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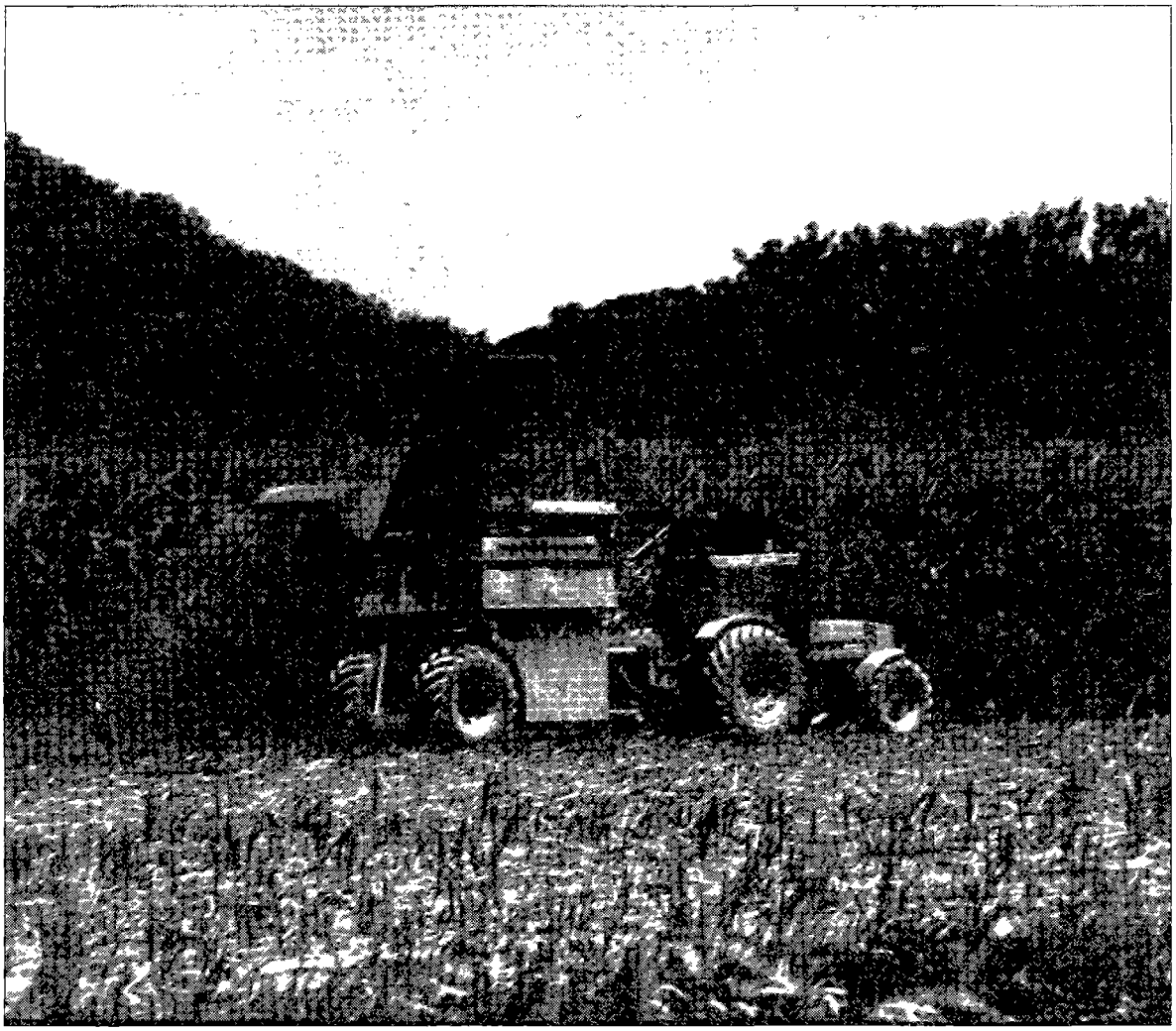

DIVISION OF SOILS Divisional Report No 115

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INDEX TO SOIL SERIES AND MAP UNIT DESCRIPTIONS

* The superscript indicates the survey in which the series was first identified. [1] Murtha, G.G. (1975). [2] Murtha, G.G. (1986). [3] Wilson, P. (1990). [4] Holz, G.K. (1985). [5] Murtha, G.G. (1989).

SOILS OF THE CARDWELL-TULLY AREA, NORTH QUEENSLAND

M.G. Cannon[1], C.D. Smith[2] and G.G. Murtha[1]

Abstract

The Cardwell-Tully area is located at approximately latitude 18°30'S and longtitude 146°E. It is the southern most section of what is locally referred to as the 'wet tropical coast of north Queensland'. Mean annual rainfall ranges from approximately 2000 mm to 4500 mm and has a pronounced summer dominance.

A soil survey at 1:50 000 scale has been conducted over an area of about 120 000 ha. Fifty-three soil series have been recognized and characterised in terms of their field morphology and major chemical and physical properties. The mapping units are associations of soil series.

The soils of the area are formed dominantly on granites and acid volcanics, some minor basalt flows, and on mixed alluvium derived from these parent materials. Topography ranges from precipitous mountains to level depositional plains. The depositional surfaces range from very extensive low angle fans to riverine and marine plains and extensive beach ridge systems.

The upland soils exhibit many properties characteristic of the soils of the humid tropics such as thick sola or very deeply weathered saprolite, freely draining and friable, acid reaction and low base status. The lowland soils are much more diverse but profile wetness, which is usually site dependent is the major factor influencing soil morphology.

There is a pronounced rainfall gradient increasing from south to north with a corresponding lowering of the base status of the soils.

GENERAL INFORMATION AND GUIDE TO THE SOILS

INTRODUCTION

This report covers an area of 120 000 ha on the eastern side of the Cardwell Range to the southern bank of the Tully River, including the Tully River valley to Cardstone (Fig. 1). The survey was undertaken to provide maps at 1:50 000 scale by a free survey technique. Colour aerial photographs taken in August 1981 at approximately 1:30 000 scale were used as the major aid in map unit

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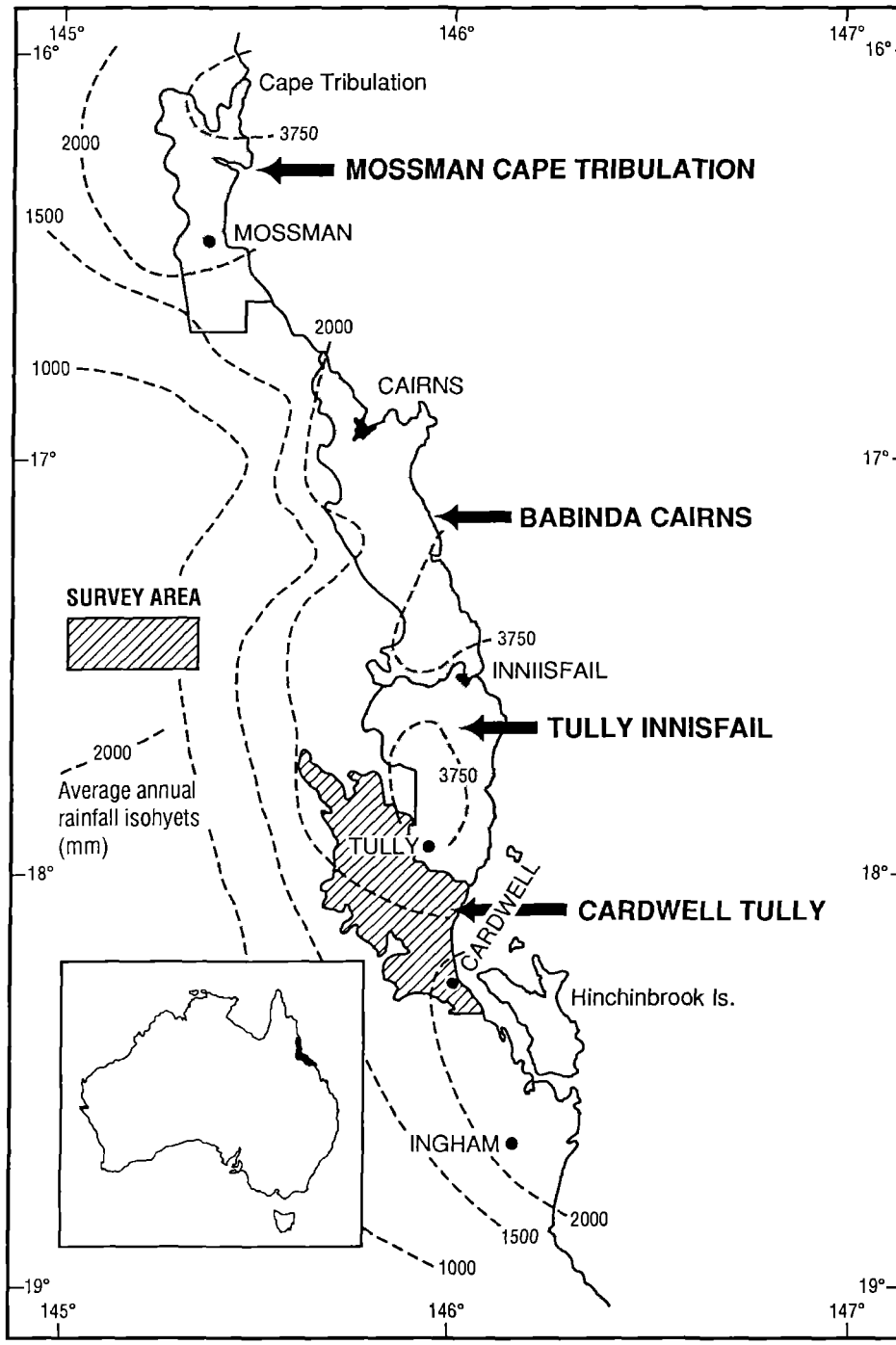


Figure 1. Locality plan.

delineation. Monochromatic aerial photographs taken in 1961 at approximately 1:80 000 scale were also used. Over large areas this older photography reflected the original vegetation patterns and was of considerable assistance in the soil mapping.

Previous soils information from the area is limited Teakle (1950) described and analysed a number of profiles, Isbell *et al.* (1968), and Isbell and Murtha (1970) produced reconnaissance soil maps with map unit descriptions only, while Murtha (1986) and Wilson (1990) published maps at soil series level and a detailed morphological and chemical characterisation of the soils of adjoining areas.

Topography ranges from precipitous mountains to level depositional plains. The depositional surfaces range from very extensive low angle fans to riverine and marine plains and extensive beach ridge systems. There is little access to the mountainous lands and these have been mapped only on the basis of geology. Unlike the survey to the north, in this area much of the potentially agricultural land (lands of < 30% slope) is relatively undisturbed. It was thus possible to sample most soils from virgin sites. The sample sites from which data is reported are located on the soil map. Where possible, sample sites were located to ensure the maximum possibility of retention for future reference.

Large areas of the coastal lowland country to the east of the Bruce Highway north of Cardwell and some other minor areas, were inaccessible at the time of this survey. These are outlined on a reliability map (Fig. 2). In these areas map units have been delineated and interpreted on the basis of photo pattern with little or no ground truth.

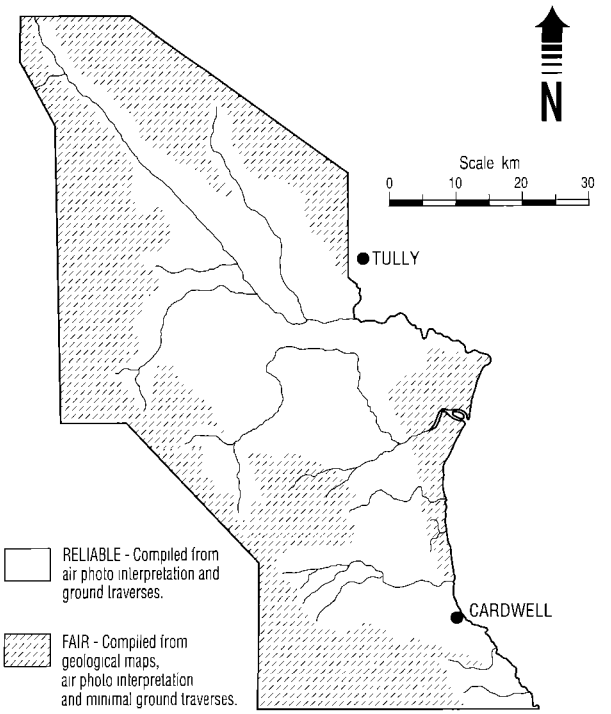


Figure 2. Survey Reliability

PHYSICAL ENVIRONMENT

Climate

The climate is characterised by very humid summers and mild, relatively dry winters. Rainfall is concentrated in the period October to March. There is a strongly declining rainfall gradient from north to south, particularly evident near the Murray River as shown by the station records (Fig. 3). The two main weather stations are Tully with mean rainfall of 4287 mm with 151 wet days, and Cardwell (2127 mm with 135 wet days). The highest annual rainfalls recorded are Tully 7800 mm, Cardwell 4300 mm and the lowest 2450 mm and 900 mm respectively. At Cardwell, mean monthly temperatures range from 14°C in June to 31°C in December, the lowest recorded is 1°C in July and the highest 43°C in February; light frosts are not uncommon in the upper Tully, Murray, and Kennedy Valleys. While estimated pan evaporation rarely exceeds rainfall, irrigation is necessary for some crops and on some soils.

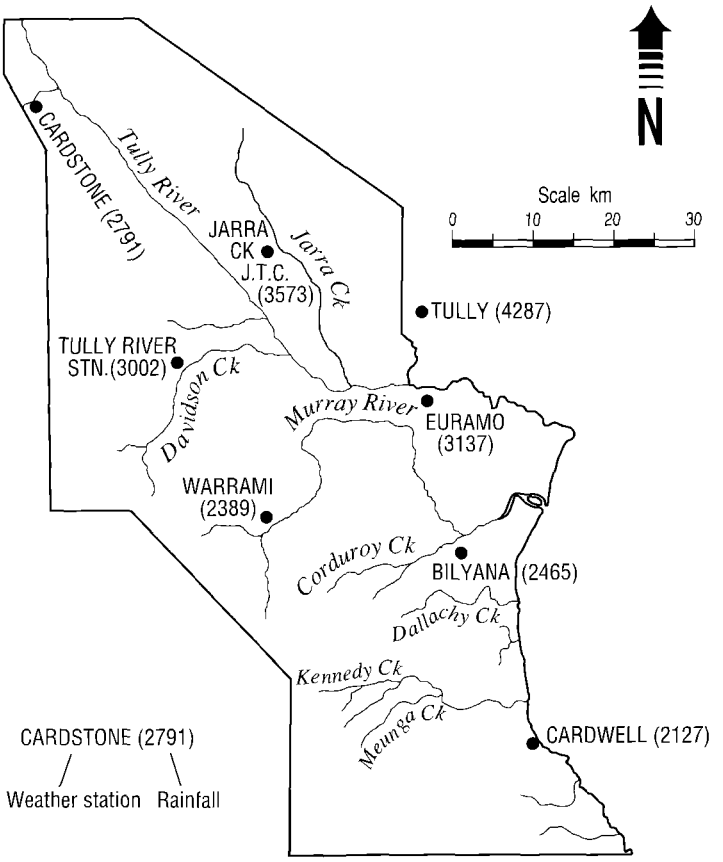


Figure 3. Drainage systems and rainfall stations with mean annual totals in mm.

Geology and Geomorphology

The Ingham (De Keyser *et al.* 1972) and Innisfail (De Keyser 1964), 1:250 000 geological series cover the survey area. The upper Carboniferous Glen Gordon Volcanics of mainly pink and grey rhyolite, dacite, some andesite and agglomerate have been intruded by an upper palaeozoic granite complex which forms the Cardwell Range south of the Tully River. As a consequence, the coalescing fans along the base of the Cardwell Range are formed from a mixture of parent materials but are dominantly fine textured deposits. South of Cardwell these fans are being incised by streams which run with little deviation to the present coastline. The Table Top and Walter Hill Ranges to the north of the Tully River are formed from the Tully Granite complex, which is characteristically coarse grained.

Several cainozoic basaltic flows overlie the Tully Granite, and remnants of these flows are found in the Tully River and Cochable Creek gorges. Only one soil of basaltic origin has been mapped, although many of the fans derived from the Table Top and Walter Hill Ranges are of mixed basaltic and granitic origin. A diorite dyke has probably formed the distinctive strongly structured soils (Dingo series) on part of the low hills of Dingo Pocket.

An extensive uniformly sloping (< 2%) landform extends from the base of the Kirrama Range between Davidson Creek in the northwest to Kennedy in the south. This landform has been interpreted as a 'sheet flood fan' of McDonald *et al.* (1984). The fans may extend up to 15 km from their assumed source, and abut the riverine alluvium or beach ridge plains. The soils have a generally fine gravelly nature, but coarse gravelly deposits in the form of prior streams or infill channels are common. To the south of Cardwell the coastal plain is very narrow and consists almost entirely of coalescing fans. It is drained by numerous short streams which deeply dissect the fans and have narrow deep channels through the extensive littoral zone.

North of Cardwell the stream pattern is complex. The Tully and Murray Rivers are the major distributaries and for most of their lower course share a common alluvial plain. This is obviously a very active alluvial system and there are numerous examples of stream capture and diversion; for example, the lower course of the Murray River is an old distributory of the Tully River. The deposits are characterised by high levels of silt and fine sand. Quaternary beach ridges (some up to 10 km inland from the present coastline) have formed a physical barrier between the streams and the ocean. Several streams terminate in deltas which form where they discharge in the extensive swamps developed to the rear of or between the beach ridges. Isolated lagoons in the beach ridge plains mark where past rivers and streams have cut through to former coastlines.

Many of the landforms in this survey area are very similar to those further north and this will be dealt with in more detail in a future paper on the geomorphology of the whole of the wet coast.

Hydrology

The major rivers and streams are shown on Figure 3.

(a) Surface hydrology

(i) Kennedy Creek to Tully River. The Tully River and its tributaries combine with the Murray River to regularly flood an extensive section of the coastal plain between Bilyana and Tully (see Cardwell Shire Flood Management Study Report 1983). The rivers and associated streams are poorly incised and lack major levee development. The monsoonal rains provide a regular potential for prolonged flooding. A chenier plain of extensive swamp and freshwater marsh runs almost unbroken amongst the beach ridges from the Tully River to Kennedy Creek. This plain helps contain much of the flood waters and is a crucial breeding habitat for marine and birdlife. It represents the only significant vegetated example of this landform on the wet tropical coast.

Dallachy and Whitfield Creeks lack a defined drainage line where they enter the chernier plain and their present mouths are now marked by tidal inlets.

(ii) Meunga Creek to Sunday Creek. Meunga Creek is the first of many relatively deeply incised channels that run directly to the sea from the Cardwell Range over the narrow coastal plain. Overbank flooding is of short duration and most streams are seasonal. Seasonal flows have been sufficiently intensive however to have deposited substantial volumes of cobble and boulders, a feature common to many of the soils of this 'southern' area. There is little levee development and only minor channel bench development of dominantly finer deposits where the streams enter the tidal zone.

(b) Subsurface hydrology

The alluvial plain of the Tully and Murray Rivers is the only substantial source of underground water suitable for irrigation. No worthwhile supplies have been found to the south and any future expansion of irrigated crops from Bilyana to Cardwell will need the establishment of surface storage facilities on Meunga and/or Kennedy Creeks. Recent increases in the use of surface and subsurface water for both town and agricultural needs have already brought about restrictions. Water quality would appear to be good although supplies drawn near the coast could have tidal as well as seasonal restrictions.

Vegetation

The vegetation of the area has been described by Tracey (1982). The area has an extremely diverse group of communities due largely to varying rainfall and soil hydrology. Nutrient levels may have some effect, but within the survey area only the southern 'drier' section and the minor basalt units vary from the generally poor naturally occurring levels of soil nutrients.

The vegetation of the mountainous regions is mainly closed vine forest or rainforest in wetter parts with open sclerophyll forests in the drier parts or on very freely draining steeper ridges. Common species of the open forest include narrow-leafed ironbark (*Eucalyptus drepanophylla*), yellow stringybark (*E. acmenoides*) and less commonly flooded gum (*E. grandis*), Gympie messmate (*E. cloeziana*) and Cadaghi (*E. torrelliana*). The well drained lower slopes and fans have open forests of narrow-leafed ironbark, poplar gum (*Eucalyptus alba*), grey bloodwood (*E. intermedia*), Moreton Bay ash (*E. tesselaris*) and blue gum (*E. tereticornis*). The wetter swampy areas contain swamp mahogany (*Lophostemon suaveolens*), several tea trees (*Melaleuca viridiflora, M. leucadendron, M. quinquenervia, M. dealbata*) and turpentine (*Syncarpia glomulifera*). Common understorey species include forest oak (*Casuarina torulosa*), she oak (*C. littoralis*), pandanus species and wattles (*Acacia aulacocarpa, A. mangium*).

The majority of the broader alluvial plains of the area have been cleared, but some lowland rainforest and palm forests remain adjacent to extensive freshwater swamps. Guava (*Psidium guajava*), wattles (*Acacia* species), and tea trees (*Melaleuca* species) are the dominant regenerative species. The Bellenden Plains which were devoid of trees when Europeans arrived, are now rapidly being overgrown with guava. Blady grass (*Imperata cylindrica*) and guinea grass (*Panicum maximum*) invade the better drained coastal plains and foothills. Para grass (*Brachiaria mutica*) rapidly colonizes the poorly drained sites and is a constant pest of waterways and drains.

The most common surviving tree species on cleared lowland areas are blue gum, Moreton Bay ash, poplar gum and yellow stringybark. The drainage lines and old meander channels are lined by Leichardt pine (*Nauclea orientalis*) and Melaleuca species.

Extensive tall open to closed forests dominanted by red stringybark (*Eucalyptus pellita*) and grey bloodwood (*E. intermedia*), with a wattle dominant understorey occur on the well drained beach ridges. Banksias, Xanthorrhoea and Casuarina occur sporadically throughout the ridges. On the poorly drained sands the communities range from tall tea tree and swamp mahogany to depauperate tea tree, reed swamps and sedges. Limited discussion on soil series-vegetation relationships is given in the individual series descriptions.

LAND USE

There are five major agricultural land use activities in the survey area. These are (i) sugar cane,, (ii) bananas, (iii) small crops, (iv) grazing, and (v) forestry.

(i) Sugarcane dominates the mid to lower Tully River levees and back plains with a few assignments on the Murray River flats. Approximately 4000 ha of Tully Mill's 13 862 ha of assigned area is located in the study area. The crop is grown on a diversity of soils. Drainage and fertilizer are the major costs in achieving viable productivity.

(ii) Approximately 1900 ha of bananas are grown in the study area, mainly adjacent to permanent streams. The largest plantations occur on the Tully River levees. Bananas require a well

drained soil without excessive flooding. Future expansion may include the use of granitic fan soils where irrigation and nutritional management will be more demanding.

(iii) Pumpkins and watermelons are the major small crops grown and are produced as a subsidiary crop on most farms. Pineapples are grown in the Bilyana area mainly for local consumption.

(iv) Beef production from improved grass/legume pastures is carried out on approximately 20 000 ha within the study area. The major grass species used are guinea and hamil (*Panicum maximum* cultivars), signal grass (*Brachiaria decumbens*) and para (*Brachiaria mutica*). Legumes used are *Centrosema pubescens*, *Pueraria phaseoloides* and *Stylosanthes guianensis*.

(v) The timber industry has experienced a decline in recent years with a decreasing supply of both cabinet and hardwood timber due in part to the inclusion of large areas in the World Heritage Estate. Extensive exotic softwood plantations near Cardwell could be expanded to meet some of the future demand although soil and topography restraints will limit this expansion. Small farm plots do exist, but no substantial use of private land for timber production has been undertaken.

While there is a diversity of crops able to be grown in the region, at present sugar cane is better adapted to the less well drained soils in the high rainfall areas of the region than most other crops. The drier southern section of the study area offers greater opportunity for crop diversification. Details on crop suitability and the various soil limitations are given by Smith *et al.* (in press).

SOILS

Soil Series

The basis for establishment of a soil series is the definition in the revision of the Soil Survey Manual (Soil Survey Staff 1980). Briefly, a series is a group of soils having horizons with essentially similar properties, arrangement in the profile and developed from similar parent materials. Factors such as significance in land use and ease of recognition and distinction from similar soils were also important criteria in the establishment of series. Forty-three of the fifty-three series described here were established in other survey areas. Correlation between surveys has allowed the retention of the original series central concept although those morphological characteristics more common to this survey are highlighted. Chemical analyses have been carried out on selected profiles but data from one profile only is presented here. Some of the soil series of minor occurrence were not sampled. The data from all profiles sampled in the areas covered by of the wet coast surveys is recorded in Technical Memorandum No. 2/92 (Murtha ,G.G. and Cannon, M.G.)*

The soil series and mapping associations described in this report are listed in the Index. The soil series have been placed in six of the groupings used in the Tully-Innisfail area report (Murtha

* Murtha, G.G. and Cannon, M.G. (1992). Morphology and chemistry of soils sampled from Cardwell to Cape Tribulation north Queensland (available on request from authors).

1986). The groups are based on parent material and/or drainage status and serve as a simplified soil map depicting soils with generally similar agronomic properties (Fig. 4).

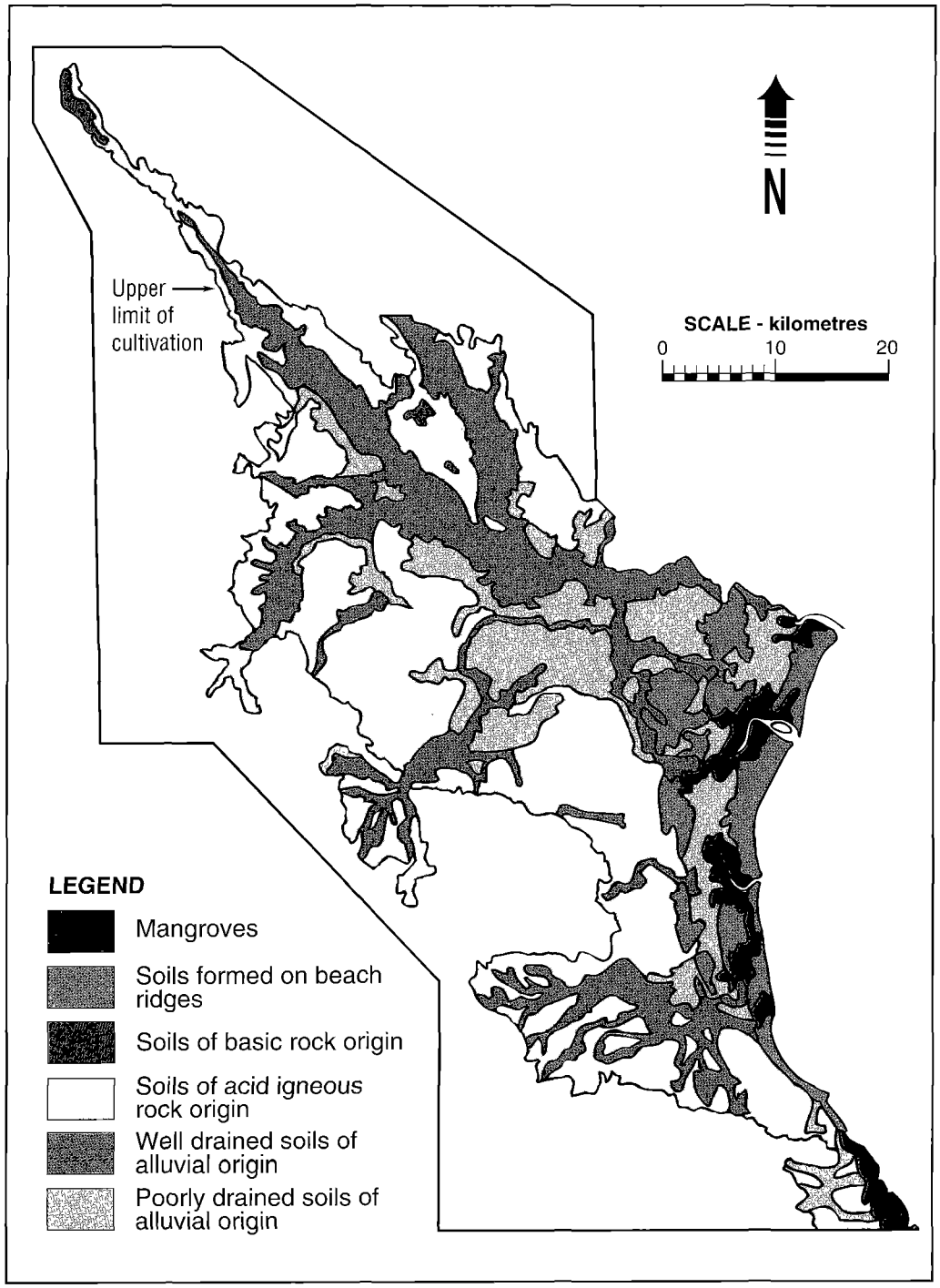


Figure 4. Generalised soil map.

Map Units

The map units are associations of soil series and have been named after the dominant soil series. Unit purity varies considerably between unique map areas (UMA). Some of this variability is due to the difficulty of boundary delineation in cropped land (particularly pasture and sugar cane) where cultural practices can mask all evidence of soil boundaries. More commonly, many soil series form part of a continuum in which soil changes are subtle and it is very difficult to delineate soil boundaries accurately at the map scale.

Use of Symbols

In an attempt to improve interpretation of the map, a system of single and multiple symbols has been adopted. For instance in Tully association there are areas which are almost pure Tully series - these are labelled Tu. Other areas may have Tully and Liverpool series as co-dominants - these are labelled Tu-Li or Li-Tu respectively. Two series in particular show a transition from one to the other rather than co-dominance. Canoe series is a soil with a yellow massive sandy B horizon and this grades to Tully series which has a yellow structured silty B horizon. An acute has been used to show this transition eg. Cn/Tu. In addition, all these symbols may appear in the one UMA. The approximate position of prior streams and infilled channels is shown by dark purple lines. In the more intricate patterns, it is not possible to depict all the prior streams.

A key to the soil series of this survey area follows, it is intended as a guide only and users should consult Tables 1-5 or the map reference when no apparent match can be made.

KEY TO THE SOIL SERIES OF THE CARDWELL-TULLY SURVEY AREA

This key is designed to assist in the identification of soils at any point inspection. Users should note that many soils, and particularly those adjacent to soil boundaries, may not exhibit all the defined properties of a particular series and many soils may appear to partly fulfil the criteria for more than one soil series. Many soil boundaries are very diffuse and the soils in these marginal areas will grade from one soil to another and have some properties common to both. Such soils are regarded as intergrades.

Operation of the Key

To use this key in the field the following steps must be taken:

(i) Expose the soil profile to at least the B horizon, or D or C where there is no B horizon present.

(ii) The moist matrix colour of the B, or C or D (where B is not present) is to be used as opposed to the mottle colour. Only 5 colours are to be used - black, brown, red, yellow and grey/gley. The

Munsell colour charts may be used as a guide but a simple colour grouping as above may be used when these charts are unavailable.

(iii) Key is entered at level 1 and then followed through until the soil series name is established. The same series may occur at more than one level in the key.

1. (a) Soil A or B horizons contain hard ironstone nodules - Feluga series.
   (b) Fibric peat > 1 m-Nind series.
   (c) Non-fibric or sapric peat < .5 m-Bulguru series.
   (d) B horizon contains angular to subangular quartzitic gravels (≥ 2 mm) - go to 2.
   (e) B horizon has subrounded to rounded quartzitic gravels (≥2 mm) - go to 9.
   (f) B horizon has no appreciable quartzitic gravels (≥ 2mm) - go to 20.
2. (a) B horizon is massive (no readily observed soil aggregates) - go to 3.
   (b) B horizon is structured (readily observed soil aggregates) - go to 7.
3. (a) B horizon is red in colour - go to 4.
   (b) B horizon is yellow in colour - go to 5.
   (c) B horizon is grey/gley in colour - go to 6.
4. (a) A horizon is dark both moist and dry to a depth of ≥ 20 cm - Alma series.
   (b) Vegetation is/was dry sclerophyll dominant - Hillview series.
   (c) Vegetation is/was rainforest dominant - Tyson series.
5. (a) A horizon is dark (both moist and dry) to a depth of ≥ 20 cm - Kirrama series.
   (b) B horizon is whole coloured to a depth of ≅ 90 cm - Thorpe series.
   (c) Other - Prior series.
6. (a) Dark medium to heavy clay with seasonally cracking surface and coarse sand to sandy clay loam D horizon - Warrami series.
   (b) Dark medium to heavy clay with seasonally cracking surface and clay B horizon - Derra series.
   (c) Humic to organic surface - Banyan series.
   (d) Whole coloured to a depth of ≅ 90 cm - Lugger series.
   (e) Duplex texture profile i.e. sharp texture break from A to B horizon - Rungoo series.
   (f) Other - Malbon series.
7. (a) B horizon is red - go to 8.
   (b) B horizon is yellow - Elphinstone series.
   (c) B horizon is grey/gleyed - Rungoo series.
8. (a) A2 present - Cadillah series.
   (b) Other - Utchee series.
9. (a) B horizon is massive (no readily observed soil aggregates) - go to 10.
   (b) B horizon is structured (readily observed soil aggregates) - go to 18.
10. (a) B horizon is red - go to 11.
    (b) B horizon is yellow - go to 12

(c) B horizon is brown - go to 15

(d) B horizon is grey/gley - Lee series.

11. (a) Formed on beach ridge - Brosnan series.

(b) Other - Goolboo series.

12. (a) Formed on beach ridge - go to 13.

(b) Other - go to 14.

13. (a) Bleached A2 horizon - Googarra series.

(b) Soil texture greater than loamy sand in some part of profile - Spanos series.

(c) Other - Toolakea series.

14. (a) Rounded cobble and boulders on surface or throughout soil - Japoon series.

(b) Stratified medium sands - Glenborra series.

(c) Stratified coarse sands - Goolboo series.

(d) A horizon black both moist and dry - Whitfield series.

(e) Texture profile decreases from surface - Liverpool series.

(f) Texture profile increases or remains ≥ SCL - Canoe series.

15. (a) Formed on beach ridge - go to 16

(b) Formed on alluvium - go to 17

16. (a) Peaty surface - Needep series.

(b) Bleached A2 - Kaygaroo series.

(c) Pale A2 - Googarra series.

(d) Other - Hull series.

17. (a) Rounded cobble and or boulders on surface - Japoon series.

(b) Stratified coarse sands - Goolboo series.

18. (a) B horizon is red - Midgenoo series associated with present or prior stream activity

(b) B horizon is yellow - Tully series associated with present or prior stream activity

(c) B horizon is brown - Innisfail series associated with present or prior stream activity

(d) B horizon is grey/gleyed - go to 19

19. (a) Medium to heavy dark cracking clay A horizon - Derra series.

(b) Coom series associated with present or prior stream activity.

20. (a) B horizon is massive (no readily observable soil aggregates) - go to 21.

(b) B horizon is structured (readily observable soil aggregates) - go to 25.

21. (a) B horizon is red - go to 22.

(b) B horizon is yellow - go to 23

(c) B horizon is brown - Liverpool series

(d) B horizon is grey/gley - go to 24

22. (a) Channel bench or prior stream - Bluewater series

(b) Stagnent alluvial plain (high terrace) Virgil series.

23. (a) Bleached A2 horizon - Cudmore series.

(b) Mottled B horizon - Jarra series.

(c) A horizon black both moist and dry - Whitfield series.

(d) Texture profile decreases from surface - Liverpool series.

(e) Texture ≤ SCL - Glenborra series.

(f) Texture profile increases or remains ≥ SCL - Canoe series.

24. (a) Bleached A2 horizon, B horizon texture ≥ CL - Cudmore series.

(b) Bleached A2 horizon, B horizon textures ≤ SCL - Arnot series.

(c) Other - Lee series.

25. (a) B horizon is red - go to 26

(b) B horizon is yellow - go to 27

(c) B horizon is brown - go to 28

(d) B horizon is grey/gley - go to 29

26. (a) Well-drained alluvium - Midgenoo series.

(b) Formed on basalt - Pin Gin series.

(c) Underlain by granitic material - Marquette series.

(d) Other - Dingo series.

27. (a) Dark to black surface both moist and dry - Mossman series.

(b) Bleached A2 horizon - Cudmore series.

(c) Mottled - Coom series.

(d) Other - Tully series.

28. (a) Black (both moist and dry) surface - Dayman series.

(b) Other - Innisfail series.

29. (a) Bleached A2 horizon and sharp texture change between A and B horizons - Porter series.

(b) Bleached A2 horizon and gradual texture change between A horizon and B horizon - Cudmore series.

(c) Humic surface - Hewitt series.

(d) Black (both moist and dry) surface - Bulgun series.

(e) Mottled - Coom series.

(f) Whole coloured - Timara series.

SOIL SERIES AND MAP UNIT INFORMATION

INTRODUCTION

This section of the report provides a morphological description of the soil series, (terminology used is from McDonald *et al.* 1990) recognized, and a description of the mapping units depicted on the accompanying map. Chemical and physical data are presented for one profile of most series but there is no discussion of the results. The report is to be read in conjunction with the land evaluation report of Smith *et al.* (in press).

The soils have been classified in terms of the Factual Key (Northcote 1979), great soil group (Stace *et al.* 1968) and Soil Taxonomy (Soil Survey Staff 1987). The latter where possible, to the great group level.

A 'p' following the principal profile form (PPF) denotes soils that have an Ap horizon. These are (by definition) usually about 25 cm thick but may be as thick as 40 cm. In addition, deep ripping further disturbs horizonation and A horizon materials may occur as deep as 80 cm. In many soils it is highly likely that the subsurface horizons such as A2, A3 and B1 have been destroyed. It has also been found (Teitzel pers. comm.) that over a relatively short time span dark colours can develop in the surface and upper B horizon under perennial pasture species. A dark A horizon is used to distinguish several soil series or variants but throughout the survey area the distribution of this particular morphological feature could not be convincingly linked to any common vegetation or topographic feature. Where possible the PPF from undisturbed sites has been recorded.

There is no provision for a number of soils in the great soil groups of Stace *et al.* (1968) and for others the classification is doubtful. The latter are indicated by a question mark. The classification to great group level in Soil Taxonomy is provisional in some instances where required data is lacking. Where there is no analytical data available and considerable doubt exists the soil has not been classified. Argillic horizons have been identified on the basis of clay increase only, no thin sections were available. There is also little information available on the weatherable minerals in the sand fraction.

In the absence of reliable data on moisture characteristics of these soils, a udic regime is inferred for all soils with fine sandy loam or finer field texture north of the line drawn on Figure 5. A ustic moisture regime is inferred for all soils to the south of this line and the coarse uniform sands i.e. most of the soils formed on beach ridges, and an aquic regime for some of the swamp soils. An iso temperature regime has been used for most soils although Murtha and Williams (1986)suggest that cultivated soils and those with a sparse ground cover may be non iso. Because there is a sparse canopy and ground cover on the beach ridges, a hyperthermic temperature regime has been used in the classification of all the podzols on the beach ridges.

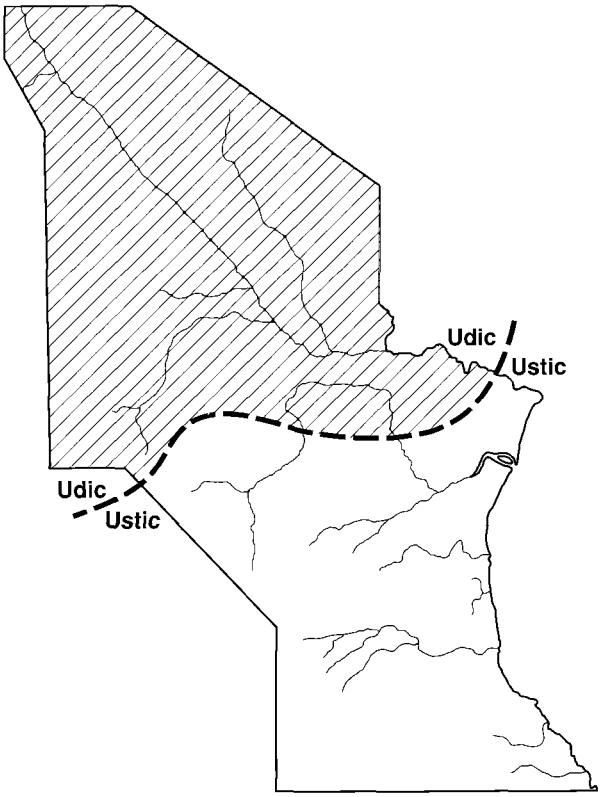


Figure 5. Assumed Ustic-Udic soil moisture regimes.

Unless specified all colours are for moist soil. The Munsell soil colour chart names have been used and some names may cover several individual colour chips. All textures refer to field manipulation of the soil and have not been fitted to a texture triangle on the basis of particle size *analysis.*

Each series is described under three headings.

1. Concept. A brief statement outlining the central concept of that series.
2. Representative Profile. This is the detailed description of the soil sampled for chemical analysis; for those soils not sampled it is the description from a representative pedon. It has been selected as being representative of the particular series and is located where possible at a site chosen which is accessible and with a reasonable chance of remaining in its present state. The classification in this section applies to the described and sampled pedon.
3. Morphological Range. The composite profile diagram depicts the horizons and depth ranges encountered during the survey. Where a range has been encountered for other morphological properties it is described under the major horizon designation. There is also a brief discussion on correlation, vegetation and a listing of PPF's (Northcote 1979) in descending order of occurrence in the series.

SOILS FORMED ON BEACH RIDGES

Nine soil series have been recognised on the beach ridges. Their field relationship is shown in Figure 6 and their properties are summarised in Table 1. The beach ridge sequences found in this survey area are very similar to those of Tully-Innisfail (Murtha 1986), although not all of the series recorded there have been found in this area. In this survey the greater number of streams incising and migrating through these ridge systems have given rise to a very complex alluvium-beach ridge pattern. Limited access throughout the ridges has made mapping difficult and a lower reliability applies to most of this area as shown in Figure 2. Although no dating has been carried out on these ridges, the extent of profile development indicates large age and/or sand source differences. The beach ridges in this area represent the largest unbroken sequence from the youngest to the oldest ridges found on the wet coast, and provide an ideal site to establish a chronology for coastline development in this environment.

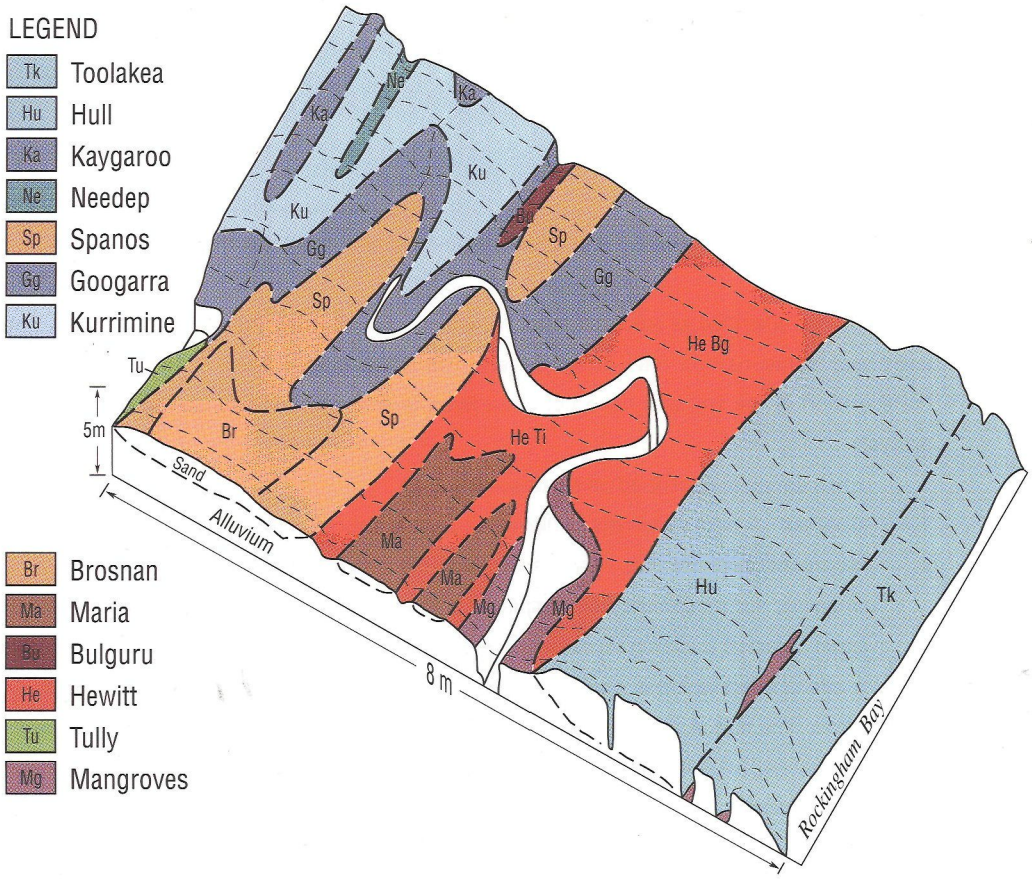


Figure 6. Schematic diagram of soils formed on beach ridges.

Beach ridges are absent along the coastline in the lee of Hinchinbrook Island, but apart from the tidal inlets occupy all of the coastline north from Cardwell to the Tully River. As a generalisation, the Hull and Toolakea associations dominate the frontal and younger sand masses while the red and yellow sands of Brosnan and Spanos series form the older ridges. The pattern is more complex however to the north of Dallachy Creek where the well developed podzols of Kurrimine and Kaygaroo series may occur in front of and behind the red and yellow sands. Googarra and Maria series occur in areas where the sands have been reworked by distributaries of the Tully or Murray Rivers.

The swales of all the sand masses are generally narrow compared to the ridges. While some swales may be only slightly lower in elevation than the ridge and have well drained profile features, most are much lower and have water tables near or above the ground surface for much of the year. As depth to water table (often above the surface in the swale) has been one of the major factors controlling soil development, the soil distribution pattern is very complex. Varying depths of fine and coarse alluvium have been deposited by stream action which has dissected the ridges and produced swales with complex soil profiles. The concept of Maria series is one of sequential deposition and erosion of both beach ridge and alluvial deposits near major streams.

TABLE 1

Soils formed on beach ridges

Soil Series	Landform	Major Distinguishing Features
Toolakea	Frontal beach ridges.	Deep coarse sands, light brown or yellowish brown in colour, little profile development apart from accumulation of organic matter in the surface (A) horizon.
Hull	Beach ridges.	Dark or pale A1 horizon; weakly developed A2 horizon; distinct brown or pale brown B horizon; coarse sand throughout.
Googarra	Older inland ridges near Murray River and Dallachy Creek.	Dark A1 horizon may be > 60 cm deep; bleached A2 horizon; a yellow whole coloured or mottled B horizon which may occur at depths > 120 cm.
Kurrimine	Rearward beach ridges between Tully River and Murray River	Strongly developed podzol; dark A1 horizon; sporadic to conspicuously bleached A2 horizon over a planar black B2h with strong bright brown mottling below.
Kaygaroo	Highest beach ridges at rear of sand masses between Tully and Murray River.	Strongly developed podzol; dark A1 horizon, conspicuously bleached A2 horizon over a strongly banded B2h horizon; tongues of the A2 horizon may occur up to 1 m into the B horizon; the upper 1 m of the profile is aeolion sorted fine sand.
Brosnan	Rearward beach ridges from Tully River to Cardwell.	Red, uniform or gradational texture soils; a dark surface variant is common in this survey area.
Spanos	Rearward beach ridges from Tully River to Cardwell.	Yellow, uniform or gradational texture soils; a dark surface variant is common in this survey area; B horizon may be mottled by 60 cm.
Maria	Reworked beach ridge sands between Tully and Murray Rivers.	Prominently mottled or gleyed, yellow gradational soil commonly with a bleached A2 horizon. The profile usually overlies fine riverine alluvium by < 1.5 m. Dark humic A horizons occur in very poorly drained areas.
Needep	Swales of beach ridges.	Peaty surface over a dark brown B horizon; water ponded for long periods each year.

TOOLAKEA SERIES (Tk)

CONCEPT

Single grain, uniform sand with little profile development apart from accumulation of organic matter in the A horizon.

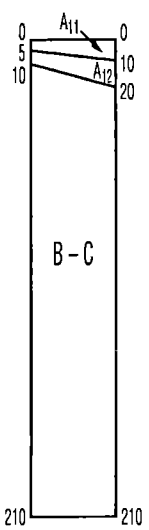
REPRESENTATIVE PROFILE

	G.S.G.*	P.P.F.**	S.T.***
CLASSIFICATION	Siliceous Sand	Uc1.21	Quartzipsamment
LANDFORM	Frontal beach ridge		RAINFALL 2250 mm
REFERENCE SITE	Cardwell 1:100 000 950820		

Horizon	Depth	
A11	0 to .01 m	Pale brown (10YR 6/3); sand; single grain; loose, dry; clear change to
A12	.01 to .10 m	Brown (10YR 5/3); sand; single grain; loose, dry; gradual change to
BC	.10 to 1.50m	Light yellowish brown (10YR 6/4); sand; single grain; loose, dry.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	A11/12	Dark greyish brown (10YR 4/2) to pale brown (10YR 6/3); sand to coarse sand; rarely broken shell and coral; clear or gradual change.
	B-C	Light yellowish brown (10YR 6/4); sand.



Typical vegetation communities: *Casuarina* and *Acacia* dominant low to mid high woodlands.

Principal profile forms encountered include Uc1.21, Uc5.

Analytical data for a profile of this series is given in Murtha (1986).

* Great Soil Group (Stace *et al.* 1968).

** Principal Profile Form (Northcote 1979).

*** Soil Taxonomy (Soil Survey Staff 1987)

HULL SERIES (Hu)

CONCEPT

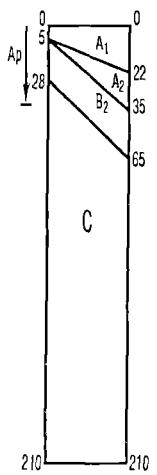
Very weakly developed podzol; A2 weakly developed or absent; no mottling or cementation in B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.
CLASSIFICATION	(Rudimentary) Podzol	Uc4.23
LANDFORM	Beach ridge	RAINFALL 2250 mm
REFERENCE SITE	Cardwell 1:100 000 943837	

Horizon	Depth	
A11	0 to .10 m	Light brownish grey (10YR 6/2); sand; single grain; dry, loose; slight pumice; gradual change to
A12	.10 to .22 m	Very dark grey (10YR 3/1m&d); sand; single grain; dry, loose; slight pumice; gradual change to
A2	.22 to .33 m	Very dark greyish brown (10YR 3/2) (10YR 5/2d); sand; single grain; dry, loose; gradual change to
B2	.33 to .60 m	Dark brown (7.5YR 3/2); sand; single grain; dry loose; diffuse change to
B3	.60 to .90 m	Patchy brown (7.5YR 4/4) and pink (7.5YR 7/4); sand; single grain; dry, loose; diffuse change to
C	.90 to 1.2 m	Yellowish brown (10YR 5/6); sand; single grain; dry, loose.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	Description
	Ap	Black (10YR 2/1) sand may have rainwashed sandgrains on surface and upper 2-3 cm.
	A1	Black (10YR 2/1) to light brownish grey (10YR 6/2); clear or gradual change
	A2	Very dark greyish brown (7.5YR to 10YR 3/2); clear or gradual change
	B2	Very dark grey (10YR 3/1) to dark brown (7.5YR 3/2).
	C	Yellowish brown (10YR 5/6) to light yellowish brown (10YR 6/4); sand.

Distinguished from Toolakea series by distinct colour B horizon.

Low to tall woodlands of *Eucalyptus pellita*, *E. tesselaris*, *E. intermedia*, *Acacia* species and *Casuarina* species.

Principal profile forms encountered include Uc4.23, Uc5.11.

GOOGARRA SERIES (Gg)

CONCEPT

A single grain, uniform textured sand with a dark A horizon, a distinct bleached A2 and a pale mottled B horizon.

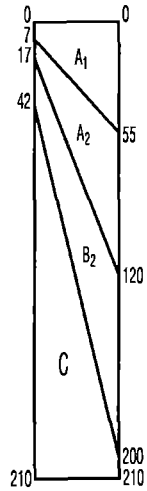
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.
CLASSIFICATION	? Siliceous Sand	Uc2.2
LANDFORM	Beach ridge	RAINFALL 2250 mm
REFERENCE SITE	Kirrama 1:100 000 883006	

Horizon	Depth	
A11	0 to .12 m	Light greyish brown (10YR 6/2); sand; single grain; loose; moderate, fine roots; gradual change to
A12	.12 to .45 m	Black (10YR 2/1); loamy sand; single grain, loose; moderate, fine roots; gradual change to
A2	.45 to .80 m	Pale brown (10YR 6/3) (10YR 8/2d); sand; single grain; loose; gradual change to
B2	.80 to 1.20 m	Distinct fine mottle, yellow (2.5Y 7/6) and yellowish red (5YR 6/6); sand; single grain; loose; water table at 110 cm.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 5*	Description
	A1	29:18	Black (10YR 2/1) to light greyish brown (10YR 6/2); loamy sand to sandy loam; single grain to weak cast.
	A2	25:26	Dark greyish brown (10YR 4/2) to pale brown (10YR 6/3); may be sporadic to conspicuously bleached.
	B2	29:16	Yellowish brown (10YR 5/4) to pale yellow (2.5Y 7/8), whole coloured or mottled; sand to loamy sand.
	C	99:47	Light grey (10YR 7/2) to very pale brown (10YR 8/4), commonly mottled with yellow (10YR 6/8) or red (10R 4/8); sand to clayey sand; single grain to massive.



Some soils have considerably deeper dark A horizons than described by Murtha (1986). The distinct A2 horizon and pale yellow B horizons distinguish this series from Hull series. Mottles in the B horizon may be slightly hard.

Low to tall woodlands of *Eucalyptus intermedia*, *E. pellita*, *Acacia*, *Melaleuca* and *Lophostemon* species.

Principal profile forms encountered include Uc2.2, Uc2.21, Uc3.21 and Uc4.2.

*Soil horizon thickness (cm) statistics for mean, standard deviation, and number of profiles.

KURRIMINE SERIES (Ku)

CONCEPT

Single grain uniform textured sand with a bleached A2 horizon overlying a strongly developed cemented podzol B horizon.

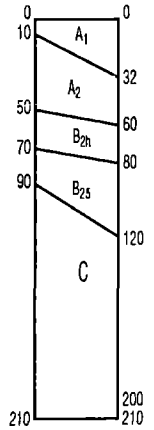
REPRESENTATIVE PROFILE

	P.P.F.	G.S.C.	S.T.	
CLASSIFICATION	Humus Podzol	Uc2.33	Troporthod	
LANDFORM	Beach ridge		RAINFALL	4000 mm
REFERENCE SITE	Kirrama 1:100 000	904006		

Horizon	Depth	
A11	0 to .10 m	Grey (10YR6/1); sand; weak 2-5mm cast; dry, loose; 10-20% 6-20mm, angular, dispersed charcoal fragments; common <1mm roots; clear smooth change to
A12	.10 to .20 m	Black (10YR2/1); sapric sand; single grain; dry, loose; common <1mm roots; diffuse change to
A13	.20 to .32 m	Black (10YR2/1); sand; single grain; dry loose; few <1mm roots; gradual, irregular change to
A22e	.32 to .51 m	White (10YR8/1), conspicuously bleached; 2-10% 5-15mm distinct grey (10YR5/1) mottles; sand; single grain; dry, loose; few <1mm roots; abrupt, smooth change to
B21h	.51 to .60 m	Black (10YR2/1); 10-20% 15-30mm prominent, red (10R4/6) mottles; sand; single grain; dry, very strong; massive, moderately cemented, organic pan; few 1-2mm roots; gradual, tongued change to
B22	.60 to .90 m	Reddish brown (5YR4/3); 10-20% 15-30mm prominent, reddish yellow (5YR6/8) mottles; sand; single grain; dry, loose; few 1-2mm roots; diffuse change to
B23/C	.90 to 1.20 m	Yellow (10YR7/8); 10-20% 15-30mm distinct, reddish yellow (5YR6/8) mottles; sand; single grain; dry, loose; diffuse change to
C1	1.20 to 1.40 m	White (2.5Y8/2); 10-20% 15-30mm faint, brownish yellow (10YR6/8) mottles; sand; dry loose; diffuse change to
C2	1.40 to 1.60 m	Yellow (10YR7/6); 10-20% 15-30mm distinct, reddish yellow (5YR6/8) mottles; sand; dry, loose.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
0–10	A1	Black (10YR 2/1), or grey (10YR 6/1) when rain washed.
10–32	A2	Dark grey (10YR 4/1) to white (10YR 8/1) pale to conspicuously bleached.
32–60	B2h	Black (10YR 2/1) with yellowish brown (10YR 5/4) and red (10R 4/6) or dark reddish brown (5YR 3/2) mottles; slightly to strongly cemented.
60–80	B2s	Reddish brown (5YR 4/3) with reddish yellow (5YR 6/8) mottles; sand; single grain, weakly cemented.
80–120	C	White (10YR 8/2 to yellow (10YR 7/6) with reddish yellow (5YR 6/8) or brownish yellow (10YR 6/5) mottles.



Differs from Kaygaroo series in having a smooth boundary to the podzol B horizon which is commonly cemented, and from Googarra series because of the distinct podzol B horizon. Most profiles had a conspicuously bleached A2 horizon which Murtha (1986) regarded as a variant of the central concept.
Low to tall woodlands of *Eucalyptus pellita, E. intermedia, Acacia* and *Casuarina* species.
Principal profile forms encountered include Uc2.33, Uc3.31, Uc4.33 and Uc2.20.

ANALYTICAL DATA

Profile T438 Map Reference KIRRAMA 1:100 000 904006
KURRIMINE SERIES Sampled from undisturbed sclerophyl-*Casuarina* forest.

Depth cm	0-10	10-20	20-32	32-51	51-60	60-90	90-120	120-140	140-160
Horizon	A11	A12	A13	A2e	B21h	B22	B23/C	C1	C2
pH	5.3	4.9	5.2	5.4	5.1	5.4	5.4	5.5	5.7
E.C. mS/cm	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	2.71		0.65		1.2			0.11	
AvP ppm	6		2		2			7	
P ret%	0				33			13	
Free Fe%	0.5		0.5		1.0			0.5	
Tot. P %	0.003		0.001		0.005			0.004	
Tot. K %	0.021		0.024		0.13			0.139	
Tot. S %	0.011		0.004		0.006			0.004	
Tot. Fe%	0.688		0.647		1.143			0.685	
Tot. Cu%	<0.0001		0.0004		0.0002			0.0003	
Tot. Zn%	0.0002		0.0003		0.0004			0.0004	
Tot. Mn%	0.003		0.003		0.006			0.007	
Exchange properties m.e./100 g soil									
Ca	1.06		0.07		<0.02			<0.02	
Mg	0.75		0.3		0.08			<0.02	
K	0.06		0.06		0.03			<0.02	
Na	0.13		0.04		0.03			0.05	
H + Al	0.58		0.1		2.13			0.17	
'ECEC'(1)	2.6		0.6		2.3			0.3	
CEC(2)	4		2		5			<1	
Base Sat(3)	50		24		3			11	
CEC(4)	3.2		2.4		2.7			0.8	
Particle Size %									
Gr	0	0	0	0	0	0	0	0	1
CS	85	73	73	76	70	67	65	67	67
FS	13	23	25	24	23	26	30	28	28
Si	2	2	2	2	1	1	2	2	2
C	1	2	0	0	6	5	4	3	3
BD	1.2	1.3				1.4	1.6	1.5	
.1 Bar	6.0	8.7				8.5	7.0	5.8	
15 Bar	3.6	3.8				4.7	3.6	2.8	

(1)Sum of basic and acidic cations (2)NH_4 OAc (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$ (4) Comp. Exch.

KAYGAROO SERIES (Ka)

CONCEPT

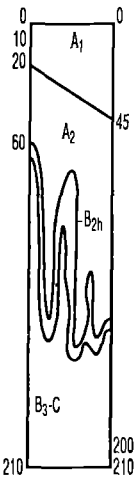
Single grain uniform textured sand with a thick conspicuously bleached A2 horizon and a well developed B with tongues of A2 horizon throughout.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	
CLASSIFICATION	Podzol	Uc2.2	
LANDFORM	Beach ridge with thick aeolion capping	RAINFALL	4000 mm
REFERENCE SITE	Kirrama 1:100 000 892 004		

Horizon	Depth	
A11	0 to .20 m	Light brownish grey (10YR 6/2) with many fine black (10YR 2/1) patches; sand; single grain; loose; many fine roots; gradual to diffuse change to
A12	.20 to .45 m	Black (10YR 2/1) grading to dark grey (10YR 4/1); sand; single grain; dry, loose; few, fine roots; diffuse change to
A21e	.45 to .90 m	Light brownish grey (10YR 6/2); sand; single grain; dry, loose; diffuse change to
A22e	.90 to 1.50 m	Light grey (10YR 7/1) (10YR 8/1d); sand; single grain, dry, loose; abrupt very irregular change to
A22e/B2hs	1.50 to 3.0 m	The boundary between A2 and B horizon is very irregular with tongues or pipes of A2 extending to at least 1 m into the B horizon. The pipes of A2 are not always vertical, the sides are slightly irregular, and they range from 8 to about 15 cm in diameter. The A2 material is the same as described above. The B horizon is patchy very dark brown (10YR 2/2) and brown (7.5YR 4/4); sand; single grain; loose when dry; diffuse change to
B3 or B2s	3.0 to 4.9 m	Patchy brown (10YR 5/3) and brownish yellow (10YR 6/8); sand; single grain; loose; diffuse change to
C	4.0 m +	Yellow (10YR 7/6); sand; single grain; loose.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	Description
	A1	Black (10YR 2/1) or may be grey (10YR 6-7/1) with black (10YR 2/1) patches throughout.
	A2	Light brownish grey (10YR 6/2) to white (10YR 8/1).
	B2h	Very dark brown (10YR 2/2) to brown (7.5YR 4/4).
	B3-C	Brown (10YR 5/3) to brownish yellow (10YR 6/8).

Differs from Kurrimine series because of an irregular B horizon and an aeolion capping, and Googarra series by having a very distinctive podzol B2h horizon. The B horizon is rarely cemented.

Low to mid-high woodlands of *Eucalyptus pellita, E. intermedia, Casuarina* and *Acacia* species.

Principal profile forms encountered include Uc2.2, Uc2.20, and Uc2.23.

NEEDEP SERIES (Ne)

CONCEPT

Coarse sandy or loamy peat over coarse sand. Water table is above the surface for much of the year.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	
CLASSIFICATION	Peaty Podzol	Uc5.11	
LANDFORM	Beach ridge swales or reworked sands.	RAINFALL	2250 mm

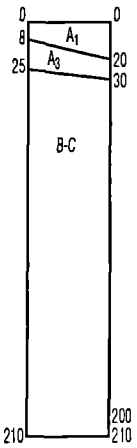
REFERENCE SITE: Kirrama 1:100 000 899029

Horizon Depth

A1	0 to .20 m	Black (10YR 2/1); fibric loam, slightly sandy; massive to weak crumb; wet friable; very fibrous and many, fine roots; gradual change to
A3	.20 to .30 m	Very dark greyish brown (10YR 3/2) sandy loam; massive; wet friable; moderate fine roots; gradual change to
B	.30 to 1.0 m	Dark greyish brown (10YR 4/2); sandy loam grading to loamy sand; massive; friable wet. Water table at 1 m rose to 15 cm from surface.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	A1	Black (10YR 2/1); fibric peat to fibric sand to fibric loam; massive to weak crumb.
	A3	Dark greyish brown (10YR 4/2) to very dark greyish brown (10YR 3/2); sandy loam.
	B-C	Dark greyish brown (10YR 4/2) to black (10YR 2/1); loamy sand to sandy loam; water table always present.



This series was observed but not described. The above profile description and range are from Murtha (1986), who also provided analytical data.

BROSNAN SERIES (Br)

CONCEPT

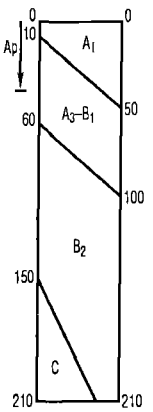
Red uniform to gradational textured coarse sandy soils. Dark A horizons are common.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Earthy sand	Uc4.21	Aquic Ustorthent	
LANDFORM	Beach ridge		RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000	918858		

Horizon	Depth	
A11	0 to .20 m	Black (10YR2/1); loamy sand; massive; moderately moist, loose; few <1mm roots; gradual, smooth change to
A3	.20 to .40 m	Brown (7.5YR4/4); loamy sand; massive; moderately moist loose; few <1mm roots; diffuse, broken change to
B1	.40 to .60 m	Brown (7.5YR5/4); <2% <5mm distinct, yellowish red (5YR4/6) mottles; loamy sand; massive; moderately moist, loose; few <1mm roots; diffuse, broken change to
B21	.60 to 1.20m	Yellowish red (5YR5/8); 2-10% 5-15mm distinct, yellow (10YR7/8) mottles; sandy loam; single grain; moderately moist, loose; 10-20% 2-6mm, subangular, dispersed quartz gravel; few <1mm roots; diffuse, broken change to
B22	1.20 to 1.50 m	Yellowish red (5YR5/8); 20-50% 5-15mm distinct, yellow (10YR7/8) mottles; sandy loam; single grain; moderately moist, loose; 10-20% 2-6mm, subangular quartz gravel, dispersed; diffuse, broken change to
C	1.50 to 1.80 m	Yellow (10YR7/8); sandy loam; single grain; moderately moist, loose; 20-50% 2-6mm, subangular, dispersed quartz gravel.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	Description
	Ap	Black (10YR 2/1); loamy sand; single grain to massive.
	A1	Black (10YR 2/1) to dark brown (7.5 YR 3/2); loamy sand to light sandy clay loam; single grain to massive.
	A3-B1	Yellowish red (5YR 5/6) to very dark greyish brown (10YR 3/2); sand to light sandy clay loam; single grain to massive.
	B2	Red (2.5YR 4/8) to yellowish red (5YR 5/8) with distinct brownish yellow to yellow (10YR 6-7/6-8) mottles lower in the profile; sand to light sandy clay loam; single grain to massive.
	C	Very pale brown (10YR 7/4) to yellow (10YR 7/8); sand to clayey sand; single grain to massive.

Generally the Brosnan series in this survey area have deeper darker A horizons, lower clay content and express mottling at shallower depths than those represented in Murtha (1986). Pale A2 horizons are common where mottles occur at a shallow depth in the profiles.

Low to mid-high woodlands of *Eucalyptus pellita*, *E. intermedia*, *Acacia* and *Xanthorrhoea* species.

Principal profile forms encountered include Uc4.21, Uc4.22, Uc5.11 and Gn2.14.

ANALYTICAL DATA

Profile T374 Map Reference KIRRAMA 1:100 000 918858
BROSNAN SERIES Sampled from undisturbed eucalypt open forest.

Depth cm	0-10	10-20	20-30	30-40	40-60	60-90	90-120	120-150	150-180
Horizon	A11	A11	A3	A3	B1	B21	B21	B22	C
pH	5.6	5.6	5.6	5.6	5.6	5.8	5.8	5.4	5.6
E.C. mS/cm	0.03	0.02	0.01	0.01	0.02	<0.01	<0.01	<0.01	<0.01
T. C. %	1.89			0.91		0.14		0.09	
N %	0.11			0.05					
AvP ppm	4			3		3			
P ret %	21								
Free Fe%	0.7	0.5	0.6	1.0		0.7		0.5	
Tot. P %	0.009			0.009		0.005			
Tot. K %	0.46			0.52		0.51			
Tot. S %	0.012			0.007		0.004			
Tot. Fe%	1.0			1.1		0.9		0.5	
Tot. Cu%	0.001			0.0021		0.0014		0.0012	
Tot. Zn%	0.0015			0.0016		0.0014		0.0014	
Tot. Mn%	0.061			0.058		0.026		0.007	
Exchange properties m.e./100 g soil									
Ca	1.12			0.37		0.28		0.35	
Mg	0.4			0.22		0.26		0.32	
K	0.07			<0.02		<0.02		0.04	
Na	<0.02			<0.02		<0.02		<0.02	
H + Al	0.78			0.8		0.23		0.3	
'ECEC' (1)	2.4			1.4		0.8		1.0	
'ECEC'/100 g C	18.5			7.8		5.3		6.7	
CEC(2)	6.3			4.0		1.6		1.5	
CEC/100 g C(2)	48			22		11		10	
Base Sat(3)	26			16		36		49	
CEC(4)	2.9			2.0		1.2		1.3	
Particle Size %									
Gr	2	1	2	1	1	3	3	3	6
CS	71	67	64	64	66	70	66	64	66
FS	11	12	14	12	13	12	16	19	19
Si	5	6	4	7	4	3	3	2	2
C	13	16	18	18	18	15	15	15	13

(1)Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2)NH_4 OAc (4) Comp. Exch.

SPANOS SERIES (Sp)

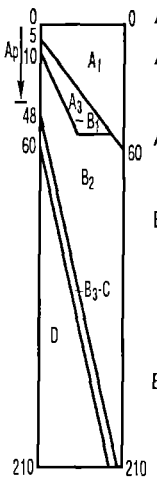
CONCEPT *Single grain to massive yellow beach ridge soil.*

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Yellow Earth	Gn2.21	Kandiustult	
LANDFORM	Beach ridge		RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000	912857		

Horizon	Depth	
A11	0 to .15 m	Very dark grey (10YR3/1); light coarse sandy clay loam, massive; many 1-2mm roots; gradual, wavy change to
A12	.15 to .30 m	Brown (10YR4/3); coarse sandy clay loam; massive; few 1-2mm roots; gradual, wavy change to
B1	.30 to .50 m	Yellowish brown (10YR5/4); clay loam,coarse sandy; massive; few 1-2mm roots; gradual, wavy change to
B21	.50 to 1.00 m	Brownish yellow (10YR6/6); coarse sandy light clay; massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; few 1-2mm roots; gradual, wavy change to
B22	1.00 to 1.50 m	Brownish yellow (10YR6/8); coarse sandy light clay; massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; gradual, wavy change to
C	1.50 to 1.80 m	Light grey (10YR7/2); 2-10% 5-15mm faint reddish yellow (7.5YR6/8) mottles; coarse sandy light clay loam; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 13*	Description
	Ap	33:4	Black (10YR 2/1); loamy sand to sandy loam; single grain to massive.
	A1	27:19	Black (10YR 2/1) to brown (10YR 4-5/3); loamy sand to *sandy clay loam coarse sandy* (*heavy variant*); single grain to massive.
	A3-B1		Very dark brown (7.5YR 3/2) to pale brown (10YR 6/3); sand to sandy clay loam to *clay loam sandy* (*heavy variant*); single grain to massive.
	B2	54:37	Light yellowish brown (10YR 6/4) to brownish yellow (10YR 6/6) to yellow (10YR 7/8) with light brown (7.5YR 6/4) and reddish yellow (7.5YR 6/8) mottles at depth; sand to sandy clay loam to *sandy medium clay* (*heavy variant*); single grain to massive.
	B3-C		Brownish yellow (10YR 6/6-8) to very pale brown (10YR 7/3) to white (2.5YR 8/1) with red (2.5YR 5/8) and yellow (2.5Y 7/8) mottles; sand to light sandy clay loam.
	D		Light grey (2.5Y 7/1) to brownish yellow (10YR 6/8); with yellow (2.5Y 7/8) and red (2.5YR 5/8) mottles; sand to medium clay.

Spanos series in this survey area differs from those described by Murtha (1986) in having generally deeper, darker A horizons, shallower occurrence of mottles, and a heavy textured variant highlighted in the range above, in italics.

Low to mid-high woodlands of *Eucalyptus pellita, E. intermedia, Lophostemon, Casuarina, Xanthorrhoea* and *Acacia* species.

Principal profile forms encountered include Uc5.22, Uc4.21 and Gn2.21.

ANALYTICAL DATA

Profile T373 Map Reference KIRRAMA 1:100 000 912857
SPANOS SERIES Sampled from undisturbed eucalypt and *Acacia* open forest.

Depth cm	0-10	15-20	20-30	30-50	50-60	60-90	90-100	100-120	120-150	150-180
Horizon	A11	A12	A12	B1	B21	B21	B21	B22	C	C
pH	5.1	5.3	5.4	5.3	5.4	5.4	5.3	5.4	5.4	5.4
E.C.mS/cm	0.05	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
T. C. %	1.3		0.61	0.46		0.25			0.012	
N %	0.10		0.05							
AvP ppm	7		3			2				
P ret %	12									
Free Fe%	0.7	0.5	0.6	0.9						
Tot. P %	0.007		0.008			0.007			0.006	
Tot. K %	0.53		0.85			0.78			0.71	
Tot. S %	0.01		0.007			0.005			0.004	
Tot. Fe%	1.0					1.3				
Tot. Cu%	0.0012					0.001				
Tot. Zn%	0.0011					0.0024				
Tot. Mn%	0.039					0.031				
Exchange properties m.e./100 g soil										
Ca	0.22		0.14	0.11		0.05			<0.02	
Mg	0.31		0.17	0.17		0.15			0.13	
K	0.05		0.06	<0.02		<0.02			<0.02	
Na	<0.02		<0.02	<0.02		<0.02			<0.02	
H + Al	1.12		1.15	1.32		1.17			0.93	
'ECEC'(1)	1.7		1.5	1.6		1.4			1.1	
'ECEC'/ 100g C	15.5		7.9	7.3		6.4			5.8	
CEC(2)	4.6		3.6	3.9		2.7			1.8	
CEC/100 C	41.8		18.9	17.7		12.3			9.5	
Base Sat3	13		11	8		9			11	
CEC(4)	2.1		1.7	1.6		1.9			1.6	
Particle Size %										
Gr	1	2	2	3	3	4	6	6	7	12
CS	74	58	59	57	53	61	58	65	64	70
FS	10	15	14	13	13	11	14	12	13	11
Si	6	9	8	8	10	7	6	4	3	3
C	11	18	19	22	23	22	23	18	19	16

(1)Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2)NH_4 OAc (4) Comp. Exch.

MARIA SERIES (Ma)

CONCEPT

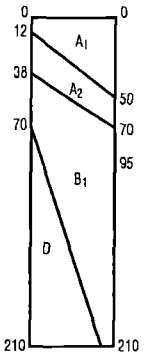
Prominently mottled, grey and yellow, gradational textured soil, commonly with a bleached A2 horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	No Suitable Group	Gn2.91	Hapludult	
LANDFORM	Beach ridge		RAINFALL	4000 mm
REFERENCE SITE	Kirrama 1:100 000 909994			

Horizon	Depth (cm)	
A11	0 to .12 m	Dark greyish brown (10YR4/2); silty clay loam (light); moderate, cast; moist, moderately weak; <1 1-2mm macropores per 100mm2; common <1mm roots; clear, wavy change to
A12	.12 to .25 m	Greyish brown (2.5Y5/2); 10-20% 15-30mm distinct olive yellow (2.5Y6/8) mottles; fine sandy light clay loam; massive; moist, very weak; <1 1-2mm macropores per 100mm2; common <1mm roots; clear, irregular change to
A2j	.25 to .46 m	White (2.5Y8/1); 10-20% 15-30mm distinct yellow (2.5Y7/8) mottles; fine sandy light clay loam; massive; moist, very weak; <1 1-2mm macropores per 100 mm2 ; few <1mm roots; gradual, tongued change to
B2	.46 to .78 m	Light grey (2.5Y7/1); 10-20% 15-30mm distinct yellow (2.5Y7/8) primary and red (2.5YR4/6) secondary mottles; sandy light clay; massive; moist, moderately weak; <1 1-2mm macropores per 100mm2; few <1mm roots; diffuse change to
2D	.78 to 1.10m	Light grey (2.5Y7/1); 10-20% >30mm prominent dark red (10R3/6) primary and light red (2.5YR6/8) secondary mottles; medium heavy clay; moderate 20-50mm prismatic; moist, very firm; 2-10% 2-6mm, angular, quartz gravel; few <1mm roots; clear, wavy change to
3D	1.10 to 1.72m	Light grey (2.5Y7/1); 10-20% >30mm distinct yellow (2.5Y7/8) primary and dark red (10R3/6) secondary mottles; medium heavy clay; massive; moist, very firm; 10-20% 2-6mm, angular, quartz gravel;

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	A1	Black (10YR 2/1) to greyish brown (10YR 5/2); sandy loam to silty clay loam (light); *massive to moderate cast; diffuse to clear change to*
	A2	Greyish brown (10YR 5/2) to white (2.5Y 8/1), may be sporadically bleached with distinct yellow (10YR 2.5Y 7/8) mottles; sandy loam to sandy clay loam
	B2	Brownish yellow (10YR 6/6) to light grey (2.5Y 7/1) distinct yellow (2.5Y 7/8) mottles; sandy clay loam to sandy light clay; clear to gradual change
	D	Light grey (2.5Y 7/1), with prominent red (10R 3/6) and distinct yellow (2.5Y 7/8) mottles; medium to heavy clay; massive to moderately structured.

Only a limited number of profiles were examined in this survey area due to very poor access. Generally the profiles are much shallower to D horizons than those of Murtha (1986) but the overall concept and relationship to other beach ridge soils is the same.

Low to mid-high woodlands of *Lophostemon*, *Casuarina* and *Melaleuca* species.

Principal profile forms encountered include Gn2.91, Um7 and Gn3.01.

ANALYTICAL DATA

Profile T435 Map Reference KIRRAMA 1:100 000 909994
MARIA SERIES Sampled from undisturbed *Lophostemon-Melaleuca* forest.

Depth cm	0-12	12-25	25-46	46-78	78-110	110-140	140-172
Horizon	A1	A12	A2j	B2	2D	3D	3D
pH	5.1	5.3	5.5	5.3	4.6	5.1	4.9
E.C. mS/cm	0.05	0.03	0.02	0.02	0.02	0.02	0.02
T.C. %	2.65		0.06	0.08	0.06		0.05
N %	0.14		<0.01	<0.01	<0.01		
AvP ppm	17		3	3	3		2
P ret %	58			11			
Free Fe%	0.8		0.3	0.4	0.4		0.4
Tot. P %	0.015		0.003	0.003	0.003		0.002
Tot. K %	0.793		0.755	0.744	0.769		0.643
Tot. S %	0.047		0.007	0.009	0.013		0.009
Tot. Fe%	1.338		0.642	0.769	1.067		0.814
Tot. Cu%	0.0004		0.0001	0.0001	<0.0001		0.0001
Tot. Zn%	0.0014		0.0005	0.001	0.0016		0.0012
Tot. Mn%	0.008		0.008	0.008	0.009		0.004
Exchange properties m.e./100 g soil							
Ca	0.04		<0.02	<0.02	<0.02		<0.02
Mg	0.18		0.19	0.19	0.17		0.05
K	0.05		<0.02	0.03	0.04		0.04
Na	0.12		0.10	0.11	0.13		0.10
H + Al	1.28		1.12	1.81	3.05		2.47
'ECEC'(1)	1.7		1.5	2.2	3.4		2.7
'ECEC'/100 g C	8.9		15.0	12.9	12.1		15.9
CEC(2)	8		1	2	3		2
CEC/100 g C	42.1		10	11.7	10.7		11.8
Base Sat(3)	5		33	17	12		10
CEC(4)	2.0		1.9	2.4	3.1		2.7
Particle Size %							
Gr	2	2	1	1	3	19	15
CS	32	25	34	34	26	58	65
FS	35	46	48	42	39	19	14
Si	14	13	8	7	7	5	4
C	19	16	10	17	28	18	17
BD	1.3	1.4	1.6	1.7	1.6		1.7
.1 Bar	31.2	29.0	25.3	25.5	29.4		22.8
15 Bar	16.9	11.3	11.1	16.4	23.6		15.0

Mineralogy of	Depth cm	I%	Ka%	Qz%	Ha/Go%	G%
the clay fraction	75-110	6-10	>80	1-5	<1	<1

(1)Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2)NH_4 OAc (4) Comp. Exch.

MAPPING UNITS: SOILS FORMED ON BEACH RIDGES

Toolakea Association (Ta)

Toolakea association forms part of the youngest beach ridge system and occurs from just south of Cardwell township to the Tully River mouth. It always occupies the frontal ridge but only rarely extends inland beyond about the third ridge. Although there is a prominent ridge-swale topography, the difference in elevation rarely exceeds 2 m. There may be some unstable ridges to 3 m in height around the mouth of some ephemeral streams.

Around Cardwell, Toolakea series occupies the whole of each Unique Map Area (UMA) but to the north Hull series commonly occurs as a co-dominant soil on the inland extremities of each UMA. Needep series occur in the swales that have surface water for extended periods each year while Hewitt series may occur in those that have received some alluvial deposition. Small areas of mangroves may also be included.

Shells or shell and coral fragments only occur on the low berm in front of the first ridge or in aboriginal middens where they are usually associated with charcoal and gravel fragments that have been used as hand tools. Pumice can occur as isolated pieces dispersed through the profile, or as a concentration on the surface, or as a buried layer.

Hull Association (Hu)

Hull association occupies the major section of the younger beach ridge system and ranges from 0.5 km to 2 km wide and forms a continuous system along the coast from Meunga Creek to the Tully River mouth, broken only by ephemeral streams.

Many of the mapped areas of this association were not examined due to very poor access (Fig. 2) and accurate air photo interpretation is difficult. In some areas the ridge-swale pattern of the beach ridges is very indistinct and the closed vine forest vegetation on the beach ridges and adjoining alluvial plains is very similar. As a consequence there is a low level of confidence of both boundary placement and purity of the units.

Several remnants of the ridges on which Hull series are dominant occur throughout the rainforest and swamp lands near Kennedy township where Kennedy and Meunga Creeks have migrated across the tidal zone. In these UMA's the ridge-swale topography is clearly evident with a 20 to 100 m interval between crests and 2-5 m difference in elevation between crest and swale. The swales are generally well drained and the soils differ little from those on the ridge.

In most units there is a gradual increase in degree of profile development in a transect inland from the coast. Where the unit extends to the coastline Toolakea series occur on low stabilised berms just above tidal range. Googarra and Maria series may occur on the inland extremity of some UMA's, and to the south of Dallachy Creek this association abuts the much older ridges of Spanos association.

Googarra Association (Gg)

Googarra association occurs to the north and south of the Murray River and approximately 5 km inland from the coast. The beach ridges on which Googarra series has formed are relatively low (1-2 m above the adjacent swamps and marginally lower than Brosnan and Spanos associations) and have no distinct ridge-swale pattern, although linear form is evident on the air photo pattern.

Those UMA's which occur to the north of Bedford Creek have soils which contain hardened red mottles in the upper part of the B horizon, a feature not common to soils of this association.

Kurrimine Association (Ku)

Only one UMA of this association has been identified, some 7-9 km from the coast in the vicinity of Bedford Creek. It is part of an extensive beach ridge system which is relatively flat with a poorly defined ridge-swale topography. Within Kurrimine association there are small remnants of the higher beach ridges on which Kaygaroo series formed, as well as small areas of yellow sands similar to Spanos series. The soils in the swales are extremely variable but all are podzols of varying degree of development. Small areas of Needep series may be included in very narrow, permanently wet swales.

Kaygaroo Association (Ka)

This association has been mapped in only two areas, one just to the north of the Murray River and one to the south approximately 5-7 km from the coast.

The northern UMA has considerable relief (2-5 m) over the surrounding beach ridge plain. It is a single broad ridge with an aeolian sand capping. Kurrimine series is found on the eastern margins and Googarra series on the western margins of the unit.

The southern UMA lacks the marked relief of the northern UMA and the unit has no ridge-swale topography. Small inclusions of Spanos and Googarra series occur on the northern and southern extremities respectively of the UMA.

Brosnan Association (Br)

Brosnan association occurs between 1 and 9 km from the coast and from just south of Cardwell township north to the Murray River. The ridges have only low relief (1-2 m) but are clearly defined against adjacent landforms on the aerial photographs.

The red sandy soil of Brosnan series is dominant with the yellow sandy Spanos series occurring on the ridge slopes and minor depressions within each UMA. Small areas of Needep series may be included where there is a water table above or near the surface for much of the year. Inclusions of soils from adjacent associations may occur where map scale prohibited more accurate placement of boundaries.

Spanos Association (Sp)

Spanos association occupies an extensive although somewhat complex section of the beach ridges. The units around Cardwell are dominated by the heavy texture variant and most soils also have a thick dark surface. Near Kennedy township the beach ridges have been bisected and truncated by local streams and overlain on their western margins by granitic fan deposits. As a result Canoe and Thorpe series may be included in some UMA's.

In the Murray River - Bedford Creek region many of the lower ridges have been reworked by local streams and Maria series may occur as a major associate. In addition there are some small remnants of the higher beach ridge on which the podzols of Kaygaroo series have formed.

Maria Association (Ma)

The major areas of this assocation occur near the lower reaches of Bedford Creek and the Murray River. There is very little surface relief throughout this unit and no evidence of the ridge-swale pattern common to the beach ridge systems. It is assumed that these soils are formed on beach ridge sands that have been reworked by local streams.

Very limited access and ill-defined photo patterns combined to give generally poor identification of series included within the unit. Maria series probably occupies about 80% of the unit but there are small areas of Spanos series and some of the lower areas have received deposition from local streams. Coom and Timara series have formed on these finer deposits.

Needep Association (Ne)

Many minor occurrences of this association have been mapped. It is particularly common in the swales of all the sand masses where the water table is above the surface throughout the wet season.

SOILS OF BASIC ROCK ORIGIN

Soils in this group have formed both in situ and on alluvial fan materials derived from basic rock.

Pin Gin series is the only soil mapped as having formed in situ on basalt. Marquette series has formed on fan materials which are interpreted as having been derived from basalt which in turn overlies fan materials from granite or possibly in situ granitic saprolite. The latter are common on the low hilly to undulating country between Jarra and Cochable Creeks on the northern side of the Tully River.

Table Top Range is largely granitic but basic intrusives, possibly diorite, occupy most of the southern extremity. Although morphologically very similar to the basaltic soils, these have been identified as a separate series: Dingo series.

Basalt from the Atherton Tableland flowed down the valleys of Cochable Creek and across the Downey Creek-Jarra Creek interfluve. Small remnants are known to exist in the Jarra Creek catchment but they have not been examined or mapped as they are inaccessible and difficult to identify on air-photo pattern.

TABLE 2.

Soils of basic rock origin.

Soils Series	Landform	Major Distinguishing Features
Pin Gin	Plateau above Cochable Creek	Deep, red strongly structured soils. Some profiles have up to 1.5 m of massive clay loam to light clay overlying the strongly structured subsoil.
Marquette	Low hills and fan slopes of the Table Top and Walter Hill Ranges.	Shallow, usually < 1 m of strongly structured reddish brown clay loam to clay typical of Pin Gin series overlying coarse, bright red granitic clays with large amounts of quartz fine gravels typical of Tyson and Utchee series.
Dingo	Low hills and fans of the Table Top and Walter Hill Ranges.	Strongly structured profile; reddish brown clay loam A; red clayey B; mottled at depth.

PIN GIN SERIES (Pg)

CONCEPT

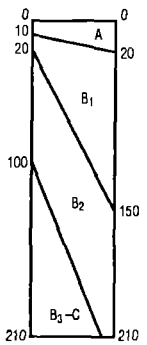
A red structured, uniform to gradational textured, clay loam to clay soil formed from basalt.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	*Krasnozem*	Uf6.31	Acrudox ?	
LANDFORM	Plateau		RAINFALL	3000 mm
REFERENCE SITE	Tully 1:100 000	544372		

Horizon	Depth (cm)	
A11	0 to .10 m	Dark reddish brown (2.5YR3/4); light clay; strong 2-5mm granular or strong 2-5mm cast; many 1-2mm roots; gradual irregular change to
A12	.10 to .20 m	Dark reddish brown (2.5YR3/4); light clay; strong 2-5mm granular or strong 5-10mm cast; many 1-2mm roots; gradual irregular change to
A3	.20 to .90 m	Red (2.5YR4/6); light clay; massive; >5, 1-2mm macropores per 100mm2; few 2-5mm roots; diffuse change to
B1	.90 to 1.50 m	Red (2.5YR4/7); light clay; weak 2-5mm subangular blocky or massive;>5, 1-2mm macropores per 100mm2 ; few 1-2mm roots;
B2	1.50 to 1.70 m	Red (2.5YR4/7); light clay; moderate 5-10mm subangular blocky; few 1-2mm roots; diffuse, irregular change to
B31	1.70 to 2.00 m	Red (2.5YR4/7); light medium clay; strong 5-10mm subangular blocky; 2-10% 20-60mm, subrounded, dispersed basalt gravel; few 1-2mm roots;
B32	2.00 to 2.70 m	Reddish brown (2.5YR4/4); light medium clay; strong 5-10mm polyhedral; 10-20% 20-60mm, subrounded, dispersed basalt gravel; diffuse change to
B33	2.70 to 3.00 m	Reddish brown (2.5YR4/4); medium clay; strong 5-10mm polyhedral; 2-10% 6-20mm, subrounded, dispersed basalt gravel.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	Description
	A	Dark reddish brown (2.5YR-5YR 3/4); clay loam to light clay; strong granular and cast.
	B1	Dark red (2.5YR 3/6) to yellowish red (5YR 3/6); light clay; massive to moderate subangular blocky.
	B2	Dark reddish brown (2.5YR 3/4) to red (2.5YR 4/7); light to medium clay; massive to strong blocky and polyhedral; small weathered basalt fragments may be present.
	B3C	Red (2.5YR 4/6-8); light clay to light medium clay; strong blocky and polyhedral; increasing amounts of weathered basalt.

The deep ≥ 60 cm massive upper sections of some profiles in this survey are different to those described by Murtha (1986). These soils are of limited aerial extent and have been mapped as a massive variant (Pg V).

Vegetation consists of tall closed forest and open forest of rainforest species.

Principal profile forms encountered include Gn 3.11, Uf6.31, and Uf5.31.

ANALYTICAL DATA

Profile T414 Map Reference TULLY 1:100 000 544372
PIN GIN SERIES Massive variant. Sampled from undisturbed rainforest.

Depth cm	0-10	20-30	30-60	90-120	120-150	150-170	170-200	200-250	250-270	270-300
Horizon	A11	A3	A3	B1	B1	B2	B31	B32	B32	B33
pH	5.5	5.5	5.3	5.1	5.2	5.3	5.3	5.3	5.2	5.1
E.C. mS/cm	0.15	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	6.06	2.16	1.58	0.56		0.25			0.13	
N %	0.52		0.16							
AvP ppm	77		160	189	130				34	
P ret%	78		87	88						
Free Fe%	8.4		9.0	9.1	9.5				11.1	
Tot. P %	0.538		0.552	0.448	0.521				0.388	
Tot. K %	0.12		0.1	0.133	0.13				0.05	
Tot. S %	0.103		0.062	0.058	0.59				0.128	
Tot. Fe%	10.6		11.6	11.9						
Tot. Cu%	0.01		0.011	0.013						
Tot. Zn%	0.058		0.017	0.015						
Tot. Mn%	0.528		0.559	0.402						
Exchange properties m.e./100 g soil										
Ca	1.3	0.11	0.06	0.02		0.03			<0.02	
Mg	1.8	0.35	0.17	0.08		0.29			0.24	
K	0.26	0.03	0.03	0.02		0.07			0.02	
Na	0.12	0.05	0.05	0.06		0.05			0.04	
H + Al	0.36		0.26	0.33		0.05			0.08	
'ECEC'(1)	3.8		0.6	0.5		0.5			0.74	
'ECEC'/100 g C	7.6		1.02	1.0		0.71			6.4	
CEC(2)	22		14	10		6			5	
CEC/100 g C(2)	44		23.7	20		8.6			9.3	
Base Sat(3)	16		2	2		7			6	
CEC(4)	4.8		1.6	1.4		1.3			0.6	
Particle Size %										
Gr	0	0	0	0	0	5	12	12	10	0
CS	9	7	6	8	2	2	4	3	4	3
FS	13	11	13	14	8	10	13	15	19	16
Si	28	25	22	24	15	18	20	22	24	25
C	50	57	59	55	74	70	63	60	54	56
BD	.8	.8	.8	1.0	1.0	1.1	1.2	1.2	1.2	1.2
.1 Bar	43.0	42.0	42.8	48.3	47.9	48.5	48.0	47.5	45.0	45.7
15 Bar	36.6	27.3	28.6	33.1	35.2	35.8	38.1	36.4	36.0	37.4

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%	Ha/Go%	G%
	20-30	1-5	66-80	1-5	11-20	6-10
	250-270	1-5	66-80	1-5	11-20	6-10

(1)Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2)NH_4 OAc (4) Comp. Exch.

MARQUETTE SERIES (Mq)

CONCEPT

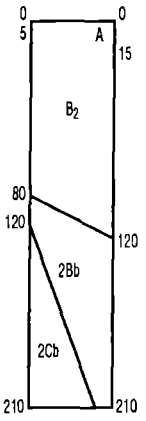
Strongly structured red soils of basic rock origin overlying granitic fans or granitic saprolite.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	*Krasnozem*	Gn3.11	Acrudox or Hapludox ?	
LANDFORM	Low hill		RAINFALL	3500 mm
REFERENCE SITE	Tully 1:100 000	761165		

Horizon	Depth (cm)	
A1	*0 to .14 m*	Reddish brown (2.5YR4/4); clay loam; moderate 2-5mm subangular blocky; moist, moderately weak; common 1-2mm roots; gradual, wavy change to
A12	.14 to .29 m	Red (2.5YR4/6); clay loam; moderate 2-5mm subangular blocky; moist, moderately weak; common 1-2mm roots; gradual, wavy change to
B1	.29 to .49 m	Dark red (2.5YR3/6); clay loam (heavy); moderate 2-5mm subangular blocky; moist, moderately weak; few 1-2mm roots; gradual change to
B2	.49 to .95 m	Dark red (2.5YR3/6); medium clay; moderate 5-10mm polyhedral parting to moderate 2-5mm angular blocky; moist, moderately weak; clear, smooth change to
2Bb	.95 to 1.49m	Red (2.5YR4/8); medium clay; moderate 2-5mm angular blocky; moist, moderately firm; 2-10% 2-6mm, angular, dispersed quartz gravel; gradual, irregular change to
2Cb	1.49 to 1.80m	Red (2.5YR4/8); 20-50% 5-15mm prominent white (7.5YR8/1) primary and reddish yellow (7.5YR7/8) secondary mottles; medium clay ; moderate 2-5mm subangular blocky; moist, moderately firm; 2-10% 2-6mm, angular, dispersed quartz gravel; 2-10% 2-6mm manganiferous, soft, segregations.

Depth range (cm)



Limited access allowed only a few soils to be examined. *In general this* series has an upper profile with morphology similar to Pin Gin series and underlain by material similar to Tyson or Utchee series.

Tall closed forest of rainforest species.

Principal profile forms encountered incude Gn3.11 and Ul6.31.

ANALYTICAL DATA

Profile T358 Map Reference TULLY 1:100 000 739217
MARQUETTE SERIES Sampled from undisturbed rainforest.

Depth cm	0-14	14-29	29-49	49-79	79-95	95-125	125-149	149-180
Horizon	A1	A12	B1	B2	B2	2Bb	2Bb	2Cb
pH	4.6	4.9	5.0	5.0	5.0	5.1	4.9	5.0
E.C. mS/cm	0.26	0.08	0.03	0.02	0.02	0.01	0.01	0.02
T.C. %	0.55		0.18	0.15		0.06		
N %	0.03	0.02	0.02	0.02				
AvP ppm	8	4	5	5		5		4
P ret %	60		76	76		27		29
Exchange properties m.e./100 g soil								
Ca	0.67		<.02	0.02		0.02		<.02
Mg	0.84		0.11	0.1		0.15		0.15
K	0.28		0.11	0.1		0.1		0.1
Na	0.11		0.04	0.04		0.03		0.03
H + Al	1.55	0.86	0.32	0.12		1.51		2.22
'ECEC'(1)	3.5		0.6	0.4		1.8		2.5
'ECEC'/100 g C	6.5		0.9	0.6		4.6		4.3
CEC(2)	9		5	5		4		3
CEC/100 g C(2)	16.7		7.7	6.2		7.7		5.2
Base Sat(3)	21		6	6		10		10
CEC(4)	2.7		1.2	0.7		2.1		0.5
Particle Size %								
Gr	0	0	1	1	1	18	4	5
CS	15	15	12	11	12	46	38	22
FS	6	1	7	11	8	6	5	5
Si	25	20	16	14	14	9	12	15
C	54	59	65	64	66	39	45	58
BD	.80	.97	.98	.99	.99	1.28	1.13	1.23
.1 Bar	28.8	34.9	34.7	33.5	33.5	23.7	28.9	26.6
15 Bar	22.0	25.8	26.7	28.3	28.3	18.9	22.1	28.3

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%	G%
	49-79	1-5	51-65	1-5	1-5	21-30	11-20
	95-125	1-5	>80	-	-	6-10	1-5

(1)Sum of basic and acidic cations

(2)NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

DINGO SERIES (Di)

CONCEPT

Moderate to strongly structured red soil formed from basic dykes within the granitic hills.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Krasnozem	Gn3.11	Hapludox	
LANDFORM	Low hill		RAINFALL	3500 mm
REFERENCE SITE	Tully 1:100 000 763166			

Horizon	Depth	
A1	0 to .12 m	Dark reddish brown (2.5YR3/4); clay loam; strong 2-5mm granular or strong 2-5mm cast; moist, moderately weak; 1-5, 1-2mm macropores per *100mm2 ; clear change to*
B21	.12 to .30 m	Red (10R4/8); medium clay; 5-10mm subangular blocky parting to moderate 2-5mm subangular blocky; moist, moderately weak; 1-5, 1-2mm macropores per 100mm2 ;
B22	.30 to .90 m	Red (10R4/8); medium clay; 5-10mm subangular blocky parting to *moderate 2-5mm subangular blocky; moist moderately weak;* 2-10% 2-6mm manganiferous nodules; 1-5, 1-2mm macropores per 100mm2 ;
B23	.90 to 1.20 m	Red (10R4/8); medium clay; 5-10mm subangular blocky parting to strong 2-5mm subangular blocky; moist, moderately weak; 1-5, 1-2mm macropores per 100mm2 ; diffuse change to
B24	1.20 to 1.40 m	Red (10R4/6); <2% <5mm *faint reddish yellow (5YR6/8) mottles; medium* heavy clay; 5-10mm subangular blocky parting to strong 2-5mm subangular blocky; moist moderately firm; <2% 20-60mm, argillaceous nodules; <1, 1-2mm macropores per 100mm2;
B/C	1.40 to 1.60 m	Red (10R4/6); 2-10% 5-15mm distinct reddish yellow (5YR6/8) mottles; medium heavy clay; 20-50mm prismatic parting to strong 10-20mm prismatic; moist moderately firm; 2-10% 20-60mm, argillaceous nodules; <1, 1-2mm macropores per 100mm2;
B/C	1.60 to 1.80 m	Red (10R4/6); 10-20% 5-15mm distinct reddish yellow (5YR6/8) mottles; medium heavy clay; 20-50mm prismatic parting to strong 10-20mm prismatic; moist moderately firm; 2-10% 20-60mm, argillaceous nodules; <1, 1-2mm macropores per 100mm2.

Dingo series has been mapped only on a small section of the Table Top Range. It supports vegetation that ranges from a relatively poor sclerophyll forest to rainforest but there appears to be no apparent difference in the soil .

ANALYTICAL DATA

Profile T444 Map Reference TULLY 1:100 000 763166
DINGO SERIES Sampled from undisturbed sclerophyll forest.

Depth cm	0-12	12-20	20-30	30-60	60-90	90-120	120-140	140-160	160-180
Horizon	A1	B21	B21	B22	B22	B23	B24	BC	BC
pH	5.2	5.2	5.2	5.1	5.0	5.1	5.1	5.2	5.2
E.C. mS/cm	0.08	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02
T.C. %	5.12	3.12		0.88		0.29			
N %	0.21	0.11		0.03					
AvP ppm	11	8		4		4		4	
P ret %	73	70		73					
Free Fe%	8.2	8.8				10.4			
Tot. P %	0.036	0.026		0.017		0.008		0.007	
Tot. K %	0.094	0.335		0.075		0.187		0.277	
Tot. S %	0.057	0.044		0.088		0.083		0.084	
Tot. Fe%	10.1	10.8		12.1		12.8		12.4	
Tot. Cu%	0.0007	0.0007		0.0005		0.0005		0.0004	
Tot. Zn%	0.0031	0.0037		0.0031		0.0028		0.0026	
Tot. Mn%	0.081	0.056		0.047		0.015		0.016	
Exchange properties m.e./100 g soil									
Ca	1.64	0.10		<0.02		0.03		<0.02	
Mg	1.26	0.30		0.43		0.51		0.57	
K	0.21	0.05		0.02		0.04		<0.02	
Na	0.14	0.03		0.02		0.05		0.04	
H + Al	1.08	1.21		0.28		2.36		3.96	
'ECEC'(1)	4.3	1.7		0.8		3.0		4.6	
'ECEC'/100 g C	7.8	2.8		1.2		5		9.8	
CEC(2)	13	9		4		6		7	
CEC/100 g C(2)	23.6	14.7		5.9		10.0		14.9	
Base Sat(3)	25	5		12		10		1	
CEC(4)	2.1	2.0		1.0		1.1		1.5	
Particle Size %									
Gr	1	0	1	2	1	1	0	1	0
CS	12	8	7	6	4	5	5	4	4
FS	10	9	9	8	6	8	9	12	12
Si	23	22	19	18	22	28	33	37	38
C	55	61	64	68	68	60	53	47	46
B D	.9	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.3
.1 Bar	34.8	41.5	40.1	43.4	49.1	46.6	45.9	42.5	41.8
15 Bar	27.6	35.2	33.7	37.1	45.3	40.8	39.9	38.6	-

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%	G%
	12-20	1-5	66-80	1-5	<1	11-20	6-10

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

MAPPING UNITS - SOILS OF BASIC ROCK ORIGIN

Pin Gin Association (Pg)

This association is restricted to the minor basalt flows along the upper reaches of the Tully River in the general vicinity of Cochable Creek. Pin Gin series occurs exclusively and the soils are generally very deep.

The largest UMA is a plateau some 250 m above Cochable Creek. Here the profile morphology differs from the modal strongly structured soil (Murtha 1986) in having a massive upper profile and this has been recognised as a variant (Pg V).

Pin Gin association has also been mapped in combination with Utchee association near the junction of the Tully River and Cochable Creek. These UMA's consist of dissected low hills and slopes where the underlying granite has been exposed. A combination of map scale and lack of access prevented separation of these diverse soils. Typical cross sections of these UMA's have Pin Gin series on the interfluve and Utchee and Tyson series on the mid and lower slopes respectively.

Marquette Association (Mq)

Marquette association occurs on fans of mixed basic rock origin which have covered granitic slopes to varying depths. This feature appears to be quite common although the aerial extent is unknown due to poor access and uniform air photo patterns, a result of dense vegetative cover. Some small areas have been mapped around the foothills of Table Top Range but it is certain that Marquette series is more extensive than is depicted on the map.

Dingo Association (Di)

This association is mapped at the southern extremity of the Table Top Range across Dingo Pocket and Scougall roads. While the soil colour and strongly structured nature of this soil is indicative of a basic rock origin only small fragments of diorite were found in the profile. Soil boring did not identify any associated unweathered substrate material.

This soil series is of minor extent and contrasts strongly with the granitic soils which surround it.

While there are two very distinct vegetation communities occurring on this soil; a poor sclerophyll forest dominated by *Eucalyptus intermedia*, and a rainforest community, no significant soil morphological differences were observed.

Mountainous Unit (M3)

Small remnants of the once extensive basalt flows that originated on the Atherton Tablelands occur throughout the extensive granitic mountain complex. They are generally plateau-like in form with very steep sides where the granitic basement rocks may be exposed. Their presence is very difficult to detect by photo interpretation and it is almost certain that they are more numerous than shown on the map.

The plateau surfaces are generally covered by a relatively thin mantle of strongly structured soils of the Pin Gin series and on some there may be substantial amounts of core stones and basalt outcrop. Minor slopes may carry a mixture of soils derived from basalt and granite and here Pin Gin, Utchee and Marquette series may be found.

SOILS OF ACID IGNEOUS ROCK ORIGIN

The soils of this group have been derived from three distinct parent materials; Tully granite, the Glen Gordon acid volcanics and an undifferentiated granite. These parent materials have very similar lithology and as a result the soils that have developed on them have very similar morphology.

Soils of this group dominate the survey area occupying approximately 60% of the total area. They range from the well drained, red earths and structured red soils of the mountains and higher fan slopes to poorly drained, coarse gradational and duplex soils. The latter occur dominantly where there is a significant slope change but may occupy minor depressions throughout the fan landscape.

Eighteen series have been identified, three of which were first described in this survey, the remainder are common to other survey areas (Table 3). Their relative landscape position is shown in Figure 7. Many of the granitic soils are underlain by strongly weathered materials which contain all the weathering products of granite. In augered material it is often difficult to distinguish between *in situ* saprolite and transported material, as a result the identification of *in situ* soils is somewhat subjective. Three series (Utchee, Cadillah, Elphinstone) have been described as *in situ* and tend to dominate the high mountain and low hill units.

The fine grained nature of the acid volcanic rocks was not reflected in the soils. All series have coarse angular quartz gravels in some or all profiles with Cudmore and Porter series having the least amount.

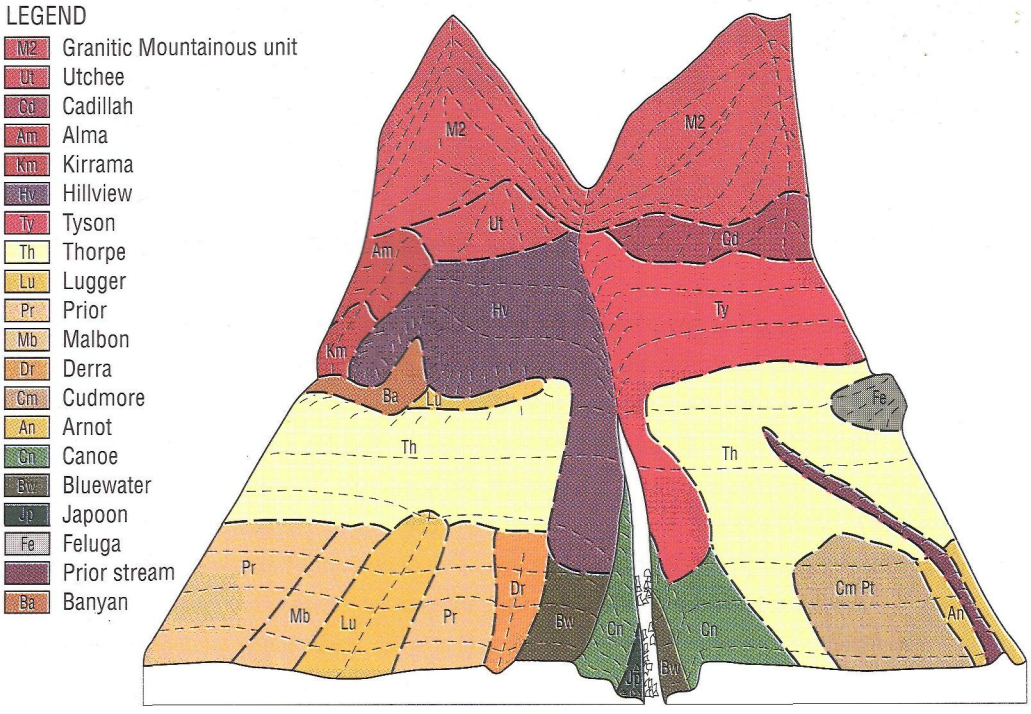


Figure 7. Schematic diagram of soils of acid igneous rock origin.

TABLE 3.

Soil of acid igneous rock origin.

Soils Series	Landform	Major Distinguishing Features
Utchee	Low hills and mountains.	Dark reddish brown sandy clay loam to clay A horizon; red, fine gravelly sandy clay to medium heavy clay B horizon with moderate to strong blocky structure over strongly weathered saprolite from 150 to 250 cm.
Cadillah	Low hills and mountains, rarely lower slopes.	Dark to dark reddish brown A horizon; a pale A2 horizon with a strongly structured red B horizon; over saprolite.
Elphinstone	Low hills and mountains, rarely lower slopes.	Dark to pale brown A horizon; pale to bleached A2 horizon; strongly structured yellow B horizon; commonly < 1.5 m to mottled saprolite.
Tyson	Upper slope of fans.	Gradational to uniform profile; red sandy clay loam to clay B horizon; commonly fine gravelly; rainforest vegetation.
Hillview	Upper slope of fans.	Gradational to uniform profile red sandy clay loam to clay B horizon; commonly fine gravelly; sclerophyll vegetation.
Alma	Slopes of low hills and upper slopes of fans.	Deep ≥ 20 cm dark (both moist and dry) A horizon; bright red medium to heavy clay massive B horizon.
Kirrama	Mid slope of fans	Deep ≥ 20 cm dark (both moist and dry) A horizon grading to a bright yellow sandy clay loam to medium clay B horizon.
Thorpe	Mid slope of fans	A massive, uniform to gradational, yellow sandy loam to sandy clay soil commonly fine gravelly throughout.
Prior	Mid to lower slope position on larger low angle fans.	A yellow and grey mottled, massive to weakly structured gradational to uniform sandy clay loam to medium heavy clay soil; commonly fine gravelly throughout.

Soils Series	Landform	Major Distinguishing Features
Malbon	Mid to lower slope position on larger low angle fans.	A grey mottled, massive to weakly structured, gradational to uniform, sandy clay loam to medium heavy clay soil commonly fine gravelly throughout.
Lugger	Lower slope of fans.	A grey massive, uniform to gradational, sandy loam to sandy clay loam soil commonly fine gravelly throughout.
Rungoo	Mid to lower slope of fans.	Fine gravelly sandy loam to sandy clay loam A1 horizon; bleached A2 horizon abruptly overlying a mottled fine gravelly clay by 90 cm, massive to weakly structured B2 horizon.
Banyan	Swamps and drainage depressions of the low angle fans.	Sapric to fibric loam A horizons with fine gravelly coarse sand to sandy clay B horizons.
Porter	Low angle fans.	Mottled grey duplex soils with dark A horizons and non-gravelly sandy clay loam to heavy clay B horizons.
Cudmore	Low angle fans.	Mottled grey gradational soils with pale to dark A horizons and grey non-gravelly clayey B horizons.
Arnot	Low angle fans and prior streams.	Uniform to weakly gradational textured fine sandy loam or sandy loam, to light sandy clay loam; mottled yellow grey B horizons.
Glenborra	Prior streams on the low angle fans.	Uniform to weakly gradational yellow fine sandy loam or sandy loam to light sandy clay loam soils.
Feluga	Lower slopes and remnants of fans.	Gradational to duplex; pale to bleached A2 horizon, mottled red and yellow clayey B horizon; fine to coarse ironstone gravels occur in the lower A and upper B horizons.

GLENBORRA SERIES (Gb)

CONCEPT

A massive, yellow sandy soil.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	
CLASSIFICATION:	Earthy sand	Uc4.21	
LANDFORM:	Prior stream, channel infill	RAINFALL	2250 mm
REFERENCE SITE:	Kirrama 1:100 000 877820		

Horizon	Depth	
A1	0 to .10 m	Dark brown (7.5YR 4/2); fine sandy loam, massive or weak cast; gradual change to
A2	.10 to .15 m	Light yellowish brown (10YR 6/5); sand to clayey sand; single grain
B2	.15 to .60 m	Yellow (10YR 7/6); clayey sand to sandy loam (heavy); single grain; fine gravels common; single grain
C	.60 to 1.20 m	Very pale brown (10YR 7/4); sand; single grain; fine gravels are common.

This soil is closely associated with Arnot series but is distinguished by its whole coloured yellow B horizon. It occurs on channel infill within the Arnot, Cudmore and Porter associations.

The range in profile characteristics is generally as described above with the greatest variation occurring below the AB profile where C or D horizons may be sand to clay texture.

Vegetation is mid-high sclerophyll woodland with *Casuarina* species understorey.

UTCHEE SERIES (Ut)

CONCEPT

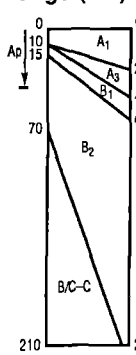
Gradational to uniform textured soil formed in situ on granite, with a weak to moderately structured red B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	No suitable group	Uf6.53/p	Kanhapludult	
LANDFORM	Low hilly		RAINFALL	3000 mm
REFERENCE SITE	Tully 1:100 000	634276		

Horizon	Depth (cm)	
Ap	0 to .20 m	Dark brown (7.5YR3/3), (7.5YR5/3 d); sandy light clay; moderate 2-5mm cast; <2% 2-6mm, angular, dispersed quartz gravel; many 1-2mm roots; gradual, irregular change to
A3	.20 to .30 m	Brown (7.5YR4/3), (10YR5/3 d); sandy light clay; weak 2-5mm angular blocky; 2-10% 2-6mm, angular, dispersed quartz gravel; common 2-5mm roots; diffuse, irregular change to
B1	.30 to .40 m	Brown (7.5YR4/4); sandy medium clay; massive; 2-10% 2-6mm, angular, dispersed quartz gravel; few 2-5mm roots; gradual, irregular change to
B21	.40 to .90 m	Red (2.5YR5/8); sandy medium clay; massive; 10-20% 2-6mm, angular , dispersed quartz gravel; few 2-5mm roots; diffuse, irregular change to
B22	.90 to 1.50 m	Red (2.5YR5/8); 2-10% 5-15mm distinct reddish yellow (7.5YR7/8) mottles; sandy medium clay; moderate 2-5mm angular blocky; 2-10% 2-6mm, angular, dispersed quartz gravel; diffuse, irregular change to
B/C	1.50 to 2.10 m	Red (2.5YR5/8); 20-50% 5-15mm distinct, reddish yellow (7.5YR7/8) mottles; sandy medium clay; moderate 2-5mm angular blocky; 2-10% 2-6mm, angular, dispersed quartz gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 11	Description
	Ap	19:8	Black (5YR-10YR 2/1) to reddish brown (5YR 4/3); sandy clay loam to light clay; weak subangular blocky and cast.
	A1	16:6	Very dark brown (7.5YR 2/2) to dark reddish grey (5YR 4/2); clay loam to light medium clay; moderate to strong cast or granular to subangular.
	A3		Dark brown (7.5YR 3/2) to strong brown (7.5YR 5/6); sandy light clay to light medium clay; weak to moderate subangular blocky.
	B1		Dark reddish brown (5YR 3/4) to strong brown (7.5YR 5/8) clay loam sandy to light medium clay; massive to moderate subangular blocky.
	B2	82:34	Red (2.5YR 5/8) to yellowish red (5YR 5/8) with reddish yellow (7.5YR 6-7/6-8) mottles at depth; light clay to medium heavy clay; moderate to strong subangular and angular blocky.
	B/C		Increasing amounts of weathered granite dominantly red (2.5YR 5/8), reddish yellow (7.5YR 6/8) and pink (7.5YR 8/4); light to medium clay texture.

Uniform fine (Uf) and gradational (Gn) profile forms are co-dominant. The deep and strongly weathered nature of these profiles makes the identification of an *in situ* soil difficult. However structure was found to be generally more evident in soils that are clearly formed *in situ* than in soils formed on transported material.

Similar soils with a distinct pale A2 horizon are identified as Cadillah series.

Typical vegetation communities are dominantly rainforest although areas of sclerophyll woodlands occur.

Principal profile forms encountered include Uf6.53, Gn3.11 and Gn3.14.

ANALYTICAL DATA

Profile T410 Map Reference TULLY 1:100 000 660145
UTCHEE SERIES Sampled from fertilized pasture paddock.

Depth cm	0-10	10-20	20-30	30-40	40-60	60-90	90-120	120-150	150-180	180-210
Horizon	Ap	Ap	A3	B1	B21	B21	B22	B22	B/C	B/C
pH	5.5	5.3	5.3	5.2	5.1	5.2	5.2	5.1	5.1	5.1
E.C.mS/cm	0.05	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01
T.C. %	3.04		1.68		0.66			0.06		
N %	0.08		0.07		0.04			0.01		
AvP ppm	190		77		4			3		
Free Fe%	1.1		1.4		1.8			1.3		
Tot. P %	0.077		0.017		0.0041			0.0048		
Tot. K %	0.06		0.07		0.09			0.26		
Tot. S %	0.034		0.019		0.021			0.026		
Tot. Fe%	1.2		1.4		1.6					
Tot. Cu%	0.0014		0.0006		0.0006					
Tot. Zn%	0.0016		0.0016		0.002					
Tot. Mn%	0.016		0.013		0.01					
Exchange properties m.e./100 g soil										
Ca	1.1		0.3		0.26			<0.02		
Mg	0.42		0.05		0.06			0.12		
K	0.24		0.05		0.03			0.03		
Na	0.05		0.03		0.03			0.03		
H + Al	0.7		0.83		0.83			1.35		
'ECEC'(1)	2.5		1.3		1.2			1.6		
'ECEC'/ 100 g C	8.6		3.7		2.9			5.5		
CEC(2)	7		6		3			3		
CEC/100 C	24.1		17.1		7.1			10.3		
Base Sat(3)	26		7		13			7		
CEC(4)	2.5		1.8		1.7			2.4		
Particle Size %										
Gr	9	17	32	35	24	19	18	25	25	43
CS	54	47	47	46	41	32	26	30	30	27
FS	7	9	8	8	7	7	9	8	9	8
Si	10	10	10	10	10	15	22	34	25	23
C	29	34	35	37	42	46	44	29	37	42
BD	1.1	1.3	1.6	1.6	1.5	1.5	1.6			
.1 Bar	18.8	19.4	18.6	18.0	20.8	31.0	31.4			
15 Bar	9.3	9.8	9.5	7.9	14.0	27.7	26.2			

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%	G%
	40-60	1-5	>80	1-5	1-5	6-10	1-5

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

CADILLAH SERIES (Cd)

CONCEPT

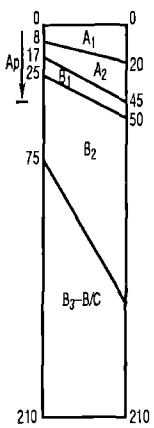
Gradational and uniform textured soil with a pale A2 and a red structured B horizon, formed in situ on granite or acid volcanics.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	? Red Podzolic	Uf4.43	Typic Kanhapludult	
LANDFORM	Low hill		RAINFALL	3000 mm
REFERENCE SITE	Tully 1:100 000	630245		

Horizon	Depth	
A11	0 to .20 m	Black (10YR2/1); light medium clay; strong 5-10mm cast; many 2-5mm roots; diffuse wavy change to
A12	.20 to .30 m	Very dark greyish brown (10YR3/2); medium clay; moderate 2-5mm subangular blocky; 0.075-1mm macropores; common 2-5mm roots; clear wavy change to
A2	.30 to .45 m	Yellowish red (5YR4/6); 10-20% 5-15mm prominent dark brown (7.5YR3/2) mottles; medium clay; moderate 2-5mm subangular blocky; 1-5, 0.075-1mm macropores per 100mm^2 ; few 1-2mm roots; clear wavy change to
B2	.45 to .90 m	Red (2.5YR5/8); medium clay; moderate 2-5mm subangular blocky; 1-5 0.075-1mm macropores per 100mm^2 ; few <1mm roots; gradual irregular change to
B3	.90 to 1.95m	Red (2.5YR4/8); 20-50% 5-15mm distinct yellow (10YR 7/8) primary and white (10YR 8/1) secondary mottles; medium clay; moderate 2-5mm subangular blocky; <1, 0.075-1mm macropores per 100mm^2 .

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	$\bar{x}:\sigma$ n=6	Description
	A1	12:4	Black (10YR 2/1) to brown (7.5YR 4/4); sapric loam to light medium clay; weak to strong granular or cast
	A2	13:6	Yellowish red (5YR 4/6) to brown (7.5YR 5/4); sandy clay loam to medium clay; massive to weak subangular blocky
	B1		Yellowish red (5YR 4-5/6-8); sandy light clay to medium clay; weak to moderate subangular blocky
	B2	71:40	Red (2.5YR 5/8) to strong brown (7.5YR 5/8); sandy light clay to medium clay; weak to moderate subangular blocky; ironstone nodules may be present
	B3-BC		Variable amounts of weathered acid igneous rock fragments grading to mottled C horizon of decomposed granitic or acid volcanic rocks.

Cadillah differs from Utchee series in having a distinct pale A2 horizon. The finer grained Glen Gordon volcanics appear to be the most common substrate.

The vegetation is dominantly mid-high to tall woodlands of *Eucalyptus acmeniodes, E. cloeziana* and rainforest.

Principal profile forms encountered include Uf4.43, Gn3.14, Gn3.74 and Dy2.21.

ANALYTICAL DATA

Profile T411 Map Reference TULLY 1:100 000 630245
CADILLAH SERIES Sampled from undisturbed vine forest with eucalypt and *Acacia* emergents.

Depth cm	0-10	10-20	20-30	30-45	45-60	60-90	90-120	120-150	150-180	180-195
Horizon	A11	A11	A12	A2	B2	B2	B3	B3	B3	B3
pH	4.7	4.7	5.0	5.0	5.1	5.2	5.1	5.1	5.0	5.0
E.C.mS/cm	0.23	0.06	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01
T.C. %	6.03		2.75			0.34			0.12	
N %	0.28		0.11			0.02				
AvP ppm	17		4			1			1	
Free Fe%	1.4		1.8			1.8			1.0	
Tot. P %	0.023		0.014			0.0094			0.0069	
Tot. K %	0.5		0.65			0.0102			1.11	
Tot. S %	0.052		0.024			0.026			0.015	
Tot. Fe%	1.6		1.9			2.0				
Tot. Cu%	0.0007		0.0006			0.0005				
Tot. Zn%	0.0019		0.0021			0.0028				
Tot. Mn%	0.007		0.006			0.005				
Exchange properties m.e./100 g soil										
Ca	1.1		0.13		0.07	0.1			0.06	
Mg	0.86		0.14		0.26	0.26			0.37	
K	0.23		0.06		0.03	0.04			0.02	
Na	0.08		0.04		<0.02	0.05			0.05	
H + Al	1.22		1.99			3.03			5.54	
'ECEC'(1)	3.5		2.4			3.5			6.0	
'ECEC'/ 100 g C	8.3		5.1			6.7			13.9	
CEC(2)	20		12			6			7	
CEC/100 C	47.6		25.5			11.5			16.3	
Base Sat(3)	11		3			7			7	
CEC(4)	2.9		2.6			2.9			5	
Particle Size %										
Gr	10	9	11	10	8	7	7	5	11	12
CS	30	23	21	20	17	16	18	20	18	14
FS	11	10	11	9	9	10	14	15	13	12
Si	17	23	21	18	20	22	25	27	26	26
C	42	44	47	53	55	52	43	39	43	48
BD	1.0	1.1	1.2	1.4	1.4	1.4	1.4	1.5	1.6	1.5
.1 Bar	34.2	39.6	39.4	39.2	38.5	37.7	36.1	37.3	36.4	39.2
15 Bar	25.6	32.8	29.2	32.0	32.2	30.8	26.5	28.3	29.4	30.9

Mineralogy of the clay fraction	Depth cm	I%	Ka%	RIM%	Qz%	Ha/Go%	G%
	45-60	11-20	66-80	<1	1-5	1-5 <1	

(1)Sum of basic and acidic cations

(2)NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

ELPHINSTONE SERIES (Es)

CONCEPT

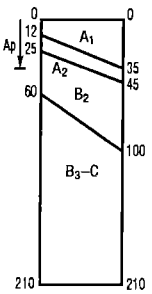
Duplex or gradational textured soil with pale A2 horizon, rarely bleached and yellow structured, B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Yellow Podzolic Soil	Dy4.21	Kandiustalf ?
LANDFORM	Hillslope	RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000 930808		

Horizon	Depth	
A11	0 to .20 m	Very dark grey (10YR3/1); clay loam, sandy (heavy); strong 2-5mm cast; dry; 2-10% 2-6mm, subangular, dispersed quartz gravel; diffuse, wavy change to
A12	.20 to .35 m	Dark greyish brown (10YR4/2); clay loam, coarse sandy; moderate 2-5mm subangular blocky; dry; 10-20% 2-6mm, subangular, dispersed quartz gravel; gradual, wavy change to
A2	.35 to .45 m	Brown (10YR5/3), (10YR6/4 d); coarse-sandy clay loam; weak 2-5mm subangular blocky; 20-50% 6-20mm, subangular, dispersed quartz gravel; clear, smooth change to
B2	.45 to .60 m	Reddish yellow (7.5YR6/6); medium clay; strong 2-5mm subangular blocky; 10-20% 2-6mm, subangular, dispersed quartz gravel; diffuse, wavy change to
BC	.60 to .75 m	Yellow (10YR7/8); 20-50% 5-15mm distinct, reddish yellow (5YR6/8) mottles; medium heavy clay; moderate 2-5mm subangular blocky; 10-20% 2-6mm, subangular, dispersed same as substrate material ; diffuse, wavy change to
C	.75 to .98 m	Yellow (10YR7/6); 20-50% 15-30mm prominent dark red (10R3/6) mottles; medium heavy clay; moderate 2-5mm subangular blocky; 10-20% 2-6mm, subangular, dispersed same as substrate material .

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	A1	Very dark grey (10YR 3/1) to brown (10YR 4/3); sandy clay loam to clay loam sandy; moderate to strong subangular blocky or granular
	A2	Dark yellowish brown (10YR 4/4) to brown (10YR 5/3), rare sporadic bleach; weak to moderate sub-angular blocky
	B2	Reddish yellow (5YR-7.5YR 6/6-8) to brownish yellow (10YR 6/8); sandy light clay to medium clay; common angular quartz gravels; weak to strong subangular blocky
	B3-C	Weathered granitic fragments, grading to weathered granite substrate.

Vegetation is mid-high to tall woodlands of *Eucalyptus intermedia, E. acmenoides* and *Syncarpia glomulifera*.

Principal profile forms encountered include Dy4.21, Gn3.24 and Gn2.24.

ANALYTICAL DATA

Profile T365 Map Reference KIRRAMA 1:100 000 930808
ELPHINSTONE SERIES Sampled from undisturbed eucalypt woodland.

Depth cm	0-10	10-20	20-30	30-35	35-45	45-60	60-75	75-90	90-98
Horizon	A11	A12	A12	A12	A2	B2	BC	BC	C
pH	5.8	5.9	6.1	6.0	6.1	5.7	5.8	5.9	6.1
E.C. mS/cm	0.03	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.01
T.C. %	5.2		2.34			0.47		0.11	
N %	0.15		0.07						
AvP ppm	7		4			3		2	
P ret %	63								
Free Fe%	1.2	1.0	1.2	0.9	1.0	1.3		1.3	
Tot. P %	0.013		0.008			0.004	0.002		
Tot. K %	0.11		0.11			0.13	0.16		
Tot. S %	0.02		0.011			0.007	0.011		
Tot. Fe%	1.3		1.7			2.1			
Tot. Cu%	<0.0005		<0.0005			<0.0005			
Tot. Zn%	0.001		0.0013			0.002			
Tot. Mn%	0.011		0.007			0.006			
Exchange properties m.e./100 g soil									
Ca	0.92		0.28			0.03		<0.02	
Mg	0.82		1.11			1.4		2.77	
K	0.2		0.09			0.07		0.09	
Na	0.05		0.03			0.02		0.03	
H + Al	1.29		0.88			1.04		0.56	
'ECEC'(1)	3.3		2.4			2.6		3.5	
'ECEC'/100 g C	13.2		8.9			5.8		6.5	
CEC(2)	16.4		8.7			4.6		4.8	
CEC/100 g C(2)	65.6		32.2			10.2		8.9	
Base Sat(3)	12		17			33		61	
CEC(4)	2.9		2.3			3.0		3.5	
Particle Size %									
Gr	10	7	12	13	18	11	12	13	13
CS	48	37	42	46	49	36	24	25	28
FS	18	22	21	21	20	10	6	4	4
Si	9	11	10	9	8	9	14	16	16
C	25	30	27	25	23	45	56	54	51

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%
	45-60	1-5	>80	<1	1-5	<1

(1)Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2)NH_4 OAc (4) Comp. Exch.

TYSON SERIES (Ty)

CONCEPT

A gradational or uniform textured soil with a red massive B horizon. On granite fans with rainforest vegetation.

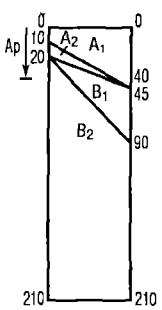
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Red Earth	Gn2.14/p	Kandiudult	
LANDFORM	Alluvial fan		RAINFALL	2389 mm
REFERENCE SITE	Kirrama 1:100 000 755079			

Horizon	Depth	
Ap	0 to .20 m	Dark brown (7.5YR3/2); sandy clay loam; weak 2-5mm cast; >5, 1-2mm macropores per 100mm^2; many 2-5mm roots; diffuse, wavy change to
A3	.20 to .30 m	Dark brown (7.5YR3/4); clay loam, sandy; massive; >5, 1-2mm macropores per 100mm^2; common 2-5mm roots; diffuse, irregular change to
B1	.30 to .60 m	Reddish brown (5YR4/4); clay loam, sandy; massive; <5mm cracks; <2% 6-20mm ferruginous soft segregations; >5, 1-2mm macropores per 100mm^2; few 1-2mm roots; diffuse, irregular change to
B21	.60 to1.50m	Red (10R4/8); sandy clay (light); massive; >5, 1-2mm macropores per 100mm^2; few <1mm roots; diffuse, wavy change to
B22	1.50 to1.80m	Red (10R5/8); sandy light clay; massive; 2-10% 20-60mm, angular dispersed quartz gravel; <10% of ped faces or walls coated with distinct, clay skin cutans; >5, 1-2mm macropores per 100mm^2; diffuse, wavy change to
B23	1.80 to 2.05m	Red (10R5/8); 10-20% 15-30mm faint, light red (10R6/8) mottles; sandy light clay; massive; <5mm cracks; 2-10% 20-60mm, angular, dispersed quartz gravel; <10% of ped faces or walls coated with distinct, clay skin cutans; >5, 1-2mm macropores per 100mm^2.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n = 10	Description
	Ap	24:10	Dark brown (7.5YR 3/2); clay loam sandy to sandy light clay.
	A1	23:19	Dark brown (7.5YR 3/2) to brown (7.5YR 4/3); sandy loam to sandy light clay loam; common angular quartz gravels; gradual or clear change
	A2	15:9	Dark reddish brown (5YR 3/4) to brown (7.5YR 4/4); coarse sandy loam to clay loam sandy; massive to weak subangular blocky; gradual or diffuse change
	B1		Reddish brown (5YR 4/4) to yellowish red (7.5YR 5/8); clay loam sandy to medium clay; massive to weak subangular blocky; gradual or diffuse change



B2 47:38 Red (10R-2.5YR 4-5/8) and yellowish red (5YR 3-5/6-8); sandy clay loam to medium clay; common angular quartzitic gravels; massive to weak subangular blocky

C Weathered granite

Many profiles examined had heavier textures in the surface horizons than described by Murtha (1986). A heavy texture variant may be mappable at a larger scale. Tyson differs from Hillview series by having a lower base saturation in the B horizon and vegetation dominated by rainforest species. It differs from Utchee series by the absence of structure throughout the profile.

Principal profile forms encountered include Gn2.14, Gn2.11 and Um5.21.

ANALYTICAL DATA

Profile T408 Map Reference KIRRAMA 1:100 000 755079
TYSON SERIES Sampled from fertilized improved pasture

Depth cm	0-10	10-20	20-30	30-45	45-60	60-90	90-120	120-150	150-180	180-205
Horizon	Ap	Ap	A3	B1	B21	B21	B21	B21	B22	B23
pH	5.4	5.3	5.1	5.1	5.1	5.1	5.3	5.4	5.0	5.4
E.C.mS/cm	0.05	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01
T.C. %	4.19		1.55		0.84		0.22		0.12	
N %	0.17		0.06		0.05		0.03		0.01	
AvP ppm	83		8		2					
Free Fe%	1.8				2.0				1.4	
Tot. P %	0.055		0.019		0.017					
Tot. K %	0.05		0.04		0.02					
Tot. S %	0.042		0.022		0.018					
Tot. Fe%	1.8		1.9		2.0					
Tot. Cu%	0.0008		0.0007		0.0007					
Tot. Zn%	0.0011		0.0012		0.0011					
Tot. Mn%	0.022		0.016		0.017					
Exchange properties m.e./100 g soil										
Ca	0.87		0.09		0.03		0.07		0.07	
Mg	0.55		0.05		0.02		0.03		0.08	
K	0.22		0.02		<0.02		<0.02		<0.02	
Na	0.06		0.03		0.02		0.02		0.02	
H + Al	1.64		1.67		1.56		1.4		0.11	
'ECEC'(1)	3.3		1.9		1.7		1.5		0.3	
'ECEC'/ 100 g C	12.7		6.1		5.3		4.0		0.8	
CEC(2)	11		5		5		2		1	
CEC/100 C	42.3		16.1		15.6		5.4		2.8	
Base Sat3	15		4		2		7		19	
CEC(4)	2.7		1.8		1.5		1.0		0.9	
Particle Size %										
Gr	1	1	4	2	4	2	7	9	12	11
CS	46	48	44	44	43	41	38	42	45	45
FS	23	19	22	22	21	20	22	19	17	16
Si	5	5	3	3	3	2	2	2	2	1
C	26	28	31	31	32	37	37	37	36	38
BD	1.1	1.3	1.3	1.3	1.3	1.4	1.3	1.3	1.3	1.4
.1 Bar	27.2	25.3	24.6	29.2	23.8	26.3	24.5	29.9	22.8	22.7
15 Bar	15.8	15.0	14.4	16.1	15.1	16.5	15.9	14.9	13.6	15.3

(1)Sum of basic and acidic cations

(2)NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

HILLVIEW SERIES (Hv)

CONCEPT

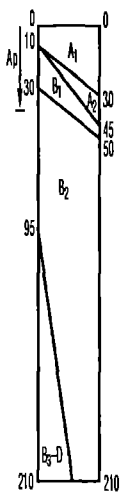
A gradational or uniform textured soil with a red massive B horizon. On granite fans with sclerophyll vegetation.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Red Earth	Gn2.14	Paleustalf	
LANDFORM	Alluvial fan		RAINFALL	2250 MM
REFERENCE SITE	Cardwell 1:100 000 068654			

Horizon	Depth	
A1	0 to .10 m	Very dark grey (10YR3/1); sandy clay loam (light); massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; common 1-2mm roots; gradual, smooth change to
A2	.10 to .20 m	Brown (10YR4/3); sandy clay loam; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel; common 1-2mm roots; gradual, smooth change to
B1	.20 to .40 m	Yellowish red (5YR5/6); clay loam, sandy; massive; 20-50% 2-6mm, subangular, dispersed quartz gravel; common 1-2mm roots; diffuse, wavy change to
B2	.40 to 2.00 m	Red (2.5YR4/8); coarse sandy clay loam; massive; 50-90% 6-20mm, subangular, dispersed quartz gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n=8	Description
	Ap	17:13	Dark reddish brown (5YR 2/2) to dark brown (7.5YR 3/2); coarse sandy loam to clay loam, sandy; massive to weak subangular blocky or cast; common angular quartz gravels
	A1	16:9	Very dark grey (7.5YR 3/1) to brown (7.5YR 4/4); light sandy clay loam to sandy clay loam; common angular and subangular quartzitic gravels
	A2	13:3	Dark brown (7.5YR-10YR 3-4/3-4); coarse sandy loam to coarse sandy clay loam; massive to weak subangular blocky; common angular and subangular quartzitic gravels; clear or gradual change
	B1		Dark red (2.5YR 3/6) to yellowish red (5YR 5/6); sandy clay loam to sandy light clay; common angular to subangular quartzitic gravels
	B2	74:39	Strong brown (7.5YR 4/6) to reddish yellow (5YR 6/6); sandy loam to medium clay; common angular and subangular quartzitic gravels
	B3-D		Brownish yellow (10YR 6/6); sand to sandy clay loam; massive

Vegetation is low woodlands to closed forests of *Eucalyptus drepanophylla*, *E. acmenoides*, *E. alba*, *E. intermedia* and *Planchonia careya*.

Principal profile forms encountered include Gn2.11, Gn2.14 and Um5.21.

ANALYTICAL DATA

Profile T360 Map Reference CARDWELL 1:100 000 068654
HILLVIEW SERIES Sampled from undisturbed eucalypt forest.

Depth cm	0-10	10-20	20-30	30-40	40-60	60-90	90-120	120-150	150-180	180-200
Horizon	A1	A2	B1	B1	B2	B2	B2	B2	B2	B2
pH	6.2	6.0	5.9	6.1	6.1	6.1	6.2	6.2	6.3	6.0
E.C.mS/cm	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	2.66	1.47	0.83		0.33	0.09		0.13		
N %	0.11	0.08	0.04							
AvP ppm	6		3							
P ret %	30									
Free Fe%	0.9		1.2		1.2					
Tot. P %	0.009		.007		.008					
Tot. K %	2.9		3.22		3.1					
Tot. S %	0.013		.007		.005					
Tot. Fe%	1.3		1.6							
Tot. Cu%	.0015		.0014							
Tot. Zn%	.002		.0024							
Tot. Mn%	.094		.075							
Exchange properties m.e./100 g soil										
Ca	3.17		0.76		0.88	1.32		1.28		
Mg	1.06		0.57		0.62	0.98		1.40		
K	0.38		0.15		0.16	0.15		0.16		
Na	0.06		0.03		0.02	0.02		<0.02		
H + Al	0.17		0.3		0.12	0.15		0.20		
'ECEC'(1)	4.8		1.8		1.8	2.6		3.1		
'ECEC'/100gC	36.9		10.6		9.0	12.4		18.2		
CEC(2)	7.9		3.2		2.3			3.4		
CEC/100gC(2)	60.7		18.8		11.5			20.0		
Base Sat3	59		47		73			84		
CEC(4)	4.3		2.0		2.1			3.5		
Particle Size %										
Gr	6	9	15	18	28	24	22	15	15	12
CS	50	47	45	44	48	49	52	48	40	43
FS	23	26	27	27	22	20	17	19	20	18
Si	14	12	11	11	10	10	10	16	17	15
C	13	14	17	18	20	21	21	17	23	24

Mineralogy of the clay fraction	Depth cm	I%	G%	Qz%	Ka%
	60-90	11-20	1-5	1-5	60-80

(1) *Sum of basic and acidic cations* (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

HILLVIEW SERIES FINE VARIANT (HvV)

CONCEPT

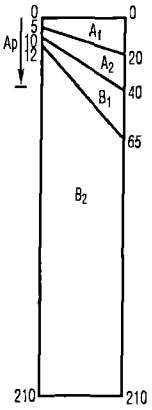
Similar to Hillview series but with finer (less coarse sand) field textures through the profile.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Red Earth	Gn2.24	Paleustult
LANDFORM	Alluvial fan		RAINFALL
REFERENCE SITE	Cardwell 1:100 000	081596	

Horizon	Depth	
A11	0 to .05 m	Very dark grey (10YR3/1); sandy clay loam; massive; moderately moist very weak; <2% 2-6mm, subangular, dispersed quartz gravel; few 1-2mm roots; clear, smooth change to
A12	.05 to .10 m	Very dark greyish brown (10YR3/2); sandy clay loam; massive; moderately moist, very weak; <2% 2-6mm, subangular, dispersed quartz gravel; few 1-2mm roots; gradual, wavy change to
A2	.10 to .25 m	Brown (7.5YR4/3); clay loam, sandy; massive; moderately moist moderately weak; <2% 2-6mm, angular, dispersed quartz gravel; few 1-2mm roots; diffuse, wavy change to
B1	.25 to .60 m	Yellowish red (5YR5/6); clay loam, sandy (heavy); massive; moderately moist, moderately weak; <2% 2-6mm, angular, dispersed quartz gravel; few 2-5mm roots; diffuse, wavy change to
B21	.60 to 1.20 m	Red (2.5YR5/8); sandy clay; massive; moderately moist moderately weak; 10-20% 2-6mm, angular, dispersed quartz gravel,; few 2-5mm roots; diffuse, wavy change to
B22	1.20 to 1.50 m	Red (2.5YR4/8); 20-50% 5-15mm distinct, light brown (7.5YR6/4) primary and yellow (10YR8/8) secondary mottles; sandy light clay; massive; moderately weak; 10-20% 200-600mm, subangular, dispersed unconsolidated substrate material; diffuse, wavy change to
B3	1.50 to 1.95 m	Brownish yellow (10YR6/5); 10-20% 5-15mm distinct red (2.5YR4/8) primary and yellow (10YR8/8) secondary mottles; sandy light clay ; massive; moderately weak; 20-50% 200-600mm, subangular, dispersed unconsolidated substrate material.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	x̄:σ n = 10	Description
	A11-12	12:4	Very dark grey (5YR-10YR 3/1) to dark brown (7.5YR-10YR 3/1-2); sandy clay loam to clay loam sandy; massive to moderate cast or subangular blocky
	A2	12:4	Dark reddish brown (5YR 3/3) to dark brown (7.5YR 3/4) to strong brown (7.5YR 5/6); sandy clay loam to clay loam, sandy
	B1		Dark brown (7.5YR 3/3) to yellowish red (5YR 5/8); clay loam to light medium clay
	B2	59:28	Red (10R-2.5YR 4-5/8) to yellowish red (5YR 5/8); clay loam, sandy to medium clay; subrounded quartzitic gravels and manganese nodules have been recorded in lower horizons.

Hillview fine variant generally has finer textures and much lower fine gravel content than Hillview series. Tyson and Hillview series are very similar soils and are distinguished in the field on their original vegetation which was rainforest and dry sclerophyll communities respectively.

Principal profile forms encountered include Gn2.11, Gn2.21, Gn2.24 and Um 5.21.

ANALYTICAL DATA

Profile T359 Map Reference CARDWELL 1:100 000 081596
HILLVIEW SERIES Fine variant. Sampled from undisturbed eucalypt open forest.

Depth cm	0-5	5-10	10-20	20-25	25-30	30-60	60-90	90-120	120-150	150-130
Horizon	A11	A12	A2	A2	B1	B1	B21	B21	B22	B3
pH	6.5	5.9	6.0	5.8	5.6	5.6	5.7	5.8	5.9	5.9
E.C.mS/cm	0.04	.02	.02	.01	.02	.02	.01	.01	.01	.01
T.C. %	3.41	1.71		0.63		0.34	0.19		0.13	
N %	0.16	0.10								
AvP ppm	19	7	5	5	5	4	4			
P ret %	19									
Free Fe%	1.3			1.4		1.3			1.3	
Tot. P %	.02			.009			.009			
Tot. K %	2.4						2.4			
Tot. S %	.02			.008			.008			
Tot. Fe%	1.4			1.6						
Tot. Cu%	.0011			.0011						
Tot. Zn%	.0038			.0036						
Tot. Mn%	.085			.053						
Exchange properties m.e./100 g soil										
Ca	6.00			0.45		0.16	0.12		0.37	
Mg	1.88			0.70		0.62	0.76		1.29	
K	0.42			0.14		0.13	0.18		0.21	
Na	0.04			0.09		<.02	<.02		0.03	
H + Al	<.05			0.60		1.06	1.67		1.25	
'ECEC'(1)	8.4			2.0		2.0	2.8		3.2	
'ECEC'/100gC	60.0			11.0		9.5	11.7		13.9	
CEC(2)	10.7					4.0	4.4			
CEC/100g C(2)	76.4					19.1	18.3			
Base Sat3	80					23	24			
CEC(4)	6.3			2.2		2.5	3.1		3.4	
Particle Size %										
Gr	0	1	1	3	6	4	2	2	2	5
CS	38	33	29	25	27	26	28	29	29	37
FS	29	32	36	37	35	34	32	29	30	26
Si	20	20	19	18	18	19	16	18	17	16
C	14	16	16	20	20	21	24	24	23	20

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc CEC (4) Comp. Exch.

ALMA SERIES (Am)

CONCEPT

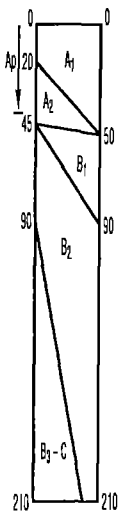
A uniform to gradational soil, with a dark (both moist and dry) ≥ 20 cm A horizon and a red massive (rarely structured) B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Red Earth	Gn2.14	Haplustox	
LANDFORM	Hillslope		RAINFALL	2250
REFERENCE SITE	Kirrama 1:100 000 844944			

Horizon	Depth	
A1	0 to .30 m	Black (10YR2/1); sandy clay loam (light); massive; moderately weak; many 2-5mm roots; diffuse, broken change to
A2	.30 to .45 m	Very dark grey (5YR3/1); sandy clay loam; massive; moderately weak; common 1-2mm roots; clear, wavy change to
B1	.45 to .50 m	Reddish brown (5YR4/3); light clay; massive; moderately firm; few 1-2mm roots; clear, wavy change to
B2	.50 to 2.00 m	Red (2.5YR4/8); medium clay; massive; moderately firm; 20-50% 2-6mm, subangular, dispersed quartz gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n = 9	Description
	Ap	38:10	Black (10YR 2-3/1); sapric loam to clay loam; massive to weak subangular blocky or cast
	A1	38:9	Black (7.5YR-10YR 2/0-1) to dark brown (7.5YR 3/2-3); sapric loam to clay loam; common angular quartzitic gravels; massive to moderate cast and subangular blocky; gradual or diffuse change
	A2	14:5	Very dark grey (5YR 3/1) to brown (7.5YR 4/4); light sandy clay loam to sandy clay loam; clear or gradual change
	B1		Dark brown (7.5YR 3/4) to strong brown (7.5YR 5/8); clay loam to light clay; massive to moderate subangular blocky
	B2	68:44	Yellowish red (5YR 3/6) to red (2.5YR 4-5/8), distinct, reddish yellow (7.5YR 6/8) mottles may occur in lower B; clay loam to medium clay; common angular gravels; massive to moderate subangular blocky; ironstone nodules have been recorded.
	B3-C		Increasing amounts of weathered granite.

The black (both moist and dry) A horizon to a depth ≥ 20 cm separates this from all other red soils of granitic origin. Mid-high woodlands to open forests of *Eucalyptus intermedia, E. acmenoides*, and *Casuarina torulosa*.

Principal profile forms encountered include Gn2.14, Gn2.11, Gn3.11, Um7.11 and Dr2.11.

ANALYTICAL DATA

Profile T361 Map Reference KIRRAMA 1:100 000 844944
ALMA SERIES Sampled from undisturbed eucalypt open forest.

Depth cm	0-10	10-20	20-30	30-45	45-50	50-60	60-90	90-120	120-150	150-180
Horizon	A1	A1	A1	A2	B1	B2	B2	B2	B2	B2
pH	5.4	5.1	5.0	4.9	5.1	5.3	5.4	5.5	5.5	5.6
E.C.mS/cm	0.07	0.06	0.04	0.04	0.03	0.02	0.01	0.01	0.01	0.01
T.C. %	9.01		5.19	4.0		0.65				
N %	0.34		0.21	0.14		0.04				
AvP ppm	9	9	5	3	3	2				
P ret %	82		83		78		41			
Free Fe%	2.0		1.9			2.4				
Tot. P %	0.03		0.021			0.011	0.008			
Tot. K %	0.19		0.16			0.13	0.06			
Tot. S %	0.05		0.032			0.016	0.024			
Tot. Fe%	1.5		2.1			2.4				
Tot. Cu%	0.0005		<0.0005			<0.0005				
Tot. Zn%.	0.0016		0.0027			0.0033				
Tot. Mn%	0.016		0.01			0.007				
Exchange properties m.e./100 g soil										
Ca	2.5		0.11			<0.02	<0.02		<0.02	
Mg	1.0		0.23			0.66	0.83		1.13	
K	0.18		<.02			<0.02	<0.02		<0.02	
Na	0.03		0.03			<0.02	<0.02		<0.02	
H + Al	0.76		2.46			0.71			0.12	
'ECEC'(1)	4.5		2.9			3.5			1.3	
'ECEC'/100gC	13.6		6.0			7.0			2.0	
CEC(2)	24.2		17.1			1.4			3.2	
CEC/100gC(2)	73.3		35.6			2.8			4.8	
Base Sat(3)	15		2			53			37	
CEC(4)	4.2		2.5			1.9			2.4	
Particle Size %										
Gr	13	7	9	18	19	22	20	22	22	19
CS	35	33	32	29	34	36	35	36	26	29
FS	13	12	13	13	12	10	9	7	6	6
Si	13	11	7	7	5	4	2	1	1	3
C	39	44	48	51	50	50	54	56	66	62

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%	Ha/Go%	G%
	60-90	1-5	>80	1-5	1-5	6-10

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

KIRRAMA SERIES (Km)

CONCEPT

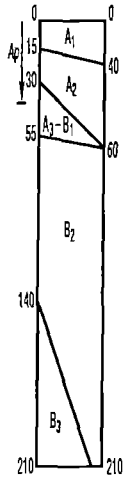
A uniform to gradational soil, with a dark (both moist and dry) ≥ 20 cm A horizon and a yellow massive (rarely structured) B horizon

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Yellow Earth	Gn2.21	Kandiustult	
LANDFORM	Alluvial fan		RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000	853933		

Horizon	Depth	
A11	0 to .10 m	Black (10YR2/1), (10YR2/1 d); sapric sandy clay loam; massive; very weak;
A12	.10 to .30 m	Very Dark grey (10YR3/1), (10YR3/2 d); sandy clay loam; massive, very weak; diffuse, broken change to
A3/B1	.30 to .55 m	Dark yellowish brown (10YR4/4); 10-20% 5-15 mm faint,brownish yellow (10YR6/8) mottles; sandy clay loam; massive; moderately weak; 2-10% 2-6mm, angular, dispersed quartz gravel; gradual, irregular change to
B21	.55 to 1.00 m	Yellow (10YR7/8); sandy light clay; massive; moderately weak; 20-50% 2-6 mm, subangular, dispersed quartz gravel; diffuse, broken change to
B22	1.00 to 1.40 m	Yellow (10YR7/8); 10-20% 5-15mm prominent, red (2.5YR4/8) mottles; sandy light clay; massive; moderately firm; 20-50% 2-6mm. subangular, dispersed quartz gravel; diffuse, broken change to
B/C	1.40 to 2.00 m	Red (2.5YR4/8); 10-20% 5-15mm distinct, yellow (10YR7/8) mottles; sandy light clay; massive; moderately firm; 20-50% 2-6mm, subangular, dispersed quartz gravel;

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 4	Description
	A1	31:12	Black (10YR 2/1) to very dark grey (10YR 3/1); light sandy clay loam to sandy clay loam (often sapric); massive to weak to moderate cast
	A2	18:4	Brown (10YR 5/3) to yellowish brown (10YR 5/4); coarse sandy loam; massive, earthy; clear or gradual change
	A3-B1		Brown (10YR 5/3) to yellowish brown (10YR 5/4); sandy clay loam to clay loam, sandy; gradual or diffuse change
	B2	68:50	Olive yellow (2.5Y 6/6) to yellow (10YR-2.5Y 7/6-8) with prominent red (7.5R-10R 5/8) mottles at depth; sandy clay loam to medium clay; clear or diffuse change
	B3-B/C		Yellow (2.5Y 7/6) to red (2.5YR 4/8) mottling of both matrix colours may become dominant; sandy clay to medium clay; massive to weak subangular blocky.

The colour of the lower B horizon may change sharply from whole coloured yellow to whole coloured red.

Vegetation is low woodland to open forest of *Eucalyptus drepanophylla, E. intermedia, E. acmenoides* and *Casuarina torulosa*.

Principal profile forms encountered include Gn2.21, Gn2.24 and Um4.23.

ANALYTICAL DATA

Profile T362 Map Reference KIRRAMA 1:100 000 853933
KIRRAMA SERIES Sampled from undisturbed eucalypt forest.

Depth cm	0-10	10-20	20-30	30-45	45-55	60-90	100-120	140-150	150-180	180-200
Horizon	A11	A12	A12	A3	B1	B21	B22	BC	BC	BC
pH	5.4	4.8	5.1	5.2	5.3	5.5	5.6	5.4	5.3	5.4
E.C.mS/cm	0.01	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	5.45		2.88			0.24	0.11		0.1	
N %	0.28		0.12							
AvP ppm	7	4	3	2	2	2			4	
P ret %	64		66		43	32				
Free Fe%	1.3		1.4			1.5				
Tot. P %	0.02		0.012			0.01			0.015	
Tot. K %	0.15		0.06			0.06			0.05	
Tot. S %	0.039		0.029			0.02			0.018	
Tot. Fe%	1.4		1.8			2.0				
Tot. Cu%	<0.0005		<0.0005			<0.0005				
Tot. Zn%	0.002		0.003			0.0036				
Tot. Mn%	0.013		0.012			0.01				
Exchange properties m.e./100 g soil										
Ca	0.16		<0.02			<0.02			<0.02	
Mg	0.24		0.06			0.45			0.85	
K	<0.02		<0.02			<0.02			<0.02	
Na	0.02		<0.02			0.04			0.03	
H + Al	2.9		1.9			0.26			0.1	
'ECEC'(1)	3.3		2.0			0.8			1.0	
'ECEC'/100g C	12.7		6.1			2.2			1.8	
CEC(2)	17.1		9.5			2.3			2.6	
CEC/100gC(2)	65.8		28.8			6.2			4.7	
Base Sat3	3		1			23			35	
CEC(4)	3.0		1.8			1.7			2.2	
Particle Size %										
Gr	3	6	8	11	15	15	24	21	19	22
CS	56	47	46	48	46	47	40	40	36	32
FS	12	17	16	15	16	14	12	8	8	8
Si	6	6	5	5	4	2	3	2	2	3
C	26	30	33	32	34	37	45	50	55	57

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	G%
	60-90	<1	>80	1-5	1-5	1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

THORPE SERIES (Th)

CONCEPT

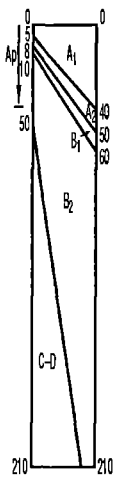
A uniform to gradational textured soil with a yellow massive B horizon fine gravel throughout.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Yellow Earth	Gn2.21	Kanhaplic Haplustalf
LANDFORM	Alluvial fan		RAINFALL 2250
REFERENCE SITE	Cardwell 1:100 000 074656		

Horizon	Depth	
A1	0 to .10 m	Very dark grey (10YR3/1), (10YR6/3 d); *coarse sandy light clay loam*; weak 2-5mm granular; 10-20% 2-6mm, subangular, dispersed quartz gravel; clear, smooth change to
A/B	.10 to .20 m	Brown (10YR4/3); sandy clay loam; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel; gradual, wavy change to
B1	.20 to .40 m	*Yellowish brown (10YR5/4); clay loam, sandy (heavy); massive*; 2-10% 2-6mm, subangular, dispersed quartz gravel; diffuse, wavy change to
B21	.40 to .60 m	Yellowish brown (10YR5/8); sandy medium clay; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel; diffuse, smooth change to
B22	.60 to .90 m	Olive yellow (2.5Y6/6); sandy light clay; massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; clear, smooth change to
D1	.90 to 1.50 m	Brownish yellow (10YR6/6); sandy clay loam (light); massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; clear, smooth change to
D2	1.50 to 1.80 m	Brownish yellow (10YR6/8); sand; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel; clear, smooth change to
D3	1.80 to 1.90 m	Very pale brown (10YR7/4); coarse sand; massive; 50-90% 6-20mm, subangular, dispersed granite, gravel; 10-20% 2-6mm manganiferous nodules.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ n = 34	Description
	Ap	21:9	Black (10YR 2/1) to brown (10YR 4/3); sandy loam to sandy light clay *(heavy variant); massive to weak subangular blocky or cast; common* angular quartzitic gravels,.
	A1	15:11	Very dark grey (10YR 3/1) to dark greyish brown (10YR 6/4); loamy sand to clay loam to light clay (heavy variant); massive to weak cast or subangular blocky; common angular quartzitic gravels.
	A2	12:5	Dark greyish brown (10YR 4/2) to light yellowish brown (10YR 6/4); loamy sand to clay loam, sandy to light clay (heavy variant); massive; common angular quartzitic gravels; gradual or clear change
	B1		Dark brown (7.5YR-10YR 3/2-3) to brownish yellow (10YR 6/6) light sandy clay loam to clay loam, sandy to light medium clay (heavy variant); massive; common angular quartzitic gravels.
	B2	42:24	Yellowish brown (10YR 5/6-8) to brownish yellow (10YR 6/6-8) occasinally yellow (10YR 7/8) and olive yellow (2.5YR 6/6); sandy clay loam to medium clay; massive; common angular quartzitic gravels.
	C/D		Stratified coarse and fine sand dominated by granitic gravels and rarely clayey layers.

Thorpe differs from Kirrama series by the absence of a deep dark A horizon. Two variants have been recognized, a fine variant lacking the fine gravels throughout, and a heavy variant which has clayey field textures and Uf texture profiles.

Vegetation is low woodland to closed forest of *Eucalyptus alba, E. intermedia, E. drepanophylla, E. acmenoides, E. teretercornis, Lophostemon* and *Syncarpia* species.

Principal profile forms encountered include Gn2.21, Um5.51, Gn2.24 and Uf/p.

ANALYTICAL DATA

Profile T364 Map Reference CARDWELL 1:100 000 074656
THORPE SERIES Sampled from undisturbed eucalypt open forest.

Depth cm	0-10	10-20	20-30	30-40	40-60	60-90	90-120	120-150	150-180	180-190
Horizon	A1	AB	B1	B1	B21	B22	2D	2D	3D	4D
pH	6.3	6.6	6.8	6.3	6.0	6.1	5.9	6.0	6.1	6.1
E.C.mS/cm	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.013
T.C. %	1.63		0.55		0.22			0.21		
N %	0.07		0.03							
AvP ppm	7		2		3			3		
P ret %	21									
Free Fe%	1.1		1.3		1.2					
Tot. P %	0.01		0.006					0.007		
Tot. K %	3.4		3.42					3.4		
Tot. S %	0.01		0.006					0.005		
Tot. Fe%	1.7		2.1		2.6					
Tot. Cu%	0.0011		0.0006		0.0006					
Tot. Zn%	0.0022		0.0028		0.0041					
Tot. Mn%	0.048		0.03		0.013					
Exchange properties m.e./100 g soil										
Ca	3.48		2.02		1.75			0.7		
Mg	0.93		0.78		1.27			1.09		
K	0.21		0.15		0.09			0.16		
Na	0.02		<0.02		0.02			0.02		
H + Al	<0.05		0.06		0.23			0.27		
'ECEC'(1)	4.7		3.0		3.4			2.2		
'ECEC'/100gC	39.2		14.3		11.7			11.0		
CEC(2)	6.3		4.4		5.7			3.7		
CEC/100gC(2)	52.5		21.0		19.7			18.5		
Base Sat(3)	73		68		55			53		
CEC(4)	5		3.4		3.7			2.6		
Particle Size %										
Gr	7	11	12	13	7	1	2	0	2	44
CS	49	43	37	35	33	31	41	34	64	55
FS	25	27	28	25	28	32	32	37	16	19
Si	13	14	14	13	10	11	8	9	5	11
C	12	16	21	27	29	26	19	20	14	15

Mineralogy of the clay fraction	Depth cm	f%	Ka%	Ch/V%	Qz%	Ha/Go%
	40-60	11-20	>80	1-5	1-5	<1

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH4 OAc (4) Comp. Exch.

PRIOR SERIES (Pr)

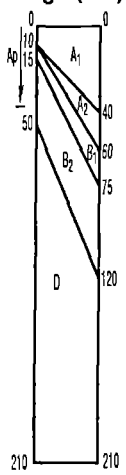
CONCEPT
A gradational textured soil with a yellow grey mottled B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Gleyed Podzolic	Gn2.84	? Kanhaplic Haplustult
LANDFORM	*Alluvial fan*		RAINFALL 2250 mm
REFERENCE SITE	Kirrama 1:100 000 843989		

Horizon	Depth	
A11	0 to .05 m	Very dark grey (10YR3/1); coarse sandy clay loam (light); weak 2-5mm cast; many <1mm roots; clear, smooth change to
A12	.05 to .10 m	Dark greyish brown (10YR4/2); coarse sandy clay loam (light); massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; many <1mm roots; clear, smooth change to
A2	.10 to .15 m	Yellowish brown (10YR5/4); coarse sandy clay loam (light); massive; 10-20% 2-6mm, subangular, dispersed quartz gravel; common <1mm roots; diffuse, wavy change to
B21	.15 to .30 m	Brownish yellow (10YR6/6); 10-20% 5-15mm distinct, brownish yellow (10YR6/8) primary and yellowish red (5YR4/8) secondary mottles; coarse sandy clay loam; massive; 20-50% 2-6mm, subangular, dispersed quartz gravel; few <1mm roots; gradual, wavy change to
B22	.30 to 1.20 m	Light brownish grey (10YR6/2); 20-50% 5-15mm prominent strong brown (7.5YR5/8) mottles; coarse sandy light clay; massive; 20-50% 2-6mm, subangular, dispersed quartz gravel; clear, smooth change to
2D	1.20 to 1.50 m	Grey (10YR6/1); 10-20% <5mm faint reddish yellow (7.5YR6/8) mottles; coarse sandy loam; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel; clear, smooth change to
3D	1.50 to 2.00 m	Grey (10YR6/1); 2-10% <5mm faint reddish yellow (7.5YR6/8) mottles; medium heavy clay; massive; 10-20% 2-6mm, subangular, dispersed quartz gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n = 13	Description
	Ap	17:6	Very dark grey (10YR 3/1) to very dark greyish brown (10YR 3/2); sandy clay loam to sandy light clay; massive to weak subangular blocky.
	A1	17:11	Very dark greyish brown (10YR 3/1) to dark greyish brown (10YR 4/2); clay loam to light clay; common angular quartzitic gravels; massive to moderate cast and subangular blocky.
	A2	14:9	Grey (10YR 5/1) to light yellowish brown (10YR 6/4), may be bleached; coarse sandy loam to clay loam, sandy;
	B1		Brown (10YR 5/3) to light grey (10YR 7/1), distinct brownish yellow (10YR 6/6.8) mottles; clay loam to light medium clay; common angular quartz gravels; massive to moderate subangular and angular blocky.
	B21	57:30	Yellowish brown (10YR 5/8) to brownish yellow (10YR 6/6-8), common distinct light grey (10YR 7/1) and yellow (10YR 6/8) mottles; clay loam to medium heavy clay; massive to moderate subangular blocky.
	B22		Grey (10YR 6/1) to light brownish grey (10YR 6/2) with red (10R 4/8) to brownish yellow (10YR 6/6-8) mottles; sandy clay loam to medium heavy clay; massive to moderate subangular blocky.
	D		Grey (10YR 6/1) to light grey (10YR 7/1) with yellowish red (5YR 5/6) to reddish yellow (7.5YR 6/8) mottles; light sandy clay loam to medium heavy clay; massive to moderate subangular and angular blocky

The yellow-grey upper B horizon distinguishes this soil from Malbon series, and the prominent mottling in the B horizon, distinguishes this soil from Thorpe series.

Vegetation is dwarf to mid-high woodlands of *Eucalyptus intermedia, E. tesselaris, Melaleuca* and *Casuarina* species.

Principal profile forms encountered include Gn2.84, Gn2.91, Gn3.71 and Uf6.62/p.

ANALYTICAL DATA

Profile T367 Map Reference KIRRAMA 1:100 000 843989
PRIOR SERIES Sampled from undisturbed *Melaleuca* low woodland.

Depth cm	0-5	5-10	10-15	20-30	30-60	60-90	90-120	120-150	150-180	180-200
Horizon	A11	A12	A2	B21	B22	B22	B22	2D	3D	3D
pH	5.9	5.6	5.7	5.8	5.5	5.7	6.1	6.0	5.7	5.7
E.C.mS/cm	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	2.89	1.62		0.31	0.13			0.05		
N %	0.15	0.08								
AvP ppm	2				2					
P ret %	28									
Free Fe%	1.0				1.1			0.4	0.3	
Tot. P %	0.009				0.003			0.001	0.004	
Tot. K %	3.06				3.44			1.0	0.54	
Tot. S %	0.031				0.012			0.002	0.003	
Tot. Fe%	1.3			1.6	1.8					
Tot. Cu%	0.0006			0.0005	0.0008					
Tot. Zn%	0.0024			0.0026	0.0026					
Tot. Mn%	0.012			0.009	0.007					
Exchange properties m.e./100 g soil										
Ca	0.16	0.05		0.02	0.02			<0.02	<0.02	
Mg	0.29	0.17		0.25	0.49			0.34	0.75	
K	0.08	0.11		0.09	0.06			0.04	0.08	
Na	0.03	0.04		0.05	0.02			<0.02	0.02	
H + Al	1.54	1.02		0.73	1.12			0.67	1.01	
'ECEC'(1)	2.1	1.4		1.1	1.7			1.1	1.9	
'ECEC'/100gC	11.7	8.7		6.5	8.1			7.9	6.6	
CEC(2)	6.5	3.8		1.0	3.8			1.6	2.0	
CEC/100gC(2)	36.1	23.7		5.9	18.1			11.4		
Base Sat3	9	10		41	15			26	44	
CEC(4)	2.3	1.3		1.3	2.1			1.7	1.7	
Particle Size %										
Gr	1	6	18	15	18	37	23	12	13	29
CS	56	60	59	54	50	48	47	53	47	41
FS	13	15	16	18	17	16	19	21	14	12
Si	13	10	10	10	12	12	13	12	10	8
C	18	16	14	17	21	25	21	14	29	39

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%
	30-60	6-10	>80	-	1-5	-
	150-180	1-5	>80	-	1-5	-

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH4 OAc (4) Comp. Exch.

MALBON SERIES (Mb)

CONCEPT

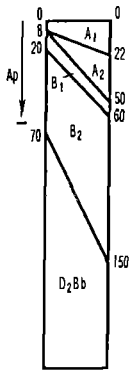
A gradational or duplex textured soil with a grey mottled massive to moderately structured B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	No Suitable Group	Gn2.81	Typic Kandiaquult
LANDFORM	Alluvial fan		RAINFALL 2250 mm
REFERENCE SITE	*Kirrama* 1:100 000	867914	

Horizon	Depth	
A	0 to .10 m	Very dark greyish brown (10YR3/2); coarse-sandy clay loam (light); massive; moderately moist very weak; 2-10% 2-6mm, subangular, dispersed quartz gravel; common 1-2mm roots; gradual, irregular change to
A/B	.10 to .17 m	Dark grey (10YR4/1); 20-50% 15-30mm distinct, light yellowish brown (10YR6/4) mottles; coarse sandy clay loam (light); massive; moderately moist, very weak; 2-10% 2-6mm, subangular, dispersed quartz gravel; common 1-2mm roots; diffuse, irregular change to
B1	.17 to .28 m	Light grey (10YR7/2); clay loam,coarse sandy; massive; moderately moist moderately weak; 2-10% 2-6mm, subangular, dispersed quartz gravel; few 2-5mm roots; clear, smooth change to
B21	.28 to .45 m	Light brownish grey (2.5Y6/2); 20-50% 15-30mm distinct, olive yellow (2.5Y6/8) mottles; sandy light clay; massive; moderately moist, moderately weak; 2-10% 2-6mm, subangular, dispersed quartz gravel; few 2-5mm roots; diffuse, irregular change to
B22	.45 to .90 m	Grey (10YR6/1); 10-20% 15-30mm distinct, olive yellow (2.5Y6/8) primary and red (2.5YR4/8) secondary mottles; sandy light clay; massive; moderately moist moderately firm; 2-10% 2-6mm, subangular, dispersed quartz gravel; few 1-2mm roots; diffuse, irregular change to
B23	.90 to 1.50 m	Light grey (10YR7/1); 20-50% 15-30mm distinct,olive yellow (2.5Y6/8) mottles; sandy light clay; massive; moderately moist, moderately firm; 20-50% 6-20mm, subangular, dispersed quartz gravel; gradual, irregular change to
2Bb	1.50 to 2.00 m	Light grey (10YR7/1); 20-50% 15-30mm distinct brownish yellow (10YR6/8) mottles; medium heavy clay; massive; moderately moist, very firm; 10-20% 6-20mm, subangular, dispersed quartz gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n = 21	Description
	Ap	18:8	Very dark greyish brown to dark greyish brown (10YR 3-4/1-2); sandy clay loam to clay loam, sandy; massive.
	A	13:4	Very dark grey (10YR 3/1) to greyish brown (10YR 5/1); light sandy clay loam to clay loam (heavy); massive to moderate cast and subangular blocky; clear or gradual change
	A2	15:12	Dark grey (10YR 4/1) to very pale grey (10YR 7/4), mottles dominantly pale to sporadically bleached; sandy clay loam to clay loam, sandy; massive; clear or gradual change
	B1		Grey (10YR 5/1) to very pale brown (10YR 7/4) with distinct brownish yellow (10YR 6/6-8) mottles; sandy clay loam to medium heavy clay; angular to subangular quartzitic gravels; massive to moderate subangular blocky.
	B2	50:26	Grey (10YR 6/1) to light grey (2.5YR 7/1) with red (10R 4/8) to brownish yellow (10YR 6/6) mottles; sandy light clay to medium heavy clay; massive to moderate subangular blocky
	D-2Bb		Dominantly clayey horizons and occasional stratified granitic gravels.

Malbon differs from Lugger and Rungoo series by having heavier textures throughout and from Prior series by having a grey dominant B horizon rather than yellow.

Vegetation is dwarf to low woodlands of *Melaleuca viridiflora* and *Lophostemon sauveolens*.

Principal profile forms encountered include Gn2.81, Dy3.41, Dy3.71 and Gn3.91.

ANALYTICAL DATA

Profile T368 Map Reference KIRRAMA 1:100 000 867 914
MALBON SERIES Sampled from undisturbed *Melaleuca, Xanthorrhoea* woodland.

Depth cm	0-10	10-17	20-28	30-45	45-60	60-90	90-120	120-150	180-200
Horizon	A1	A/B	B1	B21	B22	B22	B23	B23	2Bb
pH	5.0	5.2	5.3	6.0	6.0	6.0	6.1	5.9	5.7
E.C. mS/cm	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	1.22	0.76	0.33	0.14				0.05	
N %	0.06	0.05	0.02						
AvP ppm	4		3	2					
P ret %	18								
Free Fe%	0.6								
Tot. P %	0.005		0.002	0.002					
Tot. K %	2.98		3.66	3.62					
Tot. S %	0.011		0.007	0.003					
Tot. Fe%	1.0		0.9	1.1					
Tot. Cu%	0.0009		<0.0005	<0.0005					
Tot. Zn%	0.0014		0.0017	0.0023					
Tot. Mn%	0.009		0.008	0.006					

Exchange properties m.e./100 g soil

Ca	<0.02	0.02	<0.02	<0.02		<0.02		<0.02	
Mg	0.14	0.17	0.18	0.31		0.37		0.37	
K	0.04	0.08	0.06	0.11		0.12		0.13	
Na	<0.02	0.02	<0.02	<0.02		<0.02		0.03	
H + Al	1.28	1.26	1.09	1.02		0.95		1.3	
'ECEC'(1)	1.5	1.6	1.4	1.5		0.5		1.9	
'ECEC'/100gC	15.0	11.4	8.7	6.8		7.5		8.3	
CEC(2)	3.5	2.6	2.1	2.5		2.0		2.6	
CEC/100gC(2)	35.0	18.6	13.1	11.4		10		11.3	
Base Sat(3)	6	11	13	18		26		2	
CEC(4)	1.6	1.6	1.8	1.7		2.0		2.6	

Particle Size %

Gr	1	7	7	9	10	11	22	46	16
CS	65	52	47	40	43	47	60	48	41
FS	15	21	22	24	23	21	14	18	15
Si	11	13	14	13	15	12	6	11	7
C	10	14	16	22	20	20	21	23	38

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%
	60-90	6-10	>80	1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH4 OAc (4) Comp. Exch.

LUGGER SERIES (Lu)

CONCEPT

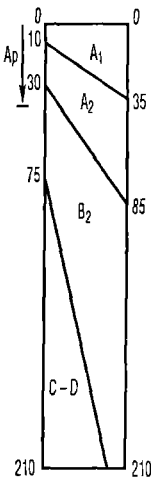
Uniform to gradational textured (*sandy loam to sandy clay loam*) with a grey massive B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	No Suitable Group	Gn2.94	*Kandiaqualf*	
LANDFORM	Alluvial fan		RAINFALL	2389 mm
REFERENCE SITE	Kirrama 1:100 000 *735051*			

Horizon	Depth (cm)	
A11	0 to .10 m	Very dark grey (10YR3/1); clay loam,coarse sandy; weak 5-10mm cast; 5-10mm cracks; 1-5, 1-2mm macropores per 100mm^2 ; common 2-5mm roots; diffuse, wavy change to
A12	.10 to .15 m	Very dark grey (10YR3/1); clay loam,coarse sandy; weak 5-10mm cast; 5-10mm cracks; 1-5, 1-2mm macropores per 100mm^2; common 2-5mm roots; clear, wavy change to
A21j	.15 to .25 m	Brown (10YR5/3), (10YR7/3d), coarse sandy clay loam (light); massive; 1-5 0.075-1mm macropores per 100mm^2; few <1mm roots; gradual, wavy change to
A22e	.25 to .40 m	Light grey (10YR7/2), (10YR8/1d), clayey coarse sand; massive; 1-5, 0.075-1mm macropores per 100mm^2 ;
	.40 to .70 m	Light grey (10YR7/2), (10YR8/1d); 10-20% 15-30mm distinct yellow (10YR7/8) mottles; clayey coarse sand; massive; 1-5, 0.075-1mm macropores per 100mm^2 ; diffuse, wavy change to
A23j	.70 to .90 m	Light grey (10YR7/2), (10YR8/1 d), 20-50% 15-30mm distinct yellow (10YR7/8) mottles; coarse sandy loam; massive; 2-10% 20-60mm, angular quartz gravel, dispersed; 1-5, 0.075-1mm macropores per 100mm^2; clear, wavy change to
B21	.90 to 1.45 m	Light grey (10YR7/1); <2% <5mm faint, yellow (10YR7/8) mottles; sandy medium clay; massive; 2-10% 20-60mm, angular quartz gravel, dispersed; 1-5, 0.075-1mm macropores per 100mm^2 ; clear wavy change to
B22	1.45 to 1.90 m	Light grey (2.5Y7/2); 2-10% 15-30mm distinct, brownish yellow (10YR6/8) mottles; sandy medium clay; massive; cutans; 1-5, 0.075-1mm macropores per 100mm^2 .

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	Description
	A1	Black (10YR 2/1) to very dark grey (10YR 3/1); coarse sandy loam to clay loam coarse sandy; massive to moderate cast.
	A2	Dark grey (10YR 4/1) to light grey (10YR 7/2), commonly bleached when dry; clayey coarse sand to coarse sandy clay loam; clear or gradual change
	B2	Light grey (10YR 7/2) to very pale brown (10YR 7/3) with distinct to prominent brownish yellow (10YR 6/8) to yellow (10YR 7/8) mottles; coarse sandy clay loam to coarse sandy light clay; clear or gradual change
	C-D	Coarse granitic sands and gravels, rarely fine clayey deposits.

Lugger and Rungoo series have many features in common and may often occur in close association. In general Lugger soils have uniform or gradational texture profiles to a depth of at least 90 cm while Rungoo series has a duplex texture profile.

In some areas podzol profiles are developing in the coarse sandy A horizons of these soils.

Distinctive clay films or clay enriched areas are a common feature of the soil matrix in the B horizons of this soil series.

Vegetation is depauperate to tall forest of Melaleuca species.

ANALYTICAL DATA

Profile T407 Map Reference KIRRAMA 1:100 000 735 051
LUGGER SERIES Sampled from fertilized pasture paddock.

Depth cm	0-10	10-15	15-25	25-40	40-70	70-90	90-120	120-145	145-175	175-190
Horizon	Ap	Ap2	A21j	A22e	A22e	A23j	B1	B21	B22	B23
pH	5.1	4.9	5.3	5.8	6.0	6.0	6.2	6.1	6.1	6.0
E.C.mS/cm	0.12	0.06	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	3.02			0.13		0.05	0.06		0.05	
N %	0.16			0.02						
AvP ppm	250			5			1		2	
Free Fe%	0.5			0.4			0.4			
Tot. P %	0.041			0.003			0.002		0.007	
Tot. K %	1.7			1.62			1.57		2.08	
Tot. S %	0.028			0.057			0.0024		0.0042	
Tot. Fe%	0.8			0.6			0.7			
Tot. Cu%	0.001			0.0005			<0.0005			
Tot. Zn%	0.0011			0.0007			0.001			
Tot. Mn%	0.02			0.014			0.011			
Exchange properties m.e./100 g soil										
Ca	1.7			0.08		0.05	<0.02	<0.02	<0.02	
Mg	0.5			0.08		0.46	0.78	1.88	1.24	
K	0.34			0.02		0.05	0.07	0.14	0.14	
Na	0.13			0.05		0.06	0.08	0.13	0.13	
H + Al	1.19			0.34		0.15	0.27	0.36	0.38	
'ECEC'(1)	3.9			0.6		0.8	1.2	2.5	1.9	
'ECEC'/100gC	22.9			8.6		2.8	6.7	7.4	6.3	
CEC(2)	8.0			1.0		1.0	2.0	2.0	3.0	
CEC/100gC(2)	47.0			14.3		8.3	11.1	5.9	10.0	
Base Sat3	30			23		65	48	100	51	
CEC(4)	2.9			0.8		1.1	1.4	1.9	2.2	
Particle Size %										
Gr	6	7	8	7	12	12	15	19	22	12
CS	44	43	52	56	56	52	61	46	56	61
FS	25	27	27	31	28	28	15	14	11	7
Si	14	13	9	7	9	9	5	6	3	3
C	17	18	11	7	8	12	18	34	30	30
BD	1.3	1.4	1.5	1.6	1.7	1.8	1.7	1.6	1.5	1.6
.1 Bar	26.2	23.1	16.0	14.1	18.6	21.6	29.1	32.0	25.4	28.6
15 Bar	14.7	13.3	6.9	5.9	9.0	12.1	20.5	22.3	16.2	17.8

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%
	120-145	1-5	>80	1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH4 OAc (4) Comp. Exch.

RUNGOO SERIES (Rg)

CONCEPT

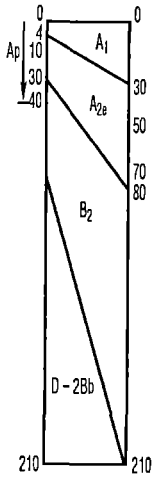
A coarse textured A horizon with a sharp texture change to a mottled, massive to weakly structured clayey B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Soloth	Dy3.82	Typic Natrustalf	
LANDFORM	Alluvial fan		RAINFALL	2250 mm
REFERENCE SITE	Cardwell 1:100 000 067655			

Horizon	Depth	
A1	0 to .10 m	Greyish brown (10YR5/2); loamy sand; massive; moderately moist, very weak; common 1-2mm roots; clear wavy change to
A2e	.10 to .35 m	White (10YR8/2), coarse sand; massive; 20-50% 2-6mm, subangular, dispersed quartz gravel; many 2-5mm roots; abrupt, irregular change to
B21	.35 to .60 m	Light brownish grey (2.5Y6/2); 20-50% 15-30mm distinct brownish yellow (10YR6/8) mottles; medium heavy clay; weak 20-50mm columnar; 10-20% 2-6mm, subangular, dispersed quartz gravel; diffuse, broken change to
B22	.60 to .90 m	Light brownish grey (2.5Y6/2); 20-50% 15-30mm distinct brownish yellow (10YR6/8) mottles; coarse sandy light clay ; massive; 20-50% 2-6mm, subangular, dispersed quartz gravel; 10-20% 2-6mm manganiferous concretions;
2Bb	.90 to 1.80 m	Light brownish grey (2.5Y6/2); 20-50% 15-30mm distinct brownish yellow (10YR6/8) mottles; coarse sandy light clay ; massive; 20-50% 2-6mm, subangular, dispersed quartz gravel; 10-20% 2-6mm manganiferous concretions.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	x̄:σ n = 10	Description
	A1	17:10	Very dark grey (10YR 3/1) to white (10YR 8/1); coarse sand to sandy clay loam; common angular quartzitic gravels; single grain to weak cast; clear or gradual change
	A2e	26:11	Dark greyish brown (10YR 4/2) to white (10YR 8/2); clayey sand to light coarse sandy clay loam; single grain to massive;
	B2	50:19	Grey (10YR 6-7/1) to light brownish grey (10YR - 2.5Y 6-7/2) with brownish yellow (10YR 6/8) and yellow (10YR 7/8) mottles; sandy light clay to medium heavy clay; common angular quartzitic gravels; massive to coarse weak prismatic; clear or gradual change
	D-2Bb		Grey (10YR 6/1) to pale yellow (2.5Y 7/4) with reddish yellow (7.5YR 6/8) mottles; coarse sandy loam to sandy medium clay; massive to moderate subangular blocky; soft segregations of manganese and iron rich patches.

Rungoo differs from Lugger series in the sharp change to a clayey B horizon at a depth of less than 90 cm. Most B horizons are massive but when structured, the units are very coarse. Weak podzol profiles have developed in the A horizons of some of these soils.

Vegetation is depauperate to tall forest of Melaleuca species.

Principal profile forms encountered include Dy3.82, Dy3.81, Dy3.41 and Dy3.42.

ANALYTICAL DATA

Profile T369 Map Reference CARDWELL 1:100 000 067655
RUNGOO SERIES Sampled from undisturbed *Melaleuca* woodland.

Depth cm	0-10	10-20	20-30	30-35	35-60	60-90	90-120	120-150	150-180
Horizon	A	A2e	A2e	A2e	B21	B22	2Bb	2Bb	2Bb
pH	6.6	6.6	6.7	6.7	6.6	6.5	6.5	6.4	3.7
E.C. mS/cm	0.02	0.02	0.01	0.01	0.04	0.03	0.10	0.12	0.24
T.C. %	0.81		0.09			0.07		0.04	
N %	0.04		0.01						
AvP ppm	4		3		2				
P ret %	18								
Free Fe%	0.5				1.2			1.5	
Tot. P %	0.002				0.001			0.002	
Tot. K %	2.68				2.6			2.92	
Tot. S %	0.005				0.006			0.002	
Tot. Fe%	0.8				1.5				
Tot. Cu%	<0.00001				<0.00001				
Tot. Zn%	<0.00001				<0.00002				
Tot. Mn%	0.0001				0.00006				
Exchange properties m.e./100 g soil									
Ca	0.24		<0.02		<0.02	<0.02		0.04	<0.02
Mg	0.28		0.13		2.31	1.92		2.3	2.44
K	0.05		0.04		0.09	0.05		0.18	0.02
Na	<0.02		0.02		0.2	0.34		0.25	1.55
H + Al	0.38		0.14		1.11	1.01		0.56	0.28
'ECEC'(1)	1.0		0.4		3.7	3.3		3.3	4.3
'ECEC'/100gC	14.3		13.3		11.2	14.3		13.7	21.5
CEC(2)	2.0		0.4		5.1	3.9		4.7	3.0
CEC/100gC(2)	28.6		13.3		15.5	17.0		19.6	15.0
Base Sat(3)	29		52		51	60		59	100
CEC(4)	1.3		0.6		3.9	3.6		4.1	2.3
Particle Size %									
Gr	7	14	26	20	10	16	20	26	23
CS	61	63	68	61	43	43	45	43	49
FS	28	26	27	31	18	26	20	22	22
Si	5	7	2	5	6	9	10	11	9
C	7	4	3	3	33	23	25	24	20

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%	Sm%	Ha/Go%
	150-180	11-20	>80	1-5	<1	<1

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH4 OAc (4) Comp. Exch.

BANYAN SERIES (Ba)

CONCEPT
Sapric to fibric A horizon over a bleached, coarse sandy A2 and sandy clay B horizons.

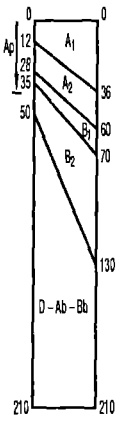
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Humic Gley	Dg4.41	*Kandiaquit*	
LANDFORM	Alluvial fan		RAINFALL	3000 mm
REFERENCE SITE	Kirrama 1:100 000	866004		

Horizon	Depth	
A1	.0 to .20 m	Black (2.5Y2/0), (2.5Y4/1 d); loam (sapric); strong 2-5mm cast; gradual change to
A2e	.20 to .40 m	White (2.5Y8/1); loamy coarse sand; massive; 2-10% 2-6mm, subangular, dispersed gravel; clear change to
B2	.40 to .80 m	Light grey (2.5Y7/1); 20-50% 15-30mm distinct yellow (2.5Y7/6) mottles; medium clay; massive; 2-10% 2-6mm, subangular, dispersed gravel; clear change to
2A1b	.80 to 1.00 m	Light grey (2.5Y7/1); coarse sandy loam; massive; 20-50% 2-6mm, subangular, dispersed gravel; clear change to
2B21b	1.00 to 1.60 m	Light grey (2.5Y7/1); 10-20% 5-15mm distinct yellow (2.5Y7/6) mottles; medium heavy clay; massive; 20-50% 2-6mm, subangular dispersed gravel; clear change to
2B22b	1.60 to 1.70 m	Light grey (2.5Y7/1); 10-20% mottles; medium heavy clay; massive; 10-20% 2-6mm, subangular, dispersed gravel.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ n = 10	Description
	O		May be a prominent O horizon 2-3 cm thick on the surface in virgin sites.
	Ap	33:11	Black (10YR 2/1); sapric to fibric loam; weak to moderate cast structure
	A	23:9	Black (10YR-2.5YR 2/1) to dark grey (10YR 4/1); sapric loam to clay loam, sandy; *common angular quartzitic gravels*; weak granular and
		cast	structure
	A2	16:7	Dark greyish brown (10YR 4/2) to white (10YR 8/2); clayey sand to coarse sandy clay loam; *single grain to massive.*
	B1		Brown (7.5YR 4/2) to light grey (10YR 7/2), distinct yellow (10YR 7/6) mottles; light sandy clay loam to clay loam, sandy; massive to moderate subangular blocky; *gradual or diffuse change*
	B2	51:26	Greyish brown (10YR 5/2) to white (10YR 8/1)m with distinct to prominent brownish yellow (10YR 6/8) to yellow (10YR 7/8) mottles; light sandy clay loam to heavy clay; *common angular quartz gravels*; massive to moderate subangular blocky.
	D-2B		Grey (10YR 7/1) and brownish yellow (10YR 6/6-8), mottled; sandy light clay to heavy clay; *massive to moderate subangular blocky*; stratified coarse sands and fine alluvium may occur.



A sapric to fibric surface separates this series from Rungoo series, the duplex texture profile separates it from Lugger series.

Vegetation is closed forest and low woodlands of *Melaleuca* species.

Principal profile forms encountered include Dg4.41, Dy3.61, Dy3.11 and Dy2.11.

ANALYTICAL DATA

Profile T459 Map Reference KIRRAMA 1:100 000 866004

BANYAN SERIES Sampled from undisturbed *Melaleuca* tall forest.

Depth cm	0-10	20-30	60-80	120-150
Horizon	A1	A2	B2	2B21b
pH	4.7	4.7	4.8	4.8
E.C. mS/cm	0.03	0.03	0.01	0.01
T.C. %	5.2			
N %	0.22			
AvP ppm	17.0			
Tot. P %	0.02	<0.01	<0.01	
Tot. K %	1.15	0.88	<0.84	
Tot. S %	0.09	0.04	0.02	
Exchange properties m.e./100 g soil				
Ca	0.23	0.19	0.16	0.02
Mg	0.31	0.06	0.38	0.89
K	0.08	0.02	0.03	0.06
Na	0.25	0.17	0.15	0.11
H + Al	2.80	1.34	1.34	2.08
'ECEC'(1)	3.67	1.78	2.06	3.16
'ECEC'/100 g C	20.4	11.9	8.2	7.9
CEC(2)	6	5	2	1
CEC/100 g C(2)	33.3	33.3	8	2.5
Base Sat(3)	10	9	36	100
CEC(4)	1	1	1	
Particle Size %				
Gr	0	7	21	16
CS	31	46	49	43
FS	19	18	16	10
Si	31	22	9	7
C	18	15	25	40

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ Cl\ CEC} \times 100$

(2) $NH_4\ Cl$ (4) Comp. Exch.

PORTER SERIES (Pt)

CONCEPT

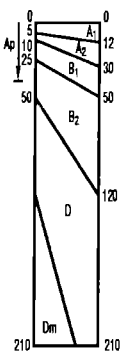
Duplex texture profile with mottled grey B horizon; few or no gravels throughout the profile.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Soloth	Dy3.42	Durustalf ?	
LANDFORM	Alluvial fan		RAINFALL	2250 mm
REFERENCE SITE	Cardwell 1:100 000	045719		

Horizon	Depth	
A1	0 to .07 m	Grey (10YR5/1); sandy clay loam (light); massive; moderately moist very weak; few <1mm roots; clear, smooth change to
A2e	.07 to .20 m	Light grey (10YR7/2), (10YR8/2d), 10-20% 5-15mm distinct, yellow (10YR7/8) mottles; sandy clay loam (light); massive; moderately moist, very weak; few <1mm roots; clear, irregular change to
B1j	.20 to .25 m	Light brownish grey (10YR6/2); 20-50% 5-15mm distinct brownish yellow (10YR6/8) mottles; light medium clay; moderate 5-10mm subangular blocky; moderately moist, moderately firm; few 1-2mm roots; diffuse, smooth change to
B21	.25 to .60 m	Light brownish grey (2.5Y6/2); 10-20% <5mm distinct, brownish yellow (10YR6/8) mottles; medium clay; moderate 10-20mm angular blocky; moderately moist, very firm; few 1-2mm roots; diffuse, broken change to
B22/2B	.60 to .90 m	Grey (5Y6/1); 2-10% <5mm distinct, yellowish brown (10YR5/8) mottles; heavy clay; moderate 10-20mm angular blocky; moderately moist, very strong.
3Dm	.90 to 1.00	Silicified pan containing 50 mm rounded granitic gravel.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 6	Description
	A1	7:3	Dark greyish brown (10YR 4/2) to brown (10YR 5/3); loam fine sandy to fine sandy clay loam; massive to weak cast or subangular blocky.
	A2	13:7	Greyish brown (10YR 5/2) to light grey (10YR 7/2); light sandy clay loam to fine sandy clay loam; manganiferous concretions common; gradual or sharp change
	B1		Light brownish grey (10YR 6/2) to brownish yellow (10YR 6/6), distinct, strong brown (7.5YR 5/6-8) to brownish yellow (10YR 6/8) mottles; clay loam, fine sandy to medium clay; massive to moderate subangular blocky; manganese concretions and nodules common.
	B2	58:18	Grey (5Y 5/1) to light grey (10YR 7/2), with yellowish brown (10YR 5/6 8) to brownish yellow (10YR 6/6-8) mottles; fine sandy clay loam to heavy clay; massive to moderate subangular and angular blocky, some coarse prismatic.
	D		Light grey (10YR 7/1) mottled; sandy light clay to medium clay; moderate to strong subangular and angular blocky.

Debil-debil surface microrelief is a common surface feature of this soil series.

Porter differs from Cudmore series by a sharp texture break to the B horizon and from Rungoo series by not having fine gravel throughout.

Silicified sands and clayey sands were encountered in several profiles and although they qualify as duripans in U.S. Taxonomy they are generally penetrable by hand auger.

Vegetation is low to mid-high woodlands of *Melaleuca viridiflora* and *Eucalyptus intermedia.*

Principal profile forms encountered include Dy3.41 and Gn3.04.

ANALYTICAL DATA

Profile T371 Map Reference CARDWELL 1:100 000 045719
PORTER SERIES Sampled from undisturbed *Melaleuca* woodland.

Depth cm	0-7	7-10	10-20	20-25	25-30	30-60	60-90	90-100
Horizon	A1	A2e	A2e	B1j	B21	B21	B22/2B	3Dm
pH	6.7	6.7	6.7	6.7	6.7	6.1	6.7	6.7
E.C. mS/cm	0.04	0.02	0.01	0.02	0.02	0.02	0.05	0.06
T.C. %	1.23		0.25	0.27		0.28		0.12
N %	0.06			0.02				
AvP ppm	5		5	2		2		2
P ret %	6							
Free Fe%	0.4							
Tot. P %	0.004					0.003		<0.001
Tot. K %	2.61					1.86		2.3
Tot. S %	0.009					0.005		0.002
Tot. Fe%	1.0					2.2		
Tot. Cu%	0.0021					0.0019		
Tot. Zn%	0.0024					0.0064		
Tot. Mn%	0.018					0.016		
Exchange properties m.e./100 g soil								
Ca	1.57		0.5	1.1		1.71		2.43
Mg	0.67		0.53	1.6		3.46		5.49
K	0.15		0.07	0.1		0.06		0.04
Na	0.06		0.1	0.23		0.5		1.28
H + Al	0.09		0.14	0.45		1.18		0.88
'ECEC'[1]	2.5		1.3	3.5		6.9		10.1
'ECEC'/100gC	31.2		14.4	12.5		19.2		33.7
CEC[2]	3.4		1.0	4.7		8.9		11.5
CEC/100gC[2]	42.5		11.1	16.8		24.7		38.3
Base Sat[3]	72		100	64		64		80
CEC[4]	2.9		2.0	4.1		7.0		10.7
Particle Size %								
Gr	1	8	1	1	1	2	1	1
CS	26	24	25	21	17	16	14	12
FS	37	39	38	28	21	35	29	27
Si	29	31	29	24	24	25	27	31
C	8	7	9	28	38	36	31	30

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Sm%	Qz
	30-60	6-10	>80	6-10	1-5
	90-100	1-5	66-80	21-30	1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH4 OAc (4) Comp. Exch.

CUDMORE SERIES (Cd)

CONCEPT

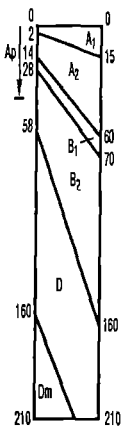
Bleached, mottled, grey gradational textured soil with few or no gravels.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	No suitable group	Gn3.04	Haplustalf	
LANDFORM	Alluvial fan		RAINFALL	2250
REFERENCE SITE	Cardwell 1:100 000	086602		

Horizon	Depth	
A1	0 to .06 m	Dark greyish brown (10YR4/2); sandy clay loam (light); massive; moderately moist, very weak; common 2-5mm roots; abrupt, smooth change to
A2e	.06 to .15 m	Light brownish grey (10YR6/2), sandy clay loam (light); massive; moderately moist, very weak; common 2-5mm roots; clear, irregular change to
B1j	.15 to .60 m	Light brownish grey (2.5Y6/2), 20-50% 5-15mm distinct, olive yellow (2.5Y6/8) mottles; sandy clay loam (light) increasing to clay loam, sandy; massive; moderately moist moderately weak; 2-10% 2-6mm, subangular, dispersed quartz gravel;. 2-10% 2-6mm manganiferous soft segregations; common 2-5mm roots; gradual irregular change to
B21	.60 to 1.10 m	Light brownish grey (10YR6/2); 10-20% 5-15mm distinct yellowish brown (10YR5/8) mottles; sandy light clay; moderate 50-100mm angular blocky; moderately moist very firm; 2-10% 6-20mm, subangular, dispersed quartz gravel; 2-10% 2-6mm manganiferous soft segregations; few 2-5mm roots; clear, smooth change to
B22	1.10 to 1.30 m	Light brownish grey (10YR6/2); 10-20% 5-15mm distinct, yellowish brown (10YR5/8) mottles; medium heavy clay; moderate 10-20mm angular blocky; moderately moist, very firm; 2-10% 2-6mm manganiferous soft segregations; few 2-5mm roots; gradual, irregular change to
2Bb	1.30 to 1.60 m	Light brownish grey (10YR6/2); medium clay; weak 50-100mm angular blocky; moderately moist, very firm; 2-10% 2-6mm manganiferous soft segregations; clear, smooth change to
3Dmb	1.60 to 1.70 m	Light brownish grey (2.5Y6/2); medium clay; massive; dry, very strong; massive, continuous, moderately cemented, duripan.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n = 14	Description
	Ap	13:11	Grey (10YR 5/1) to dark grey (2.5Y 4/1); fine sandy loam to light sandy clay loam; massive.
	A1	8:5	Dark greyish brown (10YR 4/2) to light brownish grey (10YR 5/2); loam, fine sandy to silty clay loam; massive to weak cast; clear or gradual change
	A2	16:10	Grey (10YR 5/1) to very pale brown (10YR 7/3); sand to clay loam, sandy; single grain to massive; manganese nodules may occur; clear or gradual change
	B1		Light brownish grey (10YR-2.5 Y 6/2) to very pale brown (10YR 7/4), distinct brownish yellow (10YR-2.5Y 6/8) and yellow (10YR 7/6) mottles; light sandy clay loam to light medium clay; clear or gradual change
	B2	46:29	Grey (10YR 6/1) to light grey (10YR 7/2), occasionally yellow (2.5Y 7/6), with distinct reddish yellow (7.5YR 6/8) and yellowish brown (10YR 5-6/8) to brownish yellow (10YR 6/8) mottles; light sandy clay loam to medium heavy clay; massive to moderate subangular blocky; manganese soft patches and nodules common; clear or sharp change
	Dm		Silicified sands and clayey sands; massive, hard.

Debil-debil surface microrelief is a common feature of this series.

Cudmore series is distinguished from Porter series by having a massive upper B horizon gradational texture profile and generally greater depth to the clayey B2 horizon.

Vegetation is low to mid-high woodlands of *Melaleuca viridiflora* and *Xanthorrhoea johnsonii*.

Principal profile forms encountered include Gn2.94, Gn3.04 and Gn2.74.

ANALYTICAL DATA

Profile T372 Map Reference CARDWELL 1:100 000 086602
CUDMORE SERIES Sampled from undisturbed *Melaleuca*, and *Xanthorrhoea* woodland.

Depth cm	0-6	10-15	20-30	30-60	60-90	110-120	130-150	150-160	160-170
Horizon	A1	A2e	B1j	B1j	B21	B22	2B	2B	3Dm
pH	5.6	5.4	5.5	6.1	6.2	6.0	6.0	6.0	6.0
E.C.mS/cm	0.05	0.03	0.03	0.02	0.04	0.09	0.11	0.12	0.13
T.C. %	1.55		0.13	0.06	0.06	0.05	0.07		
N %	0.05		<0.01						
AvP ppm	2								
P Ret%	10	4		1	1				
Free Fe%	0.6				0.7				
Tot. P %	0.003		0.001	<0.001			0.002		
Tot. K %	2.16		2.4	2.78			2.56		
Tot. S %	0.012		0.01	0.004			0.001		
Tot. Fe%	1.0		1.1	1.1					
Tot. Cu%	0.0011			0.0009	0.0008				
Tot. Zn%	0.0019			0.0023	0.0024				
Tot. Mn%	0.025		0.016	0.032					
Exchange properties m.e./100 g soil									
Ca	0.49	0.08	<0.02	0.07	0.76	1.58	1.6		
Mg	0.46	0.64	1.13	1.13	3.42	6.53	5.0		
K	0.1	0.11	0.07	0.05	0.04	0.03	<0.02		
Na	0.05	0.1	0.11	0.17	0.82	1.36	0.61		
H + Al	0.69	0.65	0.7	0.25	0.38	0.31	0.55		
'ECEC'(1)	1.8	1.6	2.0	1.7	5.4	9.8	7.8		
'ECEC'/100gC	22.5	14.5	14.3	17.0	20.8	32.7	30.0		
CEC(2)	3.9	2.0	2.2	1.9	6.5	9.0	11.8		
CEC/100 g C(2)	48.7	18.2	15.7	19.0	25.0	30.0	45.4		
Base Sat3	28.2	48	60	75	78	100	61		
CEC(4)	2.1	2.3	2.3	2.0	6.1		8.8		
Particle Size %									
Gr	0	3	5	3	6	9	2	1	12
CS	29	26	25	32	24	15	9	11	21
FS	40	38	39	33	29	34	35	34	33
Si	33	25	23	22	21	21	30	29	30
C	8	11	14	12	26	30	26	26	17

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Sm%	Qz%
	30-60	11-20	66-80	-	1-5
	110-120	1-5	>80	11-20%	1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

ARNOT SERIES (An)

CONCEPT

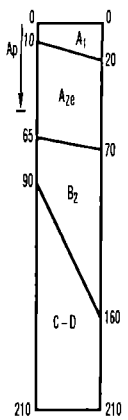
Mottled grey and yellow sandy soil with little or no quartzitic gravels.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	No Suitable Group	Uc2.2	Kandiaquult	
LANDFORM	Alluvial fan		RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000 856820			

Horizon	Depth	
A11	0 to .10 m	Dark greyish brown (10YR4/2); loamy sand; massive; many 1-2mm roots; clear, smooth change to
A12	.10 to .20 m	Greyish brown (10YR5/2); loamy sand (light); massive; many 1-2mm roots; clear, wavy change to
A21e	.20 to .40 m	Very pale brown (10YR8/3); fine sand; single grain; common 1-2mm roots; diffuse, broken change to
A22e	.40 to .70 m	White (10YR8/2); 20-50% 15-30mm prominent, brownish yellow (10YR6/8) mottles; sand; single grain; 2-10% 2-6mm, subangular , dispersed quartz gravel; common 1-2mm roots; diffuse, broken change to
A23e	.70 to 1.30 m	White (10YR8/2); 2-10% 15-30mm distinct brownish yellow (10YR6/8) mottles; sand; single grain; 2-10% 2-6mm, subangular, dispersed quartz gravel; clear, wavy change to
B2	1.30 to 1.60 m	White (10YR8/2); 20-50% 15-30mm prominent olive yellow (2.5Y6/8) mottles; sandy loam; massive; 2-10% 2-6mm, subangular, dispersed quartz gravel; clear, wavy change to
B/C	1.60 to 2.00 m	White (10YR8/2); 10-20% 15-30mm distinct brownish yellow (10YR6/8) mottles; sandy loam; single grain.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	Ap	Greyish brown (10YR 5/2) to light grey (10YR 7/1-2); loamy sand to fine sandy loam; single grain to massive.
	A1	Dark greyish brown (10YR 4/2) to greyish brown (10YR 5/2); loamy sand; single grain or massive, some weak cast; loose surface.
	A2e	Light grey (10YR 7/2) to very pale brown (10YR 8/3); sand to clayey sand; single grain to massive; clear or gradual change
	B2	Light grey (5Y 7/1) to olive yellow (10YR 6/8), brownish yellow (10YR 6/8) and white (10YR 8/2) mottles; coarse sandy loam to light sandy clay loam; single grain to massive; some iron rich patches.
	C-D	Very pale brown (10YR 7/4) with yellow (10YR 7/6) mottles; sand to sandy clay loam; single grain to massive.

Arnot series differs from Lugger series by the absence of gravels and generally less clayey textures and from Glenborra series because of its mottled B horizon.

Vegetation is low to mid-high woodlands of *Melaleuca viridiflora*, and *Casuarina* species.

Principal profile forms encountered include Uc2.23, Uc4 and Uc5.

ANALYTICAL DATA

Profile T366 Map Reference KIRRAMA 1:100 000 856820
ARNOT SERIES Sampled from undisturbed *Melaleuca Casuarina* low forest.

Depth cm	0-10	10-20	20-30	40-60	90-120	130-150	180-200
Horizon	A11	A12	A21e	A22e	A23e	B2	B/C
pH	5.9	5.7	5.9	6.5	6.6	6.3	6.6
E.C. mS/cm	0.04	0.02	0.01	0.01	0.01	0.01	0.01
T.C. %	1.46	0.79	0.21	0.07	<.01	0.04	
N %	0.05	0.03	0.01				
AvP ppm	3			2		3	
P ret %	8						
Free Fe%	0.7			0.9		1.5	
Tot. P %	0.002			<0.001		<0.001	
Tot. K %	3.16			3.66		3.36	
Tot. S %	0.008			0.002		0.001	
Tot. Fe%	1.1			1.1		1.9	
Tot. Cu%	<0.0005			<0.0005		<0.0005	
Tot. Zn%	0.0011			0.0011		0.0015	
Tot. Mn%	0.016			0.011		0.011	
Exchange properties m.e./100 g soil							
Ca	0.11		<0.02	<0.02	0.03	<0.02	
Mg	0.26		0.06	0.52	0.09	0.25	
K	0.05		<.02	<.02	0.06	0.06	
Na	0.03		<.02	0.09	0.14	0.1	
H + Al	0.83		0.35	0.12	0.4	0.54	
'ECEC'(1)	1.3		0.5	0.8	0.7	1.0	
'ECEC'/100gC	16.2		12.5	10.0	11.7	9.1	
CEC(2)	2.7		0.7	1.0	1.2	1.5	
CEC/100gC(2)	33.7		17.5	12.5	20.0	13.6	
Base Sat(3)	17		17	65	27	27	
CEC(4)	1.5		0.4	1.0	1.3	1.6	
Particle Size %							
Gr	0	0	3	2	5	1	2
CS	32	38	40	36	52	40	49
FS	47	43	45	48	32	38	34
Si	13	12	11	9	11	11	6
C	8	7	4	8	6	11	12

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

FELUGA SERIES (Fe)

CONCEPT

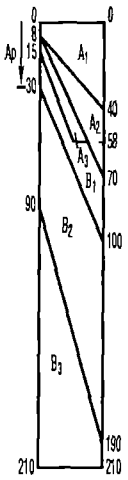
Gradational or duplex soils with mottled red and yellow B horizons and significant amounts of ironstone gravels in the profile. A whole coloured red variant is also recognised.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Lateritic Podzolic Soil	Dy3.41	Epiaquic Kandiudult
LANDFORM	Low rise		RAINFALL 2500 mm
REFERENCE SITE	Kirrama 1:100 000	862993	

Horizon	Depth	
A1	0 to .10 m	Very dark grey (10YR3/1), (10YR5/1d); sandy loam; weak 2-5mm cast; clear change to
A2e	.10 to .45 m	Very pale brown (10YR7/4); dry, conspicuously bleached; sandy loam; massive; <2% 6-20mm ferruginous nodules; gradual change to
B21	.45 to .65 m	Yellow (10YR7/6); 2-10% 15-30mm distinct, yellow (10YR7/8) mottles; light clay; moderate 5-10mm angular blocky; 10-20% 6-20mm ferruginous nodules; gradual change to
B22	.65 to .90 m	Yellow (2.5Y7/6);10-20% 15-30mm distinct, yellow (10YR7/8) mottles; sandy medium clay; strong 5-10mm subangular blocky; 2-10% 20-60mm ferruginous nodules;
B31	.90 to 1.40 m	White (2.5Y8/2); 10-20% 15-30mm distinct, yellow (10YR7/8) mottles; sandy medium clay; strong 5-10mm subangular blocky; 10-20% 20-60mm ferruginous nodules;
B32	1.40 to 2.00 m	White (2.5Y8/1); 2-10% 15-30mm distinct, yellow (10YR7/8) mottles; sandy medium clay; strong 5-10mm subangular blocky; 20-50% >60mm ferruginous nodules;

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	x̄:σ n = 20	Description
	Ap	31:7	Black (10YR 2/1) to pinkish grey (7.5YR 6/3); sandy loam to sandy clay loam (light); massive to weak subangular blocky
	A1	21:12	Black (10YR 2/1) to dark yellowish brown (10YR 4/4); sandy loam to fine sandy clay loam; massive to weak subangular blocky or cast; ironstone nodules may occur; clear change to
	A2	15:7	Greyish brown (10YR 5/2) to very pale brown (10YR 7/4), may be sporadic to conspicuously bleached; sandy loam to clay loam, sandy; massive to weak subangular blocky; ironstone nodules may occur; clear change to
	A3		Black (10YR 2/1) to brown (10YR 5/3); light sandy clay loam to clay loam, sandy; massive to weak subangular blocky; ironstone nodules and concretions common; gradual or diffuse change to
	B1		Brown (10YR 5/3) to brownish yellow (10YR 6/8) to white (10YR 8/2), yellowish brown (10YR 5/6) to yellow (10YR 7/6) mottles; fine sandy clay loam to light clay; massive to moderate subangular blocky; ironstone and manganiferous nodules and soft segregations may occur;
	B2	53:29	Yellowish brown (10YR 5/8) to light grey (10YR 7/1) to yellow (10YR 7/8), distinct and prominent yellow (10YR 7-8/6-8) and light grey (2.5Y 7/2) mottles; clay loam, sandy to medium heavy clay; massive to moderate subangular and angular blocky; few to many ironstone nodules, concretions and soft segregations; gradual or diffuse change to
	B3		Mottled dark red (10R 3/6), white (2.5Y 8/1) and yellow (2.5Y 7/8); light medium to medium heavy clay; weak to moderate subangular and angular blocky; few to common ironstone gravels.

Subsoil hydrology is probably the dominant factor influencing profile development, in particular the dominance of red or yellow subsoil colours although these colours may reflect previous rather than current hydrological conditions. Several profiles with good external drainage have yellow subsoils.

Vegetation is low woodland to woodland of *Melaleuca*, *Lophostemon* and *Casuarina* species.

ANALYTICAL DATA

Profile T458 Map Reference KIRRAMA 1:100 000 862993
FELUGA SERIES Sampled from undisturbed depauperate *Melaleuca* and *Xanthorrhoea* woodland.

Depth cm	0-10	10-20	30-40	50-60	70-90	100-130	160-190
Horizon	A	A2e	A2e	B21	B22	B31	B32
pH	5.1	5.0	5.2	5.2	4.5	4.5	4.4
E.C. mS/cm	0.03	0.02	0.02	0.01	0.01	0.01	0.01
T.C. %	2.1						
N%	0.7						
AvP ppm	16						
Tot. P %	<0.01			<0.01	<0.01	<0.01	
Tot. K %	0.03			<0.01	<0.01	<0.01	
Tot. S %	0.03			0.05	0.05	0.04	
Tot. Fe%	0.002						
Exchange properties m.e./100 g soil							
Ca	0.19	0.24	0.02	0.16	0.37	0.29	0.01
Mg	0.16	0.15	0.07	0.13	0.12	0.07	0.1
K	0.02	0.03	0.01	0.02	0.02	0.02	0.01
Na	0.25	0.1	0.08	0.14	0.14	0.14	0.07
H + Al	0.94	0.77	0.41	0.48	1.23	1.39	2.02
'ECEC'(1)	1.56	1.29	0.59	0.93	1.88	1.91	2.21
'ECEC'/100gC	12	10.75	4.54	2.91	3.48	4.24	4.6
CEC(2)	3	1	1	1	1	1	1
CEC/100gC(2)	2.3	8.3	7.7	3.1	1.8	2.2	2.1
Base Sat(3)	20	52	18	45	65	52	19
CEC(4)	1	0	1	1	1	1	1
Particle Size %							
Gr	0	0	3	37	8	21	13
CS	54	54	55	39	26	22	22
FS	27	30	28	23	11	16	14
Si	5	5	4	6	9	17	15
C	13	12	13	32	54	45	48

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ Cl\ CEC} \times 100$

(2) $NH_4\ Cl$ (4) Comp. Exch.

FEGULA SERIES RED VARIANT

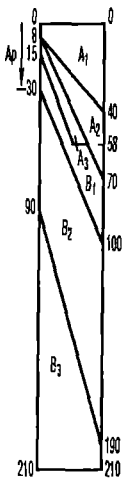
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Lateritic Podzolic Soil ?	Gn3.74	Epiaquic Kandiudult
LANDFORM	Low rise		RAINFALL 2500 mm
REFERENCE SITE	Kirrama 1:100 000 760084		

Horizon	Depth	
Ap	0 to .20 m	Very dark grey (10YR3/1); sandy clay loam (light); weak 2-5mm cast; many 1-2mm roots; gradual, wavy change to
A2	.20 to .30 m	Brown (10YR4/3), (10YR6/3d); clay loam, sandy; massive; 2-10% 20-60mm, subangular, dispersed gravel; 2-10% 6-20mm ferruginous concretions; common 2-5mm roots; gradual, irregular change to
B1c	.30 to .45 m	Brown (7.5YR5/4); clay loam, sandy (heavy); massive; 20-50% 20-60mm, subangular, dispersed gravel; 20-50% 6-20mm ferruginous concretions; common 2-5mm roots; gradual, irregular change to
B21	.45 to .60 m	Yellowish red (5YR5/8); sandy light clay; weak <2mm subangular blocky; 10-20% 20-60mm, subangular, dispersed gravel; 10-20% 6-20mm ferruginous concretions; common 2-5mm roots; wavy change to
B22	.60 to .90 m	Yellowish red (5YR5/8); sandy light clay; moderate 2-5mm subangular blocky; 10-20% 6-20mm ferruginous soft segregations; common 1-2mm roots; diffuse, wavy change to
B23	.90 to 1.20 m	Red (2.5YR4/8); 20-50% 5-15mm prominent, yellow (10YR7/6) mottles; medium clay; moderate 2-5mm subangular blocky; 10-20% 6-20mm ferruginous, soft segregations; common 1-2mm roots; gradual, wavy change to
B31	1.20 to 1.50 m	Weak red (10R4/4); 20-50% 15-30mm prominent, white (10YR8/1) primary and dark yellowish brown (10YR4/8) secondary mottles; medium clay; moderate 2-5mm subangular blocky; 20-50% 6-20mm ferruginous, soft segregations; few 1-2mm roots;
B32	1.50 to 2.00 m	Weak red (10R4/4); 20-50% 15-30mm prominent, white (10YR8/1) primary and dark yellowish brown (10YR4/8) secondary mottles; sandy light clay; moderate 2-5mm subangular blocky; 20-50% 6-20mm ferruginous, soft segregations.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 4	Description
	A	24:18	Black (10YR 3/1) to grey (10YR 5/1); sandy loam to sandy clay loam (light); massive to weak subangular blocky or cast; clear or gradual change to
	A2	18:8	Brown (10YR 4/3) to light brownish grey (10YR 6/2); sandy loam to clay loam; gradual or clear change to
	A3-B1		Brown (7.5YR to 10YR 4-5/3-4) to yellowish brown (10YR 5/6); sandy clay loam to sandy light clay; massive to moderate subangular blocky; few to common ironstone gravels
	B2	26:28	Red (2.5YR 4/6-8) to yellowish red (5YR 5/8), with stronger red (10R 4/6) and yellow (10YR 7/6) mottles; sandy light clay to medium heavy clay; massive to moderate subangular blocky; few to common ironstone nodules
	B3		Red (10R 4/4-6), white (10YR 8/1) and yellow (10YR 7/6); sandy light clay to medium clay; moderate to strong subangular or angular blocky; few to common ironstone gravels.



Vegetation is mid-high woodland of *Melaleuca vindiflora* and *Eucalyptus intermedia.*

Principal profile forms encountered include Gn3.74, Dr2.21 and Gn3.71.

ANALYTICAL DATA

Profile T409 Map Reference KIRRAMA 1:100 000 760084
FELUGA SERIES RED VARIANT Sampled from fertilized pasture paddock

Depth cm	0-10	10-20	20-30	30-45	45-60	60-90	90-120	120-150	150-180	180-200
Horizon	Ap	Ap	A2	B1c	B21	B21	B22	B31	B31	B32
pH	6.0	5.7	5.4	5.5	5.4	5.3	5.3	5.5	5.4	5.4
E.C.mS/cm	0.07	0.04	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.01
T.C. %	4.37		2.09		0.65		0.27		0.08	
N %	0.2		0.09		0.03					
AvP ppm	130		10		2				1	
Free Fe%	1.5		1.7		2.1					
Tot. P %	0.072		0.015		0.012				0.0043	
Tot. K %	0.05		0.02		0.02				0.07	
Tot. S %	0.041		0.026		0.018				0.02	
Tot. Fe%	1.6		1.7		1.9					
Tot. Cu%	0.0006		0.0014		0.0005					
Tot. Zn%	0.0008		0.0024		0.0016					
Tot. Mn%	0.007		0.006		0.005					
Exchange properties m.e./100 g soil										
Ca	1.4		0.02		0.02		<0.02		<0.02	
Mg	1.2		0.04		0.03		0.17		0.09	
K	0.83		0.14		0.04		0.02		<0.02	
Na	0.12		<0.02		0.02		0.03		0.04	
H + Al	0.586		1.14		0.83		0.71		0.96	
'ECEC'(1)	3.6		1.3		0.3		0.9		1.1	
'ECEC'/ 100gC	13.33		3.9		0.79		2.2		3.44	
CEC(2)	12.0		6.0		3.0		3.0		2.0	
CEC/100gC(2)	44.4		18.2		7.9		7.3		6.2	
Base Sat3	4		20		4		8		8	
CEC(4)	2.8		2.3		1.2		1.5		1.3	
Particle Size %										
Gr	5	13	15	30	27	22	30	58	59	51
CS	52	45	43	43	39	33	33	31	37	39
FS	15	16	17	18	15	14	13	11	12	12
Si	6	7	6	5	7	9	14	20	18	17
C	27	32	33	35	38	44	41	39	32	32
BD	1.2	1.3	1.3	1.4	1.4	1.4	1.3	1.3	1.5	1.5
.1 Bar	28.4	32.6	31.8	27.2	29.8	30.9	31.4	33.2	32.1	34.2
15 Bar	17.8	19.8	19.6	20.4	21.6	22.6	23.0	25.8	23.1	21.5

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Qz%	Ha/Go%	G%
	45-60	1-5	>80	1-5	1-5	1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

MAPPING UNITS - SOILS OF ACID IGNEOUS ROCK

Utchee Association (Ut)

This association includes all the undulating low hills to steep hills on granitic rock. It has been mapped in the Murray River gorge, upper Tully River valley, upper Kennedy Creek valley and on several of the rolling low hills on Tully River Station.

The dominant soils are the red, structured, gradational and uniform fine textured soils of Utchee series. The red podzolics of Cadillah series and yellow podzolics of Elphinstone series are the most common associated soils in most UMA's, Cadillah series occupying well-drained sites and Elphinstone series the poorly drained sites. The red earths of Tyson series and less frequently the yellow earths of Thorpe series may occur on the lower slopes. On Tully River Station Feluga series may be an associated soil on the lower slope extremities and Lugger series may occur in areas of prolonged seepage on several of the low hilly UMA's .

Uniform clay profiles were described on some virgin sites, but the majority occurred on cultivated pasture land where the texture profile may have been modified by mechanical mixing. This (Uf) texture profile was used as a criteria to distinguish Utchee from Tyson series on many of the low hills of the Tully valley as the structure is usually very difficult to detect in an augered sample.

Cadillah Association (Cd)

Only three areas of this association have been delineated, one near Cardwell township and two in the upper Tully River valley. This association occurs on low hilly to hilly topography, dominantly, but not exclusively on fine grained acid volcanics. Associated soils are Elphinstone series which occupies less well drained sites, and Utchee series the better drained sites.

Elphinstone Association (Es)

This is a minor unit and occurs as a single UMA to the west of Cardwell township on the lower slopes of Mount Elphinstone. The unit occurs as a uniform low angle pediment whose surface is broken by minor erosion gullies. The yellow podzolic soils of Elphinstone series are dominant with minor associated yellow earths of Thorpe series on the mid to lower sections and an unnamed bleached podzolic soil at the upper limit of the unit where a sharp break in slope occurs.

The soils of Elphinstone series occur throughout the granitic hills predominantly where short seasonal water tables occur.

Tyson Association (Ty)

Three soil series have been identified on the pediments and low angle fans extending from the granitic uplands. They form a hydrological catena of red, yellow and grey earths named Tyson, Thorpe and Lugger series respectively. The red Tyson soils occur on the higher, freely draining slopes and the grey Lugger soils on the lower slopes that may be saturated for long periods each

year. The yellow Thorpe soils occupy intermediate sites and have a shorter duration of saturation than Lugger series.

North of the Murray River, Tyson association has been mapped in all areas where the granite uplands abut the riverine alluvium. Within the association Utchee series may occur on the crests of low hills in the Tully River valley with minor inclusions of Lugger and Banyan series in the poorly drained sites; Feluga series may occupy low rises or extremities of these low hills. Mapping purity is highest on gentle slopes where only minor inclusions of Thorpe series occur.

Where the Tully River has truncated several fans along its course, the poorly drained soils of Timara and Hewitt series may be included in some UMA's at the point of truncation.

Alma series occurs randomly throughout the Tyson association. Although it is only of minor areal occurrence, it has a very different management requirement because of a high phosphorous retention characteristic. Granite boulders to 1 m diameter on the surface and throughout the solum may occur on the upperslopes of many UMA's.

Tyson association was first identified and mapped to the north of this area (Murtha 1986) where it occupied granite fans dominated by rainforest vegetation. Hillview association was first identified on granite fans on the Townsville coastal plain (Murtha 1975) and subsequently extended to the Herbert valley mapping by Wilson (1990). In these areas the dominant vegetation is open sclerophyll forest. Although the Tyson and Hillview soils are morphologically similar there are some differences in their chemical properties, particularly cation status, and these differences have been confirmed in the soil analysis for this survey. For mapping purposes the distinction has been made on the vegetation i.e. rainforest vs. eucalypt open forest. This vegetation boundary is diffuse and an arbitrary boundary has been drawn in the vicinity of the Murray River. To the south, red soils on granite fans are mapped as Hillview series and to the north similar soils are mapped as Tyson series.

Hillview (Hv) and Hillview Fine Variant (HvV) Associations

These associations dominate the upper slopes of the granitic fans to the south of the Murray River. Hillview soils have generally a much higher content of quartz and granitic gravel and as a result, a lower clay content and lower water and nutrient retention capacity compared to Hillview fine variant. This distinction has been made because these soils have significant potential for horticultural cropping although water availability will be their major limiting factor. Within the unit some low lying sections may contain Thorpe or Kirrrama and rarely Lugger or Rungoo series. Hillview and its fine variant were able to be mapped separately on the fans to the south of Cardwell as these were narrower and shorter than elsewhere in the survey; to the north of Cardwell the fans are generally more extensive and complex and the distinction could not readily be made. Granite boulders to 1 m diameter occur on the surface and throughout the solum on the upperslopes of many UMA's.

Thorpe (Th)

This is the most extensive of the soil associations that occur on the granitic fans. It is only of minor significance on the shorter and steeper coalescing fans but occupies most of the very extensive, low angle fans that originated in the granites of the Kirrama Range. These latter fans have less than .5% slope and may extend for up to 15 km from their source.

The unit is dominated by the yellow earth soils of Thorpe series. Hillview and Tyson series occur on better drained upper extremities of the fans while Malbon, Prior, Lugger, Rungoo and Banyan series occur on the lower, less well drained extremities.

On the short coalescing fans of the Tully River valley north of the Murray River, Tyson series occurs on the better drained upper extremities with Lugger series on the lower slopes. Banyan series occurs in minor depressions throughout the unit.

On the coalescing fans on the lower slopes of the Cardwell Range south of the Murray River to Kennedy Creek, Hillview series occur on the upper slopes with Lugger, Malbon and Prior series on the lower slopes. Canoe series may occur along minor streams traversing the fans. South of Kennedy Creek, Hillview series occurs on the upper slope with Cudmore, Porter, Arnot and Lugger series on the lower slopes, Canoe series may also occur along minor streams.

Low angle fans occur in the area from Davidson Creek in the west through Murray Upper to the east of the Bruce Highway. In some areas e.g. Murray Upper and to the east of Davidson Creek these fans have been extensively reworked by the modern drainage. In these areas small inclusions of the soils formed on recent alluvium may be included. On the sheet flood fans Malbon and Prior series are the dominant associated soils and occur in slightly lower elongate depressions. Lugger and Rungoo series are common on the poorly drained distal ends of the fans. Canoe series occurs on the minor streams draining the fans.

The Thorpe association is generally rock-free although a number of areas in the upper Tully River valley and minor areas in the Kennedy valley have sufficient cobble and stone to impede agricultural usage.

Alma Association (Am)

This is a minor association which occurs from Cardwell to the upper Tully River valley. It occupies some of the lower foothills and adjacent alluvial fans along the Kirrama Range. The association is dominated by red earth soils of Alma series whose distinguishing feature is a relatively deep (> 20 cm) black A horizon. These soils usually occupy the better-drained hillslopes and upper sections of the fans. Kirrama series which have a similar surface and yellow B horizons may occur in less well drained sections of the unit. In several UMA's the red earth soils of Tyson and Hillview series and less commonly yellow earth soils of Thorpe series may be included.

The soils of Alma series occur throughout much of the better drained granitic slopes and their apparent random occurrence suggests there is no association with landscape position or vegetation type.

The deep dark A horizons have high phosphate retention (Salins and Probert 1984*). While the soil has only a minor areal occurrence this problem makes it agriculturally significant. A few granitic surface stones occur in parts of some units.

Kirrama Association (Km)

This is a minor unit that has been mapped along the lower slopes of the Kirrama Range between Kennedy and Bilyana. It usually occurs in close association with the Alma association. Both units contain similar soils, the only difference being in dominance. Kirrama series is the dominant soil of the association but Thorpe and Alma series may be included. Hillview series may occur at the upper slope boundary.

The deep dark A horizon of Kirrama series has a similar phosphate retention capacity to Alma series (Salins and Probert 1984)*. This makes it an important soil to be recognised for although of limited areal extent it occurs sporadically throughout the lower granitic slopes as an inclusion in several associations. The Kirrama unit was found to be rock-free.

Lugger Association (Lu)

Lugger association occurs throughout the granitic fans. It commonly occurs on the lower distal ends of fans but may also occur in depressions in the better drained mid to upper slopes. The largest areas of the association occur in the Tully River valley.

The grey earth soils of Lugger series are dominant. Associated soils are Prior and Thorpe series in better drained sites with Banyan and Rungoo series in wetter areas. Rungoo series is the most commonly associated soil in the units to the south of Bilyana .

In some areas thin rudimentary podzols are forming in the upper part of Lugger series profile. This soil should probably be recognized as a separate series but not enough is known of their distribution or range in characteristics. Salins and Probert (1984)* report on the phosphate fixing nature of the podzol B horizon of this soil and their work suggests potential problems for pasture establishment. Where adequate drainage and fertilizer inputs have been applied to soils of the association they have proven to be most productive, especially for pastures and cucurbits.

Prior Association (Pr)

Prior association occurs extensively near Bilyana on a large fan emanating from the Kirrama Range. It also occupies two small UMA's on the easterly facing slopes of the Tully River valley.

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* Salins, I. and Probert, M.E. (1984). Phosphate sorbtion measurements on some soils from the wet coast of north Queensland. CSIRO (Aust.) Div. Soils Tech. Memo. No. 8/1984 (unpublished).

The unit is dominated by the distinctly mottled soils of Prior series and has inclusions of the yellow earth soils of Thorpe series in the better drained sites while the grey earth soils of Lugger series are found in less well-drained sites.

While there are only a few occurrences of this association, Prior series is a common component of all less well drained units mapped on granite fans in higher rainfall areas.

Malbon Association (Mb)

This association has been mapped on the low angle fans from Dallachy Creek to the Tully River. It usually occupies closed depressions adjacent to channel infills or prior streams. The soils of Malbon series are morphologically similar to Coom series but have been identified as a separate series due to their association with the granitic fans.

The association is dominated by the soils of Malbon series with minor inclusions of Prior series in the better drained sites and Goolboo series on channel infill. Soils similar to Coom and Timara series may occur immediately adjacent to the channel infill. This suggests that they may be discrete alluvial units within the granitic fans, possibly laid down while the associated channel was active. Derra series is an inclusion in the UMA's on Tully River Station while Porter series is an inclusion in the UMA's in the Kennedy valley.

Rungoo Association (Rg)

This association occurs on the lower slopes of the granitic fans, most commonly where the fans abut alluvium or the coastal littoral zone. The dominant soil is Rungoo series. Lugger series is the most common associated soil but small areas of Banyan series may occur throughout the association in swampy depressions. Thorpe or Prior series may occur on the upper slope margins of some UMA's.

Due to position in the landscape and impedance caused by the impermeable clay B horizon, these soils quickly become water-logged and remain so for much of the wet season. On the other hand they are reputed to be 'droughly' when artificially drained.

Banyan Association (Ba)

This association has been mapped in many of the wetter sections of the granitic landforms from Bilyana north to the Tully River. It has been included with the granitic soils rather than the poorly drained alluvium (Murtha 1986) as in this study it is generally quite separate from the alluvial units. The association is dominated by the humic gley soils of Banyan series. Some UMA's adjacent to the low hills of Tully River Station and the Tully River valley have developed shallow peaty surfaces that breakdown rapidly when drained. It is most probable that much of what is now mapped as Banyan and Lugger series were once peaty surfaced soils similar to Bulguru series. Both Nind and Bulguru series are still common inclusions. On the low angle fans of Mt Tyson extensive UMA's of Banyan association occur, with Lugger and Hewitt series being the most common inclusions.

The permanency of water tables appears to be the most important condition determining the occurrence of Banyan or Lugger series. With artificial drainage, the sapric to fibric materials in the surface horizons of Banyan series are rapidly oxidised and destroyed leaving a mineral surface similar to Lugger series.

Porter Association (Pt)

The largest areas of Porter association occur south of Cardwell with minor occurrences on the southern slopes of the Kennedy Creek valley and northern slopes of the Kirrama Range. The association is dominated by the soloth-like soils of Porter series. Cudmore is the major associated soil and is distinguished from Porter series by the absence of a sharp texture break to the B horizon.

In the Kennedy Creek valley Arnot and Glenborra series occur on numerous channel infills which transect many of the units. Marked differences in tree growth can be seen between the soloths of Porter series and the sands of Arnot and Glenborra series, reflecting the deeper rooting depth of the sands.

Where units abut alluvium, Coom series is the dominant associated soil with minor inclusions of Bulguru and Hewitt series. To the south of Cardwell the UMA's may have soils which overlie older marine sediments with significantly higher sodium levels in the lower B or D horizons.

Cudmore Association (Cm)

Cudmore association occurs on the lower fan slopes along the Cardwell Range south of the Murray River.

The association is dominated by the soils of Cudmore series. Arnot series is the major associated soil in the majority of UMA's to the north of Cardwell, while Porter series may be codominant in UMA's to the south of Cardwell. Thorpe series may occur on the upper and mid slopes of the fans and Canoe series on the levees of incised streams.

The B horizons of the sodic Cudmore soils are extremely erodible. The exchange complex is dominated by magnesium but the soils erode in the same manner as soils with high sodium percentage. Compounding this problem, the soils have a high fine sand fraction (40% in the A horizon) that is not readily transported by water and as a result chokes drainage networks.

Arnot Association (An)

Arnot association occurs on the lower extremity of the fans with a northerly aspect in the Kennedy Creek valley. The association is relatively uniform, being dominated by the siliceous sandy soils of Arnot series with minor inclusions of Glenborra , Cudmore, and Lugger series. Canoe series may be found on the levees of incised streams.

These soils are saturated for short periods during the wet season. Due to their coarse sandy texture they have low water holding capacity and are in moisture deficit for much of the year.

Feluga Association (Fe)

This association occurs on the low hills and rises throughout the survey area. They are interpreted as being the remnants of old alluvial fans but some are now remote from the hills from which they formed.

The units to the west of Cardwell occur high in the landscape and are clearly fans from the adjacent granite uplands. Some of the units on Tully River Station are attached to the low granite hills while others have been detached by recent dissection. The units to the east and north of Bilyana are surrounded by more recent sheet flood fans and are remote from the granite uplands. It is possible that these low hills are inliers of granite but no evidence of bedrock was found during the soil investigation.

The association is dominated by lateritic podzolic soils of Feluga series which are characterised by the presence of moderate to high amounts of ironstone nodules usually concentrated in the lower A and the upper B horizons. In the few deep sections observed, the solum was underlain by a deep mottled zone.

Murtha (1986) defined Feluga series as being mottled with red as the dominant colour. In this area they are mottled soils but with yellow as the dominant colour. These occur in the lower poorly drained sites and they grade to soils with red as the dominant colour to soils that are whole coloured red on the higher well-drained sites. The latter have been identified as a red variant and are mapped as the dominant soil on a few small UMA's.

Associated soils include Utchee and Tyson or Hillview series where the UMA's abut the granite hills and Lugger or Banyan series where they abut the sheet flood fans.

Small areas of Feluga series and particularly the red variant may have deep dark A horizons. As with Alma and Kirrama series these dark A horizons have a high phosphate retention.

Miscellaneous Unit (M6)

This is a highly complex unit on the southern slope of Mt Tyson. The soils have formed on alluvial fans from granite and have a high amount of fine (2-6 mm) granitic gravel. The distinctive feature of these soils is the thin, well-developed podzol profile that has formed in the upper horizons of what were probably once Lugger or Prior series. No attempt has been made to characterise these soils as their area is relatively small and there are no exposures. Banyan series is the most common associated soil.

Mountainous Unit (M2)

This unit includes all the steep, high hilly to mountainous granite and acid volcanic lands, some small basalt flows may be included. There is little access to these areas and few soils have been examined. Most examinations have been on lower slopes where it is difficult to distinguish between soil materials developed *in situ* from those that have moved downslope.

Several soil series were observed in these units including Utchee, Cadillah and Elphinstone, the latter two are dominant on the Glen Gordon volcanics while Utchee is dominant on the coarser granitic rocks. On the lower slopes Tyson and Hillview series are likely to be the most common associated soils, with occasional occurrences of Alma series.

Incised Channels (Ic)

Throughout the area, deep and generally narrow channels have incised the granitic fans. The steep sides of these channels show depositional sequences which vary greatly from clayey to gravelly textures. The base of these incisions is a complex mixture of material from both the fan surfaces and the cut sides. These materials may be reworked to form profiles similar to series such as Japoon, Liverpool, Canoe and Lugger.

WELL DRAINED SOILS FORMED ON ALLUVIUM

Twelve soil series have been recognised within this group. Their major distinguishing features are summarized in Table 4 and the field relationships of the major soils formed on alluvium are represented diagramatically in Figure 8. Most alluvia are derived from a mixture of granitic and acid volcanic parent materials. The Tully River catchment also includes some areas of basalt, and this is reflected by the occurrence of soils such as Innisfail series which occurs only where there is a significant contribution to the alluvia of more basic parent materials.

Japoon, Liverpool and Bluewater series usually occur on channel benches but towards the lower reaches of streams they may occupy the levees. Tully, Innisfail, Dayman and Mossman series occur on the levees and flood plains of the major drainage systems. Whitfield and Goolboo series are restricted to prior streams and channel infills. Virgil series is found on relict levees and on floodplains or terraces which are no longer flooded. Canoe series occurs on levees and prior streams, generally in the upper reaches of the streams from granitic uplands. Midgenoo series occur only as a minor associated soil and is not mapped separately.

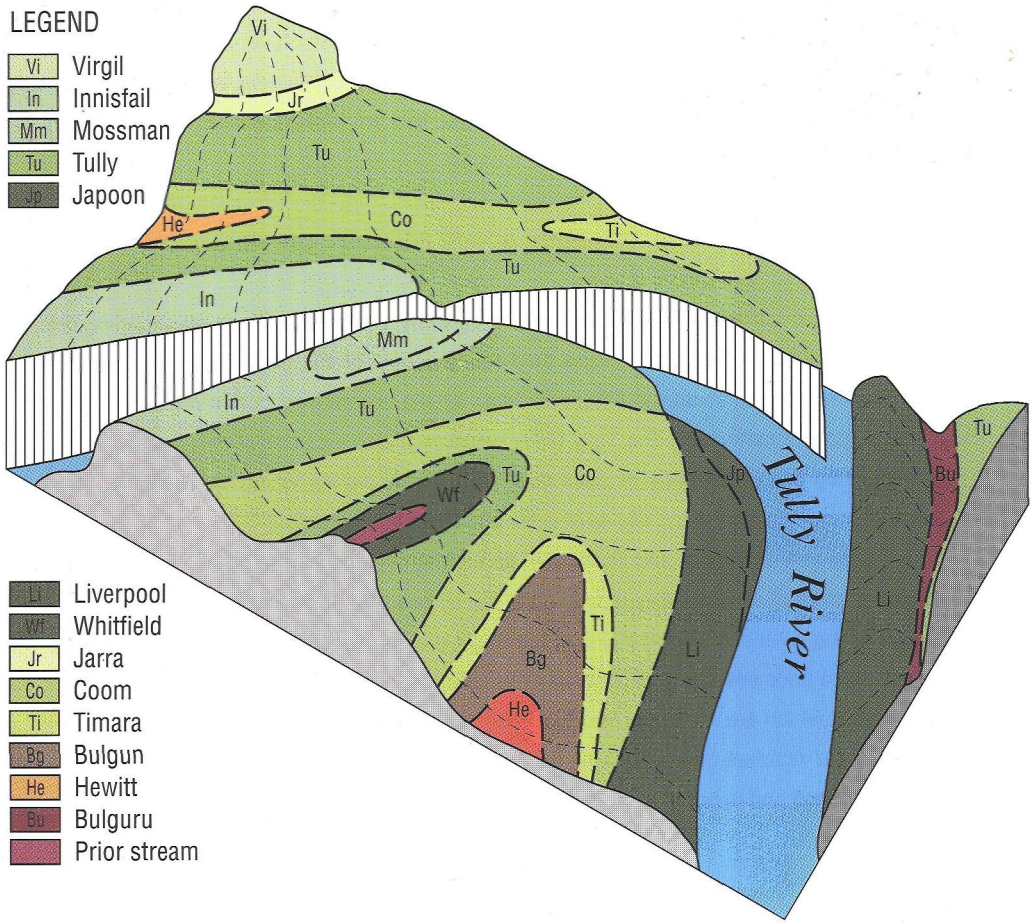


Figure 8. Schematic diagram of soils formed on well drained alluvium.

TABLE 4.

Well drained soils formed on alluvium.

Soil Series	Landform	Major Distinguishing Features
Midgenoo	Alluvial plain usually elevated.	Strongly structured red uniform to gradational soil.
Virgil	Stagnant alluvial plains.	Massive red uniform to gradational soil.
Bluewater	Channel benches, terraces, and levees.	Massive red and yellowish red uniform to gradational soil.
Innisfail	Stream levees and floodplains.	Strongly structured brown uniform to gradational soil.
Dayman	Low rises in floodplain, prior streams.	Black sapric loam A horizon over a massive to moderately structured brown B horizon, mottled at depth.
Tully	Stream levees and floodplains	Strongly structured yellow uniform to gradational texture profiles, may be mottled at depth.
Canoe	Stream levees and prior streams.	Massive yellow, uniform to gradational soil, sandy textures.
Mossman	Stream levees and flood-plains.	Dark (both moist and dry) strongly structured A horizon over structured yellow and brown B horizon, uniform to gradational texture profile.
Whitfield	Prior streams	Dark (both moist and dry) strongly structured A horizon over bright yellow massive B horizon; texture decreases from sandy clay loam with depth.
Liverpool	Low terraces, channel benches and levees.	Brown massive uniform fine sandy loam to clay loam overlying stratified sands at shallow (≤ 90 cm) depth.
Goolboo	Prior stream	Yellow and red, fine and coarse gravelly, stratified sands to sandy clay loams.
Japoon	Channel bench	Stratified coarse sands with cobble and boulders in the profile.

MIDGENOO SERIES (Mi)

CONCEPT
A red, structured clay loam to clay soil

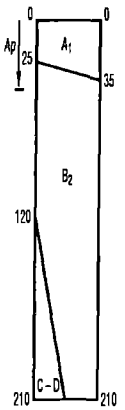
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Krasnozem	Gn3.11	Typic Paleudult	
LANDFORM	Alluvial plain		Hapludox ?	
REFERENCE SITE	Tully 1:100 000 766202		RAINFALL	3500 mm

Horizon	Depth	
A11	0 to .12 m	Dark brown (7.5YR3/2); clay loam; moderate 2-5mm cast; <2% <2mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ; common 1-2mm roots; diffuse change to
A12	.12 to .25 m	Dark reddish brown (2.5YR3/3); clay loam (light); weak 2-5mm subangular blocky; <2% <2mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ; common <1mm roots; gradual change to
A3	.25 to .38 m	Reddish brown (2.5YR4/4); 10-20% 15-30mm distinct dark reddish brown (2.5YR3/3) mottles; clay loam; weak 2-5mm subangular blocky; <2% <2mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ; few <1mm roots; diffuse change to
B1	.38 to .50 m	Dark red (2.5YR3/6); light clay; weak 5-10mm subangular blocky; <2% <2mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ; few <1mm roots; gradual change to
B21	.50 to .80 m	Red (2.5YR4/8); light medium clay; moderate 2-5mm subangular blocky; 2-10% 2-6mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ; few <1mm roots; diffuse change to
B22	.80 to 1.10 m	Red (2.5YR4/8); light medium clay; moderate 5-10mm subangular blocky; 2-10% 2-6mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ; few <1mm roots; diffuse change to
B23	1.10 to 1.60 m	Red (2.5YR5/8); <2% <5mm faint yellow (10YR7/8) mottles; medium clay; moderate 5-10mm subangular blocky; 2-10% 2-6mm manganiferous nodules; <1, 0.075-1mm macropores per 100mm^2 ;
B24	1.60 to 1.80 m	Red (2.5YR5/8); 2-10% <5mm distinct yellow (10YR7/8) mottles; medium clay; weak 10-20mm prismatic breaking to strong 5-10mm subangular blocky; 10-20% 6-20mm, rounded, argillaceous, nodules; <1, 0.075-1mm macropores per 100mm^2 .

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	Ap	Very dark grey (10YR 3/1) to brown (7.5YR 4/4); fine sandy clay loam to light clay;
	A	Dark brown (7.5YR 3/2) to dark reddish brown (2.5YR 3/3); silty clay loam to silty light clay; moderate to strong cast or subangular blocky; gradual or clear change to
	B2	Reddish brown (2.5YR 4/4) to red (2.5YR 5/8) occasionally yellowish red (5YR 5/8) or yellow (10YR 7/8) mottle; light to medium clay; weak prismatic to strong subangular blocky to angular blocky structure
	C-D	Stratified sands and clayey deposits similar to Coom and/or Timara series.



Midgenoo series commonly occurs as a minor inclusion in the soil associations mapped on the better drained alluvium where it occupies slightly elevated areas which are possibly relic levees or remnants of older terraces.

Vegetation is closed forest of Acacia species.

Principal profile forms encountered include Gn3.11, Gn3.14, Um6.33 and Um6.34.

ANALYTICAL DATA

Profile T442 Map Reference TULLY 1:100 000 776202
MIDGENOO SERIES Sampled from undisturbed closed forest with *Acacia* emergents.

Depth cm	0-12	12-25	25-38	38-50	50-80	80-110	110-140	140-160	160-180
Horizon	A11	A12	A3	B1	B21	B22	B23	B23	B24
pH	4.4	4.9	5.1	5.1	5.0	4.8	5.0	5.1	5.0
E.C. mS/cm	0.18	0.05	0.03	0.02	0.02	0.02	0.02	0.02	0.02
T.C. %	5.25		2.0		0.58		0.29		
N%	0.27		0.07		0.01				
AvP ppm	10		5		5				
P ret %	66		62		62				
Free Fe%	4.3				5.0				
Tot. P %	0.045		0.031		0.024		0.02		0.017
Tot. K %	0.17		0.16		0.18		0.25		0.375
Tot. S %	0.066		0.045		0.056		0.065		0.061
Tot. Fe%	4.72		5.17		5.816		6.232		5.944
Tot. Cu%	0.0012		0.0011		0.0012		0.0009		0.0015
Tot. Zn%	0.0031		0.0033		0.0034		0.0037		0.0042
Tot. Mn%	0.101		0.064		0.038		0.315		0.013
Exchange properties m.e./100 g soil									
Ca	0.23		<0.02		<0.02		<0.02		<0.02
Mg	0.54		0.07		0.20		0.14		0.12
K	0.08		0.02		<0.02		<0.02		<0.02
Na	0.12		0.03		0.02		0.03		0.03
H + Al	2.91		1.25		0.19		0.19		1.85
'ECEC'(1)	3.9		1.4		0.5		0.4		2.0
'ECEC'/100 C	8.0		2.8		0.9		0.7		4.1
CEC(2)	13		6.0		3.0		2.0		3.0
CEC/100gC(2)	26.5		12.0		5.2		3.4		6.1
Base Sat(3)	7		2		9		10		6
CEC(4)	3.0		2.3		1.7		1.1		1.0
Particle Size %									
Gr	2	0	0	0	0	0	0	0	0
CS	16	16	16	14	12	10	12	8	7
FS	21	22	22	22	20	19	20	22	23
Si	14	12	12	11	10	14	10	19	21
C	49	50	50	53	58	58	58	51	49
BD	1.0	1.3	1.4	1.3	1.3	1.4	1.4	1.5	1.5
.1 Bar	30.6	37.4	37.1	36.7	37.1	38.4	40.6	38.3	39.3
15 Bar	23.2	29.8	30.3	30.7	31.2	32.6	36.4	34.8	35.1

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

VIRGIL SERIES (Vi)

CONCEPT

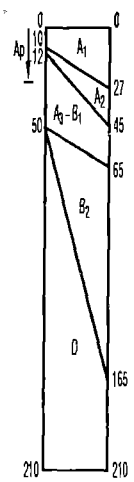
A massive, red sandy clay loam to clay soil on stagnant alluvial plains.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Red Earth	Gn2.14	*Acrudox*	
LANDFORM	Stagnant alluvial plain		RAINFALL	3500 mm
REFERENCE SITE	Tully 1:100 000	754213		

Horizon	Depth	
A11	0 to .12 m	Dark brown (7.5YR3/2); clay loam, sandy; weak 5-10mm subangular blocky parting to weak 2-5mm cast; moderately moist, very weak; common 1-2mm roots; gradual ,wavy change to
A12	.12 to .27 m	Brown (7.5YR4/4); clay loam, sandy (light); massive; moist, very weak; common 1-2mm roots; gradual, wavy change to
A3	.27 to .42 m	Strong brown (7.5YR5/6); 10-20% 5-15mm faint, strong brown (7.5YR4/6) mottles; clay loam, sandy; massive; moist, very weak; few <1mm roots; gradual, wavy change to
B1	.42 to .54 m	Red (2.5YR4/7); sandy light clay; massive; moist, very weak; few <1mm roots; diffuse, wavy change to
B21	.54 to .87 m	Red (2.5YR4/8); sandy light clay (heavy); massive; moist, very weak; few <1mm roots; gradual, change to
B22	.87 to 1.06 m	Red (2.5YR5/8); sandy medium clay; massive; moist, moderately firm; gradual, change to
B23c	1.06 to 1.33 m	Red (2.5YR4/8); 10-20% 5-15mm distinct, reddish yellow (7.5YR7/8) mottles; sandy medium clay; weak 2-5mm subangular blocky or massive; moist, moderately firm; 2-10% 2-6mm manganiferous nodules;
B24	1.33 to 1.65 m	Reddish yellow (7.5YR7/8); 10-20% 5-15mm prominent, red (2.5YR4/8) mottles; sandy medium clay; weak 2-5mm subangular blocky or massive; moist, moderately firm.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 6	Description
	Ap	19:9	Dark brown (7.5YR 3-4/2-4); sandy clay loam; massive to weak subangular blocky
	A1	16:8	Dark brown (7.5YR 3/2) to brown (7.5YR 4/2-4); clay loam, sandy (light) to light clay; massive to moderate cast; clear or gradual change to
	A3		Dark reddish brown (5YR 3/3) to strong brown (7.5YR 5/6); clay loam, sandy to light medium clay; massive to weak subangular blocky
	B1		Brown (7.5YR 4/4) to light yellowish brown (10YR 6/4); sandy clay to medium clay; gradual or diffuse change to
	B2	74:36	Red (2.5YR - 5YR 4-5/8) occasionally strong brown (7.5YR 4/6) or reddish yellow (7.5YR 7/8), may have reddish yellow (7.5YR 7/8) mottles lower in profile; sandy light clay to sandy medium clay; manganiferous nodules may be present
	D		Pinkish grey (7.5YR 6/3); clayey coarse sand; single grain.

Virgil series is morphologically very similar to Bluewater series but it occurs on older elevated alluvium while Bluewater series occurs on younger levees and channel benches.

Vegetation is mid-high to tall woodlands of *Eucalyptus teretercornis, E. alba, E. drepanophylla* and *Casuarina* species.

Principal profile forms encountered include Gn2.14, Gn2.11, Gn2.21 and Gn2.41.

ANALYTICAL DATA

Profile T443 Map Reference TULLY 1:100 000 754213
VIRGIL SERIES Sampled from undisturbed *Casuarina* woodland.

Depth cm	0-12	12-27	27-42	42-54	54-87	87-106	106-133	133-165
Horizon	A11	A12	A2	B1	B21	B22	B23c	B24
pH	5.2	5.1	5.3	5.3	5.3	5.2	5.1	5.1
E.C. mS/cm	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01
T.C. %	8.82		0.86		0.42		0.18	
N %	0.13		0.03		0.01			
AvP ppm	6		3		4		4	
P ret %	45		45		43			
Free Fe%	2.3				2.5			
Tot. P %	0.024		0.019		0.015		0.018	
Tot. K %	0.090		0.07		0.08		0.126	
Tot. S %	0.034		0.028		0.033		0.035	
Tot. Fe%	2.70		2.79		3.22		3.66	
Tot. Cu%	0.0003		0.0003		0.0003		0.0003	
Tot. Zn%	0.0018		0.0017		0.0020		0.0020	
Tot. Mn%	0.053		0.040		0.041		0.047	
Exchange properties m.e./100 g soil								
Ca	0.21		<0.02		<0.02		<0.02	
Mg	0.34		0.13		0.18		0.13	
K	0.07		<0.02		<0.02		<0.02	
Na	0.03		<0.02		<0.02		<0.02	
H + Al	1.33		0.46		0.2		0.14	
'ECEC'(1)	2.0		0.7		0.4		0.3	
'ECEC'/100gC	6.90		2.12		1.08		0.86	
CEC(2)	7.0		2.0		2.0		1.0	
CEC/100gC(2)	24.1		6.1		5.4		2.9	
Base Sat(3)	9		9		12		19	
CEC(4)	2.4		2.0		1.8		0.1	
Particle Size %								
Gr	0	1	2	3	4	7	11	6
CS	49	41	40	35	37	40	40	33
FS	16	20	21	22	21	21	20	17
Si	6	6	6	6	5	3	5	11
C	29	33	33	37	37	36	35	39
BD	1.3	1.4	1.6	1.5	1.5	1.5	1.4	1.4
.1 Bar	29.6	30.7	30.4	27.2	30.4	29.6	27.6	31.8
15 Bar	19.3	18.7	20.7	20.2	23.2	20.7	19.9	27.4

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

INNISFAIL SERIES (In)

CONCEPT

A brown, structured, uniform or gradational textured clay loam to clay soil.

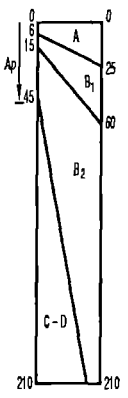
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	No suitable group	Uf6.31/p	Hapludalf
LANDFORM	Levee	RAINFALL	3500 mm
REFERENCE SITE	Tully 1:100 000 634276		

Horizon	Depth	
Ap	0 to .15 m	Dark brown (7.5YR3/2); light clay; strong 2-5mm subangular blocky; common 1-2mm roots; gradual, irregular change to
B21	.15 to .90 m	Brown (7.5YR4/4); silty medium clay; strong 2-5mm subangular blocky; 1-5, 1-2mm macropores per 100mm^2 ; few 1-2mm roots; diffuse change to
B22	.90 to 1.20 m	Strong brown (7.5YR4/6); silty medium clay; strong 2-5mm subangular blocky; 1-5, 1-2mm macropores per 100mm^2 ; few <1mm roots; diffuse change to
B23	1.20 to 1.56 m	Brown (7.5YR5/4); silty medium clay; strong 2-5mm subangular blocky; 1-5, 1-2mm macropores per 100mm^2 ; few <1mm roots; gradual, wavy change to
B3	1.56 to 2.00 m	Strong brown (7.5YR5/6), (7.5YR5/8 d); sandy light clay; weak 5-10mm subangular blocky; 1-5, 1-2mm macropores per 100mm^2 ; few <1mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ	n = 24	Description
	Ap	25:8		Dark brown to brown (7.5YR 3-5/2-4); clay loam, fine sandy, to light medium clay; moderate fine subangular blocky or cast
	A	15:8		Dark brown (7.5YR-10YR 3/2-3) to brown (7.5YR 4/3); silt loam to light clay; strong cast or subangular blocky; clear or gradual change to
	B1			Brown (7.5YR 4-5/2-4) to strong brown (7.5YR 4-5/6); clay loam to silty medium clay; moderate to subangular blocky; gradual or diffuse change to
	B2	61:39		Brown (7.5YR 4/4) to strong brown (7.5YR 5/6-8); silty light clay to medium heavy clay; weak to strong subangular blocky; gradual or clear change to
	C-D			Stratified strong brown (7.5YR 5/6) to brownish yellow (10YR 6/6); sands to medium clay; single grain to moderate angular blocky.



Innisfail series differs from Tully series by having browner (7.5YR) rather than yellow (10YR) colours and deeper non-mottled profiles, and from Liverpool series in having finer textures and strong structure. Similar soils with very dark to black surfaces are included with Mossman series.

Where the soil occurs on the backslope of levees or terraces some ped faces may have a grey 'sheen'.

Gallery rainforest remnants are all that remains of the vegetation communities on the soils of Innisfail series.

Principal profile forms encountered include Uf6.34, Uf6.31, Gn3.71 and Gn3.21.

ANALYTICAL DATA

Profile T413 Map Reference TULLY 1:100 000 634276
INNISFAIL SERIES Sampled from fertilized pasture paddock.

Depth cm	0-10	10-15	15-30	30-60	60-90	90-120	120-156	156-180	180-200
Horizon	Ap	Ap	B21	B21	B21	B22	B23	B3	B3
pH	5.7	6.0	6.1	6.1	6.5	6.1	5.9	5.8	5.6
E.C. mS/cm	0.12	0.05	0.03	0.02	0.02	0.02	0.01	0.02	0.02
T.C. %	4.06		1.6	0.84		0.35			0.24
N %	0.3			0.08					
AvP ppm	47			2		4			2
Free Fe%	3.0			3.5					2.9
Tot. P %	0.121			0.057		0.038			0.028
Tot. K %	2.02			1.94		1.98			2.15
Tot. S %	0.064			0.024		0.018			0.016
Tot. Fe%	4.8			5.4		4.6			
Tot. Cu%	0.0042			0.0031		0.0028			
Tot. Zn%	0.012			0.013		0.011			
Tot. Mn%	0.105			0.077		0.056			
Exchange properties m.e./100 g soil									
Ca	9.6		4.2	3.96		1.9			0.81
Mg	3.0		2.44	2.79		3.1			1.9
K	0.43		0.15	0.21		0.35			0.11
Na	0.09		0.12	0.10		0.08			0.09
H + Al	1.42		0.08	0.11		0.36			1.45
'ECEC'(1)	14.5		7.0	7.2		5.8			4.4
'ECEC'/100gC	45.3		21.9	18.9		16.1			18.3
CEC(2)	20.0		10.0	12.0		10.0			7.0
CEC/100gC(2)	62.5		31.3	31.6		27.8			29.2
Base Sat(3)	66		69	59		54			42
CEC(4)	7.1		4.7	6.7		6.0			4.3
Particle Size %									
Gr	0	0	0	0	0	0	0	0	0
CS	3	7	4	2	1	1	1	2	11
FS	37	33	36	35	41	38	34	50	41
Si	28	31	28	25	22	26	29	22	24
C	32	30	32	38	35	36	36	26	24
BD	.9		1.2	1.3	1.4	1.4	1.4	1.3	1.4
.1 Bar	39.5		39.9	42.3	43.2	42.5	44.2	41.5	40.5
15 Bar	28.4		29.2	33.5	35.3	34.2	35.8	27.3	28.3

Mineralogy of the clay fraction	Depth cm 15-30	I% 6-10	Ka% 66-80	Ch/V% 1-5	Qz% 1-5	Ha/Go% 1-5	G% 1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

BLUEWATER SERIES (Bw)

CONCEPT

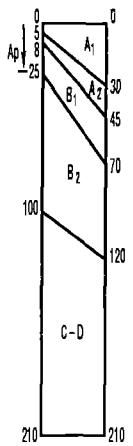
Massive, red, uniform or gradational soil.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	
CLASSIFICATION	Red Earth	Um4.23	
LANDFORM	Channel bench	RAINFALL	2250 mm
REFERENCE SITE	Tully 1:100 000	648232	

Horizon	Depth	
A11	0 to .10 m	Very dark grey (10YR3/1); clay loam, fine sandy; moderate, <10 mm cast; a *clear change to*
A12	.10 to .20 m	Dark brown (7.5YR3/2); clay loam, fine sandy; massive, clear to gradual change to
A2	.20 to 30 m	Brown (7.5YR5/4); clay loam, fine sandy; massive; diffuse change to
B21	.30 to .70 m	Yellowish red (5YR5/6); clay loam, fine sandy; massive; diffuse change to
B22	.70 to 1.20 m	Strong brown (7.5YR5/6); clay loam, fine sandy; massive; clear change to
2D	1.20 to 1.70 m	Strong brown (7.5YR5/6); loamy sand; massive.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	x̄:σ n = 11	Description
	Ap	16:4	Dark brown (7.5YR 3/2); sandy clay loam; massive
	A1	15:10	Black (10YR 2/1) to dark reddish brown (7.5YR 4/4); loam to clay loam, sandy; massive to moderate cast; *clear or gradual change to*
	A2	11:5	Dark brown (7.5YR 3/2) to brown (4/3); sandy loam to clay loam, fine sandy; gradual or clear change to
	B1		Brown (7.5YR 4/3) to yellowish red (5YR 5/6); sandy clay loam to sandy light clay.
	B2	52:22	Yellowish red (5YR 4-5/6-8); light sandy clay loam to medium clay; massive to weak subangular blocky.
	C-D		Strong brown (7.5YR 5/8) and yellowish brown (10YR 5/6); clayey coarse sand to clay loam, sandy; single grain to massive.

Vegetation is low to mid-high woodland of *Eucalyptus intermedia, E. tesselaris* and *E. alba.*

Principal profile forms encountered include Gn2.21, Gn2.24, Gn2.41 and Um4.23.

DAYMAN SERIES (Da)

CONCEPT

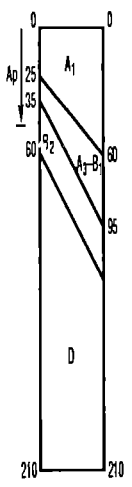
Black sapric loam A horizon with a bright brown clay loam to clay upper B horizon, mottled at depth.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	
CLASSIFICATION	No suitable group	Gn3.71	
LANDFORM	Alluvial plain (low rises)	RAINFALL	3000 mm
REFERENCE SITE	Kirrama 1:100 000	861081	

Horizon	Depth	
A11	0 to .22 m	Black (10YR2/1); loam; moderate, <5 mm cast; gradual change to
A12	.22 to .60 m	Dark brown (7.5YR3/2); loam; weak, <20 mm subangular blocky; gradual change to
B1	.60 to .68 m	Dark greyish brown (10YR4/2); clay loam; moderate, <5 mm angular blocky; clear change to
B21	.68 to .73m	Brown (10YR5/3); medium clay; moderate, <5 mm angular blocky; clear change to
B22	.73 to .86 m	Greyish brown (10YR5/2); medium clay; moderate, <10 mm angular blocky; clear change to
2D	.86 to 1.2 m	Light yellowish brown (10YR6/4), <10% <5 mm; faint, brownish yellow (10YR6/6) mottle; sandy light clay; massive.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 10	Description
	Ap	36:11	Black (10YR 2/1) to very dark greyish brown (10YR 3/2); sapric loam to sapric clay loam; massive to weak subangular blocky
	A1	42:18	Black (10YR 2/1) to dark greyish brown (2.5Y 4/2); sapric loam to clay loam; weak to moderate cast or subangular blocky.
	A3		Very dark greyish brown (10YR 3/2) to dark yellowish brown (10YR 4/4); sapric clay loam to light clay; gradual or clear change to
	B1		Dark brown (7.5YR 3/2) to dark greyish brown (10YR 4/2); sandy clay loam to clay loam; massive.
	B21	36:19	Dark yellowish brown (10YR 4/4) to dark greyish brown (10YR 4/2); loam to medium clay; massive to moderate prismatic; gradual or clear change to
	B22		Grey (10YR-2.5Y 5-7/1-2), with strong brown (7.5YR 5/8) and brownish yellow (10YR 6/8) mottles; loam to medium clay; moderate to strong prismatic or angular blocky.
	D		Grey (10YR 5/1) to very pale brown (10YR 7/3); coarse light sandy clay loam to medium heavy clay; massive to strong angular blocky.

The major distinctions between Dayman series and Hewitt series is the brown rather than grey upper B horizon and that it occurs on elevated sites on the alluvial plains rather than in depressions. Vegetation is mid-high rainforest although very few sites remain in an uncultivated condition. Principal profile forms encountered include Gn3.71, Dy5.11, U5.22.

TULLY SERIES (Tu)

CONCEPT

A yellowish brown, structured, gradational or uniform clay loam to clay soil, may be mottled at depth.

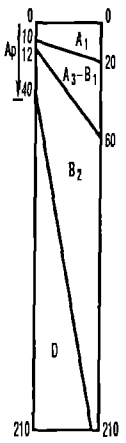
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	No suitable group	Uf6.34	Dystropept	
LANDFORM	Alluvial plain		RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000	923830		

Horizon	Depth	
A1	0 to .10 m	Dark greyish brown (10YR4/2); silty light clay; strong, 2-5mm cast; moderately moist, moderately weak; common 1-2mm roots; gradual, wavy change to
A3	.10 to .20 m	Brown (10YR4/3); light medium clay; strong, 10-20mm subangular blocky; moderately moist, moderately firm; common 1-2mm roots; diffuse, wavy change to
B1	.20 to .45 m	Brown (10YR5/3); medium clay; strong ,10-20mm subangular blocky; moderately moist, moderately firm; 2-10% 2-6mm manganiferous nodules; common 1-2mm roots; diffuse, wavy change to
B2	.45 to 1.10 m	Brownish yellow (10YR6/6); 10-20% 5-15mm distinct, very pale brown (10YR7/4) mottles; medium clay; strong 10-20mm subangular blocky; moderately moist, moderately firm; common 1-2mm roots; clear, smooth change to
2D	1.10 to 1.50 m	Pale yellow (2.5Y7/4); 20-50% 5-15mm distinct, brownish yellow (10YR6/8) mottles; clayey sand; massive; moderately moist, moderately weak; clear, smooth change to
3D	1.50 to 1.80 m	Light grey (2.5Y7/2); 10-20% <5mm faint, brownish yellow (10YR6/8) mottles; coarse sand; single grain; dry loose; 50-90% 2-6mm, subangular, dispersed quartz gravel; clear, gammate change to
4D	1.80 to 2.00 m	Greyish brown (2.5Y5/2); 10-20% <5mm faint, light olive brown (2.5Y5/6) mottles; silty clay loam; strong 50-100mm columnar; moderately moist, very firm; few <1mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ	n = 28	Description
	Ap	23:9		Very dark greyish brown (10YR 3/2) to brownish yellow (10YR 6/6), a brownish yellow (10YR 6/6) dry ploughed colour is characteristic; silty clay loam to light medium clay; weak to moderate subangular blocky
	A1	13:3		Dark greyish brown (10YR 4/2) to greyish brown (10YR 5/2) occasionally dark grey (10YR 4/1) or brown (10YR 4/3); clay loam, fine sandy to medium clay; moderate to strong subangular blocky and cast; gradual to clear change to
	A3-B1			Dark greyish brown (10YR 4/2) to yellow (10YR 7/6); light to medium clay; manganese nodules may occur; diffuse to gradual change to
	B21	61:38		Brownish yellow (10YR 6/6-8) and yellowish brown (10YR 5/4-6); clay loam, fine sandy to medium clay; moderate to strong subangular or angular blocky; manganese soft patches and nodules may occur; gradual or diffuse change to
	B22-23			Yellowish brown (10YR 5/6) to yellow (10YR 7/8), occasionally light brownish grey (10YR 6/3), common reddish yellow (5YR - 7.5 YR 6/6-8) mottles; clay loam, fine sandy to medium heavy clay; moderate to strong subangular and angular blocky; manganese nodules may occur;
	D			Brownish yellow (10YR 6/8), reddish yellow (7.5YR 6/8) and light grey (2.5Y 7/2); clayey coarse sand to medium heavy clay; single grain to moderate subangular or angular blocky.



Tully series differs from Mossman series by not having a dark (both moist and dry) surface horizon. Principal profile forms encountered include Um6.34, Uf6.34p, Dy3.1p, Gn3.7p, Uf6.33 and Gn3.71. Gallery rainforests are the most common remaining vegetation forms on Tully soil.

ANALYTICAL DATA

Profile T376 Map Reference CARDWELL 1:100 000 923830
TULLY SERIES Sampled from undisturbed gallery rainforest.

Depth cm	0-10	10-20	20-30	45-60	60-90	90-110	110-120	120-150	150-180	180-200
Horizon	A1	A3	B1	B2	B2	B2	2D	2D	3D	4D
pH	5.8	5.6	5.2	5.2	5.3	5.5	5.7	5.8	6.2	5.9
E.C. mS/cm	0.15	0.06	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.03
T.C. %	3.98		1.67	0.47		0.17		0.06		0.13
N%	0.37		0.12							
AvP ppm	22		4	2				2		1
P ret %	33									
Free Fe%	1.7	1.4	1.6	1.5	1.7					
Tot. P %	0.055		0.03	0.013				0.004		0.002
Tot. K %	2.3		2.2	2.2				3.7		2.7
Tot. S %	0.055		0.028	0.019				0.003		0.002
Tot. Fe%	2.5		2.6	2.5						
Tot. Cu%	0.001		0.0008	0.0008						
Tot. Zn%	0.0076		0.0053	0.0051						
Tot. Mn%	0.243		0.115	0.057						
Exchange properties m.e./100 g soil										
Ca	7.4		1.36	0.07		0.04		<0.02		<0.02
Mg	3.0		1.59	1.1		1.3		0.79		1.24
K	0.55		0.09	0.09		0.05		<0.02		<0.02
Na	0.03		0.05	0.04		0.13		0.08		0.45
H + Al	0.16		2.94	3.28		1.52		0.88		1.17
'ECEC'(1)	11.1		6.0	4.6		3.0		1.8		2.9
'ECEC'/00gC	26.4		15.0	10.7		9.7		20.0		20.7
CEC(2)	18.1		17.8	10.7		4.8		3.9		4.0
CEC/100gC(2)	43.1		44.5	24.9		15.5		43.3		28.6
Base Sat(3)	61		17	12		32		23		43
CEC(4)	10.3		6.1	4.7		3.1		2.3		2.8
Particle Size %										
Gr	0	0	0	0	0	0	0	0	5	1
CS	3	6	4	7	5	10	22	21	63	30
FS	17	15	16	20	29	38	52	57	27	33
Si	38	42	40	31	29	21	14	13	6	23
C	42	37	40	43	36	31	12	9	5	14

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%
	45-60	6-10	>80	<1	1-5	<1

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

CANOE SERIES (Cn)

CONCEPT

Massive, yellow, gradational to uniform soil, may become mottled at depth.

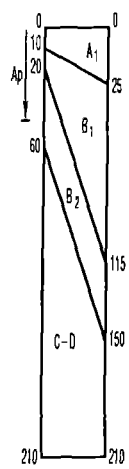
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Yellow Earth	Um5.52	Dystropept	
LANDFORM	Levee		RAINFALL	2350 mm
REFERENCE SITE	Kirrama 1:100 000 796994			

Horizon	Depth	
A1	0 to .12 m	Dark greyish brown (10YR4/2); fine sandy clay loam; weak 2-5mm subangular blocky; moderately moist very weak; common 1-2mm roots; clear, wavy change to
AB	.12 to .27 m	Brownish yellow (10YR6/6); 20-50% 5-15mm distinct, yellowish brown (10YR5/6) mottles; fine sandy clay loam; massive; moderately moist, very weak; common 1-2mm roots; gradual change to
B21	.27 to .46 m	Brownish yellow (10YR6/6); <2% <5mm faint, strong brown (7.5YR5/8) mottles; clay loam, sandy; massive; moderately moist, moderately weak; common 1-2mm roots; gradual change to
B22	.46 to .78 m	Light brownish grey (2.5Y6/3); 2-10% 5-15mm distinct, red (2.5YR5/8) mottles; sandy clay loam; massive; moist, very weak; few 1-2mm roots; gradual change to
B23	.78 to .95 m	Light grey (2.5Y7/2); 2-10% 5-15mm distinct, olive yellow (2.5Y6/8) mottles; sandy clay loam (light); massive; moist, very weak; few <1mm roots;
B24	.95 to 1.22 m	Light grey (2.5Y7/2); 2-10% 5-15mm distinct, olive yellow (2.5Y6/8) primary and red (2.5YR5/8) secondary mottles; sandy clay loam (light); massive; moist, very weak; few <1mm roots; diffuse change to
C	1.22 to 1.45 m	White (2.5Y8/2); 2-10% 5-15mm distinct, yellowish red (5YR5/8) mottles; clayey sand; massive; moist, very weak; few <1mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ	n = 19	Description
	Ap	30:22		Yellowish brown (10YR 5/4); sandy clay loam; massive.
	A	18:8		Black (10YR 2/1) to strong brown (7.5YR 5/5); sandy loam to fine sandy clay loam; massive or moderate cast;
	B1			Brown (7.5YR 4/2) to yellow (10YR 7/6); sandy clay loam to light clay;
	B2	57:26		Brownish yellow (10YR 6/6-8) to yellow (10YR 7/6) occasional faint to distinct red (10R 4/8), very pale brown (10YR 7/4) or yellow (10YR 7/8) mottles (at depth); light sandy clay loam to sandy medium clay; occasional profiles may have moderate subangular blocky structure in lower part of B2; manganese soft patches may occur; diffuse to clear change to
	C-D			Stratified sediments of sand to medium clay.



Canoe series differs from Tully series by having massive rather than structured B horizons and generally 'sandy' rather than 'silty' textures throughout.

Vegetation is mid-high to tall woodlands of *Eucalyptus alba, E. intermedia, E. tesselaris* and *E. teretercornis.*

Principal profile forms encountered include Gn2.21, Um5.52, Gn2.64, Gn2.24 and Gn2.81.

ANALYTICAL DATA

Profile T445 Map Reference KIRRAMA 1:100 000 796994
CANOE SERIES Sampled from undisturbed sclerophyll woodland.

Depth cm	0-12	12-27	27-46	46-78	78-95	95-122	122-145
Horizon	A1	AB	B21	B22	B23	B24	C
pH	5.0	5.3	5.7	5.6	5.9	6.0	6.1
E.C. mS/cm	0.112	0.034	0.016	0.013	0.014	0.015	0.015
T.C. %	1.98		0.36		0.17		0.12
N %	0.11		0.02		<0.01		
AvP ppm	13		7		5		5
P ret %	24		23				
Free Fe%	1.0		1.0		1.0		
Tot. P %	0.019		0.009		0.006		0.006
Tot. K %	3.305		3.231		3.467		3.446
Tot. S %	0.026		0.01		0.007		0.005
Tot. Fe%	1.80		2.0		2.0		1.90
Tot. Cu%	0.0005		0.0002		0.0002		0.0003
Tot. Zn%	0.0036		0.0036		0.0036		0.0028
Tot. Mn%	0.074		0.029		0.027		0.022
Exchange properties m.e./100 g soil							
Ca	1.21		<0.02		0.17		0.29
Mg	0.92		0.52		0.67		0.87
K	0.15		0.03		0.04		0.02
Na	0.08		0.07		0.17		0.14
H + Al	1.1		1.58		0.77		0.46
'ECEC'(1)	3.5		2.2		1.8		1.8
'ECEC'/100gC	18.4		11		12.9		16.4
CEC(2)	6.0		3.0		3.0		2.0
CEC/100gC(2)	31.6		15.0		21.4		18.2
Base Sat(3)	39		21		35		66
CEC(4)	2.9		2.4		2.5		2.3
Particle Size %							
Gr	0	0	0	0	0	0	0
CS	26	26	28	32	22	31	31
FS	39	40	41	41	53	47	50
Si	16	13	11	9	11	9	8
C	19	21	20	17	14	12	11
BD	1.2	1.3	1.3	1.3	1.2	1.1	1.2
.1 Bar	28.5	22.5	22.5	22.9	24.9	19.9	19.8
15 Bar	14.9	14.8	14.4	14.8	12.5	11.1	8.8

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

MOSSMAN SERIES (Mm)

CONCEPT

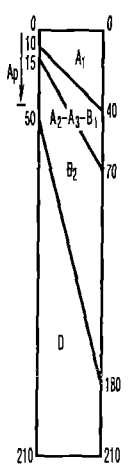
A yellow to brown structured soil with a dark (both moist and dry) A horizon, uniform or gradational texture profiles.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	No suitable group	Uf4.43	Dystropept
LANDFORM	Alluvial plain	RAINFALL	2250
REFERENCE SITE	Kirrama 1:100 000 925837		

Horizon	Depth	
A1	0 to .20 m	Very dark grey (10YR3/1); light medium clay; strong 5-10mm cast; moderately moist, moderately weak; common 1-2mm roots; gradual, wavy change to
A2	.20 to .40 m	Dark greyish brown (10YR4/2); medium clay (light); strong 5-10mm cast; moderately moist, moderately weak; common 1-2mm roots; diffuse, wavy change to
B21	.40 to .75 m	Brownish yellow (10YR6/6); medium clay; strong 2-5mm subangular blocky; moderately moist, moderately weak; common 1-2mm roots; diffuse, wavy change to
B22	.75 to 1.20 m	Yellow (10YR7/6); 10-20% 5-15mm faint, very pale brown (10YR7/4) primary and red (2.5YR4/8) secondary mottles; medium clay; strong 2-5mm subangular blocky; moderately moist, moderately firm; common 1-2mm roots; clear, wavy change to
2D	1.20 to 1.50 m	Very pale brown (10YR7/4); 20-50% 15-30mm prominent, brownish yellow (10YR6/8) mottles; sandy loam; massive; dry, moderately weak; clear, wavy change to
3D	1.50 to 1.80 m	Light grey (10YR7/2); 10-20% 15-30mm distinct, brownish yellow (10YR6/8) mottles; clayey sand; single grain; dry, very weak; clear, wavy change to
4D	1.80 to 2.00 m	White (10YR8/1); 2-10% 5-15mm distinct, brownish yellow (10YR6/8) mottles; sandy loam; weak 50-100mm columnar; dry, moderately weak.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ n = 37	Description
	Ap	25:10	Very dark greyish brown (10YR 3/2-3) to dark grey (10YR 4/2), rarely black (10YR 2/1); loam to light medium clay; weak to moderate cast or subangular blocky
	A	22:10	Very dark grey (7.5YR - 10YR 3/1) to very dark greyish brown (10YR 3/2), rarely black (10YR 2/1); clay loam, fine sandy to medium clay; weak to strong cast or subangular blocky; clear or gradual change to
	A2-A3		Very dark greyish brown (10YR 3/2) to brown (7.5YR 4/4); clay loam, fine sandy to light medium clay; moderate to strong subangular blocky; diffuse or gradual change to
	B1		Very dark greyish brown (10YR 3/2) to brownish yellow (10YR 6/6); clay loam, fine sandy to medium clay; moderate subangular blocky; rare manganese soft patches or nodules;
	B21	40:25	Brown (7.5YR-10YR 4/3) to brownish yellow (10YR 6/6-8); sandy light clay to medium clay; moderate to strong subangular or angular blocky; rare manganese soft patches and nodules; diffuse or gradual change to
	B22-23		Strong brown (7.5YR 5/6) to yellow (10YR 7/6), with distinct to prominent red (2.5YR 4/8), brownish yellow (10YR 6/6-8) and very pale brown (10YR 7/4) mottles; light medium to medium heavy clay; moderate to strong subangular blocky; rare manganese nodules
	D		Stratified sands and clays.

Mossman series differs from Tully and Innisfail series by having a dark (both moist and dry) surface horizon(s).

Vegetation is mid-high to tall woodlands of *Eucalyptus tesselaris*, *E. teretercornis* and gallery rainforest or *Imperata cylindrica* grassland.

Principal profile forms encountered include Uf6.3p, Uf4.43, Uf6.34, Gn3.71, Uf6.4p and Uf6.53.

ANALYTICAL DATA

Profile T375 Map Reference CARDWELL 1:100 000 925837
MOSSMAN SERIES Sampled from undisturbed eucalypt woodland.

Depth cm	0-10	10-20	20-30	30-40	40-60	60-75	75-90	90-120	120-150	180-200
Horizon	A1	A1	A2	A2	B21	B21	B22	B22	2D	4D
pH	6.1	6.0	6.0	5.9	5.6	5.7	6.0	6.0	6.0	6.2
E.C.mS/cm	0.09	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
T.C. %	3.98		1.59		0.34		0.17		0.12	
N %	0.27		0.09							
AvP ppm	13		4		2				3	
P ret %	26									
Free Fe%	1.3	1.1	1.3	1.3	1.3					
Tot. P %	0.045		0.029		0.007				0.007	
Tot. K %	2.72		2.54		2.96				2.92	
Tot. S %	0.033		0.022		0.011				0.003	
Tot. Fe%	1.8		2.1		1.8					
Tot. Cu%	0.0019		0.0014		0.0006					
Tot. Zn%	0.0044		0.0047		0.0018					
Tot. Mn%	1.25		0.076		0.04					
Exchange properties m.e./100 g soil										
Ca	9.9		3.63		0.96		1.2		0.82	
Mg	3.0		1.66		0.71		0.9		0.97	
K	0.51		0.31		0.19		0.14		0.07	
Na	0.04		0.04		0.03		0.1		0.04	
H + Al	0.08		0.4		1.07		0.4		0.45	
'ECEC'(1)	13.5		6.0		3.0		2.7		2.4	
'ECEC'/100gC	39.7		18.7		10.3		8.4		12.0	
CEC(2)	24.1		14.0		6.1		4.7		4.1	
CEC/100gC(2)	70.9		43.7		21.0		14.7		20.5	
Base Sat(3)	55		40		31		50		46	
CEC(4)	13.9		6.1		3.3		3.0		2.7	
Particle Size %										
Gr	0	0	0	0	1	1	0	0	0	1
CS	9	10	9	10	11	14	11	10	25	31
FS	30	28	29	32	34	31	32	37	43	39
Si	27	30	30	27	26	24	25	21	11	14
C	34	32	32	31	29	31	32	32	20	16

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	Ha/Go%
	40-60	6-10	>80	<1	1-5	<1

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

WHITFIELD SERIES (Wf)

CONCEPT

A massive or weakly structured yellow soil with a dark to black A horizon found on prior streams.

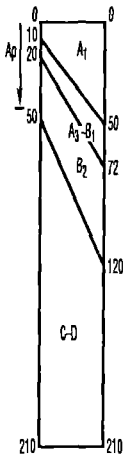
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	No suitable group	Gn2.81	Dystropept
LANDFORM	Prior stream	RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000 859857		

Horizon	Depth	
A1	0 to .10 m	Very dark greyish brown (10YR3/2); silty loam; strong 2-5mm cast; moderately moist, moderately weak; clear, smooth change to
A3	.10 to .20 m	Dark brown (10YR3/3); silty clay loam (light); moderate 2-5mm cast; moderately moist, moderately weak; gradual, wavy change to
B1	.20 to .30 m	Brown (10YR4/3); 10-20% 5-15mm faint, brownish yellow (10YR6/8) mottles; fine sandy light clay; weak 5-10mm subangular blocky; moderately moist, moderately weak; diffuse wavy change to
B2	.30 to .75 m	Yellowish brown (10YR5/4); 20-50% 15-30mm distinct, strong brown (7.5YR5/8) mottles; sandy light clay; weak 5-10mm subangular blocky; moderately moist, moderately firm; diffuse, wavy change to
B3	.75 to .95 m	Yellowish brown (10YR5/4); 10-20% 15-30mm distinct, brownish yellow (10YR6/8) mottles; sandy clay loam; massive; moderately moist, moderately weak; clear, wavy change to
2D	.95 to 1.00 m	Brownish yellow (10YR6/6); fine sand; single grain; moderately moist, loose; clear, wavy change to
3D	1.00 to 1.20 m	Brownish yellow (10YR6/7); fine sandy loam; massive; moderately moist moderately weak; clear, wavy change to
4D	1.20 to 1.50 m	Brownish yellow (10YR6/6); fine sand; single grain; moderately moist, loose; 10-20% 2-6mm, subangular quartz gravel; clear, wavy change to
5D	1.50 to 1.90 m	Yellow (10YR7/5); coarse sand; single grain; moderately moist, loose; 10-20% 2-6mm, subangular quartz gravel; clear, wavy change to
6D	1.90 to 2.10 m	Brown (7.5YR5/4); sand; single grain; moderately moist, loose.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 13	Description
	Ap	22:11	Very dark brown (10YR 2/3) to dark brown (7.5YR 3/2); sandy clay loam to clay loam, fine sandy; weak to moderate cast or subangular blocky
	A	25:13	Black (10YR 2/1) to dark grey (10YR 4/1), dark yellowish brown (10YR 4/4); sapric loam to silty clay loam; weak to strong cast or subangular blocky; clear or gradual change to
	A3-B1		Very dark greyish brown (10YR 3/2) to strong brown (7.5YR 5/6); sandy clay loam to clay loam, fine sandy; massive to weak subangular blocky; diffuse to gradual change to
	B21	41:16	Brown (7.5YR 5/4) to brownish yellow (10YR 6/6-8) to yellow (2.5Y 7/6); sandy clay loam, (light) to fine sandy light clay;
	B22		Strong brown (7.5YR 5/5) to yellow (10YR 7/6-8); sandy clay loam, (light) to clay loam, fine sandy;
	C-D		Stratified sand and/or clay.



Whitfield differs from Mossman series by having a massive B horizon and sandy textures and from Canoe and Liverpool series by the dark to black (both moist and dry) A horizon.

Vegetation is high to mid-high open woodlands of *Eucalyptus tereticornis*

Principal profile forms encountered include Um7.11, Gn2.81, Um5.52 and Gn2.21.

ANALYTICAL DATA

Profile T379 Map Reference KIRRAMA 1:100 000 859857
WHITFIELD SERIES Sampled from undisturbed eucalypt woodland.

Depth cm	0-10	10-20	20-30	30-60	75-90	95-100	120-150	150-180	190-210
Horizon	A1	A3	B1	B2	B23	2D	4D	5D	6D
pH	5.9	5.6	5.5	5.8	6.0	6.1	6.1	5.2	6.2
E.C. mS/cm	0.09	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
T.C. %	2.37	1.06		0.45	0.33	0.13	0.11		
N %	0.15	0.08							
AvP ppm	6			2					
P ret %	19								
Free Fe%	1.2	1.2	1.1						
Tot. P %	0.029			0.014					
Tot. K %	3.62			3.62					
Tot. S %	0.023			0.008					
Tot. Fe%	1.5			1.6					
Tot. Cu%	0.0008			0.0006					
Tot. Zn%	0.0047			0.0034					
Tot. Mn%	0.136			0.067					
Exchange properties m.e./100 g soil									
Ca	4.0	0.80		0.76	1.04	1.0	0.92		
Mg	1.4	0.65		0.72	0.69	0.5	0.34		
K	0.36	0.27		0.18	0.2	0.22	0.17		
Na	0.02	0.02		0.02	0.03	0.04	0.03		
H + Al	0.11	0.67		0.66	0.39	0.06	0.05		
'ECEC'(1)	5.9	2.4		2.3	2.4	1.8	1.5		
'ECEC'/100gC	28.1	10.4		10.5	12.0	13.8	13.6		
CEC(2)	11.0	4.0		4.6	4.1	2.7	2.3		
CEC/100gC(2)	52.4	17.0		20.9	20.5	20.8	20.9		
Base Sat(3)	52	43		36	48	65	63		
CEC(4)	6.5	3.2		2.9	2.7	2.2	2.2		
Particle Size %									
Gr	3	0	0	0	0	0	0	6	2
CS	14	13	12	13	20	25	44	77	70
FS	46	50	50	50	46	53	38	16	20
Si	19	15	16	15	14	9	8	3	4
C	21	23	23	22	20	13	11	4	7

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

LIVERPOOL SERIES (LI)

CONCEPT

A brown to yellowish brown massive uniform soil often with strong stratified sediments.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	*Alluvial soil*	*Uc1.12*	*Haplustult*	
LANDFORM	*Channel bench*		RAINFALL	2250 mm
REFERENCE SITE	*Kirrama* 1:100 000	833848		

Horizon	Depth	
A	0 to .10 m	Yellowish brown (10YR5/4); sandy loam (light); weak 2-5mm cast; moderately moist, very weak; common 1-2mm roots; clear, smooth change to
C	.10 to .20 m	Very pale brown (10YR7/4); sand; single grain; moderately moist, loose; few 1-2mm roots; clear, smooth change to
2Ab	.20 to .30 m	Light yellowish brown (10YR6/4); sandy loam (light); massive; moderately moist, very weak; common 1-2mm roots; gradual, wavy change to
2Bb	.30 to 1.20 m	Light yellowish brown (10YR6/4); 10-20% 5-15mm faint, yellow (10YR7/8) mottles; fine sandy clay loam (light); massive; moderately moist, very weak; few >5mm roots; diffuse, wavy change to
2Cb	1.20 to 1.80m	Light yellowish brown (10YR6/4), (10YR7/6d); fine sand; single grain; dry, loose; common 2-5mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 17	Description
	Ap	26:10	Very dark greyish brown to greyish brown (10YR 3-4/2); fine sandy loam to silty clay loam; massive to moderate cast
	A	11:3	Dark brown (7.5YR 3/2) to yellowish brown (10YR 5/4); coarse sandy loam to clay loam, fine sandy; weak to moderate cast and subangular blocky;
	B2	56:28	Brown (7.5YR - 10YR 4/3-4) to yellowish brown (10YR 5/6); loamy sand to clay loam, fine sandy; massive to weak subangular blocky;
	C-D		Yellowish brown (10YR 5/4-6) to pale brown (10YR 7/4); stratified sands to clay loam, fine sandy; single grain to weak subangular blocky

In this survey area Liverpool series occur most commonly on the lower channel benches. Most of these areas are subject to active deposition and the representative profile described above where there is a thin recent deposit over the more typical Liverpool profile is very common. Shallow recent deposits also occur on higher benches and terraces where stream migration is occurring.

The soils of Japoon series are distinguished from the soils of Liverpool series by their gravelly and coarse sandy nature rather than sandy to silty nature of the soils of Liverpool series.

Gallery rainforests are the most common remaining vegetation form on Liverpool series.

Principal profile forms encountered include Uc1.12, Um5.51, Um7.11 and Um6.34.

ANALYTICAL DATA

Profile T380 Map Reference KIRRAMA 1:100 000 833848
LIVERPOOL SERIES Sampled from undisturbed gallery rainforest.

Depth cm	0-10	10-20	20-30	30-60	60-90	90-120	120-150	150-180
Horizon	A	C	2Ab	2Bb	2Bb	2Bb	2Cb	2Cb
pH	4.9	5.1	4.9	5.0	5.1	5.0	5.4	5.5
E.C. mS/cm	0.09	0.04	0.06	0.03	0.02	0.01	0.01	0.0
T.C. %	1.27		0.7	0.5			0.24	
N %	0.11		0.11					
AvP ppm	19			3			4	
P ret %	8							
Free Fe%	1.0	0.4	0.7					
Tot. P %	0.019			0.02			0.014	
Tot. K %	3.48			3.62			3.56	
Tot. S %	0.016			0.013			0.008	
Tot. Fe%	1.2			1.5				
Tot. Cu%	0.0008			0.0006				
Tot. Zn%	0.0024			0.0034				
Tot. Mn%	0.043			0.057				
Exchange properties m.e./100 g soil								
Ca	0.35		0.26	0.26			<0.02	
Mg	0.68		0.53	0.44			0.14	
K	0.2		0.17	<0.02			<0.02	
Na	0.02		0.02	0.03			0.05	
H + Al	0.75		0.8	1.16			1.28	
'ECEC'(1)	2.0		1.8	1.9			1.5	
'ECEC'/100 g C	22.2		16.4	12.7			10.7	
CEC(2)	4.0		3.2	3.2			2.5	
CEC/100 g C(2)	44.4		29.1	21.3			17.9	
Base Sat(3)	31		31	23			9	
CEC(4)	2.4		2.0	2.3			1.8	
Particle Size %								
Gr	0	0	0	0	0	0	0	0
CS	55	74	50	19	12	36	25	52
FS	29	18	30	52	59	47	48	35
Si	7	2	9	13	11	7	12	7
C	9	6	11	15	18	10	14	6

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

GOOLBOO SERIES (Go)

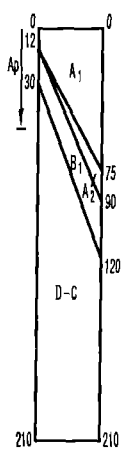
CONCEPT

A yellowish to reddish, sand to coarse sandy clay loam; occurs on prior streams and channel infills.

REPRESENTATIVE PROFILE

		G.S.G.	P.P.F.
CLASSIFICATION		Siliceous sand	Uc5.11
LANDFORM		Alluvial plain	
REFERENCE SITE		KIRRAMA 1:100 000	876858
Horizon	**Depth**		
Ap	0-35	Yellowish brown (10YR5/6) gritty loamy sand; single grain; moist, loose; diffuse change to	
B	35-75	Yellowish brown (10YR5/4) coarse sand; single grain; moist, loose; much fine quartz gravel; diffuse change to	
C	75-120+	Faint fine common mottles, brownish yellow (10YR6/6) and pale brown (10YR6/3) coarse sand; single grain; moist, loose.	

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	$\bar{x}$:σ n = 12	Description
	Ap	25:22	Very dark greyish brown (10YR3/2) and dark brown (7.5YR3/2); loamy, sand to coarse sandy clay loam; single grain to massive
	A1	29:27	Black (10YR2/1) to greyish brown (10YR5/2); loamy sand to sandy clay loam, coarse sandy; common fine gravels; massive to weak cast; clear or gradual change to
	A2		Brown (6.5YR4-5/3-4) to grey (2.5Y5/1); loamy sand to sandy clay loam (light); single grain to massive; gradual or clear change to
	B2	30:17	Brown (7.5YR4/2) to pale yellow (2.5Y7/4) occasionally yellowish red (5YR5/6); sandy loam to sandy clay loam; single grain to massive;
	D-C		Greyish brown (10YR5/2) to very pale brown (10YR7/3); clayey sand to medium clay; single grain to subangular blocky.

Principal profile forms encountered include Uc5.11, Uc5.21, Uc4.21 and Uc1.22.

Vegetation is mid-high open woodlands of sclerophyll species and understorey of *Casuarina* and *Acacia* species.

JAPOON SERIES (Jp)

CONCEPT

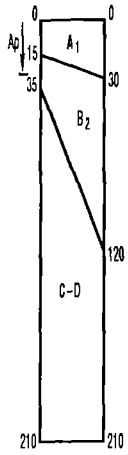
Strongly stratified coarse sands of recent alluvium.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.		
CLASSIFICATION	Alluvial Soil	Uc1.22		
LANDFORM	Alluvial plain		RAINFALL	3000 mm
REFERENCE SITE	KIRRAMA	1:100 000	798853	

Horizon	Depth	
A1	0-15	Brown (10YR 4/3) sandy loam; massive; very friable; gradual change to
B-C	15-90+	Yellowish brown (10YR 5/5) sand; single grain; loose moist and dry.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 7	Description
			May have cobble and boulders throughout the profile
	Ap	16:8	Very dark grey to very dark greyish brown (10YR 3/1-2); clayey coarse sand to sandy clay loam; single grain to massive
	A	21:6	Black (10YR 2/1) to brown (10YR 4/3); clayey coarse sand to sandy clay loam; single grain to weak cast
	B2	35:32	Yellowish brown (10YR 5/4-6); sand to coarse sandy clay loam, coarse sandy; single grain to massive; clear or sharp change to
	C-D		Brown (10YR 4/3) to yellow (10YR 7/6); coarse sand to clayey sand.

Japoon series differs from Liverpool series by the coarser textures, weak profile development, and the common occurrence of cobbles and boulders in the profile.

Vegetation is gallery rainforest.

Principal profile forms encountered include Uc5.11, Uc1.22 and Um7.

MAPPING UNITS - WELL DRAINED SOILS FORMED ON ALLUVIUM

Virgil Association (Vi)

This association has been mapped in the upper reaches of the Tully River and Davidson and Jarra Creeks. It occurs on older and higher alluvial plains which are now above flood level or are flooded very infrequently. The unit is dominated by the Virgil series soils. These are red, massive, predominantly sandy soils in contrast to the finer textured, structured soils formed on the younger alluvium. In the Jarra Creek area, Jarra series is the major inclusion with minor occurrences of Midgenoo, Innisfail and Tully series occurring in depressions along the edge of the UMA's. In Davidson Creek area, Hillview series (a granite fan soil) appears to have overlain the upper limits of some units while Whitfield and Tully series are included on the lower extremities where the association abuts the younger alluvium.

Virgil association also occurs in the upper Murray River as a small UMA abutting an area of Thorpe association. Another minor area also occurs at the junction of Kooroomool Creek and the Tully River.

Bluewater Association (Bw)

This association occurs on channel benches and levees of all minor streams from just south of Cardwell to the Murray Upper. The unit is dominated by the light to medium textured massive red soils of Bluewater series. Canoe and Lee series may be included where drainage is poorer.

All areas are dominated by cobbles and at times boulders; this generally excludes them from most forms of arable agriculture other than tree crops.

Innisfail Association (In)

This association is mapped on the flood plain and levees of the middle and upper reaches of the Tully River and near the junction of Jarra Creek and the Tully River.

The association is dominated by the brown moderately to strongly structured soil of Innisfail series. In the UMA's of the upper Tully River valley there may be inclusions of Midgenoo series and less commonly Mossman series. Several UMA's on the northern side of the Tully River have inclusions of Liverpool series and in some areas there may be substantial amounts of rounded river gravel on the surface and throughout the profile. The UMA's on the middle reaches of the Tully River have major inclusions of the well drained soils (Tully, Liverpool and Mossman series) as well as the poorly drained soils of Coom, Bulgun and Timara series.

Dayman Association (Dy)

The unit occurs on the Tully River alluvia. It is only of minor areal extent and occurs as small rises commonly associated with prior streams.

The unit is dominated by the soils of Dayman series. Common associated soils are Hewitt series where the unit lies adjacent to wetter sites and Mossman series where it occurs in the better drained sites.

These soils have a moderate to high phosphate retention characteristic.

Tully Association(Tu)

This is an extensive unit which occurs on the better drained alluvium of mixed origin. It occurs along most of the major streams throughout the mapping area. It may occur on the stream levees but more commonly occupies the well-drained levee back slopes and the flood plains. The unit is dominated by the yellow to yellow brown well-structured soils of Tully series.

The most extensive areas are on the Tully and Murray River alluvial plains where the most commonly associated soils are Liverpool, Mossman and Coom series. Liverpool series may occur on some of the smaller areas of low terrace that may be included, or on the stream levees. Coom series occurs in slightly lower poorly drained sites. Mossman series is very similar to Tully series but has a deep dark surface. It occurs in the same position in the landscape as Tully series.

Small areas of this association occur along minor streams dissecting the granite fans. In these areas Canoe, Liverpool, and Japoon series are common associates.

Some areas have been mapped interspersed with the beach ridges to the east of the Bruce Highway. There was little access to this country and delineation has relied heavily on air photo interpretation.

Goolboo and Whitfield series occur on the numerous infilled prior streams that transect most occurrences of this association.

Canoe Association (Cn)

This unit occurs on the levees and alluvial plains of minor streams which originate in the granitic and acid volcanic uplands. The yellow earth soil of Canoe series is dominant but Liverpool and Japoon series are often common associates.

There is often a very complex pattern where these minor streams merge with the alluvium of the major streams. In general there is a gradual transition from the sandy and massive Canoe series to the silty and structured Tully series. On the map this transition zone is indicated by the multiple symbol Cn/Tu. It is also common in this transition zone to find thin Canoe series soils overlying buried Tully series soils.

In the units to the south of Cardwell small areas of Cudmore and Porter series may be associated while soils of the granite fans, particularly Thorpe and Lee series, occur where this association has been mapped along streams traversing the granite fans.

Mossman Association (Mm)

This association occurs dominantly on the well drained levees and flood plains of the Tully River and a major part of Kennedy Creek. The existence of the dark A horizon is not fully understood but evidence from old air photography and from local residents suggests that areas dominated by these soils originally had a very sparse tree vegetation and a dense ground cover of blady grass (*Imperata cylindrica*).

Bulgun series which has a dark surface and a mottled B horizon is probably the most common associated soil. It commonly occurs in less well-drained sites but site drainage can not always be determined simply by position in the landscape, hence it is very difficult to separate these soils at this scale of mapping.

Goolboo and Whitfield series occur on narrow channel infill and are particularly common on the northern bank of Kennedy Creek and on the Bellenden Plains.

Whitfield Association (Wf)

Whitfield association occurs throughout the alluvial plains from Kennedy north to the Tully River valley but is not extensive. It occurs on infilled prior stream channels, many of which are too small to map at this scale. Some have been delineated simply as coloured lines on the soil map. The association is dominated by the yellow earth Whitfield series and has Goolboo and Mossman series as the most common associated soils.

Liverpool Association (Li)

Liverpool association occurs along almost every watercourse from Cardwell township north to the Tully River. It is usually confined to the lower terraces and channel benches. The association is dominated by the friable, brown, light to medium textured soils of Liverpool series. Japoon series occurs on the low benches along the upper reaches of these streams, particularly those of the Kennedy valley. In the middle reaches Canoe, Bluewater, Tully and Whitfield series are the common associated soils. Large areas of this association experience regular flooding and many areas are actively aggrading.

Japoon Association (Jp)

Small areas of this association occur in the upper reaches of the majority of major streams emanating from the granitic hills. The association is dominated by the soils of Japoon series and may have minor inclusions of Liverpool series. In some units these two soil series have been mapped as co-dominant.

Due to the high gravel content of these soils they are an important source of sand and aggregate and many areas have been worked as gravel pits and hence are highly disturbed.

POORLY DRAINED SOILS FORMED ON ALLUVIUM

Eight soil series occur in this group. They are the major component of the riverine alluvium along the lower reaches of most major streams and are particularly extensive in the area between the Murray and Tully Rivers. The field relationships of the major soils are shown on Figure 8 and their major distinguishing features are summarised in Table 5.

Coom, Timara, Bulgun and Hewitt series form a continium, becoming progressively poorer drained with distance from higher better drained levees. Coom series is flooded for short periods but has a high subsoil water table for much of the year. Timara, Bulgun, and Hewitt series are flooded for considerable periods (many months) each year, and in the latter two the water table may not recede more than 1 m below the surface in many years. Bulgun may occur in minor depressions on the better drained alluvium, but occurs more extensively as an intergrade between Coom and Hewitt series. Some of the cultivated soils that have been mapped as Bulgun series may have been more like Hewitt series in their natural condition. The oxidation that occurs after drainage results in stronger mottling of the B horizon and depletion of organic matter in the A horizon.

Jarra series occurs in minor depressions within the well-drained alluvial soils of Virgil association. The majority of poorly drained alluvial soils have strong debil-debil and swamp hummock microrelief in their natural state.

Warrami and Derra soil series are generally restricted to the local alluvium found within the granitic fans or to alluvia which have granitic uplands as their sole source of sediment. Lee series is commonly associated with Canoe series in the granitic fans to the south of Cardwell.

TABLE 5.
Poorly drained soils formed on alluvium.

Soil Series	Landform	Major Distinguishing Features
Coom	Flood plain	Mottled yellow and grey, moderate to strongly structured, uniform to gradational clay loams and clays.
Timara	Flood plain and swamps.	Uniform to gradational clay loam and clays, whole coloured grey upper B horizon, moderate to strongly structured.
Bulgun	Flood plain and swamps.	Uniform to gradational, dark (both moist and dry) A horizon over mottled grey-yellow B horizons; clay loams and clays; strongly structured.
Hewitt	Flood plain and swamps.	Sapric loamy A horizon, grey whole coloured or mottled, silty clay B horizons.
Jarra	Relic levees and terraces.	Dark loamy A horizon, pale to bleached A2 horizon, over a mottled yellow, massive to weakly structured B horizon.
Lee	Levees	Grey, massive, uniform to gradational soil.
Warrami	Alluvial plain - fan inter-face upper Murray River.	Dark to black sapric to fibric clay A horizon overlying fine gravelly and coarser granitic gravels and gravelly sandy clay loams.
Derra	Local alluvial plains within the fans.	Dark to black humic to fibric A horizons overlying fine gravelly grey and gleyed medium clays.

COOM SERIES (Co)

CONCEPT

Mottled, structured, uniform and gradational clay loam to clay soil, with predominantly silty textures.

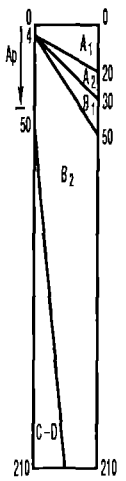
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	No suitable group	Gn3.91	Paleaquult ?
LANDFORM	Alluvial plain	RAINFALL	2250 mm
REFERENCE SITE	Kirrama 1:100 000 914822		

Horizon	Depth	
A	0 to .12 m	Very dark greyish brown (10YR3/2), (10YR6/2d); silty light clay; moderate 2-5 mm subangular blocky; moderately moist, very weak; many 1-2mm roots; clear, smooth change to
B21	.12 to .25 m	Brownish yellow (10YR6/8); 20-50% 5-15mm distinct, light brownish grey (10YR6/2) mottles; silty medium clay; moderate 5-10mm subangular blocky; moderately moist, moderately weak; many 1-2mm roots; clear, smooth change to
B22	.25 to .50 m	Light brownish grey (10YR6/2); 10-20% 5-15mm distinct, brownish yellow (10YR6/8) mottles; silty medium clay; moderate 5-10mm subangular blocky; moderately moist, moderately firm; many 1-2mm roots; diffuse, wavy change to
B23	.50 to .90 m	Light brownish grey (10YR6/2), (10YR8/1d); 10-20% 5-15mm distinct brownish yellow (10YR6/8) mottles; silty medium heavy clay; moderate 5-10mm subangular blocky; moderately moist, moderately firm; 10-20% 2-6mm manganiferous soft segregations; common 1-2mm roots; diffuse, wavy change to
B24	.90 to 1.20 m	Light brownish grey (10YR6/2); 10-20% <5mm distinct brownish yellow (10YR6/8) mottles; silty heavy clay; moderate 10-20mm angular blocky; moderately moist, very firm; <2% <2mm manganiferous soft segregations; common 1-2mm roots; diffuse, wavy change to
B25	1.20 to 2.00 m	Light brownish grey (10YR6/2); 20-50% 15-30mm prominent brownish yellow (10YR6/8) mottles; silty heavy clay; moderate 5-10mm subangular blocky; moderately moist, moderately strong; 10-20% 2-6mm manganiferous soft segregations; few 1-2mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ	n = 28	Description
	Ap	20:11		Very dark greyish brown (10YR3/2) to dark grey (10YR4/1) root line gleying common; fine sandy light clay to light medium clay;
	A1	3:6		Very dark grey (10YR3/1) to grey (2.5Y5/1), root line gleying of yellowish brown (10YR5/6-8) may occur; moderate to strong subangular blocky; clear to gradual change to
	A2			Dry profiles may exhibit sporadic bleaches (see below).
	B1			Grey (10YR5/1) to light yellowish brown (10YR6/4), faint to distinct grey (10YR5/1) to brownish yellow (10YR6/8) mottles; moderate to strong subangular blocky;
	B2	64:39		Brownish grey (10YR5/2) to very pale brown (10YR8/4), occasionally yellow (2.5Y7/6) with distinct to prominent brownish yellow (10YR6/6-8) to yellow (10YR7-8/6-8) mottles, red (2.5YR5/8) at depth; silty light clay loam to heavy clay; moderate to strong subangular blocky or prismatic; manganese soft patches and nodules may be common;
	C-D			Light grey (10YR - 2.5Y7/1-2), yellowish red (5YR5/8) to yellow (2.5Y7/8) mottles; light sandy clay loam to heavy clay; massive to strong subangular blocky.



In this environment it is extremely rare to examine a dry soil. In the moist state these soils do not have an A2 horizon but on drying both the subsurface and B horizons dry to very pale and almost white in colour. Such subsurface horizons have not been identified as bleached A2 horizons as by definition (on moist colours) they are not an A2 horizon.

Vegetation is low woodlands to open forests of *Eucalyptus teretercornis, Melaleuca*, and *Lophostemon* species.

Principal profile forms encountered include Uf6.41, Gn3.91, Uf6.4p, Uf3. and Gn3.01.

ANALYTICAL DATA

Profile T377 Map Reference KIRRAMA 1:100 000 914822
COOM SERIES Sampled from undisturbed *Melaleuca* open forest.

Depth cm	0-12	12-20	30-50	50-60	60-90	90-120	120-150	150-180	180-200
Horizon	A	B21	B22	B23	B23	B24	B25	B25	B25
pH	5.9	5.7	6.0	6.2	6.3	6.1	6.1	5.8	5.6
E.C.mS/cm	0.04	0.03	0.02	0.02	0.02	0.02	0.03	0.05	0.07
T.C. %	2.71	1.06	0.39		0.31		0.1		
N %	0.19	0.08							
AvP ppm	13	4							
P ret %	34								
Tot. P %	0.02	0.011			0.008		0.003		
Tot. K %	2.2	2.04			1.26		1.58		
Tot. S %	0.023	0.013			0.006		0.002		
Tot. Fe%	1.8	1.9							
Tot. Cu%	0.0008	<0.0005							
Tot. Zn%	0.0063	0.0071							
Tot. Mn%	0.042	0.024							
Exchange properties m.e./100 g soil									
Ca	3.43	1.38	0.69		0.68	0.67	0.7		
Mg	1.8	1.46	1.4		1.67	2.19	2.11		
K	0.28	0.07	0.1		0.07	0.08	0.07		
Na	0.24	0.25	0.31		0.45	0.26	0.76		
H + Al	0.52	1.23	1.17		1.23	1.03	1.49		
'ECEC'(1)	6.3	4.4	3.7		4.1	4.2	5.1		
'ECEC'/100gC	21.0	13.3	10.0		10.0	11.4	14.6		
CEC(2)	13.5	10.3	7.4		9.1	4.4	6.5		
CEC/100gC(2)	45.0	31.2	20.0		22.0	10.8	26.9		
Base Sat3	43	31	34		32	73	56		
CEC(4)	6.9	5.3	4.1		4.5	1.6	5.9		
Particle Size %									
Gr	0	0	2	2	2	3	5	1	0
CS	4	2	3	4	3	7	10	7	6
FS	24	22	25	24	23	24	23	33	39
Si	42	43	35	34	33	32	31	30	26
C	30	33	37	38	41	37	35	31	30

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%
	12-20	6-10	> 80	1-5	6-10
	90-120	1-5	> 80	<1	6-10

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

TIMARA SERIES (Ti)

CONCEPT

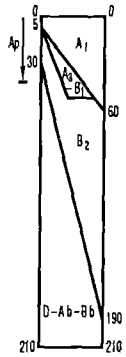
A structured, uniform or gradational textured soil, whole coloured grey in the upper B horizon and mottled in the lower B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Humic gley	Gn3.91	Typic Tropaquept
LANDFORM	Alluvial plain	RAINFALL	3000 mm
REFERENCE SITE	Tully 1:100 000 710135		

Horizon	Depth	
A11	0 to .10 m	Brown (10YR4/3), (10YR6/3d);2-10% <5mm faint very dark, greyish brown (10YR3/2) mottles; silty clay loam; strong 2-5mm cast parting to strong <2 mm granular; moderately moist moderately weak; >5, 0.075-1mm macropores per 100mm^2 ; common 1-2mm roots; diffuse, wavy change to
A12	.10 to .20 m	Dark greyish brown (10YR4/2); 2-10% <5mm faint, very dark greyish brown (10YR3/2) mottles; silty clay loam; strong 5-10mm cast parting to strong 2-5mm granular; moderately moist, moderately weak; >5, 0.075-1mm macropores per 100mm^2 ; common 1-2mm roots; diffuse, wavy change to
A3	.20 to .30 m	Dark greyish brown (10YR4/2); 2-10% <5mm faint, very dark greyish brown (10YR3/2) mottles; silty light clay; strong 5-10mm cast parting to strong 2-5 mm granular; moderately moist, moderately weak; >5, 0.075-1mm - macropores per 100mm^2 ; few <1mm roots; diffuse, wavy change to
B1	.30 to .55 m	Dark greyish brown (10YR4/2); 2-10% 5-15mm faint yellowish brown (10YR5/6) mottles; silty medium clay; strong 20-50mm prismatic parting to strong 10-20mm angular blocky; moist, moderately firm; >5, 0.075-1mm macropores per 100mm^2 ; few <1mm roots; gradual, irregular change to
B21	.55 to 1.45 m	Light grey (10YR7/2); <2% 5-15mm distinct, brownish yellow (10YR6/8) mottles; silty medium clay; strong 20-50mm prismatic parting to strong 10-20mm angular blocky; moist moderately firm; >5, 0.075-1mm macropores per 100mm^2 ; few <1mm roots;
B22	1.45 to 1.75 m	Light grey (10YR7/2); 10-20% 5-15mm prominent brownish yellow (10YR6/8) mottles; silty medium clay; strong 20-50mm prismatic parting to strong 10-20mm angular blocky; moist, moderately firm; >5, 0.075-1mm macropores per 100mm^2 ; few <1mm roots; gradual, wavy change to
B23c	1.75 to 1.90 m	Light grey (10YR7/2); 10-20% 5-15mm prominent, yellowish brown (10YR5/8) mottles; silty medium clay; strong 20-50mm prismatic parting to strong 10-20mm angular blocky; moist, moderately firm; 10-20% 6-20mm manganiferous soft segregations; >5, 0.075-1mm macropores per 100mm^2 ; few <1mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}:\sigma$ n = 6	Description
	A1	23:22	Dark greyish brown (10YR 4/2) to grey (2.5Y 5/1), light grey (10YR 7/1) and white (10YR 8/1) dry; clay loam, fine sandy to medium clay; strong cast or subangular blocky; clear or gradual change to
	A3-B1		Dark greyish brown (10YR 4/2) to grey (10YR 6/1); sandy medium to medium heavy clay; moderate to strong subangular blocky and prismatic; gradual to diffuse change to
	B2	60:44	Greyish brown (10YR 5/2) to very pale brown (10YR 7/3); brownish yellow (10YR 6/6-8) mottles at depth; sandy medium to medium heavy clay; moderate to strong subangular blocky or prismatic;
	D-Ab-Bb		Very dark grey (2.5Y 3/1) to light brownish grey (10YR 6/2); sapric loam to medium heavy clay; massive to moderate subangular blocky or prismatic.

Timara series differs from Coom series by having a whole coloured grey upper B horizon and from Hewitt series by the absence of the dark (both moist and dry) surface horizon. Debil-Debil or swamp hummock microrelief is a common feature of this series.

Typical vegetation communities are rainforest, palm forest, and open forest and woodlands of *Melaleuca* and *Lophostemon* species.

Principal profile forms encountered include Uf6.51, Gn3.91 and Uf6.41.

ANALYTICAL DATA

Profile T431 Map Reference TULLY 1:100 000 710135
TIMARA SERIES Sampled in undisturbed fan palm forest.

Depth cm	0-10	10-20	20-30	30-55	55-85	85-115	115-145	145-175	175-190
Horizon	A11	A12	A3	B1	B21	B21	B21	B22	B23c
pH	5.1	4.9	5.2	5.2	5.3	5.4	5.6	5.7	5.9
E.C. mS/cm	0.13	0.06	0.02	0.03	0.03	0.03	0.04	0.03	0.03
T.C. %	5.14		1.45		0.47			0.27	
N %	0.3		0.08						
AvP ppm	80		15		6			7	
P ret %	42		7		2			6	
Free Fe%	1.1				0.7				
Tot. P %	0.087		0.044		0.013			0.018	
Tot. K %	2.31		1.89		1.41			1.87	
Tot. S %	0.064		0.029		0.022			0.011	
Tot. Fe%	2.1		2.4		1.9			3.6	
Tot. Cu%	0.0013		0.0014		0.0015			0.0013	
Tot. Zn%	0.0097		0.0095		0.0081			0.0074	
Tot. Mn%	0.096		0.042		0.025			0.024	
Exchange properties m.e./100 g soil									
Ca	3.67		<0.02		0.28			0.81	
Mg	2.35		0.61		1.39			2.33	
K	1.54		0.06		0.05			0.07	
Na	0.00		0.19		0.32			0.6	
H + Al	1.44		4.78		1.8			1.43	
'ECEC'(1)	7.7		5.7		3.8			5.2	
'ECEC'/100gC	25.7		12.7		8.1			13.7	
CEC(2)	19.0		13		9.0			8.0	
CEC/100gC(2)	63.3		29.0		19.1			21.1	
Base Sat(3)	33		7		23			48	
CEC(4)	4.5		4.2		2.5			2.2	
Particle Size %									
Gr	0	0	0	0	0	0	0	0	0
CS	8	5	2	1	1	0	0	0	1
FS	15	13	14	12	10	9	11	14	16
Si	48	41	39	39	43	43	47	48	48
C	30	41	45	48	47	48	42	38	35
BD	0.9	1.1	1.1	1.1	1.3	1.3	1.2	1.2	1.2
.1 Bar	33.4	40.2	39.2	40.2	47.3	48.4	46.1	47.7	50.5
15 Bar	26.5	32.4	30.9	32.5	37.2	38.5	34.5	35.6	38.2

Mineralogy of the clay fraction	Depth cm 55-85			K% 1-5	Ka% >80	Qz% 1-5	G% 1-5	

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

WARRAMI SERIES (Wm)

CONCEPT

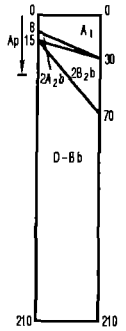
A dark clay surface layer of varying depth overlying soils formed on granitic fan materials.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	No Suitable Group	Uf/p	Kandiaqualf
LANDFORM	Alluvial plain	RAINFALL	2400 mm
REFERENCE SITE	*Kirrama* 1:100 000 723013		

Horizon	Depth	
Ap1	0 to .08 m	Very dark grey (10YR3/1); light clay; massive; <1, 0.075-1mm macropores per 100mm^2 ; gradual change to
Ap2	.08 to .13 m	Greyish brown (10YR5/2); sandy clay loam; massive; <1, 0.075-1mm macropores per 100mm^2 ; gradual change to
2A21b	.13 to .20 m	Light brownish grey (10YR6/2), (10YR8/1d); clayey coarse sand; massive; 20-50% 6-20mm, subangular, dispersed quartz gravel; <1, 0.075-1mm macropores per 100mm^2 ; gradual change to
2A22b	.20 to .30 m	Light brownish grey (10YR6/2), (10YR8/1d); <2% <5mm distinct brownish yellow (10YR6/8) mottles; sandy clay loam, coarse sandy; massive; 20-50% 6-20mm, subangular, dispersed quartz gravel; <1 0.075-1mm macropores per 100mm^2 ; gradual change to
2B21b	.30 to .70 m	Light brownish grey (10YR6/2); 10-20% <5mm distinct, brownish yellow (10YR6/8) mottles; sandy medium clay; massive; 2-10% 6-20mm, subangular, dispersed quartz gravel; 10-50% of ped faces or walls coated by distinct, clay skin cutans; <1, 0.075-1mm macropores per 100mm^2 ; gradual change to
2B22b	.75 to .90 m	Light grey (10YR7/1); 10-20% 15-30mm distinct, brownish yellow (10YR6/8) primary and yellowish brown (10YR5/6) secondary mottles; sandy medium clay; moderate 2-5mm subangular blocky; 2-10% 6-20mm, subangular, dispersed quartz gravel; >50% of ped faces or walls coated by prominent, clay skin cutans; 2-10% 2-6mm manganiferous soft segregations; <1, 0.075-1mm macropores per 100mm^2 ;
2B23b	.90 to 1.20 m	Light grey (10YR7/1); 10-20% 15-30mm distinct, brownish yellow (10YR6/8) mottles; sandy medium clay; moderate 2-5mm subangular blocky; 2-10% 6-20mm, subangular, dispersed quartz gravel; >50% of ped faces or walls by coated prominent clay skin cutans; 10-20% 2-6mm manganiferous soft segregations; <1, 0.075-1mm macropores per 100mm^2 ; gradual change to
2B24b	1.20 to 1.90 m	Light grey (10YR7/1); <2% 15-30mm distinct, brownish yellow (10YR6/8) mottles; sandy medium clay; massive; 2-10% 6-20mm, subangular, dispersed quartz gravel; 10-50% of ped faces or walls coated by distinct, clay skins cutans; <1, 0.075-1mm macropores per 100mm^2 ;

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ n = 5	Description
	Ap	14:5	Black (10YR2/1) to very dark greyish brown (10YR3/2); sandy light clay to medium clay; massive to moderate subangular blocky, weakly self mulching or seasonally cracking.
	A1	9:1	Very dark brown (10YR2/2) to very dark grey (10YR3/1); light to medium clay; weak to strong subangular blocky, weak self mulching or seasonally cracking;
	2A2b		Greyish brown (10YR 5/2) to light brownish grey (10YR6/2); clayey coarse sands to coarse sandy clay loam;
	2B2b	24:19	Dark greyish brown (10YR4/2) to light brownish grey (10YR6/2), brownish yellow (10YR6/8) mottles; sandy light clay to medium heavy clay; common angular quartzitic gravels; massive to moderate subangular blocky; trace of manganese soft patches and nodules.
	D		As above but may also be fine riverine alluvium or stratified granitic gravels.

The dark clay A horizon is assumed to be of a more recent origin, deposited in a lacustrine depositional environment. The lower horizons have been interpreted as buried soil typical of Lugger series. Soils with clay buried horizons with a surface similar to Warrami series are identified as Derra series.

All sites had been cleared and/or cultivated.

ANALYTICAL DATA

Profile T406 Map Reference KIRRAMA 1:100 000 723013
WARRAMI SERIES Sampled from improved pasture

Depth cm	0-8	8-13	13-20	20-30	30-50	50-75	75-90	90-120	120-150	150-190
Horizon	Ap1	Ap2	2A21	2A22	2B21	2B21	2B22	2B23	2B24	
pH	5.2	5.3	5.5	5.6	5.8	5.6	5.7	5.8	5.7	5.6
E.C.mS/cm	0.08	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
T.C. %	1.97		0.27		0.2			0.12		
N %	0.1		0.03							
AvP ppm	9		3		2			1		
Free Fe%	0.1		0.4		0.5					
Tot. P %	0.014		0.005		0.006					
Tot. K %	1.87		1.54		1.84					
Tot. S %	0.02		0.007		0.007					
Tot. Fe%	0.6		0.5		0.7					
Tot. Cu%	0.0013		0.0006		0.0007					
Tot. Zn%	0.0013		0.0006		0.0013					
Tot. Mn%	0.027		0.01		0.014					
Exchange properties m.e./100 g soil										
Ca	0.99		0.16		0.24			0.43		
Mg	0.78		0.2		0.6			1.48		
K	0.25		0.05		0.1			0.18		
Na	0.09		0.02		0.02			0.05		
H + Al	1.09		0.53		0.36			0.28		
'ECEC'(1)	3.2		1.0		1.4			2.4		
'ECEC'/100gC	11.8		10.0		5.6			5.8		
CEC(2)	6.0		2.0		3.0			4.0		
CEC/100gC(2)	22.2		20.0		12.0			9.7		
Base Sat(3)	35		21		35			53		
CEC(4)	2.9		0.9		1.7			2.5		
Particle Size %										
Gr	6	11	26	61	38	39	37	38	27	34
CS	40	49	71	55	53	46	43	44	37	41
FS	21	20	12	19	12	11	9	9	15	17
Si	12	12	8	11	9	8	5	7	11	14
C	27	20	10	15	25	35	43	41	37	28
BD	1.6		1.7	1.7	1.6	1.6	1.5	1.5	1.6	1.7
.1 Bar	27.5		13.6	13.8	16.1	22.3	26.9	23.3	24.7	20.8
15 Bar	18.8		8.5	7.1	10.3	19.8	21.1	20.7	19.9	14.4

Mineralogy of the clay fraction	Depth cm	K%	Ka%	Qz%
	30-50	1-5	>80	1-6

(1) Sum of basic and acidic cations

(2) NH_4 OAc

(3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(4) Comp. Exch.

DERRA SERIES (Dr)

CONCEPT

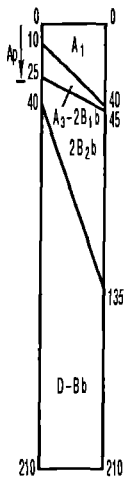
Dark clay A horizon overlying a mottled clay B horizon with fine angular gravel.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.
CLASSIFICATION	*No Suitable Group*	Uf/p
LANDFORM	Alluvial plain	RAINFALL 2400 mm
REFERENCE SITE	Kirrama 1:100 000 682091	

Horizon	Depth	
Ap	0 to .13 m	Black (2.5Y2/0); sapric light medium clay; strong 5-10mm angular blocky and moderate 2-5mm cast; clear change to
A3	.13 to .23 m	Grey (2.5Y5/1); 2-10% <5mm distinct, yellowish brown (10YR5/8) mottles; medium heavy clay; moderate 5-10mm angular blocky; clear change to
2B21	.23 to .90 m	Light grey (2.5Y7/1); 10-20% 5-15mm distinct, yellow (10YR7/8) mottles; medium heavy clay; moderate 50-100mm prismatic parting to strong 5-10mm angular blocky; 2-10% 20-60 mm, subangular coarse gravel; clear change to
2B22	.90 to 1.35 m	Light grey (2.5Y7/1); 20-50% >30mm prominent brownish yellow (10YR6/8) mottles; medium heavy clay; moderate 5-10mm subangular blocky; clear change to
3D	1.35 to 1.45 m	Pale yellow (2.5Y7/4); loamy coarse sand; single grain.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	$\bar{x}$:σ n = 19	Description
	Ap	20:5	Black (10YR 2/1) to dark grey (10YR 4/1); sandy light clay to medium clay; massive to moderate subangular blocky, weak self mulching and surface seasonal cracking.
	A	19:10	Black (10YR-2.5Y 2/1) to dark grey (10YR 4/1), rootline mottling common; sandy light clay to medium clay; weak to strong subangular blocky with weak self mulching and surface seasonal cracking.
	A3-B1		Dark greyish brown (10YR 4/2) to light grey (10YR-2.5Y 7/1), faint to distinct yellow (10YR 6/7) mottles; sandy light clay to heavy clay, commonly with angular quartzitic gravels; massive to moderate subangular blocky.
	2B2b	47:25	Light brownish grey (10YR 6/2) to light grey (10YR-2.5Y 7/1-2), with distinct to prominent brownish yellow to yellow (10YR 6-7/8)mottles; sandy light clay to heavy clay; common angular quartz gravels; massive to moderate prismatic parting to subangular and angular blocky.
	D-3Bb		Grey (10YR 6/1) to pale yellow (2.5Y 7/4) to white (10YR 8/1); sands to heavy clay.

The buried clay B horizon of Derra series distinguishes it from the granitic gravel and gravelly sandy clay loam buried B horizon of Warrami and Banyan series. The sapric A horizon and the gravels in the B horizon distinguish this soil from Bulgun series.

Vegetation is isolated trees to mid-high woodlands of *Eucalyptus teretercornis* and *Melaleuca* species.

Principal profile forms encountered include Uf6.41p, Gn3.91 and Dy3.21.

ANALYTICAL DATA

Profile T461 Map Reference KIRRAMA 1:100 000 682091

DERRA SERIES Sampled from improved pasture.

Depth cm	0-10	13-23	30-40	100-135	135-145
Horizon	Ap1	A3	2B21	2B22	3D
pH	4.4	5.0	5.2	5.4	5.5
E.C. mS/cm	0.15	0.03	0.02	0.01	0.02
T.C. %	3.7				
N %	0.28				
AvP ppm	23				
P ret %	4				
Exchange properties m.e./100 g soil					
Ca	3.5	0.79	0.46	0.37	0.24
Mg	1.5	0.86	0.82	3.1	2.1
K	.39	0.19	0.15	0.18	0.24
Na	.46	0.14	0.11	0.54	0.43
H + Al	2.58	1.9	1.07	0.61	0.23
'ECEC'(1)	8.4	3.9	2.6	4.8	3.2
'ECEC'/100gC	14.3	8.3	9.7	16.6	18.0
CEC(2)	12.00	3	2	5	3
CEC/100gC(2)	20.3	6.4	7.4	17.2	16.7
Base Sat(3)	49	66	77	84	100
CEC(4)	3.1			3	
Particle Size %					
CS	10	16	36	28	46
FS	12	18	22	29	23
Si	19	18	14	13	13
C	59	47	27	29	18

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ Cl\ CEC} \times 100$

(2) $NH_4\ Cl$ (4) Comp. Exch.

BULGUN SERIES (Bg)

CONCEPT

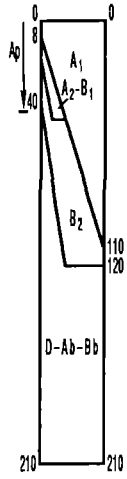
Dark (both moist and dry), A horizon overlying a mottled clay B horizon.

REPRESENTATIVE PROFILE

	G.S.G.		P.P.F.	
CLASSIFICATION	Humic Gley		Dy5.11	
LANDFORM	Alluvial plain		RAINFALL	4000 mm
REFERENCE SITE	Tully	1:100 000	875100	

Horizon	Depth	
Ap	0 to .35 m	Black (10YR2/1); <5mm faint, mottles; clay loam; moderate cast; clear change to
B1	.35 to .45 m	Dark greyish brown (10YR4/2); 10-20% <5mm faint, yellow (10YR7/6) mottles; medium clay; moderate 5-10mm subangular blocky; clear change to
B21	.45 to .75 m	Light reddish brown (2.5YR6/4); 20-50% 5-15mm distinct, olive yellow (2.5Y6/8) primary and yellowish red (5YR5/8), secondary mottles; medium clay; moderate 5-10mm subangular blocky; diffuse change to
B22g	.75 to 1.20 m	Light grey (N7/0); 20-50% 5-15mm prominent, yellowish red (5YR5/8) mottles; medium clay; moderate 5-10mm subangular blocky.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	x̄:σ	n = 25	Description
	Ap	27:11		Black (10YR 2/1) to very dark greyish brown (2.5Y 3/2); loam to light medium clay; weak to strong cast or subangular blocky
	A1	39:35		Black (10YR-2.5Y 2/1) to greyish brown (2.5Y 5/3); silty clay loam to light medium clay; weak to strong cast or subangular blocky.
	A2	27:16		Dark grey (10YR 4/1) to pinkish grey (10YR 6/2), rarely bleached; loam to clay loam sandy; weak to moderate medium subangular blocky; gradual or clear change to
	B1			Dark grey (10YR 4/1) to very pale brown (10YR 7/4), faint to distinct yellow (10YR 7/6) mottles; light clay to silty medium clay; massive to moderate subangular blocky.
	B2	37:23		Dark greyish brown (10YR 4/2) to light grey (10YR 7/2), distinct to prominent brownish yellow (10YR 6/8) and yellow (10YR 7/6) mottles, commonly red (10R 4/8) at depth; light to medium heavy clay; moderate to strong prismatic parting to strong subangular or angular blocky.
	D-Ab-Bb			Grey (10YR 6/1) to white (10YR - 2.5Y 8/2) distinct to prominent olive yellow (2.5Y 6/8) and yellow (10YR - 2.5Y 7/6-8) mottles; sand to medium clay; single grain to moderate subangular or angular blocky.

Uniformly fine (Uf) and gradational (Gn) texture profiles are co-dominant. Hewitt series is distinguished from Bulgun by its sapric or fibric surface. Coom series does not have the dark (both moist and dry) A horizon. Debil-debil microrelief is a common feature of this series.

Vegetation is mig-high to high closed forest of rainforest and *Melaleuca* species.

Principal profile forms encountered include Gn3.91, Gn3.74, Dg4.31, Dy5.11, Uf6.34 and Um6.34.

LEE SERIES (Le)

CONCEPT

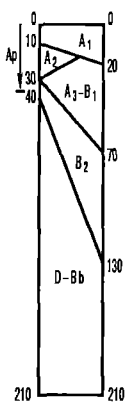
A massive grey loamy soil with uniform to gradational texture profiles

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.		
CLASSIFICATION	Grey Earth	Um5.52		
LANDFORM	Alluvial plain		RAINFALL	2250 mm
REFERENCE SITE	Ingham	1:100 000	141529	

Horizon	Depth	
A11	0 to .10 m	Black (10YR2/1); sandy clay loam; weak, 5-10 mm cast; gradual change to
A12	.10 to .20 m	Dark grey (10YR4/1); sandy clay loam; massive; gradual change to
B1	.20 to .35 m	Greyish brown (10YR5/2); sandy clay loam; massive; diffuse change to
B21	.35 to .60 m	Brown (10YR5/3); sandy clay loam; massive; diffuse change to
B22	.60 to .80 m	Very pale brown (10YR7/3); sandy clay loam; massive; diffuse change to
B23	.80 to 1.20 m	Very pale brown (10YR7/3), 20-50% 15-30 mm distinct, yellow (10YR7/6) mottle; sandy clay loam.

MORPHOLOGICAL RANGE



Depth range (cm)	Horizon	Description
	A	Black (10YR 2/1) to dark greyish brown (10YR 4/2); sandy clay loam to clay loam; massive to weak cast; gradual or clear change to
	A2	Dark greyish brown (10YR 4/2) to brown (10YR 4/3); sandy clay loam to clay loam; massive.
	A3-B1	Brown (7.5YR 4/2) to greyish brown (10YR 5/2); sandy clay loam to clay loam; massive earthy; manganiferous concretions may be common; diffuse to clear change to
	B2	Brown (10YR 5/3) to light grey (10YR 7/2); sandy clay loam to clay loam; massive; manganiferous concretions may be common.
	D	Coarse sands

Principal profile forms encountered include Um4.25, Um5.52, Gn2.81 and Gn2.84.

Vegetations is tall woodland to very tall open forest of *Eucalyptus alba, Syncarpia glomulifera* and *Melaleuca* species.

HEWITT SERIES (He)

CONCEPT

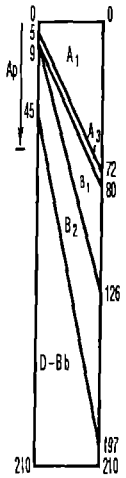
Humic to organic A horizon over whole coloured or mottled grey clayey B horizon.

REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.
CLASSIFICATION	Humic Gley	Dy5.11	Paleaquult
LANDFORM	Swamp	RAINFALL	3100 mm
REFERENCE SITE	Kirrama 1:100 000	858077	

Horizon	Depth	
A1	0 to .40 m	Black (10YR2/1), (10YR2/1 d); sapric silty loam; weak 5-10mm cast parting to weak 2-5mm granular; moist, very weak; <1, 0.075-1mm macro - pores per 100mm^2 ; common 1-2mm roots; diffuse, irregular change to
A3	.40 to .66 m	Very dark grey (10YR3/1), (10YR4/1 d); sapric silty loam; weak 10-20mm prismatic parting to moderate 5-10mm subangular blocky; moist, moderately weak; <1, 0.075-1mm macropores per 100mm^2 ; common 1-2mm roots; diffuse, irregular change to
B1	.66 to 1.26 m	Very dark greyish brown (10YR3/2); 2-10% 5-15mm distinct, light brownish grey (10YR6/2) mottles; silty clay loam; moderate 10-20mm prismatic parting to moderate 5-10mm angular blocky; moist, moderately firm; <1, 0.075-1mm macropores per 100mm^2 ; few 1-2mm roots; abrupt, irregular change to
B22	1.46 to 1.76 m	Light brownish grey (2.5Y6/2); 2-10% 5-15mm distinct reddish yellow (7.5YR6/8) primary and brownish yellow (10YR6/8), secondary mottles; silty medium clay; moderate 10-20mm prismatic parting to moderate 5-10mm angular blocky; moist moderately firm; <1, 0.075-1mm macropores per 100mm^2 ; few <1mm roots;
B23	1.76 to 1.97 m	Greyish brown (2.5Y5/2); 2-10% 5-15mm distinct, reddish yellow (7.5YR6/8) primary and brownish yellow (10YR6/8) secondary mottles; silty medium clay; moderate 10-20mm prismatic parting to moderate 5-10mm angular blocky; moist moderately firm; 10-20% 6-20mm organic (humified) soft segregations; <1, 0.075-1mm macropores per 100mm^2 ; few <1mm roots.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	x̄:σ	n = 25	Description
	Ap	37:9		Black (7.5YR - 10YR2/0-1) to very dark greyish brown (10YR3/2); sapricloam to clay loam; massive to weak cast;
	A1	27:18		Black (7.5YR2/0-1) to very dark greyish brown (10YR3/2); sapric or fibricloam to silty clay loam; massive to moderate cast or subangular blocky
	A3			Very dark grey (10YR3/1) to pale brown (10YR6/3); sapric loam to clay loam; massive to moderate subangular blocky and prismatic.
	B1			Grey (2.5Y4/1) to light yellowish brown (10YR 6/4), faint to distinct brownish yellow (10YR 5/6-8) mottles; clay loam to medium clay; massive to moderate subangular or angular blocky and prismatic.
	B2	46:31		Dark grey (10YR4/1) to light grey (10YR7/1) whole coloured with or without yellow (10YR - 2.5YR7-8/6-8) and light olive brown (2.5Y5/6) mottles; clay loam to medium heavy clay; strong prismatic parting to moderate to strong subangular or angular blocky; clear to
	D-Bb			Grey (7.5YR6/1) to white (2.5YR8/2), prominent brownish yellow (10YR5/8) and yellowish brown (10YR6/8) mottles; sand to medium clay; single grain to moderate subangular blocky.

Hewitt series differs from Bulgun series by having sapric A horizon textures and from Bulguru series which has a peaty surface. Many Hewitt profiles have been described as not having an A2. This could largely be due to the wet conditions and the difficulty in making a proper observation and description.

Swamp hummock microrelief is common in undisturbed areas.

Vegetation is open sedgeland to tall closed forest of *Melaleuca* and *Lophostemon* species.

Principal profile forms encountered include Dy5.11, Dy5.21, Dg1.1, Dg2.11 and Dg2.21.

ANALYTICAL DATA

Profile T433 Map Reference KIRRAMA 1:100 000 858077
HEWITT SERIES Sampled from undisturbed *Melaleuca* forest.

Depth cm	0-10	10-20	20-30	30-40	40-66	66-96	96-126	126-146	146-176	176-197
Horizon	A1	A1	A1	A1	A3	B11	B12	B21g	B22	B23
pH	4.8	4.8	4.7	4.7	5.0	5.1	4.9	5.1	4.9	4.7
E.C.mS/cm	0.09	0.09	0.10	0.06	0.43	0.03	0.03	0.03	0.04	0.06
T.C. %	8.9	8.3	7.25	6.2	4.76	3.31		3.15		1.22
N %	0.41		0.34		0.26	0.14		0.12		0.05
AvP ppm	304	178	166		203	255				20
P ret %	94		94		92	90		53		
Free Fe%	0.6		0.5		0.3	0.3		0.2		0.9
Tot. P %	0.164		0.154		0.134	0.132		0.041		0.031
Tot. K %	0.87		0.89		0.92	0.92		0.98		1.70
Tot. S %	0.102		0.078		0.134	0.085		0.048		0.03
Tot. Fe%	1.55		1.53		1.581	1.62		1.53		2.7
Tot. Cu%	0.002		0.0021		0.0024	0.003		0.0026		0.0016
Tot. Zn%	0.0068		0.0064		0.0067	0.007		0.0063		0.0093
Tot. Mn%	0.016		0.015		0.013	0.013		0.011		0.027
Exchange properties m.e./100 g soil										
Ca	0.06		0.34		0.16	0.19		0.49		0.7
Mg	1.24		0.24		0.15	0.28		1.34		2.36
K	0.34		0.18		0.11	0.10		0.07		0.21
Na	0.05		0.13		0.21	0.14		0.28		0.24
H + Al	4.01		3.79		3.43	3.24		5.50		3.13
'ECEC'(1)	5.7		4.7		4.1	4.0		7.7		6.6
'ECEC'/ 100gC	11.9		10.2		7.6	8.2		13.0		18.8
CEC(2)	33		30		24	25		19		11
CEC/100 g C(2)	68.7		65.2		44.4	51.0		32.2		31.4
Base Sat3	5		3		3	3		11		32
CEC(4)	3.2		2.8		2.9	2.5		5.8		4.8
Particle Size %										
Gr	0	0	0	0	0	0	0	0	0	0
CS	2	1	5	9	2	5	2	1	1	2
FS	6	6	5	7	4	5	3	2	14	13
Si	44	45	44	39	40	41	37	38	49	50
C	48	48	46	45	54	49	58	59	36	35
BD	.6	.6	.6	.6	.6	.8	.8	1.1	1.2	1.2
.1 Bar	52.9	50.5	56.3	53.1	52.0	53.1	51.0	49.6	44.7	51.5
15 Bar	41.1	36.1	41.6	39.0	40.5	44.6	43.9	39.5	35.9	42.2

Mineralogy of the clay fraction	Depth cm	I%	Ka%	Ch/V%	Qz%	G%
	126-146	1-5	>80	1-5	1-5	1-5

(1) Sum of basic and acidic cations (2) NH_4 OAc (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$ (4) Comp. Exch.

JARRA SERIES (Jr)

CONCEPT
Massive, mottled, yellow gradational soil.

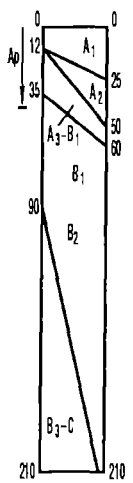
REPRESENTATIVE PROFILE

	G.S.G.	P.P.F.	S.T.	
CLASSIFICATION	Yellow Earth	Gn2.64	*Hapludox*	
LANDFORM	Alluvial plain		RAINFALL	3600 mm
REFERENCE SITE	*Tully 1:100 000 763212*			

Horizon	Depth	
A1	0 to .22 m	Black (10YR2/1); sapric loam; weak 2-5mm cast; moist, very weak; 1-5, 0.075-1mm macropores per 100mm^2 ; diffuse change
A2	.22 to .47 m	Dark greyish brown (10YR4/2); sandy clay loam; massive; moist, moderately weak; 1-5 0.075-1mm macropores per 100mm^2 ; clear change to
B1	.47 to .61 m	Brownish yellow (10YR6/6); 20-50% 5-15mm distinct, dark greyish brown (10YR4/2) mottles; clay loam, sandy; massive; moist, moderately weak; 1-5, 0.075-1mm macropores per 100mm^2 ; clear change to
B21	.61 to .90 m	Olive yellow (2.5Y6/6); 2-10% <5mm distinct red (2.5YR5/8) mottles; light medium clay; massive; moist moderately weak; 1-5, 0.075-1mm macropores per 100mm^2 ; gradual change to
B22	.90 to 1.24 m	Olive yellow (2.5Y6/6); 2-10% <5mm distinct red (2.5YR5/8) mottles; sandy medium clay; massive; moist moderately weak; 1-5, 0.075-1mm macropores per 100mm^2 ; diffuse change to
2D	1.24 to 1.54 m	Olive yellow (2.5Y6/6); 2-10% <5mm prominent, red (10R4/8) mottles; medium clay; moderate 2-5mm angular blocky; moist moderately weak; <2% 2-6mm, angular. dispersed quartz gravel; <1, 0.075-1mm macropores per 100mm^2 ; diffuse change to
3D	1.54 to 1.80 m	Light brownish grey (2.5Y6/3); 10-20% <5mm prominent, red (10R4/8) mottles; medium clay; strong 2-5mm angular blocky; moist moderately weak; <2% 2-6mm, angular, dispersed quartz gravel; <1, 0.075-1mm macropores per 100mm^2 .

NOTE: A1 material occurs as worm casts to a depth of 90 cm.

MORPHOLOGICAL RANGE

Depth range (cm)	Horizon	Description
	A1	Black (10YR 2/1) to very dark greyish brown (10YR 3/2); sapric clay loam to clay loam sandy; weak to moderate cast; clear to gradual to
	A2-A3	Dark greyish brown (10YR 4/2) to brown (10YR 4/3); sandy clay loam to light clay;
	A3-B1	Dark yellowish brown (10YR 4/4) to brown (10YR 5/3) to brownish yellow (10YR 6/6); light medium to medium clay; manganese soft segregations and nodules may occur;
	B2	Light brownish grey (2.5Y 6/2) to olive yellow (2.5Y 6/8) to pale yellow (2.5Y 7/4), with common distinct red (10R-2.5YR 3-5/6-8) to yellowish red (5YR 5/8) mottles; light to sandy medium clay; massive to weak subangular blocky; may overlie structured D horizons.
	D	Olive yellow (2.5Y 6/6) to light brownish grey (2.5Y 6/3), with red (10R 4/8) mottles; medium clay; moderate to strong blocky structure.

Some A2 horizons may have a sporadic bleach. Jarra differs from Tully series by the massive, mottled B horizons and from Canoe series by the mottled B horizon. The series only occurs in association with Virgil series. Debil-debil microrelief is a common surface feature in undisturbed sites.

Vegetation is low to mid-high woodlands of *Lophostemon* and *Melaleuca* species.

Principal profile forms encountered include Gn2.64, Gn2.61 and Uf6.62.

ANALYTICAL DATA

Profile T441 Map Reference TULLY 1:100 000 763212
JARRA SERIES Sampled from undisturbed *Lophostemon* forest.

Depth cm	0-10	10-22	22-47	47-61	61-90	90-124	124-154	154-180
Horizon	A1	A1	A2	B1	B21	B22	2D	3D
pH	4.9	5.0	5.1	5.1	5.0	4.8	4.8	4.8
E.C. mS/cm	0.06	0.03	0.02	0.01	0.01	0.02	0.02	0.02
T.C. %	5.42		1.86		0.75		0.21	
N %	0.26		0.09		0.02			
AvP ppm	11		6		5		7	
P ret %	76				45			
Free Fe%	1.7				2.0			
Tot. P %	0.043		0.03		0.026		0.026	
Tot. K %	0.134		0.114		0.111		0.151	
Tot. S %	0.060		0.039		0.027		0.024	
Tot. Fe%	2.27		2.71		2.87		2.89	
Tot. Cu%	0.0006		0.0005		0.0007		0.0003	
Tot. Zn%	0.0021		0.0025		0.0024		0.0021	
Tot. Mn%	0.015		0.036		0.024		0.021	
Exchange properties m.e./100 g soil								
Ca	<0.02		<0.02		<0.02		<0.02	
Mg	0.24		0.06		0.05		0.07	
K	0.11		0.03		<0.02		<0.02	
Na	0.16		<0.02		<0.02		<0.02	
H + Al	2.67		1.56		1.54		1.02	
'ECEC'(1)	3.2		1.7		1.7		1.2	
'ECEC'/100gC	8.9		4.9		4.2		3.2	
CEC(2)	13		6		4		2	
CEC/100gC(2)	36.1		17.1		10		5.3	
Base Sat(3)	4		2		3		6	
CEC(4)	2.0		2.4		2.3		2.0	
Particle Size %								
Gr	1	1	3	2	3	8	6	4
CS	35	41	36	36	36	39	39	30
FS	18	16	19	17	16	17	17	14
Si	11	9	10	10	8	8	6	13
C	36	34	35	37	40	36	38	42
BD	1.1	1.2	1.3	1.3	1.4	1.3	1.5	1.5
.1 Bar	30.9	30.2	32.3	30.3	31.4	29.3	30.4	33.7
15 Bar	22.5	20.6	22.6	20.8	22.8	21.5	22.4	27.4

Mineralogy of the clay fraction	Depth cm 61-90	I% 1-5	Ka% 66-80	Ch/V% 11-20	Qz% 1-5	Ha/Go% <1	G% 1-5

(1) Sum of basic and acidic cations (3) $\frac{\text{Bases}}{NH_4\ OAc\ CEC} \times 100$

(2) NH_4 OAc (4) Comp. Exch.

MAPPING UNITS - POORLY DRAINED SOILS FORMED ON ALLUVIUM

Coom Association (Co)

This unit is widespread throughout the alluvial lowlands. It occurs most commonly on the low-lying floodplains adjacent to tea-tree and reed swamps. The dominant soil of the unit is Coom series with the most commonly associated soils being Tully and Timara series.

The most extensive area of the unit is at Murray Upper where the map symbols are combinations of soil series describing the co-dominance of the associated soil eg. Co Ti, Co Bg, Co Tu. This is common to the majority of Coom association map units and depicts the transitional nature of the dominate soil series (Coom) in that it lies between the better drained soils such as Tully and Mossman series and the poorer drained soils of Timara series. In the Kennedy valley the soils of the unit may overlie granitic fans as shallow as 1 m, and prior streams with the soils of Goolboo series are a prominant surface feature.

Timara Association (Ti)

This unit occupies sites which remain wet for the majority of the year and may have permanent water tables at a depth of about 1 m. The soils of Timara series dominate the unit with the most common associated soil being Coom series; in many areas the soils may be co-dominant and identified by the symbol TiCo. While the unit is not extensive the Timara soils may be found in many minor depressions within most of the alluvial associations. Fan palm and *Melaleuca* are the dominant vegetation communities on the few undisturbed sites inspected.

Bulgun Association (Bg)

The most extensive areas of this association lie to the south of Riverdale and in the Lower Tully area. Bulgun series is the dominant soil of the unit and represents the transition from soils of Coom and Mossman series to soils of Hewitt series. The lack of a suitable virgin site makes it difficult to postulate the origin of this series. It occurs on the fringes of the swamps and plains dominated by Hewitt series and may in fact have been more like Hewitt series before draining and cultivation. It is possible that under continual cultivation and improved drainage there may be sufficient oxidation of the organic matter for the surface to become non-sapric but retain the dark colour. Bulgun series as observed in the remaining lowland rainforest had abnormally thin dark surface horizons. Because these were not regarded as being representative of the deeper A horizon soils found in the cultivated situation, no profile was sampled.

The dark surface of this series has a moderate to high phosphate retention.

Warrami Association (Wm)

This association occurs near Warrami homestead in the upper Murray River Valley. It is dominated by two soils, Warrami series which is a gravelly sand to sandy clay loam overlain by a varying

depth of dark clay, and Derra series which is a fine gravelly clay overlain by the same dark clay. It appears that these soils are largely granitic fan materials overlain by a clay surface of lacustrine origin, or by more recent overbank deposits. The whole of the unit has been drained and cleared and it is thought that the surface has been considerably modified. In the natural state it was probably much more organic. Much of the organic fraction has been oxidised and the surface is now weakly self mulching or in excessively drained areas, a cracking clay.

Associated soils include Goolboo series on channel infill and Banyan and Hewitt series in wet sites. The non-humic clayey surface of Derra series distinguishes it from the sapric to fibric surface of the soils of Hewitt series, and there is a similar distinction between the soils of Warrami and Banyan series.

Derra Association (Dr)

This association occurs on the mid to lower slopes of the broad low angle granitic fans between the Murray River and Davidson Creek. The unit is dominated by the soils of Derra series while Banyan, Hewitt and Goolboo series occur as minor associates. Although no virgin sites have been encountered, it would appear that the surface horizon is a more 'recent' overbank deposit. This surface becomes extremely hard when dry and may be weakly self mulching or cracking. High water tables are a common feature.

Hewitt Association (He)

This unit has been mapped most extensively throughout the Tully and Murray River floodplains and immediately inland of the beach ridges. Most areas are flooded for considerable periods during the year and there is always a shallow watertable present.

Hewitt is dominant soil series of the unit. Bulgun series may be co-dominant in much of the intensively cultivated lands, and to a lesser extent in the units supporting lowland rainforest. Banyan series is a common associated soil where this association abuts the low angle fans derived from granite. Where the unit occurs adjacent to the beach ridges there is commonly a thin surface layer of sapric peat. Bulguru and Nind series may also occur in abandoned oxbows in the lower Tully and Murray Rivers. In some areas Hewitt series may have exceptionally deep (> 60 cm) A horizons and the symbol HeV has been used to highlight these deep variants.

While *Melaleuca* woodlands and reeds are the most common vegetation communities occurring on this association, in the Bellenden Plains' area, there are some open grasslands dominated by blady grass and broadleaf couch. These grasslands were probably maintained by aboriginal firing. In recent years fire has been excluded from some of these areas and they are quickly being invaded by rainforest species.

Jarra Association (Jr)

The only map units of this association occur as shallow drainage lines within the Virgil surface on Jarra Creek. *Lophostemon* and *Melaleuca* woodlands are the most common vegetation communities.

The unit is dominated by Jarra series soils which appear to be reasonably permeable and their mottling is probably an expression of external or site drainage conditions.

Lee Association (Le)

This unit only occurs on the southern extremity of the survey and is more extensive in the Ingham area. The most common landform is elevated levees and less active alluvial plains.

Lee is the dominant soil of the unit with Canoe series the most common inclusion.

ORGANIC SOILS AND PEATS OF THE FRESHWATER SWAMPS AND SOILS OF THE TIDAL ZONE

Soils dominated by organic materials in the upper part of the profile occur in both freshwater and saltwater environments. The largest areas of freshwater swamps occur behind the beach ridges from the Tully River to Meunga Creek. Smaller areas occur elsewhere throughout the lowlands, as well as isolated areas on the granitic uplands. The latter are usually associated with seepage areas around the margins of alluvial fans, and may occupy elevated sites such as the low hills on Tully River Station.

Bulguru and Nind peat soils are associated with virtually permanent surface water tables. The soils of the tidal zone have not been differentiated and only a brief description of the major soils is given in the Mangrove mapping unit description.

Bulguru Association (Bu)

The Bulguru series include a wide range of soils that have a highly organic or peaty surface which is usually too thin to enable the soil to be classified as a peat.

Whilst there are some fairly extensive map units of this association, their precise identification was made difficult by generally poor access and the permanent surface or near surface water table.

The large reed and *Melaleuca* swamps to the west of the beach sand masses have been mapped as Bulguru series. As yet no exploitation of these areas has occurred, and as much of it is contained within the Edmund Kennedy National Park, little development is likely to occur. The implementation of drainage schemes in adjacent areas however, has the potential to cause significant changes to this environment.

Deep Creek at Bilyana spills out onto the largest unit of this association and other minor areas are found in the fans which slope to Meunga Creek, Murray River and Brick Creek.

The distinguishing feature of the Bulguru soils is their highly organic surface which may be sapric, hemic or fibric. In general, the fibric and hemic materials occur in areas of permanent or near permanent water and the organic horizons range from 20 cm to about 50 cm in thickness. The sapric materials are generally thinner (20-30 cm) and occur in areas with a regular annual flooding-drying cycle. The organic materials overlie strongly gleyed sediments that range from heavy clay to coarse sand.

Nind Association (Nd)

The Nind series is hemic or fibric in nature and except where the soils have been artificially drained, they are permanently flooded. The peats range from more than 3 m thick in the reed swamps to 1 to 3 m thick in the *Melaleuca* and *Pandanus* swamps.

The underlying material ranges from coarse sand (where the peats occur in the swales in the beach ridges) to very fine textured alluvium.

Nind has been mapped in one of the abandoned distributary channels of the Murray River near Barrets Lagoon. Several unmappable occurrences are found in the swales of the beach ridges.

Mangroves (Mg)

The mangrove areas are very complex, consisting mainly of reworked beach ridges north of Cardwell and clayey alluvial deposits adjacent to Hinchinbrook Channel to the south of Cardwell. Soil textures range from clayey sand to sandy clay. Some soils are highly organic. Surface leaf and stem litter is common although distribution is patchy. A so-called 'mangrove peat' is another feature of these soils. It is the product of the slow breakdown of mangrove roots in reducing conditions.

Throughout the unit there are small areas generally devoid of vegetation. Some of these are reworked sands similar to those under mangroves while others appear to be very much altered soils of the well-drained alluvium. Many of these areas appear to be orientated with prior stream patterns and for the upper 30 cm may have many of the characteristics of Tully or Liverpool series. However they very quickly grade to subsoils with very strong ochrous mottling and have shallow saline water tables.

ANALYTICAL METHODS AND ABBREVIATIONS

pH - Determined on a 1:5 soil/water suspension using glass and calomel electrodes and a direct reading meter after shaking for 1 hr.

Electrical conductivity - Measured on the above 1:5 suspension.

Total nitrogen - Determined by the Honda (1962) modification of the Kjeldahl method.

Organic carbon - Readily oxidizable organic matter was determined by the method of Walkley and Black (1934). No factor has been applied.

Phosphorus retention - Single point index by the method described in Blakemore *et al.* (1981).

Total carbon - Dry combustion using a LECO CR-12 carbon system (Nelson and Sommers 1982).

Available phosphorous - Determined by the method of Kerr and Von Stieglitz (1938) by extracting with 0.005 M sulphuric acid for 16 hrs.

Total P, K and S - Determined by X-ray spectrography as described by Stace *et al.* (1968).

Exchangeable cations and exchange capacity - Calcium, magnesium, potassium, and sodium were extracted by shaking two grams of soil with 20 ml of a mixture of 0.1 M $BaCl_2$ and 0.1 M NH_4Cl for two hours. The cations in the extract were determined by atomic

absorption spectroscopy. For CEC determination the amount of Mg absorbed by the soil at approximately soil pH and at an ionic strength of 0.006 was measured using a compulsive exchange technique (Gillman 1979). Acidic cations (H + Al) were extracted with 1 M KCl (Soil Survey Staff 1972).

Ammonium acetate CEC - Air dry soil extracted with 1 M NH_4O Ac at pH 7.0 (Soil Survey Staff 1972).

Ammonium chloride CEC - Air dry soil extracted with 1 M NH_4Cl at pH 7.0 (Bruce and Rayment 1982).

Base saturation - Calculated as a percentage, sum of basic cations and ammonium acetate CEC.

Total Cu, Zn and Mn - All profiles to T414 are by HF/HCL O_4 digest and T430 onwards are by X-ray spectrography as described by Stace *et al.* 1968).

Free Fe - Extracted with citrate-dithionite at room temperature (Holmgren 1967).

Particle size - Determined using the pipette and sieve method of Coventry and Fett (1979).

E.C. mS/cm - Electrical conductivity millisiemens per centimetre.
Org. C - Organic carbon
T.C. - Total carbon
N - Total nitrogen
Ca - Calcium
Mg - Magnesium
K - Potassium
Na - Sodium
H+Al - Hydrogen + Aluminium
CEC - Cation exchange capacity
'ECEC' - 'Effective' cation exchange capacity
Base Sat - Base saturation
AvP - Available phosphorus
Pret. - Phosphorus retained
Tot. P - Total phosphorus
Tot. K - Total potassium
Tot. S - Total sulphur
Tot. Fe - Total iron
Tot. Cu - Total copper
Tot. Zn - Total zinc
Tot. Mn - Total manganese
Gr - Gravel
CS - Coarse sand
FS - Fine sand
Si - Silt
C - Clay
BD - Bulk density
.1 Bar - Volumetric water % at 100 cm suction
15 Bar - Volumetric water % at 15 000 cm suction
Ch/V - Chloritised vermiculite
I - Illite
Ka - Kaolin
G - Gibbsite
Ha/Go - Haematite/Goethite
Qz - Quartz
RIM - Randomly interstratified minerals
Sm - Smectite

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APPENDIX 1.

Vegetation - Common and Scientific Names

Scientific Name	Common Name
Trees and shrubs	
Acacia aulacocarpa	Salwattle
A. mangium	Mangium
Alphitonia excelsa	red ash
A. petriei	soapwood, sarsparala
Avicennia species	mangrove
Banksia species	
Casuarina littoralis	she oak
C. torulosa	forest oak
Eucalyptus acmenoides	stringybark
E. alba	poplar gum
E. cloeziana	Gympie messmate
E. drepanophylla	narrow-leafed ironbark
E. grandis	flooded gum
E. intermedia	bloodwood
E. pellita	red stringybark
E. polycarpa	grey bloodwood
E. teretircornis	blue gum
E. tessellaris	Moreton Bay ash
E. torelliana	cadaghi
Eugenia species	
Euodia species	
Lophostemon sauveolens	swamp mahogany
Melaleuca leucadendron	tea tree
M. quinquenervia	" "
M. viridiflora	broadleaf tea tree
Nauclea orientalis	Leichardt pine
Pandanus species	Pandanus
Planchonia careya	cocky apple
Psidium guajava	guava
Syncarpia glomulifora	turpentine
Grasses	
Bothriochloa species	blue grass
Brachiaria decumbens	signal grass
Cyperus species	sedges
Dicanthium species	
Imperata cylindrica	blady grass
Panicum maximum	guinea grass
Themeda australis	kangaroo grass
Xanthorrhoea species	black boy