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Land Resources Bulletin

Soils and Agricultural Suitability of the South Burnett Agricultural Lands, Queensland

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formerly Department of Primary Industries

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Queensland Government
Natural Resources and Mines

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Summary

The South Burnett Agricultral Soil Survey examines the red soil plateau area and adjacent areas that extend from the Barker–Barambah Creek Irrigation area in the north to the footslopes of the Bunya Mountains in the south.

The South Burnett is an important food producing area close to Brisbane markets and export terminals. Much of the area is intensively cropped for summer and winter grains with minor areas of vineyard and fruit orchards. The area is the centre of both the peanut and navybean industries with maize, wheat and barley following close in importance. Recent expansion has also occurred in the viticulture industry.

The study area of 126 607 hectares was mapped at a scale of 1:100 000. The area is covered mostly by both the Kingaroy and Murgon 1:100 000 sheets.

Forty-nine Soil Profile Classes were delineated from soil properties, landscape and geology, and their physical and chemical characteristics. A total of 985 Unique Mapping Areas (UMAs) were separated in terms of soil and topography to produce a UMA database. This database forms the basis of soil and crop suitability maps. The database includes UMA area, location, soil, geology, chemical and physical attributes, crop suitability and soil degradation.

Fifty three percent of the survey area is considered suitable for dryland cropping, 73% is suitable for dryland sown pastures, 48% is suitable for tree and vine crops. Approximately 80% of the study area has been cultivated at some stage. Very little of the original vegetation remains intact.

Salinity occurrs extensively in the study area. The UMA data will aid land management to avoid further degradation from salinity. Surface or sheet erosion has occurred on much of the study area since the time of European settlement. This has resulted in acidification and loss of organic matter in many areas. Major soil conservation programs since the mid 1950s have seen the implementation of conservation cropping practices reducing soil degradatiion.

The report and associated maps and databases will be an aid to all land managers to help improve or maintain rural productivity while avoiding degradation.

1. Introduction

Broadly defined by the resource survey of Vandersee and Kent (1983), the agricultural lands of the South Burnett are restricted to an area of deeply weathered basalt flows and adjacent areas situated around the town of Kingaroy (Figure 1). The survey covers part of the shires of Kingaroy, Nanango and Wondai.

The survey area abuts the irrigation suitability study of the Byee area carried out by Reid *et al.* (1979) to the north.

With approximately 126 600 hectares in area, the red soil plateau has historically been famous for cropping, dairying and timber products. The region is now an important summer grain producing area concentrating on peanuts, navy beans and maize. Numerous other intensive horticultural activities including stone fruit, vineyards, corkwood and flower production have been undertaken at various times. The intensity of farming practices in the district over the last 50 years has caused concern regarding land degradation.

The objectives of the survey are:

- To produce a soil map at 1:100 000 scale for use by all land managers including soil conservationists, land owners, planners, agronomists and soil scientists
- Develop a crop suitability map at 1:100 000 scale for a range of summer and winter crops in the South Burnett
- To define soils types which can be recognised by users for the development of property plans, management strategies and strategic plans
- Provide researchers and agronomists with a soil data base enabling research into sustaining or improving primary production with minimal degradation, and the development of management practices to rehabilitate degraded land.

The information on soils, their physical and chemical properties, and distribution will assist all land managers to develop sustainable management practices which will help kerb land degradation.

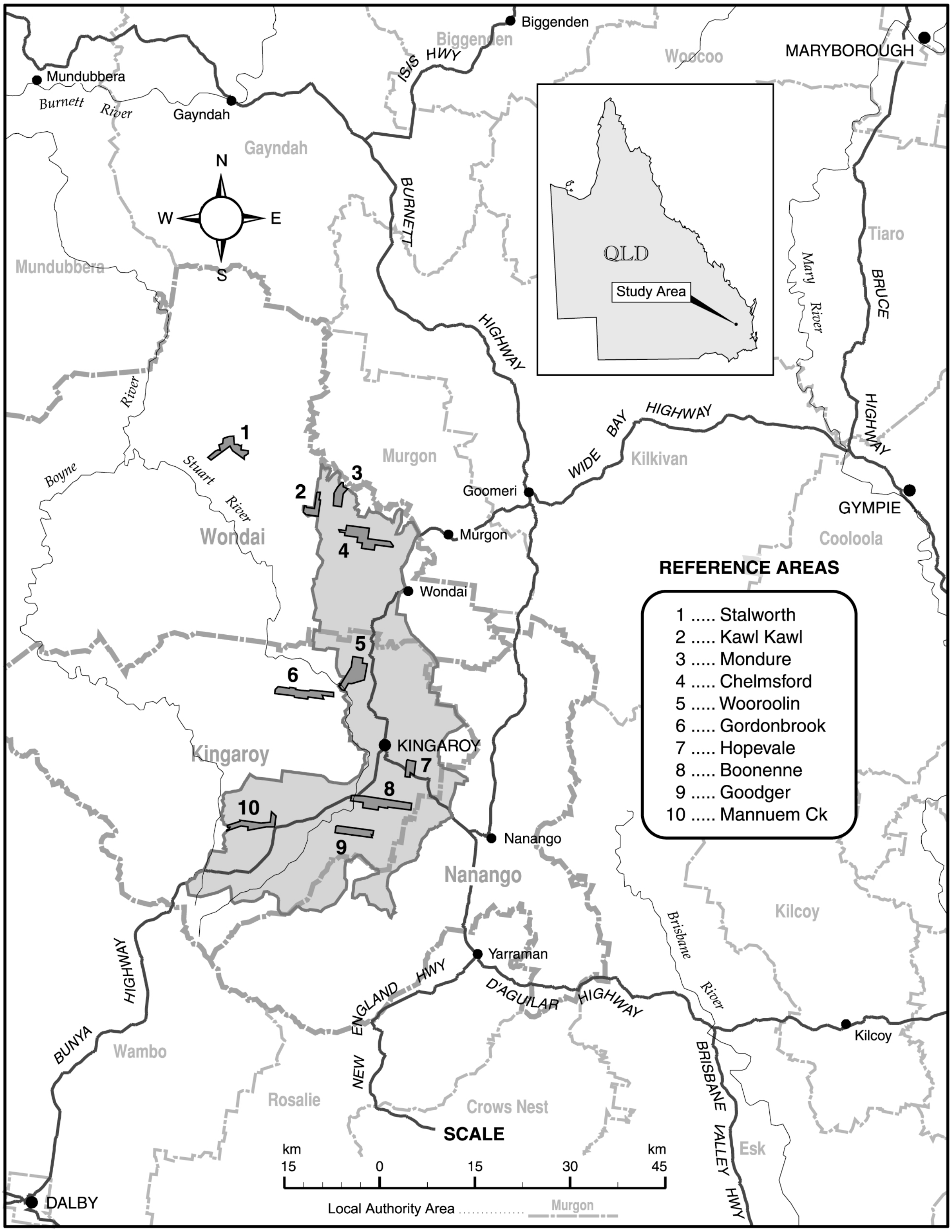

Figure 1. Locality map to show reference areas

2. The South Burnett Agricultural Area

2.1 Land Use History

European settlement commenced in the South Burnett area in 1846. Initially, the study area was part of a number of pastoral selections namely Tarong, Taabinga and Burrandowan in the south, and Barambah, Marshlands and Mondure in the north. Both sheep and cattle were run on these selections until the 1870s when the increasing incidence of grass seed (Black Spear) and predation by dingoes made sheep raising difficult, leading to beef and dairy cattle rearing becoming the predominant land use. Minor holdings still kept sheep for fat lamb production on selected pastures. It was often thought that the increased incidence of burning off of pastures may have contributed to the grass seed problem.

The occurrence of large quantities of useable timber, notably the Bunya pine (*Araucaria bidwillii*), hoop pine (*A. cunninghamii*), silky oak (*Grevillea robusta*), red cedar (*Toona australis*) and a host of other hardwoods, supported a large but short-lived timber industry. The resultant cleared lands gave rise to many mixed farming enterprises of which dairying was the major contributor.

Dairying was supported by a rail link to the coast at Maryborough where up to 8 tons of cream was transported in a single week. Numerous butter factories were built throughout the South Burnett which, together with the rail link facilitated the expansion of rural development in the area. The introduction of exotic pasture species, in particular Kikuyu in the early 1900s, increased livestock production in the red soil areas. However Kikuyu has become a problem in cropping and urban areas because of its prolific growth habits.

Another important introduction to the area from Africa in the 1920s was the groundnut (*Arachis hypogaea*) locally known as the peanut. The similarity of the red soils in the district to that of its origin allowed it to thrive. Given a weed free environment by the commonly used method of bare fallow or winter cereal rotation combined with inter-row weeding by chip hoe, tined implement and more recently herbicide application, then peanut production increased to some 23 500 tonnes from 20 340 hectares in 1979–80 (Vance 1981).

Enticed by good economic returns, many farmers reduced their dairy herds or got out of dairying completely to grow crops in the period 1950 to 1970. More country was opened up including the sandy forest soils on the outskirts of the red soil country.

This pattern of land use up to the present has resulted in a general perception by landholders that there has been a decline in soil structure and nutrient status, soil acidification; with increased salinity outbreaks and siltation of watercourses and impoundments.

The frequent occurrence of summer storms with intensities up to and including 75 millimetres per hour caused much run-off and erosion on the fallowed paddocks and led to the design and implementation of contour banks early in the district's cropping history. The very first contour bank built in Queensland was in the South Burnett in 1936. By 1989, approximately 90 percent of all cultivations in the South Burnett had been contoured.

In recent years the economic downturn has seen some diversification from the conventional crops of peanuts, maize, navy beans, sorghum and winter cereals to one of specialisation in horticultural crops and intensive specialty crops including native flowers, corkwood, hydroponically grown flowers, fruit, vegetables and vine crops such as grapes.

With the increasing environmental awareness shown by the community in the latter part of the 1980s, numerous Landcare groups have been formed which bring people together in the interests of improving environmental quality, inter-farmer co-operation and sustainable agricultural production on a catchment basis. Landcare groups have been an important target of government funding providing money for the purposes of rehabilitating degraded lands and research into the processes of degradation and possible remedies.

2.2 Climate

The study area is in the subtropical zone with hot summers and mild winters with intermittent to regular frosts (Bureau of Meterology 1990).

Rainfall is summer dominant with the majority of precipitation occurring during high intensity thunderstorm activity. Hail storms occasionally result in damage to crops particularly stone fruit orchards.

Climatic data for Kingaroy are presented in the accompanying tables. Median and mean rainfall figures are presented to show the comparison between rainfall averages, which are influenced by extreme events, and the median, which represent the **5th decile** or the midpoint of all registrations.

Table 1. Rainfall averages and medians, with minimum and maximum temperatures for Kingaroy

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Rainfall average	114.3	96.0	77.9	46.8	41.3	42.6	41.0	28.9	38.0	64.5	78.2	110.5	779.9
Rainfall median	96.7	84.2	59.0	32.6	30.0	30.1	29.2	23.1	32.7	57.7	67.2	98.1	763.7
Minimum Temp	17.4	17.5	15.8	12.1	8.6	5.4	4.0	4.8	7.9	11.7	14.4	16.5	
Maximum Temp	29.6	28.8	27.5	25.1	21.6	18.9	18.5	20.1	23.2	26.0	28.1	29.6	

Frosts occur frequently on low lying areas in the winter months, usually from May (average of 3) to September (average of 4). The greatest occurrences of frost occur in July with an average of 12 frosts in that month. The severity varies with landscape position, slope and temperature. Frost occurrences at the Kingaroy post office appear in Table 2.

Table 2. Frost days at Kingaroy

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Average	0	0	0	0	3	7	12	10	4	1	0	0
Highest	0	0	0	1	13	20	25	23	15	6	2	0
Lowest	0	0	0	0	0	0	0	0	0	0	0	0
Entries	35	35	35	35	35	35	35	35	35	35	34	35

Continual dry seasons with low rainfall totals have contributed to the district being drought declared on a few occasions. Table 3 lists drought declaration and revocation dates in three shires since 1965.

Table 3. Drought declarations and revocations since 1965

Shire	Declaration	Revocation	Duration*
Kingaroy	7 – 4 – 65 2 – 2 – 69 16 – 6 – 70 5 – 9 – 77 23 – 9 – 91	26 – 8 – 65 22 – 1 – 70 28 – 1 – 71 3 – 5 – 78 2 – 3 – 92	4 11 7 8 6
Nanango	2 – 2 – 69 16 – 6 – 70 17 – 8 – 77 23 – 9 – 91	22 – 1 – 70 28 – 1 – 71 3 – 5 – 78 2 – 3 – 92	11 7 9 6
Wondai	25 – 3 – 65 2 – 2 – 69 28 – 5 – 70 5 – 9 – 77	23 – 12 – 65 22 – 1 – 70 28 – 1 – 71 3 – 5 – 78	6 11 8 8

* months (approximately)

2.3 Geology and Landform

3.2.1 Geological units and landform

The study area is part of a high planation surface which is relatively undissected and forms a drainage subdivide between the Stuart River and Barambah Creek (Watkins 1967).

The age of this surface is late Miocone or approximately 22–26 million years and elevation is generally 440 to 540 metres above sea level but can reach 1000 metres in the Bunya Mountains a few kilometres south-west of the study area. The Bunya Mountains are the northern-most point of the Main Range volcanics where dating of a fresh basalt flow recorded a radiometric date of 22.1 million years (Webb *et al.* 1967) west of Nanango.

The Tertiary volcanics typified by this high erosional plane are considered by Macnish *et al*. (1987) to consist of a series of volcanic deposits under varying weathering regimes forming plateaux and terrace landscapes with moderate slopes and steep scarps. The occurrence of red soils in close association with basalt has long been considered to be due to weathering *in situ.* Analysis of the stratigraphy and minerology, indicates that although deposition of the red soils and basalt were of a similar age, the red compacted clayey material had already been weathered before it was covered by younger basalt flows. Fresh exposures of unweathered basalt may occur either above or below the red soil.

The elevation of the study area ranges between 260 metres above sea level on old alluvial terraces of Barambah Creek in the north, to approximately 600 meters above sea level on the north-easterly slopes of the Bunya Mountains near Halys Round Mountain. A majority of the red soils occur at an altitude of 440 to 540 meters above sea level which corresponds to the lower stratigraphic unit described by Macnish *et al.* (1987). However, landforms in the Kumbia-Kingaroy area also relate to that of the high stratigraphic level consisting of undulating plateau, moderate hillslopes and colluvial valley fills.

Minor areas of benches, saddles and spur ridges occur on the edge of the plateaux with only minor relief differences. Plateau remnants occur in the Kingaroy area at Mt Jones and Kingaroy Heights which may well be the upper stratigraphic unit referred to by Macnish *et al*. (1987).

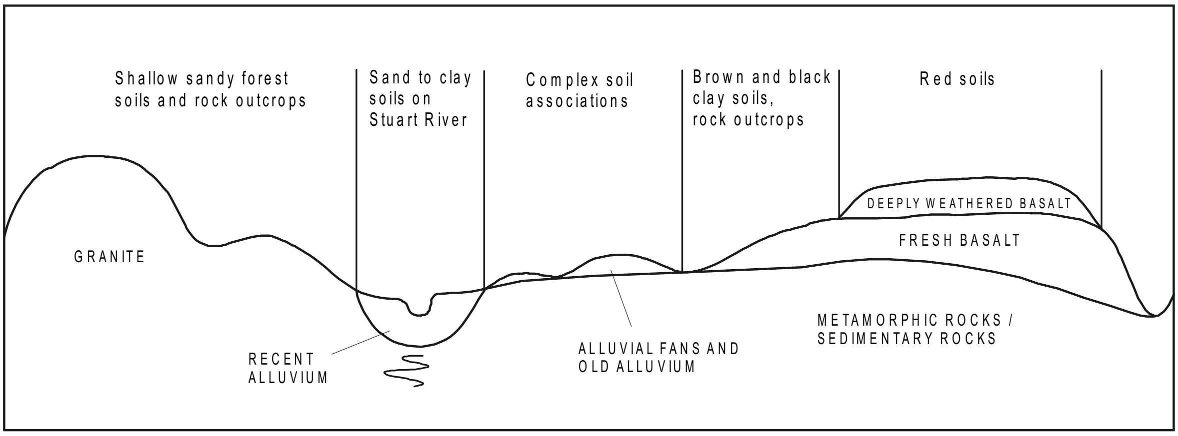

Figure 2. Schematic cross-section of the geological stratigraphy

Sheetwash and colluvium from higher elevations has been deposited in drainage depressions and on alluvial flats. Alluvial soils occur on minor valley flats along creeks and on the flood plains of major streams such as Barkers Creek, Flagstone Creek and the Stuart River. The major area of alluvial soils occurs north of the study area around Byee. These were mapped by Reid *et al.* (1979).

Granite of the Boondoomba Igneous Complex occurs on the western side of the study area. A large part of this complex is overlain by deeply weathered basalts and basalt of the Main Range Volcanics and minor areas of recent alluvia. The landforms in this geology unit range from undulating low hills to rolling hills with slopes ranging from moderate (6–7%) on crests and foothills to steep (15–35%) on mid and upper slopes.

A minor area of Devonian–Carboniferous beds which include gneiss, gneissic granodiorite or phyllite occur west of Memerambi giving rises and low hills.

On the eastern boundary of the study area, both the granites of the Boondoomba Igneous Complex and mudstones, slate, greywacke, chert and jasper of the Devonian–Carboniferous Maronghi Creek beds occur. The major portion of this country is under state forest or used for native pasture. Landforms are low hills and rises with gentle to moderate slopes.

Triassic Tarong beds of sandstone, conglomerate and coal seams appear as minor occurrences on the southern boundary of the study area. Landforms are predominately gently undulating rises to rolling rises of between 3% to 20% slope.

Sheetwash and the removal of soil downslope by illuviation into creeks and drainage depressions causes a mixing of materials originating from any number of substrate materials.

Tertiary sediments often occur at the break of slopes between the basaltic landscape and the alluvial plain. The tertiary sediments, which include sandstones, conglomerates, siltstones and mudstones occur as unconformable units often associated with volcanic flows. Small units occur in the study area north and west of Wondai and south of Kingaroy.

2.4 Vegetation

Vegetation in the study area has been described by White (1920), Ridley (1962), Reid *et al.* (1979) and Vandersee and Kent (1983). Very little of the original native vegetation remains in the study area. Most has been cleared on the red soils areas except a few isolated pockets of the original microphyll softwood scrub on scarps, road reserves and minor areas of a few hectares left on farming blocks. Many of the forest communities have been also cleared or thinned out. Clearing has caused saline outbreaks on the fringes of the red soil areas due to the changing hydrology and subsequent increases in watertable levels.

Generally, any area considered suitable for cropping was cleared by the 1930s. At the time of the peanut industry expansion in the 1970s, some granite and sandstone country was also cleared for cropping. However since the economic downturn in the industry and a series of low rainfall years these granite and sandstone areas have been returned to grazing with improved pastures or left fallow for native grass re-establishment. In some cases the areas left fallow have been subject to woody weed regrowth and undesirable grass species domination. The occurrence of regrowth such as wattle (*Acacia* spp.), dogwood (*Jacksonia scoparia*) and wild rosemary (*Cassinia leavis*) have caused problems by competing with pasture species for soil moisture, nutrients and sunlight. Regrowth of wattle, eucalypts and other shrubs have been in some instances so dense so as to make it impe+netrable to feeding cattle.

The original softwood scrub consists of crows ash (*Flindersia australis*), yellowwood (*Flindersia xanthoxyla*), Queensland cascarilla bark (*Crotin insularis*), red ash (*Alphitonia excelsa*), kurrajong (*Brachychiton populneum*), cumby cumby (*Pittosporum phylliraeoides*) and native olive (*Notelaea microcarpa*).

Forest species which are often associated with the scurb vegetation include narrow-leaved ironbark (*Eucalyptus crebra*), Yarraman ironbark (*E. melanoleuca*), gum-topped box (*E. molucanna*) and hoop pine (*Araucaria cunninghamii*). Lantana (*Lantana camara*) and wattle (*Acacia* spp.) occur as understorey species especially after disturbance. The softwood scrub vegetation type is closely associated with the red basaltic soils.

On the lower slope where soils trend towards a neutral pH, forest species start to dominate. The main species are narrow-leaved ironbark (*E. crebra*) and forest red gum (*E. tereticornis*) occurring in closed woodland to open forests, other tree species are sometimes present in this community but composition varies considerably. Species include silver-leaved ironbark (*E. melanophloia*), Moreton Bay ash (*Corymbia tessellaris*), pink bloodwood (*Corymbia intermedia*), broad-leaved apple (*Angophora subvelutina*) and gum-topped box (*E. molucanna*).

Understories in this community include the bull-oak (*Casuarina leuhmanii*), black she-oak (*C. littoralis*), forest she-oak (*C. torulosa*), quinine bush (*Petalostigma pubescens*), dogwood, wild rosemary and red ash.

On the shallow fresh basaltic soils, the silver-leaved ironbark (*E. melanophloia*) woodland community occurs. This community includes species such as the silver-leaved ironbark, narrow-leaved ironbark, Moreton Bay ash and forest red gum. Ironwood (*Acacia excelsa*), kurrajong and grass trees (*Xanthorrhoea* spp.) commonly occur in the understorey of this community.

On alluvial flats and drainage depressions, forest red gum, Moreton Bay ash, broad-leaved apple and rough-barked apple (*Angophora floribunda*) are the major species found. Gum-topped box may also occur. Weeping bottle brush (*Callistemon viminalis*) and river she-oak (*Casuarina cunninghamii*) occur on creek channels and benches. Occasionally cypress pine (*Callistris columellaris* and *C. endlicheri*), Yarraman ironbark (*E. melanoleuca*), corkwood (*Duboisia leichardtii*) and white bottle brush (*Callistemon salignos*) may occur.

Deep sandy soils formed from granite or sandstone wash tend to be the site for groves of rusty gum (*Angophora costata*) and spotted gum (*Corymbia maculata*). Spotted gum also occurs in association with narrow-leaved ironbark, small fruited grey gum (*E. propinqua*) and forest she-oak on steep upper slopes and stony ridges.

Black tea tree (*Melaleuca bracteata*) occurs on clay soils in drainage depressions and on relict terraces where drainage is restricted. It may also occur in association with gum-topped box. Only minor occurrences of brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) appear in the study area and are usually in association with black tea tree.

In saline areas, most trees tend to die off if watertables are shallow. Rhodes grass (*Chloris gayana*) and eventually couch (*Cynodon dactylon*) invade saline areas as competition from less salt tolerant species is reduced. Eventually only high salt tolerant species such as sand spurry (*Spurgularia rubra*), epaltes (*Epaltes australis*) and salt bush (*Atriplex nummuleria*) survive as small clumps amongst bare areas of salt encrusted soils. Groundsel bush (*Baccharis halimifolia*), a declared noxious weed, is another shrub that occurs in saline affected areas along watercourses and drainage depressions.

Native grasses of the area include Queensland wire grass (*Aristida queenslandia*), kangaroo grass (*Themeda triandra*), black spear grass (*Heteropogon contortus*), rats tail grass (*Sporobolus crebra*), Queensland bluegrass (*Dicanthium sericeum*), forest bluegrass (*Bothriochloa bladhii*), pitted bluegrass (*B. decipiens*), cane grass (*Arundinella nepalensis*), native chloris (*Chloris* spp.) and lovegrass (*Eragrostis* spp.). Bladey grass (*Imperata cylindrica*), red natal grass (*Rhyndelytrum repens*) and grader grass (*Themeda quadrivalvis*) commonly occur on disturbed sites such as roadsides.

Rhodes grass (*Chloris gayana*), Kikuyu (*Pennisetum clandestinum*), paspalum (*Paspalum dilatatum*), green panic (*Panicum maximum*) and some legumes (siratro and vetch) have been introduced to most areas either intentionally or through natural spread.

3. Methodology

3.1 Soil mapping

Soils of the Kingaroy area were mapped at 1:100 000 scale and evaluated for agricultural suitability.

The initial stage of the survey involved a series of transects or traverses across the study area as part the reconnaissance stage. Soil observations were made in relation to the geology and position in the landscape and from these, the extent of the survey area was established.

The majority of soil observations were made using a 50 mm steel hydraulically driven push-tube which enabled the sampling of relatively undisturbed core. In stony areas or where vehicle access was too difficult, a 75 mm diameter jarret hand auger was used. The occasional road side cutting was used where available and were often useful in determining the type of parent material, soil formation and fluvial processes involved.

Ten reference areas ranging in size from approximately 150 hectares to 1200 hectares were selected using data gathered during the transect stage. Two of these reference areas, Gordonbrook and Stalworth, situated outside of the 1:100 000 mapping area, were selected to help gather additional data on granite soils and an outlying red soil area which has a markedly lower rainfall.

All reference areas were mapped at a scale of 1:25 000 or one soil observation per 6.25 hectares approximately. These were used to build up a soils database, from which a soils reference was formed, and to develop an understanding of the relationship between soils and geology. The locality of these reference areas is shown on the locality map (Figure 1).

Using soil information gathered during the reference making stage, major soil types were selected for sampling and subsequent chemical analysis. Forty sites were sampled using a Proline drill rig taking 150 mm diameter undisturbed soil cores down to a depth of 1.5 m or until parent material was reached.

Following the formulation of a draft soils reference, the mapping phase was commenced. Free survey techniques (Reid 1988) were used which incorporated a combination of aerial photograph interpretation and ground observations to determine soils types, map boundaries and distinguish Unique Mapping Areas (UMAs). Ground observations, including the sites from the transect and reference making stages, were carried out at a density of approximately one site per 70 hectares throughout the study area. Mapping units were delineated on 1:25 000 scale aerial photographs then transferred onto 1:100 000 scale topographic map sheets for digitising.

3.2 Soil analysis

A total of 53 soil profiles were sampled for detailed laboratory analysis. These represented the major soil profile classes of the survey area.

These profiles were sampled to a depth of 1.5 m where possible, and analysed at the standard depths as shown in Table 4. The sampling intervals were occasionally altered to allow for thin surface horizons and avoid sampling across horizon boundaries (Baker and Eldershaw 1993). At each of these sites, a bulk (0–0.1 m) surface sample (composed of 8–10 subsamples) was collected for surface fertility assessment. The specific analyses performed at each depth are shown in Table 4. Full site descriptions and laboratory analyses for these sites are included in Appendix 2. More information on the specific analytical methods together with general interpretations are contained in Baker and Eldershaw (1993). The general ratings listed in Bruce and Rayment (1982) were also used for interpretation of the chemical analyses.

Table 4. Laboratory analyses performed for each standard soil depth sample

Analysis	Sample type and depth (m)						
	Bulk	Profile					
	0–0.1	0–0.1	0.1–0.2	0.5–0.6	0.8–0.9	1.1–1.2	1.4–1.5
pH, EC, Chloride	x	x	x	x	x	x	x
Exch. cations, CEC or ECEC		x	x	x	x	x	
Total P, K, S		x	x	x	x	x	
Organic C, Total N	x						
Bicarb. extractable P	x						
Extractable K	x						
Nitrate nitrogen	x	x	x	x	x	x	
Sulfate sulfur*	x						
DTPA ext. Fe, Mn, Cu, Zn	x						
Particle size analysis		x	x	x	x	x	
Dispersion ratio		x	x	x	x		
Moisture measurements –							
% air dry		x	x	x	x	x	
1500 kPa content		x	x	x	x		

* not for all bulk samples

3.3 Resource inventory compilation

Each occurrence of a mapping unit, named a unique mapping area (UMA), was given a unique number and individually described in terms of area, land resources and degradation. The land resource information includes geology, dominant soil profile class, associated soil profile classes, landform, and disturbance (land use). The proportion of each soil profile class is estimated in a UMA. Information for each of the 985 delineated UMAs is stored in a UMA database.

The UMAs have generally been named after the dominant soil profile class present. Where adjacent UMAs have been given the same code, delineation has been made on the basis of modal slope category (which would affect management). Some UMAs were delineated according to *phases*, based on attributes that would have particular significance in the use of the land (eg. eroded, rocky, saline). The dominant soil profile class occupies at least 60% of a map unit area. The estimated proportions of the dominant soil profile class and associated soil profile classes for each UMA are shown in the UMA database. Some UMAs were recorded as consisting entirely of the dominant soil. It is unlikely these UMAs are pure, and at more intense mapping scales other soils may be delineated. In UMAs where two soils were regarded as being co-dominant, the UMAs were not split (for practical reasons at this scale of mapping). These UMAs were given a combined name from the two co-dominant soil profile classes.

3.4 Land suitability evaluation

The land in each unique map area (UMA) was assessed for its suitability for each of the following:

- dryland (rainfed) cropping
- dryland sown pastures
- tree and vine crops

This evaluation includes both current and potential land uses and may be used as a basis for property planning, catchment management and strategic planning (including planning dealing with Good Quality Agricultural Land).

3.4.1 Land use limitations

To determine the suitability of a UMA for a particular land use, it is necessary to consider the requirements for each land use. Soil and land attributes that cause less than optimum conditions for the particular use are known as limitations.

The specific land use limitations considered in this survey, together with their designated codes (Land Resources Branch Staff 1990) were:

- flooding (F)
- frost (Cf)
- microrelief – or gilgai (Tm)
- nutrient deficiency (Nd)
- rockiness (R)
- salinity (Sa)
- soil depth (Pd)
- soil water availability (M)
- surface condition (Ps)
- topography- slope (Ts)
- water erosion (E)
- wetness (W)
- workability (Pm)

Limitation values were assigned to each UMA on the basis of field observations, topographic position and/or local knowledge, and soil morphological and/or chemical properties.

3.4.2 Land suitability classification

The five class suitability classification (Land Resources Branch Staff 1990) used for dryland sown pastures, dryland cropping and tree/vine crops is as follows:

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

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

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

Class 4 Marginal land with severe limitations which make it doubtful whether the inputs required to achieve and maintain production (and/or minimise land degradation) outweigh the long term benefits.

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

The first three classes are considered **suitable** for the specified land use. 'Suitable' is not the same as 'useable' and implies that the continued use of the land for the specified land use would be *sustainable* and *productive* in the long term. Land is classified as suitable on the assumption that appropriate soil conservation measures are implemented and maintained. If this is not the case, the specified land use may not be sustainable in the long term.

Class 4 land is considered to be **unsuitable** land, given that a higher level of inputs would be required to initiate and maintain production as well as contain land degradation. It is doubtful whether the cost of these inputs would outweigh the benefits in the long term, at least in the prevailing economic and technological conditions. Most Class 5 land would always remain unsuitable for that particular land use, as it has limitations that in aggregate are so severe that production would not be considered.

The types of land use considered in this study are shown below:

Dryland cropping	Cereals (grain sorghum, maize, wheat, barley, oats), grain legumes (chick peas, navy beans, soybeans, lupins), oilseeds (sunflower), forage legumes (lablab, cowpeas), peanuts and other forage crops (sorghums, millets).
Dryland sown pasture	Callide Rhodes grass, green panic, Gatton panic, Setaria, Pangola, Kikuyu, pasture legumes (Siratro, fine stem stylo, Glycine, Lotononis, Wynn cassia, Leucaena).
Tree and vine crops	Citrus, grapes, persimmon, low-chill stonefruit and low-chill apples.

As for crops, a five-class suitability system was used for dryland sown pastures.

While tree and vine crops are a minor current land use their suitability was assessed because of the considerable potential for further plantings of suitable species.

3.4.3 Land suitability assessment

Each mapping unit (UMA) was assessed as to how well it fulfils the requirements for the specified land uses. Land suitability assessment is a three stage process.

Firstly, the requirements of the specific land use are defined. Limitations to plant growth are considered as well as limitations for machinery usage and the management of land degradation.

The second stage in the process is to determine the effect of each limitation on the specific land use. This involves the derivation of *suitability subclasses*. Suitability subclasses are also rated on a scale of 1 to 5 (1 negligible, 2 minor, 3 moderate, 4 marginal, 5 severe). Suitability subclasses were defined following consultation with local extension staff, a literature review and field experience gained during the survey. The combination of suitability subclasses is then used to derive an overall *suitability class* (1–5) for each land use, for each UMA. The suitability class is usually determined by the most severe limitation identified (Land Resources Branch Staff 1990).

For each UMA, the suitability subclasses and the overall suitability class for each land use are recorded in the UMA database.

3.5 The databases

Two computer databases have been established to store data collected in the survey area: a site database and a UMA database. Data in this form is easily interrogated by user-defined queries.

Field data for the 1957 sites was recorded on field sheets. These were entered into a computer database (SALI site). Laboratory analytical data has been added to the same database for all relevant sample sites.

A comprehensive UMA database has been generated from the information on the site description sheets and interpreation of additional information relating to land suitability. For each UMA, the suitability subclasses, overall suitability classes (for sown pastures, dryland cropping and tree/vine crops) are recorded.

The complete UMA database has been integrated with the GIS spatial data so that maps pertaining to any category of UMA data can be produced.

Information in both the site database and the UMA database is available on request from the Data Coordinator, Natural Resource Sciences, 80 Meiers Road, Indooroopilly Q 4068.

4. Soils

4.1 Descriptions of the soil profile classes

The survey area has been mapped at broad regional scale by Vandersee and Kent (1983) at 1:250 000 scale and by Isbell *et al*. (1967) at 1:2 000 000 scale.

A total of 49 soil profile classes (SPCs) describe the profile attributes in detail together with soil classification, geology, landform and vegetation (Appendix I). The SPCs have been developed from 1957 site descriptions.

The SPCs have been grouped into six broad geomorphic/geological groups. These broad groups have been further subdivided on landscape (Table 5).

Table 5. The major attributes and classifications of the soil profile classes

Soil Profile Classes	Distinguishing attributes	Australian Classification*	Principle Profile Form*	Great Soil Group*
LEVEL TO GENTLY UNDULATING PLAINS ON ALLUVIUM OF CURRENT STREAMS				
Flood plains				
Hirst Ht	Brown or dark loamy sand to silty clay loam surface (0.1–0.3 m) over a red or brown structured sandy clay loam to sandy light clay B2 horizon (0.9–1.5 m) over a red or brown sand to sandy loam D horizon to 1.5m	Brown Dermosol Brown Chromosol	Gn3.22 Gn3.52 Db2.33 Db2.12 Dy3.43	No suitable group, affinities with soloth
Terrace Ta	Dark sandy light clay surface (0.1–0.2 m) over a dark medium clay B2 horizon (0.55–0.95 m) over a brown sandy light clay D horizon to 1.5m	Black Dermosol Black Vertosol	Uf6.32 Ug5.15	Prairie soil Black earth
Stagnant alluvial plains				
Avon Av	Brown sandy loam to clay loam surface (0.02–0.2 m) over a sporadically bleached A2 horizon (0.1–0.45 m) over a frequently mottled strongly alkaline, grey or brown medium clay B2 horizon to 1.5 m	Brown Sodosol Grey Sodosol	Db2.32 Db2.33 Dy2.33 Db1.33	Solodic soil
Byee By	Dark medium clay surface (0.1–0.2 m) over a dark medium clay B2 horizon (0.7–1.25 m) over a strongly alkaline, brown medium clay D horizon to 1.5m	Black Vertosol	Ug5.15	Black earth
Eastgate Eg	Dark medium clay surface (0.1–0.15 m) over a brown or black medium clay B21 horizon (0.45–0.95 m) over a strongly alkaline, brown medium clay B22 horizon to 1.5 m	Black Vertosol Brown Vertosol	Ug5.15 Ug5.34	Black earth Brown clay
Alluvial fans				
Kaber Kr	Brown light clay surface (0.2–0.3 m) over a brown medium clay B2 horizon to 1.5 m	Brown Vertosol	Ug5.34	Brown clay
Relict levees				
Weir We	Dark light clay surface (0.1–0.15 m) over a dark medium clay B2 horizon (0.6–1.05 m) over a strongly alkaline, brown light medium clay D horizon to 1.5 m	Black Vertosol	Ug5.15	Black earth

* Australian Classification - Isbell 1996
* Principle Profile Form – Northcote 1979
* Great Soil Group – Stace *et al.* 1968

Table 5 (continued)

Soil Profile Classes	Distinguishing attributes	Australian Classification*	Principle Profile Form*	Great Soil Group*
Drainage depressions				
Gueena Gn	Mottled dark medium clay surface (0.1–0.15 m) over a mottled, grey medium clay B2 horizon to 1.5 m	Grey Vertosol	Ug5.24 Ug5.28	Grey clay
GENTLY UNDULATING PLAINS TO UNDULATING RISES ON OLDER HIGHER LYING ALLUVIUM AND TERTIARY SEDIMENTS				
Hill crests and hillslopes				
Appaloosa Ap	Dark or brown light clay to medium clay surface (0.1–0.2 m) over a brown medium clay B2 horizon (0.6–1.2 m) over a mottled, brown, yellow or grey medium clay C horizon to 1.5 m	Brown Vertosol	Ug5.35 Ug5.34 Uf6.31 Ug3.3 Uf6.33 Ug5.2	Brown clay
Bushnell Bl	Gilgaied, brown or dark clay loam surface (0.05–0.2 m) over a bleached A2 horizon (0.07–0.25 m) over a frequently mottled, brown medium clay B2 horizon (0.9–1.5 m) frequently over a mottled, strongly alkaline, grey, brown or yellow light clay to medium clay C horizon to 1.5m	Brown Sodosol	Dy2.33 Dy3.33 Dy3.43 Db2.33 Db1.33	Solodic soil Solodized solonetz
Chelmsford Cf	Dark or red clay loam to light clay surface (0.05–0.25 m) over a red medium clay B2 horizon (0.85–1.3 m) over a strongly alkaline, mottled, red or grey light clay D horizon to 1.5m	Red Ferrosol	Uf6.31 Gn3.13 Gn3.12	Euchrozem
Kawl Kawl Kk	Gilgaied, dark or grey medium clay surface (0.1–0.15 m) over a grey medium clay B2 horizon to 1.5 m	Grey Vertosol	Ug5.24 Ug5.21	Grey clay
Lankowsky Lk	Red light sandy clay loam to clay loam surface (0.1–0.15 m) over a neutral, red clay loam to light clay B horizon to 1.5 m	Red Kandosol	Gn2.12 Gn2.15	Red earth
Long Peter Lp	Dark or brown clay loam surface (0.05–0.2 m) over a brown medium clay B2 horizon (1.3–1.5 m) occasionally over a mottled, grey, brown or yellow light clay to medium clay C horizon to 1.5 m	Brown Sodosol	Db1.13 Db2.13 Dy3.13 Dy2.13 Dy3.23	Solodic soil
Narrawong Nr	Red, dark or brown clay loam surface (0.05–0.15 m) over an occasionally mottled, red or brown medium clay B2 horizon (0.4–0.9 m) over a mottled, acid to alkaline, brown medium clay D horizon to 1.5 m	Red Ferrosol	Gn3.12 Gn3.52 Gn3.22 Gn3.33 Gn4.12	Euchrozem
Palouse Pl	Brown or grey sandy loam to light sandy clay loam surface (0.5–0.12 m) over a bleached A2 horizon (0.12–0.3 m) over a frequently mottled, brown medium clay B2 horizon (0.7–1.5 m) over a mottled, grey, brown or yellow light clay to medium clay C horizon to 1.5 m	Brown Sodosol	Dy3.43 Dy2.43 Db2.43 Dy3,33 Db2.33	Solodic soil Solodized solonetz

* Australian Classification - Isbell 1996
* Principle Profile Form – Northcote 1979
* Great Soil Group – Stace *et al.* 1968

Table 5 (continued)

Soil Profile Classes	Distinguishing attributes	Australian Classification*	Principle Profile Form*	Great Soil Group*
Wheatlands Wh	Brown sandy clay loam to clay loam surface (0.1–0.2 m) over a pale or occasionally sporadically bleached A2 horizon (0.1–0.3 m) over a frequently mottled, red or brown medium clay B2 horizon (1.05–1.5 m) over a frequently mottled, red or brown sandy clay loam to clay loam D horizon to 1.5 m	Red Dermosol Brown Dermosol	Gn3.16 Gn3.26 Dr2.22 Gn3.13 Dr3.33	No suitable group, affinities with red brown earth
PLAINS				
Marshlands Ml	Brown sandy clay loam to light clay surface (0.1–0.2 m) over a sporadically bleached A2 or B1 horizon (0.2–0.3 m) over a mottled, brown medium clay B2 horizon (0.4–1.5 m) over a mottled, brown medium clay to heavy clay D horizon to 1.5 m	Brown Sodosol	Db2.33 Uf6.41p Dy3.43 Dy3.31 Uf3	Solodic soil Soloth
Mondure Md	Brown or occasionally dark light clay or occasionally clay loam surface (0.05–0.15 m) over a brown medium clay B2 horizon to 1.5 m	Brown Dermosol	Uf6.31 Uf4.42 Uf6.4 Gn3.23 Db1.13	No suitable group
UNDULATING RISES TO ROLLING HILLS ON BASALT				
Hillcrests and upper hillslopes				
McEuen Mn	Dark or brown light clay to medium clay surface (0.05–0.1 m) over a dark or brown medium clay B2 horizon (0.3–0.55 m) over weathered rock	Black Vertosol Brown Vertoosl	Ug5.12 Ug5.32 Ug5.13	Black earth Brown clay
Taabinga Tb	Red clay loam to light clay surface (0.1–0.2 m) over a red light clay to medium clay B2 horizon (0.l5–1.2 m) over weathered rock	Red Ferrosol	Uf6.31 Gn3.12 Gn3.13	Euchrozem
Tureen Tn	Dark light clay or occasionally clay loam surface (0.1–0.15 m) over a dark or brown medium clay B2 horizon (0.25–0.55 m) over weathered rock	Black Dermosol Brown Dermosol	Uf6.32 Uf6.31 Db1.12	Prairie soil
Mid to lower hillslopes				
Fairdale Fd	Dark or brown medium clay surface (0.06–0.12 m) over a neutral to alkaline, dark or brown medium clay B2 horizon (0.6–0.9 m) over weathered rock	Black Vertosol Brown Vertosol	Ug5.12 Ug5.13 Ug5.32	Black earth Brown clay
Tingoora Tg	Dark or brown medium clay surface (0.05–0.2 m) over a neutral to alkaline, brown or dark B21 horizon (0.45–0.85 m) over a strongly alkaline, brown medium clay to heavy clay B22 horizon (1.2–1.5 m) over weathered rock	Brown Vertosol Black Vertosol	Ug5.32 Ug5.13 Ug5.12 Ug5.34	Brown clay Black earth
Pediments				
Iona In	Dark medium clay surface (0.1–0.25 m) over a neutral to alkaline, brown or dark medium clay B21 horizon (0.6–1.0 m) over a strongly alkaline, brown or red medium clay B22 horizon to 1.5 m occasionally over gravely D horizons	Brown Vertosol Black Vertosol	Ug5.34 Ug5.17 Ug5.15	Brown clay Black earth

* Australian Classification - Isbell 1996
* Principle Profile Form – Northcote 1979
* Great Soil Group – Stace *et al.* 1968

Table 5 (continued)

Soil Profile Classes	Distinguishing attributes	Australian Classification*	Principle Profile Form*	Great Soil Group*
Sadie Sd	Dark medium clay surface (0.05–0.1 m) over a neutral to alkaline, dark medium clay B21 and B22 horizons over a occasionally mottled, strongly alkaline, grey medium clay B23 horizon to 1.5 m	Black Vertosol	Ug5.16	Black earth
Wondai Wd	Gilgaied, dark or brown medium clay surface (0.05–0.15 m) over a brown or dark medium clay B21 horizon (0.5–1.1 m) over a frequently mottled, brown or red medium clay B22 or D horizon to 1.5 m frequently with gravel	Brown Vertosol Black Vertosol	Ug5.34 Ug5.15 Ug5.17 Ug5.35	Brown clay Black earth
UNDULATING RISES TO ROLLING HILLS ON DEEPLY WEATHERED BASALTIC MATERIAL				
Plateaus, hillcrests and upper hillslopes				
Goodger Gg	Loose, red clay loam to light clay surface (0.1–0.3 m) over an acid, red, massive to weakly structured B21 horizon (0.25–0.8 m) over an acid, red structured light clay B22 horizon to 1.5 m	Red Ferrosol	Gn3.11 Uf5.31	Krasnozem
Hopevale Hv	Loose, red loam surface (0.1–0.25 m) over an acid, red, weak to moderately structured clay loam B2 horizon (0.3–0.55 m) over deeply weathered basalt. Large amounts of ferruginous gravel throughout the profile	Red Ferrosol	Um4.21 Um5.21 Um6.24 Um6.31 Um6.33	Krasnozem Red earth
Proston Pt	Firm, red clay loam to light clay surface (0.1–0.25 m) over an acid, red, structured clay loam to light clay B2 horizon (0.9–1.5 m) with ferruginous gravel over deep weathered basalt	Red Ferrosol	Gn3.11 Uf6.31 Um6.31	Krasnozem
Mid to upper hillslopes				
Memerambi Mm	Firm, red clay loam to light clay surface (0.1–0.2 m) over an acid, red light clay B2 horizon to 1.5 m	Red Ferrosol	Uf6.31 Gn3.11	Krasnozem
Wooroolin Wr	Firm red clay loam to light clay surface (0.1–0.25 m) over an acid to neutral, red light clay B2 horizon (0.7–0.8 m) over deeply weathered basalt	Red Ferrosol	Gn3.11 Uf6.31	Krasnozem Euchrozem
Mid to lower hillslopes				
Coolabunia Cl	Firm, red clay loam to light clay surface (0.1–0.25 m) over a acid to neutral, red light clay to medium clay B21 horizon (0.45–1.0 m) over a acid to neutral, mottled, red light clay to medium clay B22 horizon (1.1–1.3 m) with large amounts of iron and manganiferous concretions over a red medium clay with weathered rock to 1.5 m	Red Ferrosol	Uf6.31 Uf6.4 Gn3.11 Gn3.12	Euchrozem Krasnozem

* Australian Classification - Isbell 1996
* Principle Profile Form – Northcote 1979
* Great Soil Group – Stace *et al.* 1968

Table 5 (continued)

Soil Profile Classes	Distinguishing attributes	Australian Classificatio*	Principle Profile Form*	Great Soil Group*
Crawford Cd	Firm, red clay loam to light clay surface (0.1–0.2 m) over an acid to neutral, mottled, red clay loam to light clay B21 horizon (0.5–0.8 m) over an acid to neutral, mottled, red or brown light clay to medium clay B22 horizon (1.0–1.3 m) with moderate amounts of manganiferous concretions over deeply weathered rock	Red Ferrosol	Uf6.31 Uf6.4 Gn3.11 Gn3.12	Euchrozem Krasnozem
Pediments				
Archookoora Ac	Red or brown light clay surface (0.1–0.25 m) over a red or brown light clay to medium clay B2 horizon (0.65–1.5 m) with manganiferous concretions over a brown medium clay D horizon to 1.5 m	Red Ferrosol Brown Ferrosol	Uf6.31 Uf6.4 Uf6.3	Euchrozem Krasnozem
Haly Hl	Red or brow light clay surface (0.15–0.2 m) over a mottled, brown medium clay B2 horizon to 1.5 m	Brown Ferrosol	Uf6.4	Xanthozem
Kumbia Kb	Brown or red clay loam to light clay surface (0.15–0.25 m) frequently with manganiferous segregations over a frequently mottled, brown or red light clay to medium clayB2 horizon (0.55–1.4 m) with manganiferous segregations over a mottled, brown or yellow medium clay to heavy clay D horizon to 1.5 m	Brown Ferrosol Red Ferrosol	Uf6.4 Gn3.12	Xanthozem
Kunioon Kn	Brown or red clay loam to light clay surface (0.1–0.25 m)with manganiferous nodules over a mottled, brown or red light clay to medium clay B2 horizon (to 1.5 m) with large amounts of manganiferous nodules	Brown Ferrosol Red Ferrosol	Uf6.4	Xanthozem
Tarong Tr	Brown sandy loam to clay loam sandy surface (0.5–0.2 m) over a bleached A2 horizon (0.15–0.3 m) over a mottled, brown or yellow light clay to medium clay B2 horizon (0.5–1.5 m) with manganiferous nodules frequently over a mottled, brown medium clay to heavy clay D horizon to 1.5 m	Brown Chromosol Brown Dermosol Yellow Chromosol Yellow Dermosol	Dy3.41 Dy3.32 Dy3.31 Db2.31	Yellow podzolic soil Brown podzolic soil No suitable group
GENTLY UNDULATING TO UNDULATING LOW HILLS ON GRANITES				
Hillcrests and upper hillslopes				
Booie Bo	Dark or brown sandy loam to sandy clay loam surface (0.1–0.2 m) over a bleached A2 horizon (0.3–0.45 m) over weathered rock	Bleached-Orthic Tenosol Orthic Tenosol	Uc2.12 Um3.12	Lithosol
Boonenne Bn	Brown sandy loam to sandy clay loam surface (0.1–0.2 m) over a conspicuously bleached A2 horizon (0.2–0.3 m) over an alkaline, mottled, brown medium clay B2 horizon (0.65–0.9 m) over weathered rock	Brown Sodosol	Dy3.43 Dy3.42 Dy2.43 Db2.42 Db2.43	Solodic soil
Dangore Dg	Dark sandy loam to sandy clay loam surface (0.08–0.2 m) over a bleached A2 horizon (0.2–0.4 m) over an acid, mottled, brown, grey or yellow fine gravely light clay to medium clay B2 horizon (0.5–1.0 m) over weathered rock	Brown Sodosol Brown Chromosol Grey Sodosol Yellow Sodosol	Dy3.41 Dy3.31 Db2.31 Db1.41	Soloth Podzolic soils

* Australian Classification - Isbell 1996
* Principle Profile Form – Northcote 1979
* Great Soil Group – Stace *et al.* 1968

Table 5 (continued)

Soil Profile Classes	Distinguishing attributes	Australian Classification*	Principle Profile Form*	Great Soil Group*
Mid to lower hillslopes				
Charlestown Ct	Dark or brown light sandy clay loam to clay loam sandy surface (0.1–0.2 m) over a bleached A2 horizon (0.15–0.2 m) over an acid to alkaline, red or brown medium clay B2 horizon (0.55–0.9 m) over weathered rock	Red Sodosol Brown Sodosol	Dr3.12 Dr2.32 Dr3.41 Db2.12 Dr1.12	Solodic soil Soloth
Gordonbrook Gd	Red or brown light sandy clay loam to sandy clay loam surface (0.1–0.15 m) over a pale A2 horizon (0.12–0.3 m) over an acid, red sandy light clay to medium clay B2 horizon (0.75–1.0 m) over deeply weathered rock	Red Chromosol Red Dermosol	Dr2.21 Uf6.4	Red podzolic soil No suitable group, affinities with soloth
Pediments				
Cooyar Cy	Dark brown or grey sandy loam to sandy clay loam surface (0.08–0.2 m) over a bleached A2 horizon (0.15–0.45 m) over an acid, mottled, brown or grey medium clay B2 horizon to 1.5 m	Brown Chromosol Brown Sodosol Brown Kurrosol Grey Sodosol	Dy3.41 Dy3.31	Yellow podzolic soil Soloth
Cushnie Cs	Dark or brown light sandy clay loam to clay loam fine sandy surface (0.08–0.15 m) over a conspicuously bleached A2 horizon (0.12–0.3 m) over a neutral to strongly alkaline, frequently mottled, brown or occasionally grey medium clay B2 horizon to 1.5 m	Brown Sodosol Grey Sodosol	Dy3.43 Dy2.42 Db2.13 Dy3.42	Solodic soil
GENTLY UNDULATING RISES TO UNDULATING LOW HILLS ON METAMORPHIC MATERIAL AND SEDIMENTARY ROCKS				
Hillcrests and upper hillslopes				
Cherbourg Cg	Brown or grey sandy loam to sandy clay loam surface (0.1–0.15 m) over a bleached A2 horizon (0.1–0.4 m) over an acid, brown medium clay B2 horizon (0.25–0.85 m) over weathered rock	Yellow Kurosol Brown Sodosol	Db2.41 Dy3.21 Dy3.41 Um1	Soloth, Lithosol No suitable group
Mid to lower hillslopes				
Hillsdale Hd	Dark or brown sandy clay loam surface (0.1–0.2 m) over a bleached A2 horizon (0.2–0.3 m) over a alkaline to strongly alkaline, mottled, brown or grey medium clay B2 horizon (0.9–1.3 m) over weathered sandstone	Brown Sodosol Grey Sodosol	Dy3.43 Db2.33 Db2.43	Solodic soil Solodized solonetz
Pediments and footslopes				
Hodgleigh Hg	Dark or brown fine sandy clay loam to clay loam sandy surface (0.1–0.2 m) over a conspicuously bleached A2 horizon (0.1–0.35 m) over a neutral, frequently mottled, brown or red medium clay B2 horizon (0.65–1.5 m) over weathered rock	Red Chromosol Brown Sodosol Brown Dermosol	Dr2.12p Dy3.42 Db2.32	Non calcic brown soil Solodic soil No suitable group

* Australian Classification - Isbell 1996
* Principle Profile Form – Northcote 1979
* Great Soil Group – Stace *et al.* 1968

4.1.1 Level to gently undulating plains on recent alluvium

Soils on low channel benches and levees associated with the flood plains of current streams (*Terrace, Hirst*) typically exhibit characteristics of soils formed in a sedimentary environment including depositional layering. The stagnant alluvial plains generally represent the slightly elevated rarely flooded plains. These plains have sodic texture contrast soils (*Avon*) and various cracking clays (*Byee, Eastgate, Weir*). Grey clays (*Gueena*) occur in drainage depressions on the alluvial plains.

Alluvial/colluvial deposits developed from small streams draining the surrounding landscapes have developed brown clays (*Kaber*) on alluvial fans and narrow alluvial plains.

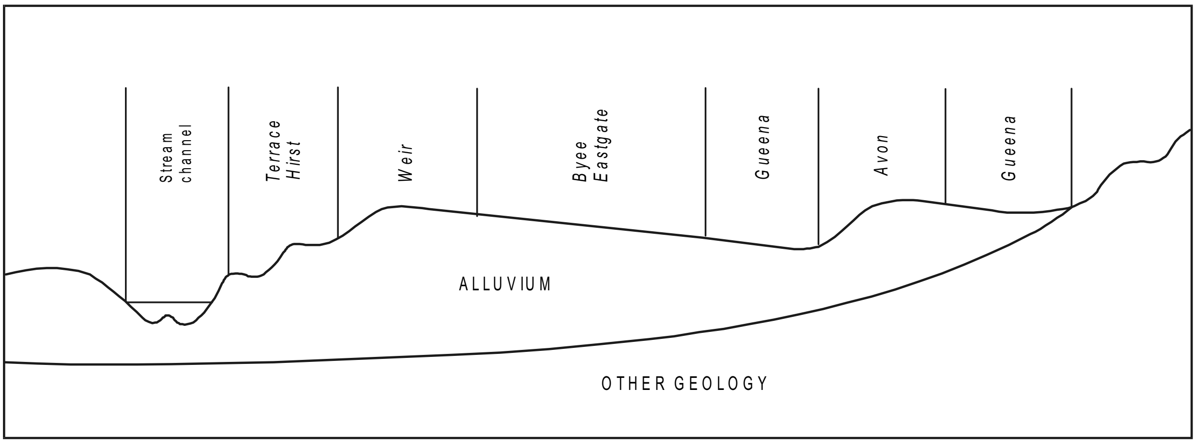

Figure 3. Typical cross-section of the recent alluvial landscapes

4.1.2. Gently undulating plains to undulating rises on older, higher lying alluvium and Tertiary sediments

The old alluvial and Tertiary sediment deposits occur high in the landscape and are not associated with current stream channels. Due to their elevations, landscapes are frequently undulating. Profile development corresponds to landscape position, degree of weathering and the occurrence of reworked alluvial/colluvial deposits over the old alluvium.

On the old alluvium and sediments, strongly sodic alkaline cracking clays (*Appaloosa, Kawl Kawl*) and sodic texture contrast soils (*Long Peter, Bushnell, Palouse*) predominate. In these soils brown colours occur on better drained positions higher in the landscape while yellow and grey colours are associated with lower landscape position. Soils are often gilgaied.

Isolated elevated remnants of alluvial/colluvial deposits overlie the older alluvial deposits in many areas. The alluvial/colluvial deposits probably originated in a wetter environment and have been eroded away in more recent times. Deep red massive soils (*Lankowsky*) and red structured soils overlying sodic old alluvial subsoils (*Chemsford*) occur on upper slopes. Mottled yellow and brown soils overlying sodic old alluvial subsoils (*Wheatlands, Mondure, Marshlands*) occur on lower slopes and plains. Soils become gilgaied where the old alluvium occurs close to the surface.

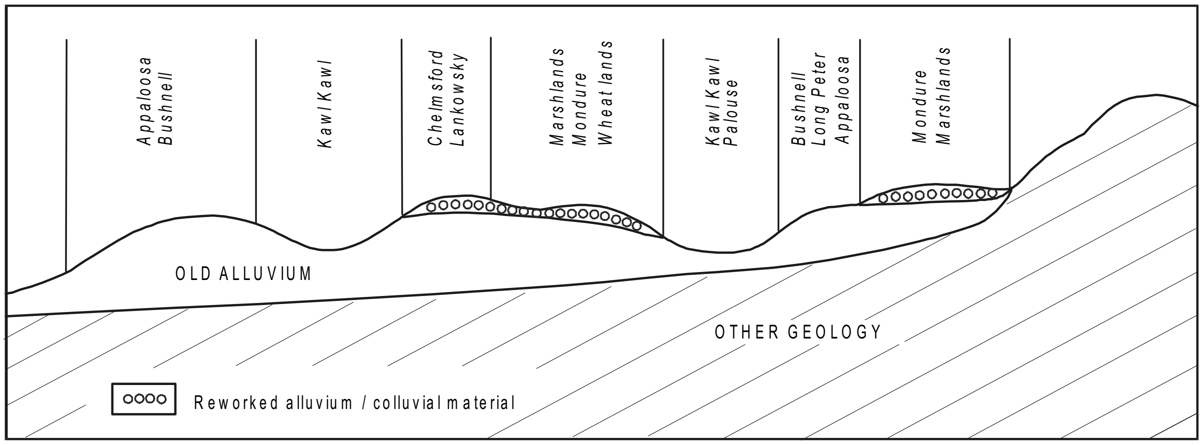

Figure 4. Typical cross-section of old alluvium and Tertiary sediments landform

4.1.3 Undulating rises to rolling hills on basalt

Soils developed from fresh exposures of Tertiary basalt occurring either above or below the red soil landscape tend to be shallow (<0.3 m) to moderately deep (>1.2 m) dark cracking clays. On crests and hillslopes with slopes of 2 to 12%, the soils can be as shallow as 0.3 m (*McEuen*), 0.6 m (*Fairdale*) or as deep as 1.2 m (*Tingoora*). These are frequently stony soils with frequent rock outcrops.

Below Haly's Round Mountain at the edge of the Bunya Mountains in the south western portion of the study area, the same parent material produces friable brown loams and clay-loams or prairie soils (*Tureen*). These are frequently stony and shallow and occur on crests and upper slopes in association with the dark clay soils *McEuen* and *Fairdale*.

Minor fluvial deposits or remnants of structured red soils (*Taabinga*) occur within this geomorphological unit on crests and flats. These overlie weathering basalt and can occur in association with the dark clay soils. They have a neutral pH and a hard setting surface.

Soils on the more gentle footslopes (slopes 1–4%) and pediments are usually very deep (>1.5 m) and vary in colour, pH and amount of coarse fragments of weathered basalt. Weak to moderate linear micro-relief occurs on long slopes. *Sadie* has a yellow to grey subsoil and an alkaline pH of 0.6 m and has a strongly self mulching surface. *Iona* has bands of carbonate in an alkaline grey-brown or brown subsoil by 0.9 and commonly has coarse fragments of weathering basalt from colluvial movement from higher lying materials. *Wondai* soil by comparison is a fairly uniform, deep, dark brown cracking clay soil becoming brown at depth, alkaline pH by 1.2 m and with minor concretions of carbonate. It occurs mainly on the pediments with little or negligible slope.

Coarse fractions of rounded basalt cobble and small boulders can occur in all soils in this unit in varying degrees of size and percentage with the greatest occurrence occurring on the crests and ridges. The remnant vegetation of this unit comprises of silver-leaved ironbark on the crests and slopes whilst forest red gum and Moreton Bay ash occur on drainage lines and along gullies.

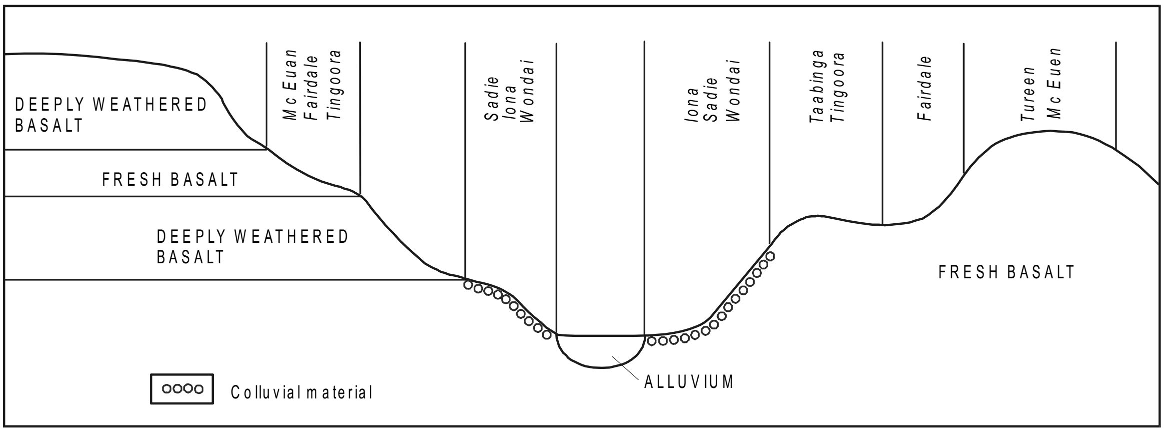

Figure 5. Typical cross-section of basalt landscapes

4.1.4 Undulating rises to rolling hills on deeply weathered basaltic material

Soil types in this landscape unit are very closely related to position in the landscape. The deeply weathered basalts may give rise to soils developed *in situ.* Others have developed from colluvial pediments derived from the basalt and/or mixed with other colluvial substrate.

Acid, red structured soils typically occur on upper slopes and plateaus of deeply weathered basalt. Soils have been subdivided into deep loose (or snuffy) surfaced (*Goodger*) or firm surfaced (*Memerambi*) soils. Shallower versions of these soils (*Proston, Hopevale, Wooroolin*) occur on steeper upper slopes crests and plateau margins.

Neutral, red structured soils (*Coolabunia, Crawford*) generally occur on mid to lower slopes (relative to the acid red soils) of the deeply weathered basalt.

Mottled brown structured soils occur on wetter lower slopes (*Haly*) and seepage areas (*Kunioon*). The amount of manganiferous segregations depends on the local landscape hydrology.

Mottled, yellow or brown structured soils (*Kumbia, Tarong, Archookoora*) occur where colluvial material from the deeply weathered basalts have been deposited over adjacent sodic old alluvial or Tertiary sediments. These soils generally occur adjacent to the basaltic rises and plateaus. The amount of manganiferous segregations also depends on local landscape hydrology.

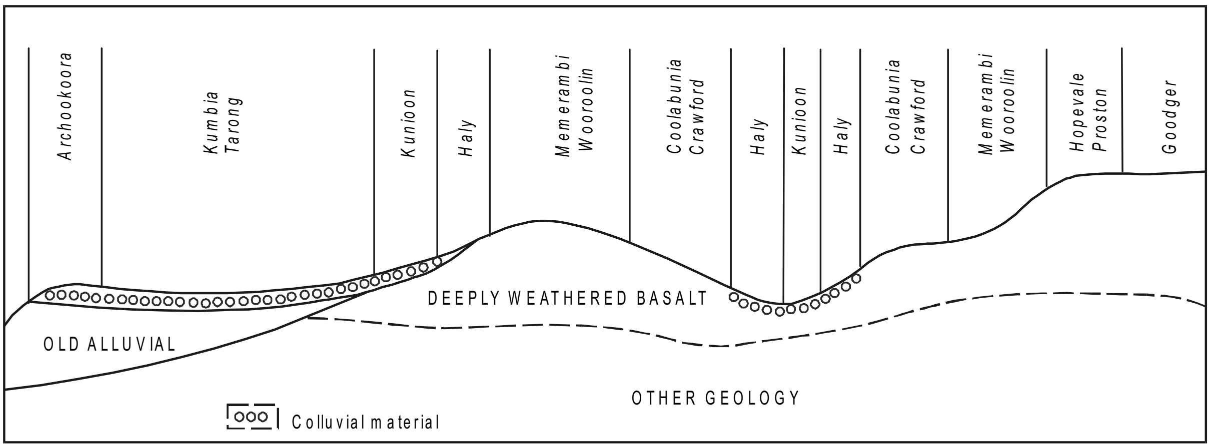

Figure 6. Typical cross-section of the deeply weathered basaltic landscape

4.1.5 Gently undulating to undulating low hills on granite

The geology comprises predominantly granite with minor granodiorites. Soils typically have light textured surfaces (sandy loams) on steeper slopes and crests while finer loams and clay loam surfaces predominate on gentle lower slopes.

Steep upper slopes and narrow crests typically have shallow sandy profiles (*Booie*) with rock outcrops. Moderately deep yellow and brown sodic texture contrast soils (*Dangore, Boonenne*) occur on upper slopes.

Broad gently sloping crests have moderately deep red texture contrast and gradational soils (*Gordonbrook*). Deeper red and brown texture contrast soils (*Charlestown*) occur on gentle mid slopes while mottled yellow and brown texture contrast soils (*Cooyar, Cushnie)* occur on lower slopes with colluvial deposition and drainage depressions.

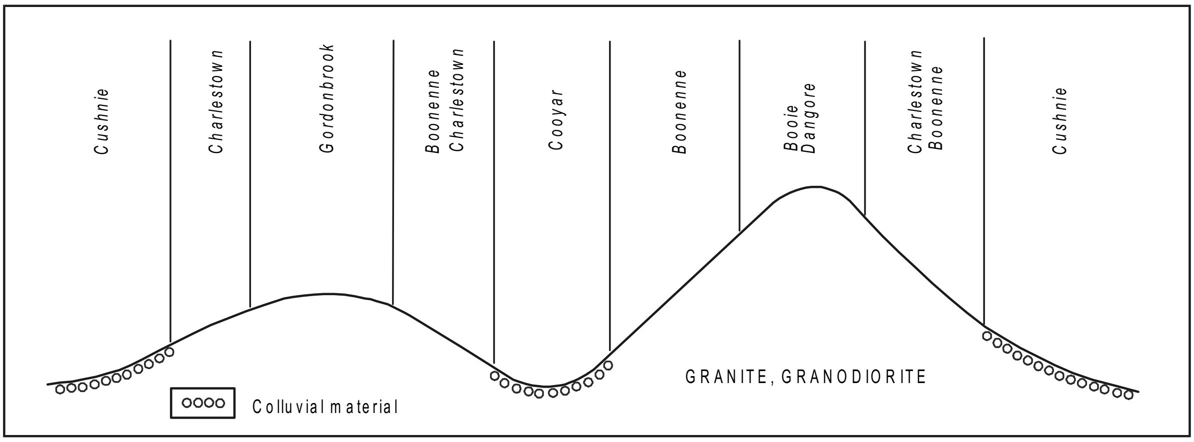

Figure 7. Typical cross-section of the granite landscape

4.1.6 Gently undulating rises to undulating low hills on metamorphic material and sedimentary rocks

Shallow sandy to loamy soils with rock outcrop (*Cherbourg*) occur on crests and upper slopes of the metamorphic rises and low hills.

Shallow texture contrast soils (*Hillsdale*) occur on mid slopes while deep sodic texture contrast soils (*Hodgleigh*) occur on lower slopes.

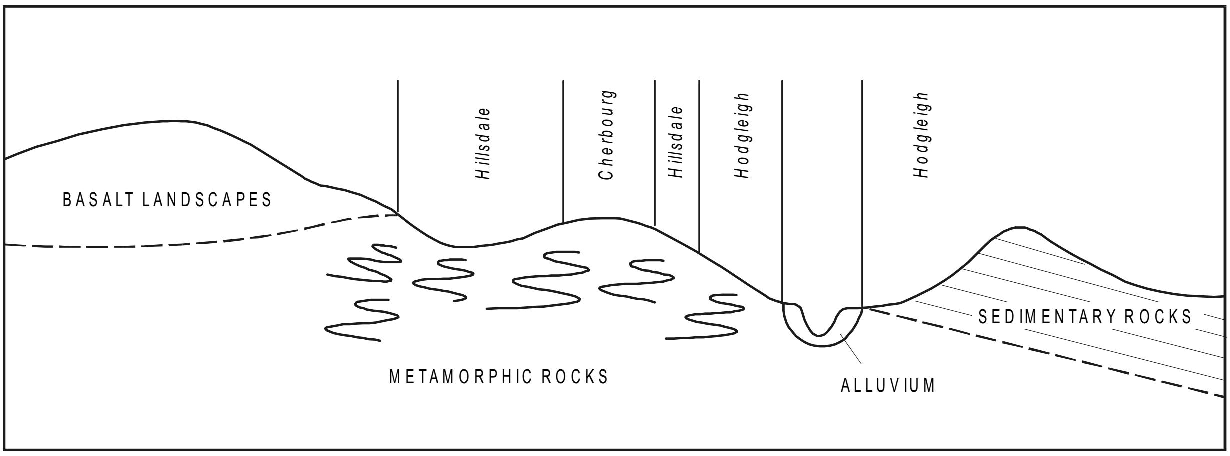

Figure 8. Typical cross-section of the metamorphic and sedimentary rocks landscapes

4.2 Soil chemical and physical properties

4.2.1 Soil Fertility

The soil chemical and physical properties are based on the soil groups for each of the six geomorphic/geological units. A total of 53 soil profiles were samples for detailed laboratory analysis. The fertility ratings in Table 6 are based on Baker and Eldershaw (1993) and Bruce and Rayment (1982).

Soil pH
Surface pH for all soils range from 4.6 to 8.4 while subsoil pH ranges from 4.0 to 9.2. The wide range of pH values reflects the diverse geology and geomorphic processes. The strongly acid pH values are usually associated with the deeply weathered landscapes. High pH (>8.5) is often associated with lime segregations.

The soils on young and old alluvium have slightly acid to neutral (pH 6.3–6.7) surfaces while subsoils are moderately alkaline to strongly alkaline (pH 8.1–9.1).

The surface pH of soils on the fresh basalts ranges from slightly acid to neutral (pH 6.1–7.0) and subsoils have neutral to moderately alkaline (pH 6.7–8.5).

On the deeply weathered basalts, pH is strongly related to landscape position. On upper slopes and plateaus, surface pH ranges from very strongly acid to slightly acid (pH 4.6–6.5) while subsoils range from extremely acid to medium acid (pH 4.0–6.0). On lower slopes and pediments, surface pH values are medium acid to slightly acid (pH 5.9–6.4) and subsoils are neutral to strongly alkaline (pH 6.7–8.5). On pediments, some buried horizons derived from old alluvial or Tertiary sediments are extremely acid (pH 4.3).

The granitic soils have medium acid to neutral (pH 5.8–6.7) surfaces and medium acid to moderately alkaline (pH 5.9–8.5) subsoils. Variations in pH are mainly related to the degree of weathering and lithology with the lower pH values on granites and higher values on granodiorites.

Soils on metamorphic and sedimentary rocks have slightly acid to mildly alkaline (pH 6.5–7.6) surfaces and slightly acid to strongly alkaline (pH 6.4–9.0) subsoils. The more acid pH values occur higher in the landscape.

Organic carbon and nitrogen
Organic carbon and nitrogen levels correspond to the amount of organic matter in the soil. Most samples were taken from undisturbed sites under native vegetation. Due to the long term agricultural development in the area, cultivated sites will have significantly lower carbon and nitrogen values.

Organic carbon ranges from low to very high (0.9–6.5%). The values generally correspond to type and density of vegetation. For example, the higher values occur under closed scrub forests while the lower values occur under open eucalypt woodlands with a sparse ground cover. The deeply weathered basaltic soils on upper slopes and plateaus with scrub vegetation have consistently high values (4.4–5.6%) while lower slopes with eucalypt vegetation have lower values (2.3–3.7%). Overall, the clay soils on all landscapes have higher values (1.7–2.9%) compared to the texture contrast soils (1.2–2.3%) which generally corresponds to a sparser ground cover.

Nitrogen values range from low to high (0.06–0.6%). Values show the same trends as organic carbon with lower nitrogen percentages corresponding to lower carbon levels.

The ratio of organic carbon to nitrogen (C/N) is often a useful indication of the ability of the soil to supply nitrogen. A high C/N ratio (>15) indicates a slow mineralisation process and reduced capacity to supply mineral nitrogen. C/N ratios vary from 8.2–29. The lower values generally correspond to the scrub soils and soils with dense grass cover. The higher values generally have eucalypt or *Acacia* vegetation.

Phosphorus
Phosphorus (P) is an important plant nutrient essential for cropping and good pasture growth.

Acid extractable P and bicarb. extractable P generally show corresponding values. Bicarb. P ranges from very low to very high (2–147 mg/kg). The lower values are characteristic of the soils on fresh basalt and old alluvium (4–12 mg/kg). The soils on young alluvium have medium to very high P levels (26–140 mg/kg). The wide range in values, but predominantly higher values, generally indicate young soils derived from mixed parent material.

The deeply weathered basaltic soils have very low (2–7 mg/kg) P levels in upper landscape positions and low to high (16–86 mg/kg) P levels in lower landscape positions. This corresponds to the relative ages and degree of weathering of the soils.

Granitic soils are very low to low (8–17 mg/kg) while the metamorphic soils have not been analysed.

Potassium
Exchangeable and replaceable potassium (K) show similar values. Exchangeable K ranges from low to very high (0.12–2.2 meq/100 g). Surface potassium levels are related to surface accumulation of organic matter and lithology of the parent material. In general, the level of organic matter is related to the density of vegetation which is related to the overall level of soil fertility. Granite rocks are high in K due to potassium feldspars and micas while granitic soils usually have low overall fertility which results in low organic matter due to sparse vegetation. As a result, the soils on granites have medium to high K values (0.27–0.67 meq/100 g). The higher values correspond to denser vegetation and higher organic C levels.

Basalt rocks typically have low K levels but basalt soils have high overall fertility and can have high organic matter levels from dense scrub or grass vegetation. As a result, the soils on fresh basalt have medium to high K values (0.37–0.65 meq/100 g) generally corresponding to medium to high organic carbon levels due to good grass cover. Deeply weathered basaltic soils have medium to very high (0.37–2.2 meq/100 g) values. Generally, the snuffy soils which originally had eucalypt vegetation have lower values.

The young alluvial soils have medium to high K values (0.26–0.99 meq/100 g). Old alluvium soils have low to very high (0.17–1.2 meq/100 g) values. The wide range in values reflects the diverse range in vegetation and parent material.

Micronutrients – Zn, Cu, Mn
Micronutrients levels are extremely variable with Zn ranging from low to high (0.2–12 mg/kg), Cu ranging from low to high (0.2–7.7 mg/kg) while Mn ranges from low to high (2–342 mg/kg). Generally, the sandy granitic soils are low to moderate in micronutrients (Zn 0.6–1.2, Cu 0.2–0.4, Mn 32–67 mg/kg). The deeply weathered basaltic soils high in the landscape (*Goodger, Hopevale*) are typically lower in Zn and Cu (Zn 0.3–0.6, Cu 0.2–0.7 mg/kg). All other soils generally have moderate to high Cu and Zn values (Zn 0.7–12, Cu 0.7–7.7 mg/kg).

Manganese levels in the old and young alluvial soils, and basaltic and deeply basaltic soils except the snuffy soils (*Goodger, Hopevale*) are predominantly high (57–342 mg/g) with some moderate values (16–33 mg/kg). The snuffy soils are lower (6–32 mg/kg) in manganese. The high manganese values on the strongly acid soils may result in manganese toxicity.

Table 6a. Soil chemical ratings for the soil profile classes

Soil profile class	Site No.	Org C %	Tot N %	Ratio C/N	Acid P mg/kg	BicarbP mg/kg	Tot P %	Extr K	Exch K meq/100g	Tot K %	Tot S %	Cu mg/kg	Zn mg/kg	Mn mg/kg
Appaloosa	RS27	1.9 (m)	.14 (l)	13.6	19 (l)	17 (l)	.066 (h)	1.0 (vh)	1.1 (vh)	.20 (l)	.030 (m)	1.6 (m)	1.6 (m)	123 (h)
Archookoora	S10	2.0 (m)	.14 (l)	14.3	3 (vl)	3 (vl)	.053 (h)	0.53 (h)	.03 (vl)	.13 (l)	.004 (vl)	2.1 (m)	1.2 (m)	226 (h)
Archookoora	S38	3.4 (h)	.23 (m)	14.8	3.4 (h)	11 (l)	0.12 (vh)	.42 (m)	.50 (m)	.101 (l)	.043 (m)	2.4 (m)	1.8 (m)	79 (h)
Avon	R527	1.4 (l)	.12 (l)	11.7	5 (vl)	8 (cvl)	.056 (h)	.57 (h)	.50 (h)	1.91 (h)	.017 (l)	0.7 (m)	0.3 (l)	33 (m)
Boonenne	S30	1.20 (l)	.07 (l)	17.1	4 (vl)	9 (v)l	.017 (l)	.27 (m)	.22 (m)	1.99 (h)	.010 (l)	0.2 (l)	0.6 (l)	32 (m)
Bushnell	S6	2.1 (m)	.19 (m)	11.1	33 (m)	22 (m)	.071 (h)	1.2 (vh)	.93 (h)	.24 (l)	.029 (m)	2.7 (m)	2.6 (m)	23 (m)
Bushnell/Palouse	S7	2.3 (m)	.16 (m)	14.4	25 (m)	11 (l)	.053 (h)	.76 (h)	.68 (h)	.16 (l)	.028 (m)	1.2 (m)	1.5 (m)	95 (h)
Bushnell/Palouse	R527	1.8 (m)	.14 (l)	12.9	18 (l)	16 (l)	.066 (h)	1.0 (h)	1.1 (vh)	.20 (l)	.03 (m)	1.5 (m)	1.5 (m)	119 (h)
Byee	RS27	1.6 (m)	.13 (l)	12.8	40 (m)	40 (m)	.056 (h)	.57 (h)	.35 (m)	.28 (l)	.022 (m)	2.9 (m)	0.7 (l)	26 (m)
Byee	BBR	2.2 (m)	.20 (m)	11	17 (l)	26 (m)	.063 (h)	.26 (m)	.18 (l)	.21 (ll	.034 (m)	3.8 (m)	1.6 (m)	58 (h)
Chelmsford	S19	3.1 (h)	.25 (m)	12.4	(svl)	11 (l)	.036 (m)	.24 (m)	.05 (vl)	.09 (vl)	.031 (m)	2.7 (m)	1.4 (m)	237 (h)
Coolabunia	S36	3.4 (h)	.24 (m)	14.2	27 (m)	16 (l)	.062 (h)	.68 (h)	.97 (h)	.15 (l)	.044 (m)	2.1 (m)	2.0 (m)	881 (h)
Eastgate	BBR S10	1.6 (m)	0.13 (l)	12.3	120 (vh)	100 (vh)	.115 (vh)	.61 (h)	.65 (h)	1.25 (h)	.019 (l0	3.0 (m)	1.0 (m)	63 (h)
Fairdale	S2	2.7 (h)	.24 (m)	11.3	8 (vl)	10 (vl)	.034 (m)	.41 (m)	.18 (l)	.38 (l)	.028 (m)	4.1 (m)	1.0 (m)	67 (h)
Fairdale	S28	2.8 (h)	.23 (m)	12.2	7 (vl)	12 (l)	.056 (h)	.37 (m)	.32 (m)	.44 (l)	.023 (m)	4.0 (m)	1.1 (m)	120 (h)
Goodger	S15	4.4 (h)	.24 (m)	18.3	8 (vl)	2 (vl)	.028 (m)	1.5 (vh)	2.2 (vh)	.23 (l)	.042 (m)	0.2 (l)	0.3 (l)	6 (m)
Goodger	S12	5.6 (vh)	.50 (h)	11.2	14 (l)	4 (vl)	.033 (m)	.78 (h)	.68 (h)	.11 (l)	.005 (l)	2.1 (m)	0.3 (l)	6 (m)
Goodger	S24	4.5 (h)	.35 (h)	12.9	7 (vl)	11 (l)	.004 (vl)	1.1 (vh)	.93 (h)	.12 (l)	.041 (m)	0.4 (n)	2.0 (m)	32 (m)
Gordonbrook	S25	3.2 (h)	.20 (m)	16	8 (vl)	17 (l)	.031 (m)	.67 (h)	.67 (h)	.16 (l)	.03 (m)	0.4 (m)	1.2 (m)	67 (h)
Gueena	BBR S5	1.7 (m)	.19 (m)	8.9	35 (m)	61 (h)	.088 (h)	.50 (h)	.80 (h)	.88 (m)	.033 (m)	3.2 (m)	1.0 (m)	57 (h)
Haly	S27	2.5 (h)	.16 (m)	15.6	12 (l)	27 (m)	.088 (h)	.33 (m)	.45 (m)	.14 (l)	.033 (m)	2.0 (m)	3.0 (m)	106 (h)
Hirst/Terrace	R527	1.3 (l0	.08 (l)	16.3	39 (m)	35 (m)	.043 (m)	.48 (m)	.44 (m)	2.54 (h)	.015 (l)	0.4 (m)	0.6 (m)	10 (m)
Hopevale	S14	2.9 (h)	.22 (m)	13.2	11 (l)	11 (l)	.068 (h)	1.8 (vh)	1.1 (vh)	.17 (l)	.051 (h)	1.3 (m)	3.2 (m)	15 (m)
Hopevale	R527	6.8 (vh)	.60v (h)	11.3	28 (m)	32 (m)	. 109(h)	1.9 (vh)	.33 (m)	.22 (l)	.103v (h)	0.7 (m)	1.7 (m)	10 (m)
Iona	S17	2.8 (h)	.21 (m)	13.3	22 (m)	18 (l)	.075 (h)	.65 (h)	1.2 (vh)	.59 (m)	.057 (h)	5.3 (h)	1.1 (m)	106 (h)
Kaber	S37	2.7 (h)	.19 (m)	20.8	-	12 (l)	.089 (h)	.78 (h)	1.0 (h)	.199 (l)	.045 (m)	3.0 (m)	0.7 (m)	4.2 (m)
Kawl Kawl	S32	2.3 (m)	.19 (m)	12.1	20 (m)	21 (m)	.055 (h)	.24 (m)	.25 (m)	.16 (l)	.04 (m)	2.0 (m)	0.8 (l)	33 (m)
Kawl Kawl	S33	1.9 (m)	.22 (m)	8.6	40 (m)	14 (l)	.033	.47 (m)	.656 (h)	.15 (l)	.073 (h)	0.6 (m)	0.5 (l)	13 (m)
Kawl Kawl	S3	2.6 (h)	.23 (m)	11.3	6 (vl)	7 (vl)	.043 (m)	.52 (h)	.51 (h)	.19 (l)	.056 (h)	1.4 (m)	0.6 (l)	25 (m)
Kumbia	S20	1.6 (m)	.13 (l)	12.3	2 (vl)	6 (vl)	.034 (m)	.32 (m)	.08 (vl)	.06 (vl)	.027 (m)	1.9 (m)	1.3 (m)	163 (h)
Lankowsky	S39	2.5 (h)	.13 (l)	19.2	-	6 (vl)	.073 (h)	.75 (h)	.78 (h)	.061 (vl)	.057 (h)	0.2 (l)	0.2 (l)	2 (l)
Long Peter	S40	1.9 (m)	.15 (l)	12.7	16 (l)	25 (m)	.093 (h)	.17 (l)	.03 (vl)	.22 (l)	.037 (m)	2.7 (m)	1.6 (m)	130 (h)

Table 6a (continued)

Soil profile class	Site No.	Org C %	Tot N %	Ratio C/N	Acid P mg/kg	BicarbP mg/kg	Tot P %	Extr K	Exch K meq/100g	Tot K %	Tot S %	Cu mg/kg	Zn mg/kg	Mn mg/kg
Marshlands	S9	2.4 (m)	.19 (m)	12.6	18 (l)	15 (l)	.063 (h)	.64 (h)	.45 (m)	.12 (l)	.027 (m)	2.0 (m)	1.6 (m)	147 (h)
McEuen	S16	2.8 (h)	.25 (m)	11.2	9 (vl)	8 (vl)	.038 (m)	.56 (h)	.35 (m)	.31 (l)	.028 (m)	5.0 (m)	1.7 (m)	107 (h)
Memerambi	S26	2.6 (h)	.32 (h)	8.1	70 (h)	86 (h)	.149 (vh)	2.2 (vh)	3.1 (vh)	.38 (l)	.04 (m)	3.8 (m)	7.3 (h)	179 (h)
Memerambi	S31	2.3 (m)	.22 (m)	10.5	46 (h)	36 (m)	.075 (h)	1.4 (vh)	.67 (h)	.54 (m)	.034 (m)	3.0 (m)	1.3 (m)	96 (h)
Memerambi	S35	2.9 (h)	.31 (h)	9.5	35 (m)	26 (m)	.022 (m)	1.4 (vh)	.65 (h)	.09 (vl)	.047 (m)	2.0 (m)	2.8 (m)	76 (h)
Memerambi	S21	2.5 (h)	.25 (m)	10	16 (l)	16 (l)	.05 (m)	1.9 (vh)	1.5 (vh)	.17 (l)	.038 (m)	1.9 (m)	2.7 (m)	142 (h)
Memerambi	S13	3.7 (h)	.32 (h)	11.6	6 (vl)	3 (vl)	.033 (m)	2.0 (vh)	.91 (h)	.13 (l)	.039 (m)	0.4 (m)	1.8 (m)	50 (h)
Memerambi	S1	4.9 (h)	.57v (h)	8.6	54 (h)	42 (h)	.13 (vh)	2.2 (vh)	2.0 (vh)	.27 (l)	.114v (h)	7.7 (h)	12 (h)	342 (h)
Memerambi	S34	2.9 (h)	.33 (h)	8.8	29 (m)	29 (m)	.073 (h)	1.9 (vh)	.67 (h)	.28 (l)	.053 (h)	4.0 (m)	4.0 (m)	211 (h)
Memerambi	S29	1.7 (m)	.12 (l)	14.2	4 (vl)	6 (vl)	.038 (m)	.37 (m)	.30 (m)	.10 (l)	.03 (m)	0.6 (m)	0.6 (m)(	24 (m)
Mondure	R527	0.9 (l)	.06 (l)	15	3 (vl)	6 (vl)	.023 (m)	.12 (l)	.14 (l)	.06 (vl)	.014 (l)	1.0 (m)	0.3 (l)	80 (h)
Mondure	S11	2.0 (m)	.13 (l)	15.5	5 (vl)	5 (vl)	.055 (h)	.35 (m)	.18 (l)	.09 (vl)	.026 (m)	2.6 (m)	1.5 (m)	320 (h)
Mondure	S8	2.1 (m)	.13 (l)	16.2	7 (vl)	6 (vl)	.062 (h)	.50 (h)	.31 (m)	.11 (l)	.028 (m)	2.0 (m)	1.2 (m)	280 (h)
Palouse	S5	1.7 (m)	.12 (l)	17	12 (l)	5 (vl)	.024 (m)	.47 (m)	.35 (m)	.18 (l)	.016 (l)	0.6 (m)	6.2 (h)	75 (h)
Palouse	S18	2.3 (m)	.17 (m)	13.5	6 (vl)	4 (vl)	.031 (m)	.59 (h)	.23 (m)	.20 (l)	.015 (l)	1.0 (m)	1.0 (m)	140 (h)
Tarong	S23	1.7 (m)	.10 (l)	17	6 (vl)	7 (vl)	.020 (l)	.13 (l)	.03 (vl)	.03 (vl)	.015 (l)	0.4 (m)	0.4 (l)	16 (m)
Tureen	S40	6.5 (vh)	.34 (j)	19.1	-	14.7 (vh)	.063 (vh)	.61 (h)	1.8 (vh)	1.93 (h)	.068 (h)	0.7 (m)	4.0 (m)	46 (m)
Weir	BBRS1	2.9 (h)	.10 (l)	29	120 (vh)	100 (vh)	.123 (vh)	.72 (h)	.66 (h)	1.39 (h)	.033 (m)	2.8 (m)	5.2 (h)	77 (h)
Weir	R527	1.6 (m)	.11 (l)	14.5	205 (vh)	140 (vh)	.104 (vh)	.99 (h)	.40 (m)	1.22 (h)	.02 (m)	2.0 (m)	1.8 (m)	48 (m)
Wooroolin	S22	3.1 (h)	.30 (h)	10.3	35 (m)	20 (m)	.042 (m)	1.0 (vh)	.82 (h)	.14 (l)	.048 (m)	0.7 (m)	3.4 (m)	70 (h)

vh – very high; h – high; m – medium; l – low; vl – very low

Table 6b. Soil chemical ratings for the soil profile classes

Soil Type	CL Depth (m)					pH Depth (m)					EC Depth (m)				
	0.05	.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2
Appaloosa	vl	m	h	h	h	6.6	7.1	8.2	8.2	8.1	vl	l	m	m	m
Archookoora	vl	vl	vl	vl	vl	6.66	6.3	6.7	6.9	6.9	vl	vl	vl	vl	vl
Archookoora	vl	vl	m	h	h	6.5	6.4	6.6	8.2	8.8	vl	vl	l	m	h
Avon	vl	m	h	h	m	6.3	8.6	8.9	9.0	9.0	vl	l	m	m	m
Boonenne	vl	vl	m	l	l	5.8	6.7	7.9	8.4	8.5	vl	vl	l	l	vl
Bushnell	vl	vl	m	h	h	6.5	7.5	8.9	8.9	8.7	vl	vl	l	m	h
Bushnell/Palouse	vl	l	h	h	h	6.8	8.0	9.0	9.1	8.9	vl	l	m	m	h
Bushnell/Palouse	vl	m	h	h	m	6.6	7.1	8.3	8.2	8.1	vl	l	m	m	m
Byee	vl	vl	vl	l	l	6.7	7.5	7.9	7.9	8.4	vl	vl	vl	l	l
Byee	vl	vl	vl	l	l	6.6	7.1	7.0	7.4	8.3	vl	vl	vl	l	l
Chelmsford	vl	vl	vl	vl	vl	6.6	6.0	6.1	6.4	8.4	vl	vl	vl	vl	vl
Coolabunia	vl	vl	vl	vl	vl	5.9	6.3	6.6	6.7	6.7	vl	vl	vl	vl	vl
Eastgate	vl	l	m	m	m	6.4	6.7	7.3	7.9	8.1	vl	vl	l	l	l
Fairdale	vl	vl	vl	vl	l	6.1	6.8	7.9	8.5	8.4	vl	vl	l	vl	l
Fairdale	vl	vl	m	m	l	6.5	6.4	7.5	8.4	8.5	vl	vl	l	l	l
Goodger	vl	vl	vl	vl	vl	5.7	.59	6.2	5.8	6.1	vl	vl	vl	vl	vl
Goodger	vl	vl	vl	vl	vl	5.5	5.8	5.8	6.0	6.1	l	vl	vl	vl	vl
Goodger	vl	vl	vl	vl	l	5.4	5.8	5.6	5.9	5.9	vl	vl	vl	vl	vl
Gordonbrook	vl	vl	vl	vl	vl	6.7	6.4	5.9	6.0	5.9	vl	vl	vl	vl	vl
Gueena	vl	l	l	m	m	6.3	7.2	7.8	8.2	9.1	vl	vl	l	l	m
Haly	vl	vl	vl	vl	vl	5.9	5.6	6.4	6.7	6.7	vl	vl	vl	vl	vl
Hirst/Terrace	vl	vl	vl	vl	l	6.0	6.4	7.3	7.1	7.6	vl	vl	vl	vl	vl
Hopevale	vl	vl	vl	vl	vl	5.9	5.2	4.9	4.6	4.4	vl	vl	vl	vl	vl
Hopevale	vl	vl	vl	vl	vl	5.8	5.2	5.2	5.1	5.0	vl	vl	vl	vl	vl
Iona	vl	vl	h	m	m	7.0	7.1	8.1	7.9	8.3	l	vl	l	l	l
Kaber	vl	l	m	m	m	6.5	6.4	6.9	8.2	8.5	vl	vl	l	l	l
Kawl Kawl	l	h	vh	vh	vh	7.6	8.2	8.3	8.3	8.4	vl	m	h	vh	vh
Kawl Kawl	h	h	h	h	m	8.4	8.8	8.8	8.8	8.9	m	h	h	m	l

Table 6b (continued)

Soil Type	CL Depth (m)					PH Depth (m)					EC Depth (m)				
	0.05	.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2
Kawl Kawl	vl	vl	vl	vl	vl	8.1	8.6	8.8	8.5	8.8	l	vl	vl	vl	vl
Kumbia	vl	vl	vl	vl	m	6.4	6.3	6.7	6.5	6.1	vl	vl	vl	vl	l
Lankowsky	vl	vl	vl	vl	vl	5.9	6.2	6.4	6.4	6.6	vl	vl	vl	vl	vl
Long Peter	vl	vl	h	h	vh	7.0	8.6	9.0	8.8	8.4	vl	l	m	h	h
Marshlands	vl	vl	m	h	h	7.5	7.0	6.6	6.4	7.5	vl	vl	l	m	m
McEuen	vl	vl	vl	vl	-	6.4	6.9	7.7	7.8	-	vl	vl	vl	vl	-
Memerambi	vl	vl	vl	vl	vl	5.4	5.5	4.6	4.3	4.0	vl	vl	vl	vl	vl
Memerambi	vl	vl	vl	vl	vl	6.4	5.7	4.7	4.5	4.5	vl	vl	vl	vl	vl
Memerambi	vl	vl	vl	vl	vl	4.9	4.4	4.5	4.2	4.6	vl	vl	vl	vl	vl
Memerambi	vl	vl	vl	vl	vl	4.6	4.7	4.5	4.4	4.7	vl	vl	vl	vl	vl
Memerambi	vl	vl	vl	vl	vl	5.6	5.8	5.5	5.3	5.3	vl	vl	vl	vl	vl
Memerambi	vl	vl	l	m	m	6.2	6.0	6.4	6.6	5.8	l	l	m	m	M
Memerambi	vl	vl	vl	vl	vl	6.5	6.7	6.4	6.2	6.0	vl	vl	vl	vl	vl
Memerambi	vl	vl	vl	vl	vl	6.0	6.5	6.3	6.3	6.4	vl	vl	vl	vl	vl
Mondure	vl	vl	m	m	-	6.0	6.1	7.9	9.2	-	vl	vl	l	l	-
Mondure	vl	vl	vl	l	m	6.0	6.3	6.7	6.6	7.8	vl	vl	vl	l	l
Mondure	vl	vl	m	h	h	7.1	6.9	6.4	6.6	8.1	vl	vl	l	m	m
Palouse	vl	m	h	h	h	7.2	8.1	6.8	6.7	7.3	vl	l	l	l	m
Palouse	vl	h	h	m	m	7.1	5.0	6.5	9.3	9.2	vl	m	m	l	l
Tarong	vl	vl	m	h	h	5.7	5.6	4.7	4.5	4.3	vl	vl	l	l	l
Tureen	vl	vl	vl	-	-	6.7	6.7	6.4	-	-	vl	vl	vl	-	-
Weir	vl	vl	m	m	m	6.4	6.7	8.2	8.8	8.7	vl	vl	l	l	l
Weir	vl	vl	vl	l	l	6.3	6.2	7.7	8.3	8.6	vl	vl	vl	vl	l
Wooroolin	vl	vl	vl	l	m	6.3	5.3	5.9	6.0	6.1	l	vl	vl	l	l

vh – very high; h – high; m – medium; l – low; vl – very low

Table 6c. Soil chemical ratings for the soil profile classes

Soil Type	Dispersion ratio					Ac/Mg					ESP					PAWC
	Depth (m)					Depth (m)					Depth (m)					
	0.05	0.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2	mm
Appaloosa	0.49	.86	.99	.99	0	1.0	.62	.35	.24	.16	2.6	13.6	22.6	24.2	26.9	80
Archookoora	.3	.41	.36	.32	.42	1.6	1.6	2.1	2.0	1.8	1.5	1.4	1.5	1.7	1.9	180
Archookoora	.27	.50	.45	.97	0	1.02	.33	.22	.25	.26	2.6	7.5	14.4	24	30	120
Avon	.57	.99	.99	.99	0	.66	.38	.30	.29	.27	3	19	32	25	31	80
Boonenne	.43	.53	.95	.30	0	1.6	.52	.04	.01	.02	2.8	5.0	28	33	32	60
Tureen	.24	.26	.41	-	-	2.5	2.2	1.9	-	-	0.4	1.0	1.6	-	-	120
Bushnell	.36	.77	.85	.86	-	2.6	.77	.42	.29	.20	1.8	9.4	22.1	29.5	32	80
Bushnell/Palouse	.46	.65	.72	.82	.88	2.2	1.9	.45	.33	.19	1.3	12.1	21.0	28.9	31.8	70
Bushnell/Palouse	.49	.96	.99	.99	-	1.0	.48	.36	.25	.17	2.6	13	22	24	26	70
Byee	.48	.47	.66	.69	-	.91	.85	.77	.68	.50	1.4	3.5	6.0	6.1	7.2	150
Byee	.34	.36	.40	.42	-	0.63	0.61	.56	0.49	0.44	2.5	2.5	3.6	4.8	5.6	150
Chelmsford	.21	.15	.09	.15	-	2.3	2.2	2.5	3.2	2.9	0.6	0.5	0.6	0.4	0.6	200
Coolabunia	.32	.28	.28	.16	-	1.8	2.9	2.24	1.8	1.5	0.9	1.1	1.8	1.9	1.5	200+
Eastgate	.56	.62	.54	.63	-	.86	1.0	1.9	.95	.91	2.5	4.3	6.5	7.7	7.7	120
Fairdale	.49	.55	.57	.53	-	.64	.74	.78	.79	.78	1.8	3.2	4.0	5.1	5.4	200
Fairdale	.46	.47	-	.56	.53	.90	.68	.56	.55	.54	1.3	2.4	4.7	4.1	4.3	180
Goodger	.34	.57	.44	.18	.13	.63	.14	.06	.03	.02	0.5	1.1	3.5	5.6	8.7	150
Goodger	-	.2	.42	.30	.01	.96	.22	.03	.02	.02	0.8	1	2	6	7.5	150
Goodger	.40	.33	.34	.33	-	1.3	1.0	0.16	.03	.02	1.3	1.9	1.7	1.7	3.3	120
Gordonbrook	.28	.40	.16	.04	.08	2.9	3.1	2.0	1.7	1.5	0.6	2.0	1.5	1.7	2.8	150
Gueena	.43	.71	.85	.89	-	.76	.73	.67	.67	.61	1.8	4.9	9.8	13.0	15.6	150
Haly	.27	.21	.27	.38	.53	2.1	0.4	.04	.06	.11	0.5	1.5	5.0	6.7	7.1	180
Hirst/Terrace	.05	.94	.78	.78	-	1.3	3.3	1.4	1.4	1.6	1.25	1.67	1.25	3.0	4.3	150
Hopevale	.20	.20	.28	.36	.62	3.7	4.5	2.2	2.0	2.3	.42	.59	.63	1.1	2.0	120
Hopevale	-	-	.31	.32	-	1.7	4.0	7.0	1.4	-	.01	.10	.12	.52	-	120
Iona	.41	.43	.46	.51	.67	1.39	1.27	1.05	0.95	1.05	0.6	1.4	2.78	3.2	3.2	180
Kaber	.33	.51	.55	.63	-	.83	.58	.48	.54	.46	2.0	5.3	8.4	8.5	10.2	200

Table 6c (continued)

Soil Type	Dispersion ratio Depth (m)					Ca/Mg ratio Depth (m)					ESP Depth (m)					PAWC
	0.05	0.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2	0.05	0.3	0.6	0.9	1.2	mm
Kawl Kawl	.35	.55	.64	.61	.78	.35	.20	.17	.12	.08	3.0	9.3	15.3	17.3	19.4	100
Kawl Kawl	.45	.61	.58	.67	.80	.28	.20	.25	.26	.33	7.0	9.0	7.0	7.0	7.0	120
Kawl Kawl	.30	.58	.56	.42	.45	3.0	2.2	1.4	.15	.88	0.2	0.5	0.5	0.9	0.7	150
Kumbia	.32	.31	.29	.02	.46	1.3	1.5	.84	.40	.31	0.6	0.9	0.8	1.3	3.4	200
Lankowsky	.42	.23	.38	.28	-	1.3	.81	1.2	1.0	1.0	2.6	.38	1.0	1.4	1.6	150
Long Peter	.35	.57	.76	.94	-	1.8	.93	.44	.20	.11	3.4	9.0	20.7	29.1	29.4	60
Marshlands	.45	.65	.51	.55	.91	1.2	.31	.09	.12	.16	2.8	6.8	15	19.1	28.8	100
McEuen	.33	.40	.68	.49	-	1.4	1.6	2.6	1.8		0.5	0.9	2.6	1.1		120
Memerambi	.22	.19	.17	.20	-	2.3	2.8	5.4	5.0	5.6	D.S	1.1	0.9	1.3	1.3	180
Memerambi	.22	.22	.01	.01	-	6.1	7.2	92	4	.98	.1	1	<1	<1	1.1	150
Memerambi	.18	.22	.20	.23	-	3.9	2.2	2.1	3.5	.28	0.3	0.4	0.4	1.5	2.2	100
Memerambi	.16	.19	.09	.04	.04	1.1	1.09	3.9	1.9	.21	0.5	0.6	0.7	0.9	0.9	120
Memerambi	.26	.21	.23	.02	.03	1.8	1.6	.05	.02	.02	0.3	0.4	0.5	0.8	1.9	150
Wooroolin	.22	.59	.18	.19	.05	2.6	1.6	.57	.55	.45	0.6	0.9	2.5	4.3	5.0	180
Memerambi	.17	.22	.27	.04	.03	4.4	3.6	3.1	2.2	0.6	0.3	0.9	1.3	1.5	1.5	
Memerambi	.25	.15	.23	.27	-	3.8	4.6	4.5	2.1	1.5	0.5	1.1	2.4	1.7	1.9	100
Memerambi	.35	.47	.34	.29	-	1.1	1.0	.13	.04	.09	1	1.2	3.5	4.7	7.0	100
Mondure	.49	.45	.90	.93	-	.35	.27	.46	.49		1.5	6.0	16.1	26.1		80
Mondure	.47	.53	.51	.60	.77	1.15	.64	.49	.41	.40	0.5	2	5	8.9	13.8	120
Mondure	.36	.62	.35	.64	.96	1.14	.57	.09	.09	.14	1.1	5.7	14.0	24.3	34.4	80
Palouse	.56	.89	.87	.88		3.3	.16	.04	.01	.02	2.6	14.5	20.7	30	32	60
Palouse	.46	.55	.82	.91	-	1.3	.15	.18	.25	.20	1.1	10.7	17.8	23.9	25.0	60
Tarong	.66	.36	.15	.54	.76	.71	.01	.01	.01	.01	.08	4.8	7.6	11.4	14.3	80
Weir	.39	.53	.55	.57	-	1.2	1.1	1.0	.9	.9	2.5	6.4	12.2	13.8	11.6	140
Weir	.81	.70	.78	.73	-	1.7	1.6	1.4	1.26	1.2	1.8	1.9	4.4	7.6	8.4	140

Salinity
Electrical conductivity (EC) is a measure of the total soluble salts in a soil while chloride (Cl) concentration indicates the contribution of chloride ions, usually as sodium chloride salt. For all soils in the Kingaroy area, chloride salts are the major contribution to salinity.

Surface EC and Cl levels are very low to low (EC <0.45 dS/m, Cl <0.03%) in the surface and very low to high (EC <0.15 to >2 dS/m, Cl <0.01 to >0.2%) in the subsoil.

Generally, higher salt levels correspond to higher pH values, particularly when pH >8.5. In the young alluvial soils, subsoil EC and Cl are low to moderate, while in old alluvium soils EC ranges from moderate to very high, and Cl from moderate to high corresponding to impermeable subsoils.

Salts in subsoils of the fresh basaltic soils are typically low except in the deep clays on lower slopes where a salt buldge with medium salt levels occurs at 0.6–0.9 m.

The highly permeable deeply weathered basaltic soils are typically very low to low in salts in the subsoils except where they overlie impermeable old alluvium or Tertiary sediments. The impermeable layers may have moderate to high salts levels. The highly permeable soils in upper landscape positions are typically recharge areas which contribute deep drainage and may result in discharge areas on adjacent lower slopes.

Granitic soils on mid to upper slopes are very low to low in subsoils salts. No profiles were analysed on lower slopes, however the presence of strongly alkaline pH (>8.5) would indicate impermeable subsoils and salt accumulation.

Sodicity and dispersion ratio
Sodicity is a measure of the exchangeable sodium percentage (ESP = exchangeable Na/CEC x 100) in the soil. Non sodic soils have an ESP <6%, sodic have an ESP 6–15%, and strongly sodic have an ESP >15% (Northcote and Skene 1972).

High sodicity influences physical properties of soils, causing clays to disperse which influences permeability and root growth. High ESP is usually associated with higher EC and Cl levels, a high dispersion ratio (>0.8), and high pH values. In low pH soils with high ESP, calcium is usually low.

ESP in the surface of all soils in the study area is predominately non sodic (ESP 0.01–3.4) with only one sample being sodic (ESP 7). Subsoil ESP ranges from non sodic to strongly sodic (ESP 0.4–34).

The subsoils of the young alluvial soils range from sodic to strongly sodic (ESP 7.2–26) corresponding to low to medium salt levels respectively. Dispersion ratios range from 0.69 to 0.99 corresponding to sodicity.

The older alluvium soils have strongly sodic subsoils (ESP 19–32) corresponding to a dispersion ratio of 0.78–0.99. These impermeable subsoils reflect moderate to very high salt levels and strongly alkaline pH (≥ 8.5).

Fresh basaltic soils are non sodic (ESP 1.6–5.4) and non dispersive (dispersion ratio 0.49–0.67) reflecting low salt levels. The deeply weathered basaltic soils are non sodic (ESP 0.18–3.3) except where soils overlie deeply weathered basalt rock or old alluvium and Tertiary sediments (ESP 7–14.3). The non sodic highly permeable soils are non dispersive (dispersion ratio 0.04–0.33) while the sodic deeply weathered clay and buried clays are also non dispersive (dispersion ratio 0.18–0.76). The non sodic soils have low salt levels and an acid to neutral pH while the sodic clays have salt accumulation.

The granitic soils have non sodic to strongly sodic subsoils (ESP 2.8–33) and non dispersive to dispersive subsoils (dispersion ratio 0.08–0.95). The non sodic soils have an acid pH while the strongly sodic subsoils are strongly alkaline.

Calcium/magnesium ratio

Calcium/magnesium ratio (Ca/Mg) is a measure of the relative abundance of the two exchangeable cations. On highly weathered soils the calcium tends to have been leached out of the profile while magnesium has accumulated. Calcium tends to accumulate in impermeable subsoils where the parent material is high in calcium, for example basalt. Also, pH is often related to relative abundance of calcium. For example, low calcium (<0.5 meq/100 g) and low Ca/Mg (<0.5) often corresponds to low pH, while high calcium (>2 meq/100 g) generally corresponds to a neutral to strongly alkaline pH. High Ca/Mg (>1) is usually associated with non dispersive soils, while low Ca/Mg (<0.5) is usually associated with dispersive soils.

Due to calcium accumulation at the surface from organic matter, all soils show a decrease in the Ca/Mg ratio with depth. The Ca/Mg ratio for all surface soils ranges from 0.28 to 6.1 while subsoils range from 0.01 to 5.6.

The young alluvial soils have a surface Ca/Mg of 0.63–1.7 decreasing slightly to 0.44–1.6 in the subsoil. These generally high Ca/Mg ratios correspond to neutral to alkaline pH.

Old alluvial soils have a surface Ca/Mg of 0.35–3.3 decreasing to 0.02–0.33 in the subsoil. These low subsoil Ca/Mg ratios indicate a relative decrease in calcium which correspond to strongly sodic and dispersive subsoils, high salt levels and high pH.

Soils on fresh basalt have a Ca/Mg ratio of 0.64–2.5 decreasing slightly to 0.54–1.9 in the subsoil. These calcium dominant or near co-dominant Ca/Mg ratio soils are generally non sodic, non saline, non dispersive and alkaline to moderately alkaline.

The surface of deeply weathered basaltic soils has a Ca/Mg ratio of 1.1–6.1 decreasing dramatically to 0.02–2.3 in the subsoil. The lower Ca/Mg ratio values correspond to the lower pH values. However, these soils are non sodic and non dispersive possibly indicating the influence of exchangeable aluminium. This results in a high soil stability where soils are strongly acid (pH <5.5).

Ca/Mg ratio of the granitic soils ranges from 1.6–2.9 in the surface decreasing to 0.01–1.5 in the subsoil. The higher Ca/Mg ratio values correspond to non sodic, non dispersive, slightly acid subsoils while the lower Ca/Mg ratio values are associated with strongly sodic, dispersive subsoils.

Plant available water capacity

Plant available water capacity (PAWC) is a measure of the amount of water stored in the soil available to plants over the rooting depth. PAWC has been determined for each 10 cm interval in the soil profile using the method of Shaw and Yule (1978). The effective rooting depth is determined as the depth of high salts (>0.6% Cl) or the depth to rock or other impermeable layers.

PAWC is also related to texture and clay types. Clay texture soils will hold greater amounts of water than sandy textured soils due to a higher proportion of fine pores. Structured soils will hold more water than similar textured non structured soils due to pore space between the structured peds.

The deep young alluvial and basaltic clays dominated by montmorillonite clays have high PAWC (120–150 mm to 1 m). The old alluvial clays have lower PAWC (80–120 mm) due mainly to shallow rooting depth (0.4–0.6 m). The sodic texture soils generally have slightly lower PAWC (60–100 mm) due to lighter surface textures and shallower rooting depth (dominantly 0.4–0.5 m).

PAWC on the deeply weathered basaltic soils ranges 120–200 mm. PAWC is high due mainly to a deep rooting depth (>1.2 m). Soils with very high organic matter in the surface have higher PAWC values.

Granitic soils have low to high PAWC (60–150 mm). The lower PAWC is associated with coarse sandy surfaced sodic texture contrast soil with a rooting depth of 0.4 m. The higher PAWC is associated with a deep, strongly structured non sodic soil.

Clay activity ratio

Clay activity ratio (CEC/Clay%) indicates the type of clay present. In general, a clay activity ratio <0.2 indicates kaolinitic clay, 0.3–0.5 indicates illite type clays, 0.5–0.7 indicates mixed clays and >0.8 indicates soils dominated by montmorillonite type clays. Due to surface organic matter influencing CEC, subsoil clay activity ratio is discussed only (≥ 0.6 m). Table 7 shows the clay activity ratio for the analysed soils.

The young alluvial soils have a CEC/clay ratio of 0.66–0.92 indicating soils are dominated by montmorillonite type clays. These montmorillonite clays usually have strong shrink swell properties and where associated with good Ca/Mg ratios (>0.5), soils are non dispersive. The lower CEC/clay ratio (0.21–0.56) in the soils on old alluvium indicates illite clays or mixed kaolinitic, illitic and montmorillinitic type clays. These lower values compared to the soils on young alluvium may indicate a longer period of weathering and/or a different source of parent material. The illite and mixed clay types in clay textured soils are frequently strongly sodic, saline and dispersive (Shaw *et al.* 1986).

The soils on fresh basalt have CEC/clay ratios of 0.72–4.4 indicating montmorillonite clays with strong shrink swell properties in clay textured soils. These soils are non sodic, non dispersive and generally fertile due to the high CEC.

Deeply weathered basaltic soils have a CEC/clay ratio of 0.1–0.4 but predominately <0.2 indicating kaolinitic clays. Where sodic buried alluvium or Tertiary sediments occur, these buried clays have a CEC/clay ratio of <0.2. These sodic buried clays are non dispersive indicating the influence of clay type on dispersion.

In the deeply weathered basaltic clays which are strongly acid (pH <5.5), the sum of cations is less than CEC indicating high levels of exchangeable aluminium (which was not assessed) and/or variable charged clays.

Granitic soils have a CEC/clay ratio of 0.19–0.78. The lower value of 0.19 is typical of the kaolinitic clays derived from potassium feldspars in granite while the higher value of 0.78 indicates montmorillonitic clays associated with granodiorite.

Table 7. Clay Activity Ratio* of soil profiles classes

SPC	Depth (m)				
	0.05	**0.3**	**0.6**	**0.9**	**1.2**
Appaloosa	0.89	0.64	0.53	0.56	0.53
Archookoora	0.57	0.52	0.29	0.25	0.28
Archookoora	0.69	0.38	0.31	0.39	0.41
Avon	0.95	0.6	0.56	0.55	0.55
Boonenne	0.67	0.22	0.3	0.43	0.78
Bushnell	0.63	0.36	0.3	0.32	0.32
Bushnell	0.82	0.41	0.34	0.3	0.28
Bushnell	0.85	0.61	0.51	0.55	0.51

Table 7 (continued)

SPC	Depth (m)				
	0.05	0.3	0.6	0.9	1.2
Byee	0.94	0.9	0.89	0.98	0.84
Byee	0.96	0.85	0.88	0.9	0.91
Chelmsford	0.46	0.29	0.21	0.27	0.4
Coolabunia	0.48	0.33	0.17	0.18	0.15
Eastgate	0.73	0.77	0.78	0.76	0.76
Fairdale	1.27	0.84	1.07	4.38	3.0
Fairdale	1.04	0.83	0.87	1.0	1.81
Goodger	5.56	6.5	0.96	0.38	0.25
Goodger	7.5	4.08	1.79	0.37	0.25
Goodger	1.09	0.87	0.59	0.29	0.16
Gordonbrook	0.71	0.17	0.19	0.2	0.2
Gueena	0.82	0.71	0.69	0.75	0.75
Haly	0.45	0.2	0.18	0.19	0.21
Hirst	1.33	1.5	0.6	0.48	0.56
Hopevale	0.57	0.47	0.37	0.26	0.21
Hopevale	8.86	8.83	4.33	1.27	-
Iona	1.26	0.86	1.03	0.99	1.14
Kaber	0.79	0.63	0.61	0.78	0.7
Kaber	0.56	0.56	0.34	0.23	0.21
Kawl Kawl	0.73	0.53	0.48	0.5	0.57
Kawl Kawl	0.87	0.42	0.36	0.39	0.42
Kawl Kawl	0.91	0.3	0.39	0.38	0.38
Kumbia	0.33	0.6	0.23	0.21	0.23
Lankowsky	1.39	1.17	0.5	0.24	0.16
Long Peter	0.74	0.46	0.43	0.48	0.49
Marshlands	0.83	0.45	0.3	0.29	0.34
McEuen	1.0	1.41	4.77	7.86	-
Memerambi	0.45	0.19	0.13	0.1	0.1
Memerambi	0.27	0.27	0.2	0.18	0.1
Memerambi	0.8	0.55	0.55	0.5	0.38
Memerambi	0.39	0.36	0.26	0.22	0.2

Table 7 (continued)

SPC	Depth (m)				
	0.05	**0.3**	**0.6**	**0.9**	**1.2**
Memerambi	1.03	1.06	0.4	0.17	0.16
Memerambi	0.92	0.43	0.22	0.18	0.17
Memerambi	0.53	0.36	0.21	0.24	0.22
Mondure	0.63	0.37	0.38	0.43	-
Mondure	0.78	0.32	0.24	0.32	0.34
Mondure	0.64	0.5	0.27	0.28	0.35
Palouse	0.67	0.24	0.29	0.34	0.43
Palouse	0.47	0.29	0.34	0.44	0.5
Tarong	0.4	0.26	0.28	0.31	0.35
Tureen	1.41	0.88	0.72	-	-
Weir	0.83	0.75	0.7	0.66	0.71
Weir	0.83	0.85	0.75	0.66	0.77
Wooroolin	0.89	0.52	0.26	0.28	0.2
Wooroolin	0.56	0.56	0.34	0.23	0.21

* The Clay Activity Ratio is calculated from the Cation Exchange Capacity (CEC) and Clay% i.e. CEC/Clay

5. Land Evaluation

5.1 Land use limitations by soil profile class

The agricultural potential of land in the survey area was assessed for:

- dryland (rainfed) cropping
- dryland sown pastures
- tree and vine crops

The five-class land suitability classification used in this study is outlined in Section 3.4. To quantify the limitations that apply in each UMA, particular limitation levels are recorded for each limitation. For example, in Table 8, there are four limitation levels for soil water availability coded M1 to M4, in order of increasing severity. On the basis of the limitation levels recorded, each UMA is then allocated to one of the pre-determined soil water suitability subclasses for each land use. All the limitations are considered in turn, and the combination of suitability subclasses in each UMA is then used to derive an overall suitability class (1 to 5) for each land use. The suitability class is usually determined by the most severe limitation identified (Land Resources Branch Staff 1990). The limitation level codes listed in each table in this section are the soil/land limitation level recorded in the UMA database.

5.1.1 Soil water availability (M)

One of the main functions of soil is to store moisture and supply it to plants between rainfall events. Plant yield is decreased by periods of water stress, particularly during critical growth periods.

The amount of water stored in the soil that is available for plant growth is called the PAWC (plant available water capacity). Soil morphological and analytical properties (texture, structure and soil depth) are used to derive estimates of PAWC for each soil profile class however, it is necessary for this to be modified depending on observations (or estimations) of soil depth. Maximum rooting depth is assumed to be 1 metre.

Soil water availability is a critical limiting factor for rainfed land use options. A limitation level of M3 (PAWC 60–90 mm) is considered inadequate for dryland cropping and is therefore given a suitability subclass of 4. A limitation level of M4 (PAWC <60 mm) is regarded as a prohibitive limitation for dryland sown pasture.

Table 8. Soil water availability limitation

Limitation level	Code	Suitability subclass for various land uses		
		Dryland sown pastures	Dryland crops	Tree and vine crops
PAWC >120 mm	M1	1	2	1
PAWC 90 – 120 mm	M2	2	3	2
PAWC 60 – 90 mm	M3	3	4	2
PAWC <60 mm	M4	4	5	3

5.1.2 Workability (Pm)

Soil workability refers to the suitability of the soil for cultivation based on strength and moisture range.

Strength of soil is its resistance to breaking or deformation (McDonald *et al.* 1990), it is a measure of how 'tough' the soil is. Moisture range refers to the appropriate range in soil moisture content over which a soil can be successfully cultivated (without compacting or pulverising the soil, both of which can lead to long-term soil damage). Some soils can be worked at any moisture content, while others have only a narrow suitability range.

Limitation levels are established from a knowledge of soil properties. Suitability subclasses are derived from local knowledge and extension advice. Extra management is required on soils with physical limitations.

Table 9. Workability limitation

Limitation level	Code	Suitability subclass for various land uses		
		Dryland sown pastures	**Dryland crops**	**Tree and vine crops**
Sands; loose to firm loams	Pm1	1	1	1
Strongly structured light clays and clay loams; coarse sandy clay loams	Pm2	1	2	1
Self-mulching clays; hard setting sandy loams to clay loams	Pm3	2	2	2
Coarse structured (hard) clays	Pm4	2	3	2
Eroded and very hard setting soils	Pm5	4	5	4

Workability is not a severe limitation for any of the land uses investigated except in the case of eroded and very hard setting soils (Pm5 attribute level).

5.1.3 Surface condition (Ps)

Seedling emergence and establishment are affected by adverse physical conditions of the surface soil including hard setting, crusting or coarse surface structure conditions. Surface condition is not a precluding limitation for any of the investigated land uses. However, soils with hard setting or crusting surfaces are given a moderate limitation for dryland cropping.

All soil profile classes were allocated an attribute level for soil condition that applied generally throughout the survey area. However, these were modified on the basis of field observations and two or three surface condition categories may apply in different situations. Site disturbance and management also have an effect.

Table 10. Surface condition limitation

Limitation level	Code	Suitability subclass for various land uses		
		Dryland sown pastures	**Dryland crops**	**Tree and vine crops**
Sands, fine self-mulching clays	Ps1	1	1	1
Coarse self-mulching clays, firm surface duplex soils	Ps2	2	2	1
Other soils – hard setting or crusting	Ps3	2	3	1

5.1.4 Nutrient deficiency (Nd)

Inadequate nutrient supply causes reduction in plant yield, especially during critical periods such as flowering and fruiting. Livestock production may be limited by either a reduction in pasture growth or pasture nutritive value caused by low soil nutrients.

Limitation levels and suitability subclasses are based on critical levels of key nutrients required for pasture production (Rayment and Bruce 1984; Ahern *et al.* 1994). Critical levels for nitrogen have not been included as nitrate-nitrogen varies according to the rate of mineralisation from soil organic matter and losses of nitrate by leaching and biological removal. Temperature, rainfall and other soil conditions also influence these processes (Rayment and Bruce 1984). Addition of nutrients is standard management practice for crops as well as tree and vine crops.

Table 11. Nutrient deficiency limitation

Limitation level	**Code**	**Suitability subclass for various land uses**		
P = bicarb. extr. P (mg/kg) **S = extr. sulfate S (mg/kg)** **K = extr. K (m. equiv/100g)**		**Dryland sown pastures**	**Dryland crops**	**Tree and vine crops**
>30 P, >5 S, >0.25 K	Nd1	1	1	1
>30 P, >5 S, <0.25 K >30 P, <5 S, >0.25 K >30 P, <5 S, <0.25 K 20 – 30 P, >5 S, >0.25 K 20 – 30 P, >5 S, <0.25 K 20 – 30 P, <5 S, >0.25 K	Nd2	2	2	1
20 – 30 P, <5 S, <0.25 K 10 – 20 P, >5 S, >0.25 K 10 – 20 P, >5 S, <0.25 K 10 – 20 P, <5 S, >0.25 K	Nd3	3	3	1
10 – 20 P, <5 S, <0.25 K <10 P, >5 S, >0.25 K <10 P, >5 S, <0.25 K <10 P, <5 S, >0.25 K <10 P, <5 S, <0.25 K	Nd4	4	4	2

On the basis of laboratory analyses, all soil profile classes were allocated an attribute level for nutrient deficiency that applied throughout the survey area.

5.1.5 Flooding (F)

Land periodically inundated by water from stream channel overflow has a flooding limitation. Flooding causes damage due to both fast flowing water and submersion by water. The severity of flooding as a limitation depends on the frequency, duration, depth and velocity of the floodwaters. The duration of inundation is perhaps the most critical factor of all and the most difficult to estimate.

Limitation levels and suitability subclasses are based on landform observations and local knowledge.

Table 12. Flooding limitation

Limitation level	Code	Suitability subclass for various land uses		
Flood frequency		Dryland sown pastures	Dryland crops	Tree and vine crops
Flood free	F1	1	1	1
>1:10 years	F2	1	2	2
1:2 to 1:10 years	F3	2	2	3
< 1:2 years	F4	2	4	4

Areas with an average flood frequency of more than one flood every two years (attribute level F4) were given a severe flooding limitation for dryland crops and tree and vine crops.

5.1.6 Frost (Cf)

Frosts may suppress growth, reduce yield or kill plants. Plant species vary in their tolerance to frost. Frost may damage the flowers or fruit of moderately sensitive crops.

Limitation levels and suitability subclasses are based on crop tolerance information, local knowledge, climate data and an assessment of local topography and landscape position. Low-lying areas may receive on average about 10–20 frosts in the period May to September (see Section 2.2)

Areas with frequent light and infrequent heavy frosts (Code Cf3) were given a moderate frost limitation for tree and vine crops.

Table 13. Frost limitation

Limitation level	Code	Suitability subclass for various land uses		
		Dryland sown pastures	Dryland crops	Tree and vine crops
Frost free	Cf1	1	1	1
Infrequent light frosts	Cf2	1	1	2
Frequent light frosts, or frequent light and infrequent heavy frosts	Cf3	2	2	3
frequent light and heavy frosts	Cf4	3	3	4

A limitation level of Cf4 was almost exclusively recorded for those soils occurring on low lying alluvium and lower slopes.

5.1.7 Rockiness (R)

Rock fragments in the plough zone, can damage and interfere with the effective use of farm machinery (including harvesting machinery).

Limitation levels are based on the size and abundance of coarse fragments (McDonald *et al.* 1990), as assessed in the field. Coarse gravel refers to fragments that are 20 to 60 mm in size (average maximum dimension), cobble/stone refers to fragments that are 60 to 600 mm in size, boulders are >600 m. Rock outcrop is defined as being continuous with bedrock.

Rockiness suitability subclasses are based on the added inputs required to cultivate and establish crops and pastures as well as harvest on stony soils, or the inputs required to remove the limitation.

Table 14. Rockiness limitation

Limitation level		Code	Suitability subclass for various land uses		
			Dryland sown pastures	**Dryland crops**	**Tree and vine crops**
Rock free		Ra1	1	1	1
Coarse gravel (20–60 mm)	<2%	Ra2	1	1	1
	2–10%	Ra3	2	3	2
	10–20%	Ra4	3	4	2
	20–50%	Ra5	4	5	3
	>50%	Ra6	5	5	4
Cobble/stone (60–600 mm)	<2%	Rb1	1	2	1
	2–10%	Rb2	2	3	2
	10–20%	Rb3	3	4	3
	20–50%	Rb4	4	5	4
	>50%	Rb5	5	5	5
Rock outcrop or boulders (>600 m)	<2%	Ro1	3	4	3
	2–10%	Ro2	4	5	4
	10–20%	Ro3	5	5	5
	20–50%	Ro4	5	5	5
	>50%	Ro5	5	5	5

For a particular soil profile class, where a significant number of UMAs (three or more) were observed to have surface rock (rocky outcrop, coarse gravel or cobble) in sufficient quantity[1] for it to be a severe limitation for land use, a rocky phase was defined.

5.1.8 Soil depth (Pd)

Shallow soils limit root growth and the ability of the plant to support itself. Requirements for anchorage are particularly important for tree crops with large canopies. Areas with a soil depth of <0.6 m (attribute level of Pd3) were given a severe soil depth limitation for tree and vine crops. Areas assessed as having a soil depth of 0.4 m or less were considered to have a severe or extreme soil depth limitation for cropping enterprises (see Table 15).

Shallow depth (<0.6 m) is a common characteristic[2] of the soil occurring on steep slopes, narrow ridges and sodic texture contrast soils.

[1] gravel >20% and cobble >10%
[2] occurring more than 50% of UMAs

Table 15. Soil depth limitation

Limitation level	Code	Suitability subclass for various land uses		
Soil depth		Dryland sown pastures	Dryland crops	Tree and vine crops
> 1 m	Pd1	1	1	1
0.6–1.0 m	Pd2	2	2	3
0.4–0.6 m	Pd3	2	3	4
0.3–0.4 m	Pd4	3	4	5
<0.3 m	Pd5	4	5	5

5.1.9 Microrelief (Tm)

Microrelief refers to the uneven land surface due to gilgai. Gilgai (or melonhole) is associated with soils containing shrink-swell clays. In the study area, gilgai was observed mainly in cracking clays and shallow colluvial deposits overlying shrink-swell clays. Gilgai microrelief results in water ponding and uneven crop production.

Limitation levels are based on the vertical interval (depth) of the depressions. In the study area, the vertical interval was rarely greater than 0.3 m. Suitability subclasses indicate the cost of works to level the land and/or the reductions in yield expected.

Table 16. Microrelief limitation

Limitation level	Code	Suitability subclass for various land uses		
Vertical interval		Dryland sown pastures	Dryland crops	Tree and vine crops
0.1 m	Tm1	1	1	1
0.1 m to 0.3 m	Tm2	1	2	1
0.3 m to 0.6 m	Tm3	2	3	3
>0.6 m	Tm4	3	3	4

5.1.10 Wetness (W)

Waterlogged soils reduce plant growth and delay effective machinery operation. Excess water in the soil impedes oxygen supply to plant roots and promotes plant diseases. Excess water can occur due to poor soil permeability, restricted surface drainage or a combination of both.

Attribute levels for wetness are based on field observations of site drainage (slope, topographic position) and soil morphological features such as mottling, colour, segregations, structure and impermeable layers. Suitability subclasses have been derived from knowledge of plant tolerance information and consultation with research and extension staff.

Table 17. Wetness limitation

Limitation level	Code	Suitability subclass for various land uses		
Drainage class (from McDonald *et al.* 1990)		Dryland sown pastures	Dryland crops	Tree and vine crops
Rapidly drained to well drained	W1	1	1	1
Moderately well drained	W2	1	2	2
Imperfectly drained	W3	2	3	4
Poorly drained	W4	3	4	5
Very poorly drained	W5	4	5	5

Wetness is a critical limitation for all land uses. Areas with imperfect drainage (limitation level W3) were given a severe limitation for tree and vine crops, while poorly drained sites (limitation level W4) were given a severe limitation for dryland crops.

5.1.11 Water erosion (E)

Soil erosion depends on rainfall intensity, land slope, soil erodibility, vegetative cover and management practices. For land uses involving regular cultivation to be sustainable, soil conservation measures are required on all sloping land. Soils in the survey area have been divided into two groups based on their erodibility and the stability of the subsoil. Texture contrast soils with sodic subsoils are more at risk than other soils and therefore have lower cultivation slope limits.

Table 18. Water erosion limitation

Limitation level	Code	Suitability subclass for various land uses		
		Dryland sown pastures	Dryland crops	Tree and vine crops
Stable soils (other than sodic texture soils)				
<1% slope	E1	1	1	1
1–5%	E2	1	2	1
5–8%	E3	2	3	2
8–15%	E4	3	4	3
>15%	E5	4	5	4
Sodic texture contrast soils				
<1–3% slope	E6	1	2	1
3–5%	E7	2	3	2
5–12%	E8	3	4	3
>12%	E9	4	5	4

Suitability subclasses for water erosion are based on the added management requirements required to control erosion. They have been determined by consultation with soil conservation extension staff.

5.1.12 Slope (Ts)

The topography limitation has a direct affect on the ease of machinery operations and land use efficiency in general. It covers the slope limits for the safe use of machinery.

The slope limit for the safe and efficient use of machinery is 15%. However, all land greater than 15% in the study area, except the deep red structured soils on deeply weathered basaltic material, is unsuitable or marginal for agricultural development due to other limitations.

Table 19. Slope limitation

Limitation level	Code	Suitability subclass for various land uses		
Slope		Dryland sown pastures	Dryland crops	Tree and vine crops
0–15%	Ts1	1	1	1
15–20%	Ts2	2	4	3
>20%	Ts3	4	5	4

5.1.13 Salinity (Sa)

Under stable climatic conditions, in a natural environment, a hydrological equilibrium occurs between water intake from rainfall and water loss through plant uptake, evaporation, runoff and leakage to groundwater (Shaw *et al.* 1986). Practices associated with agriculture, particularly clearing and irrigation are major ways in which this hydrological balance is disturbed. Increases in accession to groundwater may result in raised watertables which may be either non-saline or saline.

Intake or recharge areas are those areas in which there is a downward component to groundwater flow near the soil surface. These recharges areas tend to occur upslope and on convex topography often with shallow or permeable soils over fractured rock (Shaw *et al.* 1986).

In discharge (seepage) areas, there is an upward component to groundwater flow near the soil surface which may result in secondary salinisation due to evaporation concentration of soluble salts. Discharge areas occur at breaks of slope, in flat or incised areas or in regions of concave slope.

High soil salt levels are associated with fine grained sedimentary rocks and deeply weathered basalts while sandstones and granites usually have low salt levels.

Salinisation is consistently evident on the yellow, brown and grey soils on lower slopes of deeply weathered basalts and associated drainage lines, and on sodic clays and sodic duplex soils developed on fine grained sedimentary, metamorphic and basaltic rocks, and old alluvium and Tertiary sediments found on discharge areas.

Shaw *et al.* (1982) considered that effective drainage will be difficult to achieve, especially on the sodic soils of low hydraulic conductivity which are present in many of the potential discharge areas. Any area with existing natural salinisation is considered unsuitable for development.

Table 20. Salinity limitation

Limitation level	Code	Suitability subclass for various land uses		
		Dryland sown pastures	Dryland crops	Tree and vine crops
No salinity evident or profiles have low salt levels	S1	1	1	1
Soil profiles with low to moderate salt levels at 1 m	S2	2	2	2
Soil profiles with moderate salt levels at 0.5 m or high salt levels at 1 m	S3	3	3	3
Soil profiles with high salt levels at 0.5 m	S4	4	4	4
Surface salinity evident	S5	5	5	5

5.2 Land suitability assessment

The land suitability assessment of the survey area is summarised in Table 21. The land suitability for each soil group is summarised in Table 22. In each table, the land area in each category is shown as hectares (ha) and as a percentage (%) of the total survey area of 126 608 ha. There is no Class 1 land for any land use. Areas not assessed (dams, quarries, hills and mountains, rock) are 11 167 ha or 9.1% of the total area.

Table 21. Summary of the land suitability assessment for the survey area

Suitability Class	Dryland crops		Dryland sown pastures		Tree and vine crops	
	ha	%	ha	%	ha	%
1	0	0	3 748	3.0	3 795	3.0
2	23 912	18.9	53 487	42.2	17 516	13.8
3	42 888	33.9	35 567	28.1	40 148	31.7
4	28 118	22.2	14 727	11.6	34 656	27.4
5	31 690	25	19 079	15.1	30 493	20.5

Table 22. Summary of the land suitability assessment for soil geological groups

Soil Geological Group	Suitable for dryland crops		Suitable for dryland sown pastures		Suitable for tree and vine crops	
	ha	%	ha	%	ha	%
Soils on alluvium of current streams	11 681	9.2	11 881	9.4	8 023	6.3
Soils on older alluvium	6 044	4.8	8 452	6.7	2 078	1.6
Soils on basalt	8 891	7.0	15 209	12.0	11 749	9.3
Soils on deeply weathered basaltic material	39 021	30.8	51 433	40.6	38 098	30.1
Soils on granite	918	0.7	4 511	3.5	1 433	1.1
Soils on metamorphic and sedimentary rocks	244	0.2	1 316	1.0	78	0.1
TOTALS	**66 800**	**52.7**	**92 802**	**73.2**	**61 459**	**48.5**

Table 22 shows that the soils derived from the deeply weathered basaltic material, predominantly the red soils, account for about 50% of the land suitable for intensive development.

5.2.1 Land suitability for dryland cropping

The broadacre field crops considered in the land suitability assessment include cereals (grain sorghum, maize, wheat, barley and oats), grain legumes (chick peas, navy beans, soybeans, lupins), oilseeds (sunflower), peanuts, forage legumes (lablab, cowpeas) and other forage crops (sorghums, millets). Their agronomic and management requirements were considered similar enough not to warrant separate classification for each crop. For simplification, no attempt was made to separate winter and summer growing crops. Eight percent of the survey area is considered suitable for dryland cropping.

Ten limitations were identified as being potential severe limitations for dryland cropping in the Kingaroy area. The most important of these is soil water availability. Plant available water capacity (PAWC) of less than 90 mm in the root zone (maximum depth considered to be 1 m) was considered to be a prohibitive limitation for dryland cropping over 22 342 ha.

Land may also be considered unsuitable for dryland cropping because of the following limitations:

- Eroded and/or extremely hard setting soils (workability limitation) affect 209 ha.
- Nutrient availability. Only a total of 2858 ha has soils low in available phosphorus, sulfate sulfur and extractable potassium which are considered unsuitable; the cost of applying all nutrients would, in most situations be prohibitive.
- Wetness (poor drainage). A total of 3000 ha has poorly/very poorly drained sites which are considered unsuitable.
- Flooding. Only 86 ha has an average flood frequency of more than one flood every two years and were given a severe flooding limitation.
- Soil depth. For dryland cropping, this limitation is strongly linked to soil moisture availability. A total of 15 735 ha was assessed as having a soil depth of 0.4 m or less. These shallow soils were considered to have a severe or extreme soil depth limitation.
- Rockiness. Greater than 10–20% coarse gravel or cobble occupy 40 496 ha and is considered to be prohibitive.
- Water erosion. Sodic texture contrast soils of 5% slope or more and other soils of slope greater than 8% occupy 32 937 ha and are considered unsuitable for dryland crops.
- Salinity. Large areas (2953 ha) of existing salinity occur in the study area mainly occurring on lower slopes associated with the red soils of the deeply weathered basaltic material.
- Topography. Steep slopes prohibit the use of machinery on 38 638 ha.

5.2.2 Land suitability for dryland sown pastures

The dryland sown pastures considered in the land suitability assessment include Callide Rhodes grass, green panic, Gatton panic, setaria, pangola, kikuyu and pasture legumes (Siratro, fine stem stylo, Glycine, Lotononis, Wynn cassia, Leucaena). A total of 92 802 ha or 73.2% of the survey area is considered suitable for dryland sown pastures.

Nine limitations were identified as being potential severe limitations for dryland sown pastures in the Kingaroy area. The most important of these is soil water availability. A plant available water capacity (PAWC) of less than 60 mm in the root zone (maximum depth considered to be 1 m) was considered to be a prohibitive limitation for dryland sown pastures over 2002 ha.

Land may also be considered unsuitable for dryland sown pasture because of the following limitations:

- Eroded and/or extremely hard setting soils (workability limitation) affects 209 ha.
- Nutrient availability. Soils low in available phosphorus, sulfate sulfur and extractable potassium are considered unsuitable as the cost of applying all nutrients would, in most situations be prohibitive on 2858 ha.
- Wetness (poor drainage). Very poorly drained sites are considered unsuitable on 318 ha.
- Soil depth. A total of 21 ha was assessed as having a soil depth of 0.3 m or less and was considered to have a severe or extreme soil depth limitation.
- Rockiness. 20–50% coarse gravel or cobble is considered to be prohibitive on 24 188 ha.
- Water erosion. Sodic texture contrast soils of 8% slope or more and other soils of slope greater than 12% occupy 10 650 ha and are considered unsuitable for dryland sown pasture.
- Salinity. 2953 ha have existing salinity and are unsuitable for pastures.
- Topography. Steep slopes prohibit the use of machinery on 18 710 ha.

5.2.3 Land suitability for tree and vine crops

The tree and vine crops considered in the land suitability assessment include citrus, grapes, persimmon, low-chill stonefruit, low-chill apples.

For simplification, no attempt was made to provide information on suitability classes for each individual crop. The suitability information contained in this report is therefore general in nature. Details of specific land use and management requirements for the range of tree and vine crops suitable for south-east Queensland may be found in the *Agrilink* Series[3]. The choice of crop will depend on both a careful analysis of crop requirements (including irrigation requirements) and careful site selection. Site layout to account for variations in soil depth, site drainage, frost and wind is important.

Forty nine percent of the survey area is considered suitable for tree and vine crops. The availability of suitable irrigation water was not evaluated in this assessment but is assumed irrigation water is available from streams or on-farm storages.

Ten limitations were identified as having the potential to severely limit the production of tree and vine crops in the Kingaroy area. They are:

- Climate (frosts) severely affect 3697 ha.
- Eroded and/or extremely hard setting soils (workability limitation) affect 209 ha.
- Wetness (poor drainage). A total of 3375 ha has imperfectly drained, poorly drained and very poorly drained sites which are considered unsuitable. Clay soils on alluvial flats and most of the texture contrast soils (where there is inadequate site drainage) will generally have a severe drainage limitation.
- Flooding. Areas (84 ha) with an average flood frequency of more than one flood every two years were considered unsuitable.
- Soil depth. Areas assessed as having a soil depth of 0.6 m or less occupy 30 645 ha and were considered to have a severe or extreme soil depth limitation. Most tree crops prefer 0.6–1.5 m of well drained soil with no rock or clay layers to impede drainage. In some instances, it may be possible to achieve the minimum depth requirement by the use of mounds.
- Rockiness. >50% coarse gravel or 20–50% cobble occupy 24 068 ha and are considered to be prohibitive.
- Water erosion. Soils of 15% slope or more occupy 10 656 ha and are considered unsuitable for tree and vine crops.
- Salinity. Soils with existing salinity or high salt levels in the profile affect 2953 ha and are unsuitable.
- Microrelief. Large gilgai (>0.6 m) occupy 4040 ha. Gilgai makes leveling difficult and expensive and influences crop growth due to uneven water distribution.
- Topography. Steep slopes prohibit the use of machinery on 18 710 ha.

The incidence of severe frosts makes this a severe limitation for sensitive crops in low lying areas. It may be necessary for protective measures to be taken for some crops at certain times of the year and at certain stages in the growing cycle. For example, citrus are susceptible to frost when young, while mature plants have a degree of resistance.

[3] *Agrilink: your growing guide to better farming*. Series first published by the Department of Primary Industries (Queensland) 1997 (ISSN 13228-0457)

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APPENDIX I

Soil profile classes

Conventions used in the descriptions of the morphology, landscape and vegetation of the soil profile classes

A soil profile class is a three dimensional soil body of group or soil bodies, such that any profile within the body(s) has a similar number and arrangement of major horizons whose attributes, primarily morphological, are within a defined range. All profiles within the units have similar parent materials. The soil profile class may be at varying levels of generalisation depending primarily on the scale of the survey and density of ground observations.

A **soil variant** is a soil with profile attributes clearly outside the range of defined soil types but not extensive enough to warrant defining a new type.

A **soil phase** is a subdivision of a soil profile class based on attributes that have particular significance in the use of the soil, for example, rocky phase.

Australian Classification as described by Isbell (1996) are listed in order of frequency of occurrence.

Great Soil Group as described by Stace *et al.* (1968) are listed in order of frequency of occurrence.

Principle Profile Form (PPF) as defined by Northcote (1979) are listed in order of frequency of occurrence.

Geology as defined on the Maryborough 1:250 000 geology series map, 1992.

Surface characteristics as in McDonald *et al.* (1990).

Landform as in McDonald *et al.* (1990).

Vegetation structural formation as in McDonald *et al.* (1990)

Vegetation species listed in order of frequency of occurrence. "/" means with or without.

The **pH profiles** are based on field determination for each horizon.

Horizons as in McDonald *et al.* (1990).

Textures are field textures as in McDonald *et al.* (1990)

Structure as in McDonald *et al.* (1990).

Segregation as in McDonald *et al.* (1990).

Boundary type as in McDonald *et al.* (1990).
Frequency of occurrence
Frequently = >30% of occasions
Occasionally = <30% of occasions

Colour codes (moist) and nomenclature are those of Munsel soil colour charts (1994).

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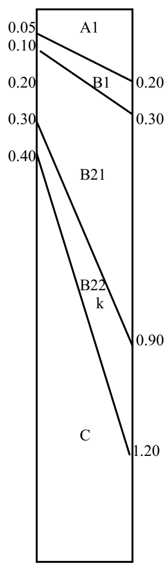
APPALOOSA (Ap)

Concept:	Brown clays frequently with weak to moderate gilgai on old alluvium
Australian Classification:	Brown Vertosol
PPF:	Ug5.35, Ug5.34, Uf6.31, Ug3.3, Uf6.33, Ug5.2
Great soil group:	Brown clay
Landform:	Crests and slopes of undulating rises. Slopes 0.5-4%
Geology:	Quaternary alluvium (Qa), Tertiary sediments (Ts)
Vegetation:	Poplar box open forest. Regrowth of black tea tree can occur after clearing. Poorly to moderately developed grass layer of blue grasses and love grasses
Surface feature:	Cracking, gilgaied, hardsetting to weak self mulching

Depth (m)



A1: Dark or brown (7.5YR, 10YR, 3/2, 3/3, 4/4); light clay to medium clay, moderate medium to fine subangular blocky; dry hard to very hard; manganiferous concretions.

B1 Occasionally present. Brown (7.5YR, 10YR 3/3, 3/4, 4/3, 4/4); light medium clay to medium clay; moderate fine to medium angular blocky; dry very hard to extremely hard; manganiferous concretions.

B21: Occassionally yellow mottled; brown (7.5YR, 10YR 3/3, 3/4, 4/3, 4.4); medium clay to medium heavy clay; strong medium lenticular or occasionally moderate medium angular blocky; dry hard to very hard; manganiferous concretions and occasionally ferruginous segregations.

B22k: Grey, gley or yellow mottles; yellow brown, yellow or grey (10YR 5/4, 5/6, 6/2, 6/4, 6/6); medium clay to medium heavy clay; moderate fine to medium angular blocky; dry very hard, manganiferous veins and or concretions, occasionally ferruginous segregations and soft or concretionary lime.

C: Grey, gley or yellow mottled; yellow brown, yellow or grey (10YR 5/4, 5/6, 6/2, 6/4, 6/6); medium clay to medium heavy clay; moderate fine to medium angular blocky; dry very hard; manganiferous veins and or concretions, occasionally ferrugenous segregations and soft or concretionary lime.

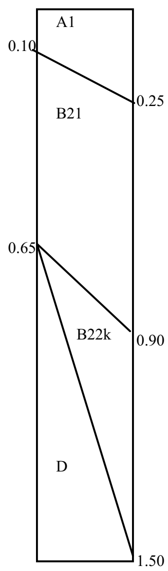
Note: Surface carried 2-10% gravel (3-50 mm), subangular to rounded, petrified wood, kaolinised basalt chert, chalcedony and ironstone with some silcrete.

Sites: 133, M214, 215, 222, 242, 243, 372, 373, 374, 405, 406, 407, 457, 461

ARCHOOKOORA (Ac)

Concept:	Red structured soil derived from deeply weathered basaltic material overlying old alluvium
Australian Classification:	Red Ferrosol, Brown Ferrosol
PPF:	Uf6.31, Uf6.4, Uf6.3
Great soil group:	Euchrozems, Krasnozem
Landform:	Crests and slopes on low hills and fans and/or higher alluvial material
Geology:	Deeply weathered basaltic colluvium over old alluvium or Tertiary sediments
Vegetation:	Narrow leaved ironbark and Moreton Bay ash open forest. Kangaroo and blue grass.
Surface features:	Firm to hardsetting. Occasionally surface angular silcrete, lateritised basalt and/or metamorphic gravels

Depth (m)



A1: Dark red dish brown or dark brown (5YR, 7.5YR 3/3, 3/5); light clay to light medium clay; strong fine granular structure; dry slightly hard consistence; 0-10% manganiferous and ferromanganiferous nodules. Clear change to

B21 Reddish brown or brown (5YR, 7.5YR 4/4, 4/6); light clay to light medium clay; strong fine polyhedral to subangular blocky structure; dry hard consistence; 10-20% manganiferous concretions and minor ferromanganiferous nodules. Diffuse change to

B22k: Dark reddish brown or brown or bright brown (5YR, 7.5YR, 10YR 3/4, 4/6, 5/6); light clay to medium heavy clay; strong fine subangular blocky to polyhedral structure; dry hard to very hard; 0-10% manganiferous segregations. Clear or gradual change

D: Brown or dull brown (7.5YR, 10YR 4/6, 5/4); medium clay to medium heavy clay; strong fine subangular blocky to medium angular blocky to lenticular structure; 0-10% manganiferous concretions

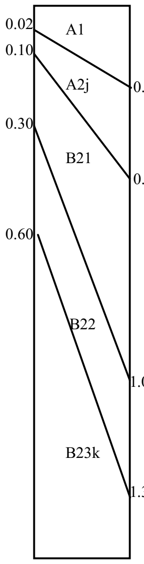
Variants: B horizons may be bright brown (7.5YR 5/6 moist) and may have a red and/or yellow mottle. B horizon may have angular blocky to fine lenticular structure. D horizons where present may be bright brown (2.5YR 5/6) and have a heavy clay texture

Sites: 99, 169, 254, 381, 382, 390, 402, 405, 410, 417, 419, 530, 538, 541, 573, 586, 598, 600, 635, 657, 658, 660, 678, 681, 682, 702, 718, 722, 724, 725, 770, 771

AVON (Av)

Concept: Sodic texture contrast soil on alluvial plains of current streams
Australian Classification: Brown Sodosols, Grey Sodosol
PPF: Db2.32, Db2.33, Dy2.33, Db1.33
Great soil group: Solodic soil
Landform type: Back plains and high terraces associated with major streams
Geology: Unconsolidated sediments from Quaternary alluvium (Qa)
Vegetation: Poplar box woodland, minor areas of forest red gum.
Surface feature: Hardsetting, occasionally crusting

Depth (m)



A1: Brownish black or dark brown (10YR 3/3, 3/3); sandy loam to clay loam; massive; dry hard consistence; trace amounts of manganiferous concretions. Gradual change to

A2j: Sporadically bleached. Brown black or dull yellowish brown (7.5YR, 10YR 3/2, 4/3, 5/4); loamy sand to clay loam, then as above. Abrupt change to

B21: Dark grey or yellow mottled; brown grey or brown (7.5YR, 10YR 4/1, 4/2, 4/3, 4/4, 4/6); medium clay to medium heavy clay; strong fine prismatic to subangular to angular blocky structure; dry extremely hard consistence; trace amounts of manganiferous and carbonate concretions and segregation. Gradual change to

B22: As above except greyish yellow brown or dully yellowish brown or brown or dark greyish yellow (10YR, 2.5Y 4/2, 4/3, 4/6). Clear change to

B23k: As above except brown or dull yellowish brown (10YR 4/4, 4/6, 5/3); light clay to medium heavy clay; moderate amounts of carbonate concretions and segregations, trace amount of manganiferous concretions.

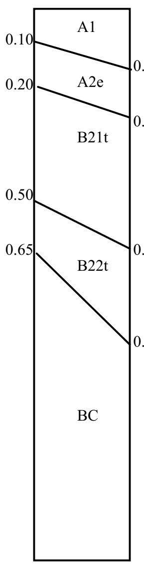
Variants: Deep surfaced sandy loam of around 0.6 occur. Moderately acid soil reaction trends in deeper surface variants. Reddish brown (5YR 4/4, 4/6) medium clay B horizons. Some variants have silty clay surface texture and moderate fine granular structure

Sites: 154. See also Gordonbrook reference area. Consult DNR study area for more detail.

BOONENNE (Bn)

Concept: Neutral to alkaline brown sodic texture contrast soil on mid to upper slopes on granite
Australian Classification: Hypernatric Brown Sodosol
PPF: Dy3.43, Dy3.42, Dy2.43, Db2.42, Db2.43
Great Soil Group: Solodic soil
Landform type: Hillslopes of undulating low hills to rolling hills. Slopes 2-10%
Geology: Granite, adamellite
Vegetation: Silver leaved ironbark, narrow leaved ironbark, bloodwood, open forest. Ground cover of wire grass
Surface feature: Firm to hardsetting

Depth (m)



A1: Brown (7.5YR, 10YR 4/3, 4/4); sandy loam to sandy clay loam; massive to weak 2-5 mm granular to subangular blocky structure; dry weak consistence; field pH 5.7-6.0. Clear change to

A2e: Conspicuously bleached; loamy sand to light sandy clay loam; massive; dry weak consistence; 2-10% manganiferous concretions; field pH 5.7-6.0. Abrupt change to

B21t: Brown mottled; yellowish brown (7.5YR 5/4, 10YR 5/6); light medium clay to medium clay; strong 20-30 mm angular blocky to prismatic structure; dry extremely hard consistence; 0-2% manganiferous segregations, field pH 6.0-8.5. Gradual change to

B22t: Grey mottled; dark yellowish brown (7.5YR, 10YR 4/4, 4/6); sandy light clay to medium clay; moderate 20-50 mm angular blocky structure; dry very hard consistence; field pH 8.5-8.9.

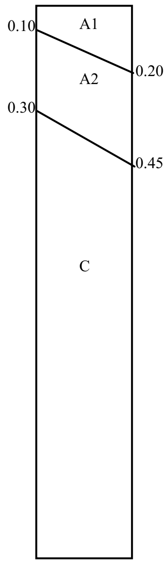
BC: Dark mottled; yellowish brown or brownish yellow (7.5YR, 10YR 5/6, 6/8); loamy sand to loamy coarse sand; massive; fragments of weathering parent material; field pH 8.6-8.8.

Sites: 146, 209, 339, 346, 464, 553, 566, 709, 710, 723, 778

BOOIE (Bo)

Concept: Shallow loams and sand with little or no horizon development formed on decomposing granite
Australian Classification: Bleached–orthic Tenosol, Orthic Tenosol
PPF: Uc2.12, Um3.12
Great soil group: Lithosol
Landform: Crests and upper slopes of undulating low hills. Slopes 2-15%
Geology: Granite
Vegetation: Rusty gum, spotted gum open forest
Surface feature: Loose to firm

Depth (m)



A1: Dark brown or brownish black (7.5YR 2/2, 10YR 3/3); sandy loam to sandy clay loam massive to weak granular; field pH 6-6.5. Clear change to

A2e,j: Conspicuously or sporadically bleached; sandy loam to sandy clay loam; massive; field pH 6-6.8. Gradual change to

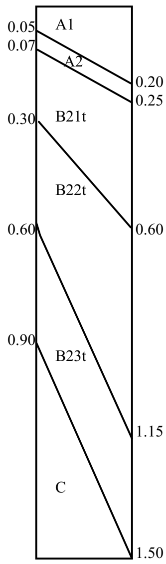
C: Weathered granite.

Sites: 141, 217, 220, 264, 280, 291, 333, 343

BUSHNELL (Bl)

Concept: Gilgaied clay loam surfaced brown sodic texture contrast soil on Tertiary sediments
Australian Classification: Brown Sodosol
PPF: Dy2.33, Dy3.33, Dy3.43, Db2.33, Db1.33
Great Soil Group: Solodic soil, solodized solonetz
Landform type: Crests and slopes of low hills. Slopes 1.5-6%
Geology: Tertiary sediments
Vegetation: Narrow leaved ironbark with gun topped box, Moreton Bay ash and belah (occasionally associated) open forest
Surface feature: Hardsetting, frequently gilgaied

Depth (m)



A1: Brown or dark (7.5YR, 10YR 2/2, 3/2, 3/3, 3/4, 4/3, 4/4); clay loam to fine sandy clay loam to silty clay loam to clay loam sandy; weak fine subangular blocky to granular; dry hard; manganiferous concretions.

A2e,j: Sporadically or conspicuously bleached. As above.

B21t: Frequently yellow, brown or dark mottled; yellow or yellow-brown or brown (7.5YR, 10YR 3/3, 3/4, 4/3, 4/4, 4/6, 5/3, 5/4, 5/6); medium clay to medium heavy clay; strong to moderate medium prismatic to columnar; dry very hard to extremely hard; manganiferous concretions and occasionally veins.

B22t: As above but frequently strong medium lenticular or moderate medium blocky; frequently soft or concretionary lime.

B23t: As above but frequently dark mottled.

C: Frequently present. Brown, grey, gley or yellow mottled; grey or yellow-brown or yellow or brown (10YR, 7.5YR, 2.5Y 4/4, 5/3, 5/4, 5/6, 6/2, 6/2, 6/6, 7/1, 7/2, 8/1, 8/2); sandy light clay to medium heavy clay; moderate medium blocky to massive; dry very hard to extremely hard; manganiferous concretions and veins, ferruginous segregations.

Notes: Surface carried 2-15% gravel (3-75 mm), angular (silcrete) to subangular to rounded – petrified wood, kaolinized basalt, chert, chalcedony, ironstone and silcrete. C horizons include mottled clay, weakly lithified argillaceous sandstone and kaolonite rich sandy material, apparently a laterite pallid zone. The later occurs low in the landscape

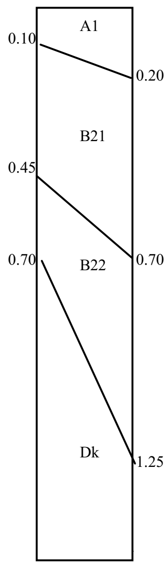
Variants: A horizons may be light clay giving Uf3 after alluviation. B21 horizon may be yellow mottled red (5YR 4/6) giving Dr3.33. This is frequently associated with sites just below basalt caps on ridges

Sites: 371, 375, 420, 427, 428, 430, 431, 432, 433, 437, 449, 452, 457, 458, 468, 488, 505, 513, 644

BYEE (By)

Concept: Moderately self mulching black cracking clay over brown calareous subsoils on alluvial plains
Australian Classification: Black Vertosol
PPF: Ug5.15
Great Soil Group: Black Earths
Landform type: Lower alluvia often associated with drainage lines form the surrounding hills. Slopes 0.5-1%
Geology: Quarternary alluvium (Qa)
Vegetation: Forest red gun open forest. Well developed grass layer of blue grasses
Surface feature: Cracking, self mulching

Depth (m)



A1: Dark (10YR 2/1, 2/2, 3/1, 3/2); medium clay to medium heavy clay; strong fine blocky; dry very hard.

B21: As above with strong medium blocky.

B22: As above with strong medium lenticular; frequently manganiferous concretions.

Dk: Brown (7.5YR, 10YR 2/3, 3/3, 4/3, 4/4); medium clay to medium heavy clay; strong medium blocky; dry very hard; manganiferous concretions, concretionary lime.

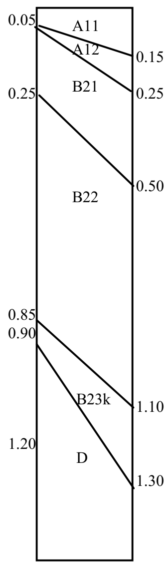
Variant: Dk horizon grey (10YR 4/2)

Sites: 28, 29, 69, 73, 82, 96, 287, 319, 326, 336, 337, 349, 351, 388, 411, 469, 608, 615, 645

CHELMSFORD (Cf)

Concept: Red structured soils derived from trasported deeply weathered basaltic material overlying old alluvium
Australian Classification: Red Ferrosol
PPF: Uf6.31, Gn3.13, Gn3.12
Great Soil Group: Euchrozems
Landform type: Crests of low hills
Geology: Deeply weathered basaltic colluvium/alluvium overlying old alluvium
Vegetation: Narrow leaved ironbark and Moreton Bay ash open forest. Strongly developed grass layer of kangaroo grass and blue grasses
Surface feature: Hardsetting

Depth (m)



A11: Dark or red (2.5YR, 5YR 3/2, 3/3, 3/4); clay loam to light clay; moderate to strong fine granular; dry slightly hard; manganiferous concretions.

A12: Frequently present in uncultivated situations. Red (2.5 YR, 5YR 3/2, 3/3); light clay; medium subangular blocky; dry slightly hard to hard; manganiferous concretions.

B21: Red (10R, 2.5 YR, 5YR 3/4); light medium clay to medium clay; strong fine to medium blocky to polyhedral; dry hard; manganiferous concretions and iron segregations.

B22: As above but red (10R, 2.5YR, 5YR 3/6) and occasionally with slickensides.

B23k: Frequently present. As above but occasionally brown (7/5YR 4/6) and with manganiferous veins and concretionary lime.

D: Red or grey mottled; red or grey (2.5YR 3.6, 10YR 7/2, 8/3); light clay to light medium clay; strong fine angular blocky to massive; manganiferous veins, ferruginous segregations and concretionary lime.

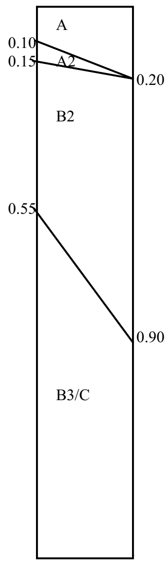
Notes: Surface carries 5-15% of gravel (3-75 mm) subangular kaolinised basalt

Sites: 374, 384, 409, 412, 415, 416, 423, 502, 503, 525, 534, 544, 549 84

CHARLESTOWN (Ct)

Concept: Hardsetting red or brown acid to neutral sodic texture contrast soil on granite
Australian Classification: Red Sodosol, Brown Sodosol
PPF: Dr3.12, Dr2.32, Dr3.41, Db2.12, Dr1.12
Great Soil Group: Solodic soil
Landform type: Mid to upper slopes on undulating hills. Slopes 3-15%
Geology: Granite
Vegetation: Narrow leaved ironbark open forest
Surface feature: Hardsetting

Depth (m)



A: Dark or dark brown (7.5YR 3/2, 3/3, 10YR 3/2, 2/3); light sandy clay loam to clay loam sandy; massive to weak granular; field pH 6.0-6.5. Clear to gradual change to

A2e,j: Frequently occur. Conspicuously or sporadically bleached; light sandy clay loam to clay loam sandy; massive. Abrupt change to

B2: Bright reddish brown or brown (2.5YR 3/6, 5YR 4/6, 7.5YR 4/4, 10YR 4/4, 5/6); medium clay to medium heavy clay; moderate to strong angular blocky; occasionally manganiferous segregations; field pH 5.3-6.5 in upper B horizon frequently increasing to 8.0-8.5 in lower B horizon. Clear change to

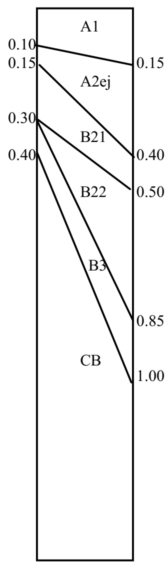
B3/C: Sandy clay loam to sandy medium clays with weathered rock.

Sites: 268, 270, 292, 335, 362

CHERBOURG (Cg)

Concept: Shallow, loose to firm, sandy loams to sandy clay loams overlying weak to moderate structured brown medium clays on sedimentary rocks, acid to neutral soil reaction trend
Australian Classification: Yellow Kurrosols, Brown Sodosols
PPF: Db2.41, Dy3.21, Dy3.41, Um1
Great Soil Group: Soloths, Lithosols, no suitable group
Landform type: Crests and upper slopes of undulating to rolling hills. Slopes 0-15%
Geology: Shales, sandstones of the Marburg Sandstones and Tarong Beds
Vegetation: *Angophora* spp., narrow leaved ironbark woodland, understory of *Acacia* spp*.*, *Aristida* spp.
Surface feature: Loose to firm

Depth (m)



A1: Brown or yellowish brown (0YR 4/4, 5/4, 4/2, 4/1); sandy loam to sandy clay loam; massive to weak 2-5 mm granular; field pH 6.0-7.0. Clear change to

A2e,j: Conspicuously bleached to sporadically bleached; greyish yellow brown or brownish grey (7.5YR, 10YR 6/2, 5/1); sandy loam to sandy clay loam; massive to weak granular structure 2-5 mm; field pH 5.5-7.0; few ferromanganiferous nodules. Abrupt change to

B21: Occasionally mottled; brown or yellowish brown (7.5YR, 10YR 4/4, 5/6); medium clay to sandy medium clay; moderate angular blocky structure; field pH 5.0-6.5; few to small amounts of ferromanganiferous nodules and segregations. Gradual change to

B22: Frequently mottled; brown or yellowish brown or bright brown (7.5YR 10YR 4/4, 5/4, 5/6); medium to medium heavy clay; moderate angular blocky structure; field pH 5.0-6.5; few to small amounts ferromanganiferous nodules and segregations. Gradual change to

B3: Mottled; yellowish brown or bright yellowish brown (7.5YR, 109YR 5/4, 5/6, 5/8, 6/6, 7/6); light clay to medium weak subangular blocky; field pH 5.0-6.5; few manganese segregations; 10% gravels and soft substrate material.

CB: Mottled; light yellowish brown (10YR 6/8); clay loam; weak subangular blocky structure; field pH 5.5. Large amounts (50%+) decomposing sandstone on shales and gravels.

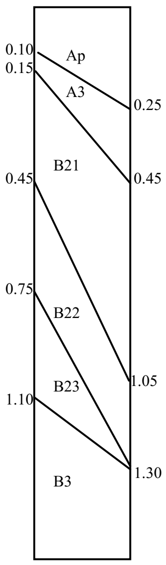
Variants: Gravelly phases may occur where parent material comes close to surface. Shallow sandy lithosols overlying parent rock occur in this landform type.

Sites: 166, 204, 308, 313, 315, 318, 350a&b, 607, 659, 800, 802

COOLABUNIA (Cl)

Concept:	Neutral to slightly alkaline strongly structured red clay soils on deeply weathered basaltic material
Australian Classification:	Red Ferrosol
PPF:	Uf6.31, Uf6.4, Gn3.11, Gn3.12
Great Soil Group:	Euchrozems
Landform type:	Mid to lower hillslopes of undulating rises to rolling hills
Geology:	Deeply weathered basaltic material (Tm)
Vegetation:	Cleared
Surface feature:	Firm, hardsetting

Depth (m)



Ap: Dark or very dark reddish brown (10R, 2.5YR, 5YR, 2/3, 2/3, 3/3, 3/4); clay loam to light medium clay; moderate to strong fine granular; dry hard; trace amounts ironstone and manganiferous concretions. Gradual change to

A3: Dark reddish brown or dark red (10R, 2.5YR, 3/3, 3/4); light clay to light medium clay; moderate fine polyhedral to fine subangular blocky; dry hard; small amounts of ironstone and manganiferous concretions. Gradual change to

B21: Dark reddish brown (10R, 2.5YR, 3/4, 3/6, 4/6); light medium clay; moderate fine to strong medium polyhedral; dry very hard, small amounts of ironstone and manganiferous concretions. Gradual change to

B22: Dark mottled; reddish brown or red (10R, 2.5YR, 3/4, 3/6, 4/4, 4/6); light clay to medium clay; strong fine to medium polyhedral; dry very hard; large amounts of ironstone and manganiferous concretions; small amounts of decomposed basalt. Gradual change to

B23: Dark and grey mottled; reddish brown (10R, 2.5YR, 3/4, 3/6, 4/6); light medium to medium clay; strong medium polyhedral; dry very hard; large amounts of ironstone and manganiferous concretions; moderate amounts of decomposed basalt. Gradual change to

B3: Reddish brown (2.5YR, 5YR, 4/6, 4/8); light medium to medium clay; strong medium polyhedral to strong medium blocky; dry extremely hard; large amounts of ironstone and manganiferous concretions; moderate amounts of decomposed basalt.

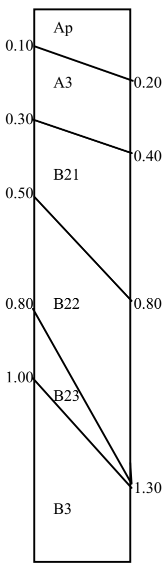
Variant: Occasionally alkaline soil reaction trends occur in lower slopes

Sites: 63, 104, 114, 119, 121, 122, 123, 128, 153, 185, 189, 190, 193, 196, 197, 203, 215, 225, 238, 239, 242, 263, 271,302, 463, 494, 495, 522, 552, 557, 562, 575, 578, 623, 634, 638, 648, 650, 655, 670, 718, 734, 744, 765, 790, 786

CRAWFORD (Cd)

Concept:	Acid to slightly alkaline mottled strongly structured red clay soils on deeply weathered basaltic material
Australian Classification:	Red Ferrosol
PPF:	Uf6.31, Uf6.4, Gn3.11, Gn3.12
Great Soil Group:	Krasnzems, Euchrozems (mottled)
Landform type:	Mid to lower slopes of undulating rises to rolling hills
Geology:	Deeply weathered basltic material (Tm)
Vegetation:	Mostly cleared
Surface feature:	Firm

Depth (m)



Ap: Dark red or reddish brown (10R, 2.5YR, 5YR, 3/3, 3/4, 4/2); clay loam to light clay; weak to strong fine granular; dry soft; moderate amounts of ironstone and manganiferous concretions; moderate amount of tuff (laterite) present in surface. Gradual change to

A3: Faint dark mottled; dark reddish brown (2.5YR, 5YR, 3/3, 3/4, 3/6); clay loam to light medium clay; weak fine granular to strong fine polyhedral; dry hard; moderate amounts of ironstone and manganiferous concretions. Gradual change to

B21: Dark mottled; reddish brown (10R, 2.5YR, 3/4, 3/6, 4/6, 4/8); clay loam to light medium clay; strong fine polyhedral to strong subangular fine blocky; dry very hard; small amounts of ironstone and manganiferous concretions; small amounts of kaolinised basalt. Gradual change to

B22: Dark red, yellow or grey mottled; reddish brown or brown (10R, 2.5YR, 5YR, 7.5YR, 3/4, 3/6, 4/4, 4/8, 5/6); light clay to medium clay; strong medium polyhedral; dry very hard; moderate amounts manganiferous concretions; small amount of ironstone and kaolinised basalt. Gradual change to

B23: As above except moderate amounts of ironstone and manganiferous concretions.

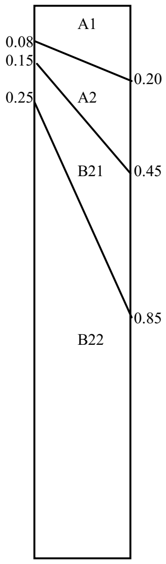
B3: As above except strong medium polyhedral to medium prismatic; dry extremely hard, large amounts of kaolinised basalt.

Sites: 213, 216, 231, 249, 275, 461, 579, 636, 639, 665, 675, 698, 715, 721, 762, 779, 785, 805

COOYAR (Cy)

Concept:	Hardsetting acid yellow texture contrast soils on pediments derived from granite
Australian Classification:	Brown Chromosol, Brown Sodosols, Brown Kurosol, Grey Sodosol
PPF:	Dy3.41, Dy3.31
Great Soil Group:	Yellow podzolic soil, soloth
Landform type:	Lower slopes of pediments. Slopes 0-4%
Geology:	Granite
Vegetation:	Poplar box open forest
Surface feature:	Hardsetting

Depth (m)



A1: Dark, dark brown or dull yellowish brown (7.5YR 3/3, 10YR 3/2, 3/4, 4/2); sandy loam to sandy clay loam; massive to weak granular; field pH 5.5-6.5. Clear change to

A2e,j: Conspicuously or sporadically bleached; sandy loam to sandy clay loam; massive to weak granular. Clear change to

B21: Mottled; bright brown or yellowish brown (7.5YR 5/2, 5/6, 10YR 4/3, 5/6); light medium clay to medium heavy clay; moderate to strong angular blocky or polyhedral; frequently ferromanganiferous or manganiferous segregations; field pH 5.0-6.5. Gradual change to

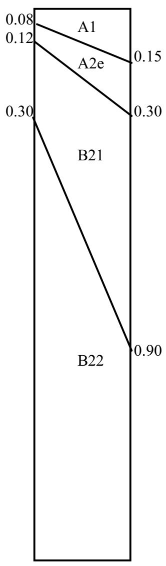
B22: Mottled; bright brown or greyish brown (7.5YR 6/2, 10YR 5/2, 5/4, 5/6); light clay to medium heavy clay; angular blocky; field pH 5.5-6.5.

Sites: 305, 328, 368, 574, 596, 617, 716, 747, 780

CUSHNIE (Cs)

Concept:	Hardsetting neutral to alkaline, sodic texture contrast soils on pediments derived from granite
Australian Classification:	Brown Sodosol, occasionally Grey Sodosol
PPF:	Dy3.43, Dy2.42, Db2.13, Dy3.42
Great Soil Group:	Solodic soil
Landform type:	Lower slopes of pediments. Slopes 1-6%
Geology:	Granite
Vegetation:	Narrow leaved ironbark, Moreton Bay ash open forest. *Aristida* species ground cover
Surface feature:	Hardsetting

Depth (m)



A1: Dark or dark brown (7.5YR 3/1, 3/2, 3/4); light sandy clay loam to clay loam and clay loam fine sandy; massive to moderate granular; field pH 6 to 6.3. Clear change to

A2e: Conspicuously bleached; sandy clay loam to clay loam fine sandy; massive. Abrupt to clear change to

B21: Frequently mottled; brown or bright brown or occasionally grey (7.5YR 4/4, 4/6, 10YR 3/3, 5/6, 2.5Y 5/2); light medium clay to medium heavy clay; strong angular blocky or occasionally columnar; frequently ferromanganiferous segregations; field pH 7-8. Clear change to

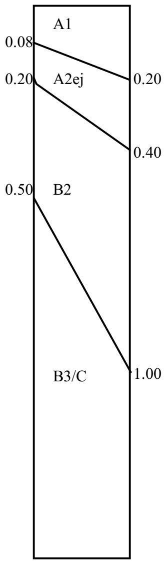
B22: Brown or dull brown (7.5YR 5/4, 4/6, 10YR 5/3, 5/5); light medium clay to medium heavy clay; strong angular blocky; 2-20% manganiferous and/or calcareous segregations; field pH 8-9.5.

Sites: 284, 322, 344, 369, 378, 540, 622, 624

DANGORE (Dg)

Concept: Hardsetting acid texture contrast soils on upper slopes and crests on granite
Australian Classification: Brown Sodosols, Brown Chromsols, Grey Sodosol, Yellow Chromosol
PPF: Dy3.41, Dy3.31, Db2.31, Db1.41
Great Soil Group: Soloth, podzolic soil
Landform type: Upper slopes and crests of undulating low hills. Slopes 0-10%
Geology: Granite
Vegetation: Narrow leaved ironbark, rough barked apple open forest
Surface feature: Hardsetting

Depth (m)



A1: Dark or brownish black (7.5YR 2/2, 3/2, 10YR 2/2, 2/3, 3/2); sandy loam to sandy clay loam; massive to weak granular; field pH 5.5-6.0. Clear change to

A2e,j: Conspicuously or sporadically bleached; sandy loam to sandy clay loam; massive. Abrupt change to

B2: Mottled; brownish black, brown or bright brown (7.5YR 5/6, 6/6, 10YR 3/3, 4/2, 4/3, 5/3, 5/4, 5/6); fine gravelly light clay to medium clay; moderate to strong angular blocky, occasionally polyhedral; frequently manganiferous nodules; field pH 5.5-6.0. Gradual change to

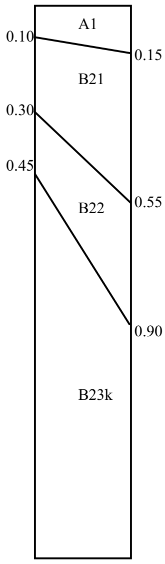
B3/C: Fine gravelly sandy clay loam to light clay or weathered rock.

Sites: 144, 210, 261, 262, 279, 288, 296, 312, 340, 550, 551, 572, 613, 776

EASTGATE (Eg)

Concept: Weak self mulching to hardsetting black or brown cracking clay on alluvial plains
Australian Classification: Black Vertosol, Brown Vertosol
PPF: Ug5.15, Ug5.34
Great Soil Group: Black earths, brown clays
Landform type: Alluvial plains and levee backslopes. Slopes 0-1.5%
Geology: Qurternary alluvium (Qa)
Vegetation: Gum topped box, poplar box with occasional forest red gum open forest woodland
Surface feature: Cracking, weak self mulching to hardsetting, occasionally weak gilgai

Depth (m)



A1: Dark (7.5YR, 10YR 2/1, 2/2, 3/1, 3/2); light medium clay to medium clay; strong fine to medium blocky; dry very hard; manganiferous concretions.

B21: Brown (10YR 3/3, 4/3) or dark (7.5YR, 10YR 2/1, 2/2, 3/1, 3/2); medium clay to medium heavy clay; strong medium blocky; dry very hard to extremely hard; manganiferous concretions.

B22: As above but frequently strong fine to medium lenticular.

B23k: Brown (7.5YR 3/3, 3/4, 4/3, 4/4, 4/6); light medium clay to medium clay; moderate to strong fine to medium blocky; dry hard to very hard; manganiferous concretions, concretionary lime.

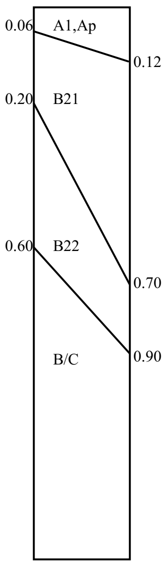
Variant: A sporadic bleach occasionally occurs towards the base of the A horizon in uncultivated situations.

Sites: 9, 14, 20, 93, 94, 113, 159, 165, 182, 211, 212, 218, 219, 228, 230, 267, 269, 286, 297, 306, 309, 311, 323, 324, 330, 334, 348, 354, 356, 357, 359, 360, 393, 403, 408, 414, 422, 434, 467, 473, 480, 567, 595, 653, 656, 719, 756, 774, 775, 782

FAIRDALE (Fd)

Concept: Moderately deep dark or brown cracking clays on basalt
Australian Classification: Black Vertosol, Brown Vertosol
PPF: Ug5.12, Ug5.13, Ug5.32
Great Soil Group: Black earth, brown clay
Landform type: Mid slopes of undulating rises to rolling hills. Slopes 2-7%
Geology: Tertiary Main Range basalt (Tm)
Vegetation: Silver leaved ironbark open forest
Surface feature: Self mulching, cracking

Depth (m)



A1,Ap: Dark or dark brown (7.5YR 3/2, 3/3, 10YR 2/2, 2/3, 3/2); light medium clay to medium clays; strong granular to subangular blocky; field pH 6.5-7.0. Clear change to

B21: Dark or brown (7.5YR 3/2, 4/4, 10YR 2/2, 3/2); medium clay to medium heavy clay; strong subangular block becoming lenticular in lower horizon; field pH 7.0-8.0. Diffuse or gradual change to

B22: Frequently occurs. Dark brown or brown (7.5YR 3/3, 4/4, 10YR 3/3, 3/4); medium clay to medium heavy clay; lenticular; frequently calcareous segregations; field pH 8.0-8.5. Gradual change to

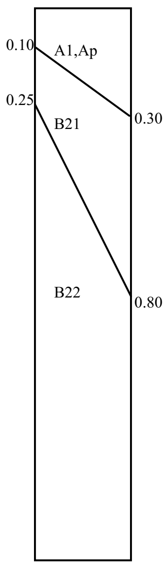
B/C: Gravelly clay loam to light clay with calcareous segregations.

Sites: 10, 25, 30, 31, 36, 58, 70, 71, 86, 87, 100, 108, 150, 180, 187, 246, 299, 483, 493, 501, 514, 515, 524, 593, 626, 641, 643, 647, 749, 795

GOODGER (Gg)

Concept: Deep loose surfaced (snuffy) red structured soil developed on deeply weathered basalt
Australian Classification: Red Ferrosol
PPF: Gn3.11, Uf5.31
Great Soil Group: Krasnozem
Landform type: Plateaus, hill crests and upper slopes. Slopes 0-12%
Geology: Deeply weathered Tertiary Main Range basalt (Tm)
Vegetation: Narrow leaved ironbark, broad leaved ironbark woodland. Mostly cleared.
Surface feature: Loose

Depth (m)



A1, Ap: Dark reddish brown (2.5YR 3/4, 4/6, 5YR 2/3, 3/6); clay loam to light clay; massive to weak granular; field pH 5.5-6.5. Clear to gradual change to

B21: Dark red or dark reddish brown (10R 3/4, 4/4, 2.5YR 3/4, 3/6, 5YR 3/6); clay loam to light clay; massive to weak polyhedral in upper horizon with increasing structure at depth; field pH 5.0-5.5. Diffuse change to

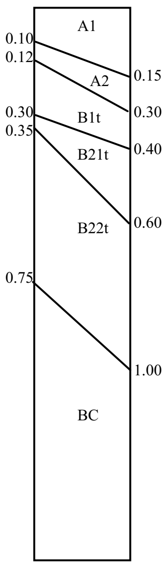
B22: Dark red, red or dark reddish brown (10R3/6, 4/6, 2.5YR 3/6, 4/6); light clay; moderate to strong polyhedral; field pH 5.0-5.5.

Sites: 244, 255, 256, 257, 258, 259, 272, 293, 535, 603, 604, 628, 666, 674, 736, 750, 757, 768, 787, 788, 798

GORDONBROOK (Gd)

Concept: Hardsetting sandy clay loam surface over a red structured clay subsoil on deeply weathered granite
Australian Classification: Dystrophic Red Chromosol, Red Dermosol
PPF: Dr2.21, Uf6.4p
Great Soil Group: Red podzolic soil; no suitable group, affinities with soloths
Landform type: Hillslopes and crests on undulating low hills. Slopes 2-6%
Geology: Granite (deeply weathered)
Vegetation: Moreton Bay ash, Apple gum, narrow leaved ironbark, silver leaved ironbark. Ground cover of wire grass and Queensland blue grass
Surface feature: Loose to firm

Depth (m)



A1: Dark reddish brown or brown (5YR, 7.5YR 2/4, 3/4); light sandy clay loam to sandy clay loam; weak fine granular structure to massive; dry weak consistence; 2-15% angular siliceous coarse fraction; field pH 6.0 to 6.3. Clear boundary to

A2: Dark yellowish red or reddish brown (5YR 3/6, 4/6); light sandy clay loam; massive; dry weak consistence; 2-15% angular siliceous coarse fraction; pH 6.0. Clear change to

B1t: Dark reddish brown or dark red (2.5YR, 5YR 3/4, 3/6); sandy light clay; weak to moderate subangular blocky to polyhedral structure; dry firm consistence; 2-15% angular quartz grains; field pH 6.0. Gradual change to

B21t: Dark red or yellowish red (2.5YR, 5YR 3/4, 3/6); sandy light clay to medium clay; moderate subangular blocky to polyhedral structure; dry firm to hard consistence; 2-15% angular quartz grains occasionally present; field pH 6.0. Gradual change to

B22t: Occasionally yellow mottled; dark red or dark yellowish brown (2.5YR, 5YR, 7.5YR, 10YR 3/4, 3/6, 4/6); sandy light clay to medium clay; moderate 10-20 mm angular blocky to strong polyhedral structure; dry hard consistence; 10-20% coarse fractions of weathered granite; field pH 6.0-5.8. Gradual change to

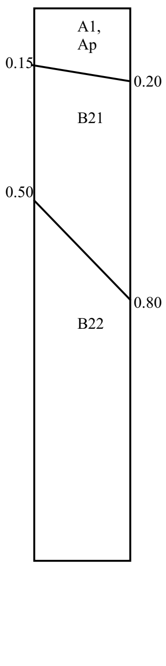
BC: Frequently mottled; reddish brown or yellowish brown (2.5YR, 5YR, 7.5YR, 10YR 3/6, 4/6); sandy clay to sandy clay loam; moderate to weak subangular blocky to polyhedral structure; dry slightly hard consistence; 30-50% coarse fraction of weathered granite; field pH 6.0-5.6.

Sites: 199, 240, 241, 245, 294, 295, 301, 539, 547, 554, 555, 620, 629, 677, 711, 712, 717, 720, 727, 745, 748,

HALY (Hl)

Concept: Mottled yellow or brown structured soils on lower slopes of basaltic pediments
Australian Classification: Brown Ferrosol
PPF: Uf6.4
Great Soil Group: Zanthozem
Landform type: Lower slopes of gently undulating pediments. Slopes 0-2%
Geology: Deeply weathered Tertiary Main Range basalt (Tm)
Vegetation: Mostly cleared. Rough barked apple, forest red gum, Moreton Bay ash and gum topped box open forest
Surface feature: Firm to hardsetting

Depth (m)



A1,Ap: Dark reddish brown or dark brown (5YR 3/3, 3/4, 7.5YR 3/4, 10YR 3/3, 3/4); light clay; strong granular; field pH 5.8-6.5. Clear to gradual change to

B21: Mottled; bright brown, yellowish brown or brown (7.5YR 5.5, 10YR 4/6, 5/6); light medium clay to medium clay; polyhedral; manganiferous nodules; field pH 6.5-7.0. Diffuse change to

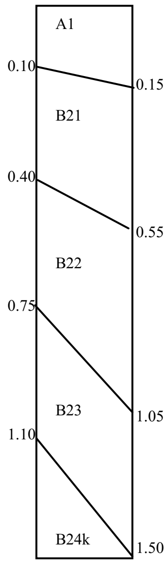
B22: Mottled; dark reddish brown, bright brown or yellowish brown (5YR 3/4, 3/6, 7.5YR 5/6, 10YR 5/6, 5/8); light medium clay to medium clay; strong polyhedral or subangular blocky; 2-20% manganiferous nodules; field pH 6.7-8.0.

Sites: 24, 55, 126, 170, 175, 178, 188, 195, 224, 227, 233, 234, 247, 276, 481, 559, 606, 691, 730, 767, 803

GUEENA (Gn)

Concept: Grey clays in drainage depressions on alluvium
Australian Classification: Grey Vertosol
PPF: Ug5.24, Ug5.28
Great Soil Group: Grey clays
Landform type: Levee backswamps and broad drainage lines. Slopes 0-1%
Geology: Quaternary alluvium (Qa)
Vegetation: Forest red gum open forest. Moderately developed grass layer of blue grasses
Surface feature: Cracking, self mulching, weak gilgai in uncultivated situation

Depth (m)



A1: Mottled; dark (10YR 2/1, 2/2, 3/1, 3/2); medium clay; strong medium blocky; dry very hard; manganiferous concretions.

B21: Brown mottled; grey (10YR, 2.5Y 4/1, 4/2, 5/2); medium clay to medium heavy clay; strong fine to medium blocky; dry very hard; manganiferous concretions.

B22 As above but strong medium lenticular.

B23: As above but only occasionally mottled.

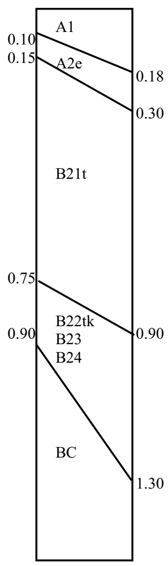
B24k: Grey (10YR, 2.5Y 4/1, 4/2) or occaionally brown (10YR 4/3); medium clay to medium heavy clay; strong fine blocky; dry very hard; manganiferous concretions, concretionary lime.

Sites: 142, 331, 342, 345, 354, 445

HILLSDALE (Hd)

Concept: Brown sodic texture contrast soil on lower slopes derived form sandstone
Australian Classification: Mesonatric Brown Sodosol, Grey Sodosol
PPF: Dy3.43, Db2.33, Db2.43
Great Soil Group: Solodic soil, solodized solonetz
Landform type: Hillslopes of undulating low hills to rolling hills. Slopes 3-12%
Geology: Sandstone
Vegetation: Narrow leaved ironbark, Moreton Bay ash. Ground cover of speargrass and kangaroo grass
Surface feature: Hardsetting

Depth (m)

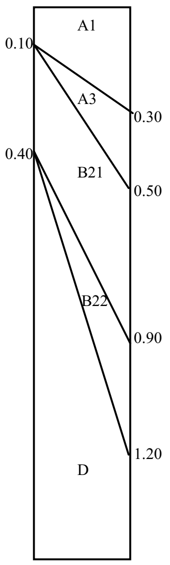


A1: Dark brown or brown (7.5YR, 10YR 2/2, 3/2, 5/3); sandy clay loam; massive to weak <2 mm granular structure; dry moderately weak consistence; field pH 5.8-6.8. Clear change to
A2e: Conspicuous or occasionally sporadically bleached; sandy clay loam; massive to weak <2mm granular structure; dry moderately weak consistence; field pH 5.3-6. Clear or abrupt change to
B21t: Grey to yellow mottled; brown or dark greyish brown (7.5YR, 10YR 4/2, 4/4); light medium clay to medium clay to sandy clay; occasionally strong 100-200 mm columnar structure breaking to strong 10-20 m prismatic or subangular blocky; dry very firm to hard consistence; 0-10% manganiferous segregations and concretions; field pH 6.8-9.1. Gradual change to
B22tk: Grey to yellow mottled; yellowish brown or light olive brown (7.5YR, 10YR, 2.5Y, 5/4, 5/6); light medium clay to medium clay; strong 20-60 mm subangular blocky to 60-200 mm prismatic structure; dry very firm consistence; 0-2% manganiferous concretions, 2-10% carbonate concretions; field pH 8.3 to 9.1. Gradual change to
B23: As above except brown (10YR 4/4); light medium clay, strong 20-60 mm angular blocky structure
B24 As above except light yellowish brown (2.5Y 6/4); light clay, then as above. Gradual change to
BC: Olive yellow (10YR 6/6); sandy clay to light clay; moderate 6-20 mm subangular blocky to massive structure; 10-50% fragments of weathered sandstone; field pH 9.1.
Sites: 111, 160, 198, 300, 358, 470, 478, 532, 543, 545, 546, 590, 800, 804

HIRST (Ht)

Concept: Massive hardsetting surface over brown structured subsoils on levels and channel benches
Australian Classification: Brown Dermosol, Brown Chromosol
Gn3.22, Gn3.52, Db2.33, Db2.12, Dy3.43
Great Soil Group: No suitable group, affinities with soloth
Landform type: Levees and terraces and backplains of minor creeks
Geology: Quaternary alluvium (Qa)
Vegetaton: Forest red gum and Moreton Bay ash open forest. Some broad leaved ironbark. Occasional stands of Belah
Surface feature: Firm to hardsetting

Depth (m)



A1: Dark brown or brownish black (7.5YR, 10YR 2/2, 2/3, 3/3, 3/2); loamy sand to sandy loam to silty clay loam; massive to moderate fine granular structure; dry slightly hard consistence. Clear change to

A3: Brown or yellow brown (7.5YR, 10YR 3/4, 4/4, 6/4); sandy loam to clay loam; weak to moderate fine granular structure. Clear change to

B21: Reddish brown or dark brown or yellowish brown (5YR, 7.5YR, 10YR 3/4, 4/6, 6/4); sandy clay loam to sandy light clay; moderate fine subangular blocky to angular blocky structure; trace amount manganese concretions. Gradual change to

B22: As above except grey to yellow mottled, and strong angular blocky structure.

D: Occasionlly grey mottled; reddish brown or brown or yellow (5YR, 7.5YR, 10YR 4/4, 4/6, 5/6); coarse sand to sandy loam; massive to weak fine granular to subangular blocky; traces of managanese concretions.

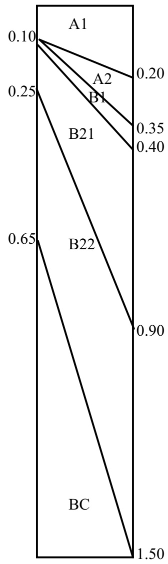
Variants: Some surface textures are sandy in alluvial fan deposits. In backplain areas, bleached variants occur. B horizons may have a sandy clay loam texture under sandy A horizons which can be massive. Some variants include deep sandy soils PPF Uc3.32.

Sites: 442. Also refer to Gordonbrook Reference area – west of study area.

HODGLEIGH (Hg)

Concept: Deep hardsetting fine sandy clay loam to clay loam sandy surface over strongly structured brown neutral clayey B horizon on lower slopes of sedimentary rocks
Australian Classification: Red Chromosol, Brown Sodosol, Brown Dermosol
PPF: Dr2.12, Dy3.42, Db2.32
Great Soil Group: Non-calcic brown, solodic soils, no suitable group
Landform type: Pediments and foot slopes of undulating low hills. Slopes 1-6%
Geology: Colluvium off Marburg sandstone and Tarong sediments
Vegetation: Narrow leaved ironbark open woodland
Surface feature: Firm to hardsetting

Depth (m)



A1: Dark brown or brown black (7.5YR, 10YR 3/2, 3/3); fine sandy clay loam to clay loam sandy; massive to moderate fine granular structure; field pH 5.8-7.0. Clear or gradual change to

A2, e,j: Occasionally sporadically on conspicuously bleached; dull orange or brown (7.5YR 3/4); sandy clay loam to clay loam sandy; massive to weak granular structure; field pH5.8–7.5; frequently moderate amounts manganese concretions. Clear change to

B1: Dark brown (7.5YR 3/4); light clay; moderate 10-50 mm angular blocky to subangular blocky; field pH 72. Gradual change to

B21: Occasionally mottled; dull yellow orange or reddish brown or brown (5YR, 7.5YR, 10YR 4/4, 4/6, 6/4); light medium to medium clay; strong fine angular blocky to coarse prismatic structure; small amounts ferruginous concretions and ferromanganiferous nodules. Gradual change to

B22: Frequently mottled; reddish brown or bright yellowish brown or brown (5YR, 7.5YR, 4/4, 6/4, 10YR 4/6); light medium clay to medium clay; strong 20-50 mm angular blocky; 0-10% manganese segregations. Gradual change to

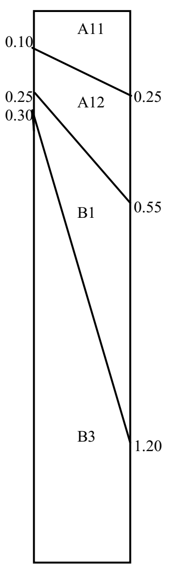
BC: Dull yellowish brown (10YR 5/4); sandy clay loam to fine sandy light medium clay; weak subangular blocky: manganese segregations.

Sites: 200, 317, 361, 801

HOPEVALE (Hv)

Concept: Shallow to moderately deep loose surface (snuffy) red structured soil developed on deeply weathered basalt
Australian Classification: Red Ferrosol
PPF: Um4.21, Um5.21, Um6.24, Um6.31, Um6.33
Great Soil Group: Red earth
Landform type: Margins of plateaus, hill crests and upper slopes of undulating rises and rolling hills. Slopes 1-3%
Geology: Deeply weathered basaltic material
Vegetation: Mostly cleared. Minor softwood scrub
Surface feature: Loose

Depth (m)



A11: Reddish brown (2.5YR, 10R 2/2, 2/3, 2/4, 3/2, 3/3, 3/4); loam; massive to weak very fine granular, large amounts ironstone; trace amounts manganiferous concretions. Clear change to

A12: As above but loam to light clay loam with extremely large amounts ferruginous gravel; weak to medium very fine granular; dry hard; trace amounts manganiferous concretions. Gradual change to

B1: As above (but not always present) clay loam with increasingly large amounts ferruginous gravel; medium fine granular; dry very hard. Gradual change to

B3: Reddish brown (2.5YR, 10R 3/3, 3/4, 3/6, 4/4); loam to light clay with very large amounts ferruginous material; massive to weak fine polyhedral; dry hard; large amounts of ironstone and trace amounts manganiferous concretions.

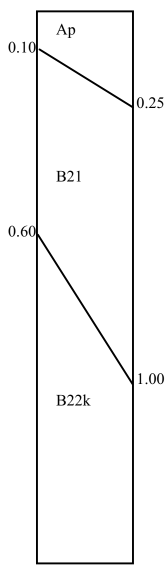
C: Lateritic, kaolinized basalt (ferruginous material).

Sites: 274, 466, 529, 591, 605, 633, 637, 738, 753

IONA (In)

Concept: Brown or black cracking clays over brown subsoils on lower slopes of pediments derived from fresh basalt
Australian Classification: Brown Vertosol, Black Vertosol
PPF: Ug5.34, Ug5.17, Ug5.15
Great Soil Group: Brown clays, black earth
Landform type: Lower slopes of gently undulating pediments. Slopes 0-5%
Geology: Tertiary Main Range basalt (Tm)
Vegetation: Silver leaved ironbark, Moreton Bay ash open forest
Surface feature: Self mulching, cracking

Depth (m)



Ap: Dark (7.5YR 3/2, 10YR 2/3); light medium clay to medium clay; strong subangular blocky; field pH 6.0-6.5. Clear change to

B21: Dark, dark brown or brown (7.5YR 2/2, 3/3, 3/4, 4/4, 10YR 3/2); medium clay to medium heavy clay; subangular blocky in upper horizon becoming lenticular in lower horizon; field pH 7.0-8.5. Diffuse change to

B22k: Dark brown or reddish brown (5YR 3/4, 4/6, 7.5YR 3/4); medium clay to medium heavy clay; strong lenticular; calcareous segregations; field pH 8.5-9.5.

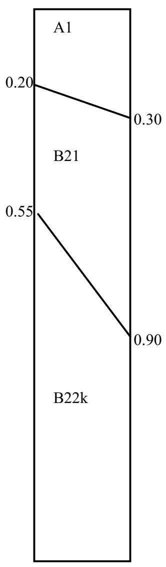
D: Gravelly horizons occasionally occur.

Sites: 118, 133, 145, 155, 161, 232, 303, 407

KABER (Kr)

Concept: Brown cracking clays on alluvial fans
Australian Classification: Brown Vertosol
PPF: Ug5.34
Great Soil Group: Brown clays
Landform type: Alluvial fans receiving wash from adjacent hills. Slopes 0.5-1.5%
Geology: Quaternary alluvium (Qa)
Vegetation: Forest red gum and broad leaved ironbark open forest
Surface feature: Cracking, weak self mulching

Depth (m)



A1: Brown (7.5YR, 10YR 3/3, 5/3); light clay to light medium clay; moderate fine blocky; dry hard to very hard; iron manganese concretions.

B21: Brown (7.5YR, 10YR 3/3, 4/3, 4/4); medium clay to medium heavy clay; strong medium blocky; dry very hard; manganiferous concretions.

B22k: As above but frequently mottled and with concretionary lime.

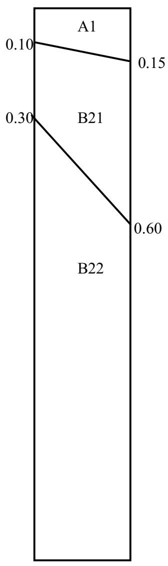
Variant: A dark (10YR 3/1, 3/2) medium clay D horizon may occur below 0.9 m.

Sites: 5, 23, 266, 283, 290, 477, 486, 528, 531, 560, 565, 583, 611, 612, 619, 627, 673, 733, 746, 755, 760, 777

KAWL KAWL (Kk)

Concept: Gilgaied grey clay on old alluvium
Australian Classification: Grey Vertosol
PPF: Ug5.24, Ug5.21
Great Soil Group: Grey clay
Landform type: Gently undulating plains. Slopes 0-5%
Geology: Quaternary alluvium (Qa), Tertiary sediments (Ts)
Vegetation: Brigalow, belah, gum topped box open forest with softwood scrub understorey. Extensively cleared.
Surface feature: Gilgaied, hardsetting, cracking

Depth (m)



A1: Dark, grey yellow brown or dark greyish yellow (7.5YR 2/2, 3/2, 10YR 2/2, 3/1, 3/3, 4/2, 2.5Y 5/2); light medium clay to medium clay; strong subangular blocky or occasionally granular; field pH 6.5-9. Clear to gradual change to

B21: Brownish grey or dark greyish yellow (10YR 4/1, 4/2, 2.5Y 5/2); light medium clay to medium heavy clay; angular blocky or lenticular; field pH 7-9. Clear change to

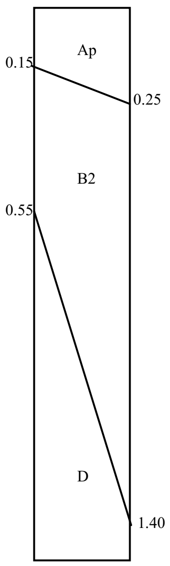
B22: Frequently mottled; brownish grey, greyish yellow brown or dark greyish yellow (7.5YR 4/2, 10YR 4/1, 10YR 5/1, 10YR 5/2, 2.5Y 5/2); light medium clay to medium heavy clay; lenticular; calcareous segregations; field pH 8-9.5.

Sites: 556, 588, 592, 610

KUMBIA (Kb)

Concept: Mottled, yellow or brown structured soils derived from tertiary deeply weathered pediments over buried tertiary clays
Australian Classification: Brown Ferrosol, Red Ferrosol
PPF: Uf6.4, Gn3.12
Great Soil Group: Xanthozem
Landform type: Lower slopes of very gently undulating pediments. Slopes 0-3%
Geology: Deeply weathered Tertiary Main Range basalts (Tm)
Vegetation: Mostly cleared. Rough barked apple, forest red gum Moreton Bay ash and gum topped box open forest
Surface feature: Hardsetting

Depth (m)



Ap: Dark brown or dull reddish brown (5YR 4/4, 7.5YR 3/3, 3/4, 10YR 3/4); clay loam to light medium clay; moderate to strong granular; frequently manganiferous segregations; field pH 5.8-6.3. Clear change to

B2: Frequently mottled; brown, yellowish brown or reddish brown (5YR 4/6, 7.5YR 4/4, 4/6, 5/6, 10YR 4/6, 5/6); light clay to medium clay; strong polyhedral; manganiferous segregations; field pH 6-8. Clear change to

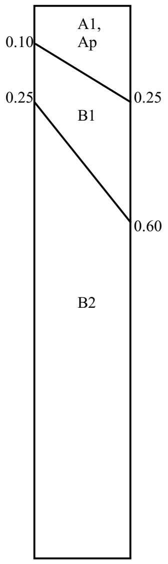
D: Mottled; brown, dull brown, bright brown or yellowish brown (7.5YR 4/4, 5/4, 5/6, 10YR 4/6, 5/6, 6/6); medium clay to heavy clay; strong angular blocky, field pH 7-9.

Sites: 2, 3, 85, 90, 97, 101, 125, 127, 131, 164, 167, 168, 173, 184, 191, 194, 204, 237, 248, 404, 406, 471, 498, 589, 594, 597, 640, 652, 758, 783

KUNIOON (Kn)

Concept: Mottled, yellow or brown structured soil with large amounts (>20%) of manganiferous nodules on pediments derived from deeply weathered basalt
Australian Classification: Brown Ferrosol, Red Ferrosol
PPF: Uf6.4
Great Soil Group: Xanthozem
Landform type: Lower slopes of gently undulating pediments. Slopes 0-3%
Geology: Deeply weathered Tertiary Main Range basalt (Tm)
Vegetation: Rough barked apple, forest red gum, Moreton Bay ash open forest
Surface feature: Hardsetting

Depth (m)



A1,Ap: Dark brown or dark reddish brown (5YR 3/4, 4/4, 7.5YR 3/3, 3/4); clay loam to light clay; moderate to strong granular; 2-20% manganiferous nodules; field pH 6.0-6.5. Clear to gradual change to

B1: Mottled; brown, reddish brown or yellowish brown (5YR 4/4, 4/6, 7.5YR 4/3, 4/4, 4/6, 5/6, 10YR 5/6); light clay to light medium clay; strong granular or polyhedral; 2-50% manganiferous nodules; field pH 5.5-7.0. Gradual change to

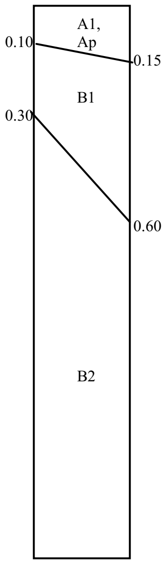
B2: Mottled; bright brown, reddish brown or dull yellow orange (5YR 4/6, 5/6, 7.5YR 5/6, 10YR 4/6); light clay to medium clay; strong polyhedral; 10-50% manganiferous nodules; field pH 5.0-7.0.

Sites: 6, 120, 129, 135, 176, 177, 202, 206, 221, 536, 569, 642, 697, 706, 713, 714, 793

LANKOWSKY (Lk)

Concept: Deep red massive soils on deeply weathered Tertiary sediments
Australian Classification: Red Kandosol
PPF: Gn2.12, Gn2.15
Great Soil Group: Red earth
Landform type: Upper slopes and crests of gently undulating low hills. Slopes 1-4%
Geology: Tertiary sediments (Ts)
Vegetation: Cleared
Surface feature: Firm

Depth (m)



A1, Ap: Dark reddish brown (5YR 2/4, 3/3); light sandy clay loam to clay loam; massive to weak granular; field pH 5.8-6.0. Gradual change to

B1: Dark reddish brown (2.5YR 3/4, 5YR 3/3); sandy clay loam to clay loam; massive; field pH 6.0-7.0. Diffuse change to

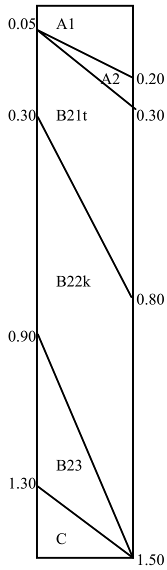
B2: Dark reddish brown (2.5YR 3/6); clay loam to light clay; massive to weak polyhedral; field pH 6.7-7.0.

Sites: 757, S39

LONG PETER (Lp)

Concept: Hardsetting clay loam surfaced, brown sodic texture contrast soil on Tertiary sediments hillcrests
Australian Classification: Brown Sodosol
PPF: Db1.13, Db2.13, Dy3.13, Dy2.13, Dy3.23
Great Soil Group: Solodic soil
Landform type: Broad crest of low hills. Slopes 0-1.5%
Geology: Tertiary sediments (Ts)
Vegetation: Gum topped box and narrow leaved ironbark open forest. Regrowth of black tea tree can occur after clearing. Moderately developed grass layer of blue grass and love grass
Surface feature: Hardsetting

Depth (m)



A1: Dark or brown (7.5YR, 10YR 2/2, 2/3, 3/2, 3/3, 3/4); clay loam, clay loam sandy to fine sandy clay loam; weak to moderate medium blocky; dry hard; manganiferous concretions.

A2: Occasionally present. As above but brown (10YR, 7.5YR 4/4).

B21t: Occasionally red, yellow or brown mottled; brown or yellow brown or yellow (7.5YR, 10YR 3/4, 4/3, 4/4, 3/5, 5/4, 5/6, 5/8); light medium clay to medium heavy clay; strong medium blocky to prismatic; dry hard to extremely hard; manganiferous concretions.

B22 k: Brown or yellow brown or yellow (7.5YR 10YR 3/4, 4/3, 4/4, 4/6, 5/4, 5/6, 5/8, 6/8); medium clay to medium heavy clay; moderate medium blocky to strong medium lenticular; dry very hard to extremely hard; manganiferous concretions, soft or concretionary lime; occasionally ferruginous segregations.

B23: As above but without lime, discontinuous mangans occasionally occur.

C: Occasionally present. Moderately grey, gley, brown or yellow mottled; grey or yellow brown or yellow or brown (10YR, 7.5YR 4/4, 4/6, 5/4, 5/6, 6/2, 6/4, 7/2); sandy light clay to medium heavy clay; moderate medium blocky; dry very hard to extremely hard; manganiferous concretions and vein; ferruginous segregations.

Notes: 2-15% surface gravel (3-75 mm), angular (silcrete) to subangular to rounded petrified wood, kaolinised basalt, chert, chalcedony, ironstone and silcrete.

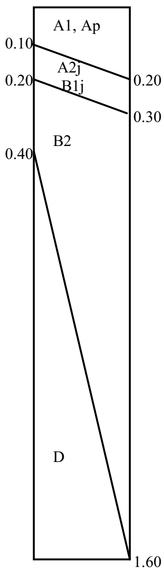
Variants: Loam A11 horizons 2.5 to 8 cm thick occasionally occur in uncultivated situations

Sites: 440, 462, 465, 497, 517

MARSHLANDS (Ml)

Concept: Gilgaied, hardsetting, texture contrast and uniform soils over sodic D horizons on old alluvial plains
Australian Classification: Brown Sodosol
PPF: Db2.33, Uf6.41p, Dy3.32, Dy3.31, Uf3
Great Soil Group: Solodic soil, soloth
Landform type: Plains. Slopes 0-3%
Geology: Quaternary alluvium (Qa), Tertiary sediments (Ts
Vegetation: Poplar box open forest
Surface feature: Hardsetting

Depth (m)



A1, Ap: Dark brown or dull yellowish brown (7.5YR 3/3, 3/4, 10YR 3/4, 4/3); sandy clay loam to light clay; strong granular; 2-10% manganiferous concretions; field pH 6-6.5. Clear change to

A2j, B1j: Sporadically bleached in undistributed soils; dark brown, dull yellowish brown or brown (7.5YR 3/4, 4/3, 4/4, 10YR 3/4, 4/4); sandy clay loam to light clay; strong granular to subangular blocky; 2-20% manganiferous concretions; field pH 6.5-7.5. Clear to abrupt change to

B2: Mottled; yellowish brown or brown (7.5YR 4/6, 10YR 4/4, 4/6, 5/6, 5/8); light medium clay to medium clay; polyhedral or subangular blocky; 2-20% manganiferous concretions; field pH 5.8-8.5. Clear change to

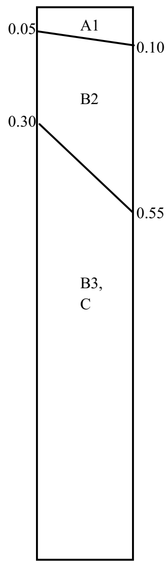
D: Mottled; brown or yellowish brown (7.5YR 4/6, 5/6, 10YR 4/4, 4/6, 5/6); medium heavy to heavy clay; angular blocky, prismatic or lenticular; 2-20% manganiferous concretions and occasionally calcareous segregations; field pH 7.0-9.0.

Sites: 364, 383, 389, 397, 418, 439

McEUEN (Mn)

Concept: Shallow dark clays on basalt
Australian Classification: Black Vertosol, Brown Vertosol
PPF: Ug5.12, Ug5.32, Ug5.13
Great Soil Group: Black earths, brown clay
Landform type: Upper slopes and crests of undulating rises and low hills. Slopes 0-10%
Geology: Tertiary Main Range basalt (Tm)
Vegetation: Silver leaved ironbark open forest
Surface feature: Self mulching, cracking, surface coarse fragments

Depth (m)



A1: Dark, brownish black or dark brown (7.5YR 3/2, 3/3, 10YR 2/2, 2/3); light clay to medium clay; strong subangular blocky; field pH 6.0-7.0. Clear change to

B2: Dark, brownish black or dark brown (7.5YR 2/3, 3/2, 3/3, 10YR 2/2, 3/2, 3/3); medium clay to medium heavy clay; strong subangular blocky or lenticular; field pH 7.8-8.5. Clear change to

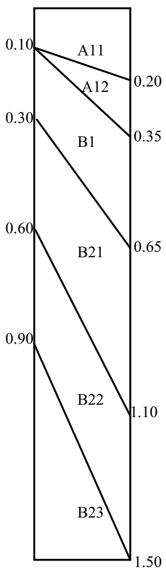
B3, C: Dark, brownish black or dark brown (10YR 2/3, 3/3); light clay to medium heavy clay with rock fragments or weathered rock; field pH 8.5-8.8.

Sites: 4, 16, 19, 21, 34, 54, 77, 78, 81, 83, 84, 92, 98, 109, 110, 127, 134, 137, 152, 156, 172, 175, 281, 285, 289, 426, 485, 489, 492, 516, 519, 527, 568, 631, 649, 667, 701, 742, 773, 763

MEMERAMBI (Mm)

Concept: Deep acid red structured uniform and gradational soils on deeply weathered basalt
Australian Classification: Red Ferrosol
PPF: Uf6.31, Gn3.11
Great Soil Group: Krasnozem
Landform type: Mid to upper slopes of undulating rises to rolling hills
Geology: Deeply weathered Tertiary Main Range basalt (Tm)
Vegetation: Mostly cleared
Surface feature: Firm

Depth (m)



A11: Dark reddish brown (2.5YR, 10R, 3/3, 3/4); clay loam to light clay; weak very fine granular to moderate fine granular; dry slightly hard; small amounts ferruginous material included; ironstone and manganiferous concretions.

A12: As above except strong fine granular to strong fine polyhedral; dry hard; moderate amounts ferruginous ironstone; small amounts manganiferous concretions.

B1: As above but light to light clay; ferruginous material increasing with depth.

B21: Reddish brown (2.5YR, 10R, 3/4, 3/6); light clay to light medium clay with 15-50% rounded ferruginous coarse material; strong medium subangular blocky to strong fine polyhedral; dry very hard; moderate amounts ironstone and' manganiferous concretions.

B22: As above with >50% rounded ferruginous coarse material and subangular lateritic material.

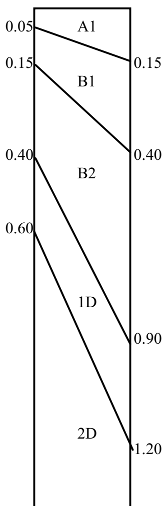
B23: As above but clay loam to light clay, large amounts ferruginous gravel, strong fine polyhedral; dry very hard.

Sites: 107, 148, 149, 169, 236, 251, 252, 260, 265, 273, 277, 523, 563, 570, 571, 581, 602, 625, 630, 632, 668, 669, 671, 679, 680, 683, 684, 685, 687, 688, 694, 739, 741, 751, 754, 759, 764, 766, 792, 796, 799, 807

NARRAWONG (Nr)

Concept: Mottled red structured soil derived from transport deeply weathered basaltic material overlying old alluvium
Australian Classification: Red Ferrosol
PPF: Gn3.12, Gn3.52, Gn3.22, Gn3.33, Gn4.12
Great Soil Group: Euchrozems
Landform type: Sloping area or crests of rises. Slopes 1-5%
Geology: Transported material of basaltic origin overlying Tertiary sediments
Vegetation: Cleared
Surface feature: Hardsetting

Depth (m)



A1: Red brown or dark (5YR, 7.5YR 2/2, 3/2, 3/3, 3/4); clay loam to clay loam sandy; moderate fine subangular blocky; dry slightly hard; manganiferous concretions.

B1: Red or red-brown (2.5YR, 5YR 3/4, 4/4, 4/6) or occasionally brown (7.5 YR 4/4); light clay; strong fine blocky to moderate fine subangular blocky; dry hard to slightly hard; manganiferous concretions.

B2: Occasionally yellow mottled; red or brown (2.5YR, 5YR, 7.5YR 4/6, 4/8); light medium clay; strong fine to medium blocky to polyhedral; dry very hard to hard; manganiferous concretions.

1D: Frequently red or yellow mottled; brown or yellow (10YR 4/4, 4/6, 5/6); light medium clay to medium heavy clay; moderate fine to medium angular blocky or occasionally strong medium lenticular; dry hard to very hard; manganiferous concretions.

2D: Frequently grey or yellow mottled; brown or yellow (7.5YR, 10YR 4/6, 5/8, 6/6); medium to medium heavy clay; moderate fine to medium blocky; dry very hard, manganiferous concretions and veins, frequently concretionary lime.

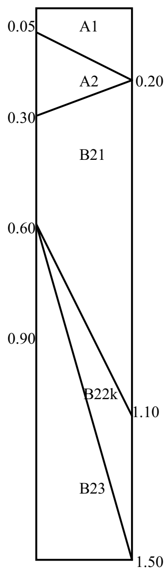
Notes: Surface 1-5% subangular to rounded ironstone, kaolinized basalt chert chalcedony and silcrete gravel 3-50 mm

Sites: 131, 213, M216, 217, 234, 268

MONDURE (Md)

Concept: Non cracking brown clays on elevated old alluvial plains
Australian Classification: Brown Dermosol
PPF: Uf6.31, Uf4.42, Uf6.4, Gn3.23, Db1.13
Great Soil Group: No suitable group
Landform type: Elevated plains. Slopes 1-3%
Geology: Quaternary alluvia (Qa)
Vegetation: Narrow leaved ironbark and gun topped box with occasional forest red gum open forest, moderately developed grass layer of kangaroo grass and glue grass
Surface feature: Firm to hardsetting, occasionally gilgaied

Depth (m)



A1: Brown or red brown (7.5YR, 5YR 3/3, 3/4, 4/4) or occasionally dark (7.5YR 3/2); light clay or occasionally clay loam; weak fine granular; dry slightly hard to hard; manganiferous concretions, occasionally ironstone segregations.

A2: Occasionally present. As above dark mottled; brown (7.5YR 4/4); light clay.

B21: Occasionally red mottled; brown or yellow brown or yellow (7.5YR, 10YR 3/4, 4/3, 4/4, 4/6, 5/4, 5/6); light medium clay to medium clay; moderate medium blocky; dry hard to extremely hard; manganiferous concretions.

B22k: Frequently present. Brown or yellow brown or yellow (7.5YR, 10YR 3/4, 4/3, 4/4, 4/6, 5/4, 5/6); medium clay to medium heavy clay; moderate medium blocky to strong medium lenticular; dry very hard to extremely hard; manganiferous concretions, concretionary lime.

B23: As above but occasionally yellow or grey mottled; manganiferous concretions and/or veins, with or without lime.

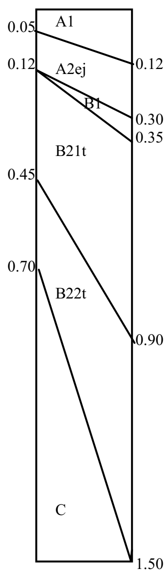
Notes: Surface carries 0-10% subangular to rounded kaolinised, ironstone, laterite, basalt and silcrete gravel
5-100 mm.

Sites: 126, 127, 182, 189, 190, 191, 194, 196, 203, 204, 205, 206, 207, 208, 507

PALOUSE (Pl)

Concept: Hardsetting sandy loam to light sandy clay loam surfaced mottled brown sodic texture contrast soil on Tertiary sediments
Australian Classification: Brown Sodosol
PPF: Dy3.43, Dy2.43, Db2.43, Dy3.33, Db2.33
Great Soil Group: Solodic soil, solodized solonetz
Landform type: Crest and slopes of low hills. Slopes 1-7%
Geology: Tertiary sediments (Ts)
Vegetation: Narrow leaved ironbark, gum topped box and belah open forest
Surface feature: Hardsetting

Depth (m)



A1: Brown or grey (7.5YR, 10YR 3/3, 3/4, 4/2, 4/3, 4/4); sandy loam to light sandy clay loam to fine sandy loam; massive to weak fine granular or subangular blocky; very slightly hard to very hard; manganiferous concretions.

A2j,e: As above but sporadically or conspicuously bleached and occasionally loamy sand.

B1: Occasionally present. Dark mottled; yellow brown (10YR 5/4); sandy clay; strong coarse columnar; dry extremely hard; manganiferous concretions.

B21t: Frequently brown, red or yellow mottled; yellow or yellow brown or brown (7.5YR, 10YR 4/3, 4/4, 4/6, 5/3, 5/4, 5/6, 6/3); light medium clay to medium heavy clay; strong coarse columnar to strong medium prismatic; dry extremely hard; manganiferous concretions.

B22t: As above but whole coloured, occasionally strong coarse lenticular and frequently with soft or concretionary lime.

C: Brown, grey, gley or yellow mottled; grey or yellow brown or yellow (10YR 5/6, 6/2, 6/4, 6/6, 7/1, 7/2, 8/1, 8/2); sandy clay loam to sandy light clay to medium clay; moderate medium angular blocky to massive; dry hard to extremely hard; manganiferous veins and ferruginous segregations.

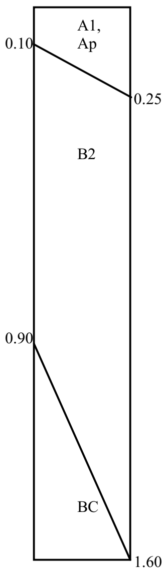
Notes: Surface carries 2-15% angular (silcrete) to subangular to rounded, petrified wood, kaolonized basalt, chert, chalcedony, ironstone and silcrete gravel 3-75mm. Up to 15% stone cover of weakly lithified argillaceous sandstone also occurs in some areas. This apparently turns from grey to yellow-brown on exposure and is the massive, extremely hard material mentioned in the C horizon

Sites: 150, 151, 169, 518, S5. M219, 220, 221, 228, 233, 271, 280, 281, 290, 330, 343, 365, 423, 452

PROSTON (Pt)

Concept: Red structured soil with large amounts of ferruginous gravel on deeply weathered basalt
Australian Classification: Red Ferrosol
PPF: Gn3.11, Uf6.31, Um6.31
Great Soil Group: Krasnozem
Landform type: Upper slopes and hill crests of undulating rises and rolling hills, and plateau margins. Slopes 5-20%
Geology: Deeply weathered Tertiary Main Range basalt (Tm)
Vegetation: Soft wood scrub. Mostly cleared
Surface feature: Firm

Depth (m)



A1,Ap: Dark reddish brown (2.5YR 3/3, 3/5, 3/6); clay loam to light clay; weak to moderate granular; 2-20% ferruginous gravel, field pH 5.5-6.0. Clear to gradual change to

B2: Dark reddish brown or dark red (2.5YR 3/4, 3/6, 4/6, 10R 3/4); clay loam to light clay; moderate to strong polyhedral; 10-50% ferruginous gravel; field pH 4.5-6.0. Gradual to diffuse change to

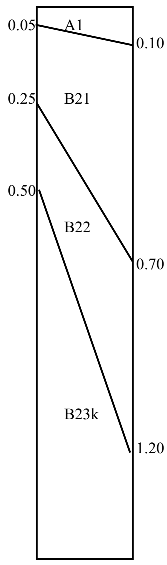
B/C: As above with weathered rock.

Sites: 115, 201, 253, 580, 663, 784

SADIE (Sd)

Concept: Deep black cracking clays on lower slopes of pediments derived from fresh basalt
Australian Classification: Black Vertosol
PPF: Ug5.16
Great Soil Group: Black earth
Landform type: Lower slopes of pediments. Slopes 0-1%
Geology: Quaternary alluvium (Qa)
Vegetation: Forest red gum open forest with occasional broad leaved apple. Well developed grass layer of blue grasses
Surface feature: Cracking, self mulching

Depth (m)



A1: Dark (7.5YR, 10YR, 2/2/, 3/2) or occasionally brown (10YR 2/3, 3/3); light medium clay to medium heavy clay; strong fine granular, dry very hard.

B21: Dark (7.5YR, 10YR 2/1, 2/2, 3/1, 3/2); medium clay to medium heavy clay; moderate medium to fine subangular blocky; dry very hard; occasionally manganiferous concretions, iron segregations and concretionary lime.

B22: As above but strong medium to coarse lenticular; manganiferous concretions, iron segregations and occasionally concretionary lime.

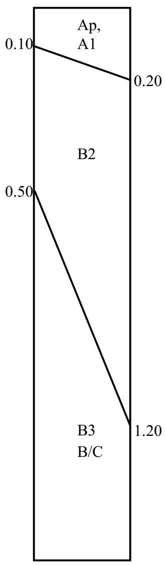
B23k: Occasionally yellow or grey mottled; grey or yellow brown (10YR, 2.5Y 4/2, 4/2, 5/3) or occasionally dark (10YR 2/1, 3/1); medium clay to medium heavy clay; moderate fine to medium subangular blocky; dry very hard; manganiferous concretions and moderate amounts concretionary lime.

Sites: 152, 166, 167, M206, 207, 433, 450, 451, 454

TAABINGA (Tb)

Concept: Neutral structured red soil on weathered basalt
Australian Classification: Red Ferrosol
PPF: Uf6.31, Gn3.12, Gn3.13
Great Soil Group: Euchrozem
Landform type: Upper slopes and crests of undulating rises to rolling hills. Slopes 2-5%
Geology: Tertiary Main Range basalt (Tm)
Vegetation: Cleared
Surface feature: Hardsetting

Depth (m)



Ap,A1: Dark reddish brown (2.5YR 3/4, 5YR 2/3, 3/3, 3/4, 3/6); clay loam to light clay; moderate to strong granular; frequently ferruginous concretions; field pH 5.5-6.8. Gradual change to

B2: Reddish brown or dark reddish brown (2.5YR 3/6, 4/6. 5YR 3/4, 3/6, 4/6); light clay to medium clay; moderate to strong polyhedral; frequently ferruginous concretions; field pH 7.0-8.5. Gradual change to

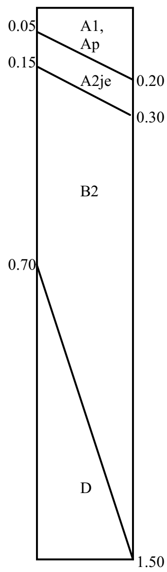
B3, B/C: Mottled; bright brown, reddish brown or dull brown (2.5YR 4/6, 5/8, 5YR 4/6, 4/8, 5/6, 5/9, 7.5YR 5/4); clay loam to medium clay with rock fragments or weathered rock; field pH 7.0-9.0.

Sites: 7, 8, 11, 89, 102, 103, 327, 526

TARONG (Tr)

Concept: Hardsetting, bleached, brown or yellow texture contrast soils on pediments derived from mixed basaltic material and sediments
Australian Classification: Brown Chromosol, Brown Dermosol, Yellow Chromosol, Yellow Dermosol
PPF: Dy3.41, Dy3.32, Dy3.31, Db2.31
Great Soil Group: Yellow podzolic soil, brown podzolic soil, no suitable group
Landform type: Lower slopes of gently undulating pediments. Slopes 0-4%
Geology: Mixed basaltic material and unconsolidated sediments
Vegetation: Narrow leaved ironbark open forest with scattered forest red gum
Surface feature: Hardsetting

Depth (m)



A1,Ap: Dark brown or greyish brown (5YR 3/4, 7.5YR 3/4, 4/2, 10YR 3/3, 3/4); sandy loam to clay loam sandy; granular or massive; field pH 6.0-7.0. Clear change to

A2j,e: Sporadically or conspicuously bleached; sandy loam to clay loam sandy; massive to weak granular; frequently manganiferous nodules; field pH 6.0-7.0. Clear to abrupt change to

B2: Mottled; yellowsh brown, bright brown or greyish brown (7.5YR 5/6, 5/8, 10YR 4/4, 4/6, 5/4, 5/6, 6/8); light clay to medium clay; polyhedral or subangular blocky; 2-20% manganiferous nodules; field pH 6.0-7.5. Clear change to

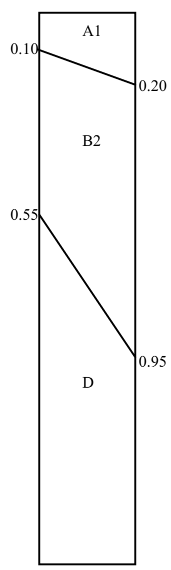
D: Frequently occurs. Mottled; bright brown or yellowish brown (7.5YR 5/6, 10YR 4/4, 5/6, 5/8); medium clay to heavy clay; lenticular or angular blocky; field pH 5.5-9.0.

Sites: 106, 186, 214, 222, 223, 226, 229, 438, 537, 618, 690, 707, 708, 726, 731, 781, 789, 808

TERRACE (Ta)

Concept: Dark clay over buried deposition layers on flood plains
Australian Classification: Black Dermosol, Black Vertosol
PPF: Uf6.32, Ug5.15
Great Soil Group: Prairie soil, minor black earth
Landform type: Flood plain below main levee level. Slopes 1-10%
Geology: Quaternary alluvium (Qa)
Vegetation: Forest red rum, rough barked apple and broad leaved ironbark open forest. Some red bottlebrush occurs. Moderately developed grass layer of blue grasses
Surface feature: Firm

Depth (m)



A1: Dark (10YR, 2.5Y 3/1, 3/2); sandy light clay; strong fine subangular blocky; dry very hard.

B2: Dark (10YR 2/3, 3/2); light medium clay to medium clay; strong fine subangular blocky; dry very hard.

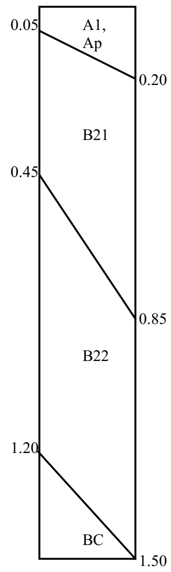
D: Brown (7.5YR, 10YR 3/3, 4/3, 4/4); sandy light clay; moderate medium subangular blocky; dry hard.

Sites: 314, 321, 444, 599. See also Gordonbrook Reference Area sites - west of study area. DNR, Indooroopilly.

TINGOORA (Tg)

Concept: Deep black and brown clays on fresh basalt
Australian Classification: Brown Vertosol, Black Vertosol
PPF: Ug5.32, Ug5.13, Ug5.12, Ug5.34
Great Soil Group: Brown clay, black earth
Landform type: Mid to lower slopes on undulating rises and low hills. Slopes 3-8%
Geology: Tertiary Main Range basalt (Tm)
Vegetation: Silver leaved ironbark open forest. Extensively cleared
Surface feature: Self mulching, cracking

Depth (m)



A1,Ap: Dark or dark brown (7.5YR 2/1, 3/2, 3/4, 10YR 3/3); light medium clay to medium clay; strong subangular blocky; field pH 6.0-8.5. Clear change to

B21: Dark or dark brown (7.5YR 3/2, 3/3, 4/3, 10YR 2/3, 3/3); medium clay to medium heavy clay; strong lenticular; field pH 7.0-8.5. Gradual change to

B22k: Dark brown, brown or dull yellowish brown (7.5YR 3/4, 4/3, 4/4, 10YR 4/3); medium clay to heavy clay; strong lenticular; 10-20% calcareous segregations; field pH 8.5-9.3. Clear to gradual change to

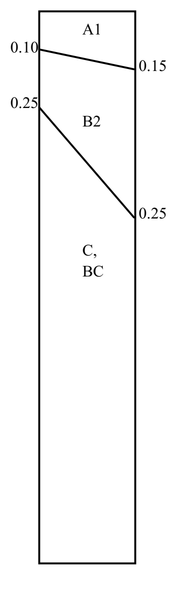
BC: Brown (7.5YR 3/4, 10YR 3/6); clay loam to medium clay with rock fragments; field pH 8.5-9.5.

Sites: 26, 171, 282, 425, 476, 500, 651, 740, 809

TUREEN (Tn)

Concept: Stony, shallow, black to brown soils on fresh basalt
Australian Classification: Uf6.32, Uf6.31, Db1.12
PPF: Black Dermosol, Brown Dermosol
Great Soil Group: Praire soil
Landform type: Upper slopes and crests of undulating rises and low hills. Slopes 0-15%
Geology: Tertiary main range basalt (Tm)
Vegetation: Silver leaved ironbark, narrow leaved ironbark open forest
Surface feature: Firm

Depth (m)



A1: Dark (7.5 YR 2/1, 2/2, 2/3, 3/2, YR 2/1, 2/2); light clay or occasionally clay loam; strong granular; field pH 6.0-7.0. Clear change to

B2: Dark brown or dark (7.5YR 3/2, 3/3, 3/4, 10YR 2/3, 3/2, 3/3,3/4); light medium clay to medium clay; strong subangular blocky; field pH 6.0-8.0. Clear to gradual change to

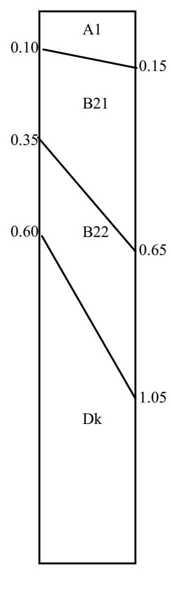
C, BC: Weathered rock or clay with weathered rock

Sites: 15, 22, 33, 35, 37, 42, 53, 65, 72, 75, 80, 91, 124, 130, 136, 138. 143. 151. 307, 389

WEIR (We)

Concept: Black cracking clays on levees
Australian Classification: Black Vertosol
PPF: Ug5.15
Great Soil Group: Black earths
Landform type: Relect levees of present and former stream channels. Slopes 0.5-2%
Geology: Quaternary alluvium (Qa)
Vegetation: Forest red gum, rough-barked apple and broad leaved ironbark open forest
Surface feature: Hardsetting to weak self mulching

Depth (m)



A1: Dark (10YR 3/1, 2/2, 3/1, 3/2); light clay to light medium clay; strong fine subangular blocky; dry hard.

B21: Dark (10YR 2/1, 2/2, 3/1, 3/2); medium clay; strong medium subangular blocky; dry very hard.

B22: As above with strong medium lenticular structure and occasionally manganiferous concretions.

Dk: Brown (7.5YR, 10YR 3/3, 3/5, 4/3, 4/4); light medium clay; strong fine to medium subangular; dry very hard; manganiferous concretions, concretionary lime.

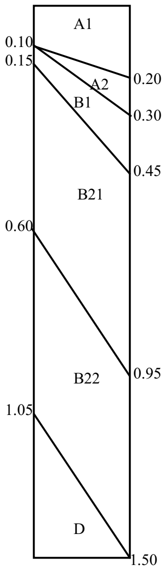
Variant: A sporadic bleach occasionally occurs towards the base of the A horizon in uncultivated situations.

Sites: 304, 310, 312, 316, 320, 329, 332, 338, 341, 347, 352, 355, 646

WHEATLANDS (Wh)

Concept: Alkaline and neutral, red gradational and texture contrast soils on old alluvium
Australian Classification: Red Dermosol, Brown Dermosol
PPF: Gn3.16, Gn3.26, Dr2.22, Gn3.13, Dr3.33
Great Soil Group: No suitable group, affinities with red brown earth
Landform type: Hillcrests and hillslopes of gently undulating plains to undulating rises. Slopes 1-4%
Geology: Elevated Quaternary alluvium (Qa)
Vegetation: Forest red gum and broad leaved ironbark open forest. Moderately developed grass layer of blue grasses
Surface feature: Hardsetting

Depth (m)



A1: Brown (7.5YR 3/4, 4/3); sandy clay loam to clay loam sandy; massive; dry slightly hard to hard; occasionally manganiferous concretions and veins.

A2: Occasionally sporadically bleached. As above, but brown or yellow brown (7.5YR 4/4, 5/6).

B1: Red brown or brown (5YR, 7.5YR 3/6, 4/4, 4/6); sandy light clay to light clay; moderate medium angular blocky; dry hard; frequently manganiferous concretions and veins.

B21: Frequently mottled; red brown or brown (5YR, 7.5YR 3/6, 4/4, 4/6); medium clay; strong medium angular blocky; dry hard; frequently manganiferous concretions and veins.

B22: As above but always has manganiferous concretions and veins.

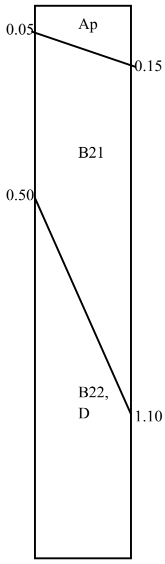
D: As above but sandy clay loam to clay loam sandy frequently with subangular gravel.

Sites: 365, 543. Also described in Barker-Barambah Irrigation Suitability Study, Reid *et al*. 1979.

WONDAI (Wd)

Concept: Gilgaied brown or black cracking clays on lower slopes of pediments derived from fresh basalt
Australian Classification: Brown Vertosol, Black Vertosol
PPF: Ug5.34, Ug5.15, Ug5.17, Ug 5.35
Great Soil Group: Brown clays, black earth
Landform type: Lower slopes of gently undulating pediments. Slopes 2-6%
Geology: Tertiary Main Range basalt (Tm)
Vegetation: Gum topped box, narrow leaved ironbark open forest. Mostly cleared
Surface feature: Gilgaied, cracking, weak self mulching

Depth (m)



Ap: Dark or dark brown (7.5YR 3/2, 3/3, 3/4, 10YR 2/2); light medium clay to medium heavy clay; subangular blocky; field pH 6.0-7.0. Clear change to

B21: Dark brown, brown or dark (7.5YR 3/2, 3/3, 3/4, 4/4, 4/6, 10YR 2/2); medium clay to medium heavy clay; subangular blocky or lenticular; occasionally managaniferous nodules; field pH 6.0-8.0. Diffuse change to

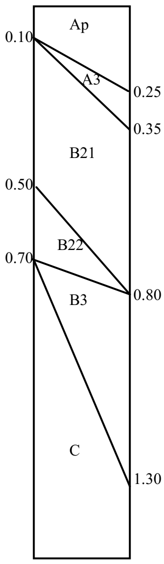
B22,D: Frequently mottled; dark brown or brown (5YR 3/4, 4/4, 7.5YR 3/4, 4/4, 4/6, 5/6, 10YR 3/4, 5/4); medium clay to medium heavy clay; lenticular B22 or polyhedral to subangular blocky D horizons frequently with gravel; frequently with calcareous segregations; field pH 7.5-8.5.

Sites: 79, 370, 372, 385, 456, 482, 490, 491, 499, 518, 521, 548, 564, 696, 700, 704, 761

WOOROOLIN (Wr)

Concept: Shallow, moderate to well structured, red clay soil over kaolinized basalt
Australian Classification: Red Ferrosol
PPF: Gn3.11, Uf6.31
Great Soil Group: Krasnozem, Euchrozem
Landform type: Upper slopes of gently undaulting to rolling hills
Geology: Deeply weathered Main Range basalt (Tm)
Vegetation: Most cleared. Minor softwood scrub
Surface feature: Firm

Depth (m)



Ap: Very dark reddish brown (10R, 2.5 YR, 2/3, 2/4, 3/3, 3/4); clay loam to light clay; weak to moderate fine granular; dry hard; moderate amounts of ironstone and manganiferous concretions. Clear or gradual change to

A3: Very dark reddish brown (10R, 2.5YR, 2/3, 3/3, 3/4, 3/6); light clay; strong fine granular to strong fine blocky; dry hard; moderate amounts of ironstone and manganiferous concretions. Gradual change to

B21: Reddish brown (10R, 2.5YR, 3/3, 3/4, 3/6, 4/3, 4/6); light clay to light medium clay; strong fine to medium polyhedral; dry very hard; moderate amounts of ironstone and manganiferous concretions; moderate amount of kaolinized basalt. Gradual change to

B22: Reddish brown (10R, 2.5 YR, 3/4, 3/6, 4/3, 4/4, 4/6); light clay to light medium clay; strong fine to medium polyhedral; dry very hard; moderate amounts of ironstone and manganiferous concretions; moderate amounts of kaolinized basalt. Gradual change to

B3: Reddish brown (10R, 2.5 YR, 3/4, 3/6); light clay to medium clay; strong fine to strong medium polyhedral; dry very hard; large amounts of ironstone and manganiferous concretions, moderate to large amounts of kaolinized and decomposing basalt. Gradual change to

C: Kaolinized basalt

Variant: Occasionally alkaline soil reaction trends occur in lower solum

Sites: 132, 139, 147, 157, 163, 233, 243, 250, 558, 561, 577, 576, 582, 587, 601, 603, 661, 672, 676,