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THE SOILS OF WALKAMIN RESEARCH STATION

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Resource Management

DPI QUEENSLAND
DEPARTMENT OF PRIMARY INDUSTRIES

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SUMMARY

The 259 ha Walkamin Research Station is located on the Kennedy highway at Walkamin 12km south of Mareeba , north Queensland (Figure 1). It is situated on gently undulating rises on Mareeba granites and Hodgkinson formation metamorphics and level to gently undulating basalt lava plains of the Atherton basalts.

The soil resources of the station were assessed by a field survey involving traverses 100m apart, and the collection of representative soil profiles for laboratory analyses. Nine soil series and two phases were mapped at 1:10000 scale from 150 ground observations.

The survey identified 93 ha of arable land, 45 ha of limited arable land, 87 ha of pasture land and 18 ha of non agricultural land. The remainder of the area is used for research station infrastructure.

1. INTRODUCTION

The Queensland Department of Primary Industries Walkamin Research Station is located on the Kennedy highway at Walkamin approximately 12 km south of Mareeba (Figure 1). The 258.6 ha station was established in late 1959, in conjunction with the Queensland Water Resources Commission. Its main purpose being to evaluate the economic use of irrigation water from Tinaroo Dam on the Tobacco soils within the Mareeba Dimbulah Irrigation Area (MDIA). A block layout of the station is shown in Figure 2.

The present study was initiated when the Walkamin Research Station committee requested a detailed soil survey and agricultural land suitability assessment for the following reasons:

- the inadequacy of present resource information for the station.
- the prospects for expansion of horticultural and pastoral research.
- to use the red basaltic soils more efficiently in terms of irrigation and research projects.

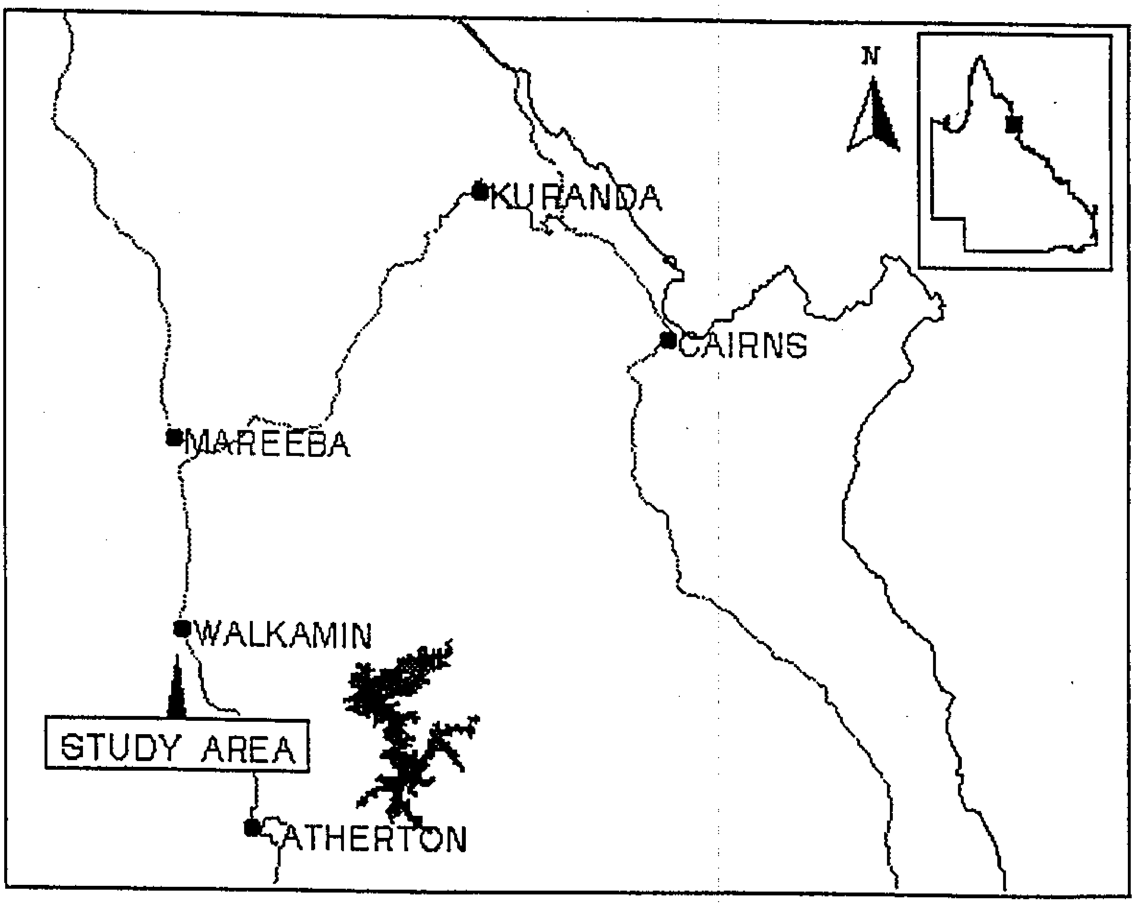


Figure 1. Locality plan

PHYSICAL RESOURCES

2.1 Climate

The station experiences a markedly wet and dry seasonal climate. Annual average rainfall is 1030 mm, three quarters of which falls in the November to March period (Appendix I). Monthly maximum temperatures range from 30°C to 23°C while the minimum fluctuates between 18°C and 10°C. Frosts are light and occur on average once every 2 years. Elevation is approximately 570 m above sea level.

2.2 Geology

The geology of the Atherton Tableland area has been mapped by Best (1962) at 1:250 000 scale. The station has been mapped into the following geological units:

- Hodgkinson Formation Metamorphics - DCh (siltstone, mudstone, greywacke).
- Mareeba granites - Cgm (grey porphyritic biotite granites).
- Atherton Basalts - Cza (grey fine grained olivine basalt).
- Walsh Bluff Volcanics - Pl (rhyolite).

During the Lower Devonian to Middle Carboniferous Period the Hodgkinson sediments were metamorphosed. Granites were then intruded into the surrounding country rock during the Carboniferous period. Vulcanism followed, and lavas of the Atherton basalts flowed down many of the post - tertiary valleys during the Pliocene Period. It is believed that the basalt on the station originates from Bones Knob, a volcano near Tolga. Bore logs from the area suggest that the basalt maybe up to 40 m thick. (Water Resources Commission, pers comm.).

2.3 Geomorphology

Soils derived from the metamorphic rocks have formed around the centre of the station on colluvium. The granitic derived soils have formed on colluvium from the mountain range to the west of the station whilst the soils derived from basalt have formed on lava flows originating from Bones Knob approximately 10 km south.

The major influence on the geomorphological processes of the station are these basalt flows. At the margins of these flows, local creeks have dissected to form a new base level. Underlying material of unknown origin has caused lateral water movement in a westerly direction from the front of the station. This is indicated by the change in soil colour from red to yellow in this direction.

2.4 Vegetation

The vegetation communities on the station have a fairly similar composition. There is some species variation across different soils, lithologies and landscape positions. Soil type and landscape position seem to govern the type and size of tree the most.

The well drained red basaltic soils are dominated by box (*Eucalyptus leptophleba)* and pink bloodwood (*Eucalyptus clarksoniana)* while the poorer drained areas are dominated by box (*Eucalyptus leptophleba*), poplar gum (*Eucalyptus platyphylla*) bloodwood (*Eucalyptus erythrophloia*) and tea trees (*Melaleuca viridiflora, M. nervosa, M. minutifolia*).

Of the two woody-fruited bloodwoods, *E. clarksoniana* dominates the eastern part of the station, *E. erythrophloia* the western part. This is more a topographic connection than anything else. The former tends to favour the gentler surfaces, while locally the latter is usually associated with broken country or steeper slopes, such as the edges of basalt flows and gully sides of the two creeks.

The creeks and gullies are characterised by blue gums (*Eucalyptus tereticornis*) on the alluvial flats and swamp mahoganey (*Lophostemon suaveolens*) on the banks. Pandanus (*Pandanus spp.*) clumps grow in the gully soaks. They have flourished markedly in the gully that drains the Fisheries ponds, especially since it became a permanent stream.

There is only one area (the old tobacco plot on a well drained granitic soil) where the vegetation is representative of a soil division. Here ironwood (*Erythrophloeum chlorostachys*) and Moreton Bay ash (*Eucalyptus tesselaris*) are dominant. The latter suggesting that there is also ground water throughout the year.

Quinine bush (*Petalostigma pubescens*) and other small trees such as tea trees (*Melaleuca spp.*) dominate the soils with the most impeded drainage.

Appendix IIb shows major vegetation species on a mapping unit basis. Note: only those mapping units where native vegetation still remains are shown.

3. LAND RESOURCE SURVEY METHOD

The purpose of a survey determines the scale of the published map which in turn governs the density of ground observations (McDonald 1975). A minimum survey scale of 1:10 000 was chosen to satisfy the needs of grazing and intensive horticulture on the Station. The published map however, is at 1: 5 000 scale to produce a map large enough for Research station usage.

One hundred and fifty sites were described using a 100m x 150 m grid pattern. (McDonald et al, 1990). A site intensity of one site every 1.6 hectares was achieved. This figure is an average only, with site intensity being higher on the better soils at the front of the Station. A full site description (soil morphology, landform, geology and vegetation) was done at each site. Soils were then grouped into Soil Profile Classes (Isbell, 1988) according to morphological similarities. Each major Soil Profile Class was sampled for chemical analysis by Agriculture Chemistry Branch Mareeba. Locations of these sites can be seen on the soils map. Chemical analysis results are given in Appendix IVa.

Observation pits were excavated in 5 of the most common soils.

1. Mapee Rocky phase
2. Mapee
3. Walkamin
4. Walkamin Shallow phase
5. Glenray

The location of these pits is indicated on the soils map (P1, P2, P3, P4, P5). These pits are permanently fenced and are available for inspection by contacting the Station manager Walkamin Research Station.

4. SOILS

4.1 Soil Series

Nine soil series and two phases were identified on the station. (See soils map). Descriptions of these soils along with accompanying information are provided in Appendix IIIa and IIIb.

4.2 Soils derived from granitic and rhyolitic rocks

A Carbeen (Cr) soil has formed on undulating rises along the southern edges of V and W block. (Figure 2). The soil has a dark sandy clay loam A1 horizon over a pale A2 horizon over mottled yellow-brown sandy clay textured B horizons over decomposing granite at about 1m.

A Station (St) soil has formed in colluvial material on the lower slopes of gently undulating rises. Profiles have predominantly grey surface horizons of sandy loam to sandy clay loam texture, bleached A2 horizons and yellow brown to grey sandy medium to medium heavy clay B horizons. These soils can be seen around the centre of the Station in R and S block. (Figure 2)

A Lotus (Lt) soil occurs on the footslopes of gently undulating rises in U block (the old tobacco plot) in the southwestern corner of the Station (Figure2). These soils have a grey loamy coarse sand surfaces underlain by occasionally bleached grey sandy B horizons.

4.3 Soils Derived From Granitic or Metamorphic Rocks

A Glenray (Gr) soil has formed on the gently undulating slopes just southwest of the fisheries ponds in and around P block (Figure 2). It is likely to be relict fan material of granitic or metamorphic origin as evidence of both lithology's can be found. These soils have dark sandy clay loam surfaces over a pale A2 horizon over mottled yellow clay loam sandy to sandy light medium clay B horizons with quartz pebbles and ferromanganiferous nodules.

4.4 Soils Derived From Basaltic Rocks

A Mapee (Mp) soil has formed on the slopes of the gently undulating to level lava plains at the front of the station (Figure 2). They have dark or red light clay surfaces grading into deep red structured clay B horizons often with small black manganiferous nodules. These soils are deep and well drained.

A Mapee Rocky phase (Mp Rp) has been mapped in I block and on the ridge top of V and W block above Maude Creek (Figure 2) These soils are similar to the Mapee soil however contain 20-50% basalt rock, particularly on the surface. The rock seems to decrease in abundance with depth.

The Walkamin (Wk) soil occurs on footslopes of lava plains around the southeastern corner of the Station (C block) and south of the fisheries ponds (O block) adjacent to the cultivated Mapee soils (Figure 2).The profiles usually consists of a dark coloured, light clay surface over deep yellow well structured light to light medium clay B horizons with common manganiferous and ferromanganiferous nodules. Mottling is often present at lower depths.

A Walkamin Shallow phase (Wk Sp) has been identified mainly in Q block and the forestry block with smaller occurrences in V, W and T block (Figure 2). They are similar in appearance to the Walkamin soils, however they are underlain by a coarse structured grey/brown heavy clay B horizon at depths below 70cm.

A Snider (Sd) soil occurs on the footslopes of the level lava plains (Western end of Q block, along the top of W block and in the far North Western corner of T block) (Figure 2). They commonly consist of shallow profiles with dark, light to light medium clay surface horizons containing basalt fragments and manganiferous nodules, overlying mottled brown medium heavy clay B horizons also with basalt fragments and manganese nodules.

A Morgan (Mg) soil has formed on fans of gently undulating and undulating lava plains (north western edge of V block, towards Maude creek) (Figure 2). This soil has a dark light to medium clay textured surface with basaltic pebbles over a mottled brown medium heavy clay acid to neutral B horizon containing calcium carbonate nodules and manganese nodules over decomposing basalt.

4.5 Soils Derived From Alluvium

A Maud (Md) soil has been identified on terraces of level to gently undulating alluvial plains along Maud creek. (See soils map). These are uniform textured soils with dark medium clay surfaces grading into structured grey medium heavy clay B horizons containing carbonate nodules. Layers of unrelated soil material can often be found at depth. These layers represent different alluvial deposition events.

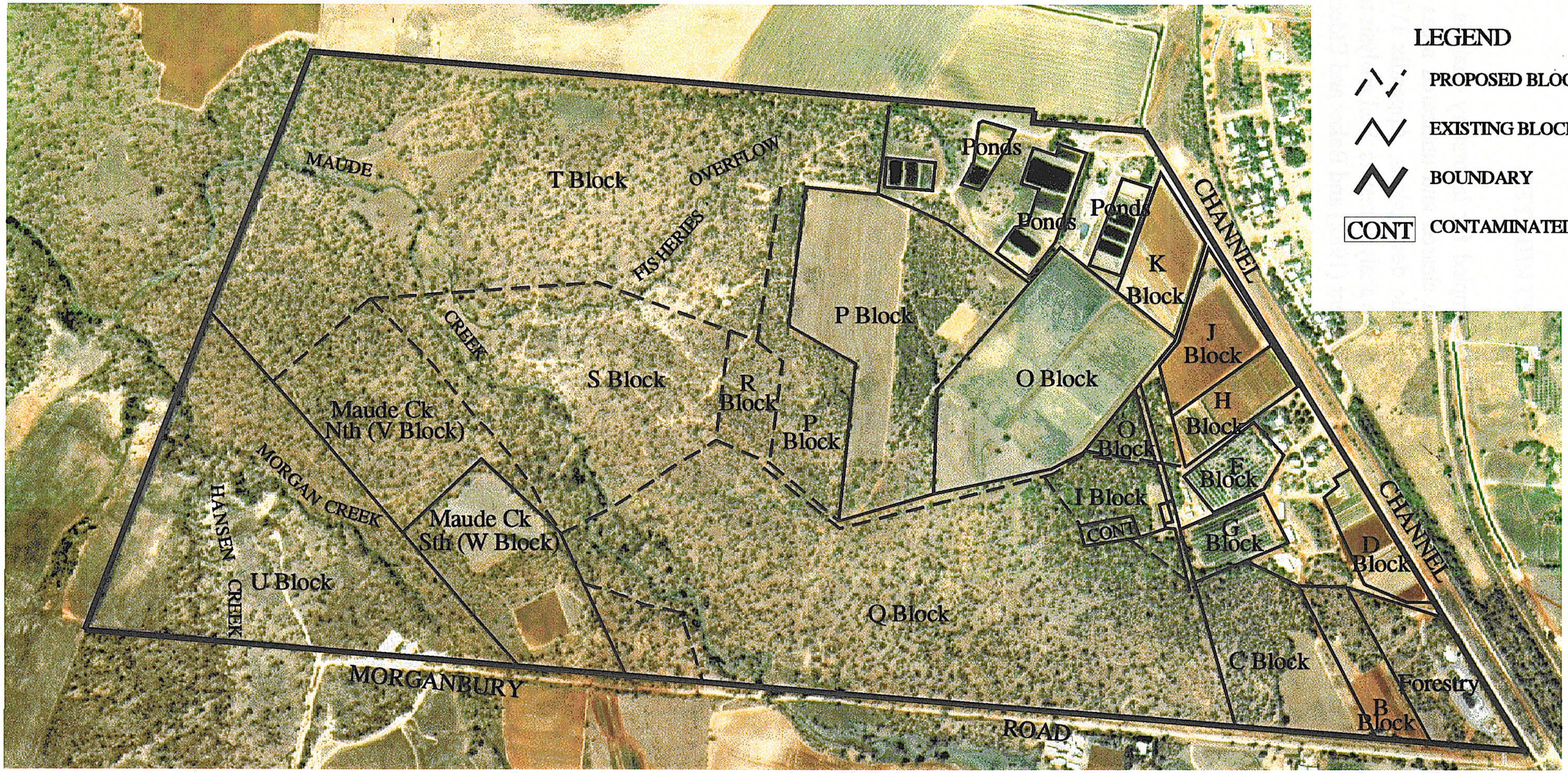
4.6 Miscellaneous Units

Includes stream channels and land that is used for fisheries ponds or buildings.

4.7 Soil Classification

On the map reference, soils are classified into Great Soil Group (Stace et al., 1968); Principle Profile Form (Northcote, 1979) and The Australian Soil Classification System (Isbell 1993 3rd Approximation).(Appendix II).

Figure 2 –Block layout of Walkamin Research Station



DPI REF NO: 94-MISC-M-654 Scanned Photo - Mareeba Dimbulah Irrigation Area, Run 4 Photo 78, Date - 23/11/90

5. SOILS - CHEMICAL & PHYSICAL ATTRIBUTES

A total of 12 representative soil profiles were sampled for laboratory analysis. The major soils (Walkamin & Mapee) have been sampled in both cleared and uncleared areas for comparative purposes. Appendix II shows representative profile descriptions, Appendix IVa gives chemical analysis results and Appendix IVb gives particle size analysis results Soil analysis methods and interpretation of data are those of Bruce and Rayment (1982) and Baker and Eldershaw (1993).

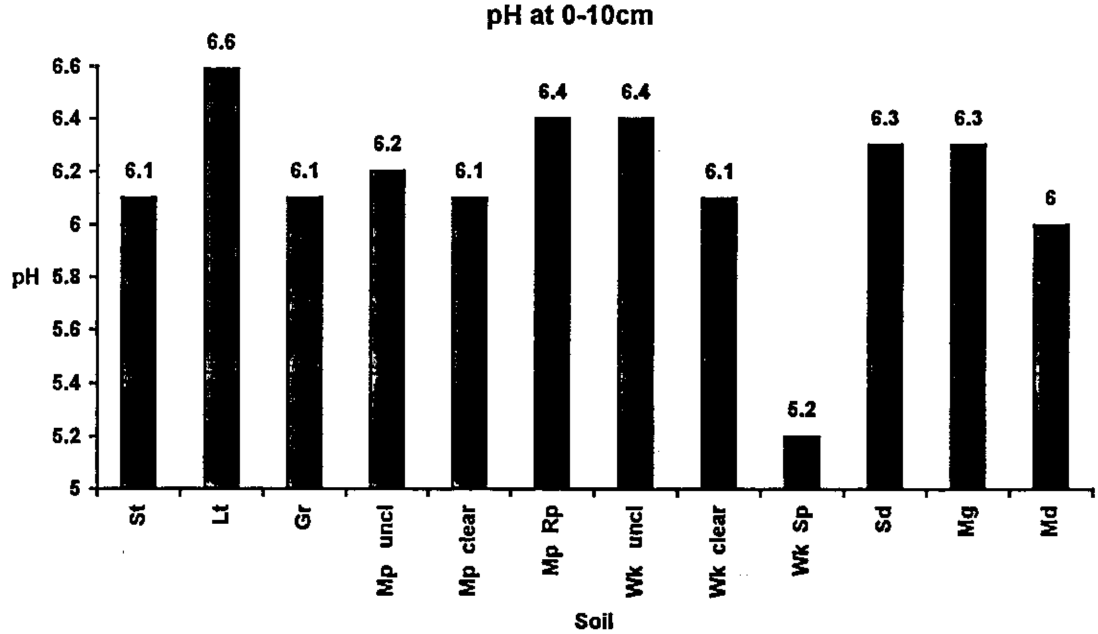
5.1 pH, Salinity and Sodicity

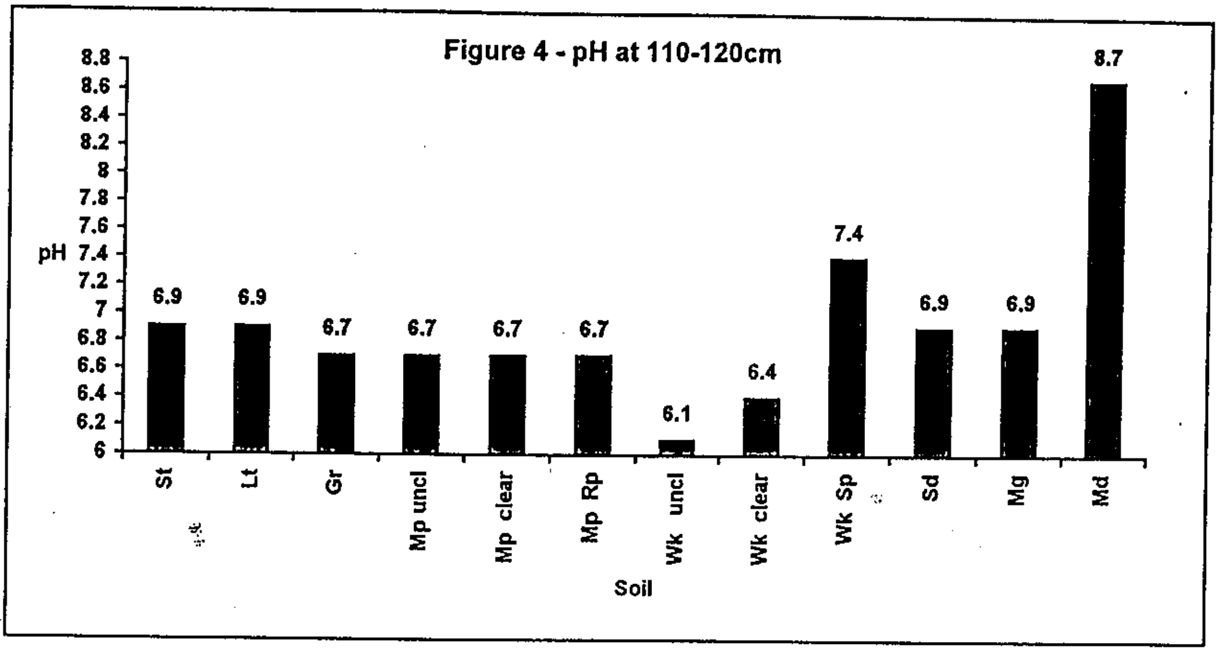
pH

Surface pH (0-10cm) ranged from 5.2 in the Walkamin shallow phase to 6.6 in the Lotus soil. (Figure 3). Subsoil pH values ranged from 7.4 (at 60 cm) in the Walkamin shallow phase to 8.7 in the Maud soil series (below 40cm). pH values below 5.5 can create difficult growing conditions for all but acid tolerant plants, usually due to excessive accumulations of aluminium, manganese and iron. (Baker and Eldershaw, 1993).

The high pH at depth in the Maud Series (figure 4) is due to the high levels of calcium carbonate nodules in the soil. (Appendix IIIa). Soil pH greater than 7.5 may have toxicity or deficiency problems whilst soils with pH greater than 8.5 are likely to have low availability of trace elements Zn, B, Mn, Fe and higher availability of Mo.

Figure 3 - Surface pH at 0-10cm





Salinity

Electrical conductivity readings (Table 1) were very low in all soils (Baker 1991) indicating negligible salinity concerns (Appendix IVa).

Sodicity

An indication of sodicity is given by calculating the exchangeable sodium percentage (ESP) (Baker and Eldershaw, 1993). High levels were found at depth (80-90cm) in the Glenray and Maud soils. High levels of sodium ions can cause dispersion of clay upon wetting leading to severe gully erosion. Chemical imbalances can also occur.

5.2 Particle size analysis

Appendix IVb shows the percentage of clay, silt, fine sand and coarse sand present in the sampled profiles. The Mapee soils have the highest clay content (>70%) while the Lotus soils have the lowest (<16%).

Chemically, particle size analysis values can help evaluate the capacity of a soil to hold nutrients (ie exchange sites on clay colloids), especially in irrigation areas. Physically, the proportions of different particle sizes give good indications of the physical properties of the soil.

The Station soil for example has high amounts of fine sand which causes the soil to set hard especially in the surface. This causes impedance of root growth and seedling emergence. The soil fertility status is also low. The Mapee soil on the other hand has a high clay content which is indicated by their good structure and generally good chemistry. The Lotus soil has a high amount of coarse sand which allows for good drainage, however because there is the clay content is low, the fertility status is low.

5.3 Effective Cation Exchange Capacity & Clay Activity Ratios

Cations (ie positively charged ions) are held on the surface of charged soil minerals, organic matter and within the crystalline framework of some clay minerals to form a reservoir of nutrients in the soil (Baker & Eldershaw, 1993).

Effective cation exchange capacity (ECEC) measures the capacity of a soil to retain important soil nutrients such as calcium, magnesium, potassium and sodium as well as hydrogen and aluminium. (Baker & Eldershaw, 1993).

The very low cation exchange capacity in the Lotus soil series (less then 4 meq/100 g) reflects the low clay content and suggests that managed fertiliser inputs should be made to avoid leaching of applied fertiliser cations.

The Walkamin, Mapee, Maud, Morgan and Snider soils, all have ECEC's greater than 10 meq per 100 g of soil. The remainder have ECEC's between 4 and 10 meq/100g.

The clay activity ratio (ratio of ECEC to % clay) is a useful indication of clay mineralogy. Clay mineralogy types and ratios are:

<0.3 Kaolinite (non cracking clay);
0.3-0.5 Illite (non cracking clay);
0.5-0.8 Zone of uncertainty (probably mix of illite and smectite);
>0.8 Smectite (cracking clay).
(Baker & Eldershaw 1993).

Clay activity ratios for the sampled soils can be seen in Table 1.

Table 1 - Clay activity ratios at 50-60cm.

SOIL	RATIO
1. Station	0.24
2. Lotus	0.13
3. Glenray	0.06
4. Mapee (uncleared)	0.08
5. Mapee (cleared)	0.08
6. Mapee Rocky phase	0.07
7.Walkamin (uncleared)	0.03
8.Walkamin (cleared)	0.04
9. Walkamin Shallow phase	0.11
10 .Snider	0.36
11 .Morgan	0.63
12. Maud	0.33

Ratios indicate that nine of the soils are kaolinite dominated clays and two are illite dominated. One soil falls into the 0.5-0.8 category, where there is uncertainty as to the clay mineralogy. It is currently regarded as a combination of illite and smectite..
No soils are smectite dominated.

Clay mineralogy is also a good indicator of a soils state of weathering. In this case the predominance of kaolinite is indicative of highly weathered soils.

5.4 Soil Fertility Ratings

Fertility data for the 0-0.1m bulk samples are presented in Table 2.

Table 1 - Fertility data for the 0-0.1m bulk samples.

	Wk SP	Wk uncl	Wk cl	Mp uncl	Mp Rp	Mp cl	Gr	Md	St	Mg	Sd	Lt
pH	strongly acid	slightly acid	slightly acid	slightly acid	slightly acid	slightly acid	slightly acid	slightly acid	slightly acid	slightly acid	slightly acid	neutral
Acid P (ppm)	low	mod	low	mod	mod	low	mod	mod	low	mod	mod	mod
Bicarb P (ppm)	low	mod	low	mod	mod	low	low	mod	low	low	low	low
ECEC	mod	mod	mod	mod	mod	mod	mod	mod	low	mod	mod	low
OC	mod	mod	mod	mod	mod	low	mod	mod	low	mod	mod	low
Extr Cu	mod	mod	mod	mod	mod	mod	mod	mod	low	mod	mod	low
Extr Zn	high	high	mod	high	high	mod	mod	high	mod	mod	mod	mod
Extr Mn	high	high	high	high	high	high	mod	high	mod	high	high	mod
EC	low	low	low	low	low	low	low	low	low	low	low	low

As mentioned previously ECEC is a useful indication of general fertility The ECEC's (in the top 30cm) of all but two soils sampled indicate there should be no fertility problems that cannot be overcome by normal fertiliser applications. Exceptions are the Lotus and Station soils which have low levels of phosphorous, potassium and organic carbon. These soils will require extra fertiliser applications. The results probably reflect the highly weathered nature of these soils and the nutrient deficient parent materials these soils were derived from.

The low ECEC values found in the cleared Mapee and Walkamin soils compared to their uncleared counterparts is possibly due to the agricultural activities that have taken place on them. Crop harvest and tillage practices combine to remove major soil nutrients and organic matter while the use of nitrogen based fertilisers reduce pH. All of these factors combine to reduce ECEC.

It can be seen in Appendix IV that the Glenray soil is strongly sodic at 80-90cm (> 15% ESP) and the Maud soil is sodic (ESP 6-15%) at 80-90cm. This should not be of concern for shallow rooted crops under appropriate irrigation management. Excess irrigation however can cause increased mobility of sodium from upslope to downslope positions.

The dispersive nature of sodium dominated clays also leads to increased erosion risk.

Plant available phosphorous is considered adequate when levels exceed 36 ppm in the surface 0-10cm (Baker and Eldershaw ,1993) Appendix IVa shows that the only soils on the station meeting these levels are the Mapee (uncleared and rocky phase), Maud, Glenray and Walkamin (uncleared). The remainder are considered low and will require phosphorous applications for adequate plant growth.

The higher levels of phosphorous in the surface of the Walkamin (uncleared) and Mapee (uncleared) compared to their cleared counterparts is another indicator of prior agricultural activities.

Exchangeable potassium (Appendix IVa) is adequate (>0.3 meq/100g; Baker and Eldershaw, 1993) for cropping in the surface of most soils except for the Station and Walkamin (cleared). In the case of the Walkamin cleared, this could be due to the improved pastures grown on this area. Grasses extract potassium more efficiently than legumes leading to deficiency. (Baker and Eldershaw, 1993)

Copper and Zinc (Appendix IVa) are at adequate levels (.>0.4 mg/Kg and >0.8mg/Kg respectively. Baker and Eldershaw, 1993) in the surface of all except the Station and Lotus soils. This is probably due to the highly weathered nature of the surface layers of these two soils, indicated by the bleached (pale) colours and low clay contents.

Manganese levels are generally well above the 20mg/Kg critical level for manganese sensitive plants (Baker and Eldershaw, 1993). Toxicity could become a problem if pH levels are allowed to drop below pH 5.2 (Baker and Eldershaw, 1993). However soils in this environment are normally well buffered against acidification.

Organic carbon levels are acceptable in all soils except for the Morgan, Snider, Mapee (cleared) and Lotus

5.5 Soil Physical Attributes

Appendix IVb shows the particle size analysis results for sampled profiles. The Mapee soils have the highest clay contents and the best physical attributes of all the soils on the Research Station. This is due to their good structure and internal drainage.

Generally there is a good correlation between field texture particle size analysis. The Snider however has been field textured as a sandy light medium clay yet the particle size analysis indicates sandy clay loam. The high percentages of silt and fine sand probably account for this overestimation in the field. These lighter textures may give lower moisture storage capacities than would be expected for light clays.

6. LAND USE

Over the years, Walkamin Research Stations land use has changed to meet the developing needs of the district. Currently its research activities include those listed below.

Crop research - Conducted into the established summer crops of maize and peanuts as well as into more recently introduced crop species including sorghum, soybeans, rice, sunflowers, cotton, pigeon pea, lupin and cassava. Research input for each species is attuned to current viability of production. This input always includes variety testing, plant population, nutrition, water requirements and agronomy as well as weed, pest and disease control.

Tropical fruits - Tree crop evaluation deals with a range of mango, avocado, lychee and longan cultivations. Research into coffee production began a few years ago. QDPI's. Plant Protection group also maintains an orchard for pest and disease research.

Pasture research - This focuses on irrigated pastures for beef cattle production. Walkamin is the research base for the extensive dry tropic grazing areas of north Queensland. Investigations are mainly concerned with protein deficiency during the day period from winter to early spring.

Seed production - The district is suitable for seed production and a tropical pasture seed industry is closely coupled with the viability of the beef cattle industry.

Freshwater fishing - Queensland freshwater fisheries are upgraded by the breeding, stocking and monitoring of native fish species. Fingerlings are released into all major rivers and water storage's along the Queensland east coast. A barramundi breeding program began in 1984.

7. AGRICULTURAL LAND SUITABILITY

7.1 Introduction

Land resource information can be interpreted and presented in the form of either a five class land suitability classification or a four class system using broad agricultural groups. Groups in this classification are: arable, limited arable, pastoral and non agricultural land. The latter has been chosen for simplicity and applicability to the requirements of the research station. For further information and land suitability for a wider range of land uses please refer to the following report: Soils and land suitability of the Atherton Tablelands, North Queensland (Malcolm et al 1996 unpublished).

7.2 Agricultural land suitability groups

This is a hierarchical classification system comprising class A to D land (Table 3)

Table 3 Agricultural Land Classes

CLASS	DESCRIPTION
Class A	**Crop Land** - Land suitable for current and potential crops with limitations to production which range from none to moderate levels.
Class B	**Limited Crop Land** - Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
Class C	**Pasture Land** - Land suitable only for improved or native pasture due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
Class D	**Non Agricultural Land** - Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

The system assumes that the crop land is also suitable for lower ranked uses. Pastoral land on the other hand is not necessarily suitable for every arable land use.

Agricultural land classification is based on the assessment of land properties which determine the sustainable long term productivity of particular land uses. These properties have been termed land limitation factors or limitations. These limitations effect crop growth, machinery and irrigation usage as well as land degradation. The primary limitations used to allocate land to one of the four agricultural land classes in this survey were : wetness, rockiness, soil physical condition, topography, erosion potential, flooding and plant available water content (Anon, 1990). Agricultural classes were allocated to all mapping units on the soils map depending on the characteristics of the mapping unit. The characteristics of the mapping unit and agricultural land class is shown in Table 4.

Due to the diversity of land uses on the Research Station, the agricultural land classes have been further subdivided.

Table 4 - Major Mapping Unit Attributes and Agricultural Land Class

Map unit no.	Map unit	Area (ha)	Attributes	Land Class
1	ML	12.1	Fisheries ponds	
2	Wk	14.7	slope 0-3%, drainage *4, permeability* 3	A3
3	Mp	16.7	slope 0-3%, drainage 5, permeability 4	A1
4	ML	3.1	Buildings	
5	WkS	5.4	slope 0-3%, drainage 3, permeability 3 profile average depth to heavy clay 70 cm	B2
6	Mp	2.4	slope 0-3%, , drainage 5, permeability 4	A1
7	Wk	12.0	slope 0-3%, drainage 4, permeability 3	A3
8	MpR	6.1	slope 0-3%, drainage 5, permeability 4, rock 20 - 50%, 60 - 200mm basalt rock	B1
9	ML	0.7	Cattle yards	
10	WkS	15.8	slope 3-12%, drainage 3, permeability 3, profile average depth to heavy clay 70cm	B2
11	Gr	34.5	slope 0-3%, drainage 3, permeability 3	A3
12	Sd	18.0	slope 3-12%, drainage 3, permeability 3, rock 10-20% 20-60mm basalt. Profile average depth 50cm	C
13	St	9.3	slope 0-8%, drainage 2, permeability 2, hardsetting	C
14	St	1.7	slope 0-8%, drainage 2, permeability 2, hardsetting	C
15	Mp	2.7	slope 3-12%, drainage 5 permeability 4, rock 2-10% 60-200mm basalt	A2
16	Sd	12.5	slope 3-12%, drainage 3, permeability 3 rock 10-20% 20-60mm basalt	C
17	WkS	8.6	slope 3-12%, drainage 3, permeability 3, rock <2% 60 - 200mm basalt	B2
18	MpR	6.5	slope 3-12%, drainage 5, permeability 4, rock 20-50% 60-200mm basalt	A2
19	Cr	4.8	slope 0-8%, drainage 3, permeability 3	B2
20	Sd	1.7	slope 3-12%, drainage 3, permeability 3, rock 10-20% 20-60mm basalt	C

Table 4. continued.

Map unit no.	Map unit	Area (ha)	Attributes	Land Class
21	St	7.8	slope 5-10%, drainage 2, permeability 2	C
22	Lt	1.3	slope 0-3%, drainage 6, permeability 4	B2
23	St	0.8	slope 5-10%, drainage 3, permeability 3	C
24	Gr	3.4	slope 0-8%, drainage 3, permeability 3	A3
25	Creek	6.9		D
26	Md	3.4	slope 0-3%, drainage 2, permeability 2	C
27	Creek	11.3		D
28	Md	23.2	slope 1-5%, drainage 3, permeability 3, rock 10-20% 60-200mm basalt	C
29	Sd	0.8	slope 1-5%, drainage 3, permeability 3, rock 10-20% 60-200mm basalt	C
30	Lt	1.8	slope 0-3%, drainage 6, permeability 4	B2
31	Sd	3.7	slope 3-12%, drainage 3, permeability 3, rock 10-20% 60-200mm basalt	C
32	Md	0.45	slope 0-1%, drainage 2, permeability 3	C
33	Mg	3.4	slope 1-5%, drainage 2, permeability 3, rock 10-20% 20-60mm basalt	C
34	WkS	1.1	drainage 3, permeability 3	B2

***Drainage classes**
1 = Very poorly drained
2 = Poorly drained
3 = Imperfectly drained
4 = Moderately well drained
5 = Well drained
6 = Rapidly drained

***Permeability classes**
1 = Very slowly permeable
2 = Slowly permeable
3 = Moderately permeable
4 = Highly permeable

Crop land (Class A1)

Crop land is suitable for the largest range of crops and has virtually no limitations. From this point of view, the deep Mapee soils (mapping units 3 and 6) are regarded as the most arable on the station. Soil depth, slope, physical condition and plant available water content are all favourable (Table 4).

Crop land (Class A2)

Some areas of Mapee soils (mapping unit 15) contain 2-10% basalt rock thus making them slightly less suitable for agriculture. Rock picking is considered worthwhile in these areas as most rock seems to be concentrated in the surface. All other physical and morphological properties remain the same as the Mapee soils above. and therefore if rock picked these areas would be upgraded to class A1 (Table 4).

Crop land (Class A3)

Wetness is of major concern to most crops especially during the wet season. The Walkamin and Glenray soils (mapping units 2, 7, 11 and 24) are morphologically similar to the Mapee soils except they are not as well drained. This is indicated by their yellow colour. A possible cause for this is some sort of underground geological restriction which prevents water from moving quickly through these areas and causing a fluctuating water table. This is probably the only major limitation to agricultural production on these soils (Table 4).

Limited crop land (Class B1)

Mapping unit 8 and 18 have been termed Mapee 'Rocky phase' they contain significant amounts of surface rock (10-50%, 60-200mm) which would be expensive to rock pick. This however is at the discretion of station management and if picked soil quality would be deemed class A1 (Table 4).

Limited crop land (Class B2)

This land is not suitable for all of the crops grown on the station. Slope, erosion, wetness and rockiness are the major limiting factors of this land. Often where wetness is the problem, the construction of drainage systems will allow the soils to become arable all year round. The soils in this group are the Walkamin shallow phase (mapping units 5, 10, 17 and 34); the Carbeen (mapping unit 19) and the Lotus soils (mapping units 22 and 30) due to their rapid permeability, low nutrients levels and low plant available water content (Table 4).

Pasture land (Class C)

This is land that is suitable only for pasture improvement or native grazing due to a range of limiting factors (Table 4). In this group there is the Snider soils (mapping units 12,16,20,29 and 31) which are shallow (generally less than 50 cm) and contain rock fragments throughout the profile. The Morgan series has a combination of poor drainage, high clay contents which effect workability as well as significant amounts of rock. Due to wetness and susceptibility to flooding, the Maud series (mapping units 26 and 32) would be best suited to improved pasture or grazing of native pastures. The Station soils are suitable only for grazing of native pastures because of their high erodibility and hard setting nature (Table 4).

Non Agricultural Land (Class D)

The only non agricultural land on the station are the creeks, drainage lines and fisheries ponds. (mapping units 1, 25 and 27) (Table 4).

8. ACKNOWLEDGMENTS

The authors wish to thank :

Brett Nagel (Experimentalist DPI Mareeba) for his involvement in data entry and soil profile class descriptions.

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APPENDIX I

Rainfall Summary for Walkamin Research Station (1967-1992)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean	231	221	238	51	26	21	9	11	9	22	80	117	1035
Median	171	204	197	47	18	18	6	6	5	11	50	115	973
Standard Deviation	182	114	187	31	24	16	8	18	12	25	64	77	325
Lowest Rainfall	23	60	31	6	6	1	1	0	0	0	4	10	562
Highest Rainfall	817	514	649	121	89	68	28	80	50	107	258	291	1751
Number of Years	25	25	25	24	24	24	24	24	24	24	24	24	24

APPENDIX IIa

Explanation of codes used in the 'native vegetation' table

BOX. *Eucalyptus leptophleba.* Molloy box. The dominant tree species on the station.

BWD1. *Eucalyptus clarksoniana.* formerly polycarpa, the most common local bloodwood.

BWD2.*Eucalyptus erythrophloia.* formerly dichromophloia, a reddish, flaky-barked bloodwood with concolorous leaves and a tendency to shed bark from its branch ends.

MBA. *Eucalyptus tesselaris.* Moreton Bay ash, a black-stockinged, gum barked, paper-fruited bloodwood.

WGM. *Eucalyptus papuana.* white gum, another paper-fruited bloodwood.

PGM. *Eucalyptus. platyphylla.* formerly alba. Poplar gum, broad-leaved. Probably the second most common tree on the station.

IBK. *Eucalyptus crebra.* The common ironbark of the local basalt.

BGM. *Eucalyptus tereticornis.* blue gum (forest red gum), a common river gum.

MEL1. *Melaleuca viridiflora.* A common broad-leaved tea tree, with a sickle shaped leaf.

MEL2. *Melaleuca nervosa.* Another common tea tree, with smaller leaves, hairy when young.

MEL3. *Melaleuca minutifolia.* The commonest local black or fine-leaved tea tree.

GRG. *Grevillea glauca.* A common beefwood with broad grey leaves and big round woody cleft fruits.

GRP. *Grevillea parallela.* A common beefwood with strap-like leaves and white inflorescences.

GRM. *Grevillea mimosoides.* A woody shrub.

HAK. *Hakea persiehana.* Needlewood. Proteaceae.

PER. *Persoonia falcata.* An inconspicuous proteaceous shrub.

CKD. *Erythrina vespertilio.* Corkwood or bat's wing coral tree.

IWD. *Erythrophloeum chlorostachys.* Ironwood.

QUI. *Petalostigma pubescens.* Quinine.

ALP. *Alphitonia obtusifolia.* A relative of sarsparilla with the characteristic pale undersides to leaves

WAT. *Acacia spp.* Includes several species of wattles with phyllodes. - *A. flavescens, A. crassicarpa* (solid trees), *A. leptocarpa* and *A. bidwillii*, (a tree or shrub with spines and pinnate leaves).

EUF. *Euroschinus falcata* var. falcata(?). Anacardiaceae. A medium sized tree.

CKA. *Planchonia carya.* Cocky apple.

LOP1. *Lophostemon grandiflorus* subsp. riparius. A creek bank tristania with a grey, tightly grained bark.

LOP2. *Lophostemon suaveolens.* Swamp mahoganey, formerly Tristania.

NAO. *Nauclea orientalis.* Leichhardt tree.

CYP. *Callitris intratropica.* Cypress pine.

PAN. *Pandanus spp.* The common creek pandanus.

BUR. *Bursaria incana.* a small leaved tree. Leaves have grey undersides.

APPENDIX IIb - Native vegetation of Walkamin Research Station

map unit	box	bwd 1	bwd 2	mba	wgm	pgm	ibk	bgm	mel 1	mel 2	mel 3	grg	grp	grn	hak	per	cwd	iwd	qui	alp	wat	euf	cka	lop 1	lop 2	nao	cyp	pan	bur
1	*	*				*		*		*															*				
2	*	*				*				*			*			*									*				
3	*	*				*	*						*												*				
5	*	*				*	*			*		*	*								*				*				
6	*	*				*	*															*			*				
7	*				*	*	*		*	*		*			*										*				
8	*	*										*	*								*		*						
10	*					*			*				*		*														
11	*	*			*	*	*		*	*		*	*		*				*	*	*				*				
12	*				*	*			*		*				*														
13	*	*			*	*			*	*	*	*			*				*								*	*	
14	*	*			*	*					*				*														
15	*	*										*	*		*														
16	*		*			*	*		*						*														
17	*	*	*		*	*						*			*														
18	*		*		*		*					*					*												
19	*		*		*	*	*								*														
20	*		*		*		*					*			*														
21	*	*					*		*		*	*	*	*		*			*	*	*			*					*
22	*	*	*	*		*						*	*	*				*	*	*	*		*	*					*
24	*					*	*		*			*							*	*	*								
25	*					*	*					*	*		*							*		*		*		*	

APPENDIX IIb - Native vegetation of Walkamin Research Station

map unit	box	bwd 1	bwd 2	mba	wgm	pgm	ibk	bgm	mel 1	mel 2	mel 3	grg	grp	grm	hak	per	cwd	iwd	qui	alp	wat	euf	cka	lop 1	lop 2	nao	cyp	pan	bur
26	*	*	*			*		*							*								*						
27																													
28	*				*	*					*				*										*				*
30	*	*				*									*										*				
31	*	*	*			*									*														
33	*		*				*								*														
34	*	*				*				*																			

APPENDIX IIIa
Notes for use with Soil Profile Class descriptions

1. The most commonly observed range of profile attributes are described, together with less frequent variations outside this range.

2. Australian Soil Classification System is derived from Isbell (1993), 3rd approximation. Only Suborder, and Order are indicated.

3. Great Soil Group is derived from Stace *et al.* (1968)
   Note : NSG indicates "No Suitable Group" affinities with the closest fitting soil type.

4. Principle Profile Form (PPF) is taken from Northcote, 1979 and are listed in order of frequency of occurrence. The following profile texture trends have been used.

   Uniform (Uf)- fine textured profiles (clay) in which there is little, if any change in texture with increasing depth.
   Uniform cracking (Ug) - clay soils which crack deeply upon drying.
   Gradational (Gn)- profiles in which the texture gradually becomes finer (more clayey) with increasing depth, such that there is a difference in texture between the upper and lower horizons
   Duplex (Dy)- profiles with a marked texture increase between the upper and lower horizons

5. Landform terminology is derived from McDonald *et al.* (1990)

6. Colour codes are those of the revised standard soil colour charts (Oyama and Takehara, 1967). Colour names are those of McDonald (personal communication) based on the value/chroma rating system of Northcote (1979) and utilising the following table.

Value/Chroma 2a = 4/1 - 4/2 to 6/1 - 6/2

Value/Chroma 2b = 5/3 - 5/4 to 6/3 - 6/4

Value/Chroma Rating	1	2a	2b	4	5
Hue					
10R	dark	red/grey	red-brown	red	red
2.5YR	dark	grey-brown	red-brown	red	red
5YR	dark	grey-brown	brown	red-brown	red-brown
7.5YR	dark	grey-brown	brown	yellow-brown	brown
10YR	dark	grey	yellow-brown	yellow	brown
2.5Y	dark	grey	yellow-brown	yellow	olive-brown
5Y	dark	grey	yellow-brown	yellow	olive

7. Texture, structure and consistence as per McDonald et al (1990).

8. Field pH: as per Raupach and Tucker (1959) except that values were derived from indicator applied to crushed soil fragments rather than from a paste of soil and indication fluid. It was measured at depths of 0.05, 0.30, 0.60, 0.90, 1.2.and 1.5m.

9. Clear or abrupt boundaries are indicated by solid lines (-) while gradual or diffuse boundaries are indicated by a broken line (---).
Horizon boundary : sharp, abrupt or clear (<5-50 mm) gradual or diffuse (>50 mm).

10. Depth of solum (taken from Isbell, 1993)

Very shallow	<0.25 m
Shallow	0.25 - 0.5 m
Moderately deep	0.5 -<1.0 m
Deep	1.0 -1.5 m
Very deep	1.5 - 5.0m

11. Soil horizonation (soil layers)
A1 - horizon at or near the soil surface with some accumulation of organic matter

A2 - horizon having, either alone or in combination, less organic matter, sesquioxides or silicate clay than the adjacent horizons. It is usually differentiated by its paler colour.

A3 - transitional horizon between A and B, that is dominated by properties of the A.

B1- transitional horizon between A and B that is dominated by properties characteristic of the underlying B horizon

B2 - horizon showing one or more of the following: maximum colour development, concentration of silicate clay, sesquioxides, or organic matter; structure and/or consistence unlike the A horizons immediately above or below.

B3 - transitional horizon between B and C that is dominated by the properties characteristic of the above B horizon

C - usually consolidated or unconsolidated, partially weathered parent material or sedimentary laminae

D - material below the A, B or C horizons that cannot be given a reliable horizon designation

APPENDIX IIIb - Soil Profile Class Descriptions

Soil Profile Class: Station (St)

Concept: Moderately deep, grey-brown, pedal duplex soils on granite and rhyolite

Australian Classification: Grey Chromosol

Great Soil Group: NSG affinities with soloth

Principle Profile Form: Dy 5.42, Dy 3.42, Dy 5.62, Dy 2.23

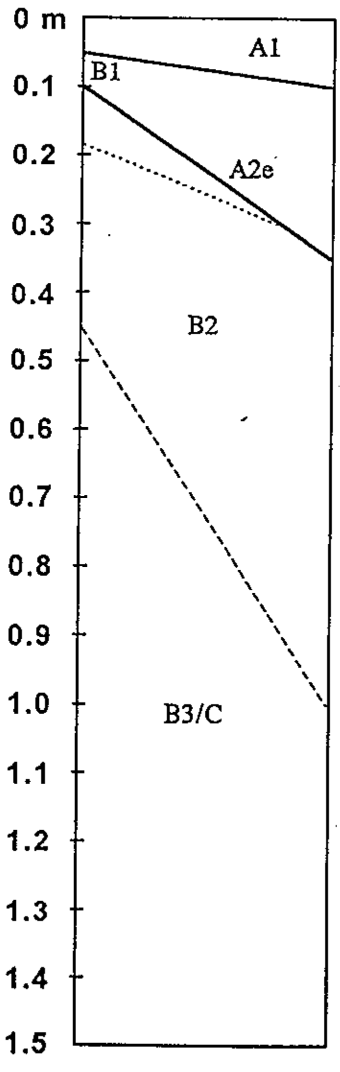
Landform: Lower slopes of gently undulating rises

Geology: Mareeba Granites and Walsh Bluff volcanics (rhyolite)

Vegetation: Eucalyptus, Melaleuca, Grevillea and Petalostigma species

Surface Condition: Hard setting

Soil description



A1: Grey (10YR4/1-2), Dark (10YR2-3/2), Brown (10YR2-3/3). 0-<2% , <5mm faint orange mottles; sandy loam to clay loam sandy; 0-<2%, <2mm quartz pebbles, massive to weak 2-5mm granular . pH 6.0-7.0. Clear change to:

A2: Yellow-brown (10YR5-6/3-4) (conspicuously bleached when dry); 0 -2%, <5mm faint orange mottles; sandy loam to clay loam sandy;<2%, <2mm quartz pebbles; massive to weak 2-5mm granular 0-20%, 2-6mm, ferromanganese nodules; pH 6.0-7.0. Clear change to:

B1: (where present)Yellow-grey (2.5YR6/3); brown (10YR4/3); yellow -brown (10YR5/4); 0-20% 5-15mm orange and red mottles; clay loam sandy to sandy light medium clay; 0-2% 2-6mm quartz pebbles; moderate 2-5mm subangular blocky; 0-10% 2-6mm ferromanganese nodules pH6.0-6.5. Sharp change to:

B2: Yellow brown (10YR5/4, 10YR6/4, 10YR6/3, 7.5YR5/5); Grey (2.5Y6/2, 10YR5/2) yellow (10YR5/5) or brown (10YR4/3); sandy medium to coarse sandy medium heavy clay; 0-20% 2-20mm quartz or rhyolitic pebbles; weak to moderate 2-20mm angular blocky, 0-10% 2-6mm ferromanganese nodules; pH6.0-6.5. Gradual change to:

B3/C: Decomposing granite or rhyolite

Soil Profile Class: Carbeen (Cr)

Concept: Moderately deep, yellow-brown, pedal, duplex soils on granite and rhyolite

Australian Classification: Yellow Chromosol

Great Soil Group: NSG affinities with yellow podzolic soil

Principle Profile Form: Dy 5.21, Dy 5.61

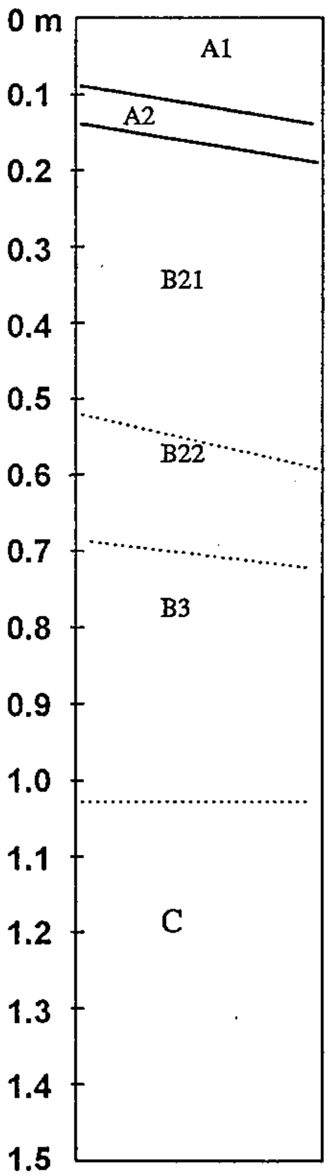
Landform: Hillslopes of gently undulating and undulating rises

Geology: Mareeba Granite and Walsh Bluff volcanics (rhyolite)

Vegetation: Eucalyptus and Hakea species

Surface Condition: Firm to hardsetting

Soil Description:



A1: Dark (10YR2/2) or brown (10YR2/3); sandy clay loam; 0-10%; 2 -20mm quartz pebbles; weak <2-5mm granular; <2% ferromanganese nodules. pH 6.5-6.8. Clear change to:

A2: Brown (10YR3-4/3-4); <2-10% <5mm faint to distinct orange mottles; sandy clay loam <2% 2-6mm quartz pebbles; massive to weak <2mm granular; 0-2% <2mm manganese nodules. pH 6.0-6.5. Sharp change to:

B21: Brown (10YR4/4), or Yellow brown (10YR5/4); 10-20% 5-15mm distinct red and orange mottles sandy light to coarse sandy light medium clay; 0-<2% 2-6mm quartz pebbles; weak to moderate 2-5mm subangular blocky. pH 6.0-6.5. Clear change to:

B22: Yellow-brown (10YR6/4); 10-20% 5-30mm prominent red or orange mottles; coarse sandy medium clay; moderate 2-10mm angular blocky. pH 6.0-6.5. Gradual change to:

B3: Grey (10YR6/2); 10-20%, 5-15mm distinct yellow mottles; sandy medium heavy clay; 2-10% <2mm quartz pebbles; 5 to moderate >30mm prismatic. pH 6.0.

C: Decomposing granite

Soil Profile Class: Lotus (Lt)

Concept: Moderately deep yellow-brown, apedal, uniform textured sandy soil on granite.

Australian Classification: Arenic Rudosol

Great Soil Group: NSG affinities with earthy sand

Principle Profile Form: Uc 2.21, Uc 4.34

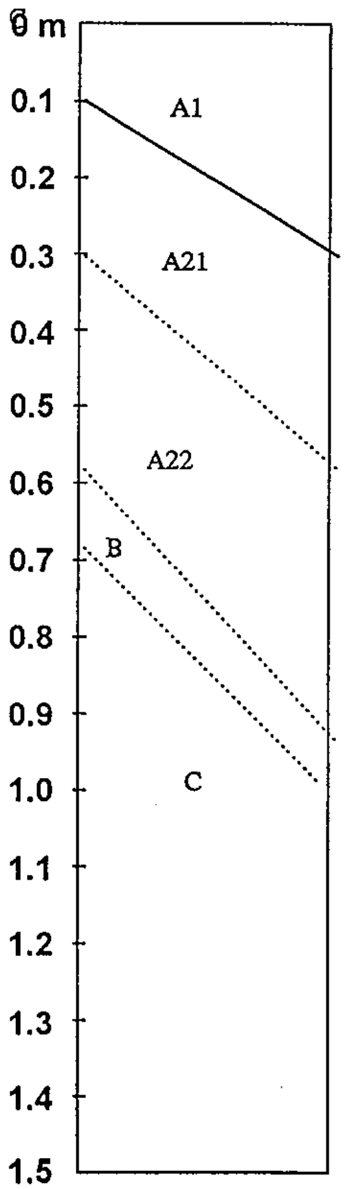
Landform: Hillslopes and footslopes of gently undulating rises

Geology: Mareeba granite

Vegetation: Eucalyptus species

Surface Condition: Loose to hardsetting

Soil Description



A1: Grey (10YR4/2) or brown (10YR43) loamy coarse sand to coarse sandy loam; 0-10%, 2-6mm quartz pebbles; massive to single grain. pH 6.5-7.0. Clear change to:

A21: Yellow brown (10YR53) (conspicuously bleached or pale when dry) loamy coarse sand; 0-10% 2-6mm quartz pebbles; massive to single grain. pH 6.5-7.0. Clear change to:

A22: Yellow brown (10YR 63) (conspicuously bleached or pale when dry) loamy coarse sand,0-10% 2-6mm quartz pebbles; massive to single grain; 0-10% 2-6mm manganese nodules. pH 6.5-7.0. Clear change to:

B: Yellow brown (10YR5/4 10YR6/3); coarse sandy loam,0-10% 2-6mm quartz pebbles, single grain to massive; 0-<2% 2-6mm manganese nodules. pH 6.5-7.0. Gradual change to:

C: Decomposing granite

Soil Profile Class: Glenray (Gr)

Concept: Deep yellow, apedal, gradational sandy clay soils on metamorphic/ granitic rocks

Australian Classification: Yellow kandosol

Great Soil Group: Yellow earth

Principle Profile Form: Gn 2.22, Gn 2.25, Um 4.23

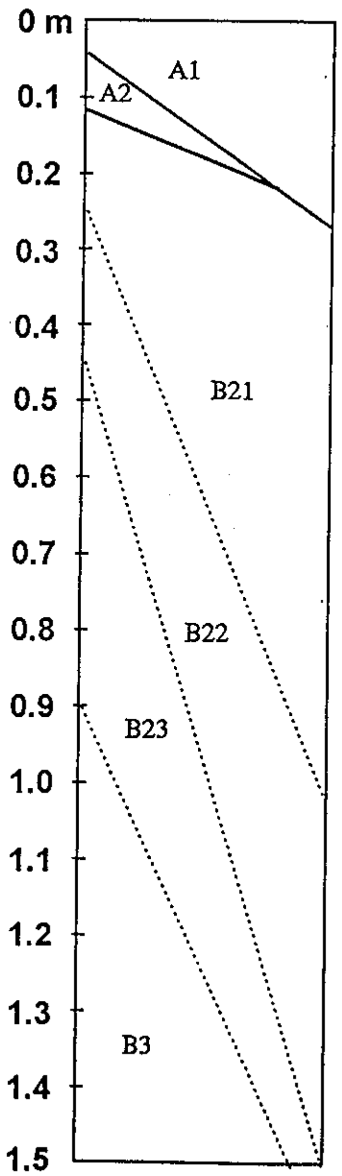
Landform: Slopes of gently undulating relict fans

Geology: Mareeba granites or Barron River metamorphics

Vegetation: Eucalyptus, Melaleuca, Grevillea,Petalostigma, Alphitonia and Acacia species

Surface Condition: Firm to hardsetting

Soil Description



A1: Dark (10YR2-3/2) or brown (7.5YR3-4/3-4, 10YR2-3/3) sand clay loam to light clay; massive; <2% -10% 2-6mm ferromanganese nodules; pH5.8-7.0. Clear change to:

A2: Brown (10YR3-4/3-4) or yellow brown (10YR5/3-4) pale(dry), sandy clay loam to clay loam sandy; massive; <2%, 2-6mm ferromanganese nodules: pH 5.8-7.0. Gradual change to:

B21: Yellow (10YR5/6) or brown (10YR4/6, 7.5YR4/6); 0-10% distinct orange mottles; clay loam sandy to light medium clay; weak <2-5mm subangular blocky; 0-10% 2-6mm quartz pebbles; <2%-50% 2-20mm ferromanganese nodules; pH 5.8-7.5. Gradual change to:

B22: Yellow (10YR5/6-8), or yellow brown (10YR5-6/3-4) 10-20%, 5-30mm faint to prominent orange mottles; clay loam sandy to light medium clay; weak <2-5mm subangular blocky; <2%-10%, 2-60mm quartz pebbles; 0-50% <2-20mm ferromanganese nodules; pH 5.8-8.0. Gradual change to:

B23: (where present)Yellow-brown (10YR5-6/3-4); or yellow (10YR5/6); 2-50% 5-15mm distinct orange mottles; clay loam to sandy light medium clay, 0-10%, 2-20mm quartz pebbles; weak 2-5mm subangular blocky; 2-50% ferromanganese nodules. pH 6.5-8.5. gradual change to:

B3: Grey (10YR5-7/1-2, 2.5Y6/1-2); 0-50%, 5-30mm distinct red mottles; coarse sandy clay ; 0-20%, 2-6mm quartz pebbles; weak 2-10mm angular blocky; 2-10% 2-6mm ferromanganese nodules. pH 6.5-85.

Soil Profile Class: Mapee (Mp)

Concept: Very deep, red, pedal, uniform clay soils formed on basalt

Australian Classification: Red Ferrosol

Great Soil Group: Euchrozem

Principle Profile Form: Uf 6.31

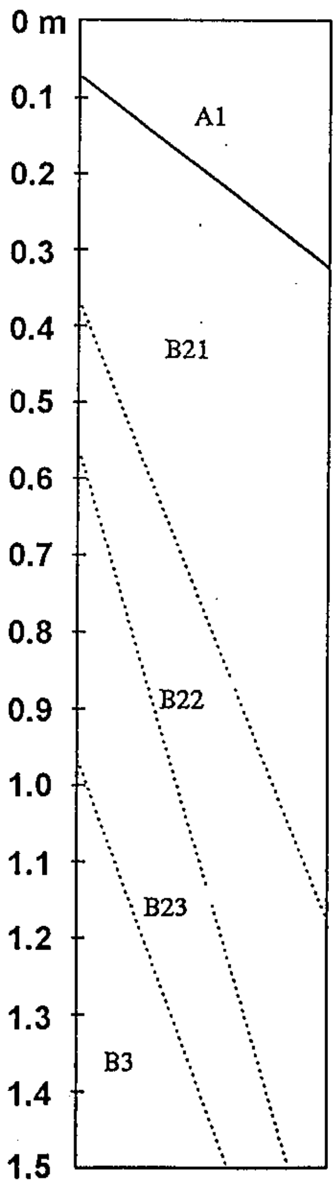
Landform: Slopes of gently undulating to level lava plains

Geology: Atherton basalt

Vegetation: Eucalyptus species

Surface Condition: Firm

Soil Description



A1: Dark (10R2-3/2) or red (10R3/3-4); light to light medium clay; moderate <2-5mm granular; 2-20% 2-6mm manganese nodules and soft segregations. pH 6.5-7.0. Clear change to:

B21: Red (10R3-5/6, 2YR3-4/4-6); light clay to light medium clay; moderate 2-5mm polyhedral, 2-10% medium manganese nodules. pH 6.5-7.0. Gradual change to:

B22: Red (10R3/5-6, 2.5YR3-4/5-6); light to light medium clay, moderate 2-5mm polyhedral; 2-10% medium manganese nodules. ph 7.0-7.5. Gradual change to:

B23: Red (10R3/4-6, 2.5YR3-4/5-6) light to light medium clay; <2% 6-10mm weathered basalt pebbles; moderate 2-10mm polyhedral; <2-20% 2-20mm manganese nodules or soft segregations. pH 7.0-7.5. Gradual change to:

B3: (where present)Red (10R4/6) or grey brown (10YR61, 7.5YR4/1-4, 5YR5/2-5); 10-20% 5-15mm distinct orange, grey or brown mottles; light medium clay; 2-10% medium polyhedral; 2-10% 5-10mm manganese nodules. pH 7.5-8.0

Soil Profile Class: Mapee Rocky phase (MpRp)

Concept: As for Mapee with 20-50% basaltic surface coarse fragments

Australian Classification: Red Ferrosol

Great Soil Group: Euchrozem

Principle Profile Form: Uf 6.31

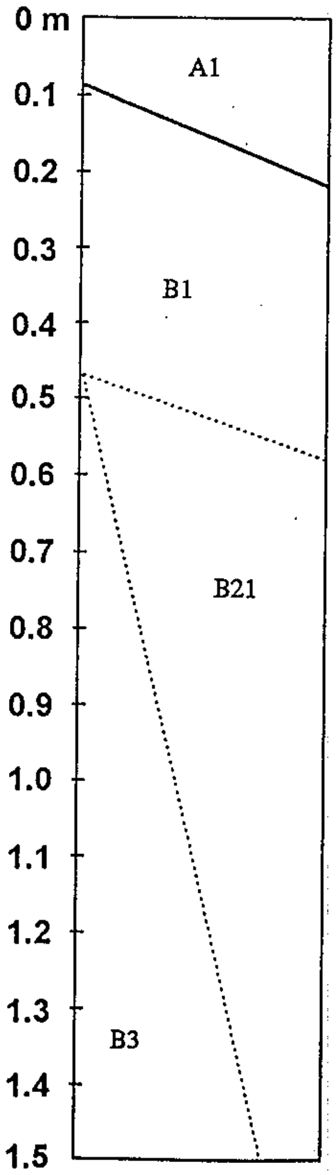
Landform: Slopes of gently undulating to level lava plains

Geology: Atherton basalt

Vegetation: Eucalyptus and Grevillea species

Surface Condition: Firm

Soil Description:



A1: Dark (10R2-3/2, 2.5YR2/2), red (2.5YR3/3-4, 10R2/3) or red brown (5YR2-3/3-4); light to light medium clay; moderate 2-5mm granular; 0-10% 6-60mm basaltic pebbles; <2-10%, <2-6mm manganese nodules pH 6.5-7.0. Clear change to:

B1: (where present) Red (10R 3/6); 2.5YR3/4); light to light medium clay; weak 2-5mm polyhedral; 0-20% 20-60mm 2-60mm basaltic pebbles; <2% 2-6mm manganese nodules; pH 6.8-7.0. Gradual change to:

B21: Red (10R3/6; 2.5YR 3/4-6); light to medium clay; moderate to strong 2-5mm polyhedral; <2%-20% 2-60mm manganese s nodules. pH 7.0-7.5. Gradual change to:

B3: Red (10R3/4-5, 2.5YR4/6); 2-20%, 5-15mm orange or red mottles; light clay; moderate 2-5mm polyhedral; 10-20%, 6-20mm 20-60mm large basaltic pebbles; 2-10% 2-6mm manganese nodules. pH.7.5-8.0

Soil Profile Class: Walkamin (Wk)

Concept: Very deep yellow-brown, pedal, uniform clay soils on basalt

Australian Classification: Brown dermosol

Great Soil Group: Xanthozem

Principle Profile Form: Uf 6.4, Uf 6.31, Uf 6.33, Uf 6.41

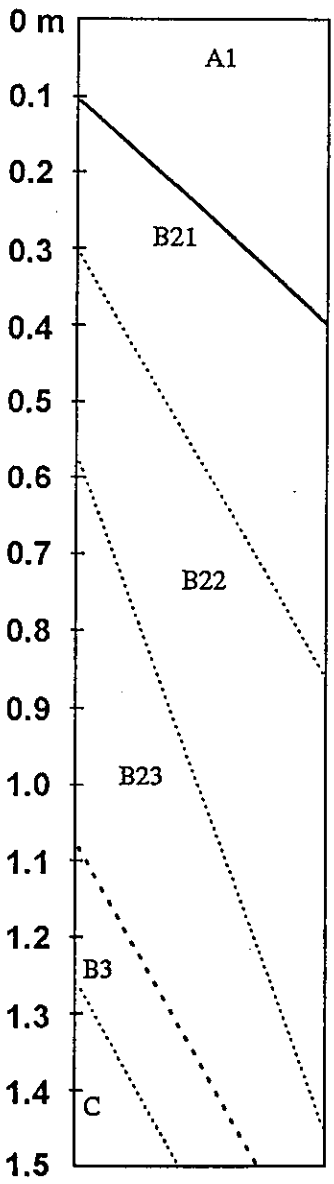
Landform: Footslopes of level lava plains

Geology: Atherton Basalt

Vegetation: Eucalyptus, Melaleuca and Lophostemen species

Surface Condition: Firm

Soil Description:



A1: Dark (10YR2-3/2-3, 7.5YR2-3/2-3); or brown (10YR2-4/3); light to light medium clay; weak to strong 2-5mm granular; 2-10%, 5-15mm ferromanganese nodules or soft segregations. pH 6.0-7.0. Clear change to

B21: Brown (10YR4/4-6, 7.5YR3-4/4-6); yellow (10YR5/5-6) yellow brown (10YR5/4-5); 0-50% 5-15mm distinct orange and red mottles; moderate 2-10mm polyhedral; 2-10% 2-6mm ferromanganese nodules. pH 6.5-7.0. Gradual change to

B22: Brown (10YR4/4-6, 7.5YR4-5/4-6); yellow brown (10YR5-6/3-4, 7.5YR5/5-6); yellow (10YR5-6/5-6); light to light medium clay; 0-50% 5-15mm distinct orange and red mottles; moderate 2-10mm polyhedral ;2-50% 2-15mm ferromanganese nodules. pH 6.5-7.5. Gradual change to:

B23: Brown (10YR4-5/3-5); yellow brown (10YR4-6/3, 7.5YR5/6) grey (10YR4-6/2); 0-50% 2-30mm prominent red and orange mottles medium heavy clay; moderate 2-10mm polyhedral 2-50% 2-20mm ferromanganese nodules. pH 7.0-8.0. Gradual Change to:

B3: (where present)Grey (10YR5-6/1-2, 2.5Y6/2); grey brown (7.5YR5/1-2); 2-50% 5-30mm prominent red and orange mottles; light to medium heavy clay; 2-90% 6-60mm decomposing basalt pebbles; moderate 2-20mm subangular blocky and lenticular; 2-20%, 2-6mm ferromanganese nodules. pH 7.0-8.5

C: 50-100% decomposing basalt.

Soil Profile Class: Walkamin Shallow phase (WkSp)

Concept: Moderately deep yellow-brown, pedal, uniform clay soil on basalt overlying D horizons of heavy clay

Australian Classification: Brown Dermosol

Great Soil Group: Xanthozem

Principle Profile Form: Uf 6.4, Uf 6.31, Uf 6.33, Uf 6.41

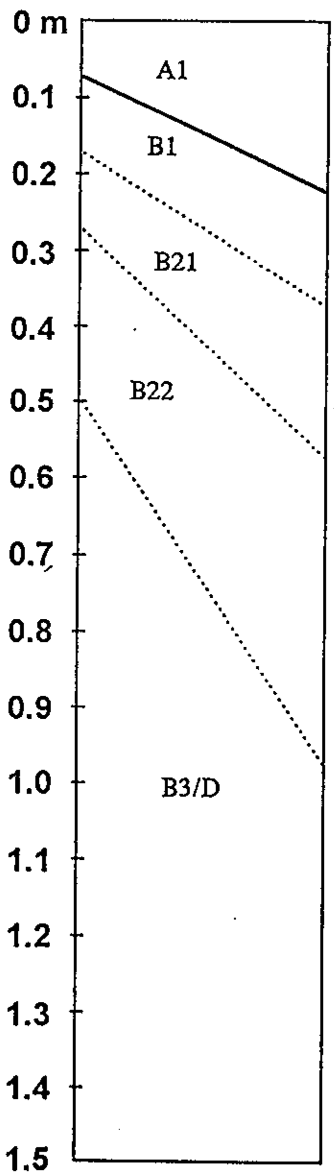
Landform: Footslopes of the level lava plains

Geology: Atherton basalt

Vegetation: Eucalyptus and Hakea species

Surface Condition: Firm

Soil Description:



A1: Dark (10YR2-3/1-2,7. 5 R2-3/1.5YR2-3/2); 0-20% <5mm faint orange mottles; weak to strong 2-5mm granular; 2-20%, 2-6mm ferromanganese nodules. pH 6.0-7.0. Clear change to:

B1: Brown (10YR3-4/4-6, 7.5YR3/4); 0-10% <5mm faint orange or red mottles; light to light medium clay; weak to moderate 2-5mm granular; 2-20% 2-6mm ferromanganese nodules. pH 6.5-7.0. Claear change to:

B21: Brown (10YR3-4/4-6, 7.5YR4-5/3-6) or yellow brown (10YR5/4; 5YR5/6); 0 to 20% 5-30mm distinct orange and red mottles; light to medium clay; <2-20%, 2-60mm basalt pebbles; moderate 2-10mm polyhedral; 2-50%; 2-6mm ferromanganese nodules. pH 6.5-7.5

B22: Brown (10YR4/3-6, 7.5YR4/4-6); yellow brown (10YR5-6/3-4); 2-50% 5-15mm prominent orange and red mottles; 0-20% 2-20mm basalt pebbles; moderate 2-5mm polyhedral; 2-50%, 2-6mm ferromanganese nodules. pH 6.5-7.5. Clear change to:

B3/D: Grey (10YR4-6/1-2), yellow brown (10YR5/3-4); 2-50%, 2-30mm prominent orange, red and yellow mottles; light to medium heavy clay; 2-50% 6-60mm weathered basalt pebbles; moderate to strong 5-20mm lenticular parting to moderate to strong 2 to 5mm polyhedral.pH 8.0

Soil Profile Class: Snider (Sd)

Concept: Shallow black or brown, pedal, uniform clay soils containing basalt rock

Australian Classification: Brown Dermosol

Great Soil Group: NSG affinities with prairie soil

Principle Profile Form: Uf 6.31

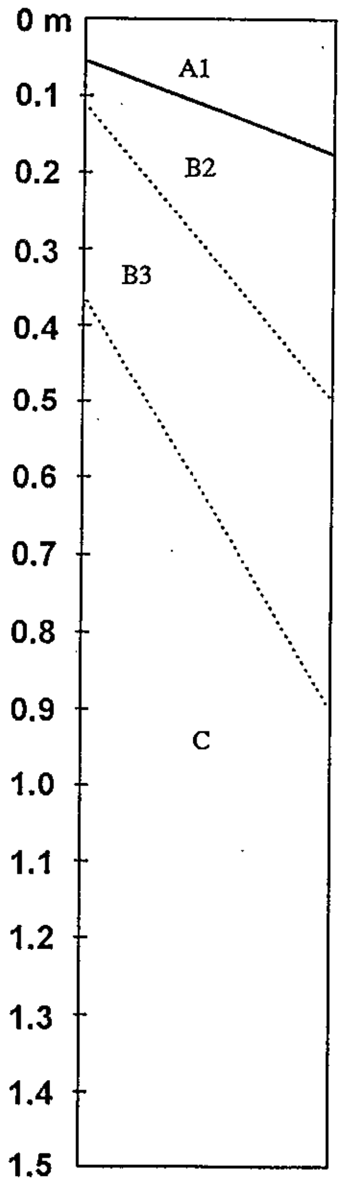
Landform: Footslopes of the level lava plains

Geology: Atherton basalt

Vegetation: Eucalyptus and Hakea species

Surface Condition: Firm

Soil Description



A1: Dark (10YR2-3/2-3, 7.5YR2/2) or brown (10YR2-3/3); light to light medium clay; 0-20% 6-20mm basalt pebbles; moderate 2-5mm granular; <2-10% ferromanganese nodules. pH 6.0-7.0. Clear change to:

B2: Brown (10YR3-4/3-4, 7.5YR4/3-4); 0-20%, <5-15mm faint orange, and red mottles; light to medium heavy clay, 0-50% 6-60mm basalt pebbles; moderate 2-5mm polyhedral; 0-20%, 2-6mm or ferromanganese nodules. pH 6.5-7.5

B3: Brown (7.5YR4-5/4, 10YR3-4/4) or yellow brown (10YR5/3-4); 0-20%, <5-15mm distinct orange, red and yellow mottles; light to medium heavy clay; 0-50% 6-60mm basalt pebbles; moderate 5-30mm angular blocky or lenticular breaking to angular blocky; 0-10% 2-6mm manganese nodules. pH 7.5

C: 90-100% basalt and altered basalt.

Soil Profile Class: Morgan (Mg)

Concept: Deep brown, pedal, uniform cracking clay soils on basalt

Australian Classification: Brown Dermosol

Great Soil Group: NSG affinities with brown clay

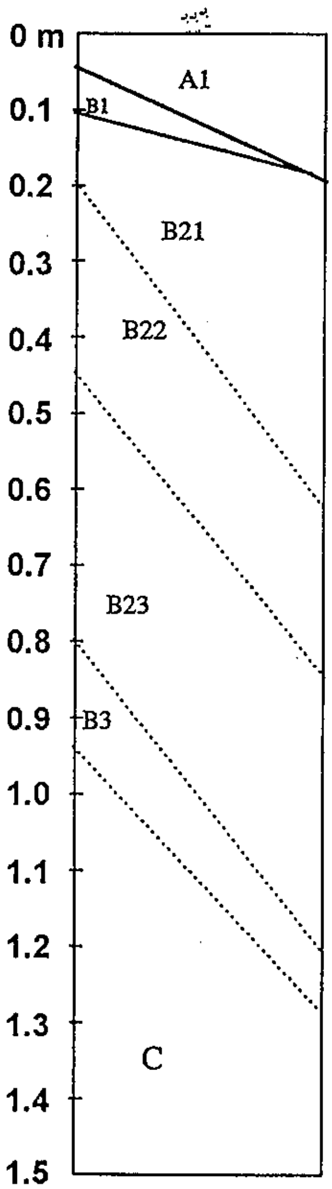
Principle Profile Form: Uf 6.31, Uf 6.33, Ug 5.32, Ug 5.3

Landform: Fans of the gently undulating to undulating lava plains

Geology: Atherton basalt

Vegetation: Eucalyptus and Hakea species

Surface Condition: Firm to self mulching



Soil Description:

A1: Brown (10YR2-4/3, 7.5YR3/3) or dark (10YR2/1-2); 0-2%, <5mm faint orange mottles; light to medium heavy clay; weak to moderate 2-5mm granular. pH 6.0-6.5. Clear change to:

B1: (where present) Brown (10YR3-4/3); 0-20%, <5mm faint orange mottles; sandy medium to medium clay; weak to moderate 2-10mm polyhedral. pH 6.5-7.5. Gradual change to:

B21: Brown (10YR2-4/3-4, 7.5YR3-4/3-4); 0-10% <5-15mm faint to prominent orange, red or yellow mottles; light medium to medium heavy clay 0-50%; basalt stone; moderate 2-5mm polyhedral or 5 to 20mm lenticular; 0-10% manganese nodules or soft segregations. pH 6.8-7.5. Gradual change to:

B22: Brown (10YR4/3-4, 7.5YR4/4) or grey (10YR4/1-2); 0-20%, <5-15mm prominent orange mottles; medium to medium heavy clay; 0-50%; 15-30mm basalt stone; moderate 2-20mm polyhedral, or lenticular; 2-20% 2-20mm manganese or calcium carbonate nodules. pH 7.0-8.0. Gradual change to:

B23: (where present)Grey (10YR4-5/1-2) yellow brown (10YR5/3), 0 to 20%, 5-15mm prominent orange mottles; medium heavy to heavy clay; 0-10% 6-20mm basalt stone; moderate 10-20mm angular blocky or lenticular; 0-10%, 2-6mm manganese nodules. pH 7.5-8.5. Gradual change to:

B3: Yellow brown (10YR5/2) or grey (10YR34); 0-50% 15-30mm prominent mottles; light clay to coarse sandy medium heavy clay; 0-50%, 20-60mm basalt stone; moderate 2-5mm angular blocky. pH 8.0-8.5.

C: Decomposing basalt

Soil Profile Class: Maud (Md)

Concept: Deep grey, pedal, uniform cracking clay soils on basalt

Australian Classification: Grey Vertosol

Great Soil Group: Grey clay

Principle Profile Form: Ug 5.22

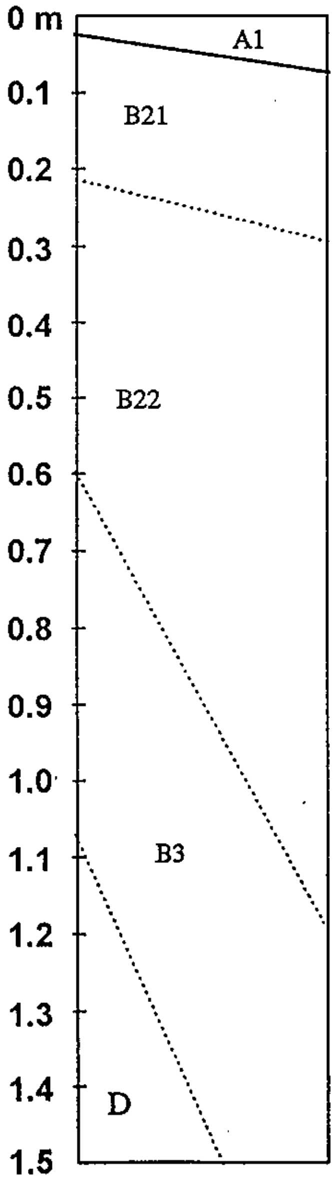
Landform: Level to gently undulating alluvial plains

Geology: Quaternary alluvium

Vegetation: Eucalyptus and Hakea species

Surface Condition: Firm to self mulching

Soil Description



A1: Dark grey (10YR2-4/1); 0-10% 5-15mm distinct gleyed mottles; light medium to medium clay; weak to strong 2-5mm granular; 0-<2% ferromanganese nodules. pH 6.0-7.0. Clear change to:

B21: Grey (10YR4/1, 2.5Y4/1); <2-10% faint to distinct orange and gleyed mottles; medium heavy clay; moderate 2-10mm angular blocky; 0-2% ferromanganese nodules;pH 7.0-7.5. Gradual change to :.

B22: Grey (10YR4-5/1); medium heavy clay; moderate 10-20mm lenticular; 2-10% 2-6mm ferromanganese and calcium carbonate nodules. pH 7.5-8.5. Gradual change to:

B3: Grey (10YR4/2, 2.5Y4/1); 10-20% <5mm to 30mm prominent to distinct orange and pale mottles; medium to medium heavy clay; 2-20% 6-60mm basalt pebbles; moderate 10-20mm lenticular. pH 8.0-8.5

D: Stratified layers.

APPENDIX IVa

Chemical Analysis Results

Lab. No.	Description	pH (1:5 water)	E.C. (dS/M)	O.C. (%)	Bicarb P	Acid P	Exchangeable cations (m.e. 100g)				DTPA (mg/kg)				CEC m.e/100g
							Na	K	Ca	Mg	Cu	Zn	Mn	Fe	
	Walkamin Sp														
	uncleared														
12871	bulk 0-10cm	5.4	0.04	2.44	10	16					1.4	2.0	116	81	
12872	profile 0-10	5.2	0.04				0.16	0.46	5.92	3.02					9.56
12873	20-30	5.7	0.02				0.13	0.08	3.07	3.04					6.32
12874	50-60	5.8	0.01				0.11	0.10	3.75	3.12					7.08
12875	80-90	6.2	0.02				0.25	0.05	3.25	3.30					6.85
12876	110-120	7.4	0.09				8.60	0.07	8.50	4.20					21.37
12877	140-150	7.8	0.14				2.04	0.20	13.04	14.40					29.68
	Glenray														
12878	bulk 0-10cm	6.2	0.06	2.59	9	40					0.5	1.4	57	79	
12879	profile 0-10	6.1	0.03				0.07	0.27	3.17	2.18					5.69
12880	20-30	6.4	0.01				0.01	0.10	1.07	2.07					3.25
12881	50-60	6.6	0.01				0.17	0.03	0.55	2.47					3.22
12882	80-90	6.5	0.02				0.74	0.04	0.05	2.44					3.25
12883	110-120	6.7	0.02				0.92	0.03	0.08	2.56					3.59
12884	140-150	6.7	0.02												

APPENDIX IVa continued

Lab. No.	Description	pH (1:5 water)	E.C. (dS/M)	O.C. (%)	Bicarb P	Acid P	Exchangeable cations (m.e. 100g)				DTPA (mg/kg)				CEC m.e/100g
							Na	K	Ca	Mg	Cu	Zn	Mn	Fe	
	Walkamin														
	uncleared														
12885	bulk 0-10	6.1	0.06	3.48	29	38					1.2	3.8	89	59	
12886	profile 0-10	6.2	0.07				0.06	0.70	9.52	3.30					13.58
12887	20-30	6.4	0.02				0.04	0.13	1.88	1.95					4.0
12888	50-60	5.9	0.03				0.02	0.03	0.26	1.82					2.13
12889	80-90	5.9	0.03				0.10	0.02	0.27	2.82					3.21
12890	110-120	6.1	0.03				0.14	0.02	0.26	2.90					3.32
12891	140-150	6.3	0.03												
	Mapee														
	uncleared														
12892	bulk 0-10cm	6.2	0.06	3.39	105	207					1.8	2.7	168	36	
12893	profile 0-10	6.2	0.04				0.01	0.76	7.76	2.74					11.27
12894	20-30	6.4	0.03				0.01	0.65	4.65	2.31					7.62
12895	50-60	6.6	0.02				0.01	0.57	3.79	2.60					6.97
12896	80-90	6.7	0.02				0.01	0.58	4.05	2.92					7.56
12897	110-120	6.7	0.01				0.02	0.62	4.40	3.10					8.14
12898	140-150	6.7	0.01												

APPENDIX IVa continued

Lab. No.	Description	pH (1:5 water)	E.C. (dS/M)	O.C. (%)	Bicarb P	Acid P	Exchangeable cations (m.e. 100g)				DTPA (mg/kg)				CEC m.e/100g
							Na	K	Ca	Mg	Cu	Zn	Mn	Fe	
	Mapee Rp														
	uncleared														
12899	bulk 0-10cm	6.3	0.06	3.32	51	70					1.9	3.8	181	53	
12900	profile 0-10	6.4	0.05				0.01	0.68	5.94	2.92					9.55
12901	20-30	6.6	0.05				0.08	0.51	3.15	2.53					9.27
12902	50-60	6.7	0.02				0.03	0.38	2.31	2.70					5.42
12903	80-90	6.7	0.02				0.03	0.47	2.70	3.02					6.22
12904	110-120	6.7	0.03				0.18	0.29	2.13	3.22					5.82
12905	140-150	6.8	0.02												
	Maud														
12906	bulk 0-10cm	6.2	0.04	2.13	92	183					2.3	2.6	70	103	
12907	profile 0-10	6.0	0.05				0.04	0.73	7.72	3.92					12.41
12908	20-30	6.6	0.06				0.11	0.29	9.14	4.10					13.64
12909	50-60	8.4	0.14				0.52	0.33	15.74	4.22					20.81
12910	80-90	8.7	0.15				1.56	0.23	13.42	4.20					19.41
12911	110-120	8.7	0.10				3.60	0.25	10.12	4.06					18.03
12912	140-150	8.6	0.09												

APPENDIX IVa continued

Lab. No	Description	pH (1:5 water)	E.C. (dS/M)	O.C. (%)	Bicarb P	Acid P	Exchangeable cations (m.e. 100g)				DTPA (mg/kg)				CEC m.e/100g
							Na	K	Ca	Mg	Cu	Zn	Mn	Fe	
	Station														
12913	bulk 0-10cm	6.3	0.04	1.30	8	19					0.1	0.3	18	35	
12914	profile 0-10	6.1	0.05				0.10	0.15	2.54	1.18					3.97
12915	20-30	6.5	0.02				0.08	0.16	1.72	1.24					3.2
12916	50-60	6.9	0.02				0.48	0.20	4.80	3.80					9.28
12917	60-70	6.9	0.02				0.24	0.16	2.32	1.76					4.48
	Walkamin														
	cleared														
12918	bulk 0-10cm	6.2	0.06	3.43	10	19					2.0	1.6	102	110	
12919	profile 0-10	6.1	0.07				0.11	0.19	4.95	2.94					8.19
12920	20-30	5.9	0.04				0.02	0.04	1.08	1.58					2.72
12921	50-60	6.0	0.03				0.01	0.02	0.12	2.50					2.65
12922	80-90	6.2	0.02				0.05	0.02	0.17	2.62					2.86
12923	110-120	6.4	0.02				0.11	0.02	0.10	2.90					3.13
12924	140-150	6.6	0.02				0.24	0.16	0.12	2.08					2.60
	Morgan														
12925	bulk 0-10cm	6.2	0.04	1.85	4	20					1.9	1.2	47	56	
12926	profile 0-10	6.3	0.02				0.21	0.30	9.32	3.72					13.55
12927	20-30	6.6	0.02				0.96	0.28	15.16	12.16					28.56
12928	40-50	6.9	0.03				1.80	0.20	15.72	12.80					30.52

APPENDIX IVa continued

Lab. No	Description	pH (1:5 water)	E.C. (dS/M)	O.C. (%)	Bicarb P	Acid P	Exchangeable cations (m.e. 100g)				DTPA (mg/kg)				CEC m.e/100g
							Na	K	Ca	Mg	Cu	Zn	Mn	Fe	
	Snider														
12929	bulk 0-10cm	6.2	0.04	1.77	10	25					1.0	1.5	69	97	
12930	profile 0-10	6.3	0.04				0.03	0.46	6.72	3.32					10.53
12931	20-30	6.5	0.01				0.94	0.22	9.70	4.06					14.92
12932	45-55	6.9	0.04				1.40	0.16	13.68	12.08					
	Mapee														
	cleared														
12933	bulk 0-10cm	6.2	0.05	1.39	8	18					1.3	0.9	95	14	
12934	profile 0-10	6.1	0.02				0.01	0.49	6.10	2.82					9.42
12935	20-30	6.4	0.02				0.01	0.13	3.38	2.41					5.93
12936	50-60	6.4	0.04				0.01	0.08	3.16	2.66					5.91
12937	80-90	6.3	0.03				0.05	0.05	2.76	2.70					5.56
12938	110-120	6.5	0.02				0.11	0.06	2.97	3.10					6.24
12939	140-150	6.7	0.02												
	Lotus														
12940	bulk 0-10cm	6.6	0.04	0.70	4	18					0.1	0.7	30	5	
12941	profile 0-10	6.5	0.05				0.01	0.17	1.78	0.40					2.36
12942	20-30	6.8	0.02				0.01	0.09	1.09	0.24					1.43
12943	50-60	6.9	0.01				0.01	0.05	1.17	0.23					1.46
12944	80-90	6.9	0.01				0.01	0.05	1.36	0.19					1.61
12945	110-120	6.9	0.01				0.01	0.06	1.64	0.46					2.17

APPENDIX IVb

Lab.#	Depth cm	clay %	silt %	fine sand %	coarse sand %	sand %
Walkamin shallow phase uncleared						
12872	0-10	53	19	9	20	28
12873	20-30	63	11	9	18	26
12874	50-60	64	11	6	18	25
12875	80-90	61	11	8	20	28
12876	110-120	72	14	5	9	14
Glenray						
12879	0-10	29	5	20	46	66
12880	20-30	42	3	18	37	55
12881	50-60	54	3	12	31	43
12882	80-90	56	3	12	30	42
12883	110-120	48	4	11	37	48
Walkamin cleared						
12886	0-10	34	21	17	28	45
12887	20-30	54	15	15	16	31
12888	50-60	64	10	9	16	26
12889	80-90	65	10	8	18	25
12890	110-120	65	12	6	18	23
Mapee uncleared						
12893	0-10	51	15	15	20	35
12894	20-30	76	8	5	11	17
12895	50-60	80	8	4	8	12
12896	80-90	71	14	9	7	15
12897	110-120	68	19	8	5	13
Mapee Rocky phase uncleared						
12900	0-10	53	17	15	15	30
12901	20-30	75	11	7	7	13
12902	50-60	76	15	5	3	9
12903	80-90	63	26	7	3	10
12904	110-120	57	27	12	4	16
Maud						
12907	0-10	34	24	15	27	42
12908	20-30	37	14	10	39	49
12909	50-60	63	18	7	12	19
12910	80-90	54	12	10	24	34
12911	110-120	46	10	12	31	43
Station						
12914	0-10	14	9	32	45	77
12915	20-30	13	10	31	46	77
12916	50-60	39	9	13	39	52
12917	60-70	19	7	12	62	74

APPENDIX IVb continued

		% clay	% silt	% fine sand	% coarse sand	% sand
Walkamin cleared						
12919	0-10	45	15	14	27	41
12920	20-30	58	8	10	23	33
12921	50-60	65	5	7	22	30
12922	80-90	63	6	8	23	31
12923	110-120	64	7	6	23	29
Morgan						
12926	0-10	43	15	15	27	42
12927	20-30	47	16	16	21	37
12928	40-50	26	18	22	34	56
Snider						
12930	0-10	27	15	19	39	58
12931	20-30	42	15	16	28	44
12932	45-55	38	14	18	30	48
Mapee cleared						
12934	0-10	68	11	9	12	20
12935	20-30	76	8	6	10	16
12936	50-60	77	11	5	7	12
12937	80-90	68	19	7	6	13
12938	110-120	60	23	10	7	17
Lotus						
12941	0-10	9	6	21	64	85
12942	20-30	9	6	26	60	85
12943	50-60	11	6	30	53	83
12944	80-90	14	7	31	48	79
12945	110-120	16	5	24	55	79

APPENDIX V

Detailed Morphological Descriptions of Sample Sites

Soil Profile Class:	Station
Australian Classification:	Grey Chromosol
Great Soil Group:	No suitable grouping affinities with Soloth
Principle Profile Form:	Dy3.42
Landform:	Gently sloping rise
Geology:	Mareeba Granites and Walsh Bluff Volcanics
Surface Condition:	Hard setting
Slope:	8.0%

Profile Morphology:

Horizon	**Depth**	**Description**
A1	0-11cm	Dark (10YR3\1), fine sandy loam; <2%20-60mm subangular rhyolite; weak 2-5mm granular; pH6.8.
A21	11-29cm	Conspicuously bleached (10YR7\1) (dry) sandy loam; 10-20% 20-60mm subangular rhyolite; massive; pH 6.8.
A22	29-42cm	Conspicuously bleached (10YR8\2) sandy clay loam; <2% 6-20mm subangular rhyolite; massive pH 6.8.
B21	42-72cm	Grey (10YR5\2); 20-50% prominent orange mottles; sandy medium clay; ,2% 20-60mm rhyolite; moderate 2-5mm angular blocky; pH 6.8.
C	72-80cm	50-90% decomposing rhyolite and granite.

Soil Profile Class:	Lotus
Australian Classification:	Arenic Rudosol
Great Soil Group:	No suitable grouping affinities with earthy sand
Principle Profile Form:	Uc2.21
Landform:	Footslope of a rise
Geology:	Mareeba granite
Surface Condition:	Loose
Slope:	1.0%

Profile Morphology:`

Horizon	**Depth**	**Description**
A1	0-25cm	Grey (10YR4\2) loamy coarse sand; massive; pH 7.0.
A21	25-50cm	Conspicuously bleached (10YR7\3) (dry); loamy coarse sand; 2-10% 2-6mm subangular quartz; massive to single grain; pH 6.8.
A22	50-92cm	Conspicuously bleached (10YR7\3) (dry); loamy coarse sand; 10-20% 2-6mm subangular quartz; massive to single grain; pH6.3.
B21	92-100cm	Yellow-brown (10YR6\4); clayey coarse sand; 2-10% 6-20mm granite; pH6.5
B22	1.00-1.35cm	Clayey coarse sand; 2-10% 2-6mm quartz; massive; pH 6.5.

Soil Profile Class: Glenray
Australian Classification: Yellow Kandosol
Great Soil Group: Yellow earth
Principle Profile Form: Gn2.22
Landform: Gently undulating rise
Geology: Mareeba Granites or Hodgkinson Formation
Surface Condition: Firm to hardsetting
Slope: 1.5%

Profile Morphology:`

Horizon	Depth	Description
A1	0-09cm	Dark (10YR3\2) clay loam sandy; weak 2-5mm granular; ,2% <2mm manganese nodules; pH 6.5.
A3	09-17cm	Brown (10YR3\3) sandy light clay; 2-10% 2-6mm subangular quartz; massive; <2% ferromanganese nodules; pH 6.8.
B1	17-35cm	Brown (10YR4\6) sandy light clay; 2-10% 2-6mm subangular quartz; massive; 2-10% 2-6mm ferromanganese nodules; pH 7.0.
B21	35-91cm	Yellow (10YR5\6) clay loam sandy; <2% <2mm subangular quartz; weak 2-5mm angular blocky; 10-20% 6-20mm ferromanganese nodules pH 6.8.
B22	91-136cm	Yellow (10YR5\7) clay loam sandy;10-20% 2-6mm subangular quartz; weak 2-5mm angular blocky; 2-10% 2-6mm ferromanganese nodules; pH 7.0
B3	136-150cm	Grey (10YR5\1) 10-20% 5-15mm distinct red mottles; coarse sandy light medium clay; 20-50% 2-6mm subangular quartz; moderate 2-5mm angular blocky; 2-10% 2-6mm ferromanganese nodules; pH 7.0.

Soil Profile Class: Mapee (uncleared)
Australian Classification: Red Ferrosol
Great Soil Group: Euchrozem
Principle Profile Form: Uf6.31
Landform: Gently undulating rise
Geology: Atherton Basalt
Surface rock: <2% 20-60mm basalt
Surface Condition: Firm
Slope: 0.8%

Profile Morphology:`

Horizon	Depth	Description
A1	0-12cm	Dark (2.5YR3\2) light clay; moderate 2-5mm granular; 2-10% <2mm manganese soft segregations; pH6.8.
B1	12-27cm	Red (2.5YR3\4) light medium clay; weak 2-5mm polyhedral; 2-10% 2-6mm manganese nodules; pH 7.0.
B21	27-62cm	Red (2.5YR3\6) light medium clay; <2% 6-20 mm subrounded basalt; strong 2-5mm polyhedral; 2-10% 2-6mm manganese nodules; pH 7.0
B22	62-117cm	Red (2.5YR3\6) light medium clay; <2% 6-20 mm subrounded basalt; strong 2-5mm polyhedral 2-10% 2-6mm manganese nodules and soft segregations; pH 7.0.
B23	117-142cm	Red (2.5YR5\6) light medium clay; 10-20% 2-6 mm subrounded weathered basalt; <2% 2-6mm manganese nodules; pH 7.0.
BC	142-158cm	Red (2.5YR5\6) light medium clay; 20-50%; subrounded weathered basalt; moderate 2-5mm polyhedral; 2-10% 2-6mm manganese nodules and soft segregations; pH 7.3.

Soil Profile Class:	Mapee (cleared)
Australian Classification:	Red Ferrosol
Great Soil Group:	Euchrozem
Principle Profile Form:	Uf6.31
Landform:	Gently undulating rise
Geology:	Atherton Basalt
Surface rock:	<2% 20-60mm basalt
Surface Condition:	Firm
Slope:	0.5%

Profile Morphology:`

Horizon	**Depth**	**Description**
Ap1	0-12cm	Dark (2.5YR3\2) light clay; moderate 2-5mm granular; 2-10% <2mm manganese soft segregations; pH6.8.
Ap2	12-28cm	Red (2.5YR3\3) light clay; moderate 2-5mm granular; 2-10% <2mm manganese soft segregations; pH6.8.
B21	28-64cm	Red (2.5YR3\5) light clay; moderate 2-5mm polyhedral; ,<2% 2-6mm manganese nodules; pH 7.0.
B22	64-95cm	Red (2.5YR3\6) light clay; strong 2-5mm polyhedral; 2-10% 2-6mm manganese soft; segregations pH 7.0
B23	95-162cm	Red (2.5YR3\6) light clay; moderate 2-5mm polyhedral <2% 2-6mm manganese nodules and soft segregations; pH 7.2.
B3	162-170cm	Red (2.5YR5\6) light clay; 10-20%; weathered basalt; moderate 2-5mmpolyhedral; 10-20% 2-6mm manganese soft segregations; pH 7.3.

Soil Profile Class: Mapee Rocky phase (uncleared)
Australian Classification: Red Ferrosol
Great Soil Group: Euchrozem
Principle Profile Form: Uf6.31
Landform: Gently undulating rise
Geology: Atherton Basalt
Surface rock: 20-50% 20-60mm basalt
Surface Condition: Firm
Slope: 1.0%

Profile Morphology:`

Horizon	Depth	Description
A1	0-10cm	Dark (10YR3\2) light clay; moderate 2-5mm granular; 2-10% 2-5mm subrounded basalt; 2-10% <2mm manganese soft segregations; pH6.0.
B1	10-30cm	Red (2.5YR3\4) light clay; <2% 6-20mm subrounded basalt; weak 2-5mm polyhedral; 2-10% 2-6mm manganese nodules; pH 6.5.
B21	30-100cm	Red (2.5YR3\5) light clay; 2-10% 6-20 mm subrounded basalt; moderate 2-5mm polyhedral; 2-10% 2-6mm manganese nodules; pH 7.0
B22	100-130cm	Red (2.5YR3\6) light clay; 2-10% 6-20mm subrounded basalt; strong 2-5mm polyhedral 2-10% 2-6mm manganese nodules and soft segregations; pH 7.0.
B3	130-150cm	Red (2.5YR4\4) 2-105 2-5mm distinct yellow mottles light medium clay; 10-20%; subrounded weathered basalt; strong 2-5mm polyhedral; 2-10% 2-6mm manganese nodules and soft segregations; pH 7.0.

Soil Profile Class:	Walkamin (cleared)
Australian Classification:	Brown Dermosol
Great Soil Group:	Xanthozem
Principle Profile Form:	Uf6.31
Landform:	Footslope of a lava plain
Geology:	Atherton Basalt
Surface Condition:	Firm
Slope:	0.5%

Profile Morphology:`

Horizon	**Depth**	**Description**
Ap	0-12cm	Brown (10YR3\3) light clay; moderate 2-5mm granular; 2-10% 2-6mm manganese nodules; pH 6.5
B21	12-33cm	Brown (10YR4\5) <2% 2-5mm distinct orange mottles; light clay; moderate 2-5mm polyhedral; 2-10% 2-6mm ferromanganese nodules; pH 6.3.
B22	33-109cm	Brown (10YR4\5) 2-10% 2-5mm distinct orange mottles; light clay; moderate 2-5mm polyhedral; 10-20% 2-6mm ferromanganese nodules; pH 6.8
B23	109-141cm	Brown (10YR4\5) 2-10% 2-5mm distinct orange mottles; light clay; moderate 2-5mm polyhedral 10-20% ferromanganese nodules; pH 7.0.
B3	141-169cm	Grey (2.5Y5\2) 10-20% distinct orange mottles; light medium clay; weak 5-10mm prismatic; 10-20% 2-6mm ferromanganese nodules; pH 7.0

Soil Profile Class: Walkamin Shallow phase (cleared)
Australian Classification: Brown Dermosol
Great Soil Group: Xanthozem
Principle Profile Form: Uf6.4
Landform: Footslope of a lava plain
Geology: Atherton Basalt
Surface Condition: Firm
Slope: 0.5%

Profile Morphology:`

Horizon	**Depth**	**Description**
A11	0-08cm	Brown (7.5YR3\3) light clay; moderate 2-5mm granular; 2-10% 2-6mm ferromanganese nodules ph 6.8.
A12	08-20cm	Brown (7.5YR3\4) <2% <5mm faint orange mottles light clay; moderate 2-5mm granular; 10-20% 2-6mm ferromanganese nodules; pH 6.0
B21	20-70cm	Brown (10YR4\6) 2-10% <5mm distinct orange mottles; light clay; moderate 2-5mm polyhedral; 10-20% 2-6mm ferromanganese nodules; pH 6.0
B22	70-140cm	Yellow (10YR5\6) 2-10% <5mm distinct orange mottles; light clay; moderate 2-5mm polyhedral; 10-20% 2-6mm ferromanganese nodules; pH 6.0

Soil Profile Class: Walkamin Shallow phase(uncleared)
Australian Classification: Brown Dermosol
Great Soil Group: Xanthozem
Principle Profile Form: Uf6.4
Landform: Footslope of a lava plain
Geology: Atherton Basalt
Surface Condition: Firm
Slope: 0.5%

Profile Morphology:`

Horizon	Depth	Description
A11	0-09cm	Dark (10YR3\2) <2% 5-15mm distinct yellow mottles; light clay; strong 2-5mm granular; 10-20% 2-6mm ferromanganese nodules; pH 6.8
A12	09-15cm	Brown (10YR3\3) <2% 5-15mm distinct yellow mottles; light clay; moderate 2-5mm granular; 10-20% 2-6mm ferromanganese nodules; pH 7.0
B21	15-37cm	Brown (10YR4\4) 2-10% 5-15mm distinct yellow mottles; light clay; moderate 2-5mm polyhedral; 10-20% 2-6mm ferromanganese nodules; pH 7.0.
B22	37-79cm	Brown (10YR4\5) 10-20% 5-15mm distinct orange mottles; light clay; <2% 6-20mm subangular weathered basalt; strong 2-5mm polyhedral; 20-50% 2-6mm ferromanganese nodules; pH 7.3.
B23	79-94cm	Grey (10YR5\2) 10-20% 15-30mm prominent red mottles; light clay strong 2-5mm polyhedral; 20-50% 2-6mm ferromanganese nodules; pH7.3.
B31/D1 2B	94-112cm	Grey (5Y5\1) 20-50% 15-30mm prominent red mottles; heavy clay; 2-10% 200-600mm sub rounded basalt; moderate 10-20mm prismatic breaking to moderate 2-5mm lenticular; ,2% <2mm ferromanganese nodules; pH 9.0.
B32/D2	112-150cm	Grey (2.5Y4/1) heavy clay; moderate 10-20mm lenticular; pH 9.0.

Soil Profile Class: Maud
Australian Classification: Grey Vertosol
Great Soil Group: Grey clay
Principle Profile Form: Ug 5.22
Landform: Plain of an alluvial plain
Geology: Quaternary alluvium
Surface Condition: Firm to self mulching
Slope: 0.2%

Profile Morphology:`

Horizon	Depth	Description
A11	0-04cm	Dark (10YR4\1) light mediium clay ; strong 2-5 mm granular; <2% <2mm manganese nodules pH 6.8.
A12	04-10cm	Dark (10YR3\1) medium clay; moderate 5-10 mm granular; <2% <2mm manganese nodules; pH 7.0.
A13	10-25cm	Dark (10YR3\1) medium clay; moderate 2-5mm granular; <2% <2mm manganese nodules; pH 7.0
B1	25-29cm	Grey (10YR4\1) medium clay; <2% 5-10mm subrounded basalt; mmoderate 2-5mm angular blocky; 20-50% ,2mm ferromanganese nodules; pH 7.0.
B21	29-40cm	Grey (2.5Y4\1) <2% 5-15mm distinct orange mottles; medium heavy clay; moderate 5-10mm lenticular; 2-10% <2mm manganese nodules; pH 7.0
B22	40-70cm	Grey (2.5Y5\1) medium heavy clay; strong 10-20 mm lenticular; 2-10% 2-5mm calcium carbonate nodules; pH 8.5.
B23	70-97cm	Grey (2.5Y4\1) 2-10% 5-15mm distinct orange mottles; medium heavy clay; strong 10-20mm lenticular; 10-20% calcium carbonate nodules; pH 8.5.
D1	97-138cm	Grey (2.5Y5\1) 10-20% 5-15mm distinct orange mottles; medium heavy clay; <2% 2-6mm subangular quartz; moderate 2-5mm lenticular; <2% <2mm manganese nodules; pH 8.5.
D2	138-165cm	Grey (10YR5\1) 2-10% 5-15mm distinct orange mottles; medium clay; 2-10% 2-6mm quartz; weak 5-10mm lenticular; <2% 2-6mm manganese nodules; pH 8.5.

Soil Profile Class: Morgan
Australian Classification: Brown Dermosol
Great Soil Group: No suitable grouping affinities with Brown clay
Principle Profile Form: Uf 6.4
Landform: Gently undulating rise
Geology: Atherton Basalt
Surface Condition: Firm to self mulching
Slope: 2.5%

Profile Morphology:

Horizon	Depth	Description
A1	0-10cm	Dark (10YR2\2) medium heavy clay; 10-20% 6-20mm subrounded basalt; strong 2-5mm granular; pH 5.8.
B21	10-40cm	Brown (10YR4\3) 10-20% <5mm distinct red mottles; medium heavy clay; 10-20% 20-60mm subrounded basalt; moderate 10-20mm lenticular; pH 6.0.
B3	40-58cm	Grey (10YR4/1) 10-20% <5mm distinct orange mottles; medium clay; 50-90% 20-60mm subrounded basalt; moderate 5-10mm angular blocky; 10-20% 6-20mm manganese nodules; pH 8.5.
C	58-80cm	>90% weathering basalt.

Soil Profile Class:	Snider
Australian Classification:	Brown Dermosol
Great Soil Group:	No suitable group affinities with Prairie soil
Principle Profile Form:	Uf6.31
Landform:	Undulating rise
Geology:	Atherton Basalt
Surface Condition:	Firm
Slope:	4.0%

Profile Morphology:

Horizon	**Depth**	**Description**
A1	0-08cm	Dark (10YR2\2) sandy light medium clay; <2% 2-6mm angular basalt; moderate 2-5mm granular 2-10% 2-5mm ferromanganese nodules; pH 6.8.
B2	08-30cm	Brown (10YR3\3) medium clay; 10-20% 6-20 mm subrounded basalt; weak 2-5mm polyhedral 2-10% 2-6mm manganese nodules; pH 6.0.
B3	30-50cm	Brown (10YR4\3) 2-10% 5-15mm distinct red and yellow mottles; medium heavy clay; 20-50% 20-60mm subrounded basalt; moderate 10-20mm angular blocky; 10-20% 2-6mm manganese nodules; pH6.5.
C	50-60cm	Grey (10YR5\1) 10-20% <5mm distinct orange mottles; heavy clay; 50-90% 20-60mm subangular basalt; moderate 10-20mm lenticular; 10-20% 2-6mm manganese nodules; pH 7.0.