REPORT ON THE LAND UNITS

of

WAGAIT ABORIGINAL RESERVE

by

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CONTENTS

Acknowledgements

Page No.

Chapter 1 Introduction 1
2 Description of Land Units 3
3 Physiography 27
4 Soils 31
5 Vegetation 42
6 Limitations to and Potential for Land Use 52
7 References 61

Appendix I Soils Description 63
II Botanical Species Check List 87

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INTRODUCTION

A survey of Wagait Aboriginal Reserve was requested by the Land Board, Northern Territory Administration in 1972. The primary aim of the survey was to determine the suitability of the Reserve for agricultural and pastoral enterprises.

The land systems of the Reserve were mapped at a scale of 1:500,000 by Christian and Stewart (1953) during the Katherine-Darwin Region survey in 1946. At such a small scale only 5 land systems were recognised (Charles Point, Brocks Creek Ridge, Litchfield, Sub Coastal Plain and Littoral).

For this more recent survey, land units (Hooper 1970) were adopted as the mapping entity and mapped at 1:50,000 scale. A land unit is a uniform assemblage of topography, soils and vegetation, and, therefore, has uniform land use potential.

Size and Location

Wagait Aboriginal Reserve covers approximately 1,424 square kilometres of country, 70 kilometres south-west of Darwin. Fig. 1 indicates its location.

The Reserve adjoins Finniss River Station on its northern boundary and Stapleton Station (La Belle Outstation) on its southern boundary. The western boundary follows the coastline southwards from the mouth of the Finniss River. The eastern boundary adjoins freehold blocks and runs in a general south-south-westerly direction from Farrants Creek across Burton's Creek and McCallam Creek to the south-eastern corner of the Reserve.

Climate

There are no meteorological recording stations on the Reserve and neither of the adjoining properties can provide any detailed meteorological data.

It is broadly true to state that the Reserve has a climate similar to Darwin and its immediate hinterland. It experiences a monsoonal climate with hot, wet summers and warm, dry winters. The Reserve falls within the 1,400mm and 2,000mm isohyets (Bureau of Meteorology, Darwin). Rainfall and humidity could be expected to increase westwards, while sea breezes are likely to moderate temperatures on the coast.

The incidence of cyclones is not known. Some areas, strewn with fallen eucalypts, provide evidence that cyclones or violent local storms have struck the coast in recent years. There is also evidence that sea water has been blown over the coastal dunes and damaged vegetation.
Figure 1 Location map
Survey Technique

Before going into the field, the available literature was consulted. This included the report of the land system survey of the Katherine-Darwin region (Christian and Stewart, 1953). Geological maps (1:250,000 and 1:63,000 scale) and reports were also consulted.

The different photo patterns, which appeared to represent different topography-soils-vegetation associations (i.e., land units), were delineated under stereoscopic examination of 1:16,000 scale aerial photography. Investigation sites were selected in representative photopatterns.

Field surveying was carried out from early July to mid-October, 1972. In all, 508 investigation sites were recorded during 48 days of land traverse and 3 days of aerial traverse by helicopter. At each site, records were taken of landform, geology, soils, drainage, vegetation and other relevant data.

During the wet season a brief trip was made to the Reserve to identify grasses and low shrubs which had dried up and burnt during the previous dry season. The potential land use of the area was also discussed with an Animal Production Officer. The extent of flooding on the paludal plains, estuarine plains, and paperbark swamps was investigated in a fixed wing aircraft during the late wet season.

After field surveying, the final interpretation of the aerial photographs was carried out and land units were remapped. The land units were described in detail after collation of all field data.
2 DESCRIPTION OF LAND UNITS

A description of physiography, soils and vegetation for the land units of the Reserve is set out in the following section. Limitations to and potential for agricultural or pastoral use have also been included.

Where mentioned drainage impedence increases in the order excessively well, well, moderately well, imperfectly, poorly and inundated. With regard to waterlogging and inundation, 'short' describes a period of up to 1 month, 'moderate' from 1 to 2 months and 'long' from 2 months to beyond the duration of the wet season.

Some terms used in the Potential Land Use section require clarification. 'Arable' refers to land suitable for cultivation and cropping. 'Soil conservation measures necessary' refers to soil conservation inputs when cultivation is practised preceding cropping or pasture improvements. Obviously the soil conservation measures will vary depending on the intensity of development. 'Limited or rough grazing' refers to low and controlled stocking rates on native pastures.

The boundaries between most land units in the rugged terrain and undulating terrain are clear. Similarly, boundaries between some land units in low lying areas are clear; e.g. between Melaleuca closed forests (7b) and closed grasslands (7a) on paludal plains. However, the boundaries between many other land units are diffuse and not easily recognised. Thus, land units 2d.1, 2d.2 and 2e, land units 4b, 4c and 4d and land units 5c.1, 5d and 5e.1 usually merge with each other.
RUGGED TERRAIN

la.
Physiography: Rugged sandstone hills with slopes greater than 25%; height greater than 50 metres above surrounding terrain; boulder strewn slopes and rocky crests.
Soils: Very shallow lithosols.
Vegetation: Variable, but generally open forest or woodland (E. miniata, E. bleeseri); minor areas of closed forest as for 5a.2.
Limitations: Very shallow rocky soil; steep slopes.
Potential Land Use: Unsuitable for pastoral production; mostly inaccessible; should be left as catchment reserves; wildlife refuges.

lb.
As for la but slopes 5-30%; height 20-60 metres above surrounding terrain; includes lower sandstone hills associated with la and hills of silicified sediments; vegetation also includes low woodland (Erythrophleum, Cochlospermum).

lc.1
Physiography: Footslopes of low sandstone hills (lb); slopes less than 5%.
Soils: Moderately deep, red earthy sands (Cockatoo) formed over sandstone; well drained.
Vegetation: Tussock grassland of annual Sorghum and Plectrachne with widely scattered shrubs.
Limitations: Erodible; susceptible to run-off from higher slopes.
Potential Land Use: Suitable for improved perennial pasture with minimal soil surface disturbance; conservation measures necessary.
Physiography: Footslopes of the sandstone hills (la, lb); slopes less than 5%.

Soils: Deep, yellow earthy sands (Arnhem) and loamy yellow earths; imperfectly to moderately well drained.

Vegetation: Woodland, low woodland or low open woodland (Erythrophleum, Terminalia grandiflora, Planchonia, Parinari nonda) often with dense shrub understory; annual and perennial grasses; scattered patches of closed forest as for 5a2.

Limitations: Very erodible; susceptible to high amounts of run-off from adjacent steep slopes; patches of dense vegetation.

Potential Land Use: Limited grazing of native pastures; clearing would create a severe erosion hazard.
UNDULATING TO GENTLY UNDULATING TERRAIN

Undulating to gently undulating terrain associated with granodiorite, pegmatite and quartz of the Litchfield Complex.

2a.

Physiography: Massive outcrops of granodiorite and pegmatite and strike ridges of quartz.

Soils: Lithosols; large areas of bare rock surface.

Vegetation: Variable, ranging from patches of semi-deciduous closed forest (Ficus sp., Alstonia actinophylla, Strychnos lucida, Erythrina vespertilio) to woodland (E. miniata, E. clavigera) to low open woodland (Livistona); sparse annual and perennial grasses.

Limitations: Extremely rocky; shallow soils.

Potential Land Use: Unsuitable for pastoral production; wildlife refuges.

2b.

Physiography: Low erosional rises with broad crests and convex slopes (less than 3%); scattered granodiorite and quartz outcrop.

Soils: Shallow yellow podzolics; frequently gravelly, sometimes stony.

Vegetation: Low open woodland (Livistona, Grevillea pteridiifolia) or low open shrubland (Eugenia bleeseri, Parinari nonda, Pandanus, Grevillea dryandri, Acacia gonocarpa); minor areas of low open woodland (Gardenia megasperma, Erythrophleum, Owenia vernicosa, Petalostigma); annual (Sorghum) and perennial (Themeda australis, Heteropogon triticeus) grasses.
Limitations: Shallow soils; poor water-holding capacity; rock outcrop.

Potential Land Use: Suitable for grazing of native pastures; sites for farm buildings, yards, water troughs.

2c.

Physiography: Gently undulating crests and convex slopes (less than 2.5%); abundant granodiorite outcrop; located only west of Murrenja Hill.

Soils: Deep, sandy yellow podzolics (Masson I, II), imperfectly drained; rare deep gleyed podzolics; often severe 'debil-debil' surface.

Vegetation: Low woodland (Pandanus, Grevillea pteridiifolia, Tristania lactiflua, Petalostigma pubescens, Melaleuca viridiflora, Banksia, Livistona); perennial grasses (Themeda australis, Chrysopogon fallax, Heteropogon triticeus).

Limitations: Abundant rock outcrop; slopes erodible if disturbed.

Potential Land Use: Suitable for grazing of native pastures; small rock-free areas on crests suitable for improvement with perennial pastures.

2d.1

Physiography: Gently undulating crests and upper convex slopes (generally less than 2%, rarely greater than 2%); widely scattered granodiorite and quartz outcrop.

Soils: Deep, sandy yellow podzolics (Masson I, II), well drained; some 'debil-debil' surface.
Vegetation: Livistona low woodland with scattered Pandanas sp., Acacia dimidiata, Erythrophleum and Owenia vernicosa; annual (Ectrosia leporina) and perennial (Themeda australis, Heteropogon triticeus, Sorghum plumosum, Coelorhachis) grasses.

Limitations: Erodible if totally cleared and cultivated.

Potential Land Use: Suitable for improvement with perennial pastures; soil conservation measures necessary.

2d.2

As for 2d.1 but vegetation more open, mainly Livistona low open woodland, or lower, low shrubland sometimes open-heath, (Eugenia bleeseri, Parinari nonda, Pandanus) with scattered tall shrubs (Pandanus, Livistona). Suitable for improvement with perennial pastures, but no cultivation slashing or burning should occur due to the likelihood of subsequent suckering.

2e.

Physiography: Gently undulating crests and convex upper slopes (less than 2%) with widely scattered granodiorite outcrop; concave lower slopes (less than 1.5%) sometimes as seepage areas.

Soils: Predominantly deep, sandy yellow podzolics (Masson I, II); minor areas of siliceous sands (Cullen I, II) and gleyed podzolics.

Vegetation: Low woodland with mixed species (Pandanus, Grevillea pteridiifolia, Melaleuca viridiflora, Banksia, Petalostigma pubescens, Livistona) on crests and upper slopes; Pandanus low woodland, occasionally low open forest, or Banksia low woodland on lower slopes.

Limitations: Erodible if totally cleared and cultivated; lower slopes subject to run-on.
Potential Land Use: Crests and upper slopes suitable for improvement with perennial pastures; soil conservation measures necessary; lower slopes suitable for grazing of native pastures.

2f. Physiography: Short concave slopes, 20-200 metres wide, forming the fringe between the higher, gently undulating terrain of the 2 and 3 units and the plains or drainage floors; divided into an upper imperfectly drained colluvial slope (less than 2%) with large termitaria and a lower colluvial slope (less than 1%) which is subject to seasonal inundation for short periods; frequent buffalo wallows and pig holes on lower slopes.

Soils: Deep, sandy yellow podzolics (Masson II) formed over granodiorite on upper slopes, often with colluvial surface; shallow humic gleys overlying sands derived from granodiorite on lower slopes.

Vegetation: Grassland with Ectrosia leporina, Themeda australis, Coelorhachis, and Eriachne sp. on upper slopes merging to grassland with Panicum sp., Paspalum orbiculare, Pseudoraphis, Ischaemum arundinaceum and Ophiuros on lower slopes.

Limitations: Erodible; subject to run-on from higher slopes; subject to seasonal flooding for short periods.

Potential Land Use: Suitable for grazing of native pastures.

Gently undulating terrain associated with detritus overlying granodiorite of the Litchfield Complex.

3a. Physiography: Low rises and convex slopes (3-5%); common laterite outcrop and pavement; scattered outcrops of quartz and granodiorite.
Soils: Lithosols and very shallow, gravelly yellow earths (Koolpinyah).

Vegetation: Low open woodland Livistona, Pandanus, Grevillea pteridiifolia, Petalostigma pubescens) and low open shrubland (Eugenia bleeseri and Acacia gonocarpa) with sparse annual (Sorghum sp., Ectrosia leporina, Aristida sp.) and perennial grasses (Themeda australis, Plectranche, Heteropogon triticeus).

Limitations: Very shallow soils: very poor water-holding capacity; rock outcrop and pavement.

Potential Land Use: Suitable only for very rough grazing of native pastures.

3b.
Physiography: Crests and convex slopes (less than 3%); minor rock outcrop.

Soils: Shallow, gravelly yellow earths (Koolpinyah) over lateritic hardpans, micaceous shists and layers of quartz gravel.

Vegetation: As for 3a., but also areas of low open woodland (Petalostigma pubescens, Tristania lactiflua, Melaleuca viridiflora).

Limitations: Erodible; shallow soils; poor water-holding capacity.

Potential Land Use: Suitable for grazing of native pastures.

Gently undulating terrain associated with detrital laterite east of Murrenja Hill.

4a.
Physiography: Low lateritic rises and breaks of slope (greater than 3%); often extensive laterite outcrop and veins of quartz.
Soils: Lithosols and shallow, gravelly red earths (Hotham).

Vegetation: Open forest or woodland (E. miniata, Erythrophleum, E. clavigera); perennial grasses (Themeda australis, Heteropogon triticeus, Chrysopogon fallax); minor areas of semi-deciduous closed forest (Ficus sp., Bombax ceiba, Strichnos lucida, Alstonia).

Limitations: Shallow, gravelly soils; rock outcrop.

Potential Land Use: Suitable for grazing of native pastures.

4b. Physiography: Gently undulating slopes (less than 3%); scattered laterite outcrop.

Soils: Shallow (60cm) loamy red earths (Hotham) and yellow earths (Koolpinyah); often with lateritic and quartz gravel.

Vegetation: Open forest (E. miniata, Erythrophleum, E. grandifolia, E. foelscheana) with a palm understorey (Livistona, Pandanus) and perennial grasses (Heteropogon triticeus, Themeda australis, Coelorhachis) in the south-eastern corner; merging to woodland (E. papuana, E. clavigera, Erythrophleum, E. grandifolia) north-west of La Belle Outstation.

Limitations: Shallow soils; minor outcrop; erodible if soil surface unduly disturbed.

Potential Land Use: Suitable for improvement with annual pastures; short growing season after the finish of rain; minimal soil disturbance necessary during establishment.

4c. Physiography: Gently undulating slopes (less than 1.5%).
Soils: Moderately deep (100cm) loamy red earths (Hotham, Berrimah III) and yellow earths (Wagait) over laterite; sometimes deeper (150cm) but gravelly.

Vegetation: Open forest or woodland as for 4b; one area of low open woodland (Livistona, Pandanus) south of the Two Sisters Hills.

Limitations: Erodible if soil surface unduly disturbed; hard setting surface would restrict infiltration; possible narrow available moisture range; moderate water-holding capacity.

Potential Land Use: Arable; more suitable for fodder crops than cash crops; suitable for improvement with perennial pastures.

Physiography: Gently undulating slopes (less than 1.5%).

Soils: Deep (greater than 150cm), loamy red earths (Berrimah III) and yellow earths (Wagait); low amounts of ironstone gravel; subsoil mottling.

Vegetation: Open forest of well formed trees (E. miniata, Erythrophleum, E. foelscheana, E. grandifolia) with a palm understorey (Livistona, Pandanus); dense perennial grasses (Coelorachis, Heteropogon triticeus, Themeda australis).

Limitations: Erodible if soil surface unduly disturbed; hard setting surface would restrict infiltration; possible narrow available moisture range.

Potential Land Use: Arable; suitable for cash crops, fodder crops, horticultural crops and improvement with perennial pastures; soil conservation measures necessary.

Gently undulating terrain associated with laterite and Permian siltstone on the west coast.
5a.1

Physiography: Low lateritic rises and steep breaks of slopes (less than 15%); slopes strewn with laterite outcrop.

Soils: Lithosols and very shallow, gravelly red earths (Hotham).

Vegetation: Open forest to woodland (E. miniata, Erythrophleum, E. blesseri, E. tetrodonta) with a palm understorey (Livistona, Cycas media); low open woodland (Livistona, Grevillea pteridiifolia, Acacia, Petalostigma pubescens); sparse perennial grasses (Thymedea australis).

Limitations: Very shallow, gravelly soils; rock outcrop; presence of Cycas media.

Potential Land Use: Suitable for rough grazing of native pastures.

5a.2

As for 5a.1, but vegetation replaced by semi-deciduous closed forest (Ficus sp., Bombax ceiba, Strychnos lucida, Brachychiton sp., Eugenia suborbicularis, Acacia auriculiformis, Denhamia obscura, Canarium australianum, Bambusa arnhemica) with lianas. Unsuitable for any form of pastoral production because of very dense vegetation; wildlife refuge.

5a.3

Physiography: Low siltstone rises; slopes less than 10%; strewn with siltstone rock.

Soils: Lithosols and very shallow red earths (Berrimah II).

Vegetation: Grassland (Heteropogon triticeus, Themeda australis, Plectachne) with scattered palms (Pandanus, Livistona); minor patches of semi-deciduous closed forest (as for 5a.2) on rocky crests.

Limitations: As for 5a.1.

Potential Land Use: As for 5a.1.
5b.

Physiography: Gently undulating slopes (less than 5%); extensive laterite outcrop or laterite pavement.

Soils: Lithosols and very shallow, gravelly red earths (Hotham), yellow earths (Koolpinyah) and yellow podzolics interspersed with laterite outcrop; lithosols surrounded by laterite pavement.

Vegetation: Open forest as for 5a.1 around laterite outcrop; low open woodland (Grevillea pteridiifolia, Livistona, Acacia spp., Cycas media, Cochlospermum fraseri) with sparse annual grasses (Aristida sp., Eriachne sp.) around laterite pavement.

Limitations: Very shallow soils; laterite outcrop and pavement; presence of Cycas media.

Potential Land Use: Suitable for rough grazing of native pastures; excellent sites for farm buildings, yards, water troughs.

5c.1

Physiography: Gently undulating slopes (less than 2%); scattered laterite outcrop.

Soils: Shallow, loamy red earths (Hotham) (70cm) over laterite or siltstone.

Vegetation: Open forest (E. miniata, E. tetrodonta; Erythrophleum) with low tree and palm (E. foelscheana, E. ferruginea, Petalostigma pubescens, Planchonia, Livistona, Grevillea pteridiifolia, Pandanus, Cycas media) understorey merging to low open forest with slender specimens of the same species as above; perennial grasses (Themeda australis, Coelorhachis, Heteropogon triticeus).

Limitations: Shallow soils; scattered outcrop; erodible if soil surface unduly disturbed; presence of Cycas media.
Potential Land Use: Suitable for improvement with annual pastures; short growing season after the finish of rain; minimal soil disturbance necessary during establishment.

5c.2

Physiography: Gently undulating slopes immediately behind the coastal dunes; subject to salt spray during storms and possible salt water flooding during cyclones.

Soils: As for 5c.1; excess salt would appear to be leached out of the profile.

Vegetation: Low open woodland (Pandanus, Acacia, Grevillea pteridiifolia, Planchonia, Buchanania obovata); sparse grasses (Themeda). Abrupt change into open forest of 5c.1 on eastern edge of unit.

Limitations: As for 5c.1; subject to salt spray and salt water flooding.

Potential Land Use: Suitable only for rough grazing of native pastures.

5d.

Physiography: Gently undulating slopes (less than 2%); rare laterite outcrop.

Soils: Moderately deep (100cm), loamy red earths (Berrimah I) over laterite; hard setting surface; often an extremely hard A3 horizon.

Vegetation: As for 5c.1, but eucalypts of the open forest better formed and with larger canopies.

Limitations: Erodible if soil surface unduly disturbed; hard setting surface would restrict infiltration; possible narrow available moisture range; moderate water-holding capacity; presence of Cycas media.
Potential Land Use: Arable; more suitable for fodder cropping than cash crops; suitable for improvement with perennial pastures.

5e.1
Physiography: Gently undulating slopes (less than 1%).
Soils: Deep (greater than 150cm), loamy red earths (Berrimah I) presumably formed over laterite; hard setting surface; often an extremely hard A3 horizon.
Vegetation: Tall open forest (E. tetrodonta) or open forest, rarely low open forest, (E. miniata, E. tetrodonta, Erythrophleum) with low tree (Planchonia, E. foelscheana, Pandanus, Livistona, Cycas media) understorey; dense perennial grasses (Themeda, Heteropogon triticeus, Coelorhachis) and annual Sorghum.
Limitations: Erodible if soil surface unduly disturbed; hard setting surface would restrict infiltration; possible narrow available moisture range; presence of Cycas media.
Potential Land Use: Arable; suitable for cash crops; fodder crops, horticultural crops and improvement with perennial pastures; soil conservation measures necessary; forestry.

5e.2
Physiography: Gently undulating slopes (less than 3%).
Soils: Deep (greater than 150cm), loamy red earths (Berrimah II) derived from siltstone; hard setting sandy loam surface; minor areas of deep, loamy yellow earths (Wagait).
Vegetation: Low open shrubland (Pandanus, Livistona) with low shrubs (Parinari nonda, Eugenia bleeseri); perennial grasses (Themeda australis, Ectrosia leporina).
Limitations: Erodible if cultivated; hard setting surface.

Potential Land Use: Suitable for improvement with perennial pastures.

5f.1

Physiography: Short concave slopes (less than 1%), 10-30m wide, forming the fringe between the higher gently undulating terrain of 5 units and the plains; subject to inundation for short periods.

Soils: Shallow humic gleys and gleyed podzolics overlying lateritic gravel; 'debil-debil' surface.

Vegetation: Pandanus low woodland to low open forest with scattered Tristania lactiflua, Grevillea pteridifolia and Pentalostigma pubescens; perennial grasses (Imperata, Panicum mindanaense, Ischaemum arundinaceum) and sedges (Cyperus sp.).

Limitations: Erodible: subject to run-on from higher slopes; subject to seasonal flooding for short periods.

Potential Land Use: Suitable for grazing of native pastures during the dry.

5f.2

Physiography: Short concave slope (less than 1%), 10-30m wide, forming the fringe between the higher gently undulating terrain of 5 units and Melaleuca closed forest and drainage lines and floors.

Soils: Deep, imperfectly drained yellow podzolics, and gleyed podzolics.

Vegetation: Open forest to low open forest (Banksia, Tristania lactiflua, E. polycarpa, E. papuana, Melaleuca sp., Grevillea pteridifolia, Metrosideros); perennial grasses (Coelorhachis, Chrysopogon latifolius, Themeda australis).
Limitations: Erodible; subject to run-on from higher slopes; waterlogged for moderate periods.

Potential Land Use: Suitable for grazing of native pastures during the dry.

Drainage lines, floors and depressions.

6a.1

Physiography: Narrow drainage lines, 50-200m wide, rarely 400m; incised, sometimes with active erosion; often a series of small waterholes.

Soils: Variable, including alluvial soils, humic gleys, yellow podzolics, gleyed podzolics and grey clays; poorly drained.

Vegetation: Variable, but commonly grassland with trees (Tristania lactiflua, Melaleuca sp., Metrosideros, E. papuana, Pandanus) fringing the incised creek line.

Limitations: Very erodible; carry large quantities of water during the wet.

Potential Land Use: Not suitable for pastoral production; should be maintained as grassed waterways; stock should be excluded from the area.

6a.2

Narrow drainage lines as for 6a.1, but not incised; should be maintained as grassed waterways to prevent erosion.

6a.3

Physiography: Narrow drainage lines with a permanent creek or permanent seepage through the subsoil.

Soils: Deep siliceous sands or humic gleys; permanently moist.
Vegetation: Evergreen tall closed forest (rainforest) (Melaleuca spp., Carpentaria acuminata, Livistona benthamii, Acacia auriculiformis, Nauclea orientalis) with ferns (Hydriastele) and vines.

Limitations: Erodible; carry large quantities of water during the wet.

Potential Land Use: Should be fully protected from disturbance; scientific and recreational importance; wildlife refuge.

6b.

Physiography: Broad stable drainage floors up to 1 500m wide; sometimes cut by a major creek or waterhole; flooded for short periods or waterlogged for long periods during the wet.

Soils: Variable, including grey clays, soloths, humic gleys, gleyed podzolics, yellow podzolics and alluvial soils; poorly drained.

Vegetation: Dominantly grassland (Ischaemum arundinaceum, Panicum sp., Coelorachis, Themeda australis, Sorghum sp.) with scattered low trees (Melaleuca viridiflora, Tristania lactiflua, Pandanus); some areas of open woodland (Melaleuca dealbata, E. papuana).

Limitations: Erodible; flooded or waterlogged; carry large amounts of slow moving water during the wet.

Potential Land Use: Suitable for limited grazing of native pastures during the dry season; pasture establishment with species tolerant of inundation behind ponding banks, which will hold back water for long periods.
6c.

Physiography: Internal drainage depressions up to 600m wide; up to 3m deep; seasonally ponded; small holes of permanent water.

Soils: Deep grey clays, soloths, yellow podzolics and yellow earths; poorly to very poorly drained.

Vegetation: Swamp grasses, reeds and sedges; *Melaleuca* open forest.

Limitations: Flooded for long periods.

Potential Land Use: Watering points for livestock; waterbird refuge.
FLAT TERRAIN

Paludal Plains

7a.1

Physiography: Broad paludal plains situated between units of high terrain, particularly 2 units; seasonally or permanently inundated up to 1m; circular mounds, 5m wide by 1m high, scattered over unit.

Soils: Humic gleys (Burton) formed over marine muds; very poorly drained; very organic surface.

Vegetation: Perennial closed grassland (Hymenachne dominant, Eleocharis sp., Nelumbo, Scleria sp., Phragmites, Oryza australiensis) in inundated areas; widely scattered Livistona benthamii on mounds.

Limitations: Seasonally or permanently inundated; untrafficable; susceptible to surface degradation if overgrazed.

Potential Land Use: Suitable for controlled grazing of native pastures late in the dry season; buffalo more suited to conditions than cattle; waterbird refuge; the organic surface in the permanently inundated areas very susceptible to overgrazing.

7a.2

Physiography: Broad paludal plains situated between units of high terrain, particularly 2 units; inundated for up to 8 months of the year; small, shallow, permanently wet depressions scattered through the unit.

Soils: As for 7a.1.

Vegetation: Perennial closed grassland (Oryza australiensis dominant, Eleocharis sp., Scleria sp., Pseudoraphis) on the flat plain; Hymenachne and Nelumbo in the small depressions.
Limitations: Inundated for prolonged periods; untrafficable during the wet season; susceptible to surface degradation if overgrazed.

Potential Land Use: Suitable for controlled grazing of native pastures during the middle and late dry season.

7a.3 Physiography: Broad paludal plains situated between units of high terrain; inundated for up to 8 months of the year; in places, permanently inundated; or higher and drier linear plains beside units 7a.1 and 7a.2.

Soils: Very poorly drained humic gleys (Burton) in lower plains; humic gleys and grey clays (Cormor I) in higher situations.

Vegetation: Reedland with Scleria poaeformis dominant, accompanied by Hymenachne in wetter areas and Ischeamum arundinaceum and Ophiuros in drier areas.

Limitations: Permanent or seasonal inundation; untrafficable; unpalatable species.

Potential Land Use: Unsuitable for pastoral production; wildlife refuge.

7a.4 Isolated areas and old stream channels within 7a.1 supporting dense clones of Phragmites; clones often circular in shape and have abrupt boundaries; scattered to moderately dense clumps of Melaleuca; unpalatable; unsuitable for pastoral production; wildlife refuge.

7b. Physiography: Broad paludal plains either seasonally or permanently inundated; north-eastern areas dissected by rivers, creeks and waterholes; drier isolated patches within 7a.2.
Soils: Humic gleys (Burton) in wetter situations; grey clays (Carmor I) in drier situation; alluvial soils along river and creek levees.

Vegetation: Melaleuca closed forest to open forest; dominantly M. viridiflora and M. cajuputi; widely scattered orchids (Dendrobium sp.); Oryza, Hymenachne, Phragmites and Scleria grass understoreys. Patches of closed forest (Melaleuca argentea, M. symphyocarpa M. cajuputi, Acacia auriculiformis, Carpentaria acuminata, Livistona benthamii, Bambusa, Barringtonia, Nauclea, Pandanus) along levees of stream channels.

Limitations: Seasonally or permanently inundated; untrafficable.

Potential Land Use: Unsuitable for pastoral production; recreational potential, particularly on waterways; wildlife refuge; botanical reserve; possible forestry potential.

Estuarine Plains

8a.1

Physiography: Broad estuarine plains; almost flat; gilgaied micro-relief; inundated with fresh water for 4-5 months of the year.

Soils: Deep grey clays (Carmor I, II, Wildman) over saline mud; coarse cracking surface; alkaline subsoil; rare humic gleys (Burton) with shallow organic surface.

Vegetation: Perennial tussock grassland, dominantly Ischaemum arundinaceum, Imperata and single stems of Phragmites; minor occurrence of Ophiuros, Scleria, Eleocharis and Phyla; dense swards of Xerochloa near the saline flats of 9a.

Limitations: Seasonally flooded; gilgaied; cracking surface; alkaline subsoil.
Potential Land Use: Suitable for grazing of native pastures during the dry; possibly suitable for establishment of permanent pastures, especially para grass; possibly suitable for rice growing.

Physiography: Shallow meandering channels which were once the former course of the Finniss River; stable; scattered permanent shallow waterholes.

Soils: Deeply cracking grey clays (Carmor I, Wildman) or humic gleys (Burton) with a shallow organic surface; alkaline subsoils.

Vegetation: Grassland (Hymenachne, Phragmites, Pseudoraphis); some dense patches of Phyla and Polygonum barbatum; Barringtonia and dense Phragmites around permanent waterholes.

Limitation: Flooded during the wet.

Potential Land Use: Should be maintained as stable waterways; very limited grazing of native pastures during the dry; watering points; pasture establishment with species tolerant of inundation behind ponding banks, which will hold back water for long periods.

Physiography: Channels in the headwaters of tidal creeks; flooded by brackish water during the wet.

Soils: Deeply cracking grey clays; acidic subsoil.

Vegetation: Dominantly bare; scattered Fimbristylis, Phragmites.

Limitations: Seasonally flooded; cracking surface; acidic subsoil.

Potential Land Use: Unsuitable for pastoral production; should be maintained as a grassed waterway.
Physiography: Cheniers aligned approximately parallel to the coastline; sometimes a series of closely spaced cheniers each up to 30m wide, rising 0.5-lm above the surrounding estuarine plain.

Soils: Shallow (50cm) yellow calcareous sands (Dune Sand II) over consolidated alkaline deposits of sand, shells and secondary carbonate.

Vegetation: Grassland (Coelorhachis, Aristida sp., Panicum mindanaense, Ectrosia leporina) or low woodland (Pandanus, Ficus opposita, Eugenia bleeseri).

Areas of semi-deciduous closed forest as for 9b.

Limitations: Erodible if unduly disturbed; low water holding capacity.

Potential Land Use: Suitable for limited grazing of native pastures.

Littoral Complex

9a.

Littoral Complex consisting of:

(i) tidal creeks;

(ii) mangrove low closed forest on saline mud; tidally flooded;

(iii) Arthrocnemum herbland (samphire) on solanchaks (Carpentaria); some bare areas; only flooded during high tides;

(iv) tussock grassland (Sporobolus virginicus, Xerochloa, Diplachne) on alkaline grey clays (Carmor II); subjected to brackish conditions during the wet.
Unsuitable for pastoral production; recreation and marine reserves.

9b. Physiography: Old stable beach ridges adjacent to the coast; commonly a series of beach ridges each up to 20m wide and 1-3m high.

Soils: Moderately deep (100cm) yellow calcareous sands (Dune Sands II) as for 8c.

Vegetation: Semi-deciduous closed forest (Acacia auriculiformis, Ficus sp., Terminalia sp., Canarium australianum, Strychnos lucida); numerous vines.

Limitations: Dense vegetation; erodible if disturbed.

Potential Land Use: Unsuitable for pastoral production; suitable for a botanical reserve; wildlife refuge.

9c. Physiography: Coastal foredunes adjacent to the coast; 2-5m high.

Soils: Calcareous sands (Dune Sand I); wave thrown and wind blown sands.

Vegetation: Spinifex grassland with scattered Pandanus, Eugenia suborbicularis and Ficus opposita.

Limitations: Extremely erodible if disturbed.

Potential Land Use: Unsuitable for pastoral production; should be fully protected from disturbance and maintained in a stable condition; recreational reserves; act as wind and sea water barrier for inland areas.
PHYSIOGRAPHY

Wagait Aboriginal Reserve can be divided into 9 physiographic regions represented by unit numerals 1 to 9 in the land unit key. The Reserve lies within the Western Fault Block which is due to down movement during the Late Tertiary uplift or to less elevation than occurred in areas east of the faultline (Christian and Stewart, 1953).

1. The most rugged terrain is represented by riverine deposits of Chilling Sandstone, laid down during the Lower Proterozoic, which extend north-south in the middle of the Reserve. Geological erosion has removed all except a few remnants. A northern remnant is Peaked Hill (62m ASL) near the mouth of the Finniss River. Only a few low remnants exist across the estuarine plain. The highest remnants are represented by Mount Johns (140m) and Murrenja Hill (140m) on the southern boundary. The western sides of these two mountains have boulder strewn slopes (greater than 25%) rising 60m above the surrounding terrain, while the eastern slopes are less steep and grade into low rocky hills and sandy footslopes (less than 5%). Dolerite outcrop occurs west of Mt. Johns and south of Murrenja Hill. The only other rugged rocky terrain is represented by the Two Sister Hills (77m ASL) which are remnants of silicified sediments on the eastern boundary.

2. The three areas of undulating to gently undulating terrain associated with the granodiorite, pegmatite and quartz of the Litchfield Complex are located in the north-eastern corner, immediately east of Mount Johns and west of Murrenja Hill.

The terrain is in an advanced stage of geological erosion and consequently has low relief. Low erosional rises and broad crests are flanked by long convex colluvial slopes (less than 2.5%). Short concave colluvial slopes (less than 2%) abut the drainage lines and paludal plains. The angular drainage pattern is characteristic of granite areas, being governed by the near right angle joints in the parent rock.

The north-eastern segment is characterised by scattered low outcrops of granodiorite with frequent massive outcrops and strike ridges of quartz. Two massive outcrops of pegmatite occur south of the Two Sister Hills. In contrast, the segment west of Murrenja Hill has frequent massive outcrops (tors) of granodiorite but little evidence of quartz outcrop. The segment east of Mt Johns is devoid of outcrop.
3. The gently undulating terrain located in the southern section of the Reserve, east of Murrenja Hill, has a landform and drainage pattern similar to that of the terrain associated with the Litchfield Complex. Lateritised outcrop and pavement are very common, while granodiorite and quartz are very rare. Metamorphosed Archean rocks, such as micaceous shist, occur in the Litchfield Complex. Several outcrops of micaceous shist were noted in creek lines, while some soil profiles overlay the same lithology. The soils associated with the lateritised outcrop and pavement are very gravelly and lack the coarse sand fraction of the soils of the Litchfield Complex. This suggests that detrital material overlies granodiorite.

4. The terrain associated with the detrital laterite east of Murrenja Hill is gently undulating. Scattered throughout are low laterite rises and breaks of slope with lithosols, extensive detrital laterite outcrop and veins of quartz. The remaining areas are generally long slopes less than 1.5%, with very little outcrop and deeper soils.

The drainage features are relatively scarce due to the porous nature of the soils. Shallow internal drainage depressions and broad drainage floors serve the south-eastern corner while the rest of this terrain is dissected by widely scattered non-incised drained lines.

5. The terrain associated with the laterite and Permian Siltstone west of Murrenja Hill on the coast is gently undulating. The few occurrences of Permian Siltstone outcrop and soils derived from Permian Siltstone are restricted to the eastern edge of this physiographic entity. However, the dominant terrain for the eastern edge is gently undulating rises and slopes (less than 15%) with extensive laterite outcrop. These slopes are drained by short, non-incised drainage lines flowing eastwards into paludal plains.

Westwards, the terrain dips gently (slopes less than 1%) towards the coast. Laterite outcrop is common on these gentle slopes in the north, but rare in the south. The absence of frequent drainage lines, save for two broad drainage floors flowing westwards into tidal creeks, confirms that the soils, derived from lateritised Permian siltstone, are porous and that water flows laterally through the soils or between the laterite and Permian sediments westwards towards the sea.

6. The drainage lines serving the terrain associated with the Litchfield Complex are often incised and sometimes occur as a string of waterholes. They are generally narrow, 50-200m wide, and carry large volumes of water during the wet season. The major creeks, McCallum, Burtons and an unnamed creek, dissect the Litchfield Complex and fan out into broad drainage lines which carry large waterholes.
The drainage lines serving the low lateritic slopes are broad and, as they carry water at relatively low velocity, they are rarely incised. Shallow, internal drainage depressions up to 500m wide, which are seasonally inundated, are scattered through the laterite terrain in the west. One depression in the south-eastern corner of the Reserve has permanent water.

7. The paludal plains are flat, low lying areas of estuarine origin which become inundated with water which runs off the higher level granodiorite terrain and from the floodwaters of the Finniss River, McCallum Creek, Burton's Creek and other drainage lines. East of Mt Johns, the plains have developed between tongues of granodiorite terrain, while further north they are dissected by the meandering channels of the freshwater Finniss River. Large tracts of paludal plains west and north of Mt Johns have one indistinct drainage channel running in a north-south direction. The plains can be subdivided into those that are seasonally inundated, drying out in August, and those that are permanently inundated.

The latter plains are dotted with low (1m), flat-topped circular mounds. The clay dominant material of the mounds is not related to the sand dominant material of the surrounding high country, so the mounds are not remnants of the surrounding Litchfield Complex. While the clay on the mounds is dark it is not highly organic so the mounds were not formed by aggradation of organic matter and silt around old tree roots. It is highly unlikely that water flowing slowly across the original plain dissected the plains and left the scattered mounds as remnants. One possible explanation is collapse or slumping of the original plain floor through compression of low lying organic layers or expulsion of water. The mounds could have been left as remnants of the original plain floor.

8. The estuarine plain covers a vast area of land in the north-western section of the Reserve, adjacent to Fog Bay and on either side of the salt-water Finniss River. The estuarine deposits were presumably laid down after the last Pleistocene rise in sea level (Noakes 1949). Many soil profiles contain marine shells. The plain was dissected by the channels of the Finniss River, which allowed pedogenic development of the marine sediments under freshwater conditions. The channel of the Finniss River has since migrated north by 2-3 kilometres.

Cheniers, 0.2-1m high, are found at the western end of the plain and run parallel to the coast up to 4 kilometres inland from the present high tide mark. Cheniers have shallow, sandy profiles over cemented layers of water worn gravel, sand, shell, coral and secondary carbonate, which in turn are perched upon the clay deposits of the estuarine plain. The chenier...
materials were thrown up due to water action from tides and currents and were exposed due to a progradation of the coastline, without a fall in sea level (Jennings, J N, pers. comm.) or due to a change in tidal range following modifications of the sea floor sediments.

The plain is seasonally inundated with up to 0.5m of water and dries out in April. Gilgai formation and deep surface cracking are features of the plain.

9. The Littoral Complex fringing the coast consists of coastal fore-dunes and older beach ridges, tidal mudflats and tidal creeks. The majority of fore-dunes are found along the western coast from the southern boundary northwards past Point Blaze. These dunes, often 5 metres high, are stabilised by a thick sward of Spinifex.

The beach ridges behind the coastal fore-dunes are closely arranged in series parallel to the coast and immediately abut lateritic terrain at their rear. The beach ridges are up to 3m high, with a sandy profile overlying consolidated layers of sand, shell and coral cemented with calcareous material. These consolidated layers are presumably underlain by weathering laterite which extends seawards as a lateritic shelf (sea floor) and outcrops (rocky points). The rear-most beach ridge was originally the coastal fore-dune. Subsequent storm activity probably threw up a fore-dune in front of it, while wind blown sand added to its height. Over time, the coastal fore-dune moved seawards leaving behind a series of closely spaced beach ridges. The dense vegetation (closed forest) which established on them ensures their extreme stability.

The tidal mudflats with their associated tidal creeks are restricted to the Fog Bay coastline and one area south of Point Blaze. The mudflats experience decreasing degree of salinity moving inland from the coast, i.e. areas covered by salt water at each high tide, areas covered with salt water only at very high (king) tides and areas covered with brackish water during the wet season.
4. **SOILS**

(a) **Soil Classification**

The soils have been classified primarily into 12 Great Soil Groups (Stace et al., 1968). Some groups have been further classified into families, then series if there is sufficient variation at the family level. Two series have been further divided into types. Family names are given where they have been described elsewhere (e.g., Darwin, Croker Island, Katherine-Douglas Area) and new family names have been created where a previously unrecorded soil was described from several profiles.

The Great Soils Groups (GSG) represented in the low lying drainage lines and seepage areas are not further divided into soil families because they exhibit such a high degree of variability depending on their position within the drainage line.

(b) **Soil Description**

A brief description is given here of the soil profiles with relevant comments on factors influencing profile development. A more detailed soil description is given in the Appendix. Detailed discussion of some of the soil forming factors involved in high rainfall areas is given by Hooper (1969) and Aldrick (1972, 1975).

1. **GSG - Solonchaks**

   **Family: Carpentaria**

   Carpentaria soils are subject to salt water inundation during very high tides and have developed from tidal muds. The soil surface has a typical puffy appearance and polygonal cracking pattern. Salt encrustation and high surface pH are evidence of their high salinity (Day, 1975).

   The surface is a greyish brown or olive grey medium clay grading to a strongly mottled light grey or light brownish grey light-medium clay in the subsoil, which is always highly alkaline. The profiles grade into gleyed mud.
2. GSG Lithosols  
Family: Not specified

Lithosols occur throughout the rugged and undulating terrain and are associated with rocky slopes over 5%. They are typically gravelly and shallow and their characteristics vary with their parent rock. The lithosols associated with Chilling sandstone and granodiorite are sandy and have dark greyish brown surfaces and light yellowish brown subsoils, while those associated with laterite are dominantly reddish brown in colour with a loamy texture.

3. GSG Calcareous Sands  
Family: Dune Sands

Dune Sands are wind blown and water thrown sands which make up the coastal fore-dunes, beach ridges and cheniers. These soils have been divided into two series.

Dune Sands I occur on recent unconsolidated coastal fore-dunes. They exhibit very little profile development throughout save for some slight organic colouring in the Al horizon due to the Spinifex grassland. The profile is predominantly loose sand with scattered shell fragments.

Dune Sands II occur on consolidated beach ridges and cheniers. The profile consists of loose sand or loamy sand with shell fragments overlying a calcareous layer of sand, shells and secondary carbonate. The depth of loose sand on the higher beach ridges can be 150cm, while it may be only 20cm on the lower cheniers. Surfaces are generally dark brown, but can approach black under the semi-deciduous closed forests of the beach ridges. Subsoils grade into brown and yellowish brown colours with high pH.

4. GSG Siliceous Sands  
Family: Cullen

Cullen soils are deep uniform sands formed over granodiorite or its sandy colluvium. Texture varies from loamy coarse sand through clayey coarse sand to coarse loamy sand, but there is often a texture drop from the topsoil to the A2 horizon which frequently acts as an aquafer. Two series were recorded. Series I has a pinkish grey or light brownish grey subsoil with slight mottling, while the other (Series II) has a yellowish brown subsoil with slight mottling. Drainage is free in the upper horizons but restricted in the subsoil.
5. GSG  Earthy Sands

Family: Cockatoo

Cockatoo soils are moderately deep, red earthy sands of uniform texture formed over sandstone on well drained footslopes. The topsoil is a dark brown sand with a loose surface, grading into a reddish brown or red sandy loam subsoil.

Family: Arnhem

Arnhem soils have similar profiles to Cockatoo soils except they have a very dark topsoil grading through dark greyish brown to a yellowish brown subsoil. These yellow earthy sands form on the colluvial accumulations from sandstone of steep slopes. The profiles are deep and moderately well drained.

6. GSG  Grey Clays

Family: Carmer

Carmor soils are deep grey clays which are inundated for 3-4 months of the year with fresh water. Texture ranges from a light medium clay at the surface to a heavy clay in the transitional zone, then decreases to a medium clay in the subsoil. The surface colour is very dark grey or black, then grades into olive grey or light brownish grey in the subsoil. Root line staining is a feature of the surface, while the subsoil is usually moist and strongly mottled, indicating poor drainage.

The surface is deeply cracked and forms large blocks on drying. Broad, shallow gilgais are a common feature. Shell fragments are scattered through the profile below 20cm, while secondary carbonate is abundant in the highly alkaline subsoil.

Two series were recognised. Series I has a slightly acid surface and is slightly organic, while Series II has a neutral to slightly alkaline surface and sometimes has a fine salt crust.

Family: Wildman

Wildman soils are deep, grey clays similar to Carmor I soils but lack secondary carbonate in the subsoil.
7. GSG Soloths

Family: Not specified

Soloths are texture contrast soils formed under poor drainage conditions, often in association with debil debil mounds. The very dark grey to dark greyish brown topsoil overlies an unbleached paler A2 horizon. The topsoil textures are typically sandy, often pulverulent, and have hard consistence. A clear boundary accompanies the transition to the dense, clayey B horizon. Subsoil colours are light grey or light brownish grey with strong yellow-brown and red-brown mottling. The profiles have acid reaction trend throughout.

Soloths grade into solodics, which are similar soils but slightly more dense and alkaline in the subsoil.

8. GSG Red Earths

Family: Berrimah

Berrimah soils are deep (greater than 150cm) loamy red earths with high agricultural potential because of their high moisture status. They are porous and have acid reaction trend. Three series were recognised on the Reserve.

Series I, the most common, is a uniform textured, well drained red earth, formed over laterite associated with Permian Siltstone. The dark brown or dark reddish brown clay loam (with sand) surface is hard setting and grades through an A3 to a red or dark red heavy clay loam subsoil, rarely light clay. A feature in some profiles is an increase in texture (to light clay) and consistence (to dry, extremely hard) in the A3 horizon (10-30cm deep), followed by a decrease in texture (to heavy clay loam) and consistence (to dry, hard) in the subsoil. Small amounts of ferruginous gravel are sometimes present deep in the subsoil.

A shallower phase of Berrimah I soils occurs over extensive areas. The moderately deep, loamy red earths overlie hard laterite and siltstone at 100cm depth and the subsoil, close to the parent material, is characterised by low to moderate amounts of ferruginous nodules.

Series II is a well drained, gradational textured, loamy red earth formed over Permian Siltstone or its colluvium. This series, which has restricted occurrence, differs from series I soils by having a sandy loam surface which increases to sandy clay loam then to a heavy clay loam in the subsoil. Surface colour is dark brown, grading to a weak reddish brown A2, then into a dark red subsoil.
Series III is a moderately well drained variant of Series I, i.e. uniform textured, loamy red earth. Mottling and soft ferruginous nodules in the subsoil are indicative of slight drainage impedance. Texture is similar to Series I soils, but colours are less red through the profile. Several profiles had low to moderate amounts of ferruginous gravel, increasing down the profile.

Family: Hotham

Hotham soils are shallow, lateritic red earths with moderate to high amounts of gravel in the profile. The soils are porous and well drained and most have a uniform texture of clay loam throughout, though some surfaces are sandy clay loam. Surface colour ranges from very dark greyish brown to dark brown. A weak A2 horizon is often present. Subsoil colour is usually dark red or red, particularly when overlying hard laterite, but may be yellowish red when overlying weathering laterite.

9. GSG Yellow Earths

Family: Wagait

Wagait soils are the yellow earth equivalent of Berrimah I red earths occurring over weathering laterite or on gentle colluvial slopes in lateritic, siltstone and sandstone areas. Profiles are moderately well to imperfectly drained with mottled subsoils and have a uniform clay loam texture with earthy fabric throughout. Small amounts of ferruginous gravel are found at depth.

Family: Koolpinyah

Koolpinyah soils are shallow sandy and loamy yellow earths with medium to high amounts of ferruginous and quartz gravel throughout the profile. The soils are usually only 40-60cm deep, verging on skeletal, bottoming on lateritic hardpans or layers of quartz gravel. Surface colours are very dark greyish brown grading to yellowish brown subsoils. The profiles are well drained and leached.

10. GSG Yellow Podzolics

Family: Masson

Masson soils are moderately deep yellow podzolics developed on granodiorite. Some profiles, particularly those that are not strongly leached, grade into yellow earths while others in imperfectly drained situations on lower colluvial slopes grade into gleyed podzolics.
Development has occurred with strong leaching and termite activity, so the profiles have three basic layers:

M - leached sandy topsoil
S - quartz stone and gravel layer
W - lower mottled, clayey subsoil grading into weathering granodiorite

The formation of quartz stone and gravel layers in granitic soils at Brocks Creek, NT has been attributed to termite activity (Williams 1968). The gravel layers which he studied were wider (30-100cm) and were overlain by less topsoil (15-30cm) than those at Wagait (15cm and 60cm respectively). However, the percentage of vein quartz within the granodiorite at Wagait is less than the 10% at Brocks Creek and slopes were also less than 1% at Wagait. Similar termite species are found in both areas (Williams, personal communication).

Briefly, the process of stone layer formation due to termite activity involves the following steps:

(i) weathering of granodiorite which is intruded with quartz veins. The micas and feldspars weather to clay minerals, while the quartz remains as coarse, angular sand grains, gravel and stone.

(ii) termites remove the finer earth fractions (clay, silt and fine to medium sand) from down to 60cm depth (or above the wet season water table) and use it in the construction of their mounds. Thus, the coarse sand and quartz gravel and stone are concentrated in the top 60cm of soil.

(iii) the termite mounds weather away. Some of the fine material is eluviated through the profile, while some is transported to lower slopes and some remains.

(iv) the process has continued in the above cycle for thousands of years.

The first 60cm of the profile is sandy, well drained, sometimes excessively drained and leached. Topsoil colours are very dark greyish brown overlying moderately well developed A2 horizon, but rarely are they bleached. The subsoils are moderately well to imperfectly drained, yellowish brown in colour, with strong mottling which increases with depth into the weathering granodiorite. Reaction trend is slightly acid.
Profile depth varies from 60 to 80cm above weathering granodiorite. The stone layer is not always present because it depends on the presence of quartz veins in the parent material. Sometimes the unbleached A2 lies directly above the stone layer, while in many profiles it is separated from the stone layer by an horizon similar in base colour to the subsoil, but with the same texture as the topsoil. The subsoil can often be divided into two horizons, both of similar texture and basal colour, but the upper horizon lacks the mottling of the lower horizon.

Two series were observed. The first series (Masson I) is gradational textured and is divided into two surface types, namely loamy coarse sand to coarse sandy loam surface and sandy clay loam surface. The second series (Masson II) is duplex in texture and is divided into two types on surface texture as for series I. The duplex yellow podzolic with a loamy coarse sand surface is most common.

11. GSG Gleyed Podzolic

Family: Not specified

Gleyed podzolics are gradational or duplex textures soils, with acid reaction trend, occurring in imperfectly or poorly drained situations. Soil surfaces are often slightly organic, and, thus, very dark grey in colour. Pale A2 horizons are a feature of these soils, but are rarely bleached. The A1 and A2 horizons have characteristic rusty root line staining. Subsoil colours grade through greyish brown to light brownish grey or light grey with strong yellowish brown, reddish brown and white mottling.

The topsoil is dominantly organic sandy loam or sandy clay loam over a pulverulent A2 of similar texture. For gradational profiles there is a diffuse boundary to the B horizon, textures grading through clay loam to light-medium clay deep in the subsoil. The boundary to the clayey B horizon in duplex profiles is clear. Ferruginous nodules are present in some subsoils.

The soils grade into yellow podzolics in better drained positions and into soloths and humic gleys in the poorer drained positions.
12. GSG Humic Gleys

Family: Burton

Burton soils are poorly drained humic gleys with deep organic A horizons. An organic mat of varying depth is present. A thin, black organic loam from 2-10 cm commonly overlies a black organic clay loam to 30 cm depth. There is often a clear boundary to a dark grey, mottled, light or medium clay which forms a transition zone. The subsoil is permanently waterlogged, and consequently the grey or light grey medium clay is strongly mottled. The profile grades into gleyed parent alluvium.

Reaction trend is always acid at the surface but can be either acid or alkaline in the subsoil.

(c) Soil Geography

The distribution of soils can be considered in terms of the nine physiographic regions of the Reserve. Some soils are restricted to one physiographic region (e.g. solonchaks to the littoral areas), while others, particularly the lithosols, occur in several physiographic regions.

1. Shallow lithosols and gravelly yellow podzolics are dominant on the crests and steep slopes of the rugged hills. The slopes are strewn with sandstone and quartz outcrop and, consequently, the soils are very rocky.

Red earthy sands have formed over sandstone on the well drained footslopes of low hills east of Murrenja Hill. Yellow earthy sands have developed in moderately well drained situations from sands deposited at the western base of Murrenja Hill and the eastern footslopes of northern remnants of Chilling Sandstone. Imperfectly drained footslopes of low sandstone hills are covered with loamy yellow earths developed on colluvium.

2. The soils associated with the Litchfield Complex are generally sandy. Development of profiles around massive outcrops of granodiorite and pegmatite and strike ridges of quartz is minimal, lithosols being predominant. Fine sandy yellow podzolic with high amounts of gravel are found on the low erosional rises. Yellow podzolics, with coarse sandy surface horizons, develop on granodiorite on the gently undulating crests and convex colluvial slopes. Lower down the slope, where drainage is imperfect, siliceous sands and gleyed podzolics develop from sandy colluvium. Humic gleys occur on the lowest slopes which are seasonally inundated.
3. The dominant soils developed on the detritus overlying the granodiorite of the Litchfield Complex are shallow lithosols and gravelly yellow earths. The shallow yellow earths are imperfectly drained and overlie lateritic hardpans, micaceous shists and layers of quartz gravel.

4. Red lithosols and shallow gravelly red earths are associated with laterite outcrop on low rises and slope (greater than 1.5%) east of Murrenja Hill. As the degree of slope decreases the soils become deeper and less gravelly. Loamy red earths and yellow earths with mottled subsoils develop over weathering laterite.

5. Red lithosols and shallow, gravelly red earths are associated with laterite and siltstone outcrop on the low rises and slopes (greater than 2%) near the west coast. The soils on the gentle slopes less than 2% are almost exclusively loamy red earths. Some bottom on hard laterite at 90-120cm and frequently have laterite outcrop scattered around the surface while others are greater than 150cm in depth. There are rare occurrences of sandy surfaced, loamy red earths and loamy yellow earths associated with Permian siltstone.

Humic gleys, yellow podzolics and gleyed podzolics occur in the imperfectly drained fringes separating the upland lateritic areas from the paludal plains and drainage lines.

6. Low lying drainage areas carry a variety of soil types which alter with changes in alluvial deposits, drainage, slope etc. Coarse sand is a feature of soils in drainage lines of the Litchfield Complex, while fine sand and silt are in greater abundance in soils in drainage lines of the lateritic areas. Yellow earths, yellow podzolics, gleyed podzolics, soloths, solodics, grey clays, humic gleys and their intergrades are the common soils in these areas and are listed in order of development under increasing drainage impedance. A common feature through many of the profiles is the layering of alluvial deposits, which subsequently undergo soil development.

7. Humic gleys have developed on extensive areas of paludal plains under conditions of permanent inundation. The seasonally inundated paludal plains are also dominated by humic gleys with a shallow organic horizon, but also have grey clays.

8. Grey clays with marine shell fragments and secondary carbonate have developed over saline muds on the estuarine plain under seasonal freshwater inundation. The grey clays close to the coast have neutral or slightly alkaline surfaces due to the influence of brackish water, while further inland the surfaces are slightly acidic.
REPORT ON THE LAND UNITS
of
WAGAII ABORIGINAL RESERVE
by
B A FORSTER

Land Conservation Section
Animal Industry and Agriculture Branch
Department of the Northern Territory
DARWIN NT

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CANBERRA 1977
There is a minor occurrence of humic gleys with grey clays in the old channels of the Finniss River. Grey clays with acidic subsoils are found in channels at the headwater of tidal creeks. Yellow calcareous sands overlie sand, shell and secondary carbonate deposits on the cheniers, which dissect the estuarine plain.

9. The Littoral Complex around Fog Bay and the Finniss River is dominated by saline muds which are tidally flooded daily and solonchaks which are only flooded at very high tides. The solonchaks grade into grey clays with saline surfaces on areas inundated with brackish water during the wet season.

The stable beach ridges are composed of yellow calcareous sands overlying consolidated, alkaline deposits of sand, shells and secondary carbonate. The coastal fore-dunes are composed of wave thrown and wind blown sands.
<table>
<thead>
<tr>
<th>Life Form &amp; Height of Tallest Stratum</th>
<th>PROJECTIVE FOLIAGE COVER OF TALLEST STRATUM</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Dense 70-100%</td>
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<td></td>
<td>Mid-Dense 30-70%</td>
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<td></td>
<td>Sparse 10-30%</td>
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<tr>
<td></td>
<td>Very sparse 10%</td>
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</tbody>
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| Trees 20m+                         | Tall closed forest                          |
| Trees 10-20m                       | Tall open forest                             |
| Trees 3-10m                        | Tall woodland                                |
|                                   | Tall open woodland                           |
| Trees 20m+                         | Tall closed forest                           |
| Trees 10-20m                       | Tall open forest                             |
| Trees 3-10m                        | Tall woodland                                |
| Shrubs 2-8m                        | Closed scrub                                 |
| Shrubs 3-10m                       | Open scrub                                   |
| Shrubs 2-8m                        | Tall shrubland                               |
| Herbs                              | Closed herbland                              |
| Herbs                              | Herbland                                     |
| Herbs                              | Open herbland                                |
| Closed tussock grassland           | Tussock grassland                            |
| Closed grassland                   | Grassland                                    |
| Closed sedgeland                   | Sedgeland                                    |
| Closed reedland                    | Reedland                                     |

TABLE 1 Structural Forms of Vegetation (adapted from Specht, 1970).
5 VEGETATION

(a) Introduction

The vegetation of the Reserve has been described by Christian and Stewart (1953) during the 1946 survey of the Katherine-Darwin region. Due to the greater sampling intensity, a greater variation in vegetation communities has been recorded from the present land unit survey.

The classification of vegetation communities used for this survey follows that adopted by Specht (1970) with some modification and is shown in Table 1. The heights of the tallest tree strata have been changed to greater than 20 metres, between 10 and 20 metres and between 3 and 10 metres. Understorey and emergent layers have also been described. The distinction between a low tree and a shrub is rather obscure, so some communities could conceivably be either low woodland or tall shrubland. The existence of 'Palmlands' could further confuse the classification.

Some difficulties were experienced in recording the vegetation structure and species. The survey was carried out during the dry season after many of the ground species on the rugged terrain and the undulating to gently undulating terrain had been burnt or had senesced. In such cases, grasses and other ground species could only be identified if they had distinctive root and butt structures. Some species on the plains had not set seed and thus were difficult to identify, while others were inundated and inaccessible.

Some difficulty was experienced in distinguishing between E. grandifolia and E. alba var. australasica, so only E. grandifolia is mentioned here.

The species of the semi-deciduous closed forests (units 1a, 1b, 1c2, 2a, 4a, 5a2, 5a3, 8c, 9b) and evergreen tall closed forests (6a3, 7b) were not fully recorded due to difficulties in obtaining foliage and fruit due to tree height.

(b) Effect of Climate

The monsoonal climate dictates the pattern of vegetative growth on the upland areas. The wet season with high rainfall and relatively low evapotranspiration favours prolific growth, except during the monsoonal period when there is complete cloud cover. As the dry season approaches, with its high evapotranspiration, most species become conditioned to many months of drought.
Various ecologists including Perry (1960, 1970), Specht (1965), Story (1969), Robinson (1972) and Forster (1975) have described three groups of species according to their method of surviving the drought. The three groups are:

(i) Perennial drought resisting species (evergreen species) eg some Eucalypts, the Acacias, Tristania lactiflua, Livistona humilis, Petaiostigma pubescens, Alstonia actinophylla, Plectrachne pungens.

(ii) Perennial drought-evading species (semi-deciduous and deciduous species) eg most Eucalypts, Erythrina vespertilio, Cochlospermum, Terminalia ferdinandiana, Croton arnhemica, perennial grasses and other herbs.

(iii) Ephemeral drought-evading species eg annual grasses and other herbs.

Cyclones or violent storms would appear to be the reason for a gradation in community structure from open forest to low open forest (E. tetrodonta, E. miniata) on the moderately deep, loamy red earths (unit 5d) near the west coast. In one area on the coast large trees from an open forest were lying strewn on the ground, with no evidence of severe fire damage. Further east, a more dense stand of slender trees of the same species forms a low open forest. The most likely explanation for this variation in communities is that strong winds uproot the trees which then are burnt by a subsequent fire. At the same time, fire stimulates Eucalypt sucker regrowth. A similar variation in vegetation communities occurs on the shallow loamy red earths (unit 5c1) and also on the deep loamy red earths (unit 5e1) with the addition of tall open forest (E. tetrodonta). It is significant to note that the tall open forest communities occur only on deep loamy red earth, as recorded on Croker Island (Forster 1975), while open forests (E. tetrodonta, E. miniata) with E. ferruginea low tree understorey are restricted to the moderately deep or shallow red earths. Thus a particular edaphic condition is favourable for a particular community and any variation in that community can be accounted for by storm or fire damage.

c) Effect of Fire

The effect of fire on the stable vegetation communities of the upland areas is minimal as the communities are conditioned to yearly or less frequent burning. Most upland areas were burnt at the time of the survey. Grasses were burnt to butt level, but few trees or tall shrubs were seriously burnt. The effect of fire on storm damaged Eucalyptus communities has been mentioned earlier.
Lacey and Whelan (1974) have recorded the regeneration of many species from lignotubers, rhizomes, roots and fallen stems after fire damage. The low shrubland and open-heath growing on the yellow podzolics (unit 2d2) are maintained by frequent (annual) fires and subsequent regeneration by rhizomes of Eugenia bleeseri and by either lignotubers, rhizomes or root suckers in Parinari nonda.

The author observed one instance where fire was used to drive cattle out of Livistona low woodland and Pandanus, Tristania low woodland in the north-east corner of the reserve. Some grassland on the estuarine plain was burnt by Aboriginals during the mid-dry season to allow easy access to some permanent waterholes in the former channel of the Finniss River.

During an aerial inspection, a large area of Oryza closed grassland on a paludal plain was seen burning at the end of the dry season. No follow up ground observations were made, but the dense organic mat could conceivably smoulder until the first rains. The destruction of the surface organic mat exposes the soil surface to drying and cracking. Since the maintenance of a dense sward is dependant on high soil moisture levels, the surface organic mat should be protected from fire and over-grazing.

(d) Effect of Physiography

The effect of physiography on vegetation structure and species is well illustrated on the Reserve. The rugged sandstone hills (1a) (Mt Johns, Murrenja Hill) support E. miniata, E. bleeseri open forest or woodland, while the silicified sediments of the Two Sister Hills (1b) support an Erythrophleum, Cochlospermum, Livistona low woodland.

The massive outcrops of granodiorite (2a) west of Murrenja Hill are covered by semi-deciduous closed forest communities, while the majority of the surrounding terrain is covered by low woodland communities with Livistona or Pandanus dominant or a mixture of Pandanus with others such as Grevillea pteridiifolia, Melaleuca viridiflora and Banksia.

The two areas associated with laterite both support Eucalyptus open forest to woodland communities, but differ in the species present. E. miniata and Erythrophleum are the dominant species on the detrital laterite (unit 4) with E. grandifolia sub-dominant, while the communities on the laterite on the west coast (unit 5) have E. miniata, E. tetrodonta and Erythrophleum as the dominant species. The few outcrops of Permian siltstone (5a3) are covered by semi-deciduous closed forest and surrounded by grassland.
Grassland, reedland and Melaleuca closed forest to open forest communities are present on the plains of quaternary alluvium. Several types can be distinguished and are discussed later.

The littoral complex, the final physiographic type, has distinctive mangrove, samphire, grassland and semi-deciduous closed forest communities.

(e) Effect of Soils and Drainage

Within any one physiographic region, parent material, slope, drainage and hydrology influence the formation of different soils, which carry different vegetation. The major interaction between soils, drainage and vegetation are dealt with in the following sections.

(f) Description of Vegetation

In the following discussion, brief descriptions are given of the major vegetation communities with reference to physiography, soil type and surface drainage where appropriate.

(i) Tall Closed Forest

Evergreen tall closed forest, merging to closed forest, (rainforest) is confined to seepage areas (6a3) which provide the moisture necessary for such prolific growth of species tolerant of permanently moist conditions. The canopy is completely closed. Several layers of trees and palms exist, however, as noted earlier, there were difficulties in identification. Carpentaria acuminata palm is often emergent but generally accompanies Livistona benthamii palm. Acacia auriculiformis, Terminalia sp., Nauclea orientalis and Melaleuca spp., are present. Ferns, eg Hydriastele sp., sometimes form an understory.

The aerial photographs indicate some evergreen tall closed forest, or closed forest, in seepage lines down the steep side of Murrenja Hill, however, difficulties with access prevented investigation of these areas.

(ii) Closed Forest

Evergreen closed forest lines the banks of the Finniss River and creeks. The community is dominated by Melaleuca species, including M. argentea, M. symphyocarpa and M. cajuputi while Bambusa arnhemica and Pandanus sp., are the other most common species. Acacia auriculiformis, Carpentaria acuminata, Livistona benthamii, Barringtonia acuminata, and Nauclea orientalis are scattered along the levees.
Melaleuca closed forests, merging to open forest, (7b) are found on the paludal plains associated with the old meandering channels of the freshwater Finniss River and on the paludal plains west, north-west and north of Mt Johns. The different ages of *M. viridiflora* and *M. cajuputi*, the dominant species, suggest that the communities are dynamic. Grassy understories of *Dryza* are found on the seasonally inundated areas, while *Hymenachne*, *Phragmites* and *Scleria* inhabit the permanently inundated areas with humic gleys. Areas of grey clay or humic gleys, which have lost their organic surface through overgrazing, are devoid of grasses and tend to have more fallen trees.

Semi-deciduous closed forests are found on steep slopes and hills with extensive laterite (4a, 5a2), sandstone (1a, 1b, 1c2), siltstone (5a3) and granodiorite rock (2a) and on beach ridges (9b) and cheniers (8c) adjacent to the coast. The height of the community is variable, mostly in the 10-20 metre height range, but some enter the tall closed forest and low closed forest categories. Trees such as *Ficus* spp., *Strychnos lucida*, *Erythrina vespertilio*, *Alstonia actinophylla*, *Acacia auriculiformis* intertwined with numerous vines provide total canopy cover.

The laterite, sandstone, siltstone and granodiorite rock must be deeply cracked and weathered to retain moisture to support such prolific growth. The presence of small thickets of semi-deciduous closed forest isolated from the main areas of closed forest provides evidence that these communities were more extensive in the past but have been reduced in extent by fire.

The closed forest of the beach ridges (9b) grows on droughty yellow siliceous sands underlain by shells and secondary carbonate. If the assumption is made that water flows seaward (ie east to west) between the layers of laterite and Permian sediments, then fresh water is available underneath the beach ridges for the dense communities. The buried marine clay sediments probably act as an aquaclude, while the sand, shells and carbonate deposits act as an aquifer. Similarly, seepage of moisture from the surrounding clay sediments into the porous subsoil of the yellow siliceous sands allows dense vegetative growth on the cheniers (8c).

(iii) Low Closed Forest

Mangrove vegetation, as low closed forest, sometimes closed forest, lines the tidal creeks, but generally becomes more open on the saline mud and sand. Aerial photographs indicate patterns of zonation representing different species but these were not identified.
(iv) Tall Open Forest

*E. tetrodonta* tall open forest (5e1) is confined to the deep, loamy red earths with high moisture status near the coast. *E. foelscheana* and *Erythrophleum* form a second storey tree layer while *Pandanus, Livistona, Planchonia* and the poisonous *Cycas media* form a low tree and shrub understorey. The species in the dense, perennial tussock grass layer will be mentioned later. The tall open forests were probably more extensive in the past, but have been affected by strong winds and fire.

(v) Open Forest (and Woodland)

Slender trees of *E. miniata, Erythrophleum, and E. clavigera* form open forest and woodland communities on the lithosols and shallow gravelly red earths overlying detrital laterite (4a), but as soil moisture status increases, *E. grandifolia* replaces *E. clavigera* and the trees become taller and thicker, reaching their best size on the deep red earths and yellow earths which show some subsoil mottling (4d). *E. miniata* trees attain their greatest height and diameter in an open forest community growing on a deep red earth near the southern boundary. Palm understoreys (*Livistona, Pandanus*) are common, particularly on the deeper red earths.

*E. miniata, E. tetrodonta, E. bleeseri* and *Erythrophleum* open forest to woodland, sometimes grading to low open forest, with a palm understorey (*Livistona, Cycas media*) is the dominant community on the lithosols and shallow red earths of the hills and slopes with extensive laterite outcrop (5a1, 5b). As soil depth and moisture status increases, (5c1, 5d), tree height and diameter increase, while *E. bleeseri* is replaced by *E. foelscheana* and *E. ferruginea* which form an understorey with *Planchonia, Terminalia ferdinandiana* and the palms *Livistona, Pandanus* and *Cycas media*. In places, well formed *E. foelscheana* and *E. ferruginea* dominate the open forest. *Erythrophleum* dominant open forests are common on the eastern side of the lateritic terrain (5d).

The dominant perennial tussock grasses forming the grassy understorey to the above communities are *Themeda*, *Heteropogon triticeus, Chrysopogon fallax, Coelorhachis*, *Sehima* and *Imperata*. Annuals such as *Schizachyrium* and *Sorghum* sp. have scattered occurrence, while *Aristida* sp. and *Eriachne avenacea* occur around laterite pavement.
Open forest, merging to low open forest, of Banksia, Tristania lactiflua, Metrosideros, E. polycarpa and E. papuana form linear units (Sf2) separating the upland lateritic areas from the Melaleuca closed forests and drainage lines. These species, growing on imperfectly drained yellow podzolics and gleyed podzolics, are tolerant of waterlogging for extended periods.

(vi) Woodland

Woodland communities occur on the moderately well drained yellow earthy sands of the western footslopes (lc2) of Murrenja Hill. The trees are not uniformly placed but, rather, tend to clump around water flow off the hill. Erythrophleum, Terminalia grandiflora, E. papuana, Melaleuca sp. and Pandanus are common species.

(vii) Low Woodland

The footslopes (lc2) of low hills east of Murrenja Hill carry low woodland with a mixture of non-Eucalypt species including Eugenia bleeseri, Petalostigma pubescens, Planchonia Pandanus and Melaleuca sp. on imperfectly drained yellow earths.

Low woodlands dominated by Banksia dentata favour the gleyed podzolics on the imperfectly drained lower slopes, sometimes seepage areas, of the terrain associated with granodiorite (2e). A different low woodland community favours the low moisture status of the shallow, gravelly yellow podzolics of the low erosional rises (2b). The species, Erythrophleum, Gardenia megasperma, Owenia vernicosa and Petalostigma pubescens, are conditioned to dry environments.

Livistona humilis low woodland is the dominant community on the yellow podzolics derived from granodiorite (2d1). This palm, which is shallow rooted and has a small bulb at its base, is conditioned to the dry nature of the coarse sandy topsoil. Scattered Pandanus, Acacia dimidiata, Erythrina and Owenia vernicosa accompany Livistona while low shrubs are common as a sparse understorey.

Many species which are tolerant of waterlogging (Pandanus, Grevillea pteridiifolia, Melaleuca viridiflora, Tristania lactiflua, Banksia dentata) exist together in low woodland communities (2c, 2e) on similar crests and upper colluvial slopes with siliceous sands and similar yellow podzolics on which Livistona low woodland grows. No discernable differences in moisture status or drainage of the yellow podzolics were observed. Only on the imperfectly
drained lower slopes (seepage areas) where Pandanus dominant low woodlands were found was there any significant change in soil type indicating drainage impedance, namely yellow podzolics grading into gleyed podzolics. Pandanus low woodland, sometimes low open forest, also forms a linear unit (5f1) separating the upland lateritic areas from the plains. The community grows on shallow humic gleys overlying laterite and is subject to inundation for short periods.

Perennial tussock grasses such as Themeda, Heteropogon triticeus, Chrysopogon fallax, Sorghum plumosum, Coelorhachis, Ectrosia leporina and Pseudopogonatherum contortum are ubiquitous below the low woodlands, forming dense swards on the low erosional rises, crests and convex colluvial slopes. Annual species such as Sorghum sp., Schizachyrium fragilis and Thaumastochloa major are most common on the shallow, gravelly yellow podzolics.

(viii) Low Open Woodland

Low open woodlands Petalostigma pubescens, Tristania lactiflua and Melaleuca viridiflora occur on the imperfectly drained shallow yellow earths (3b) and experience seasonal waterlogging followed by long periods of drought.

The Livistona dominant community becomes more open and forms a low woodland with Pandanus, Grevillea pteridiifolia, and Eugenia bleeeria when it is subjected to the low moisture status of the lithosols and shallow, gravelly yellow podzolics and yellow earths on the low erosional rises and convex slopes (2a, 3a, 3b).

The grasses mentioned in section (vii) are also present in these areas but do not form such dense swards. Plectrachne pungens is also present, while annuals are more common.

Near Pt Blaze, low open woodland, growing on shallow loamy red earths (5c2) is protected from the sea by 5m high sand dunes and bounded abruptly on its inland side by Eucalyptus open forest. It seems likely that either salt spray or salt water invasion during strong winds and high seas has killed a more extensive open forest. The salt is subsequently leached out of the soil by the high rainfall.

Low open woodland (Pandanus, Livistona) with low shrubs occurs on the deep, loamy red earths and yellow earths formed over Permian siltstone (5e2). The hard setting sandy loam surface and steeper slopes, allowing better drainage, could account for the depauperate community in comparison to the Eucalyptus open forest on the deep, loamy red earths derived from laterite. Similar depauperate communities occur on Croker Island (Forster, 1975) and abruptly adjoin open forest, both growing on deep red earths.
(ix) Low Shrubland

Low shrubs, namely Eugenia bleeseri, Parinari nonda, Pandanus, Acacia gonocarpa, Grevillea driandri, G. angulata, G. mimosoides and Grewia retusifolia form extensive areas of fire induced low shrubland to open heath communities (2d2) on the yellow podzolics of the granodiorite terrain. The community becomes more open (low open shrubland) on shallow, gravelly soils (2b, 3a, 3b).

(x) Closed Grassland

The closed grassland communities of the paludal plains vary according to the relative elevation and drainage. Hymenachne grows on humic gley soils in permanently inundated areas (7a1), often sunken plains, in association with Eleocharis, Nelumbo and Scleria, while Phragmites forms dense circular clones in deep permanently inundated areas (7a4). Oryza australiensis dominant closed grassland (7a2), on the other hand, occurs on plains which are seasonally inundated and dry out by July or August.

(xi) Tussock Grassland

Plectrachne, annual Sorghum tussock grassland with widely scattered shrubs, is well suited to the droughty, sandy surface of the deep, red earthy sands (1c1). The elevation of the footslopes of the high and low hills ensures good drainage.

Tussock grassland communities occur on the concave colluvial slopes (2f) which form the fringe between the upland granodiorite areas and the paludal plains. The upper imperfectly drained colluvial slopes have Themeda, Ectrosia leporina, Coelorhachis and Eriachne spp. while the lower slopes have Panicum sp., Pseudoraphis spinescens, Paspalum orbiculare, Ischaemum arundinaceum and Ophiuros exaltatus which are all tolerant of inundation for short periods. Similar tussock grasslands with Coelorhachis, Aristida sp. and Panicum mindanaense cover the yellow siliceous sands of the low cheniers.

The dominant vegetation on the seasonally inundated estuarine plains (8a1) is perennial tussock grassland growing on deeply cracking, alkaline grey clays. In contrast to the dense clones it forms under permanently inundated conditions, Phragmites occurs as a single stem grass with Ischaemum and Imperata, which are dominant. Towards the coast around Fog Bay and along the salt-water Finniss River, the above species are gradually replaced by Xerochloa imberbis as the surface of the grey clay becomes more saline. The Xerochloa tussock grassland, in turn, grades into Sporobolus virginicus, Diplachne grassland under more saline conditions and this community is eventually replaced by samphire, namely Arthrocnemum, on the tidally influenced solonchaks.
(xii) Grassland

Grassland with Hymenachne, Phragmites and Pseudoraphis is dominant on the grey clays and humic gleys in the old shallow channels of the Finniss River (8a2), but some areas have been invaded by weeds such as Phyla nodiflora and Polygonum barbartum. The coastal fore-dunes (9c) are stabilised by Spinifex longifolius grassland with scattered low trees and shrubs.

(xiii) Reedland

Scleria poaeformis reedland (7a3) does not appear to have a specific drainage requirement as it is found with Hymenachne on plains which are inundated for extended periods, with Ischaemum and Ophiuros on the drier fringe of plains and with Phragmites on drier plains where the humic gleys have shallow organic surfaces.
LIMITATIONS TO AND POTENTIAL FOR LAND USE

Resource surveyors gain considerable knowledge of the physiographic, drainage, edaphic and botanical characteristics of land units in their survey area. They can be regarded as authorities on the intrinsic limitations to land use of each land unit in their survey area. On the other hand, their knowledge of potential for land use is limited by the many extrinsic factors which have to be considered, factors which are better dealt with by specialist pasture agronomists, animal production officers, etc.

Certain principles of land use applicable to the Reserve should be explained as follows:

1. Pasture species to be introduced to the Reserve should be selected for their growth under and tolerance to certain environmental conditions. Suitable species are not necessarily available for all conditions. Pasture species can be grouped according to growth under and tolerance to the following drainage conditions:

   (a) excessively to well drained
   (b) moderately well drained
   (c) imperfectly drained with water-logging for short periods
   (d) poorly drained with water-logging for moderate to long periods
   (e) poorly drained with inundation for short periods
   (f) poorly drained with inundation for long periods
   (g) poorly drained with permanent inundation

2. Shallow or very gravelly soils have low water holding capacity and dry out quickly. Annual species are best suited to these soils because they can utilise the available moisture during a short growing season, then set seed. Perennial pastures would have lower production on shallow soils than on deep soils.

   Deep soils (eg loamy red earths) have a moderate to high water holding capacity and while the topsoil might dry out quickly, the subsoil remains moist for a considerable period after the last rains. Perennial pastures are best suited to these soils because they can utilise the available subsoil moisture over a long growing period. Similarly, grain or seed crops receive sufficient moisture to set seed.
Moderately deep soils might not have the available moisture to allow high yields from grain or seed crops. However, fodder crops, which need not set seed, could be grown successfully.

Some factors favourable to plant growth can be overridden by unfavourable factors. The high moisture status of solidics is overridden by their poor drainage and alkaline subsoil.

3. Areas of low shrubland (Eugenia bleeseri, Parinari nonda, Acacia gonocarpa) should not be cultivated, cleared or burnt as these practices induce strong suckering.

Similarly, suckering can be a major problem when areas of Eucalyptus open forest are cleared.

4. If total clearing is to occur to allow grain or fodder cropping, belts of trees should be left for shade, while cultivation should be along the contour. The convex slopes in the granodiorite areas should allow recognition of the approximate contour, but the contours will not be so easily recognised in the lateritic areas. Grass strips along the contour, at suitable intervals down the slope, will reduce run-off and minimise loss of topsoil.

5. Large areas of Livistona low woodland may have to be cleared to allow easy mustering of cattle. In some areas, visibility is restricted to about 50 metres. Where the low woodland has a low shrub understorey, clearing should not occur because of suckering problems.

6. Perennial tussock grasses dominate the herbaceous understorey throughout the undulating to gently undulating terrain. The competition from these grasses is strong. Where introduced pasture seed is to be sown without any clearing and cultivation, the grasses should be grazed, burnt or slashed prior to seeding.

7. Cycas media, present under the Eucalyptus open forests on the west coast, has poisonous fronds which induce Zamia staggers if eaten by cattle. Cattle should not be grazed in areas where Cycas is present in large numbers. The economic eradication of this plant is a problem still under investigation.

8. There are adequate supplies of surface water in waterholes and creeks throughout the granodiorite areas. However, surface water is limited throughout the laterite areas. The lack of drainage features throughout the laterite areas suggests that underground water supplies might be substantial, but this needs to be confirmed by boring.
9. At present, weeds are not a problem on the Reserve and every effort should be made to exclude them from the Reserve. Only certified seed should be used for pasture establishment.

10. Feral pigs are causing considerable damage to pastures on the undulating terrain and paludal plains. They can carry diseases, such as tuberculosis. It will be necessary to reduce their numbers considerably.

11. The paludal plains support dense stands of Hymenachne and Oryza, both grasses with high crude protein levels. Analysis of the leaves of Hymenachne and Oryza harvested in January from a paludal plain showed crude protein levels (oven dried) of 18.3% and 12.5% respectively. Such figures demonstrate the high potential that these grasses have for meat production.

12. Perennial pasture species suitable for deep loamy red earths and yellow earths with moderate to high moisture status include:

(i) legumes: Stylosanthes guayanensis (perennial Stylo)
Calopogonium mucunoides (Calopo)
Phaseolus atropurpureus (Siratro)
Centrosema pubescens (Centro)

(ii) grasses: Digitaria decumbens (Pangola Grass)
Brachiaria decumbens (Signal Grass)
Panicum maximum (Guinea Grass)
Andropogon gayanus

Pasture species suitable for shallow red earths and yellow earths with low moisture status include:

(i) legumes: Stylosanthes humilis (Townsville Stylo)
Calopogonium mucunoides (Calopo)

(ii) grasses: Urochloa mozambicensis (Sabi Grass)
Cenchrus ciliarus (Buffel Grass)
Cenchrus setigerus (Birdwood Grass)

13. Grain crops suitable for deep loamy red earths and yellow earths include maize, soybean, peanuts and sorghum. Fodder crops suitable for deep and moderately deep loamy red earths and yellow earths include Bullrush Millet, Sudax, Dolichos lablab, and Cowpeas. Dolichos is suitable for hay production as are some pasture legumes.

14. Low erosional rises (units 2b, 3a, 4a, 5a) are most suitable for watering points, yards and buildings because cattle pads, fences and roads can radiate downslope away from the structure and, therefore, erosion is minimised.
In the following, the intrinsic limitations to pastoral/agricultural land use of the land units are discussed and suggestions are also made for land use potential. In some cases, land use alternate to pastoral activities is suggested. Limitations considered are slope, soil depth, water holding capacity, gravel, stone and rock content, erodibility, soil and surface drainage, water-logging, flooding, inundation, consistence, soil alkalinity or acidity, weeds and noxious plants, dense vegetation.

(a) Limitations which preclude pastoral land use (1a, 5a2, 6a3, 6c, 7a3, 7a4, 7b, 8b, 9a, 9b, 9c).

The extremely rocky and very steep slopes of the high hills (unit 1a) make accessibility to these areas difficult. Difficulties would be experienced in mustering stock. The hills act as watershed catchments and wildlife refuges, while excellent vistas are also present.

The semi-deciduous closed forests on the laterite slopes (5a2) and beach ridges (9b) and scattered in other units (1a, 1b, 1c2, 2a, 4a, 5a3, 8c) are refuges for wildlife, particularly birds. Their dense vegetation and scarcity of grass limits their suitability for grazing. These areas are also of botanical interest due to their diversity of species.

The evergreen tall closed forests along seepage lines and creeks (6a3) should be considered for scientific reserves, since their occurrence in the Top End is limited. Wildlife, particularly birds, seek refuge in the dense vegetation. Any practices which could damage and reduce the area of the community should be stopped. Such practices include total clearing and cropping in the catchment of the seepage area, fire and puddling of the moist soil surface by cattle, pigs and buffalo.

The permanent waterholes in the internal drainage depressions (6c) can be used as watering points. Seasonally inundated depressions (6c) support Melaleuca communities with bare ground underneath and are of no agricultural use. Some have grass and sedge communities which can be lightly stocked during the dry. Some channels at the head of tidal creeks (8b) are devoid of vegetation and are of no grazing value.

Scleria reedland (7a3) and Phragmites closed grassland and dense clones (7a4) which grow on the paludal plains are not suitable for grazing, as both species are unpalatable. The humic gleys on which they grow will support Hymenachne and Oryza. However, there could be problems in removing the former two species and establishing the latter.
The Melaleuca closed forests on the paludal plains (7b) adjacent to the Finniss River in the north-east corner of the Reserve are of scientific and recreational interest. The large areas of dense Melaleuca cajuputi and M. viridiflora communities interspersed with palms and Indo-Malayan tree species growing on the river banks are interesting botanically. Many bird species are present, particularly water birds. Reptiles, such as crocodiles, goannas and snakes, are abundant along the water courses, which also offer excellent opportunities for line fishing and boating. Large animals such as cattle, buffalo and pigs should be excluded from these areas. There is very little grass understorey, while the dense vegetation and swampy conditions would make mustering of stock difficult. Fencing is extremely expensive, high impossible. In addition, overgrazing can lead to loss of grass cover, drying and cracking of a former moist, organic surface. In some areas where this has occurred many trees have died and fallen over.

The large areas of Melaleuca closed forest to open forest (7b) west, north-west and north of Mt Johns have *Oryza* grassy understorey and are mostly quite dry during the mid-to-late dry season. This area might be suitable for forestry, though has not been investigated by forestry authorities. Stock may destroy regenerating seedlings and suckers of this dynamic community, while mustering would be a problem.

Excellent recreational opportunities exist along the beaches, rocky points, coastal fore-dunes (9c), tidal creeks (9a) and the salt-water Finniss River. The large areas of mangrove low closed forest along Fog Bay and south of Point Blaze are important habitats and food sources for fish and crustaceans. The coastal fore-dunes, stabilised by Spinifex grassland, act as sea barriers. Excessive disturbance through pedestrian or vehicular movement can allow blowouts along the dunes and, subsequently, seawater can flow inland during violent storms. The salt flats (9a) have little grazing value save for the areas of *Sporobolus*, Diplachne and *Xerochloa* tussock grassland on the extremities, which merge with the estuarine plain.

(b) Severe limitations (1b, 2a, 2b, 3a, 3b, 4a, 5a1, 5a3, 5b, 5c2, 6a1, 6a2, 8c).

Land units 1b, 2a, 3a, 4a, 5a1, 5a3 and 5b have shallow, gravelly lithosols and abundant rock outcrop or pavement. The very low water holding capacity of the soils and their inherent infertility limit their potential for improvement with improved pastures. Steep slopes on some low hills (1b) and massive granodiorite tors and pegmatite and quartz outcrops (2a)
present problems to vehicular and stock movement. The units are suitable for grazing of native pastures during the wet, as the native pastures respond to early wet season rains and have their greatest nutritive value during the early and mid wet seasons.

Land units 2b, 3b and some of 5b (cf. open forest areas) have shallow, gravelly red earths, yellow earths or yellow podzolics and scattered rock outcrop. Annual pasture species, such as Townsville Stylo, would establish, but because of the low water holding capacity of the soils and their inherent infertility, pasture yields would not be very high. Considering the economic implications, these units should be given low priority in any pasture improvement programme. The units are suitable for grazing of native pastures during the wet.

Land unit 5c2 has shallow red earths, which, in most circumstances, would be suitable for the establishment and growth of annual pasture species. However, this unit is subject to salt water invasion during violent storms, which could damage the pasture. Pasture improvement does not seem economically feasible. Grazing of native pastures is suggested as the best land use.

Units 2f, 5f1 and 5f2 which are linear units separating the upland areas from the paludal plains, are suitable for limited grazing of native pastures during the dry. The upper slopes of these units, particularly of 2f, have soils with sandy surfaces, which are susceptible to run-off from higher slopes. Seepage areas tend to occur in these units. The lower slopes are waterlogged or inundated for short periods. Stock should preferably be excluded from these areas, however, this would be difficult due to the linear nature of the unit. Consequently, the lower slopes are best fenced in with the paludal plains and used for dry season grazing. The naturally clear upper slopes of 2f are suitable for fencing, providing the fence line runs approximately along the contour.

The narrow drainage lines (6a1, 6a2) carry large volumes of water during the wet season and, hence, are susceptible to erosion if the grass cover is removed. For this reason, the soil surface should not be unduly disturbed. Stocking of native pastures should be kept to a minimum and only allowed during the dry season.

The cheniers (8c) support tussock grassland which is suitable for rough grazing during the dry, assuming that stock are excluded from the surrounding estuarine plain during the wet season. The cheniers provide the only elevated land within the estuarine plain in the west and hence are likely to be used as stock camps. Unpalatable species might have to be established on the cheniers to stabilise the sandy soils.
(c) Permanent and seasonal inundation (6b, 7a1, 7a2, 8a1, 8a2).

The broad drainage floors (6b) and the shallow relict channels within the estuarine plain (8a2) carry large volumes of water during the wet season, but the water is slow moving, so erosion hazard is minimal. Some areas might be suitable for the establishment of Para Grass, or even Hymenachne and Oryza behind low ponding banks which will hold back water for long periods. Grazing during the dry season should be kept at a level to maintain the grass cover. Permanent waterholes provide watering points.

The closed grasslands, dominated by Hymenachne and Oryza (7a1, 7a2), which occur on the paludal plains, are suitable for grazing during the mid-late dry season. The plains with Oryza dry out around August, so grazing can occur from that month through to December, when the soil surface becomes wet again. Many areas of Hymenachne are permanently inundated which creates problems with grazing and mustering. Buffalo will graze areas 1m deep in water, while cattle prefer areas with less than 50cm inundation. The binding strength of the grass roots is lowered under wet surface conditions, so a large proportion of plants can be pulled out of the soil. Surface puddling from stock hooves can exacerbate the problem. Hence stocking numbers should be kept to a minimum, preferably excluded, on the permanently inundated plains. However, large areas of Hymenachne closed grassland are only seasonally inundated, drying out about September, allowing 3 months of grazing until December. In fact, the early wet season rains appear to 'sour' the pastures, because buffalo and cattle prefer to graze the regenerating perennial grasses on the upland soils at this time of the year.

Since the productivity of Hymenachne and Oryza is dependant on very high soil moisture levels, which in turn are dependant on the maintenance of a thick surface organic mat, strictly controlled stocking rates are required. These stocking rates can not be quoted but should be set to maintain the thick surface organic mat. The plains should be fenced off from the upland areas to prevent grazing while the humic gley soils are wet. The advantage of fertilising Hymenachne and Oryza pasture to raise production is uncertain. Officers of the Agriculture Section are conducting fertilizer trials on Hymenachne pastures growing on acid grey clays near Point Stuart, east of Darwin.

The permanently inundated paludal plains are a water-bird refuge.
The grey clays of the estuarine plain (8a1) are inundated for 4-5 months of the year, drying out in April. The plains should not be grazed while the soils are wet since excessive puddling can lead to degradation of the soil surface structure and grass pastures, allowing invasion by weeds such as Phyla. The Imperata, Ischaemum pastures should provide nutritious feed during the early-mid dry season. Para grass has been successfully established on grey clays on Croker Island, so it should also establish and grow successfully on similar grey clays on the estuarine plain on the Reserve.

Trials at the Coastal Plains Research Station indicate that high rice yields are possible on irrigated Carmaclays (Langfield, E.C.B., 1973). However, irrigation on the estuarine plain would be a major project of irrigation and drainage channels. The feasibility of rain grown rice is not known.

(d) Definite but moderate limitations (lcl, lc2, 2c, 2d1, 2d2, 2e, 4b, 5cl, 5e2).

Units 1c1, lc2, 2c, 2d1, 2d2 and 2e all have deep soils which are suitable for perennial pastures, either grasses or legumes. The soils in well or moderately well drained situations (namely red earthy sands of lcl, yellow earthy sands of lc2, yellow podzolics of 2d1 and 2d2, and red earths and yellow earths of 5e2) will support pasture species tolerant of such drainage conditions. On the other hand, the soils in imperfectly drained situations (namely yellow earths of lc2 and yellow podzolics and siliceous sands of 2c and 2e) will support pasture species tolerant of imperfect drainage conditions.

However, the above units have limitations on their land use. Units lcl and lc2 occur in footslope situations, and, as such, are susceptible to erosion due to run-off from the hills. Units 2c, 2d1, 2d2, 2e and 5e2 have soils with sandy surfaces which are susceptible to erosion if unduly disturbed. The crest areas are relatively stable, but the lower slopes are most erodible. In addition, unit 2c has abundant outcrop so only rock free areas can be pasture improved, while units 2d1 and 2d2 have an abundance of low shrubs, which sucker if disturbed, as mentioned earlier.

Units 4b and 5cl have shallow lateritic soils, with scattered outcrop, that will support annual pastures such as Townsville Stylo. Because of the low moisture holding capacity, pasture yield will be limited. Erosion is not a problem, particularly where the surface might have a gravel veneer.
(e) Few limitations (4c, 4d, 5d, 5el).

The arable soils of the Reserve are loamy red earths and yellow earths included in units 4c, 4d, 5d and 5el. Moderately deep soils in units 4c and 5d are more suitable for fodder cropping and perennial pastures, as explained earlier. Deep soils in units 4d and 5el are more suitable for grain and seed crops and perennial pastures.

The units are not in erodible situations, but land preparation should be carried out with minimum disturbance to the soil surface. In the initial clearing programme, strips of native vegetation should be left along the contour at suitable spacings down the slope. The width of cleared land between strips of native vegetation should be decreased as the degree of slope increases. Grass strips on the contour should also be incorporated into a rotational cropping programme. Clearing should not occur directly above an arable unit. All cultivation should be on the contour.

As mentioned earlier Eucalyptus suckering and weed infestation are problems likely to be encountered with clearing. The eradication of Cycas media would have to precede any intensive grazing programme.

Grazing Systems

Considering the pastures available, a possible grazing system could be:

(i) early and mid wet season - native pastures on the upland country.

(ii) late wet - improved pastures and fodder crops on the upland areas.

(iii) early dry - improved pastures and fodder crops on the upland areas; native and improved pastures on the estuarine plain.

(iv) mid dry - native and improved pasture on the estuarine plain; Oryza on the paludal plains.

(v) late dry - improved pastures on the estuarine plain; Oryza and Hymenachne on the paludal plains; supplement and conserved fodder.

The above system could incorporate pastoral activities over the whole of the Reserve or only the eastern half.
7. REFERENCES


APPENDIX 1

SOIL CLASSIFICATION

A 'Factual Key' for the 'Principal Profile Forms' (Northcote, 1971) has been assigned to soil profiles to indicate the characters of the A-B solum. The 'Factual Key' is not applicable to yellow podzolic profiles derived from granodiorite because of the strong influence of termite activity in profile development. 'Specific occurrence' refers to the land unit(s) in which the typical soil profile occurred, while 'general occurrence' refers to the land units in which the soil profile with stated variations occurs. Terms describing horizon differentiation, mottles, nodules, texture, consistence, structure and fabric are described in the U.S.D.A. Soil Survey Manual (1960) and by Northcote (1971).

Great Soil Group: Solonchak
Soil Family: Carpentaria
Factual Key: Ug5.28
Parent Material: Marine deposits
Occurrence - Specific: 9a

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>A1</td>
<td>Greyish brown (2.5Y 5/2) medium clay; puffy appearance with salt encrustations; pH 9.0</td>
<td>olive grey (5Y 4/2)</td>
</tr>
<tr>
<td>1-5</td>
<td>A2</td>
<td>Greyish brown (2.5Y 5/2) medium clay; dry, extremely hard; coarse crumbs less than 5cm; smooth ped fabric; pH 9.0</td>
<td>olive grey (5Y 4/2)</td>
</tr>
<tr>
<td>5-30</td>
<td>A3</td>
<td>Greyish brown (2.5Y 5/2) medium clay; dry, extremely hard; massive or medium blocky; smooth ped fabric; pH 9.0</td>
<td>olive grey (5Y 5/2)</td>
</tr>
<tr>
<td>30-95</td>
<td>AC</td>
<td>Olive grey (5Y 5/2) light-medium clay; few yellow-brown mottles; moist, very firm; massive to strong blocky; smooth ped fabric; pH 9.0</td>
<td>light brownish grey strong blocky (2.5Y 6/2)</td>
</tr>
<tr>
<td>95-130</td>
<td>C/D</td>
<td>Light grey to grey (5Y 6/1) light clay; wet, slightly sticky; massive to strong blocky; common yellow-brown mottles; pH 9.0</td>
<td></td>
</tr>
<tr>
<td>130+</td>
<td>C/D</td>
<td>Strongly mottled gleyed mud; light clay</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group: Lithosols
Soil Family: Not specified; red
Factual Key: Uml.43
Parent Material: Laterite
Occurrence - Specific: 4a, 5a1
- General: 4a, 5a1, 5a2, 5a3

Soil Profile Description

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<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
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<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Very dark greyish brown (10YR 3/2) sandy clay loam; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>dark brown clay loam</td>
</tr>
<tr>
<td>10-20</td>
<td>A3</td>
<td>Dark reddish brown (5YR 3/4) clay loam with sand; 10% ferruginous gravel; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>yellowish red (5YR 4/8) or dark red (2.5YR 3/6)</td>
</tr>
<tr>
<td>20-40</td>
<td>B1</td>
<td>Dark reddish brown (5YR 3/4) clay loam; 50% gravel; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>no variation</td>
</tr>
<tr>
<td>40+</td>
<td>C</td>
<td>Ferruginous gravel and parent material</td>
<td>no variation</td>
</tr>
</tbody>
</table>
Great Soil Group: Lithosols
Soil Family: Not specified; yellow
Factual Key: Ucl.41
Parent Material: Granodiorite, sandstone
Occurrence -
  Specific: 2a, 2b
  General: 1a, 1b, 2a, 2b, 3a

<table>
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<tr>
<th>Depth Horizon (cm)</th>
<th>Description</th>
<th>Variation</th>
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<tbody>
<tr>
<td>0-10 A1</td>
<td>Dark greyish brown (10YR 4/2) loamy coarse sand; dry, slightly hard; massive; sandy/earthy fabric; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>10-30 B1</td>
<td>Yellowish brown (10YR 5/4) loamy coarse sand; dry, slightly hard; massive; earthy fabric; pH 6.0; up to 50% quartz gravel</td>
<td>light yellowish brown (10YR 6/4); coarse sandy loam; may be deeper</td>
</tr>
<tr>
<td>30+ C</td>
<td>Gravel and parent material</td>
<td></td>
</tr>
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</table>
Great Soil Group: Calcareous Sands
Soil Family: Dune Sands
Series: No. 1
Factal Key: Ucl.11
Parent Material: Water thrown and wind blown beach sand
Occurrence: Specific: 9C

Soil Profile Description

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<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
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</thead>
<tbody>
<tr>
<td>0-20</td>
<td>A1</td>
<td>Very dark greyish brown (10YR 3/2) sand; dry, loose; massive; single grained; pH 6.5</td>
<td>black (10YR 2/1) organic loamy sand</td>
</tr>
<tr>
<td>20-60</td>
<td>B</td>
<td>Pale brown (10YR 6/3) sand with scattered shell fragments; dry, loose; massive; single grained; pH 7.0-8.0</td>
<td>very pale brown (10YR 7/3)</td>
</tr>
<tr>
<td>60+</td>
<td>C</td>
<td>Sand or consolidated beach sand, coral, shell fragments and secondary carbonate; pH 9.0</td>
<td></td>
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</table>
Great Soil Group : Calcareous Sands  
Soil Family : Dune Sands  
Series : No. 2  
Factual Key : Uc5.12  
Parent Material : Beach sand, coral and shell fragments  
Occurrence - Specific : 8c, 9b  

Soil Profile Description

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<tr>
<td>0-10</td>
<td>A1</td>
<td>Dark brown (7.5YR 3/2) loamy sand; dry, loose; massive; sandy fabric; pH 6.0</td>
<td>black (10YR 2/1); organic loamy sand</td>
</tr>
<tr>
<td>10-70</td>
<td>A3</td>
<td>Brown (7.5YR 4/4) loamy sand; dry, loose; massive; sandy fabric; pH 7.0</td>
<td>dark brown (7.5YR 3/2)</td>
</tr>
<tr>
<td>70-150</td>
<td>B</td>
<td>Strong brown (7.5YR 5/6) clayey sand; dry, loose and moist, very friable; massive; sandy fabric; 20% coral, shells and secondary carbonate; pH 8.5</td>
<td>may be shallower</td>
</tr>
<tr>
<td>150+</td>
<td>C</td>
<td>Consolidated deposit of beach sand, coral, shells and secondary carbonate</td>
<td></td>
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</table>

Viewed at 08:02:19 on 18/02/2010
Great Soil Group: Siliceous Sands
Soil Family: Cullen
Series: No. 1
Factual Key: UC4.24
Parent Material: Granodiorite; coarse sandy colluvium
Occurrence - Specific: 2e

Soil Profile Description

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<th>Description</th>
<th>Variation</th>
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<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Very dark grey (10YR 3/1) coarse sandy loam; dry, slightly hard; massive; earthy fabric; pH 6.0</td>
<td>very dark greyish brown (10YR 3/2)</td>
</tr>
<tr>
<td>10-40</td>
<td>A2 (unbleached)</td>
<td>Dark greyish brown (10YR 4/2) loamy coarse sand; dry, loose; massive; sandy fabric; pH 6.0</td>
<td>brown (10YR 4/3)</td>
</tr>
<tr>
<td>40-120</td>
<td>B</td>
<td>Pinkish grey (7.5YR 6/2) clayey coarse sand; few yellow-brown mottles; moist; friable; massive; sandy fabric; pH 6.0</td>
<td>light brownish grey (10YR 6/2)</td>
</tr>
<tr>
<td>120+</td>
<td>BC</td>
<td>Weathering granodiorite</td>
<td></td>
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Great Soil Group: Siliceous Sands  
Soil Family: Cullen  
Series: No. 2  
Factual Key: Uc4.21  
Parent Material: Granodiorite; coarse sandy colluvium  
Occurrence - Specific: 2e

### Soil Profile Description

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<th>Description</th>
<th>Variation</th>
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<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Very dark grey (10YR 3/1) loamy coarse sand; dry, loose; massive; sandy fabric; pH 5.5</td>
<td></td>
</tr>
<tr>
<td>10-30</td>
<td>A2</td>
<td>Brown (10YR 4/3) clayey coarse sand; dry, slightly hard; massive; sandy fabric; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>30-120</td>
<td>B</td>
<td>Yellowish brown (10YR 5/6) clayey coarse sand; 5% angular quartz gravel; common yellow-brown and red-brown mottles; moist, friable; massive; sandy fabric; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>120+</td>
<td>BC</td>
<td>Weathering granodiorite</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group : Earthy Sands
Soil Family : Cockatoo
Factual Key : Uc5.21
Parent Material : Sandstone
Occurrence - Specific : 1Cl

Soil Profile Description

<table>
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<tr>
<th>Depth (cm)</th>
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<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>A1</td>
<td>Dark brown (7.5YR 3/2) sand; dry, loamy sand loose; massive; sandy fabric; pH 6.5</td>
<td></td>
</tr>
<tr>
<td>5-30</td>
<td>A3</td>
<td>Dark reddish brown (5YR 3/4 clayey sand; dry, loose; massive; sandy/earthy fabric; pH 6.0</td>
<td>light sandy loam</td>
</tr>
<tr>
<td>30-100</td>
<td>B1</td>
<td>Yellowish red (5YR 4/6) sandy loam; slightly moist, friable; massive; earthy fabric; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>100-150</td>
<td>B2</td>
<td>Red (2.5YR 5/6) sandy loam; moist, friable; massive; earthy shallower fabric; pH 6.0</td>
<td>may be shallow</td>
</tr>
<tr>
<td>150+</td>
<td>BC</td>
<td>Weathering sandstone</td>
<td></td>
</tr>
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</table>
Great Soil Group : Earthy Sands  
Soil Family : Arnhem 
Factual Key : UC5.23 
Parent Material : Colluvial sands 
Occurrence - Specific : 1C2

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<tr>
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<tr>
<td>0-15</td>
<td>A1</td>
<td>Very dark greyish brown (10YR 3/2) loamy sand; dry, hard; earthy fabric; pH 6.0</td>
</tr>
<tr>
<td>15-40</td>
<td>A3</td>
<td>Dark brown (10YR 3/3) loamy sand; dry, hard; massive; earthy fabric; pH 6.0</td>
</tr>
<tr>
<td>40-90</td>
<td>B1</td>
<td>Yellowish brown (10YR 5/4) loamy sand; dry, slightly hard; earthy fabric; pH 6.0</td>
</tr>
<tr>
<td>90-120</td>
<td>B2</td>
<td>Light yellowish brown (10YR 6/4) clayey sand; dry, slightly hard; yellowish brown (10YR 5/6)</td>
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</table>
Great Soil Group: Grey Clays  
Soil Family: Carmor  
Series: No. 1  
Factual Key: Ug5.16  
Parent Material: Estuarine deposits

<table>
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<th>Description</th>
<th>Variation</th>
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<tbody>
<tr>
<td>0-5</td>
<td>All'</td>
<td>Black (10YR 2/1; 2.5Y 2/0; 5Y 2/1) slightly organic light clay; common rusty root line staining; dry, extremely hard; granular; smooth ped fabric; pH 6.0</td>
<td>very dark grey (10YR 3/1; 2.5Y 3/1); organic clay loam</td>
</tr>
<tr>
<td>5-40</td>
<td>A12</td>
<td>Very dark grey (10YR 3/1; 2.5Y 3/0) heavy clay; few yellow-brown mottles; dry, extremely hard; coarse blocky; smooth ped fabric; common amorphous carbonate; pH 8.0</td>
<td>dark grey (10YR 4/1; 2.5Y 4/0); medium clay</td>
</tr>
<tr>
<td>40-70 AC</td>
<td>(transition)</td>
<td>Grey (2.5Y 5/1, 6/1) heavy clay; strong yellow-brown and olive mottles; moist, very firm; indistinct structure; smooth ped fabric; abundant amorphous carbonate; pH 8.5</td>
<td>marine shell fragments; slickensides</td>
</tr>
<tr>
<td>70-180 C</td>
<td></td>
<td>Olive grey (5Y 4/2, 5/2) medium clay; strong yellow-brown and olive mottles; wet, sticky; indistinct structure and fabric; abundant amorphous carbonate and marine shell fragments; pH 9.0</td>
<td>light brownish grey (2.5Y 6/2); heavy clay</td>
</tr>
<tr>
<td>180+ G</td>
<td></td>
<td>Gleyed (5GY 5/1) light clay; wet, very sticky; abundant marine shell fragments; pH 9.5</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group : Grey Clays  
Soil Family : Carmor  
Series : No. 2  
Factual Key : Ug5.28  
Parent Material : Estuarine deposits  
Occurrence - Specific : 8al

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>All</td>
<td>Very dark grey (5Y 3/1) medium clay; common rusty root line staining; dry, extremely hard; granular; smooth ped fabric; few marine shell fragments and amorphous carbonate; pH 7.0-8.5</td>
<td>fine salt crust; massive; earthy fabric</td>
</tr>
<tr>
<td>5-20</td>
<td>A12</td>
<td>Greyish brown (2.5Y 5/2) heavy clay; common dark grey mottles; moist, extremely firm; coarse blocky; smooth ped fabric; common marine shell fragments and amorphous carbonate; pH 9.0</td>
<td>olive grey (5Y 4/2)</td>
</tr>
<tr>
<td>20-60</td>
<td>AC (transition)</td>
<td>Light brownish grey (2.5Y 6/2) heavy clay; common yellow-brown mottles; moist, extremely firm; indistinct structure; smooth ped fabric; common shells and amorphous carbonate; pH 9.0</td>
<td>pale brown (10YR 6/3); medium clay</td>
</tr>
<tr>
<td>60-150</td>
<td>C</td>
<td>Light brownish grey (2.5Y 6/2) medium clay; common yellow-brown and blue-grey mottles; wet, sticky; indistinct structure and fabric; common shells and amorphous carbonate; pH 9.5</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group : Grey Clays
Soil Family : Wildman
Factual Key : Ug5.16
Parent Material : Estuarine deposits
Occurrence - Specific : 8a1, 8a2

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>A1</td>
<td>Black (10YR 2/1; 2.5Y 2/0; 5Y 2/1) light-medium clay; rusty root line staining; dry, extremely hard; granular; smooth ped fabric; pH 5.5-6.5</td>
<td>very dark grey (5Y 3/1)</td>
</tr>
<tr>
<td>5-30</td>
<td>A1</td>
<td>Very dark grey (10YR 3/1; 5Y 3/1) heavy clay; few yellow-brown mottles; dry, extremely hard; coarse blocky; smooth ped fabric; pH 8.0</td>
<td>medium clay</td>
</tr>
<tr>
<td>30-60</td>
<td>AC</td>
<td>Grey (2.5Y 6/0; 5Y 6/1) medium heavy clay; common yellow-brown and dark grey mottles; moist, extremely firm; fine blocky; smooth ped fabric; slickensides; pH 9.0</td>
<td>light brownish grey (2.5Y 6/2) olive grey (5Y 5/2); light-medium clay</td>
</tr>
<tr>
<td>60-130</td>
<td>C</td>
<td>Grey (5Y 5/1, 6/1) light - medium clay; abundant yellow-brown and dark grey mottles; wet, sticky; indistinct structure and fabric; pH 9.0</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group: Soloths
Soil Family: Not specified
Factual Key: Dq2.71
Parent Material: Alluvium
Occurrence - Specific: 6b
General: 6a1, 6a2, 6b, 6c

### Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20</td>
<td>A1</td>
<td>Very dark grey (10YR 3/1) loamy sand; dry, slightly hard; massive; earthy; pH 5.5; rusty root line staining</td>
<td></td>
</tr>
<tr>
<td>20-50</td>
<td>A21 (unbleached)</td>
<td>Greyish brown (10YR 5/2; dry 10YR 7/2) loamy sand, dry, slightly hard; massive; earthy; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>50-60</td>
<td>A22</td>
<td>Light brownish grey (10YR 6/2; dry 10YR 7/2) sandy loam; dry, hard; massive; earthy; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>60-160</td>
<td>B</td>
<td>Light grey (10YR 7/1) clay loam to light clay with sand; common red-brown and yellow-brown mottles; moist, very firm; massive; earthy; pH 5.5; 5% ferruginous nodules</td>
<td></td>
</tr>
</tbody>
</table>

- Some profiles too wet to sample below 100cm
Great Soil Group : Red Earths
Soil Family : Berrimah
Series : No. 1
Factual Key : Um5.52
Parent Material : Laterite
Occurrence - Specific : 5el
General : 5d, 5el

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Dark brown (7.5YR 3/2) clay loam with sand; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>dark reddish brown (5YR 3/4); heavy sandy clay loam</td>
</tr>
<tr>
<td>10-30</td>
<td>A3</td>
<td>Dark reddish brown (5YR 3/4) clay loam; dry, very hard; massive; earthy fabric; pH 6.0</td>
<td>light clay; dry, extremely hard</td>
</tr>
<tr>
<td>30-70</td>
<td>B1</td>
<td>Dark red (2.5YR 3/6) clay loam; dry, hard; massive; earthy; pH 5.8</td>
<td></td>
</tr>
<tr>
<td>70-150</td>
<td>B2</td>
<td>Red (10YR 4/6; 2.5YR 4/8) heavy clay loam; moist, friable; massive; earthy; 5% ferruginous nodules at bottom; pH 5.5</td>
<td>light clay</td>
</tr>
</tbody>
</table>

A shallow phase, 100cm deep, is common; 10-20% ferruginous nodules are present below 90cm.
Great Soil Group: Red Earths  
Soil Family: Berrimah  
Series: No. 2  
Factual Key: Gn2.14  
Parent Material: Siltstone  
Occurrence Specific: 5e2

## Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Dark brown (7.5YR 3/2) sandy loam; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>very dark greyish brown (10YR 3/2)</td>
</tr>
<tr>
<td>10-40 (unbleached)</td>
<td>A2</td>
<td>Reddish brown (5YR 4/4) sandy clay loam; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>dark brown (7.5YR 4/4)</td>
</tr>
<tr>
<td>40-90</td>
<td>B1</td>
<td>Dark red (2.5YR 3/6) clay loam with sand; dry, hard; massive; earthy fabric; pH 6.0</td>
<td>yellowish red (5YR 4/6)</td>
</tr>
<tr>
<td>90-150</td>
<td>B2</td>
<td>Dark red (10YR 3/6; 2.5YR 3/6) heavy clay loam with sand; moist, friable; massive; earthy fabric; pH 6.0</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group : Red Earths  
Soil Family : Berrimah  
Series : No. 3  
Factual Key : Um5.52  
Parent Material : Laterite  
Occurrence -  
Specific : 4d  
General : 4c, 4d  

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Very dark greyish brown (10YR 3/2) clay loam with sand; dry, hard; massive; earthy; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>10-30</td>
<td>A3</td>
<td>Dark brown (7.5YR 3/2) clay loam; dry, hard; massive; earthy fabric; pH 5.8</td>
<td>dark reddish brown (5YR 3/3, 3/4)</td>
</tr>
<tr>
<td>30-80</td>
<td>B1</td>
<td>Yellowish red (5YR 4/6) clay loam; few red brown mottles; dry, hard; massive; earthy fabric; pH 5.5; 10% ferruginous gravel</td>
<td></td>
</tr>
<tr>
<td>80-150</td>
<td>B2</td>
<td>Dark red (2.5YR 3/6) clay loam; few yellow-brown and white mottles; moist, friable; massive; earthy fabric; pH 5.5; 10-20% ferruginous nodules</td>
<td>heavy clay loam</td>
</tr>
</tbody>
</table>
### Great Soil Group: Red Earths
### Soil Family: Rotham
### Parent Material: Laterite
### Depth Horizon (cm)
<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 Al</td>
</tr>
<tr>
<td>10-30 A3</td>
</tr>
<tr>
<td>30-70 B</td>
</tr>
<tr>
<td>70+ BC</td>
</tr>
</tbody>
</table>

### Variation:
- dark reddish brown clay loam;
- dark brown clay loam;
- dry hard red clay loam;
- yellowish red clay loam;
- sandy clay loam;
- dry, very hard red clay loam;
- yellowish red clay loam;
- dry hard red clay loam;
- ferruginous concretions;
Great Soil Group: Yellow Earths
Soil Family: Wagait
Factual Key: Ums.5.52
Parent Material: Laterite
Occurrence - Specific: 4d, 5e2
General: 1c2, 4c, 4d, 5e2

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Very dark greyish brown (10YR 3/2) clay loam with sand; dry, hard; massive; earthy; pH 6.0</td>
<td>fine sandy clay loam</td>
</tr>
<tr>
<td>10-20</td>
<td>A3</td>
<td>Dark brown (10YR 3/3) clay loam with sand; dry, extremely hard; massive; earthy; pH 6.0</td>
<td>light clay with sand; brown (7.5YR 4/4)</td>
</tr>
<tr>
<td>20-90</td>
<td>B1</td>
<td>Yellowish brown (10YR 5/6) clay loam; few red-brown mottles; dry, hard; massive; earthy; pH 5.5</td>
<td>strong brown (7.5YR 5/6); light clay</td>
</tr>
<tr>
<td>90-150</td>
<td>B2</td>
<td>Yellowish brown (10YR 5/6) light clay; common red-brown and yellow mottles; moist, firm; massive; earthy; 10% ferruginous nodules; pH 6.0</td>
<td>strong brown (7.5YR 5/6)</td>
</tr>
</tbody>
</table>
Great Soil Group : Yellow Earths  
Soil Family      : Koolpinyah  
Factual Key.     : Um5.51  
Parent Material. : Laterite  
Occurrence -     
Specific         : 4b, 5b  
General          : 3b, 4b, 5b

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>A1</td>
<td>Very dark greyish brown (10YR 3/2) fine sandy clay loam; 30% ferruginous concretions; dry, slightly hard; massive; earthy; pH 6.5</td>
<td>dark brown (10YR 3/3)</td>
</tr>
<tr>
<td>10-40</td>
<td>A3</td>
<td>Dark greyish brown (10YR 4/2) clay loam with sand; 30% ferruginous concretions; dry, hard; massive; earthy; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>40-80</td>
<td>B</td>
<td>Yellowish brown (10YR 5/4) clay loam with sand; 40% ferruginous nodules; moist, friable; massive; earthy; pH 5.5; common red-brown and dark yellow-brown mottles</td>
<td>some profiles are deeper (100cm); strong brown (7.5YR 5/6)</td>
</tr>
<tr>
<td>80+</td>
<td>BC</td>
<td>Weathering laterite</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group: Yellow Podzolics  
Soil Family: Masson  
Series: No. 1, Type 1  
Factual Key: Not applicable  
Parent Material: Granodiorite  
Occurrence - Specific: 2d1, 2d2  
General: 2c, 2d1, 2d2, 2e

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>M1</td>
<td>Very dark grey (10YR 3/1) loamy coarse sand to coarse sandy loamy dry, slightly hard; massive; sandy/earthy; pH 6.5</td>
<td>very dark greyish brown (10YR 3/2)</td>
</tr>
<tr>
<td>10-25</td>
<td>M2</td>
<td>Dark greyish brown (10YR 4/2) coarse sandy loam; dry, slightly hard; massive; earthy; pH 6.0</td>
<td>brown (10YR 4/3, 5/3); sandy clay loam</td>
</tr>
<tr>
<td>25-70</td>
<td>M3</td>
<td>Yellowish brown (10YR 5/4) coarse sandy clay loam with 20% angular quartz grit; dry, hard; massive; earthy; pH 6.0</td>
<td>light yellowish brown (10YR 6/4); brownish yellow (10YR 6/6) clay loam with coarse sand</td>
</tr>
<tr>
<td>70-80</td>
<td>S</td>
<td>Light yellowish brown (10YR 6/4) sandy loam with 60-80% angular quartz stone, gravel and grit; pH 6.5</td>
<td>not always present</td>
</tr>
<tr>
<td>80-95</td>
<td>W1</td>
<td>Yellowish brown (10YR 5/6) clay loam with coarse sand and quartz grit; moist, firm; massive; earthy; pH 6.0; 2% quartz gravel</td>
<td>light yellowish brown (10YR 6/4); light clay with coarse sand and grit</td>
</tr>
<tr>
<td>95-120</td>
<td>W2</td>
<td>Yellowish brown (10YR 5/6) clay loam to light clay with coarse sand and quartz grit; abundant red-brown and yellow-brown mottles; moist, firm; massive; earthy; pH 6.0; 2% quartz gravel</td>
<td>coarse sandy clay</td>
</tr>
<tr>
<td>120+</td>
<td>WC</td>
<td>Weathering granodiorite</td>
<td></td>
</tr>
</tbody>
</table>

Series No. 1, Type 2 has a coarse sandy clay loam or clay loam with sand topsoil (M) overlying the stone line (S).
Great Soil Group : Yellow Podzolics
Soil Family : Masson
Series : No. 2, Type 1
Factual Key : Not applicable
Parent Material : Granodiorite
Occurrence -  
Specific : 2d1, 2d2
General : 2c, 2d1, 2d2, 2e, 2f

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>M1</td>
<td>Very dark greyish brown (10YR 3/2) loamy coarse sand; dry, slightly hard; massive; sandy/earthy; pH 6.0</td>
<td>very dark grey (10YR 3/1)</td>
</tr>
<tr>
<td>10-25</td>
<td>M2</td>
<td>Brown (10YR 5/3) coarse sandy loam; dry, slightly hard; massive; earthy; pH 6.0</td>
<td>dark greyish brown (10YR 4/2)</td>
</tr>
<tr>
<td>(unbleached)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-60</td>
<td>M3</td>
<td>Yellowish brown (10YR 5/4, 5/6) coarse sandy loam with 20% angular quartz grit; dry, slightly hard; massive; earthy; pH 6.0</td>
<td>light yellowish brown (10YR 6/4)</td>
</tr>
<tr>
<td>60-75</td>
<td>S</td>
<td>Light yellowish brown (10YR 6/4) loamy sand with 60-80% angular quartz stone, gravel and grit</td>
<td>not always present</td>
</tr>
<tr>
<td>75-120</td>
<td>W</td>
<td>Yellowish brown (10YR 5/6) clay loam to light clay with coarse sand and grit; abundant red-brown and yellow mottles; moist, firm; massive; earthy; pH 6.0; 2% quartz gravel</td>
<td>light yellowish brown (10YR 6/4)</td>
</tr>
<tr>
<td>120+</td>
<td>WC</td>
<td>Weathering granodiorite</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group : Yellow Podzolics  
Soil Family : Masson  
Series : No. 2, Type 2  
Factual Key : Not applicable  
Parent Material : Granodiorite  
Occurrence -  
Specific : 2dl, 2e  
General : 2d1, 2d2, 2e  

Soil Profile Description  

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>M1</td>
<td>Very dark grey (10YR 3/1) sandy clay loam; dry, slightly hard; massive; earthy; pH 6.0</td>
<td>very dark greyish brown (10YR 3/2); heavy sandy loam</td>
</tr>
<tr>
<td>10-30</td>
<td>M2</td>
<td>Dark greyish brown (10YR 4/2) coarse sandy clay loam; dry, slightly hard; massive; earthy; pH 6.0</td>
<td>brown (10YR 4/3, 5/3)</td>
</tr>
<tr>
<td>30-60</td>
<td>M3</td>
<td>Yellowish brown (10YR 5/4, 5/6) coarse sandy clay loam; 20% angular quartz grit; dry, hard; massive; earthy; pH 6.0</td>
<td>not always present</td>
</tr>
<tr>
<td>60-75</td>
<td>S</td>
<td>Light yellowish brown (10YR 6/4) loamy sand with 60-80% angular quartz, stone, gravel and grit</td>
<td></td>
</tr>
<tr>
<td>75-140</td>
<td>W</td>
<td>Yellowish brown (10YR 5/6) light clay with coarse sand and grit; abundant red-brown and yellow-brown mottles; moist, firm; massive; earthy; pH 6.0; 2% quartz gravel</td>
<td>yellowish brown (10YR 6/6); light yellowish brown (10YR 6/4); medium clay; mottles 100-140cm</td>
</tr>
<tr>
<td>140+</td>
<td>WC</td>
<td>Weathering granodiorite</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group: Gleyed Podzolics
Soil Family: Not specific
Factual Key: Gn2.84
Parent Material: Colluvium, alluvium

**Occurrence**
- Specific: 5f2
- General: 5f1, 5f2, 6a1, 6a2, 6b

**Soil Profile Description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>A1</td>
<td>Very dark grey (10YR 3/1) slightly organic sandy clay loam; dry, slightly hard; rusty root line staining; massive; earthy; pH 5.5</td>
<td></td>
</tr>
<tr>
<td>15-70</td>
<td>A2 (unbleached)</td>
<td>Pale brown (10YR 6/3) clay loam with coarse sand; rusty root line staining; dry, hard; massive; earthy; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>70-100</td>
<td>B1</td>
<td>Very pale brown (10YR 7/3) clay loam with sand; common red-brown and yellow-brown mottles; moist, firm; 10% ferruginous nodules; massive; earthy; pH 6.0</td>
<td></td>
</tr>
<tr>
<td>100-150</td>
<td>B2</td>
<td>Light grey (10YR 7/1) clay loam to light clay; abundant red-brown, yellow-brown and white mottles; 30% ferruginous nodules; moist, firm; massive; earthy; pH 5.5</td>
<td></td>
</tr>
</tbody>
</table>
Great Soil Group : Humic Gley
Soil Family : Burton
Factual Key : Dd2.11
Parent Material : Alluvium
Occurrence -
Specific : 7a1, 7a2
General : 2f, 5f1, 6b, 7a1, 7a2, 7a3, 7a4, 7b, 8a1, 8a2

Soil Profile Description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5</td>
<td>All</td>
<td>Black (10YR 2/1) organic loam; moist, firm; massive; earthy; pH 5.8; rusty root line staining</td>
<td>up to 10cm deep</td>
</tr>
<tr>
<td>5-20</td>
<td>A1</td>
<td>Black (10YR 2/1) organic clay loam; moist, firm; massive; earthy; pH 5.8</td>
<td></td>
</tr>
<tr>
<td>20-50</td>
<td>B1</td>
<td>Dark grey (10YR 4/1) medium clay; common yellow-brown and light grey mottles; moist, very firm; indistinct structure; smooth ped fabric; pH 5.5</td>
<td>abrupt change; medium-heavy clay; pH 7.5 - 8.5</td>
</tr>
<tr>
<td>50-70</td>
<td>B2</td>
<td>Light grey (10YR 6/1) light to medium clay; abundant yellow-brown, red-brown and dark grey mottles; wet, very sticky; indistinct structure and fabric; pH 5.5</td>
<td>pH 9.0</td>
</tr>
</tbody>
</table>
APPENDIX II

BOTANICAL SPECIES CHECK LIST

Compiled by: A Czachorowski

The botanical species check list is not a complete list of species present on Wagait Aboriginal Reserve, rather it is a list of species observed during the 1972 dry season survey. Consequently, many annual species which are only recognisable during the wet season are omitted. Many tree species were also present as low shrubs or suckers, but are only recorded in the tree section.

(i) Trees

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia auriculiformis</td>
<td>Earpod Wattle</td>
</tr>
<tr>
<td>A. aff. bidwillii</td>
<td>Wattle</td>
</tr>
<tr>
<td>A. dimidiata</td>
<td>Wattle</td>
</tr>
<tr>
<td>Alphitonia excelsa</td>
<td>Red Ash</td>
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<tr>
<td>Alstonia actinophylla</td>
<td>Milkwood</td>
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<tr>
<td>Banksia dentata</td>
<td>Bottle Brush</td>
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<tr>
<td>Barringtonia acutangula</td>
<td>Freshwater Mangrove</td>
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<tr>
<td>Bombax ceiba</td>
<td>Kapok Tree</td>
</tr>
<tr>
<td>Brachychiton paradoxum</td>
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<tr>
<td>Buchanania obovata</td>
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<tr>
<td>Canarium australianum</td>
<td>White Cedar</td>
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<tr>
<td>Carpentaria acuminata</td>
<td>Carpentaria palm</td>
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<tr>
<td>Cathormion umbellatum</td>
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<tr>
<td>Cochlospermum fraseri</td>
<td>Kapok</td>
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<tr>
<td>Coleus scutellarioides</td>
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<tr>
<td>Croton arnhemicus</td>
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<td>Denhamia obscura</td>
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<td>Dolichandrone' filiformis</td>
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<tr>
<td>Erythrina orientalis</td>
<td>Flame tree, Batwing</td>
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<tr>
<td>Erythrina vespertilio</td>
<td>Ironwood</td>
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<tr>
<td>Erythrophleum chlorostachys</td>
<td>Poplar Gum, Timor</td>
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<tr>
<td>Eucalyptus alba var australasica</td>
<td>White Gum</td>
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<tr>
<td></td>
<td>Smooth Barked</td>
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<tr>
<td>E. blesseri</td>
<td>Bloodwood</td>
</tr>
<tr>
<td>E. clavigera</td>
<td>Cabbage Gum</td>
</tr>
<tr>
<td>E. confertiflora</td>
<td>Apple Gum</td>
</tr>
<tr>
<td>E. ferruginea</td>
<td>Rusty Bloodwood</td>
</tr>
<tr>
<td>E. foelscheana</td>
<td>Cabbage Gum (NT); Bloodwood</td>
</tr>
</tbody>
</table>
E. grandifolia
E. latifolia
E. miniata
E. papuana
E. polycarpa
E. porrecta
E. tetrodonta
Eugenia bleeseri
Eugenia suborbicularis
Ficus opposita
Ficus sp.
Gardenia megasperma
Grevillea heliosperma
G. mimosoides
G. pteridiifolia
Gronophyllum ramsayi
Hakea arborescens
Livistona benthamii
Livistona humilis
Melaleuca argentea
M. cajuputi
M. dealbata
Melaleuca sp.
M. symphyocarpa
M. viridiflora
Metrosideros eucalyptoides
Nauclera coadunata
Owenia vernicosa
Pandanus sp.
Parinari nonda
Persoonia falcata
Petalostigma pubescens
Planchnonia careya
Strychnos lucida
Terminalia canescens
T. ferdinandiana
T. grandiflora
Tristania lactiflua
Vavaea australiana
Wrightia saligna
Xanthostemon paradoxus

Bloodwood
Woolly Butt
Ghost Gum
Grey Bloodwood
Darwin Stringybark
Sandpaper Fig
Fan Palm, Sand Palm, Fire Palm
Paperbark
Paperbark
Paperbark
Paperbark
Paperbark
Paperbark
Leichhardt Tree
Emu Apple
Screw Pine
Quinine Bush
Strychnine Tree
Rosewood
Billygoat Plum
Indian Mulberry
White Wood
(ii) Shrubs

<table>
<thead>
<tr>
<th>Shrub Name</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Acacia gonocarpa</td>
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<tr>
<td>Calytrix achaeta</td>
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<tr>
<td>C. exstipulata</td>
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<tr>
<td>Cycas media</td>
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<tr>
<td>Grevillea magnifica</td>
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<tr>
<td>G. dryandri</td>
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<tr>
<td>Grewia retusifolia</td>
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<tr>
<td>Jacksonia dilatatum</td>
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<td>Petalostigma quadriloculare</td>
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<td>Verticordia cunninghimi</td>
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</table>

(iii) Grasses

<table>
<thead>
<tr>
<th>Grass Name</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Alloteropsis semialata</td>
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<tr>
<td>Aristida sp.</td>
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<tr>
<td>Bambusa arnhemica</td>
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<tr>
<td>Brachiaria miliiformis</td>
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<tr>
<td>B. mutica</td>
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<tr>
<td>Brachyachne sp.</td>
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<tr>
<td>Chrysopogon fallax</td>
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<tr>
<td>C. latifolius</td>
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<tr>
<td>Coelorchachis rottboelliioides</td>
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<tr>
<td>Cymbopogon bombycinus</td>
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<tr>
<td>Dichanthium tenuiculum</td>
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<tr>
<td>Digitaria sp.</td>
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<tr>
<td>Diplachne sp.</td>
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<tr>
<td>Ectrosia leporina</td>
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<tr>
<td>Eragrostis japonica</td>
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<tr>
<td>Eriachne burkittii</td>
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<tr>
<td>E. obtusa</td>
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<tr>
<td>Eriachne sp.</td>
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<tr>
<td>Eriachne triseta</td>
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<tr>
<td>Heteropogon triturceus</td>
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<tr>
<td>Hymenanachae acutigluma</td>
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<tr>
<td>Imperata cylindrica</td>
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<td>Ischaemum arundinaceum</td>
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<tr>
<td>Ophiuros exalatus</td>
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<tr>
<td>Oryza australiensis</td>
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<td>Panicum mindanaense</td>
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<td>Panicum sp.</td>
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<td>Panicum trachyrhachis</td>
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<tr>
<td>Paspalum orbiculare</td>
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<tr>
<td>Phragmites karka</td>
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<tr>
<td>Plectranche pungens</td>
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<tr>
<td>Pseudopogonatherum contortum</td>
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<tr>
<td>Pseudoraphis spinescens</td>
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</tbody>
</table>

Wattle
Zamia Palm
Three-awned Spear Grass
Bamboo
Armgrass Millet
Para Grass
Couch Grass
Golden Beard Grass
Blady Grass
Lemon Scented Grass
Tassel Bluegrass
Finger Grass
Beetle Grass
Hare's Foot Grass
Delicate Lovegrass
Kerosene Grass
Northern Wanderrie Grass
Wanderrie Grass
Giant Spear Grass
Blady Grass
Cane Grass
Wild Rice
Panic Grass
Panic Grass
Millet Grass, Ditch Grass
Cane Grass, Tropical Reed
Soft spinfex
Black Top
Couch Grass
Schizachyrium fragile
Sclerandrium truncatiglume
Sesnema nervosum
Setaria apiculata
Sorghum sp.
Sorghum plumosum
Spinifex longifolius
Sporobolus virginicus
Thaumastochloa major
Themeda australis
Vetiveria pauciflora
Xerochloa imberbis

(iv) Herbs, Sedges

Arthrocnemum sp.
Carallia brachiata
Centrolepis exerta
Cyperus sp.
Dendrobiium sp.
Eleocharis sp.
Euphorbia mitchelliana
Exacum tetradontum
Fimbristylis sp.
Gomphrena flaccida
Helichrysum bracteatum
Hydrastele wendlandiana
Hypnus suavolens
Indigofera saxicola
Ludwigia sp.
Marsilea sp.
Nelumbo nucifera
Philydrum lanuginosum
Phyla nodiflora
Polygonum barbatum
Ptilotus distans
Scleria ciliaris
Scleria poaeformis
Sida sp.
Tephrosia sp.
Trachymene discoides
Typha sp.
Xyris sp.

Red Spatha Grass
White Grass
Pigeon Grass
Annual Sorghum
Perennial Sorghum
Spinifex
Sand Couch; Salt Water Couch
Kangaroo Grass

Samphire
Flat Sedge
Native Orchid
Spike Rush
Sedge
Fern
Horehound
Nardoo Clover
Lotus Lilly
Fog Fruit
Reed
Reed
Bullrush