References


SOILS


I. Introduction

The area surveyed is a portion of the Daly River Basin which was mapped as the Tipperary land system by Christian and Stewart (1953). A description of the soils of the Tipperary land system was given by Stewart in 1953 and in more detail in 1956. The ‘General Report on Lands of the Tipperary Area, Northern Territory, 1961’ by Speck, et al. was published in 1965. In that report van de Graaff further described the soils of this area.

The essential characteristics of the climate that affect pedological processes were noted by van de Graaff (1965), as follows:

1. Rainfall during the wet season appreciably exceeds evapotranspiration and normal soil storage, thus leaching of soluble materials from the soil profile is likely.
2. Temperatures are high throughout the wet season, hence weathering is likely to be rapid.
3. The average rainfall per wet day is 0.60 in and rapid erosion resulting from this high intensity is probably responsible for the occurrence of skeletal soils or outcrop on most slopes of more than 5%.
4. In the dry season all soils except those in the immediate vicinity of springs and permanent streams dry out completely over the full depth of sampling (3½ ft) and probably much deeper. Precipitation of dissolved materials and oxidation are therefore important processes in these soils.

Van de Graaff (1965) estimated that over 90% of the soils of the Tipperary land system had ‘earth’ type profiles. He described the general characteristics of these profiles as follows:

1. There are no sharply defined colour, textural or structural horizons, but they merge gradually one with the next.
2. Generally clay content increases gradually with depth but some soils have little change in clay content throughout the profile. (Most of the clay is kaolinite).
3. The soils lack pedality. Very sandy horizons may have single-grain structure but otherwise the soils are massive with varying amounts of visible pores which in lower horizons characteristically have thin clay-skin linings.
4. Subsoil colours range from dark red through yellow-red, yellow-brown, brown and greyish brown, and rusty mottling is general in the last three colours.
5. The soils are medium acid to neutral in reaction and normally there is little change throughout the profile.
6. The soils have a low ability to store water. Arndt, Phillips and Norman (1963) present data showing a range of 4.3 to 6.8% available water in various horizons of a Tippera family soil and 1.8 to 4.7% in various horizons of a sandy member of Blain family.

II. Soil chemistry

Complete analytical data are not available for all of the soil families described but many of the soils have been analysed and the figures are appended to the profile descriptions given in Appendix I.
Generally, the soils have a low chemical fertility status with very low cation exchange capacities (commonly 2–10 m.eq %) and organic matter levels (commonly 1–2%). Available phosphorous levels (Olsen) are also low—commonly 2–10 ppm. in A1 horizons. Field responses to nitrogen and particularly to phosphorous are recorded throughout the area.

III. Soil classification

The major subdivision of the soils into Great Soil Groups has been based on the system proposed by Stace, et al. (1968) in ‘A Handbook of Australian Soils’. The only departures from this system occur in the alluvial subgroup of the Red Earths where some Yellow Earths have been included because of morphological similarities in the soils due to their common parent materials and similar modes of origin.

The soil family classification given here is based on the outlines given by Stewart and van de Graaff and is intended as an extension of the work of van de Graaff. Some reorganization of his classification has been undertaken, but most of the criteria used to separate soil families remain the same. Many of the family names used by Stewart and van de Graaff have been retained, but they have been subdivided into soil series and more closely defined. Several new families have been added.

The criteria used to separate series are those defined by the USDA Soil Survey Manual (1960). The series that constitute a family have similarities in colour, texture, parent material, mode of origin and drainage characteristics. In some cases phases of soil series have been defined and the occurrence of different soil types has been noted in some of the commoner series. Full descriptions of the soil series are given in the appendix.

Note that the surface colours given in most of the family descriptions that follow are the most common colours and do not cover the whole range of colours that can occur. The surface colour depends very largely on the organic content of the surface, which varies locally with soil-water relations, degree of protection from fire, and with the rate at which erosion is occurring. In some cases erosion has exposed the top of the B horizons of loamy Red Earths with a consequent reddening in colour; in other cases where erosion has stripped the A1 horizon from a Podzolic soil, the exposed A2 gives the surface a paler colour. All colours given are moist Munsell colours unless otherwise stated.

The ‘Principle Profile Form’ as defined by Northcote (1965) has been quoted for each series described and many of Northcote’s terms and criteria have been used. The fabric term ‘sandy/earthy’ is not Northcote’s, but is intended to describe a condition between Northcote’s ‘sandy’ and ‘earthy’ fabrics. In soils with ‘sandy/earthy’ fabric, sand grains are distinct and easily observable, but they have a definite clay or organic coating which gives the soil a low degree of cohesion.
### IV. Outline of series classification

<table>
<thead>
<tr>
<th>Great Soil Group (Stace et al. 1968)</th>
<th>Family</th>
<th>Northcote Key</th>
<th>No. of Series</th>
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<tr>
<td>Siliceous Sands.</td>
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<td>Stray</td>
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<td>Rendzinas</td>
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<td>Phillips</td>
<td></td>
<td>Gc2.21</td>
<td>1</td>
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<tr>
<td>Ingrid</td>
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<td>Gn2.81</td>
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<tr>
<td>Other Soils:</td>
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<tr>
<td>Lithosols</td>
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<td>Alluvial Soils</td>
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<td>Solodized Solonetz</td>
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<tr>
<td>Yellow Podzolics on granite</td>
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</tbody>
</table>

34
DESCRIPTION OF SOIL FAMILIES

A. Siliceous Sands

(1) Cypress Family
These are deep, well-drained sands occurring commonly on Claravale land system, particularly in the south of the area. Cypress soils may occur in association with soils of either Cockatoo or Claravale families. A typical profile is:

0–6 in Brown or dark brown sand or loamy sand, often with a surface veneer of pinkish washed sand; loose.

6–24 in Strong brown sand or loamy sand, unbleached A2, loose or soft.

24–40 in Yellowish red loamy sand or clayey sand, soft or very friable.

40–60 in Red or yellowish red loamy sand or light sandy loam, friable, with a few ferruginous nodules.

(2) Stray Family
Stray soils form on sandy colluvial material that has accumulated on lower slopes. They function as aquifers or seepage areas and are moderately well or imperfectly drained. They may be associated with any sandy soil upslope such as Cypress, Cockatoo, Claravale or Jindare, and frequently abut drainage lines. One series has been described. A typical profile is:

0–6 in Dark greyish brown sand or loamy sand, loose or soft.

6–36 in Brown or yellowish brown loamy sand, loose, often moist.

36–60 in Yellowish brown sand or clayey sand, moist and very friable.

B. Earthy Sands

(1) Cockatoo Family
These soils form on the extensive alluvial-colluvial mantle referred to by Wright (1965) and Mabbutt (1965). A typical profile is:

0–7 in Dark reddish brown sand or loamy sand, loose or soft.

7–18 in Dark red or red loamy sand, soft or slightly hard.

18–60 in Dark red or red clayey sand to sandy loam, slightly hard or friable.

Two series have been described. The sandier series occurs most frequently in the south of the area, on Blain and Claravale land systems. It usually has a thin layer of washed quartz sand on its surface. The other series, with a coarse sandy loam subsoil, usually occurs on Blain land system, but only in the northern half of the area, where it merges with the sandy Red Earths. Ferruginous nodules have been found in some profiles, and each series has a corresponding gravelly phase. Cockatoo soils are well to excessively well drained.

C. Red Earths
Red Earths are the most common soils in the area. They have been divided into three major subgroups, with differences in parent material and different profile characteristics. One subgroup consists of soils with predominantly siliceous sola, with coarse sand evident throughout their profiles. Another subgroup contains soils that are loamy in texture without conspicuous coarse sand in their profiles, and the final subgroup is an alluvial category. These last occur on alluvial terraces along the major creeks and rivers and have a high proportion of fine sand and silt in their profiles.

(a) Sandy Subgroup
In the central part of the basin the silicified Oolloo limestones have been mapped by the Bureau of Mineral Resources. In this area the soils of Kimbyan land system (Oolloo Family) belong to the sandy subgroup of the Red Earths, not to the loamy subgroup. It is likely that they are formed directly from the Oolloo limestones and some elements of a karst topography can be seen in this central area. A rough pavement of siliceous limestone frequently occurs on the soils and may be the remains of a more resistant limestone layer. It is also possible that these soils were derived from arenaceous sediments bedded with the Oolloo limestones.

The depth of these soils has been found to be only 8–10 ft. This could affect their ability to store water which could in turn influence the selection of woodland vegetation. Some of the soils in this category are
moist at three or four feet in depth throughout the year, and although they are well-drained they support a forest of *E. papuana* and Ironwood. These occur commonly near the major rivers and are mapped as land unit 4c.

In both Kimbyan and Blain land systems there is more variation in the mapped land units due to variations in rockiness, slope and vegetation type than there is due to soil differences. The mapped land units for areas of sandy Red Earths are separated primarily according to whether the soil supports woodland or forest vegetation and then according to whether the surface one or two feet of soil is quite sandy, with predominantly annual grasses, or medium textured, with predominantly perennial grasses. Areas that have a severe limestone pavement have been treated similarly to rocky areas of Tippera or Tindall soils and mapped as units 3a or 3b. This seems justified despite the small differences in soils as the degree of rockiness involved precludes improvement of most of these areas.

The central area of the basin is further complicated by the fact that some of the soils of the sandy subgroup (Oolloo family) have a dry consistence that is abnormally hard. The reason for this variation is not known. However, the effect of unusual hardiness on the native vegetation selected is quite apparent, with the harder soils tending to select woodland tree forms and species and perennial grasses, and the softer ones generally selecting forest tree forms and species and annual grasses. In this respect the unusual hardiness of the soil causes it to behave like a soil of heavier texture than it actually is. Soils in the harder consistence category, perhaps because of their cover of woodland, have usually been mapped in Kimbyan land system and are now contained in map unit 4al.

(1) *Venn Family*

These soils are always gradational textured. Three series have been described, differing in the thickness and texture of the lower horizons. Each series is divided into two soil types on the basis of surface texture variation. The drainage of Venn soils is unimpeded.

A typical profile is:

<table>
<thead>
<tr>
<th>Depth (in)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>Dark reddish brown sand to sandy loam, slightly hard.</td>
</tr>
<tr>
<td>4–14</td>
<td>Dark reddish brown or dark red <em>loamy sand</em>, slightly hard or hard (diagnostic horizon).</td>
</tr>
<tr>
<td>14–24</td>
<td>Dark red sandy clay loam, hard to very hard.</td>
</tr>
</tbody>
</table>

24–60 in Dark red or dusky red sandy clay loam to light clay with sand, hard or very hard and often subplastic.

(2) *Oolloo Family*

These soils have not previously been described in the area. They are characteristically uniform textured, but the more marginal members are gradational textured. Three series have been described, with varying thickness and texture of the lower horizons. Each series is divided into two types on the basis of surface texture variations, and a gravelly phase is recorded for four of the six types. Oolloo soils are well drained.

A typical profile is:

<table>
<thead>
<tr>
<th>Depth (in)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>Dark reddish brown sandy loam or sandy clay loam, hard.</td>
</tr>
<tr>
<td>4–14</td>
<td>Dark reddish brown or dark red <em>sandy clay loam</em>, hard to extremely hard (diagnostic horizon).</td>
</tr>
<tr>
<td>14–60</td>
<td>Dark red or dusky red sandy clay loam to light clay with sand, very hard or extremely hard.</td>
</tr>
</tbody>
</table>

(3) *Blain Family*

Soils of this family are normally gradational textured, but one series has texture contrast profiles. The gradational series have been separated on the basis of variations in thickness and texture of the lower horizons. These soils are all well drained.

A typical profile is:

<table>
<thead>
<tr>
<th>Depth (in)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>Dark reddish brown sand or loamy sand, soft or slightly hard.</td>
</tr>
<tr>
<td>4–14</td>
<td>Dark reddish brown or dark red <em>loamy sand</em>, soft or slightly hard (diagnostic horizon).</td>
</tr>
<tr>
<td>14–26</td>
<td>Dark red sandy loam to sandy clay loam, hard.</td>
</tr>
<tr>
<td>26–60</td>
<td>Dark red or red sandy clay loam to light clay with sand, hard, sometimes moist and firm.</td>
</tr>
</tbody>
</table>

(b) *Loamy Subgroup*

The loamy subgroup contains three families. They occur in several land systems, but mainly in Kimbyan land system and only on the Tindall or Jinduckin geological formations.

Soils in this subgroup have frequently been recorded in association with limestone, and their parent material is reported to be limestones or other calcareous sediments of the Daly River and Port Keats groups (Stewart 1956).

Where some elements of a karst topography can be found, such as in Budbudjong land system near Katherine, it is likely that these Red Earths are derived from limestone.
However, over most of the survey area no karst is evident, and the limestones occur as thin layers interbedded with relatively soft shales and siltstones. No other calcareous sediments were found in the area except for a small exposure of soft material near Katherine. This exposure was associated with dark cracking clay soils. The shales and siltstones are non-calcareous and dark reddish brown in colour (Red-bed shales—Muspratt, 1969, personal communication). They have often been recovered in a more or less weathered form from underneath Red Earth profiles and are proposed as the parent materials of these soils. The limestone pavement that often occurs on loamy Red Earths is probably the remains of the more resistant limestone layers. It is important to note that some geological variation occurs in the siltstones, particularly in the Tindall deposits, with thin bands of finer or coarser material being intermixed.

(1) Tippera Family
Soils of the Tippera family occur commonly on sediments of the Jinduckin formation, but they occur on the Tindall formation sediments also. They are massive with a porous earthy profile, and are well drained. A typical profile is:

0- 4 in Dark reddish brown or dusky red fine sandy clay loam or clay loam, very hard.
4-12 in Dark reddish brown or dark red light clay, very hard or extremely hard.
12-26 in Dark red or dusky red medium clay with moderate blocky structure, breaking to granular; extremely hard.
38-46 in Dark red or dusky red clay loam, massive, very hard.

Three series have been described. The normal one is described above. Another is a drainage line soil with a dark, organic, alluvial/colluvial surface and some subsoil mottling, and the third is a hydromorphic variant with paler, more gravelly surface horizons and subsoil gravel and mottling.

(2) Tindall Family
The areas of Kimbyan land system mapped (CSIRO) in the east of the Daly Basin are formed on sediments of the Tindall formation. Tindall soils, named after this formation, occur almost exclusively on these sediments. They are very similar to the Tippera family soils, but they normally have medium clay B horizons and their subsoils are structured. Usually the structured material occurs in bands that appear to be geologically controlled, as they can occur at any depth in the profiles, and one or more structured bands may be present. A typical profile is:

0- 4 in Dark reddish brown sandy clay loam or clay loam, very hard.
4-12 in Dark reddish brown or dark red light clay, very hard or extremely hard.
12-38 in Dark red or dusky red medium clay with moderate blocky structure, breaking to granular; extremely hard.
38-46 in Dark red or dusky red clay loam, massive, very hard.

Three series have been described. The normal one is described above. Another is a drainage line soil with a dark, organic, alluvial/colluvial surface and some subsoil mottling, and the third is a hydromorphic variant with paler, more gravelly surface horizons and subsoil gravel and mottling.

(3) Emu Family
The parent material of these soils is siltstone containing a high proportion of fine sand and silt-sized particles. The fine sand is a conspicuous feature of the profile. Emu soils superficially resemble Tippera soils and may be mapped in the same land units. However, the difference in origin is always evident as Emu soils are lighter in texture with quite conspicuous fine sand. A typical profile is:

0- 4 in Dark reddish brown or dark brown fine sandy clay loam to fine sandy clay loam, hard.
4-12 in Dark reddish brown fine sandy clay loam to clay loam with fine sand, hard to extremely hard.
12-30 in Dark reddish brown or dark red clay loam with fine sand or light clay with fine sand, very hard to extremely hard.
30-60 in Dark reddish brown or dark red light clay with fine sand or fine sandy clay, hard to extremely hard. This horizon contains pieces of weathered fine sandy siltstone, sometimes ferruginized.
Two series have been described—the normal series as above and a drainage-line soil. The drainage-line soil has a darker, more organic, alluvial/colluvial surface.

(c) **Alluvial Subgroup**

A wide range of soils is contained in this sub-group, all of them occurring on the levees of the major creeks and rivers. The older river levees are restricted and only a few of their soils have been recorded. Most of the alluvial soils are found on the younger levees, which are extensive. A textural continuum exists in these soils and individuals with subsoil textures from sand to clay are recorded. Those that are very sandy may be more properly classified as Siliceous Sands or Earthy Sands, but they are included here because of their common alluvial origin and because of the textural continuum that exists.

A range occurs in sub-soil colour, from dark reddish brown to yellowish brown. The yellower soils have also been included in this subgroup of Red Earths because of their common parent materials and similar modes or origin. Frequently, the yellower ones occur in slightly less well-drained situations, where weak concretions and mottles are forming in the subsoil.

Separation of these soils into families is based on their age and texture, as these seem to be related to levee size, and geomorphogeny. Some levees are small and coarse in texture, as they are formed by deposition from infrequent but high velocity floods. Others are more extensive and finer in texture, as they form in areas where floods are more frequent but less competent.

(1) **Manbulloo Family**

Manbulloo soils occur in thin strips along river banks on slopes of up to 2%. They are well or excessively well drained, and tend to be highly erodible. Their texture profile is similar to that of Cockatoo soils.

A typical profile is:

- 0–6 in Dark brown or dark reddish brown sand or loamy sand, loose.
- 6–24 in Yellowish red or dark reddish brown loamy sand, slightly hard.
- 24–36 in Yellowish red or red clayey sand, often moist, and very friable.
- 36–60 in Yellowish red or red clayey sand or sandy loam, moist and friable.

This family is represented by one series.

(2) **Daly Family**

One series of Daly soils has been described. These are gradational textured soils and their texture profile is similar to that of Venn series 2 or 3.

A typical profile is:

- 0–4 in Dark brown loamy sand or light sandy loam, slightly hard.
- 4–24 in Yellowish red sandy loam, slightly hard, sometimes friable.
- 24–40 in Yellowish red or red sandy loam or light sandy clay loam, hard or friable.
- 40–60 in Red or yellowish red sandy clay loam, often silty, hard or friable.

(3) **Katherine Family**

One series and a poorly drained phase have been described. Katherine soils are distinctly layered, with coarse younger alluvia overlying older, heavier material. They are not common soils.

A typical profile is:

- 0–4 in Dark brown sand or loamy sand, soft or slightly hard.
- 4–10 in Yellowish red loamy sand or sandy loam, slightly hard.
- 10–26 in Yellowish red or red sandy clay loam, hard, or moist and firm.
- 26–36 in Red clay loam, grading to light clay, hard. This is a transitional horizon.
- 36–50 in Red or dark red light clay or sandy clay, very hard, or moist and firm.
- 50–60 in Red or dark red light or medium clay, moist and firm with a few yellow mottles.

The poorly drained phase has a paler colour and a weak A2 horizon from 4–10 in. It has more subsoil mottling and a lower subsoil permeability.

(4) **Edith Family**

Edith soils occur on levees that are only just above present flood levels, and they are only moderately well drained. They are loamy in texture and usually silty. The subsoils are faintly mottled and some soft or weakly cemented rounded brown concretions occur in them, which seem to have formed from old mottles. Two series have been described, one with reddish profile colours and one with yellowish colours. The latter is less well drained and has a poorly drained phase.

A typical profile is:

- 0–6 in Dark brown or dark yellowish brown silty loam or clay loam, slightly hard.
- 6–14 in Dark brown or yellowish brown, silty, sandy clay loam to silty light clay, hard.
- 14–40 in Dark reddish brown or dark yellowish brown silty clay loam or silty light clay, hard, with some weak concretions.
40-60 in Red or yellowish brown silty clay loam to silty medium clay, very hard, with weak concretions and common yellow mottles.

The poorly drained phase of the yellower series has a low subsoil permeability and is mottled almost to the soil surface.

(5) **Belbowie Family**
These soils form on the older levees which are only extensive along the Daly River, downstream from its junction with Stray Creek. They are loamy in texture and may have reddish or yellowish profile colours. The reddish series has profiles similar to those of Tippera series 2 and the yellowish series is similar to Elliott series 2.

A typical profile is:

- **0–6 in** Very dark greyish brown or black organic clay loam, sometimes silty, hard or very hard.
- **6-15 in** Dark reddish brown or dark brown clay loam or light clay, very hard.
- **15-30 in** Dark reddish brown or yellowish brown light clay, very hard or extremely hard, with some faint mottling.
- **30-60 in** Dark reddish brown or yellowish brown light or medium clay, very hard, with reddish mottling.

(6) **Gypsy Family**
These soils are formed on creek alluvia and in some situations are actively aggrading. They have uniform texture profiles and contain a high proportion of fine sand. Most profiles are shallow with a buried soil or country rock being encountered within the 5 ft profile. Only one series has been recorded.

A typical profile is:

- **0–6 in** Very dark greyish brown or black organic clay loam, some­times silty, hard or very hard.
- **6-15 in** Dark reddish brown or dark brown clay loam or light clay, very hard.
- **15-30 in** Dark reddish brown or yellowish brown light clay, very hard or extremely hard, with some faint mottling.
- **30-60 in** Dark reddish brown or yellowish brown light or medium clay, very hard, with reddish mottling.

(7) **Umbrawarra Family**
These soils are formed on coarse river alluvia. They occur along Stray Creek near Jindare and in the upper parts of the Douglas and Katherine rivers. It is likely that the alluvium was derived originally from granite or Kombolgie sandstones. Umbrawarra soils are imperfectly drained.

A typical profile is:

- **0–4 in** Very dark greyish brown coarse sand or loamy sand, soft.
- **4–24 in** Yellowish brown coarse sand or loamy sand A2 horizon, soft.
- **24–40 in** Strong brown or yellowish brown coarse loamy sand or sandy loam, slightly hard, some faint mottling.
- **40–60 in** Strong brown sandy loam or sandy clay loam with a low permeability and many red and yellow mottles.

Only one series of Umbrawarra soils has been recorded.

**D. Yellow Earths**

Yellow Earths are not common in the Daly Basin. They were included in the Yellow Podzolics by Stewart (1956), but described as Yellow Earths by van de Graaff (1961). The more common family, Elliott, is usually associated with loamy Red Earths, and the Elizabeth family soils are associated with sandy Red Earths.

The Yellow Earths have moderate to slow subsoil permeabilities and their profiles tend to be partially waterlogged and boggy in the wet season. Their yellow colour has been ascribed to the concentration of free iron oxides in concretions and mottles and to some hydration of these oxides due to impeded drainage (Stewart, 1956 and van de Graaff, 1965).

(1) **Elliott Family**
Superficially, soils of Elliott family are like those of Tippera family, but are yellowish in colour. The colour difference is usually easily observable in the termitaria that abound on soils of both families.

A typical profile is:

- **0–4 in** Dark brown slightly organic sandy clay loam, hard.
- **4–14 in** Dark yellowish brown sandy clay loam to clay loam, hard, with a few mottles and some gravel.
- **14–30 in** Yellowish brown or strong brown clay loam or light clay, very hard, with about 10% ferruginous concretions and common motting.
- **30–60 in** Yellowish brown or strong brown mottled light or medium clay, very hard, with about 20% small ferruginous concretions.

In some profiles the 4–14 in horizon is a very weak unbleached A2 horizon; these are intergrades with the Yellow Podzolics. Permeability of the subsoil decreases with depth, but at least the upper parts of the profile are porous, massive and earthy. Drainage ratings vary from moderate to imperfect.
Two series have been described, corresponding to the first two series of Tippera family. The first is shown above and the second is a drainage-flat soil with a dark organic surface and more mottling in the profile.

(2) Elizabeth Family

Elizabeth soils are moderately well to well drained. Some soils included in this family have weak A2 horizons and are thus intermediates with the Yellow Podzolics.

A typical profile is:

0–3 in Dark greyish brown sand or loamy sand, loose or slightly hard.
3–12 in Strong brown or yellowish brown loamy sand, slightly hard.
12–20 in Strong brown or yellowish red light sandy loam, slightly hard, with a few ferruginous concretions.
20–36 in Strong brown or yellowish red sandy clay loam, hard or very hard, with a few ferruginous concretions.
36–60 in Yellowish red sandy clay or light clay, very hard, with about 20% small ferruginous concretions and some red or yellow mottles.

E. Yellow Podzolics

These comprise some of the worst-drained soils in the Daly Basin. They have gradational texture profiles sometimes tending to be texture contrast. An A2 horizon and a medium to heavy textured yellowish subsoil are usual. The subsoils are of low permeability and soil drainage is impeded. The three families described are not related and do not necessarily occur together. Generally, these soils exist in small units, but they occur fairly commonly.

A note about 'Florina' soils is necessary here. Soils of this name were called Lateritic Podzolics by Stewart (1956) and Sandy Brown Earths by van de Graaff (1961). The range of characteristics allowed has, in the past, been wide—e.g., a subsoil texture of sand or clay was allowed by van de Graaff (1961) who considered further subdivision on the basis of subsoil texture unwarranted. However, much confusion has arisen as a result of the broadness of the range and an attempt has been made here to subdivide this group of soils and narrow their range of characteristics. Some of the original 'Florinas' are now classified as Yellow Podzolics, and others as Lateritic Podzolics. As these soils now occur in any one of five families, the name 'Florina' has been given to the soil most commonly referred to as Florina in the area. This soil often occurs in Kimbyan land system.

(1) Ejong Family

In many respects Ejong soils are an intermediate between Elliott series 1 soils and Florina series 3 soils. Ejong soils have an unbleached A2 horizon and mottled, gravelly subsoils with some illuvial clay. However, they are not as poorly drained or as strongly leached as the Florina soils. They often occur in Beemla and Woggaman land systems and it is likely that they have formed on strongly pre-weathered rock from an exhumed laterite profile.

A typical profile is:

0–4 in Dark brown sandy clay loam, hard.
4–12 in Light yellowish brown sandy clay or clay loam A2 horizon, hard.
12–38 in Yellowish brown or brownish yellow clay loam or light clay, hard or very hard, with some red mottling and a few ferruginous gravels.
38–60 in Yellowish brown clay loam or light clay, extremely hard, with common red and yellow mottling and about 25% small ferruginous concretions.

When wet, Ejong soils have a characteristically 'spewey' consistence.

(2) Florina Family

Florina soils are loamy in texture, with a bleached A2 horizon, and a laterite-like hardpan at depth. Their subsoils are mottled and gravelly and they are characteristically waterlogged and boggy in the wet season.

A typical profile is:

0–6 in Very dark greyish brown sandy loam or sandy clay loam, with about 15% ferruginous concretions and a 20% surface veneer of gravel.
6–15 in Yellowish brown or dark yellowish brown sandy clay loam or clay loam bleached A2 horizon, with about 25% ferruginous concretions and some rusty mottles.
15–36 in reddish brown, light yellowish brown, or strong brown clay loam with about 25% ferruginous concretions and common mottling.
36–60 in reddish brown, light brownish grey or reddish yellow gritty
Erosion on a cattle-pad, on an Emu soil. This is land unit 3d2

A 3ft profile of a typical Elliott series 1, showing yellowish termitaria
Red shales, probably 'Red-bed' shales, exposed in a cutting. These are the parent materials of Tindall soils.
This profile is a Tippera series 2, from a drainage flat.

A typical Coolibah soil profile. This one is not high in carbonates.
A gravelly Lateritic Podzolic soil of Claravale family with a 100% erosion pavement of ironstone gravels
clay, with about 20% ferruginous concretions and intense mottling in a laterite-like pattern. This horizon contains illuvial clay and is a pan of low permeability.

Three series have been described, with differences in subsoil colour. They have subsoil value/chroma ratings (Northcote, 1965) of 2, 4 or 5 respectively. Soil drainage is imperfect or poor, but very poor for the series with value/chroma 2. A fourth series occurs in the north of the area only and has very pale, pulvurulent, fine sandy A1 and A2 horizons over a subsoil of value/chroma rating 4 and the usual laterite-like pan.

(3) Douglas Family

These soils occur along river backplains and in, or adjacent to, drainage lines in sandy areas. The parent material is alluvium or colluvium. The profile is similar to that of an Elizabeth family soil in texture and colour. A typical profile is:

0–6 in Very dark greyish brown sand or loamy sand, loose or soft, often with a pink surface veneer of washed sand.
6–20 in Pale brown or yellowish brown loamy sand bleached A2 horizon. soft, with faint rusty mottling
20–40 in Light yellowish brown sandy clay loam or light sandy clay, commonly mottled with red, yellow and grey.
40–60 in Yellowish brown sandy clay, very hard, with many red and brown mottles and much illuvial clay; impermeable. Drainage is imperfect or poor.

The sand grains that make up the skeleton of Douglas soils are coarse and round and are surrounded by films of yellowish clay. Consequently in the wet season when water perches on the heavier subsoil, these soils become very boggy.

F. Lateritic Podzolics

These soils have thick sandy surface horizons including an A2 horizon. The distribution of gravel in the profile is variable, but all these soils have gravelly subsoils. The gravel is sometimes so abundant that it cannot easily be penetrated with a soil auger and consequently many of the subsoils could not be inspected. Also, as some of these soils are very deep, the 5 ft profile inspected sometimes consisted only of A horizons.

It is difficult to decide in the field whether the gravel in these soils has formed or is forming in situ, or is a currently weathering relic. However, the present drainage status of the profiles seems to provide some indication and correlates fairly well with topographic situation and presumed parent material. For instance, it is likely that some of these soils are forming from detrital laterite, particularly soils of Claravale family, as these occur on slopes and crests beneath hills of silicified sandstones, which are probably remnants of a laterite pallid zone. These soils are well or moderately well drained. The soils of Jindare family, however, seem to have formed on sandstones that may have been ferruginized. One series has a gritty pan of low permeability in its subsoil, which supports a perched water table in the wet season. Drainage is imperfect.

The gravel in these soils consists of platy or angular pieces of sandstone, partly ferruginized and coated externally with a smooth layer of iron-rich compounds (case-hardened). It is likely that this gravel has formed in situ.

(1) Claravale Family

These soils are probably derived from laterite or detrital laterite. The most common series (series 1) has most of its gravel concentrated in the lower parts of the A2 horizon.

A typical profile is:

0–4 in Very dark greyish brown loamy sand, soft or loose, with a surface veneer of about 10% gravel.
4–14 in Brownish yellow or yellowish brown loamy sand A2 horizon, loose, with 2–15% ferruginous nodules.
14–30 in Yellowish brown or pale brown clayey sand or light sandy loam, with about 40% ferruginous nodules.
30–60 in Yellowish red clayey sand or light sandy loam with about 60% ferruginous nodules and some reddish mottles.

The second series contains no profile gravel until about 48 in in depth and may be an intergrade between Claravale and Cypress soils. The third series is very gravelly throughout. A shallow phase of the third series has considerable laterite outcrop.

(2) Jindare Family

Two series of Jindare soils have been described. These commonly occur in Jindara land system on partly ferruginized sandstones. One series has a gritty hardpan at about 3 ft in depth, and is imperfectly or poorly drained.
A typical profile is:

0–6 in Very dark greyish brown loamy sand or light sandy loam, with about 10% ferruginised sandstone nodules. The surface may have a veneer of 50% of these nodules.

6–20 in Light yellowish brown loamy sand or sandy loam bleached A2 horizon, with about 20% ferruginised sandstone nodules.

20–36 in Yellowish brown light sandy clay loam, hard, with about 30% ferruginised sandstone nodules and some faint mottling.

36–60 in Yellowish red gritty sandy clay loam, extremely hard and impermeable, with many red and yellow mottles.

The second series has similar A horizons but its texture does not rise above sandy loam and the hardpan is replaced by strongly weathered sandstone.

G. Gleyed Podzolic Soils

These soils have been called Meadow Podzolic soils by Stewart (1956) and Mottled Greyish Brown Earths by van de Graaff (1965). They are formed on low lying, fine textured alluvial material and occur along river backplains, in drainage lines or around billabongs. They are seasonally inundated.

On the perimeter of the Daly Basin Marrakai soils have been found in association with Solodized Solonetz soils, which have a similar surface appearance.

(1) Marrakai

The soil surface is light grey when dry, but dark grey, dark greyish brown or very dark greyish brown if wet. Characteristically, the A1 and A2 horizons have rusty rootline mottling and are pulverulent.

A typical profile is:

A second series is similar in most respects but is heavier in texture, with subsoil texture rising to heavy clay.

H. Grey, Brown and Red Clays

The family name 'Cununurra' adopted by Stewart (1956) from Burvill (unpublished data) has been retained, but applied more specifically to those clay soils exhibiting seasonal cracking and with a structured 'self-mulching' surface. Two other families have been described—Banyan and Coolibah. Some of these soils (particularly Banyan and Coolibah) form on fine textured alluvial deposits in depressed areas, along river backplains and drainage flats. These soils are seasonally inundated and poorly drained. Others (from Banyan and Cununurra families) form on limestones or other calcareous sediments or on shales, under sedentary conditions, and again suffer an annual inundation. Most of the Cununurra family soils are formed on basalt, and although these are not inundated they are still poorly drained. They were only found in the east of the area, near Katherine. The families have been separated firstly on their tendency to crack; Coolibah soils do not show seasonal cracking. The cracking clays have been subdivided into those with a strongly structured 'self-mulching' surface (Cununurra) and those with an apparently massive surface (Banyan).

In the north of the survey area the cracking clays that occur on the river backplains seem to be actively aggrading. Surface colours are more yellow, and textures may be light clay for about eight inches. Buried organic material in the surface soil produces rusty mottling.

(1) Cununurra

These soils are strongly gilgaied, with an amplitude of relief exceeding 9 in. They are usually formed on basalt or its transported weathering products. Two series have been described. The first is a grey clay, with abundant secondary carbonate in the subsoil which may impart a pale colour to the soil. Its pH values are over 8.5 and may rise to 10.0.

A typical profile is:

A second series is in most respects but is heavier in texture, with subsoil texture rising to heavy clay.
14–36 in Dark greyish brown silty heavy clay, extremely hard, with about 5% carbonate nodules and some amorphous carbonate.

36–60 in Dark greyish brown heavy clay, extremely hard, with abundant nodular and fine amorphous carbonate and some fragments of rock.

The second series is a brown clay with very little secondary carbonate and pH values no higher than 8.5.

(2) Banyan
Banyan soils are similar in colour and texture to Cununurra soils, but they are massive right to the surface. Their gilgais are small and scattered with an amplitude of relief usually less than 9 in. Three series have been described. One has grey clay subsoils with abundant secondary carbonate and a high subsoil pH. Yellow and brown mottling is common in the subsoils of this series. Another series has brown clay subsoils, with very little secondary carbonate, and a subsoil pH of about 8.5. The third series normally has brownish colours, but has no secondary carbonate in the profile. Its subsoil pH values vary from 5.5–7.0. This series has mottled subsoils and seems to occur in waterlogged areas.

A typical profile of series 3 is:

0–6 in Very dark greyish brown silty medium clay, extremely hard, with some rusty mottles.

6–20 in Brown or very dark greyish brown silty heavy clay, extremely hard, with some manganiferous concretions and olive and grey mottles.

20–60 in Brown or very dark greyish brown heavy clay, moist and extremely firm, with some manganiferous concretions and olive and grey mottles. pH 6.5.

(3) Coolibah
Only one series of Coolibah soils has been described. These are uniform textured, non-cracking clays, with no gilgai. Their parent material is alluvial, but their origin is not clear. They are probably related geomorphogenically to the older levees of Belbowie family.

A typical profile is:

0–4 in Very dark greyish brown silty clay loam to medium clay, hard.

4–14 in Very dark greyish brown silty medium clay, extremely hard, with some secondary carbonate and a few yellow mottles.

14–40 in Very dark greyish brown or dark brown medium to heavy clay, extremely hard, with carbonate nodules and common red and yellow mottles.

40–60 in Very dark greyish brown or dark brown medium to heavy clay, moist and extremely firm, with some carbonate nodules and many red and grey mottles.

I. Rendzinas
Rendzinas form throughout the survey area, but are only common in Green Ant land system in the north. Usually they form on soft limestones or secondary residual calcareous material at seepage points, but some form in drainage lines that are subjected to inundation by calcareous waters. They are loamy in texture, with a characteristically black ‘self-mulching’ surface soil and a pale, yellowish calcareous subsoil.

(1) Phillips Family
These soils have a black ‘self-mulching’ surface and a texture build-up to medium clay at about 18 in. The subsoil has a lighter texture and is pale in colour due to the presence of carbonates. Phillips family soils are poorly or imperfectly drained and are calcareous throughout.

A typical profile is:

0–8 in Black organic calcareous clay loam, often silty, very hard, ‘self-mulching’.

8–18 in Very dark brown light or medium clay, often silty, very hard, weakly structured and calcareous.

18–40 in Greyish brown light clay or silty clay loam, very hard, calcareous.

40–60 in Yellowish brown light clay, calcareous, with common pale brown and red mottles. Permeability of this horizon is very low.

(2) Ingrid Family
Ingrid soils are similar to Phillips soils but are not calcareous throughout, and are not so strongly ‘self-mulching’. These are drainage line soils.

A typical profile is:

0–6 in Black organic clay loam or light clay, hard, sometimes weakly ‘self-mulching’.

6–14 in Very dark grey medium or heavy clay, very hard, sometimes weakly structured.
14–30 in Dark greyish brown light or medium clay, very hard, with common reddish mottles.
30–50 in Yellowish brown light clay, hard, often calcareous, with common reddish mottles.
50–60 in Yellowish brown light clay, hard, calcareous, with many reddish or yellowish mottles and low permeability.

J. Other Soils

(a) Only one group of these soils is at all extensive—the Lithosols. Lithosols occur throughout the survey area where slopes exceed 5%. They are typically stony and shallow and their characteristics vary with their parent rock.

(b) Alluvial soils with very little profile differentiation occur along the major creeks and river channels. These are not common.

(c) In areas of Gleyed Podzolic soils (Marrakai) a few profiles of Solidized Solonetz soils have been found. These are mainly in the south of the area and on the outer fringes of the basin.

(d) Yellow Podzolics formed on the Cullen and Fenton granites occur on inliers of these granites on the eastern edge of the basin, particularly north of the Douglas River.

References


VEGETATION


The climate of the Tipperary area, part of which is covered by this report, has been adequately described by Slatyer (1960). The long dry winter period has been the main influence in the selection of the vegetation. Climatically the area under consideration can be considered reasonably uniform although rainfall increases by about 10 in from south to north. In spite of this higher rainfall the effective growing season is not significantly longer. The influence of grazing animals on the natural vegetation is very small except in the immediate vicinity of the major rivers and waterholes. Cattle populations are very low and few herbivorous marsupials were seen in the course of fieldwork. The effects of soil animals, in particular termites, on the vegetation are virtually unknown. Undoubtedly the natural vegetation is conditioned to the presence of termites, and termites are more numerous in certain areas and on certain soils than others. Termites might therefore be expected to play a significant role in the maintenance of the native vegetation. The influence of fire is unknown, but there is no evidence to suggest that it has had a greater or lesser effect on any particular area. Fire is a regular feature of the environment over most if not all of the area.

Since the long dry season has been the main selective force, the plant species can be grouped according to their means of survival through these droughts (Perry, 1960; Speck, 1965).

Perennial drought-resisting species—The vegetative parts of this group remain green through the dry season. This group includes many of the Eucalypts, the Acacias and many other shrubs and trees, and Spinifex (Plectrachne pungens).

Perennial drought-evading species—This group includes deciduous trees and shrubs, and the perennial grasses which die back to their perennating organs. Many shrubs are completely deciduous (e.g. Terminalia ferdinandiana, Cochlospermum fraseri and Planchonia careya). Few tree species are completely deciduous but many, including some Eucalypts, lose most of their leaves during the dry season and are at their barest for a short period at the end of the dry season. Some, eg E. alba and E. patellaris, grow new leaves many months before the end of the dry season. It is difficult to understand what drought-evading advantage this habit could confer.

Ephemeral drought-evading species—Plants in this group germinate and grow rapidly in the wet season, and die early in the dry season. With the exception of the annual Sorghums, few are of any importance as contributors to total biomass, and they have been ignored in this report.

Field assessment of the vegetation

In assessing natural vegetation it has been found necessary to record not only the species present but also their appearance or physiognomy. It is considered that a combination of these two aspects should by and large be correlated with the various edaphic factors of a site, other environmental factors being equal.

An area delineated on an aerial photograph as having a uniform photo pattern in regard to tree density and tone and background grey tone is considered as a unit. The vegetation assemblage that exists on the ground and is so represented on the aerial photograph has to be described. This is done by listing the species present within a range of height classes from less than 1 ft to more than 70 ft. The relative abundance of species is noted within each height class. An estimate of ground cover is made for each class—canopy cover of trees and shrubs and total cover for the herbaceous vegetation. Heights and canopy-cover percentages are estimated with
periodic checks on the accuracy of estimates. Within the broad limits of each height or canopy class there is unlikely to be any serious error made.

For the purposes of this assessment any woody species below 25 ft in height is considered to be a shrub.

**Analysis of data**

The data thus collected allows the vegetation to be classified on the following scheme.

- **Criterion 1** Height of tallest tree layer less than 35 ft, 35–50 ft, or more than 50 ft.
- **Criterion 2** Total canopy cover percentage for all trees less than 10%, 10–30%, 30–70% and more than 70%.
- **Criterion 3** The presence or absence of a significant shrub layer. Shrubs contributing more than 10% canopy or ground cover are considered significant. Juvenile individuals or suckers of species present in the tree layers are not considered as contributing to the shrub layers. (Regeneration is considered later in this report).
- **Criterion 4** The herbaceous vegetation, which is classified into dominant tall perennial grasses, dominant annual Sorghum or Spinifex, the presence of “frontage” grass species, and dominant weed species such as *Hyptis suaveolens* and *Acanthospermum hispidum*.

Using these four criteria it is possible to build up the following physiognomic vegetation classes:

1. **G** — grassland (trees and shrubs absent or insignificant).
2. **LS** — low shrubland (trees with less than 10% canopy; shrubs less than 10 ft tall dominant).
3. **TS** — tall shrubland (tree layer with less than 10% canopy; shrubs taller than 10 ft dominant).
4. **LOW** — low open woodland (tree layer 25–35 ft with less than 10% canopy; few or no shrubs).
5. **LW** — low woodland (tree layer 25–35 ft with more than 10% canopy. There may or may not be a taller tree layer but if there is it contributes less than 10% canopy).
6. **W** — woodland as for LW but trees 35–50 ft. (There may be a taller tree layer but then the total tree canopy is less than 30%).
7. **OF** — open forest (tallest tree layer over 50 ft and total tree canopy more than 30%).
8. **FF** — fringing forest (trees over 50 ft and canopy more than 70%. Only grows along major rivers).
9. **LF** — Lancewood low forest.

**Subscripts**

1. **S** — shrubs contributing more than 10% canopy.
2. **a** — annual Sorghum or Spinifex-dominated pasture.
3. **p** — tall perennial grass-dominated pasture.
4. **w** — pasture severely infested with weeds.
5. **f** — frontage grass pasture.

On this scheme therefore Wa is woodland with annual grasses; LOWp is low open woodland with perennial grasses; OF/S/a is open forest with shrub layer and annual grasses.

Leaving aside the question of species differences the advantage of this physiognomic classification is that it describes in an easily understood way what is actually observed in the field. Its main disadvantage lies in the somewhat arbitrary boundaries chosen, which means that there is a certain amount of overlap between classes.
The value of certain species as indicators

It is considered that to incorporate species into the above physiognomic classification would produce a key that is too unwieldy to use. However, field observations and correlations with soil type suggest that certain species do indicate certain site factors. It is proposed therefore to write notes on those species considered to have valid indicator value.

The indicator value of any plant species lies not so much in its actual presence at any site but in its relative abundance and growth habit. The odd plant of almost any species can be found growing anywhere by pure chance. Only its abundance and vigour will indicate the environmental factors which actively select and promote its growth and distribution.

Species characteristic of rocky ridges and scarps

*E. dichromophloia* was only observed growing in these situations. It was frequently associated with *E. alba*.

Lancewood (*Acacia shirleyi*) is characteristic of ‘breakaways’ on deeply weathered pallid and mottled rock, particularly following the heads of gullies, in the lower rainfall areas of the region.

Indicators of shallow or skeletal soils

*E. latifolia*, particularly when associated with *E. alba*, is indicative of very shallow soils which may also have impeded drainage.

Dense low Ironwood (*Erythrophleum chlorostachys*) scrub up to 20 ft high is characteristic of stony skeletal soils.

*E. setosa* is frequently found on shallow stony soils which appear to be developed on deeply weathered pallid rock.

*Calythrix* spp. are indicative of very shallow lateritic soils.

*Terminalia canescens* and *Petalostigma quadriloculare* are frequently found on shallow, stony and poorly drained soils.

Indicators of shallow Claravale family soils

*E. bleeseri* forms almost pure mid-height woodland stands on these soils which are usually less than 3 ft deep over laterite. These areas support a very sparse Spinifex-dominated pasture, usually with an abundant cover of the low shrub *Petalostigma haplocladum*.

In their natural state these areas are of very low potential. It is probable that they are subject to periods of waterlogging in the wet season and the soils have a very low waterholding capacity.

Indicators of very sandy soils

*E. miniata* (Woolly Butt) as the dominant species in an open forest association is generally indicative of extremely sandy conditions. It is a shallow rooted tree (Stocker, personal communication) and can therefore tolerate shallow soils. The local pastoralists consider ‘Woolly Butt country’ as some of the worst and most drought affected country in the area.

*Acacia* spp. occur as extremely dense thickets beneath open forest on the very sandy soils (Cypress, Cockatoo and Claravale families) to the north-west of Claravale Homestead and south of the Daly River near Claravale. Their significance is not understood but their presence renders already poorly productive country even more so, by making mustering more difficult and by competing with grasses.

*Livistona humilis* (Fan Palm) only appears in any abundance to the north-west of Claravale Homestead, on sandy soils. This is probably the southerly edge of its distribution.
Alphitonia excelsa, Bossiaea phylloclada and Pachynema spp. are all indicative of very sandy conditions.

**Indicators of wet sandy soils (Stray and Douglas family soils)**

*E. polycarpa* is strongly indicative of wet sandy conditions, either in distinct drainage floors or in sandy outwash areas. It is often associated with dense *Melaleuca* sp.-*Grevillea pteridifolia* scrub in which case the soil generally has a hard pan at shallow depth, or with scattered *Grevillea pteridifolia* and *Verticordia cunninghamii* shrubs in which case the sand is usually deeper. *E. polycarpa* trees are tall, well formed and generally widely scattered with many open treeless spaces.

**Indicators of impeded drainage on loamy textured soils**

A wide range of species, particularly shrubs, indicates that the drainage of an area is suspect. Some of these are also indicative of shallow soils suggesting that soils with impeded drainage are effectively shallow. Among these species are *E. latifolia, E. alba, Terminalia canescens, T. ferdinandiana, Petalostigma quadriloculare, Grevillea heliosperma* and *Melaleuca viridiflora*.

**Indicators of drainage floors on loamy Red Earths (Tippera, Tindall and Emu families)**

On a relatively flat plain of loamy red earth it is important, but often difficult, to be able to recognise the drainage floors. If clearing and cultivation of such a plain is contemplated, it is important to understand that these drainage floors must be treated with special care and left uncleared as broad grassed waterways. They are characterised by slightly taller trees, often with *E. bigalerita* and *E. miniata* and frequently very dense sucker regrowth. Grasses too are usually denser, and *Coelorhachis rotboellioides* and *Heteropogon contortus* are often present.

**Indicators of sandy levees (Manbulloo and Daly families)**

*E. papuana, Gyrocarpus americanus, Canarium australianum and Bauhinia cunninghamii* all frequently occur on sandy levees. These areas are also characterised by the dominance of short annual grasses (*Eragrostis* spp. and *Aristida* spp.) and heavy infestations of weed species (*Hyptis suaveolens, Acanthospermum hispidum* and *Calotropis procera*).

**Indicators of cracking clay plains (Banyan family)**

Typically the broad plains following the Daly River carry a very open woodland of *E. microtheca* (Coolibah). Usually this is monospecific but there may also be present *E. papuana* and low *Acacia bidwillii*.

**Indicators of uniform areas of deep sandy Red Earths**

*E. tetradonta* (Stringy Bark) growing in an open forest community of tall well-formed trees in an almost pure stand is strongly indicative of these soils. *E. tetradonta* has a very strong and deep tap root which suggests that these soils are very deep and free draining (Stocker, personal communication).

*E. tetradonta* is capable of producing very dense sucker regrowth. This could be a serious limitation on the clearing of these areas.

*E. tetradonta* is tolerant of a broad range of soils and generally its associated species are the better indicators. Only when it grows in pure open forest stands as above is it a good indicator.

**Indicators of sandy Red Earths with better than normal moisture status**

Ironwood, 50–60 ft high with broad well-formed trunks, *E. papuana, Canarium australianum* and *Gyrocarpus americanus* are characteristic trees on these areas. They are all tall well-formed trees, frequently rather scattered in distribution with extensive open spaces. Generally associated with them, and with a very clumped distribution, is *Bauhinia cunninghamii*. 

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**Indicators of shallow loamy Red Earths**

Deep Tippera soils generally carry a very uniform low woodland association of *E. tectifica* and *E. foelscheana*. In areas where these soils are shallow or where rock is actually exposed the low woodland becomes less uniform and mixed with low Ironwood, *Cochlospermum fraseri* and *Hakea arborescens*. Where limestone outcrop or pavement is moderate to severe, low stunted *Gyrocarpus americanus* is to be found.

**Indicator of Tindall soil**

Almost monospecific and very uniform stands of *E. oligantha* (Broad-leafed Box) grow on these soils. The distribution of these soils and therefore of *E. oligantha* appears to be restricted almost exclusively to areas round the edge of the Daly Basin on soils which are either derived from the Tindall limestones or from associated sediments. Tindall soil may be found without this *E. oligantha* association but rarely if ever is this association found growing on any other soil.

**Indicator of calcareous soils (Rendzinas)**

*Tristania suaveolens* forms very open monospecific stands on highly calcareous backplains along Stray Creek and Fergusson River.

**Grasses as indicators**

The value of grasses as indicators is marred by the fact that the country is viewed mostly in the dry season by which time much of the grass has been burnt off. As with the trees and shrubs, the quality and vigour of the pasture stand is as important as the species present.

The presence of the tall perennial grasses, *Sehima nervosum*, *Themeda australis*, *Sorghum plumosum* and *Chrysopogon latifolius*, of which *Sehima nervosum* is by far the most common in this region, in general indicates the heavier textured Red and Yellow Earths. Dense stands of almost pure *Themeda australis* occur on minor areas of yellow alluvial soils of heavier texture and on soils of the Elliott family.

The dominance of annual *Sorghum* (*S. stipoideum*) or Spinifex (*Plectrachne pungens*) is indicative of soils of low waterholding capacity, either deep sands or shallow soils. Spinifex appears to have a selective advantage over annual Sorghum on sandy soils having a loose to soft surface consistency. However, in the north of this region Spinifex appears to be approaching the limit of its climatic range and is found on pale sands, only very rarely on red sands. This may also indicate a lower fertility or waterholding capacity of the pale sands.

The presence of the low creeping grass *Chamaeraphis hordacea* on loose surfaced pale sandy soils, which often carry a lower and more open tree cover, and a more mixed and open grass cover than might be expected, tends to suggest that it is not only low waterholding capacity that selects this species but some other edaphic factor. It is tentatively suggested that this other factor is impeded drainage leading to waterlogging and 'spewey' conditions in the wet season.

The weed species *Hyptis suaveolens* and *Acanthospermum hispidum* (Goat's Head Burr) are characteristic of the major river levees. Their spread has probably been encouraged by the heavy biotic pressure on these areas. *Calotropis procera* (Rubber Bush) is another species prevalent along the major rivers.

**Comparison between the vegetation of the region between Stray Creek and Fergusson River and that between Stray Creek and Douglas River**

A comparison between the floristics of the two areas reveals certain interesting differences as shown in Table 1. Whether these differences are entirely due to climatic difference or to different proportions of soil types or to different sampling techniques is not known. However, there is evidence to suggest that there is an important floristic boundary lying between Claravale and Jindare homesteads. Lancewood is found
growing on pallid and mottled zone 'breakaways' on the Woggaman Land System to
the north-east of Claravale Homestead but is not found further north. *Livistona humilis*
is very rare south of Claravale but becomes more and more common on sandy soils
to the north.

The grass *Imperata cylindrica* was not observed south of Stray Creek yet it occurs
frequently to the north.

Similarly *Chamaeraphis hordacea* is extremely rare north of Stray Creek yet
frequent in the south of the southern region.

Table 1. Occurrence of some species as a percentage of total recorded sites.

<table>
<thead>
<tr>
<th>Species</th>
<th>Between Stray Creek and Douglas River</th>
<th>Between Stray Creek and Fergusson River</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>E. bleeseri</em></td>
<td>0.7</td>
<td>6.3</td>
</tr>
<tr>
<td><em>Livistona humilis</em></td>
<td>15.4</td>
<td>4.9</td>
</tr>
<tr>
<td><em>Plectrachne pungens</em></td>
<td>7.0</td>
<td>22.1</td>
</tr>
<tr>
<td><em>Coelorhachisrottboellioides</em></td>
<td>19.9</td>
<td>2.4</td>
</tr>
</tbody>
</table>

The distribution of *E. bleeseri* probably reflects regional soils differences rather
than climatic differences since this species is common in both higher and lower
rainfall areas.

The fact has to be accepted that there does not always appear to be a good degree
of correlation between vegetation and soils in the Daly Basin. Some units are very
uniform and in these both the soils and the vegetation will be essentially similar
throughout. Other units are essentially variable, and variability is one of the distin­
guishing characteristics of these units. It is in these units that the nature of the
vegetation rather than the description of a 5 ft augered profile can be the more telling
gauge of the variability of the unit. Only when a large number of soil profiles have
been described from different localities can the variability in the soils be related back
to the variability in the vegetation.

An accurate description of the soil from a 5 ft auger hole cannot take into account
all the many other site factors which could influence the growth of the natural
vegetation. The solum below 5 ft is not inspected. The amount of run-on or run-off
can only be deduced. The porosity and waterholding capacity of a soil can only be
inferred. The actual figures are not known and there may be significant differences
between similarly described soils. Fertility levels cannot be ascertained in the field.
There is a lack of climatological data for the area. There could be significant local
variation in climate unaccounted for by meteorological stations outside the area.

The natural vegetation is the only index of biological productivity available in an
area where records and knowledge are scant. Land unit mapping, as against strict
soil mapping, is an ecological exercise which must take the natural vegetation into
account as much as the soil. If, by so doing, gaps are revealed in the understanding of
the ecology of the area, then land unit mapping becomes a useful tool in directing
and motivating future and necessary research as well as recording a statement of the
existing soil and vegetation. Only by painstakingly collecting and recording informa­
tion on the vegetation and soils does a picture emerge to show the edaphic require­
ments and the ecological significance of the various plant species.

References

APPENDIX I

Schematic cross-sections

Five cross-sections of typical parts of the survey area have been drawn, to illustrate the relationships between the mapped land units and the general topography of the landscape. Four of these show land units in a land system context, and one shows the components that occur in one of the more important arable land units.

It is important to realise that the cross-sections are schematic, and whilst they do represent the landscape in a general way, they are not taken from actual examples.

Some details of the land units are included on the sections. Soils and surface rocks are shown, and the vegetation is represented diagramatically. However, for full details of the units the reader should consult the descriptions of the land units contained in the report.
Schematic Cross-section 3.

Budbudjong Land System

- 3d
- 3a
- 6b
- 2d
- 3c
- 3b

Kimbyan Land System (on Tindall formation)

- 3d
- 3e
- 3c
- 7d
- 3d

1 mile

- Tippera
- Tippera
- Banyan
- Tippera
- Tindall
- Tindall
- Tindall
- Tindall Series 2.
- Tindall

2 miles

- E. miniata
- E. tectifica
- E. foelscheana
- E. microtheca
- E. tetrodonta
- E. oligantha
- E. patellaris
- Cochlospermum fraseri

0 ft

40 ft

20 ft

Silicified Limestone

Limestone Pavement
Schematic Cross-section 5.
Land Unit 3d (Kimbyan or Tagoman Land System)

Deep soil
Locally shallow
Limestone pavement
Limestone outcrop
Deep soil
Shallow drainage floor
Erodible
Local depression
Limestone pavement

Tippera (or Tindall) series 1.
Tippera series 2.
Tippera
Florina or Elliott
Tippera

E. miniata
E. tectifica
E. foelscheana
Grevillea pteridifolia
Limestone Pavement

E. tetrodonta
Cochlospermum fraseri
Silicified Limestone
APPENDIX II
Soil Series Descriptions

GREAT SOIL GROUP: Siliceous Sands
SOIL FAMILY: Cypress
SOIL SERIES: 1
NORTHCOTE KEY: Uc4.21
DRAINAGE: Well drained
PARENT MATERIAL: Uncertain, but probably detrital laterite, and/or pallid-zone sandstones.

0–½ in Pale pinkish or yellowish washed quartz sand, loose.

½–6 in Brown (10YR 3/3) or dark brown (10YR 5/3) sand or loamy sand, loose; sandy fabric; pH 6.5.

6–24 in Strong brown (7.5YR 5/6, 5/8) or brownish yellow (10YR 6/6) sand or loamy sand, loose; sandy fabric; pH 6.0. This horizon is an incipient unbleached A2.

24–40 in Yellowish red (5YR 4/8, 5/8) loamy sand or clayey sand, slightly moist and very friable or dry and soft; sandy/earthy fabric; pH 6.0. A few ferruginous nodules may occur in this horizon.

GREAT SOIL GROUP: Siliceous Sands
SOIL FAMILY: Stray
SOIL SERIES: 1
NORTHCOTE KEY: Uc5.11 (Uc1.22)
DRAINAGE: Imperfectly or moderately well drained
PARENT MATERIAL: Colluvial sandy accumulations, of local origin.

0–6 in Very dark greish brown (10YR 3/2) or dark greyish brown (10YR 4/2) slightly organic sand or loamy sand, loose or soft; sandy/earthy fabric; pH 6.5–7.0.

6–36 in Brown (10YR 4/3) or yellowish brown (10YR 5/6, 5/8) loamy sand, loose; sandy/earthy fabric; pH 6.5–7.0.

36–60 in Yellowish brown (10YR 5/6, 5/8) sand or clayey sand, moist and very friable; sandy/earthy fabric; pH 6.5–7.0.

GREAT SOIL GROUP: Earthy Sands
SOIL FAMILY: Cockatoo
SOIL SERIES: 1 (including gravelly phase and shallow phase)
NORTHCOTE KEY: Gn2.11, .12
DRAINAGE: Well drained
PARENT MATERIAL: Colluvial sandy accumulations, or sandstone.

0–6 in Dark reddish brown (5YR 3/3, 3/4) or rarely dark brown (10YR 3/3) sand or loamy sand, loose or soft; sandy/earthy fabric; pH 6.5.

6–18 in Dark red (2.5YR 3/6) or red (2.5YR 4/6, 4/8) loamy sand, soft or slightly hard; sandy/earthy fabric; pH 6.0–7.0. Rarely this horizon is an incipient unbleached A2.

18–60 in Dark red (2.5YR 3/6) or red (2.5YR 4/6, 4/8) sandy loam, slightly hard or moist and friable; earthy fabric; pH 6.0–7.0.

The gravelly phase has from 25–50% ferruginous nodules in the last horizon.

GREAT SOIL GROUP: Earthy Sands
SOIL FAMILY: Cockatoo
SOIL SERIES: 2 (including gravelly phase)
NORTHCOTE KEY: Uc5.21 (Gn2.11, .12)
DRAINAGE: Well drained
PARENT MATERIAL: Colluvial sandy accumulations, or sandstone.

0–6 in Dark reddish brown (5YR 3/3, 3/4) or rarely dark brown (10YR 3/3) sand or loamy sand, loose or soft; sandy/earthy fabric; pH 6.5.

6–18 in Dark red (2.5YR 3/6) or red (2.5YR 4/6, 4/8) loamy sand, soft or slightly hard; sandy/earthy fabric; pH 6.0–7.0. Rarely this horizon is an incipient unbleached A2.

18–60 in Dark red (2.5YR 3/6) or red (2.5YR 4/6, 4/8) sandy loam, slightly hard or moist and friable; earthy fabric; pH 6.0–7.0.

The gravelly phase has from 25–50% ferruginous nodules in the last horizon.

GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Venn
SOIL SERIES: 1
SOIL TYPES: Sand or loamy sand, and sandy loam
NORTHCOTE KEY: Gn2.11, .12.
DRAINAGE: Well drained
PARENT MATERIAL: Unknown, but probably colluvial accumulations from weathering red sandstones, or other arenaceous rocks.

0–4 in Dark reddish brown (5YR 3/3, 3/4) sand to sandy loam, slightly hard; earthy fabric; pH 6.5.

4–12 in Dark red (2.5YR 3/6, 10R 3/6) or dark reddish brown (2.5YR 3/4) sandy loam, slightly hard; earthy fabric; pH 6.5.

12–20 in Dark red (2.5YR 3/6, 10R 3/6) or dark reddish brown (2.5YR 3/4) sandy clay loam, very hard; earthy fabric; pH 6.5.

20–60 in Dark red (2.5YR 3/6, 10R 3/6) or dark reddish brown (2.5YR 3/4) sandy clay or light clay, dry very hard or moist firm; earthy fabric; pH 6.0–7.0.

GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Venn
SOIL SERIES: 2
SOIL TYPES: Sand or loamy sand, and sandy loam.

NORTHCOTE KEY: Gn2.11, .12.

DRAINAGE: Well drained

PARENT MATERIAL: Unknown, but probably colluvial accumulations from weathering red sandstones or other arenaceous rocks.

0–4 in Dark reddish brown (5YR 3/3, 3/4) or dusky red (2.5YR 3/2) sand to sandy loam, slightly hard; earthy fabric; pH 6.0–6.5.

4–12 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) sandy loam, hard; earthy fabric; pH 6.5.

12–24 in Dark reddish brown (2.5YR 3/4), dark red (10R 3/6) or dusky red (10R 3/4) sandy clay loam, very hard; earthy fabric; pH 6.5.

24–60 in Dusky red (10R 3/4) to dark red (2.5YR 3/6, 10R 3/6) clay loam with sand, or light sandy clay, very hard to extremely hard; earthy fabric; pH 6.0–7.0. Textures may be sub-plastic.
### Venn Series 3

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Depth (in)</th>
<th>pH</th>
<th>Air Dry Moist. %</th>
<th>E.C. (25°) m.mhos/cm</th>
<th>O.M. % O.D. wt. %</th>
<th>N %</th>
<th>Particle Size</th>
<th>Ex. Cap.</th>
<th>Ex. Cations</th>
<th>Avail P(Olsen) p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF4.565</td>
<td>0-2</td>
<td>6.7</td>
<td>0.5</td>
<td>0.021</td>
<td>1.12</td>
<td>0.029</td>
<td>..</td>
<td>2.9</td>
<td>2.76</td>
<td>0.60 0.18 0.086</td>
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<tr>
<td></td>
<td>2-14</td>
<td>6.7</td>
<td>2.4</td>
<td>0.013</td>
<td>0.89</td>
<td>0.027</td>
<td>..</td>
<td>3.3</td>
<td>2.24</td>
<td>0.66 0.21 0.086</td>
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<tr>
<td></td>
<td>14-26</td>
<td>..</td>
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<tr>
<td></td>
<td>26-60</td>
<td>6.45</td>
<td>6.9</td>
<td>0.004</td>
<td>..</td>
<td>..</td>
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</table>

**GREAT SOIL GROUP:** Red Earths  
**SOIL FAMILY:** Venn  
**SOIL SERIES:** 3  
**SOIL TYPES:** Sand or loamy sand, and sandy loam  
**NORTHCOTE KEY:** Gn2.11, .12  
**DRAINAGE:** Well drained  
**PARENT MATERIAL:** Unknown, but probably colluvial accumulations from weathering red sandstones or other arenaceous rocks.

0-2 in Dark reddish brown (5YR 3/3, 2.5YR 3/4) loamy sand or sandy loam, soft or slightly hard; earthy fabric; pH 6.5. Some loose pink sand may lie on the surface.

2-14 in Dark reddish brown (2.5YR 3/4), dark red (10R 3/6, 2.5YR 3/6) or dusky red (10R 3/3) light sandy clay loam, dry and hard; earthy fabric; pH 6.5.

14-26 in Dark reddish brown (2.5YR 3/4), dark red (10R 3/6, 2.5YR 3/6) or dusky red (10R 3/3, 3/4) sandy loam, slightly hard or hard; earthy fabric; pH 6.5.

26-60 in Dark red (2.5YR 3/6, 10R 3/6), dark reddish brown (2.5YR 3/4) or dusky red (10R 3/4), sandy clay loam, dry hard or moist friable; earthy fabric; pH 6.0-7.0.
## Ooloo Series 1

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Depth (in)</th>
<th>pH (H₂O − 1:5)</th>
<th>Air Dry Moist. %</th>
<th>E.C. (25°) m.mhos/cm</th>
<th>O.M. % O.D. wt.</th>
<th>Particle Size</th>
<th>Ex. Cap. Ca m-equiv/100 g.O.D.</th>
<th>Ex. Cations Mg Na P(Olsen) p.p.m.</th>
<th>Avail P(Olsen) p.p.m.</th>
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</thead>
<tbody>
<tr>
<td>K.211</td>
<td>0–4</td>
<td>6.47</td>
<td>.</td>
<td>0.022</td>
<td>0.84</td>
<td>0.019</td>
<td>66 19 13</td>
<td>1.8</td>
<td>0.76 0.11 0.04</td>
</tr>
<tr>
<td></td>
<td>4–14</td>
<td>6.30</td>
<td>.</td>
<td>0.018</td>
<td>.</td>
<td>.</td>
<td>65 16 18</td>
<td>1.4</td>
<td>0.92 0.14 0.09</td>
</tr>
<tr>
<td>14–60</td>
<td>6.12</td>
<td>.</td>
<td>0.011</td>
<td>.</td>
<td>42 13 143</td>
<td>.</td>
<td>1.9 1.25 0.15 0.08</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

**GREAT SOIL GROUP:** Red Earths  
**SOIL FAMILY:** Ooloo  
**SOIL SERIES:** 1  
**SOIL TYPES:** Sandy loam, sandy clay loam (including sandy clay loam gravelly phase)  
**NORTHCOTE KEY:** Gn2.11, Um5.52  
**DRAINAGE:** Well drained  
**PARENT MATERIAL:** Unknown, but probably Ooloo limestones and/or detrital accumulations from these.

0–4 in Dark reddish brown (5YR 3/3, 2.5YR 3/4) or dusky red (2.5YR 3/2) sandy loam or sandy clay loam, hard or slightly hard; earthy fabric; pH 6.5.

4–14 in Dark reddish brown (5YR 3/4, 2.5YR 3/4) or dusky red (10R 3/3, 3/4) sandy clay loam, slightly hard or very hard; earthy fabric; pH 6.5. Some ferruginous nodules may occur.

14–60 in Dark red (2.5YR 3/6, 10R 3/6) or dusky red (2.5YR 2/4, 10R 3/4) sandy clay to light clay, moist friable or dry very hard; earthy fabric; pH 6.5. Some ferruginous nodules may occur.

The gravelly phase has up to 60% ferruginous nodules in the 14–60 in horizon.
### Ooloo Series 2

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Depth (in)</th>
<th>pH</th>
<th>E.C. (25°) m.mhos/cm</th>
<th>O.M. %</th>
<th>O.D. wt %</th>
<th>N %</th>
<th>Particle Size</th>
<th>Ex. Cap.</th>
<th>Ex. Cations</th>
<th>Avail (Olsen) p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>K.780</td>
<td>0-4</td>
<td>6.60</td>
<td>0.019</td>
<td>1.84</td>
<td>0.024</td>
<td>54</td>
<td>CS 31 FS 4 Si 11</td>
<td></td>
<td></td>
<td>3.46 1.5 0.16 0.028 16.1</td>
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<td></td>
<td>4-14</td>
<td>6.70</td>
<td>0.014</td>
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<td></td>
<td>53</td>
<td>26 2 18</td>
<td></td>
<td></td>
<td>2.48 1.1 0.09 0.030 21.2</td>
</tr>
<tr>
<td></td>
<td>14-60</td>
<td>6.55</td>
<td>0.010</td>
<td></td>
<td></td>
<td>34</td>
<td>19 1 46</td>
<td></td>
<td></td>
<td>2.26 1.78 0.21 0.065 9.5</td>
</tr>
</tbody>
</table>

GREAT SOIL GROUP: Red Earths  
SOIL FAMILY: Ooloo  
SOIL SERIES: 2  
SOIL TYPES: Sandy loam (including sandy loam gravelly phase) and sandy clay loam (including sandy clay loam gravelly phase)  

NORTHCOTE KEY: Um5.52 (Gn2.11)  
DRAINAGE: Well drained  
PARENT MATERIAL: Unknown, but probably Ooloo limestones and/or detrital accumulations from these.

From 10–60% ferruginous nodules may be present in the gravelly phases.

### Ooloo Series 3

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Depth (in)</th>
<th>pH</th>
<th>E.C. (25°) m.mhos/cm</th>
<th>O.M. %</th>
<th>O.D. wt %</th>
<th>N %</th>
<th>Particle Size</th>
<th>Ex. Cap.</th>
<th>Ex. Cations</th>
<th>Avail (Olsen) p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-4</td>
<td>Dark reddish brown (5YR 3/3, 3/4, 2.5YR 3/4, 2/4) or dark brown (7.5YR 3/2) sandy loam or sandy clay loam, soft to very hard; earthy fabric; pH 6.5.</td>
<td>2.48 1.1 0.09 0.030 21.2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4-14</td>
<td>Dark red (2.5YR 3/6) or dark reddish brown (2.5YR 3/4) sandy clay loam or fine sandy clay loam, hard to very hard; earthy fabric; pH 6.5.</td>
<td>2.26 1.78 0.21 0.065 9.5</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>14-60</td>
<td>Dark red (2.5YR 3/6, 10R 3/6), dark reddish brown (2.5YR 3/4) or dusty red (10R 3/4) clay loam with sand or sandy clay loam which is sub-plastic to sandy clay or light clay; dry hard or very hard or moist firm; earthy fabric; pH 6.0–6.5.</td>
<td>3.46 1.5 0.16 0.028 16.1</td>
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</tr>
</tbody>
</table>

GREAT SOIL GROUP: Red Earths  
SOIL FAMILY: Ooloo  
SOIL SERIES: 3  
SOIL TYPES: Sandy loam and sandy clay loam (including sandy clay loam gravelly phase)  

NORTHCOTE KEY: Um5.52  
DRAINAGE: Well drained  
PARENT MATERIAL: Unknown, but probably Ooloo limestones and/or detrital accumulations from these.

From 10–60% ferruginous nodules may be present in the last horizon of the gravelly phase.
## Blain Series 2

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Depth (in)</th>
<th>pH</th>
<th>Air Dry Moist. %</th>
<th>E.C. (25°) mhos/cm</th>
<th>O.M. % O.D. wt. N, %</th>
<th>Particle Size CS</th>
<th>Ex. Cap.</th>
<th>Ex. Cations Ca Mg K Na</th>
<th>Avail (Olsen) m-equiv/100 g. O.D. p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB70.434</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>4–12</td>
<td>5.8</td>
<td></td>
<td>0.035</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>12–18</td>
<td>6.5</td>
<td></td>
<td>0.025</td>
<td></td>
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<td>18–24</td>
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</tr>
<tr>
<td></td>
<td>24–60</td>
<td>6.1</td>
<td></td>
<td>0.015</td>
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</table>

### GREAT SOIL GROUP: Red Earths

**SOIL FAMILY:** Blain  
**SOIL SERIES:** 1  
**NORTHCOTE KEY:** Gn2.11, .12  
**DRAINAGE:** Well drained

**PARENT MATERIAL:** Unknown, but probably colluvial accumulations from weathering red sandstones or other arenaceous rocks.

- **0–4 in:** Dark reddish brown (5YR 3/3, 3/4) sand or loamy sand, loose to soft; sandy/earthy fabric; pH 6.5–7.0.
- **4–12 in:** Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6, 10R 3/6) sand, clayey sand or loamy sand, slightly hard; sandy/earthy fabric; pH 6.5–7.0.
- **12–18 in:** Dark red (2.5YR 3/6, 10R 3/6) sandy clay loam, hard; earthy fabric; pH 6.5.
- **18–36 in:** Dark red (2.5YR 3/6, 10R 3/6) sandy clay, dry hard or moist firm; earthy fabric; pH 6.5–7.0.

**36–60 in:** Dark red (2.5YR 3/6, 10R 3/6) light clay with sand, dry hard or moist firm; earthy fabric; pH 6.5–7.0.

This horizon is rarely a weak unbleached A2.

- **12–18 in:** Dark red (2.5YR 3/6, 10R 3/6) sandy loam, very hard; earthy fabric; pH 6.5–7.0.
- **18–24 in:** Dark red (2.5YR 3/6, 10R 3/6) sandy clay loam, very hard; earthy fabric; pH 6.5–7.0.
- **24–60 in:** Dark red (2.5YR 3/6, 10R 3/6) clay loam with sand, or light sandy clay, hard to very hard or moist and friable; earthy fabric; pH 6.5–7.0.
GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Blain
SOIL SERIES: 4
NORTHCOTE KEY: 4.51, .52
DRAINAGE: Well drained
PARENT MATERIAL: Unknown, but probably colluvial accumulations from weathering red sandstones or other arenaceous rocks.

0-4 in Dark reddish brown (5YR 3/3) sand or loamy sand, soft; sandy/earthy fabric; pH 6.0-7.0.

4-22 in Red (2.5YR 4/6) or dark reddish brown (2.5YR 3/4) sand to loamy sand, slightly hard; sandy/earthy fabric; pH 6.0-7.0.

22-32 in Red (2.5YR 4/6) or dark red (2.5YR 3/6) silty loam or sandy clay loam, hard; earthy fabric; pH 6.5-7.0.

32-60 in Dark red (2.5YR 3/6) or red (10R 4/6) sandy clay loam or clay loam, dry hard to moist firm; earthy fabric; pH 6.5-7.0.

0-4 in Dark reddish brown (5YR 3/3) sand or loamy sand, soft; sandy/earthy fabric; pH 6.0-7.0.

26-60 in Dark red (2.5YR 3/6) or red (10R 4/6, 4/8) sandy clay loam, dry hard or moist firm; earthy fabric; pH 6.0-7.0.

3-14 in Dark reddish brown (2.5YR 3/4, 5YR 3/4) or dark red (2.5YR 3/6) loamy sand, slightly hard; earthy fabric; pH 6.0-7.0. This horizon may be an incipient unbleached A2.

14-26 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) sandy loam, slightly hard or hard; earthy fabric; pH 6.0-7.0. A thin layer of loose pink sand may lie on the surface.
### Tippera Series 1

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Depth (in)</th>
<th>pH</th>
<th>Dry Moist. %</th>
<th>E.C. (25°C) m.mhos/cm</th>
<th>O.M. % O.D.</th>
<th>N %</th>
<th>Particle Size</th>
<th>Ex. Cap.</th>
<th>Ex. Cations</th>
<th>Avail P(Olsen) p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Ca</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>m-eq/100 g</td>
<td>p.p.m.</td>
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<tr>
<td>ADLH.1113</td>
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<td>.</td>
<td>0.072</td>
<td>2.04</td>
<td>0.084</td>
<td>58</td>
<td>19</td>
<td>23</td>
<td>4.50</td>
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<tr>
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<td>4–12</td>
<td>6.45</td>
<td>.</td>
<td>0.045</td>
<td>.</td>
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<td>47</td>
<td>14</td>
<td>39</td>
<td>4.88</td>
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<td>3.00</td>
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<td>26–60</td>
<td>6.82</td>
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<td>47</td>
<td>14</td>
<td>39</td>
<td>4.88</td>
</tr>
</tbody>
</table>

**GREAT SOIL GROUP:** Red Earths  
**SOIL FAMILY:** Tippera  
**SOIL SERIES:** 1  
**SOIL TYPES:** Sandy clay loam and clay loam  
**NORTHCOTE KEY:** Gn2.11  
**DRAINAGE:** Well drained  
**PARENT MATERIAL:** Red siltstones, associated with either the Jinduckin formation or the Tindall limestones.

0–4 in: Dusky red (2.5YR 3/2) or dark reddish brown (5YR 3/3, 3/4, 2.5YR 3/4) clay loam or fine sandy clay loam, very hard; earthy fabric; pH 6.0–6.5. Some small ferruginous concretions and some clay skins.

4–12 in: Dark reddish brown (2.5YR 3/4, 5YR 3/4) or dark red (2.5YR 3/6) clay loam or light clay, very hard or extremely hard; earthy fabric; pH 6.0–6.5.

12–26 in: Dark red (2.5YR 3/6, 10R 3/6) or dark reddish brown (2.5YR 3/4) light or medium clay, dry extremely hard or moist very firm; earthy fabric; pH 6.0–6.5. Some small ferruginous concretions and some clay skins.

26–60 in: Dark red (10R 3/6, 2.5YR 3/6) or dark reddish brown (2.5YR 3/4) light clay, dry very hard or moist firm; earthy fabric; pH 6.0–6.5. Some small ferruginous concretions.

**GREAT SOIL GROUP:** Red Earths  
**SOIL FAMILY:** Tippera  
**SOIL SERIES:** 2  
**NORTHCOTE KEY:** Gn2.11  
**DRAINAGE:** Well or moderately well drained  
**PARENT MATERIAL:** Local colluvia and alluvia from surrounding areas of loamy Red Earths, overlying a Tippera (Series 3) subsoil. This is a drainage-line soil.

0–6 in: Very dark brown (10YR 2/2) or black (7.5YR 2/0, 5YR 2/1) fine sandy loam to silty clay loam, very hard; earthy fabric; pH 6.0.

6–14 in: Very dark greyish brown (10YR 3/2) or dark reddish brown (5YR 3/4) sandy clay loam or silty clay loam, very hard; earthy fabric; pH 6.0. A few small distinct rusty mottles may occur.


30–60 in: Dark red (2.5YR 3/6) or red (10R 4/6) light or medium clay, very hard; earthy fabric; pH 6.0. A few small ferruginous concretions may be present and medium distinct yellow red-brown and black mottles are common.

Continued
GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Tippera
SOIL SERIES: 3
NORTHCOTE KEY: Gn2.14 (.11)
DRAINAGE: Moderately well drained

PARENT MATERIAL: Mainly red siltstones, sometimes thinly overlain by remnants of older sandstone-derived soils.

0–5 in Dark brown (10YR 3/3, 4/3) or very dark greyish brown (10YR 3/2) sandy clay loam or clay loam, hard; earthy fabric; pH 6.0–6.5. Up to 2% small ferruginous concretions.

5–12 in Dark reddish brown (5YR 3/4, 3/3), dark brown (7.5YR 4/4) or dark yellowish brown (10YR 5/4) gritty clay loam or light clay, hard or very hard; earthy fabric; pH 6.0–6.5. Up to 10% small ferruginous concretions, faint mottling and some clay skins. This horizon is often a weak unbleached A2.

12–34 in Dark red (2.5YR 3/6), yellowish red (5YR 4/6) or dark brown (7.5YR 4/4) gravelly light or medium clay, very hard; earthy fabric; pH 6.0. Up to 10% ferruginous concretions, faint red and yellow mottling and some clay skins.

34–60 in Dark red (2.5YR 3/6) or dark reddish brown (2.5YR 3/4) light clay, hard or extremely hard; earthy fabric; pH 5.5–6.0. Up to 10% ferruginous concretions, common red, yellow and black mottling and some clay skins.
Tindall Series 1

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**Site No.**

**Depth (in)** | **pH** | **Air Dry Moist.** | **E.C. (25°) mmhos/cm** | **O.M. %** | **% O.D. wt.** | **N %** | **Particle Size** | **Ex. Cap.** |
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**GREAT SOIL GROUP:** Red Earths

**SOIL FAMILY:** Tindall

**SOIL SERIES:** 1

**SOIL TYPES:** Sandy clay loam, and clay loam

**NORTHCOTE KEY:** Gn3.11, Gn2.11, (.12)

**DRAINAGE:** Well drained

**PARENT MATERIAL:** Red-bed shales associated with the Tindall limestones.

**Note:** Two profile descriptions of this series have been given to illustrate the range that can occur and the dependence of these soils on local lithology.

**Profile A**

0-4 in Dark reddish brown (5YR 3/3, 3/2, 2.5YR 3/4, 2/4) sandy clay loam or clay loam, very hard to extremely hard; earthy fabric; pH 6.0-6.5. This material may have smooth-ped fabric and blocky structure.

24-40 in 24-40 in Dark red (2.5YR 3/6, 10R 3/6) or dark reddish brown 2.5YR 3/4) medium clay, very hard to extremely hard; 10% blocky structure, breaking to granular, smooth-ped or earthy fabric; pH 6.0-6.5.

40-48 in Dark red (2.5YR 3/6, 10R 3/6) or dark reddish brown (2.5YR 3/4) light clay, very hard; earthy fabric; pH 6.0-6.5.

48-60 in Dark red (10R 3/6) or dark reddish brown (2.5YR 3/4) medium clay, extremely hard; smooth-ped or earthy fabric; pH 6.0-6.5. About 10% of this horizon has a moderate blocky or fine granular structure.

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**Profile B**

0-4 in Dark reddish brown (5YR 3/3, 3/2, 2.5YR 3/4, 2/4) sandy clay loam or clay loam, hard or very hard; earthy fabric; pH 6.0-6.5.

4-12 in Dark reddish brown (5YR 3/3, 3/4, 2.5YR 3/4) or dark red 2.5YR 3/6 light clay, very hard or extremely hard; earthy fabric; pH 6.0-6.5.

12-44 in Dark reddish brown (2.5YR 3/4) or dusky red (10R 3/3, 3/4) medium or heavy clay, extremely hard; smooth-ped or earthy fabric; pH 6.0-6.5. About 10% of this horizon has a moderate blocky or fine granular structure.

44-60 in Dark reddish brown (2.5YR 3/4) or dusky red (10R 3/3, 3/4, 2.5YR 3/2) medium clay, extremely hard; smooth-ped or earthy fabric; pH 6.0-6.5. From 10-50% of this horizon has a moderate blocky structure breaking to granular. Up to 10% ferro-manganiferous concretions may occur.
## Tindall Series 2

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**Note:** Buffalo had frequently camped in this area.

**GREAT SOIL GROUP:** Red Earths  
**SOIL FAMILY:** Tindall  
**SOIL SERIES:** 2  
**NORTHCOTE KEY:** Gn3.11, Gn2.11, (.12)  
**DRAINAGE:** Well drained  
**PARENT MATERIAL:** Red-bed shales associated with the Tindall limestones, overlain by local alluvia and colluvia. This is a drainage-line soil.

0-4 in Dark brown (7.5YR 3/2) or very dark brown (10YR 2/2) organic clay loam or sandy clay loam, slightly hard; earthy fabric; pH 6.0-6.5.

4-14 in Dark reddish brown (5YR 3/4) or dark brown (7.5YR 4/4) organic clay loam or fine sandy clay loam, very hard; earthy fabric; pH 6.0-6.5.

14-48 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) medium clay, extremely hard; smooth-ped or earthy fabric; pH 6.5-7.0. From 10-50% of this horizon has a moderate blocky structure. About 2% ferro-manganiferous concretions may be present.

48-60 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) light or medium clay, extremely hard; earthy or smooth-ped fabric; pH 6.5-7.0. This material may have blocky structure and may contain some ferro-manganiferous concretions.
Tindall Series 3

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GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Tindall
SOIL SERIES: 3
NORTHCOTE KEY: Gn3.11, Gn2.11, (.12)
DRAINAGE: Well or moderately well drained
PARENT MATERIAL: Red-bed shales associated with the Tindall limestones.

0-5 in  Very dark greyish brown (10YR 3/2) or dark brown (7.5YR 3/2)
sandy clay loam or clay loam, very hard or extremely hard; earthy fabric; pH 6.0-6.5. A thin veneer of gravel may be present on the surface.

5-14 in  Dark reddish brown (5YR 3/4) heavy clay loam or light clay, very hard; earthy fabric; pH 6.0-6.5. About 2% ferro-manganiferous concretions may be present and some faint mottles.

14-40 in  Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) light clay, very hard; smooth-ped or earthy fabric; pH 6.0-7.0. From 10-20% may have a moderate blocky structure. Up to 5% ferruginous concretions and some black mottles may occur.

40-60 in  Dark red (2.5YR 3/6) or dark reddish brown (2.5YR 3/4) light or medium clay, very hard or extremely hard; smooth-ped or earthy fabric; pH 6.0-7.0. From 10-20% may have a moderate blocky structure. Up to 5% ferruginous concretions and some black mottles may occur.
## Emu Series 1

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GREAT SOIL GROUP: Red Earths  
SOIL FAMILY: Emu  
SOIL SERIES: 1  
NORTHCOTE KEY: Gn2.11  
DRAINAGE: Well drained  

PARENT MATERIAL: Red siltstones containing a high proportion of fine sand and silt-sized particles; often associated with the Tindall limestones.

0-4 in Dark brown (7.5YR 3/2) or dark reddish brown (5YR 3/4, 2.5YR 3/4) fine sandy loam to fine sandy clay loam, hard or very hard; earthy fabric; pH 6.0-6.5.

30-60 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) light clay with fine sand or fine sandy clay, hard to extremely hard; earthy fabric; pH 6.0-6.5. This horizon may contain fragments of yellowish, strongly weathered fine sandy siltstone, and relatively unweathered siltstone may occur before 60 in.

6-14 in Dark brown (7.5YR 3/2) or dark reddish brown (5YR 3/4, 2.5YR 3/4) fine sandy clay loam or clay loam with fine sand, hard to very hard; earthy fabric; pH 6.0-6.5.

14-30 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) clay loam with fine sand or light clay with fine sand, very hard to extremely hard; earthy fabric; pH 6.0-6.5.

GREAT SOIL GROUP: Red Earths  
SOIL FAMILY: Emu  
SOIL SERIES: 2  
NORTHCOTE KEY: Gn2.11  
DRAINAGE: Well or moderately well drained  

PARENT MATERIAL: Local colluvia and alluvia from surrounding areas of loamy Red Earths, overlying an Emu series 1 subsoil. This is a drainage-line soil.

0-6 in Very dark greyish brown (10YR 3/2) or dark brown (10YR 3/3) clay loam with fine sand or light clay with fine sand, very hard to extremely hard; earthy fabric; pH 6.0-6.5.

30-60 in Dark reddish brown (2.5YR 3/4) or dark red (2.5YR 3/6) light clay with fine sand or fine sandy clay, hard to extremely hard; earthy fabric; pH 6.0-6.5. This horizon may contain fragments of yellowish, strongly weathered fine sandy siltstone, and relatively unweathered siltstone may occur before 60 in.
### Manbulloo Series 1

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**GREAT SOIL GROUP:** Red Earths  
**SOIL FAMILY:** Manbulloo  
**SOIL SERIES:** 1  
**NORTHCOTE KEY:** Uc4.22 (Gn2.14)  
**DRAINAGE:** Well or excessively well drained  
**PARENT MATERIAL:** Coarse river alluvia, deposited from infrequent very high floods.  

0–6 in Dark brown (7.5YR 3/2, 4/2), dark yellowish brown (10YR 3/4) or dark reddish brown  
24–36 in Red (2.5YR 4/6, 4/8), yellowish  
36–60 in Red (2.5YR 4/6, 4/8), yellowish or rarely dark red (2.5YR 3/6) clayey sand to sandy loam, moist friable; earthy fabric; pH 6.0–7.0.
Daly Series 1

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GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Daly
SOIL SERIES: 1
NORTHCOTE KEY: Gm2.11, .12
DRAINAGE: Well drained
PARENT MATERIAL: River alluvia.

0–4 in Dark brown (7.5YR 3/2, 4/2),
dark reddish brown (5YR 2/2, 3/4) or
dark yellowish brown (10YR 3/4) loamy sand to sandy
loam, slightly hard; sandy/earthy fabric; pH 6.0–7.0.

40–60 in Red (2.5YR 4/6), dark red
(2.5YR 3/6) or yellowish red (5YR 4/6) sandy clay loam,
often silty, dry hard or moist friable; earthy fabric; pH 6.0–7.0.

4–10 in Reddish brown (5YR 4/4) or
yellowish red (5YR 4/8) sand to sandy loam, soft or slightly
hard; earthy or sandy/earthy fabric; pH 6.0–7.0. This horizon may be an
incipient unbleached A2.

10–24 in Red (2.5YR 4/6) or yellowish
red (5YR 4/8, 5/8) sandy clay loam, dry hard or moist firm;
earthly fabric; pH 6.0–7.0.

24–40 in Red (2.5YR 4/6, 4/8) or dark
red (2.5YR 3/6) clay loam, grading to sandy clay or light
clay, dry hard or moist firm; earthy fabric; pH 6.0–7.0. A
few yellow mottles may occur.

This horizon is transitional to a
buried soil, formed in an
older layer.

Continued
40-50 in Red (2.5YR 4/6) or dark red (2.5YR 3/6) light to medium clay or sandy clay, dry very hard or moist firm; earthy fabric; pH 6.0-7.0. A few yellow mottles may occur.

50-60 in Red (10R 4/6) or dark red (2.5YR 3/6) light to medium clay or sandy clay, dry very hard or moist very firm; earthy fabric, with illuvial clay skins; pH 6.0-6.5. Yellow or whitish mottles are common.

The poorly drained phase is paler in colour (Hue 10YR, value/chroma 4) and more mottled in the subsoil. The deep subsoil has distinct illuvial clay and is of low permeability.

GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Edith
SOIL SERIES: 1
NORTHCOTE KEY: Gn 2.11, 12
PARENT MATERIAL: River alluvia; deposition from annual floods.

0-6 in Dark brown (10YR 3/3), very dark greyish brown (10YR 3/2) or dark reddish brown (5YR 3/2) silty loam to clay loam, slightly hard or hard; earthy fabric; pH 6.0-6.5.

6-14 in Dark brown (7.5YR 4/4), yellowish red (5YR 4/6, 4/8) or dark reddish brown (5YR 3/3, 3/4) silty sandy clay loam to silty light clay, hard or very hard; earthy fabric; pH 6.0-7.0.

14-40 in Dark reddish brown (2.5YR 3/4) or yellowish red (5YR 4/6, 4/8) silty clay loam or silty light clay, sometimes fine sandy clay, hard; earthy fabric; pH 6.0-7.0.

40-60 in Red (2.5YR 4/6) to dark reddish brown (2.5YR 3/4) silty clay loam to silty light or medium clay, very hard or extremely hard; earthy fabric; pH 6.0-7.0. Some (2%) weakly cemented reddish or brownish concretions of soil material may be present and a few fine mottles.
## Edith Series 2

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<th>O.M. %</th>
<th>O.D. %</th>
<th>N %</th>
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### GREAT SOIL GROUP: Red Earths

### SOIL FAMILY: Edith

### SOIL SERIES: 2 (including poorly drained phase)

### NORTHCOTE KEY: Gn2.21, .22

### DRAINAGE: Moderately well drained

### PARENT MATERIAL: River alluvia; deposited by annual floods.

- **0-6 in**: Dark brown (10YR 3/3), dark yellowish brown (10YR 4/4) or rarely very dark brown (10YR 2/2) silty loam to clay loam, slightly hard; earthy fabric; pH 6.0-6.5.
- **6-14 in**: Dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/8) or strong brown (7.5YR 5/6) silty sandy clay loam to silty light clay, hard; earthy fabric; pH 6.0-6.5. Some (2%) soft reddish brown concretions of soil material. This horizon may be a weak unbleached A₂.
- **14-40 in**: Dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6, 5/8) or strong brown (7.5YR 5/6) silty clay loam or silty light clay, hard; earthy fabric; pH 6.0-7.0. Some (5%) weakly cemented reddish or brownish concretions of soil material and common red or yellowish mottles.
- **40-60 in**: Light yellowish brown (10YR 6/4), yellowish brown (10YR 5/6, 5/8) or dark brown (7.5YR 5/6) silty clay loam to silty medium clay, hard or very hard; earthy fabric; pH 6.0-7.0. Some (2%) weakly cemented reddish or brownish concretions of soil material and common reddish or greyish mottles.

The poorly drained phase has common subsoil mottling, with some reddish brown or grey rootline mottles extending to the soil surface. The lower parts of the profile contain many clay skins and have some smooth-ped fabric. Subsoil permeability is low. These soils are often similar to those of Marrakai family.

### GREAT SOIL GROUP: Red Earths

### SOIL FAMILY: Belbowie

### SOIL SERIES: 1

### NORTHCOTE KEY: Gn2.11, .12

### DRAINAGE: Moderately well drained

### PARENT MATERIAL: River alluvia; older levees.

- **0-6 in**: Very dark greyish brown (10YR 3/2), dark reddish brown (5YR 2/2) or black (5YR 2/1, 7.5YR 2/0) organic clay loam, sometimes silty, hard or very hard; earthy fabric; pH 6.0-7.0.
- **6-15 in**: Dark reddish brown (5YR 3/3, 3/4) clay loam or light clay, sometimes silty, very hard or extremely hard; earthy fabric; pH 6.5-7.0.
- **15-30 in**: Dark reddish brown (5YR 3/4) or dark red (2.5YR 3/6) light clay, very hard or extremely
GREAT SOIL GROUP: Red Earths
SOIL FAMILY: Belbowie
SOIL SERIES: 2
NORTHCOTE KEY: Gn2.21, .22 (Gn2.24)
DRAINAGE: Moderately well or imperfectly drained
PARENT MATERIAL: River alluvia; older levees.

0–6 in Very dark greyish brown (10YR 3/2), dark reddish brown (5YR 2/2) or black (5YR 2/1, 7.5YR 2/0) organic clay loam, hard or very hard; earthy fabric; pH 6.0–7.0.

6–14 in Dark brown (7.5YR 4/4) clay loam or light clay, hard or very hard; earthy fabric; pH 6.0–7.0. This horizon may be a weak unbleached A2.

14–30 in Yellowish brown (10YR 5/6) or strong brown 7.5YR 5/6, 5/8) light clay, very hard or extremely hard; earthy fabric with some clay skins; pH 6.5–7.0.

20–60 in Dark reddish brown (5YR 3/4), dark red (2.5YR 3/6) or red (2.5YR 4/6) light or medium clay, very hard or moist very firm; earthy fabric, but sometimes smoothped; pH 6.5–7.0. Reddish mottles and clay skins are common.

Faint reddish mottles may occur.

30–60 in Yellowish brown (10YR 5/6, 5/8) light or medium clay, very hard or moist firm; earthy fabric; pH 6.5–7.0. Few fine faint black mottles may occur and a few small ferruginous concretions.

39
### Elliott Series 1

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**GREAT SOIL GROUP:** Yellow Earths  
**SOIL FAMILY:** Elliott  
**SOIL SERIES:** 1  
**NORTHCOTE KEY:** Gn2.61, .62 (Gn2.21, .22)  
**DRAINAGE:** Moderately well to imperfectly drained  
**PARENT MATERIAL:** Unknown, but thought to be derived in situ from loamy Red Earths or red-bed shales.

- 0– 4 in Dark brown (10YR 3/3, 7.5YR 4/4) or very dark greyish brown (10YR 3/2) slightly organic sandy clay loam, hard; earthy fabric; pH 6.0–6.5.
- 4–14 in Strong brown (7.5YR 5/6), yellowish brown (10YR 5/4, 5/6, 5/8) or dark yellowish brown (10YR 4/4) sandy clay loam to clay loam, hard or very hard; earthy fabric; pH 6.0–6.5. Faint red mottling, and occasional small concretions.
- 14–30 in Yellowish brown (10YR 5/4, 5/6, 5/8) or strong brown (7.5YR 5/6) clay loam to light clay, hard or very hard; earthy fabric; pH 6.0–6.5. From 5–10% small ferruginous concretions may occur, the percentage increasing with depth. Some profiles have common red or yellow mottles.
- 30–60 in Yellowish brown (10YR 5/4, 5/6, 5/8) or strong brown (7.5YR 5/6) light or medium clay, or sandy clay, dry hard to very hard or moist firm; earthy fabric; pH 6.0–7.0. Up to 25% small ferruginous concretions occur, associated with common (5–15%) red or yellow mottles. A gravelly clay pan, or rarely limestone, underlies the soil, sometimes at about 3 ft.

**GREAT SOIL GROUP:** Yellow Earths  
**SOIL FAMILY:** Elliott  
**SOIL SERIES:** 2

**NORTHCOTE KEY:** Gn2.61 (Gn2.21)  
**DRAINAGE:** Moderately well or imperfectly drained  
**PARENT MATERIAL:** Not fully known, but thought to be derived in situ from loamy Red Earths, with a local alluvial/colluvial overlay and a definite organic influence. These are drainage flat soils.

- 0– 6 in Black (5YR 2/1) or very dark grey (10YR 3/1) organic clay loam to light clay, often silt, hard; earthy fabric; pH 6.5–7.5.
- 6–15 in Very dark greyish brown (10YR 3/2) silty clay loam or light clay, hard or very hard; earthy fabric; pH 6.5–7.0. Some faint rusty mottles may be present.
- 15–30 in Yellowish brown (10YR 5/6) or strong brown (7.5YR 5/6) light clay, hard or very hard; earthy fabric; pH 6.5–7.0. From 5–10% small ferruginous concretions and common reddish mottles occur.

*Continued*
30–60 in Yellowish brown (10YR 5/6, 5/8) or strong brown (7.5YR 5/6) light or medium clay, hard or very hard or moist firm; earthy fabric; pH 6.0–6.5. Up to 25% small ferruginous concretions may occur, associated with common (5–15%) red, yellow or grey mottles.

GREAT SOIL GROUP: Yellow Earths
SOIL FAMILY: Elizabeth
SOIL SERIES: 1
NORTHCOTE KEY: Gn2.21, .22 (Gn2.24, .25)
DRAINAGE: Moderately well or well drained
PARENT MATERIAL: Unknown, but usually found in association with sandy Red Earths and may share their origin.

0–3 in Dark brown (10YR 3/3, 7.5YR 3/2), dark greyish brown (10YR 4/2) or very dark greyish brown (10YR 3/2) sand or loamy sand, loose to slightly hard; sandy/earthy fabric; pH 6.5–7.0.

3–12 in Strong brown (7.5YR 5/6), dark yellowish brown (10YR 4/4) or dark brown (7.5YR 4/4) sand or loamy sand, loose or slightly hard; sandy/earthy fabric; pH 6.5–7.0. A few (2%) small ferruginous concretions occur in some cases. This horizon may be an incipient unbleached A2.

12–20 in Yellowish brown (10YR 5/6, 5/8), strong brown (7.5YR 5/6, 5/8) or yellowish red (5YR 5/6) loamy sand or sandy loam, slightly hard or hard; earthy fabric; pH 6.0–7.0. Up to 5% small ferruginous concretions may occur.

20–36 in Strong brown (7.5YR 5/6, 5/8) or yellowish red (5YR 5/6, 5/8) sandy clay loam or light sandy clay, dry very hard or moist friable; earthy fabric; pH 6.0–7.0. From 10–20% small ferruginous concretions.

36–60 in Yellowish red (5YR 5/6, 5/8) or red (2.5YR 5/6, 5/8) sandy clay loam, sandy clay or light clay, very dry hard or moist friable; earthy fabric; pH 6.0–7.0. Up to 30% small ferruginous concretions may occur and some profiles have common red or yellow mottles.

GREAT SOIL GROUP: Yellow Podzolics
SOIL FAMILY: Ejong
SOIL SERIES: 1
NORTHCOTE KEY: Gn2.64
DRAINAGE: Imperfectly drained
PARENT MATERIAL: Unknown, but probably formed on strongly pre-weathered rock from an exhumed laterite profile.

0–4 in Dark brown (10YR 3/3, 4/3, 7.5YR 3/2) or very dark greyish brown (10YR 3/2) sandy clay loam, hard; earthy fabric; pH 6.0–6.5.

4–12 in Light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4, 5/6) or brown (10YR 4/3) A2 horizon of sandy clay loam, hard; earthy fabric; pH 6.0–6.5.

12–38 in Yellowish brown (10YR 5/6), strong brown (7.5YR 5/6) or brownish yellow (10YR 6/6) clay loam or light clay, dry to extremely hard; earthy fabric; pH 5.5–6.5. Some profiles have red mottling.

38–60 in Yellowish brown (10YR 5/6, 5/8) or strong brown (7.5YR 5/6) clay loam to medium clay, sometimes gritty, dry extremely hard or moist very firm; earthy fabric; pH 5.5–6.5. Common to many red and yellow mottles, and up to 30% small ferruginous concretions may occur. This material contains illuvial clay and has a very slow permeability.

GREAT SOIL GROUP: Yellow Podzolics
SOIL FAMILY: Florina
SOIL SERIES: 1
NORTHCOTE KEY: Gn2.54
DRAINAGE: Imperfectly to poorly drained
PARENT MATERIAL: Unknown.

0–6 in Very dark grey (10YR 3/1), very dark greyish brown (10YR 3/2)

Continued
or dark brown (10YR 4/3) sandy loam or sandy clay loam, slightly hard; earthy fabric; pH 6.0–6.5. From 15–30% ferruginous concretions occur in the soil and 10–20% on the soil surface.

6–15 in Yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4) or brown (10YR 5/3) bleached A2 horizon of sandy clay loam, hard; earthy fabric; pH 5.5–6.5. From 20–30% ferruginous concretions and a few rusty mottles occur.

15–34 in Dark yellowish brown (10YR 4/4), reddish brown (5YR 4/4) or brown (7.5YR 4/4) sandy clay loam to clay loam with sand, hard or very hard; earthy fabric; pH 5.5–6.0. From 15–30% ferruginous concretions. Mottling with red, yellow and black is common.

34–60 in Reddish brown (5YR 4/4), brown (7.5YR 4/4) or yellowish red (5YR 4/6) gritty clay or sandy clay, extremely hard; earthy fabric with some smooth faces; pH 5.5–6.0. From 10–20% ferruginous concretions, and many reddish brown, yellow and black mottles occur. This material contains illuvial clay, has a very slow permeability and often looks like soft laterite.

GREAT SOIL GROUP: Yellow Podzolics
SOIL FAMILY: Florina
SOIL SERIES: 2
NORTHCOTE KEY: Gn2.94
DRAINAGE: Poor to very poorly drained
PARENT MATERIAL: Unknown.

0– 6 in Dark greyish brown (10YR 4/2), greyish brown (10YR 5/2) or dark yellowish brown (10YR 4/4) sandy loam or sandy clay loam, slightly hard; earthy fabric; pH 5.5–6.5. From 5–15% ferruginous concretions occur in the soil and 10–20% on the soil surface.

6–15 in Pale brown (10YR 6/3) or brown (10YR 5/3) bleached A2 horizon of sandy clay loam or clay loam, slightly hard or hard; earthy fabric; pH 5.5–6.0. From 20–30% ferruginous concretions and some grey or yellow mottles.

15–34 in Light yellowish brown (10YR 6/4) or grey (10YR 6/1) sandy clay loam or sandy clay, hard or very hard; earthy fabric; pH 5.5–6.0. From 15–20% ferruginous concretions and common red and yellow mottling.

34–60 in Light brownish grey (10YR 6/2) or yellowish brown (10YR 5/4) gritty sandy clay or medium clay, extremely hard; earthy fabric with some smooth faces; pH 6.0–6.5. From 5–10% ferruginous concretions and many red, yellow and brown mottles occur. This material contains illuvial clay, has a very slow permeability and often looks like soft laterite.

GREAT SOIL GROUP: Yellow Podzolics
SOIL FAMILY: Florina
SOIL SERIES: 3
NORTHCOTE KEY: Gn2.74
DRAINAGE: Imperfectly or poorly drained
PARENT MATERIAL: Unknown.

0– 4 in Black (10YR 2/1) or very dark greyish brown (10YR 3/2) sandy loam or sandy clay loam, slightly hard; earthy fabric; pH 6.0–6.5. From 15–20% ferruginous concretions occur in the soil and 15–30% on its surface.

4–14 in Dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) bleached A2 horizon of sandy clay loam or clay loam, slightly hard to very hard; earthy fabric; pH 6.0–6.5. From 20–30% ferruginous concretions and a few rusty mottles occur.

14–30 in Yellowish brown (10YR 5/4, 5/8), strong brown (7.5YR 5/6) or yellowish red (5YR 5/6) clay loam or light clay, hard or very hard; earthy fabric; pH 5.5–
From 15-30% ferruginous concretions occur and red, yellow and black mottles are common.

30-60 in Brownish yellow (10YR 6/6, 6/8), reddish yellow (7.5YR 6/6) or yellowish red (5YR 5/6) clay loam to medium clay, dry extremely hard or moist very firm; earthy fabric, with some smooth faces; pH 5.5-6.0. From 5-15% ferruginous concretions and many red, yellow and grey mottles occur. This material contains illuvial clay, has a very slow permeability and often looks like soft laterite.

GREAT SOIL GROUP: Yellow Podzolics
SOIL FAMILY: Florina
SOIL SERIES: 4
NORTHCOTE KEY: Gn2.74
DRAINAGE: Imperfectly or poorly drained
PARENT MATERIAL: Unknown; thought to be fine-grained arenaceous rocks, weathering in low-lying areas under the influence of high rainfall and run-on.

0- 4 in Very dark grey (10YR 3/1) or very dark greyish brown (10YR 3/2) loamy sand or light sandy loam, soft or slightly hard, strongly pulverulent; earthy fabric; pH 5.5-6.0. Sometimes the last horizon is absent and is replaced by weathering fine grained sandstone containing many black mottles.

GREAT SOIL GROUP: Yellow Podzolics
SOIL FAMILY: Douglas
SOIL SERIES: 1
NORTHCOTE KEY: Gn2.74 (Gn2.94, Dy5.81)
DRAINAGE: Imperfectly or very poorly drained
PARENT MATERIAL: Local sandy alluvia or colluvia, or rarely river alluvia. Drainage line or river backplain soils.

0– 6 in Very dark greyish brown (10YR 3/2), dark grey (10YR 4/1) or dark brown (10YR 4/3) sand or loamy sand, rarely sandy loam, loose or soft; sandy/earthy fabric; pH 6.0-7.0.

6–20 in Pale brown (10YR 6/3), yellowish brown (10YR 5/8) or light brown (7.5YR 6/4) bleached A2 horizon of sand or loamy sand, rarely sandy loam, soft or slightly hard; sandy/earthy fabric; pH 6.0-7.0. Faint organic or rusty mottling.

20-40 in Light yellowish brown (10YR 6/4), pale brown (10YR 6/3) or brownish yellow (10YR 6/6) sandy clay loam or light sandy clay, dry hard or moist friable; earthy fabric; pH 5.5-6.5. This horizon is commonly mottled with red, yellow and grey and sometimes contains a few ferruginous concretions.
much illuvial clay is present. The subsoil becomes impermeable between 40 and 70 in.

GREAT SOIL GROUP: Lateritic Podzolics
SOIL FAMILY: Claravale
SOIL SERIES: 1
NORTHCOTE KEY: Uc4.21
DRAINAGE: Moderately well or well drained
PARENT MATERIAL: Probably detrital laterite in association with weathered pallid-zone quartzite (‘billy’).

0–4 in Dark brown (10YR 3/3, 4/3), very dark greyish brown (10YR 3/2) or dark yellowish brown (10YR 3/4) slightly organic loamy sand, soft or loose; sandy/earthy fabric; pH 6.0–6.5. The soil surface may have a 5–10% cover of ferruginous nodules.

4–14 in Brownish yellow (10YR 6/6), yellowish brown (10YR 5/4, 5/6) or pale brown (10YR 6/3) A2 horizon of loamy sand, loose; sandy/earthy fabric; pH 6.0–7.0. From 2–15% ferruginous nodules may occur, the percentage increasing with depth.

14–30 in Yellowish brown (10YR 5/6, 5/8), pale brown (10YR 6/3) or strong brown (7.5YR 5/6) clayey sand or light sandy loam, slightly hard or hard; sandy/earthy fabric; pH 6.0–7.0. The percentage of ferruginous nodules increases to about 40%.

30–60 in Yellowish red (5YR 4/8) clayey sand or light sandy loam with high amounts (50–80%) of ferruginous nodules, and some faint red mottling. This overlies dense gravel or weak vesicular laterite.

Note: A shallow (skeletal) phase of this series occurs frequently in areas dominated geologically by laterite. The shallow phase is very gravelly, with frequent exposures of laterite.
### Jindare Series 1

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**GREAT SOIL GROUP:** Lateritic Podzolics  
**SOIL FAMILY:** Jindare  
**SOIL SERIES:** 1  
**NORTHCOTE KEY:** G2.74 (Dy 5.81)  
**DRAINAGE:** Imperfectly or poorly drained  
**PARENT MATERIAL:** Strongly pre-weathered and ferruginized arenaceous sediments.  
0– 6 in Dark grey (10YR 4/1), very dark greyish brown (10YR 3/2) or dark greyish brown (10YR 4/2) loamy sand to sandy loam, soft or slightly hard; sandy/earthy fabric; pH 6.5. Up to 10% ferruginized nodules. The soil surface may have a 50% cover of these nodules.  
6-20 in Light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4, 5/6) or pale brown (10YR 6/3) bleached A2 horizon of loamy sand to sandy loam, slightly hard or hard; earthy fabric; pH 6.0–6.5. From 15–30% ferruginized nodules.  
20-36 in Yellowish brown (10YR 5/6, 5/8), strong brown (7.5YR 5/6), yellowish red (5YR 5/6) or brownish yellow (10YR 6/6) gravelly light sandy clay loam, slightly hard or hard; earthy fabric; pH 6.0–6.5. Some faint mottling and up to 30% ferruginized nodules.  
36-60 in Yellowish red (5YR 4/6, 4/8, 5/6, 5/8) or strong brown (7.5YR 5/6) gritty sandy clay loam or light clay, dry extremely hard or moist very firm; pH 5.5–6.5. This material is strongly mottled with red and yellow and has all pores clogged with illuvial clay. It is usually impermeable by 60 in.

**Note:** The gravels throughout this soil are very strongly weathered but have a rough platy shape—a relic of the original bedding layers of the parent rocks.

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**GREAT SOIL GROUP:** Lateritic Podzolics  
**SOIL FAMILY:** Jindare  
**SOIL SERIES:** 2  
**NORTHCOTE KEY:** Uc4.21  
**DRAINAGE:** Moderately well drained  
**PARENT MATERIAL:** Partly ferruginized sandstones.  
0– 4 in Dark brown (10YR 4/3, 7.5YR 3/2) or very dark greyish brown (10YR 3/2) sand or loamy sand, loose; sandy/earthy fabric; pH 6.5–7.0. Up to 10% platy case-hardened sandstone gravel, frequently up to 80% on the surface.  
4–14 in Brown (10YR 4/3, 7.5YR 4/4, 5/4) or yellowish red (5YR 4/8) sand or loamy sand A2 horizon, soft; sandy fabric; pH 6.0–6.5. Up to 50% platy case-hardened sandstone gravel, the percentage increasing with depth.  
14–30 in Yellowish brown (10YR 5/6), brown (7.5YR 5/4) or yellowish

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Continued
red (5YR 5/6, 5/8) sand or loamy sand, sandy or sandy/earthy fabric; pH 6.0–6.5. Up to 60% platy sandstone gravel and a few red or yellow mottles. This merges with the parent material.

30 in + Strongly weathered sandstone.

GREAT SOIL GROUP: Gleyed Podzolic Soils
SOIL FAMILY: Marrakai
SOIL SERIES: 1
NORTHCOTE KEY: Gn2.84, .64
DRAINAGE: Poorly drained
PARENT MATERIAL: Local or river alluvia in low-lying (ponded) situations.

0–4 in Dark greyish brown (10YR 4/2), very dark greyish brown (10YR 3/2), dark grey (10YR 4/1) or grey (5Y 5/1) sandy clay loam or clay loam, often silty, hard or very hard; earthy fabric; pH 6.0–6.5. Faint rusty root-line mottling. Pulverulent.

4–18 in Light brownish-grey (2.5Y 6/2), greyish brown (2.5Y 5/2) or yellowish brown (10YR 5/4) unbleached A2 horizon of clay loam or sandy clay, often silty, hard or very hard, pulverulent; earthy fabric; pH 5.5–6.0. Faint or common rusty root-line mottling.

18–40 in Pale brown (10YR 6/3), brownish yellow (10YR 6/8) or yellowish brown (10YR 5/4) clay loam to light clay or sandy clay, very hard, earthy fabric; pH 5.5–6.0. Common red, brown and grey mottles.

40–60 in

Yellowish brown (10YR 5/6), brownish yellow (10YR 6/8) or light brown (7.5YR 6/4) clay loam to light clay or sandy clay, very hard or extremely hard; earthy fabric; pH 5.5–6.0. Common or many red, brown and pale grey mottles. This horizon becomes an impermeable hardpan.

36–60 in

Light yellowish brown (10YR 6/4), brown (10YR 4/3, 7.5YR 5/1) or yellowish brown (10YR 5/6) silty light to medium clay, dry extremely hard or moist very firm; earthy or smooth-ped fabric; pH 6.0–7.0. Common to many brown, pale grey and black mottles.

GREAT SOIL GROUP: Grey, Brown and Red Clays
SOIL FAMILY: Cununurra
SOIL SERIES: 1
NORTHCOTE KEY: Ug5.28 (.27)
DRAINAGE: Imperfectly or poorly drained
PARENT MATERIAL: Basalt or other basic fine-textured rock, or transported weathering products of these rocks.

0–4 in Dark grey (10YR 4/1), very dark greyish brown (10YR 3/2) or brown (10YR 4/3, 7.5YR 3/2) silty loam to silty clay loam, slightly hard or hard; earthy fabric; pH 6.0–6.5. Some rusty root-line mottling. Pulverulent.

4–14 in

Yellowish brown (10YR 5/4, 5/6), greyish brown (10YR 5/2) or brown (10YR 4/3, 7.5YR 5/4) unbleached A2 horizon of loam to silty clay loam, hard or very hard; earthy fabric with some smooth faces; pH 5.5–6.0. Common rusty root-line and light olive mottles. Pulverulent.

Continued
moist firm; earthy or smooth-ped fabric; pH 6.0–7.5; granular or fine blocky structure ('self-mulching'). Some (5%) secondary carbonate nodules, and some manganiferous concretions.

**4-14 in** Dark greyish brown (2.5Y 4/2), very dark greyish brown (2.5Y 3/2) or very dark grey (5Y 3/1) silty medium or heavy clay, dry very hard or moist extremely firm; smooth-ped fabric; pH 7.5–8.5. Weak blocky structure, and up to 5% secondary carbonate nodules. Some manganiferous concretions.

**14-36 in** Dark greyish brown (2.5Y 4/2), dark grey (10YR 4/1) or dark olive grey (5Y 3/2) silty medium to heavy clay, dry extremely hard or moist extremely firm; smooth-ped fabric; pH 8.5–9.5. Up to 5% secondary carbonate nodules and sometimes fine amorphous carbonate.

**36–60 in** Dark greyish brown (2.5Y 4/2), olive grey (5Y 4/2) or yellowish brown (10YR 5/4) silty medium or heavy clay, dry extremely hard or moist extremely firm; smooth-ped fabric; pH 8.5–10.0. Up to 25% secondary carbonate which often forms a dense pan, and some fine amorphous carbonate which may impart a very pale colour to the sub-soil. Fragments of country rock are often encountered by 60 in.

**GREAT SOIL GROUP:** Grey, Brown, and Red Clays.

**SOIL FAMILY:** Cununurra.

**SOIL SERIES:** 2.

**NORTHCOTE KEY:** UgS.34.

**DRAINAGE:** Poorly drained.

**PARENT MATERIAL:** Basalt or other basic fine-textured rock, or transported weathering products of these rocks. Very few of these soils have been recorded.

**0–4 in** Very dark greyish brown (10YR 3/2) or dark brown (10YR 3/3, 3/4) silty medium clay, dry hard or moist firm; earthy or smooth-ped fabric; pH 6.0–7.5; granular or weak blocky structure ('self-mulching'). Some manganiferous concretions.

**4–14 in** Brown (10YR 4/3) or dark brown (10YR 3/3) silty medium or heavy clay, dry very hard or moist extremely firm; earthy or smooth-ped fabric; pH 6.0–7.5. May have a weak blocky structure. Some manganiferous concretions.

**14–36 in** Brown (10YR 4/3) or dark brown (10YR 3/3) silty medium or heavy clay, dry extremely hard or moist extremely firm; smooth-ped fabric; pH 6.0–7.5. A few (1–2%) carbonate nodules and some manganiferous concretions may occur in the lower parts.

**GREAT SOIL GROUP:** Grey, Brown, and Red Clays.

**SOIL FAMILY:** Banyan.

**SOIL SERIES:** 1.

**NORTHCOTE KEY:** UgS.59.

**DRAINAGE:** Very poorly drained.

**PARENT MATERIAL:** River alluvia or fine textured basic rocks.

**0–4 in** Black (SY 2/1), very dark greyish brown (10YR 3/2) or dark greyish brown (10YR 4/2) silty medium or heavy clay, earthy fabric; massive; pH 6.0–6.5. Some manganiferous concretions and secondary carbonate nodules and some rusty mottling.

**4–14 in** Dark greyish brown (2.5Y 4/2, 10YR 4/2) or black (2.5Y 2/1) silty medium or heavy clay, smooth-ped fabric; pH 6.5–7.5. Some manganiferous concretions and secondary carbonate nodules, and few yellowish mottles.

**14–40 in** Dark greyish brown (2.5Y 4/2, 10YR 4/2) light olive brown (2.5Y 5/4) or yellowish brown (10YR 5/4) medium or heavy clay, smooth-ped fabric; pH 8.5–9.0. Up to 5% secondary carbonate nodules and some manganiferous concretions.

Continued
Common small yellow and grey mottles.

40–60 in Dark greyish brown (10YR 4/2), light olive brown (2.5Y 5/4) or yellowish brown (10YR 5/6) heavy clay, smooth-ped fabric; pH 8.0–8.5. Some secondary carbonate nodules and manganiferous concretions. Country rock may be encountered before 60 in.

GREAT SOIL GROUP: Grey, Brown, and Red Clays
SOIL FAMILY: Banyan
SOIL SERIES: 3
NORTHCOTE KEY: Ug5.62 (.59)
DRAINAGE: Poorly or imperfectly drained
PARENT MATERIAL: River alluvia; these are backplain soils.

0–4 in Very dark grey (10YR 3/1), very dark greyish brown (10YR 3/2) or sometimes black (10YR 2/1) silty clay loam to medium clay, hard or very hard; earthy fabric; pH 6.0–6.5. Smooth micro-relief. Some profiles have a thin granular surface layer.

4–14 in Very dark grey (10YR 3/1) or very dark greyish brown (10YR 3/2) silty medium to heavy clay, extremely hard; earthy or smooth-ped fabric, sometimes weakly structured; pH 6.5–7.0. Some secondary carbonate nodules and occasional yellow mottles.

14–40 in Very dark greyish brown (2.5Y 3/2, 10YR 3/2), dark greyish brown (2.5Y 4/2, 10YR 4/2) or dark brown (7.5YR 4/4) medium to heavy clay, dry extremely light yellowish brown (10YR 6/4) silty heavy clay, moist extremely firm; pH 5.5–7.0. Commonly mottled with black, olive and grey. Some manganiferous concretions.
hard or moist extremely firm; 
earthly or smooth-ped fabric; 
pH 7.5–8.5. Common secondary 
carbonate nodules, man-
 ganiferous concretions and 
common red, yellow and grey 
mottles.

40–60 in Very dark greyish brown (2.5Y 
3/2, 10YR 3/2), dark brown 
(7.5YR 3/2) or reddish brown 
(5YR 4/4) medium to heavy 
clay, dry extremely hard or 
moist extremely firm; earthy or 
smooth-ped fabric; pH 7.5–9.0.
Calcareaeous.

18–40 in Greyish brown (10YR 5/2), 
dark greyish brown (10YR 4/2) 
or yellowish brown (10YR 5/6, 
5/4) light clay or silty clay 
loam, very hard or moist very 
firm; earthy fabric; pH 8.5–9.0. 
Calcareaeous.

40–60 in Greyish brown (10YR 5/2) or 
yellowish brown (10YR 5/4, 
5/6) light or medium clay, hard 
or moist firm; earthy fabric; 
pH 8.5–9.0. Calcareaeous. 
Common pale brown or reddish 
mottles and abundant secondary 
carbonate. Permeability is very 
slow.

GREAT SOIL GROUP: Rendzinas 
SOIL FAMILY: Phillips 
SOIL SERIES: 1 
NORTHCOTE KEY: Gc2.21 
DRAINAGE: Poorly or imperfectly drained 
PARENT MATERIAL: Soft limestones or other 
soft calcareous deposits; secondary resid-
ual calcareous material at seepage points 
or calcareous alluvia/colluvia in drainage 
lines.

0–8 in Black (2.5Y 2/0, 10YR 2/1) or 
very dark grey (10YR 3/1) 
organic clay loam or light to 
medium clay, often silty, very 
hard; fine blocky structure 
('self-mulching'), smooth-ped or 
earthly fabric; pH 8.5–9.0. 
Calcareaeous.

0–6 in Black (2.5Y 2/0, 10YR 2/1) or 
very dark grey (10YR 3/1) 
organic clay loam to medium 
clay, hard or very hard; some-
times weakly structured; earthy 
fabric; pH 6.0–6.5.

6–14 in Black (10YR 2/1), very dark 
grey (10YR 3/1), very dark 
greyish brown (10YR 3/2) or 
dark brown (10YR 3/3) medium 
to heavy clay, very hard or 
extremely hard; sometimes 
weakly structured; earthy 
fabric; pH 6.0–7.5. Some 
yellow mottles.

14–30 in Dark greyish brown (2.5Y 4/2, 
10YR 4/2), yellowish brown 
(10YR 5/4, 5/8) or light yellow-
ish brown (2.5Y 6/4) light to 
medium clay, very hard to 
extremely hard; earthy fabric; 
pH 7.0–8.5. Common yellow 
or reddish mottles.

30–50 in Yellowish brown (10YR 5/6, 
5/8), pale brown (10YR 6/3) or 
very pale brown (10YR 7/3) 
light clay, hard or very hard or 
moist firm; earthy fabric; pH 
7.5–9.0; often calcareaeous. 
Common or many yellow or 
reddish mottles.

50–60 in Yellowish brown (10YR 5/4), 
light olive brown (2.5Y 5/6) or 
dark brown (7.5YR 4/4) light 
clay, hard or moist firm, cal-
careaeous; earthy fabric; pH 8.0– 
9.0. Many reddish or yellowish 
mottles. This may be underlain 
by lumps of secondary carbon-
ate or a buried soil.
APPENDIX III

Vegetation classification

The classification of the vegetation of the Daly Basin as proposed in this report differs significantly from that in the CSIRO report of the Lands of the Tipperary Area, 1961. There are two reasons for this. First the system proposed here follows more closely that suggested for the mapping of vegetation in Australia and uses the two parameters, height and canopy cover, instead of height and tree shape as proposed by CSIRO. Secondly these two parameters, height and canopy can be distinguished on aerial photographs whereas tree shape cannot. There is the additional justification that the present proposed terms are more likely to be understood by a greater number of people.

The use of the term open forest has been restricted to those communities with trees taller than 50 ft and canopies greater than 30%. The term woodland is restricted to communities of 35–50 ft in height and canopies of 10–30%. Low woodland is 25–35 ft in height with the same canopy range, whereas low open woodland has a canopy of less than 10%. The use of the term savannah woodland has been discontinued since it is considered confusing. Savannah could legitimately be applied to low open woodland communities.

The inclusion of subordinate shrub layers is justified on descriptive grounds and because they can be discerned on aerial photographs.

The present system of classification incorporates the basic life form of the herbaceous layer in contrast to the system of CSIRO which treated trees and grasses as two distinct entities. Although this inclusion of the herbaceous layer leads to the formation of many more vegetation classes, it is considered that the combination is a better indication of the ecological status of an area than either one or the other.

Descriptions of the vegetation classes follow according to strict analysis of results. Reference should be made to the key to the species. Italics signify greatest frequency of occurrence (though not necessarily actual dominance); parentheses signify occasional occurrence.

O Fa: Open forest with Spinifex and/or annual Sorghum—

50–65 ft (75 ft) *Ete Emm* (Ebl)
35–50 ft *ERch Tgr Efo*
25–35 ft (OWve) (Efe)
<25 ft *PEqu ERel PLca (PAz)*
(BUob) (ACzz)
3–6 ft *SOan PLpu HEtr SEn CHla (SOpl) (PAju)*

O Fp: Open forest with dominant perennial grasses—

70–80 ft *Ete Emm*
50–70 ft *ERch Tgr Efo*
35–50 ft (Tgr Efo (Etc)
25–35 ft *ERel PEqu PLca (Tfe)*
<25 ft *SEne CHla SOpl SOan HEtr THau*

W–OF S/a: Woodland to open forest with well-developed shrub layer and annual Sorghum and Spinifex—

50–70 ft *Ete Emm*
35–50 ft *ERch Tgr Ebl Efo*
25–35 ft *ACzz (OWve)*
<25 ft *PEqu ACzz PLca PAz (ERel)*
(BUob) (GAm) (ALE)
(LIhu) (PAz) (ERel)
(LIhu) (PAz) (ERel)

3–6 ft *SOan PLpu HEtr PAju*
<25 ft  BAcu*  PEqu  HAar  ERel  PLca  BRpa  PAz
3– 6 ft  SOan  SEn e  HEtr  HEco  SOpl  CHla

LOWP: Low open woodland with perennial grasses—
25–35 ft  Etc  Efo  Eco  Egr  (Ela)
<25 ft  GAme  BRpa  (Tfe)  (HAar)
3– 6 ft  SEn e  THau  CHla  SOpl  HEco  (SOan)  (HEtr)

TSA: Tall shrubland with annual grasses—
25–35 ft  Etc  Ela  Eco  (Ete)
<25 ft  PEqu  GRhe  ERch  Tfe  Tca
3– 6 ft  SOpl  SEn e  (THau)  (CHla)  (SOan)

LOWa: Low open woodland with annual Sorghum and/or Spinifex—
25–35 ft  Etc  Egra  Eal  Efo  Ete  ERch
<25 ft  PEqu  ACzz  BUob  Tfe  (OWve)  (GAme)  (Tca)  (PAz)  (GRhe)
3– 6 ft  SOan  PLpu  HEtr

LOWp: Low open woodland with perennial grasses—
25–35 ft  Etc  Efo  Eco  Egr  (Ela)
<25 ft  GAme  BRpa  (Tfe)  (HAar)
3– 6 ft  SEn e  THau  CHla  SOpl  HEco  (SOan)  (HEtr)

LOW/Wp: Low woodland with perennial grasses—
35–50 ft  Ete  ERch  Egc  (Eal)
<25 ft  Efo  ERch  Egc  (Eal)
3– 6 ft  EGC  HEtr  (SOan)

LOWa: Low open woodland with annual Sorghum and/or Spinifex—
25–35 ft  Etc  Egra  Eal  Efo  Ete  ERch
<25 ft  GRhe  ERel
Species named in classification of vegetation with abbreviations and common names where appropriate—

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<th>Abbreviation</th>
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<td>S O pl</td>
<td>Sorghum plamosum</td>
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<tr>
<td>THau</td>
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</table>

Wattles, Bauhinia, Kurrajong, White Cedar, Kapok, Ironwood, Kerosene Wood, Salmon Gum, Bloodwood, Cabbage Gum, Bloodwood, Cabbage Gum, Woolly Butt, Broad-leaf Box, Ghost Gum, Grey Box, Swamp Bloodwood, Grey Box, Stringy bark, Messmate, Cooliman, Fan Palm, Sand Palm or Fire Palm, Paperbark, Emu Apple, Screw Palm, Quinine Bush, Rosewood, Billygoat Plum, Black Spear Grass, Spinifex, White Grass, Perennial Sorghum, Kangaroo Grass

¹ Taxonomic investigations have recently revealed this species to be Grevillea decurrens.