THE PASTORAL LAND RESOURCES
OF INDIANA STATION

A.R. Grant

Soil and Land Resources Unit,
Conservation Commission of the Northern Territory
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SUMMARY

Indiana Station, located 160 km east of Alice Springs and occupying an area of 2991 sq. km, has been surveyed and mapped into 25 land units at a mapping scale of 1:100,000. The purpose of the survey has been to provide land resource information at a suitable scale to assist with land management on the station, and in particular, to form a basis for the planning of development.

This report includes a general physical description of the station, together with a detailed account of the landform, soil and vegetation attributes of each of the land units. The management implications associated with pastoral use of the land are also indicated.

The most productive pastoral land on the station consists of pediment surfaces supporting annual grass pastures, but extensive alluvial plains carrying kerosene grass comprise the major grazing resource. Most land units have only a slight water erosion hazard and the actual area of active erosion is very limited. Where gully erosion has occurred, it has usually been initiated by surface disturbances such as grader cuts or stock pads which have intercepted and re-directed sheet runoff flows. Loose, coarse-textured alluvial soils are subject to a moderate wind erosion hazard, but with other soil types, this hazard is only slight.

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SECTION ONE - INTRODUCTION

A detailed knowledge of the different types of country on a station and their reaction to grazing is an essential precursor to good land husbandry and grazing management. Most pastoralists gain a comprehensive first-hand appreciation of the land attributes of their station through working and living in the particular environment, observing the way in which stock use pastures and the response of the country to season.

A land resource survey can complement this local knowledge by formally documenting the types of country on the station, accurately mapping their distribution, and indicating the potential productivity and land management hazards associated with each. As such it provides a tangible basis for making property management and development decisions. Besides the station manager, land resource information is especially valuable to Government advisers in the fields of soil conservation, pasture management and livestock husbandry, and land administrators.

This land resource survey documents the pastorally different land types of Indiana Station, located 160 km east of Alice Springs and occupying an area of 2991 sq. km. The station flanks the eastern extremities of the Harts and Macdonnell Ranges, and lies on the north-western margin of the Simpson Desert.

The survey was initiated by Mr Fred Bird, lessee-manager of Indiana, who has operated the property since it was originally taken up in the early 1950's. Fred requested a land inventory map with sufficient detail to provide a suitable basis for the planning of further development on the station. To meet his requirements, the station has been mapped into land units with pastorally-different attributes (soil and vegetation type, grazing characteristics, stocking capacity and erosion hazard) at a scale of 1:100,000. This report provides an account of the physical environment of the station and describes in detail each land unit and its pastoral management features.
SECTION TWO - THE PHYSICAL ENVIRONMENT - INDIANA STATION

A. Previous Surveys

The land resources of Indiana have been previously described at a reconnaissance level by Perry et al (1962), who identified six land systems at a regional mapping scale of 1:1,000,000. A land system is a descriptive grouping of related land units, which define 'an area, or groups of areas, throughout which there is a recurring pattern of topography, soils and vegetation' (Christian and Stewart, 1953).

The land systems mapped on Indiana Station during this original survey included the following:

Singleton land system - aeolian sandplain, supporting mainly spinifex. Four unmapped units are specified, including hummocky sandplain surfaces, low sandy rises and adjacent swales, and small alluvial flats.

Indiana land system - undulating stony plains, a lightly dissected peneplain surface, supporting sparse low trees over short grasses and forbs. Alluvial plains and valley floors comprise minor units. The northern part of Indiana was the 'type area' of this land system.

Kanandra land system - sandy alluvial plains, sparsely timbered and supporting kerosene grass. It is sub-divided into nine units, the main landforms being alluvial fans, active floodout lobes and adjacent inter-drainage plains.

Dinkum land system - sandplain supporting mulga or gidyea over short grasses and forbs, interspersed with areas of spinifex and stony plains carrying witchetty bush. This is described as six units including sandplain, stony rises, valley floors, reef outcrops and erosional slopes.

Bond Springs land system - low rocky hill country supporting witchetty bush and other shrubs over sparse grasses and forbs. It consists of five units, mainly hills and ridges but also erosional slopes, drainage flats and creek channels.

Harts land system - encompasses mountainous terrain supporting witchetty bush and other low shrubs over spinifex or sparse grasses.

Adjacent areas of the Simpson Desert region, to the south and east of Indiana, have also been described in terms of land systems by Purdie (1984) at a scale of approximately 1:2,000,000.

While the land system mapping described by these authors is suitable for the purposes of regional planning and assessment, it provides insufficient detail to assist with the planning of pastoral management, and was not intended for this application. For station management purposes, mapping at a larger scale based on simple land units, each with uniform pastoral characteristics,
is required. Land systems, on the other hand, are compound units, each encompassing several unmapped types of country.

B. GEOLOGY

The geology of Indiana Station has been mapped and described by Shaw and Milligan (1969) and Shaw and Freeman (1985) as part of regional geological surveys.

The basement material of the area consists of early-Proterozoic (1800-2500 m.yr. old) metamorphic and igneous rocks of the Arunta Block, mainly gneiss and schists of the Harts Range Group, as well as intrusive granites. The Stanovos Gneiss Member, consisting of quartzofeldspathic and biotite gneiss, quartzite, marble and amphibolite, outcrops with bold relief in the Mt Lloyd area south of Indiana homestead. The Brady Gneiss of calc-silicate rock and biotite gneiss has been mapped in the Newmarket Bore area, and the Irindina Gneiss of biotite and quartzofeldspathic gneiss, amphibolite, calc-silicate rock and marble recorded near Acacia Bore. Arunta-Block rocks outcropping over the remainder of the station are not differentiated on existing mapping.

Although most of the station area consists of surfaces and materials that developed during the Cainozoic (60 m.y.a. - present), the geology of this era is only briefly documented in available literature.

During the Tertiary period (60 m.y.a. - 2 m.y.a.), the landscape was tectonically stable and subjected to warm humid climates conducive to the deep weathering of surface rocks and maximum geologic erosion. Featureless peneplain surfaces resulted, with a well-developed laterite profile consisting of a cemented capping of ferruginous material (ironstone) overlying a pallid zone of kaolinitic clays, eventually grading into bleached bedrock of a depth of several metres. The laterite profile occurs throughout Indiana, but has been stripped from areas with moderate relief and slopes, or that are subject to stream action, and is extensively buried by Quaternary alluvial and aeolian deposits.

A period of erosion and sedimentation occurred in the mid-Tertiary period (approx. 26 m.y.a. leading to the deposition of lacustrine (lake-bed) sediments within depressions in the peneplain, and subsequent seasonal aridity promoted the precipitation of limestones on the surface of these deposits. Residuals of these sediments, known as the Waite Formation, consist of siltstones capped with chalcedonic limestone, and rest on deeply-weathered rock.

During the late Tertiary and early Quaternary (26-1.8 m.y.a.), stream activity and erosion processes were renewed, possibly as a result of an uplift of the land surface. Deeply-weathered material was stripped from upland areas, revealing freshly-weathered surfaces of Arunta Complex rock. The gently-undulating
plains between Brumby, Epsom and Atula Bores include such stripped and partially stripped surfaces.

The hard-capping of the Waite Formation resisted erosion, and consequently residuals of these sediments persist as flat-topped hills (mesas) elevated above the surrounding stripped land surface (e.g. east of Crossing Bore). Terraces of calcrete and fans of colluvial gravel derived from the Waite Formation usually flank the residuals.

The sandy alluvial plains along Huckitta Creek and in the southwest of the station were mainly deposited in the late Pleistocene (prior to 10,000 yrs ago). Alluvial deposits of several ages can be identified, corresponding with fluctuations in stream activity with changes in climate leading up to the peak of aridity 16-18,000 years ago.

Extreme aridity at this time was witness to the development of the Simpson Desert dunefields to their present extent (Bowler, 1976) and the movement of aeolian sand on to Indiana from the south and south-east. Sandplain deposits now blanket much of the peneplain surface, and intermingle with alluvium near New Black Diamond Bore.

Present day floodplains probably date from stream activity during the Holocene (about 10,000 y.a.), and contemporary flood events indicate that these floodplains remain occasionally active.

C. LANDFORMS

The landforms of the study area have been grouped into the following categories in this report:

1) **Hilly terrain**

This is characterized by moderate to strong relief and slopes of greater than 6%, drained by an open network of narrow watercourse channels. Run-off rates are high, but the erosion potential is moderated by the stoniness of the land surface.

2) **Peneplain surfaces**

A peneplain is a featureless, level or slightly undulating surface, the end product of a long cycle of geologic erosion. This group of units consists of a Tertiary peneplain with a well developed laterite profile, and landscapes formed from the partial dissection of this surface. The peneplain has very low relief and run-off is dispersed through sheet flow rather than concentrated into well-defined drainage features. However, partly dissected areas often feature greater slopes and the flow of run-off into broad depressions.

3) **Pediment surfaces**

Pediments are rock-floored plains, typically having very gentle slopes, low surface relief and few drainage features. They
typically occur in places where geomorphic processes have completely stripped soft, deeply-weathered materials, exposing the freshly-weathered parent rock to soil formation.

iv) **Mesas and associated terrain**

This group consists of mesas, calcreted terraces, alluvial fans and plains which have developed as a result of the dissection of Tertiary deposits (the Waite Formation). Slope and relief are variable. The mesa surfaces represent relics of an old land surface and are either surrounded by breakaways or merge into the surrounding land surface where partly buried by an aeolian cover.

v) **Alluvial Fans**

These consist of a sequence of superimposed alluvial fans deposited by creek channels draining the eastern-most catchments of Harts Range. The sediments are uniformly sandy, reflecting their origin in the coarse-grained metamorphic rocks of the Harts Range Group. The fans represent four phases of deposition associated with fluctuations in climate during the late Pleistocene and Holocene.

vi) **Sandplain**

The extensive sandplains of the eastern and central parts of Indiana consist of aeolian deposits which probably attained their present form and extent during the peak of aridity, 16-18,000 years ago. At this time, sands originating as extensive alluvial deposits fanning out from the foot of Harts Range were transported to the north-west by strong prevailing south-easterly air flows. The sandplains have very low relief, and drainage features are generally absent.

D. **SOILS**

Soil properties reflect the geology of the parent material from which they are formed, the landform on which they occur, and the climatic regime that prevailed during their period of development. Many soils on Indiana have developed from highly-weathered materials and consequently have a low abundance of the freshly-weathered minerals that confer soil fertility. They developed in a relatively moist climate which prevailed before the onset of increasing aridity and sand movement 25,000 years ago.

In this report, the soils of Indiana are described in terms of their texture, colour, pH, fabric and structure, and are classified according to their Australian Great Soil Group (Stace et al, 1968) and Principal Profile Form (Northcote, 1979).

i) **Soil Characteristics**

Texture is a property determined by the proportion of sand, silt and clay particles within the soil matrix, and is indicated by the behaviour of a moistened soil sample. Because most soils on Indiana are derived from highly weathered parent materials, they
have a very low silt content (less than 10%). The range of soil textures found on the property include clayey sands (5-10% clay), sandy loams (10-15% clay), sandy clay loams (20-30% clay), sandy clays (35-40% clay), and light clays (35-40% clay, up to 25% silt).

Texture determines soil permeability and moisture-holding capacity, and influences fertility as most plant nutrients are bound to clay minerals. It is a major determinant of the type of pasture that grows on a particular area.

Soil colour is assessed in the field using a standard Munsell colour chart, which forms the basis of the colour names used in this report. The soils of Indiana are predominantly red due to pigmentation by the iron oxide haematite, derived from the weathering of iron-rich clay minerals.

Soil pH indicates the acidity or alkalinity of the soil. A neutral soil has a pH value of 7.0, and a lower pH indicates acidity, a higher pH alkalinity. Most soils on Indiana have a neutral reaction trend, with a surface value of between pH 5.5 and pH 7.5, and a deep subsoil value between pH 6.5 and pH 8.0.

Soil fabric refers to the arrangement of individual particles within the soil material. An earthy fabric is characterised by a porous, dusty appearance of the soil matrix and the absence of peds (soil aggregates which are distinctly separate). A sandy fabric has closely packed sand grains, also with few if any peds. When peds are present, they may have a porous, rough-faced fabric, or smooth, lustrous surfaces.

Soil structure is determined by the size, shape and abundance of peds. Coherent soils with no distinct peds are considered to have massive structure, while highly pedal soils such as the cracking clays of mitchell grass plains are strongly structured.

ii) Soil Types

The following Australian Great Soil Groups were recorded on the station:

Red earths - These are the most common soil type on the station, and vary considerably according to the nature of their parent material. Deep soils with low fertility have developed on laterite, while shallow, mineral-rich soils occur on freshly-weathered granite and gneiss. They are medium-textured soils, red in colour with massive structure and an earthy fabric. Profiles feature a gradual increase in clay content with depth.

Texture-contrast soils (including solodics and desert loams) - An abrupt boundary between a shallow, sandy A-horizon (topsoil) and a heavy textured pedal B-horizon (subsoil) characterizes these soils. They occur on stripped deeply-weathered landscapes usually with a surface lag deposit of quartz gravel, and on drainage floors in granite country. Soils without protective surface gravels are highly erodible.
Red calcareous soils - These are usually shallow, medium-textured soils which are highly alkaline, having developed directly from underlying calcareous rocks or calcrite.

Alluvial soils - On Indiana, these include sandy soils developed from Holocene sediments in which soil characteristics have yet to develop, and older deposits which are red in colour and have obvious soil fabric development. Most of these soils are sandy loam in texture, and profiles are often interbedded with lenses of creek gravels. The sand component is of coarse grain size, reflecting the coarse-textured crystalline nature of its parent materials in the Harts Range.

Earthy sands - These are similar to red earths, but have developed from Pleistocene aeolian materials on sandplain areas. They have deep, uniform profiles, usually clayey sand or sandy loam in texture, with little increase in clay content with depth. They are red in colour, with massive structure and earthy fabric.

Lithosols - Shallow, gravelly soils predominate or slopes in excess of about 3%, where natural erosion is active enough to limit soil development.

The Principal Profile Form is a notation derived from a key based solely on the physical characteristics of the soil profile. The main divisions and subdivisions of the key are:

Uniform soils - profiles are of uniform texture throughout
   Uc - coarse textured
   Um - medium textured
   Uf - fine textured, not cracking
   Ug - fine textured, cracking

Gradational soils - are of increasingly finer (more clayey) texture with depth
   Gc - calcareous (limey) throughout
   Gn - non-calcareous throughout

Duplex soils - profiles have an abrupt texture boundary between the A-horizon (topsoil) and B-horizon (subsoil)
   Dr - red clay B-horizons
   Db - brown clay B-horizons
   Dy - yellow-grey clay B-horizons
   Dd - dark clay B-horizons
   Dg - grey clay B-horizons

Organic soils - not present in Central Australia

These notations are accompanied by a numerical code to describe diagnostic characteristics of individual soil profiles, as defined in Northcote (1979). The Principal Profile Forms recorded on Indiana include Gn 2.12, Gn 4.12, Gc 2.21, Dr 4.12, Dr 4.52, Uc 1.23, Uc 5.21, and Um 5.51.

iii) Soil Erodibility

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The potential for a soil to erode is termed its erodibility, and is influenced by the nature of its parent material and the landform on which it occurs as well as inherent soil factors. The latter may include texture, salinity, ease of dispersion (sodicity) and the presence or absence of surface crusts and gravels.

In general, only soils with textures of sandy loam or lighter are likely to experience significant wind erosion. Water erosion is unlikely to affect very light-textured porous soils or clays, but will affect sandy loam or sandy clay loam surfaces. Saline or sodic soil materials (such as the B-horizon of solodic soils) are susceptible to scalding or shallow gullying.

Gullying is often initiated where sheet runoff flows are concentrated into a channel by a linear surface feature such as a graded line or pad. Deep gullying is usually restricted to alluvial landforms, while the soils of pediment or peneplain surfaces are more susceptible to sheet erosion and rilling. The soils that have developed from partially stripped deeply weathered rocks (the pallid zone of laterite profiles) are particularly susceptible to shallow gullying or scalding, possibly as a result of slightly saline or sodic conditions.

E. VEGETATION

The distribution, composition and pastoral value of the various vegetation types on Indiana directly reflect the geology, landform and soil types of the country as outlined in the preceding pages. In particular, soil texture seems to have a major influence on the composition of pastures through its effect on nutrient availability and moisture-holding or infiltration characteristics. Within each vegetation type, the actual species composition of pastures can vary according to the effects of fire, seasonal rainfall pattern and grazing history.

In terms of pastoral land use, the vegetation types can be categorized into several broad pasture groups.

i) Annual grass pastures

Annual grass pastures, consisting predominantly of oat, woollyoat, mulga and limestone oat grasses grown on relatively fertile shallow soils, usually with sandy clay loam surface textures, which have developed directly on freshly-weathered parent rocks. They have high palatability and feed value, mainly due to the abundance of oat and woollyoat grasses. Other species such as mulga grass may be quite acceptable to stock while young, but palatability and nutritional value decline with maturity. Limestone oat grass, which occurs on red calcareous soils, has poor palatability, even when green.

Since these pastures attract selective grazing pressures, and their viability is subject to annual seed setting, they are susceptible to change in composition with grazing use.
ii) Kerosene grass pastures

Kerosene grass pastures grow on soils of low to moderate fertility and usually in association with sandy loam surface textures. On Indiana, they are present on the alluvial soils, certain medium-textured red earths, and also on earthy sands as a recovery phase following the burning of spinifex.

Although kerosene grass is moderately palatable when green, its acceptability and feed value declines significantly with maturity and haying off. Minor pasture components such as oat grass and herbage are selectively grazed after summer rains, and stock turn to the kerosene grass as other feed becomes scarce. The impact of grazing on the composition of these pastures is relatively minor and special management other than the maintenance of moderate stocking rates is not necessary.

iii) Eight-day grass pastures

Pastures consisting predominantly of eight-day grass grow on texture contrast soils associated with both open stony plains and gidgee flats in the northern and north-eastern parts of the station.

Eight-day grass is a 'resurrection' species which can survive long periods of drought and rapidly resprout after light rains. It is highly palatable and nutritious while green, but its value is limited by low bulk and poor persistence. The leaf material rapidly disintegrates with the onset of dry conditions.

These pastures require an opportunistic grazing strategy, with rapid stocking immediately after rains and destocking several months later as feed disappears.

iv) Spinifex

Hummock grasslands of spinifex grow on the earthy sands of aeolian origin. Where the aeolian soils are deep, the spinifex occurs in association with an open shrubland of blue mallee. However, in areas where the aeolian deposit comprises only a shallow mantle over buried soils, the upper stratum consists of an open woodland of whitewood, supplejack, corkwood or dogwood.

Spinifex country has very limited pastoral value except during seasons when parakeelya is abundant. However, burning may induce short-term desirable changes in plant composition, including an initial phase of kerosene grass and herbage growth given suitable seasonal conditions.

Additional information concerning the feed value and response to grazing of pasture species can be found in the Central Australian Range Herbarium (McColl and Ulyatt, 1982).
SECTION THREE - LAND UNITS OF INDIANA STATION

A. SURVEY METHODOLOGY

Indiana has been mapped into twenty five land units at a scale of 1:100,000 on the basis of the stereo-interpretation of aerial photography and extensive ground survey.

The available air photography included a complete coverage of black and white contact prints, flown in 1971 at a scale of 1:80,000, a near-complete black and white coverage flown in 1980 at a scale of 1:35,000, and a limited coverage of colour photos, flown in 1984 at a scale of 80,000. Tentative land unit boundaries were mapped on both scales of photography prior to the conduct of a ground survey, and suitable sites for field examination were selected according to this preliminary classification.

Field survey work occupied approximately four weeks in mid-1985 and consisted of vehicle traverses between recording sites, which were selected at an average intensity of 1:40 sq. km. Since the eastern portion of the station is undeveloped, access was often difficult and required extended cross-country travel. At each site, landform, soil and vegetation characteristics were documented and representative areas photographed. Soil profiles were recorded using a hand auger, usually sampling to a depth of 0.6 m, below which the dry condition of the soil rendered further penetration impractical.

Final amendments to land unit boundaries were made during a comprehensive re-examination of the aerial photography subsequent to the field survey. The boundaries proved particularly difficult to delineate in the southern part of the station, were aeolian, alluvial and peneplain landforms all feature very subdued relief, uniform soil colour and similar vegetation photo-patterns. They were collated on 1:80,000 photography using a zoom transferscope, and then transferred to a base map at a final scale of 1:100,000.

B LAND UNITS

Each land unit described in this report delineates areas with relatively uniform landform, soil and vegetation attributes, which are reflected in its stocking capacity, response to grazing, attractiveness to cattle and erosion potential. Slight variability will be evident within each unit, consistent with the degree of resolution possible at a mapping scale of 1:100,000. The units have been grouped into categories according to landform patterns.

The description of each unit is structured according to the following headings:

GENERAL DESCRIPTION - a brief outline of the main features of the landscape.

GEOLOGY - an indication of surface geology.
LANDFORM - a description of the terrain in terms of the landform pattern (e.g. floodplain, dunefield) and its relief, slope and drainage features.

SOILS - includes Great Soil Group classification, Principal Profile Form and a profile description including field texture, Munsell colour names, soil pH, soil fabric and the presence or absence of carbonates.

VEGETATION - a statement of the structure of the vegetation community (e.g. open woodland, shrubland) with a listing of the main species present. Where the original vegetation has been altered, both the existing and former components are indicated.

LAND MANAGEMENT CONSIDERATIONS - a comment on the grazing potential of the land unit and any land management hazards likely to be encountered with its pastoral use, including susceptibility to erosion and pasture degradation. Desirable land management practices are indicated where applicable.

C. LAND UNIT DESCRIPTIONS

1. Hilly Terrain

The land units of this group are characterised by moderate to strong relief and slopes of greater than 6%, with a shallow, stony soil cover. Runoff rates are high, but the erosion potential is moderated by the stoniness of the land surface.

Land Unit - 1.1

GENERAL DESCRIPTION - Hills of granite with annual grasses.

GEOLOGY - Early-Proterozoic metamorphic rocks, mainly granitic gneiss (Irindina Gneiss?).

LANDFORM - Massive, steep-sided hills and ridges, usually with broad, rounded crests. Drainage features are usually absent.

SOILS - Pockets of gravelly lithosol amongst rock outcrop.

VEGETATION - Mostly treeless, supporting a sparse annual cover of mainly woolly oat grass with tarvine.

LAND MANAGEMENT CONSIDERATIONS - No erosion hazard. Stock seem to make some use of the grass on these hills when palatable feed is in short supply elsewhere.
Land Unit 1.1

Near Acacia Bore. Annual grasses predominate on the slopes, which provide limited grazing when feed is scarce on more accessible terrain. The gentle slope in the foreground belongs to Unit 3.i.

Land Unit 1.2

Rocky hill country south of Indianna homestead. Shallow, gravelly soils support witchetty bush and annual grasses.
Land Unit - 1.2

GENERAL DESCRIPTION - Low rocky hills of gneiss and schist with witchetty bush over annual grasses.

GEOLOGY - Early-Proterozoic metamorphic rocks, mainly gneiss and schist (Stanovos Gneiss Member).

LANDFORM - Low rocky hills with relief to about 10 m and gentle slopes (less than 10%), drained by narrow creek channels.

SOILS - Shallow, gravelly lithosols (Um 5.51) amongst rock outcrop. They are usually sandy clay loam in texture with an earthy fabric and neutral or slightly alkaline reaction trend. The gravel component is highly micaceous.

VEGETATION - A sparse cover of witchetty bush with mulga, solitary bloodwoods and low shrubs (predominantly blue-leaf cassia and fuschia bush). Ground-cover consists of mainly woollyoat, oat, wanderrie and rough wire grasses together with tarvine. Perennial grasses such as umbrella grass occur beneath the shrub canopy.

LAND MANAGEMENT CONSIDERATIONS - The shallow soils have a moderate water erosion hazard. Storm runoff is likely to scour stock pads and earthworks such as bulldozed fencelines and tracks. Where clearing is necessary, minimal soil disturbance is desirable.

This unit grows good quality pastures, but cattle will make light use of the feed while able to graze more accessible flat terrain. Prolonged overgrazing will result in a decline in the abundance of umbrella grass and eventually woollyoat grass, and promote an increase in the abundance of unpalatable rough wire grass.
Land Unit - 1.3

GENERAL DESCRIPTION - Residuals of deeply-weathered rock with mulga and sparse grasses.

GEOLOGY - Tertiary deeply-weathered rocks and laterite.

LANDFORM - Very rugged hill terrain often capped with duricrust (see Unit 4.1) or with peaked summits, featuring steep slopes, relief up to about 30m and poorly-defined drainage. Also includes low hills of terreginous rock with gentle slopes and rounded crests.

SOILS - Absent, or as pockets of shallow, poorly developed lithosols.

VEGETATION - Sparse mulga or rarely gidyea with fuschia bush. Groundcover is usually absent, but isolated tussocks of woollyoat grass grow on areas with sufficient depth of soil.

LAND MANAGEMENT CONSIDERATIONS - No erosion hazard. Much of this landscape supports dead mulga, often burnt, suggesting that this unit once grew sufficient fuel in wet seasons to support a fire. This phenomenon occurs on similar deeply-weathered outcrops throughout the north-east Alice Springs district.

Land Unit 1.3 North-east of Baden's Camp Bore. These hills support sparse mulga and fuschia bush but negligible pasture growth.
2. **PENEPLAIN SURFACES**

A peneplain is a featureless, level or slightly undulating surface, the end product of a long cycle of geologic erosion. This group of units consists of a Tertiary peneplain surface with a well-developed laterite profile, and landscapes formed from the partial dissection of this surface.

**Land Unit - 2.1**

**GENERAL DESCRIPTION** - Plains with witchetty bush over kerosene and oat grasses.

**GEOLOGY** - Tertiary lateritic deep weathering profile.

**LANDFORM** - A very gently undulating peneplain surface with very low relief and slopes of less than 1%. The landscape is drained by sheet flow, and defined drainage channels are absent except where watercourses from adjacent upland land units traverse this unit. These watercourses are shallow and narrow, and usually flanked by stripped surfaces (see Unit 3.1). Low rises of laterite (ironstone gravel) are occasionally present.

**SOILS** - Red earths (Ge 2.12). Profiles typically trend from a dark red or dark reddish-brown sandy clay loam, pH 6.0-7.0, at the surface to a red light clay, pH 6.5-7.5, by a depth of 0.5 m. They are massive and have an earthy fabric. Some soils (e.g. N.E. of Atula Creek) are mildly alkaline and have carbonate nodules at depth, but most are non-calcareous. Stone or gravel is usually absent from the soil profile.

**VEGETATION** - An open shrubland of witchetty bush with occasional ironwood, fork-leaved corkwood, sandalwood and broombush. Pastures consist predominantly of kerosene, oat and woollyoat grasses, together with eight-day and mulga grasses, woollybutt and tarvine. Curly windmill, umbrella and kangaroo grasses grow beneath the witchetty bush canopy but are uncommon. Downslope areas adjacent to drainage depressions often support mulga with wiregrass, woollybutt and silky browntop.

**LAND MANAGEMENT CONSIDERATIONS** - Pastures on this unit are of moderate quality, with a useful topfeed reserve. Declining pasture condition will be marked by a decrease in the proportion of the most palatable species, oat and woollyoat grasses, together with an apparent increase in the proportion of kerosene grass. Palatable perennial grasses, particularly umbrella grass, will gradually disappear with grazing use.

The unit has low slope, permeable soils and is without lines of concentrated drainage flow. It therefore has a slight water erosion hazard. However, tracks and graded lines that channel the surface flow of runoff during storms will initiate minor rilling. Limited wind movement may occur when surfaces are denuded and disturbed, particularly where the witchetty bush is sparse, but soils are sufficiently cohesive and fine-textured to resist serious drift.
Soils that are calcareous at depth are a favoured habitat of rabbits. Old, uninhabited rabbit warrens are common on these soils and are usually associated with large quantities of dead timber. Rabbits preferentially graze witchetty bush seedlings, stress mature plants during drought, and in time can virtually eliminate this topfeed. Young witchetty bush appears to have re-established since these warrens have been abandoned, and the immediate control of any recolonization would be highly desirable.

Land Unit 2.1

This area east of Gidyaa Bore had never been grazed at the time of the survey. Pastures consist of kerosene and oat grasses, with scattered tussocks of silky browntop.
Land Unit - 2.2

GENERAL DESCRIPTION - Stony plains with sparse cassias over eight-day grass.

GEOLOGY - Tertiary lateritic deep-weathering profile.

LANDFORM - Stony plains with gentle slopes and low relief, drained by widely spaced broad depressions. They occasionally feature prominent quartz reef outcrops. The plains are the partially stripped residuals of the peneplain surface (Unit 2.1).

SOILS - Texture-contrast soils (Dr 4.12). Profiles feature an abrupt boundary from a red, sandy clay loam A-horizon, pH 6.0-6.5, to a slightly darker sandy clay B-horizon, pH 6.5-7.0, at a depth of 0.3 m. They are massive and earthy throughout. Surfaces are crusted and mantled with a lag gravel of quartz pebbles with some ironstone nodules.

VEGETATION - Scattered low shrubs, mainly broombush, blue-leaf cassia and green-leaf cassia, occasionally with witchetty bush. Pastures are sparse, and consist mainly of eight day grass and some tarvine. Woolly oat and mulga grasses are sometimes present but seldom common, and buckbush is seasonally abundant. Drainage depressions support open whitewood and fork-leaved corkwood with golden beard grass and some woolly oat grass.

LAND MANAGEMENT CONSIDERATIONS - Little substantial feed is grown on this land type. Eight-day grass is quick to produce highly palatable growth in response to rain, but this rapidly disintegrates when exposed to warm weather. Its usefulness is therefore seriously limited by its short lifespan.

The surface mantle of stone assists in protecting soils on this unit from wind and water erosion. Surfaces are loamy in texture and not subject to serious wind erosion, although the movement of sandy deposits may occur during prolonged drought.
This unit is distinguished by a lag gravel of quartz and an open cover of cassias (middle distance). Pastures consist mainly eight-day grass, evident only as dormant crowns in dry seasons (foreground).
Land Unit 2.3

GENERAL DESCRIPTION - Stony plains with whitewood over eight-day grass.

GEOLOGY - Tertiary lateritic deep-weathering profile.

LANDFORM - Partially stripped peneplain surfaces, consisting of plains with gentle slopes (less than 1%) and low relief. Defined drainage routes are absent and runoff is dispersed by sheet flow.

SOILS - Texture-contrast soils (Dr 4.52). The A-horizon consists of a dark reddish-brown sandy clay loam, pH 7.5, 0.3 m deep, with an abrupt boundary to a dark red sandy clay B-horizon, pH 7.5. Profiles are massive and earthy throughout. Surfaces are crusted and have a sparse lag deposit of quartz gravel.

VEGETATION - Sparse stunted whitewood, usually with scattered broombush, in association with pastures of mainly eight-day grass, some oat and mulga grasses, buckbush and tarvine. Umbrella grass and native panic occur infrequently as solitary tussocks.

LAND MANAGEMENT CONSIDERATIONS - As with Unit 2.2, this type of country can produce a rapid response of eight-day grass after rain, but the feed will rapidly disintegrate with the onset of warmer weather. Grazing potential is therefore relatively limited.

Prolonged heavy grazing pressure will eventually result in a decline in the abundance of oat and umbrella grasses.

Although supporting a sparse groundcover, the soils of this unit have only a slight water erosion potential. They are relatively permeable and on very gentle slopes, draining by sheet flow. However, rilling is likely to occur if grader cuts or similar minor earthworks intercept the surface flow of runoff and channel it downslope. A surface veneer of sandy material is likely to drift when bare and disturbed, but in general, the medium-textured A horizon has a minor wind erosion hazard.
The stunted growth habit of the whitewood is characteristic of this unit. Pastures are sparse, consisting of mainly eight-day, oat and mulga grasses.
3. PEDIMENT SURFACES

A pediment surface is a rock-floored plain characterized by very gentle slopes, low surface relief and few drainage features. Since soils develop directly from freshly-weathered parent rock, they have a superior mineral content and fertility to those derived from deeply-weathered substrates. Typically, pediment surfaces occur in situations where geomorphic processes have completely stripped deeply-weathered substrate materials.

Land Unit - 3.1

GENERAL DESCRIPTION - Granite plains with sparse bloodwood and corkwood over annual grasses.

GEOLOGY - Early-Proterozoic metamorphic rocks, mainly granite.

LANDFORM - Level or slightly undulating pediment plains with very low relief. Defined drainage channels are usually absent and the landscape drains by sheet flow. Small fans of coarse-textured alluvium may be present adjacent to range and outcrop areas.

SOILS - Red earths (Gn 2.12), consisting of a dark red sandy clay loam, pH 6.5-7.5, at the surface, trending to a red sandy clay, pH 7.0-8.0, by a depth of 0.4 m. Profiles become gravelly beneath this depth, grading down to decomposed parent rock. The soil material is massive, earthy and non-calcareous. Surfaces are crusted and quartz gravel is usually present.

VEGETATION - Sparse fork-leaved corkwood and mallee bloodwood in association with an annual grass cover of oat, woollyoat or mulga grasses. Other species present include tarvine, lifesaver burr and occasionally kerosene grass (on sandy deposits).

LAND MANAGEMENT CONSIDERATIONS - This is highly productive grazing country growing quality pastures well-favoured by stock. Consequently it can attract heavy grazing pressures in relation to surrounding, less attractive pastures. Prolonged overgrazing will eventually result in a decline in the proportion of oat and woollyoat grasses in the pasture, and an increase in less palatable species.

This landscape has low slope, permeable soils and drains by sheet flow. The water erosion hazard is therefore slight, but storm runoff is likely to initiate rilling where surface flows are concentrated along stock pads or graded tracks. Care is therefore desirable when undertaking minor earthworks. Since surface soils are medium-textured and cohesive, the wind erosion hazard is also slight, although sandy deposits will be subject to minor drift if denuded.
Land Unit 3.1  A small area of granite plain east of Atula Creek. The stunted mallee form of bloodwood is a feature of this land type. Woollyoat and mulga grasses predominate.

Land Unit 3.2  This area, near Atula Creek, is remote from water and is virtually ungrazed. Pastures consist mainly of woollyoat grass.
Land Unit - 3.2

GENERAL DESCRIPTION - Plains with whitewood over annual grasses.

GEOLOGY - Early-Proterozoic metamorphic rock, mainly gneiss.

LANDFORM - Very undulating pediment plains with little surface relief. Drainage features are usually absent, although broad shallow depressions are present on areas receiving run-on from adjacent landscapes.

SOILS - Red earths (Gn 2.12). Profiles grade from a dark reddish-brown, light sandy clay loam, pH 7.0-7.5 at the surface, to a reddish brown sandy clay loam, pH 7.5, by a depth of 0.5 m. They are massive and earthy throughout, and free of gravel. Quartz pebbles are occasionally present on the soil surface.

VEGETATION - Sparse whitewood with pastures consisting mainly of woollyoat grass. Other species present include oat, kerosene and mulga grasses, buckbush and tarvine. Perennial grasses, mainly native panic, umbrella and curly windmill grasses grow beneath the tree canopy. Kerosene and woollybutt grasses are predominant on shallow deposits of aeolian sand where this unit adjoins spinifex.

LAND MANAGEMENT CONSIDERATIONS - These pastures are of excellent quality and will readily fatten stock. However, prolonged excessive grazing pressure will eventually result in a decline in the abundance of woollyoat and oat grasses, and an increase in less palatable species such as mulga grass.

Since soils are permeable and on gentle slopes, the water erosion hazard is slight, except where storm runoff is channelled by grader cuts, wheel tracks or other surface disturbances. This has occurred north of Baden's Camp Bore, on the track to the Brush Yard area, which is now badly rilled and gullied. In this situation, the location of access tracks along ridge lines is desirable. Surfaces are relatively loose and sandy, and may be subject to wind movement if denuded.
Land Unit - 3.3

GENERAL DESCRIPTION - Undulating plains and rises with oat grass.

GEOLOGY - Early Proterozoic metamorphic rocks, mainly calcareous gneisses (Brady Gneiss).

LANDFORM - Undulating plains and rises with low relief and slopes less than about 6%. Areas of stronger relief are drained by narrow watercourse channels. Surfaces are generally featureless other than minor rock outcrop.

SOILS - Red calcareous soils (Um 5.51). These are shallow soils, sandy clay loam in texture, and pH 9.0 throughout, grading in colour from a reddish brown at the surface to a yellowish red at 0.3 m. At this depth, they overlie a massive calcrete pan. The soil material is massive and earthy, and features finely-divided carbonate throughout. Quartz gravel and ironstone nodules are commonly present on the soil surface, which is weakly crusted.

VEGETATION - An annual grassland of oat and limestone oat grasses. Solitary specimens of ironwood, supplejack, whitewood and bloodwood occur throughout.

LAND MANAGEMENT CONSIDERATIONS - This unit supports good quality pastures that attract moderate grazing use. Limestone oat grass, however, is an unpalatable species which may increase in relative abundance if pastures are subjected to prolonged heavy grazing pressures. Notably, small areas of this unit had been virtually ignored at the time of this survey, despite drought conditions. Palatability may rapidly decline as feed becomes weathered.

This landscape has a slight water erosion hazard, locally accentuated by moderate slopes. Soil disturbance on the steeper areas may initiate minor gullying, and if groundcover is poor, storm runoff may scour drainage lines. As soils are medium-textured, they are not subject to serious wind erosion.
Land Unit 3.3  Low rolling hills near Brumby Bore. The sparse tree cover is typical of this unit, with annual pastures of oat and limestone oat grasses.

Land Unit 3.4  Soils are medium-textured and moderately resistant to wind erosion when bare, although sandy surface deposits (left foreground) may exhibit some movement.
Land Unit - 3.4

GENERAL DESCRIPTION - Plains with ironwood over annual grasses.

GEOLOGY - Early Proterozoic metamorphic rocks, mainly gneiss, with Quaternary alluvium.

LANDFORM - Undulating plains with some scattered rocky outcrops, drained by narrow creeks with scalded margins or broad depressions floored with alluvium (see Unit 5.1).

SOILS - Red earths (Gn 2.12). Profiles grade from a reddish-brown sandy clay loam, pH 7.0, at the surface to a red light clay, pH 7.5, at a depth of 0.3 m, and are massive and earthy throughout. Surfaces are slightly stony and have a weak crust, occasionally veneered by sandy material.

Texture-contrast soils (Dr 4.12) occur along the creek margins, and alluvial soils (Uc 5.21) in the broad depressions.

VEGETATION - A very open cover of ironwood with an annual pasture of woollyoat and mulga grasses. Most areas currently support a sparse regeneration of ironwood, the young growth presently up to a metre tall.

The texture-contrast soils along the creeks support solitary needlewoods with goathead burr, eight-day grass and scattered tussocks of curly windmill grass. The alluvial soils carry an open woodland of ironwood over kerosene grass.

LAND MANAGEMENT CONSIDERATIONS - Pastures are of good quality and will fatten stock in average seasons. Periodic spelling is desirable to avoid an increase in the proportion of less productive short-lived grasses, and a decline in the abundance of woollyoat grass.

Gently-sloping areas will suffer sheet erosion and minor rilling if subjected to storm runoff when surfaces are bare. Soils are medium-textured and relatively resistant to wind erosion, although the movement of sandy deposits will occur when surfaces are bare. The small areas of texture-contrast soils are extensively scalded, and the alluvial soils are subject to gullying if runoff flows are channelled by surface disturbances such as tracks or graded lines. This has happened along the Indiana access road south of Brumby Bore.
Land Unit - 3.5

GENERAL DESCRIPTION - Scalded drainage floors with annual grasses.

GEOLOGY - Early-Proterozoic metamorphic rocks, mainly granite.

LANDFORM - Broad, very gently sloping drainage floors with surfaces dissected by extensive scalding and gully ing.

SOILS - Texture-contrast soils (Dr 4.12). Profiles consist of a red sandy loam A-horizon, pH 6.5, which is massive and earthy, with an abrupt boundary at a depth of 0.2 m to a reddish-brown sandy clay B-horizon, which is moderately pedal. Surfaces are weakly crusted and veneered with sandy deposits.

VEGETATION - Treeless. Areas of topsoil unaffected by erosion support mainly eight-day grass together with mulga, woollyoat, button and love grasses, buckbush and goathead burr. These soils often support cotton bush and perennial grasses such as umbrella grass, but no evidence of these species was recorded for this unit on Indiana.

LAND MANAGEMENT CONSIDERATIONS - This landscape is of limited extent, but is highly susceptible to land degradation.

The soils are highly erodible and most areas have been extensively damaged by scalding and gully ing. Most of this erosion damage is long-standing, but the area of scalding and gullying will continue to slowly expand while this type of country remains stocked.

Stock have a strong preference for grazing on this unit, compounding the high erosion hazard by placing stress on pastures. The existing groundcover, which is comprised of mainly short-lived grasses, may have replaced a more stable pasture of perennial and annual species.
Land Unit 3.5 The texture-contrast soils of this unit are highly erodible and are consequently extensively scalded and gullied. Pasture growth on the remaining areas of topsoil consists of short-lived grasses which provide poor soil protection in dry seasons.
4. MESAS AND ASSOCIATED TERRAIN

This group of units consists of mesas, calcrete terraces, coluvial fans and plains which have developed as a result of the dissection of Tertiary lacustrine deposits (Waite Formation). Several of the units are characterised by the presence of gidgee woodland.

Land Unit 4.1

GENERAL DESCRIPTION - Mesa surfaces with witchetty bush and annual grasses.

GEOLOGY - Tertiary chalcedonic limestone and siltstone (Waite Formation).

LANDFORM - Plateau surfaces with level relief and up to about 30 m elevation above the surrounding land surface. Plateau margins are often dissected by narrow stream channels, but drainage features are otherwise absent.

SOILS - Texture-contrast soils (Dr 4.52). Profiles consist of a red sandy clay loam A-horizon, with an abrupt boundary at a depth of 0.15 m to a strongly cemented sandy clay B-horizon, which forms a hardpan. Surfaces are crusted and strewn with angular chalcedony gravel, which is abundant throughout the A-horizon. Soil is absent on large areas of chalcedony outcrop.

VEGETATION - A very sparse shrubland of witchetty bush with fuschia bush and blue-leaf cassia. Groundcover is comprised of sparse mulga and oat grasses, with scattered tussocks of desert bluegrass, native panic or wire grass. Areas of chalcedony outcrop usually support limestone oat grass.

LAND MANAGEMENT CONSIDERATIONS - This unit has a moderate grazing capacity, but is limited in total area. Small areas on prominent 'flat tops' are virtually inaccessible to stock. Erosion hazard is minimised by the extensive cover of surface gravel.
Land Unit 4.1  Near Christmas Dam. The stony surfaces of this unit support a sparse cover of annual grasses. Note the vigorous regeneration of witchetty bush following successive favourable seasons.

Land Unit 4.2  10 km east of Baden's Camp Bore. Note the decaying timber of long dead witchetty bush (centre) and recruitment of young seedlings. Pastures consist mainly of oat grass and are of high quality.
Land Unit 4.2

GENERAL DESCRIPTION - Limestone terraces with witchetty bush over oat grass.

GEOLOGY - Quaternary calcretes.

LANDFORM - Terraces formed on mesa footslopes through the precipitation of carbonate in zones of prior groundwater outcrop. The terrace surfaces have gentle slopes flanking the breakaways of Unit 4.1, drained by an open network of narrow incised creeklines.

SOILS - Red calcareous soils (Gc 2.21). Profiles consist of an earthy or weakly pedal red sandy clay loam, pH 8.5, at the surface, grading into a pedal light clay, pH 9.0, by a depth of 0.6 m. They are highly calcareous, fine carbonate content increasing with depth. Surfaces are crusted and strewn with abundant fragments of chalcedony and nodules of calcrete. The abundance of carbonate increases down the profile, forming a nodular pan at depth.

VEGETATION - A very sparse shrubland of witchetty bush, occasionally with blue-leaf cassia or isolated prickly wattle, bloodwood or mulga. Pastures are dominated by oat grass, but other species present include mulga, eight-day and kerosene grasses, native panic, buckbush, potato bush and common sida. A corridor of ghost gum over desert bluegrass and kangaroo grass occurs along major drainage lines.

LAND MANAGEMENT CONSIDERATIONS - The pastures on this unit are of high quality and palatability. They will respond best to light stocking as the abundance of less palatable herbage species such as common sida tends to increase when pastures of this type are subjected to prolonged heavy grazing pressures.

The red calcareous soils have a slight erosion hazard. Graded lines, tracks or stock pads channelling water downslope are likely to initiate rilling, and surfaces will suffer minor windsheeting if denuded.

Old rabbit warrens are relatively common on this land unit, although none inspected had signs of recent occupation. Rabbits were probably responsible for a decline in the original witchetty bush cover by limiting seedling establishment through selective grazing. Little mature witchetty bush remains, but the abundance of dead timber suggests a greater shrub density in the past. Rabbits are no longer present, and a healthy shrub regeneration is currently in progress.
Land Unit 4.3

GENERAL DESCRIPTION - Stony terraces with gidyea over bladder saltbush and annual grasses.

GEOLOGY - Quaternary colluvium, mainly chalcedony gravel.

LANDFORM - Terraces of gravelly colluvium fanning out from the base of mesa breakaways, with stony, gently-sloping surfaces (up to 2% slope) drained by a close network of narrow, incised watercourses.

SOILS - Very stony red earths (Gn 4.12). Profiles trend from a weakly pedal red sandy clay loam, pH 6.5, at the surface to a weakly pedal, dark red light clay, pH 7.0, at a depth of 0.2 m. The soil material consists of 50% gravel to this depth, mainly angular fragments of chalcedony. Soil surfaces are crusted and feature an abundant mantle of gravel.

VEGETATION - An open woodland of gidyea in association with sparse bladder saltbush and occasionally fuschia bush. Groundcover is very sparse, and consists mainly of copperburr, with oat, woollyoat and kerosene grasses and katoora.

LAND MANAGEMENT CONSIDERATIONS - Pastures are sparse and have a very low grazing potential.

Most surfaces are protected from erosion by the extensive cover of stone and gravel. Disturbance on steep side slopes adjacent to drainage lines may initiate minor rilling.
Land Unit 4.4

GENERAL DESCRIPTION - Alluvial tracts with gidyea over annual and perennial grasses.

GEOLOGY - Quaternary alluvium.

LANDFORM - Alluvial plains with slopes of 1% or less and very low surface relief, usually fed by small creek channels arising in adjacent landforms (Units 4.1 and 4.3). Creek flows flood out into broad shallow depressions which, in the south-eastern part of the station, are ponded by sandplain deposits to form small swamps, usually about 0.3 km in diameter.

SOILS - Red earths (Gn 4.12). Typical profiles grade from earthy or weakly pedal dark red sandy clay loam, pH 6.5-7.0, at the surface to a moderately pedal red light clay, pH 7.5-8.5, by a depth of 0.5 m. A well-developed surface crust is usually present. Slightly heavier-textured soils with gilgai features occur along drainage depressions, and cracking clays are present in the swamps.

VEGETATION - An open woodland of gidyea, sometimes with sparse broombrush or emu-bush, over an annual grass cover of oat and mulga grasses. Curly windmill grass, katoora and ruby saltbush grow beneath the canopy of the gidyea.

The drainage depressions support an open grassland of barley mitchell grass with silky browntop, desert bluegrass and goathead burr. Small gilgaiied areas, however, grow only barley mitchell grass. An open woodland of coolibah with an understory of lignum and northern bluebush is characteristic of the small swamps.

Of particular note is the stand of tall gidyea near Gidyea Bore, which is an uncommon poorly-documented species. It is otherwise known only from Lake Gregory, W.A., and near Richmond and Hughenden, Qld. It appears to be regenerating satisfactorily.

LAND MANAGEMENT CONSIDERATIONS - These pastures are of good quality and palatability. Oat grass, the most valuable component of the pasture, will tend to decrease if subjected to prolonged heavy grazing pressures, to be replaced by less productive species such as mulga grass. Moderate utilization and periodic spelling is therefore desirable. When the Christmas Dam area is stocked, the small swamps with northern bluebush will be a focus of grazing pressure, and the eventual decline of this useful feed species will be difficult to avoid.

The red earths have a slight to moderate erosion hazard. Surface disturbances that channel runoff downslope may initiate minor gullying, a hazard accentuated when surfaces are bare. Since surface soils are medium-textured, they will suffer only superficial windsheeting when denuded. The gilgaiied soils and cracking clays are not subject to erosion.
Land Unit 4.4  Near Gidyea Bore. The tall gidyea in this vicinity does not occur elsewhere in the N.T. and is of limited distribution in other states. Barley Mitchell grass (foreground) is present in drainage depressions on this unit.

Land Unit 4.5

The main pasture species on this unit is eight-day grass, which produces a rapid but short-lived growth response after rain. Curly windmill grass grows beneath the gidyea canopy, and bladder saltbush (foreground) is occasionally present.
Land Unit - 4.5

GENERAL DESCRIPTION - Plains with gidyea over eight day grass.

GEOLOGY - Tertiary deeply-weathered rock and Quaternary alluvium.

LANDFORM - Level plains with very low relief, often with stony surfaces. Defined drainage systems are absent, and creek channels draining adjacent landscapes are narrow and incised when traversing this unit. Small claypans up to 100 m in diameter are locally common.

SOILS - Texture-contrast soils (Dr 4.52). Typical profiles consist of a reddish-brown sandy loam A-horizon, pH 7.3, to a depth of 0.3 m, with an abrupt boundary to a strongly cemented red sandy clay loam. Variants have sandy clay loam surfaces overlying a sandy clay. They are massive and earthy throughout. Surfaces are crusted and a lag gravel of quartz pebbles is sometimes present, accompanied with a gravelly layer above the hardpan.

VEGETATION - A sparse open woodland of gidyea with some areas supporting a denser timber cover. Groundcover consists mainly of eight-day grass, together with sparse oat and mulga grasses and grey copperburr. Goathead burr is common over large areas and bladder saltbush is occasionally present. Curly windmill grass is dominant under the gidyea canopy, usually with native panic and ruby saltbush. Sparse, tussocks of barley mitchell grass are present in depressions, and samphire occurs in slightly saline drainage floors west of Atula Creek.

LAND MANAGEMENT CONSIDERATIONS - These pastures have the potential to grow a flush of very palatable feed immediately after rain, but the eight-day grass usually disintegrates rapidly with the onset of warmer weather. Short-term opportunistic grazing is therefore favoured. The sparse woollyoat grass and tussocks of curly windmill grass beneath the gidyea canopy provide the most substantial feed at other times.

Goathead burr is commonly regarded as an indicator of poor range condition. However, it is abundant over large areas of this unit east of Atula Bore which have never been grazed.

Since soils are moderately permeable and on very gentle slopes they have a slight water erosion hazard. However, the landscape naturally drains by sheet flow, and surface disturbances such as stock pads or graded lines that channel runoff are likely to initiate rilling or minor gullying. Denuded areas will be subject to windsheeting and sand drift, particularly where surfaces are disturbed. If major soil loss occurs, a scalded surface may develop, requiring special reclamation measures.
5. ALLUVIAL PLAINS

This group of units consists of a sequence of superimposed alluvial fans deposited by creek channels draining the eastern-most catchments of Harts Range. The sediments are uniformly sandy, reflecting their origin in the coarse-grained metamorphic rocks of the Harts Range Group. The fans represent four phases of deposition associated with fluctuations in climate during the late Pleistocene and Holocene. The oldest deposit, Unit 5.1, is partially buried by fans of Unit 5.2, the surfaces of which have been modified by wind action to form a sandplain, Unit 5.3, probably during the peak of aridity 16-18,000 years ago. Unit 5.4 consists of subsequent (post-Glacial or Holocene) floodout lobes, and Unit 5.5 includes present-day floodplains.

Land Unit - 5.1

GENERAL DESCRIPTION - Alluvial plains with ironwood over kerosene grass.

GEOLOGY - Pleistocene alluvium.

LANDFORM - Alluvium plains and tributary drainage floors featuring very low surface relief and slopes of less than 1%. Drainage features are absent.

SOILS - Alluvial soils (Gn 2.12, Uc 5.21). Surface soils consist of a red sandy loam, pH 6.5-7.0, usually trending to a red sandy clay loam, pH 6.5-7.0, by a depth of 0.4 m, although uniform-textured profiles were recorded. Profiles are massive and earthy throughout, and are mostly free of gravel. Surfaces are weakly crusted or loose.

VEGETATION - An open woodland of ironwood over pastures of kerosene grass and woollybutt. Other species usually present include oat, woollyoat, eight-day and golden beard grasses and tarnine. Curly windmill and umbrella grasses grow beneath the tree canopy. A dense regeneration of ironwood germinated in the wet seasons of the mid 1970's and is presently up to two metres in height.

LAND MANAGEMENT CONSIDERATIONS - The kerosene grass and woollybutt pastures are of moderate quality and palatability, and are relatively resilient to grazing pressure. Declining pasture condition will be evidenced by a decrease in the abundance of the most palatable species, principally oat, woollyoat and umbrella grasses. Spiny saltbush and glycine grow on ungrazed areas, but are notably absent where there has been a history of stocking.

The dense regeneration of ironwood may present management problems if sufficient canopy cover develops to suppress pasture growth. Most seedlings are well-established and are beyond control using burning practices.

The soils of this unit are permeable and on very low slopes, and in most circumstances will not be subject to water erosion.

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However, minor gullying will occur where sheet runoff flows are channelled by tracks, stock pads and other surface disturbances. Erosion is best prevented by avoiding the flat grading of tracks and fencelines, particularly where it may intercept drainage flows. Surfaces are coarse-textured and lack cohesion when disturbed, so are susceptible to windsheeting and minor drift when denuded.

Land Unit 5.1 Near Acacia Bore. A dense regeneration of ironwood up to 3m in height has established throughout the open cover of mature trees.
Land Unit 5.2

GENERAL DESCRIPTION - Alluvial plains with corkwood and colony wattle over kerosene grass.

GEOLOGY - Pleistocene alluvium.

LANDFORM - Sandy alluvial plains and floodout deposits with very low surface relief and slopes of less than 1%. Drainage features are absent.

SOILS - Alluvial soils (Uc 5.21). Profiles are uniform to a depth of at least 0.5 m, consisting of a red sandy loam or light sandy clay loam, pH 6.5-7.0, and are massive and earthy throughout.

VEGETATION - Sparse fork-leaved corkwood and dense thickets of colony wattle in association with pastures of kerosene grass and woollybutt. Other species present include golden beard and woollyoat grasses, tarvine, caltrop and sida. The dense growth of colony wattle presently a feature of this land type is probably a cyclical response to the prolonged period of high rainfall in the mid-1970's, and may diminish with the onset of drier conditions.

LAND MANAGEMENT CONSIDERATIONS - Pastures on this unit are moderately productive and resilient to grazing pressure. Overgrazing will result in a decrease in the abundance of woollyoat grass, which comprises only a limited component of the pasture even in ungrazed areas. Herbage growth is likely to increase.

Mustering operations can be hampered by the dense thickets of colony wattle. No control methods are currently known.

This landscape has a moderate wind erosion hazard. Surfaces are coarse-textured and loose and therefore likely to drift if denuded.
Land Unit 5.2

Dense thickets of colony wattle have established amongst a sparse cover of forkl-leaved corkwood on this unit. Pastures consist mainly of kerosene grass but short-lived grasses and herbage are dominant on heavily-used areas.

Land Unit 5.3

Pastures consist mainly of kerosene grass and are relatively resilient under grazing.
Land Unit - 5.3

GENERAL DESCRIPTION - Sandplain with whitewood over kerosene grass.

GEOLOGY - Pleistocene alluvium.

LANDFORM - Sandplain with level surfaces and very low relief, occasionally featuring low linear dunes with broad rounded crests.

SOILS - Earthy sands (Uc 5.21). Profiles are massive and earthy throughout, consisting of a red sandy loam, pH 6.5-7.0, to a depth of at least 0.7 m. Slightly heavier textures are sometimes encountered at this depth. Surfaces are usually loose.

VEGETATION - A sparse cover of whitewood and supplejack, often as discrete clumps. Pastures consist mainly of kerosene grass, but also include woollybutt, golden beard, woollyoat, oat and eight-day grasses. Umbrella and curly windmill grasses are usually present beneath the tree canopy.

LAND MANAGEMENT CONSIDERATIONS - Pasture on this unit are of moderate quality and relatively resilient to grazing pressure. Valuable species such as oat and umbrella grasses, which comprise only a small component of the pasture, will tend to disappear from heavily-grazed areas, to be replaced by short-lived grasses and herbage.

The soils are moderately susceptible to wind erosion and will drift if denuded. The risk of water erosion is minor.

Land Unit - 5.4

GENERAL DESCRIPTION - Floodouts with kerosene grass.

GEOLOGY - Holocene alluvium.

LANDFORM - Sandy floodout lobes with slopes of less than 1%. Surface features are absent.

SOILS - Alluvial soils (Uc 5.21). Profiles are deep and uniform, consisting of a red loamy sand surface, pH 7.0, grading into a red sandy loam, pH 7.0, to a depth of at least 0.7 m and have a sandy or slightly earthy fabric throughout. Lenses of fine gravel are occasionally present. Surfaces remain loose.

VEGETATION - Treeless, sometimes supporting small clumps of supplejack or fork-leaved corkwood. Pasture cover is comprised of kerosene grass with woollybutt, woollybutt wanderrie, purple plum, woollyoat and oat grasses, rattlepod, tarvine, caltrop and verbine.
LAND MANAGEMENT CONSIDERATIONS - The kerosene grass pastures are of moderate quality and palatability, locally enhanced by the presence of verbine. They are relatively resilient to prolonged heavy grazing pressure, although the initially low proportion of highly palatable species may be reduced.

The soils are susceptible to wind erosion and will be subjected to windsheeting and drift if denuded. The coarse grain size of surface soils will tend to moderate soil loss. The water erosion hazard is minimal.

Land Unit 5.4
This unit supports moderately palatable pastures relatively resilient to grazing pressure. Herbage species such as rattlepod (foreground) are common.
Land Unit 5.5

GENERAL DESCRIPTION - Creek channels and floodplains with river red gum, prickly wattle and corkwood over kerosene and perennial grasses.

GEOLOGY - Holocene alluvium.

LANDFORM - Active floodplains up to a kilometre in width, featuring braided creek channels, low levee deposits and shallow flood channels that carry flows only during major flood events. Large floods may initiate lateral migration of the stream channels or the creation of new channels.

SOILS - Coarse-textured alluvial soils (Uc 1.23), consisting of relatively recent sediments with minimal soil development. Lenses of fine and coarse gravel are common. The bed load of the creek channels consists of white quartz sand.

VEGETATION - The creek and flood channels are fringed by a corridor of river red gum, occasionally with solitary bean trees or ghost gums, over tussocks of curly windmill grass or silky browntop. The floodplains support scattered river red gum, fork-leaved corkwood and thickets of prickly wattle in association with kerosene grass. Sandhill canegrass, rattlepod, camel melon and other herbage species are common.

LAND MANAGEMENT CONSIDERATIONS - The coarse grain size of the sands on this unit somewhat reduces their susceptibility to wind erosion. Minor drift will occur when surfaces are denuded, but revegetation will be rapid following rains.

Kerosene grass is only a moderately productive pasture species, but stock favour grazing along creek frontages, particularly when palatable herbage is available.
6. SANDPLAIN

Land units of this group consist of aeolian sand deposits which probably attained their present extent during the peak of aridity, 16-18,000 years ago. At this time, sands originating as extensive alluvial deposits fanning out from the foot of Harts Range were transported to the north-west by strong prevailing south-easterly air flows. Popular theories suggest that sandplains develop on sands with a broad particle size range, whereas the materials of the dunefields to the south are of a more uniform particle size.

The differences between these units seemingly arise according to the nature and depth of burial of underlying soil materials. Three of the units are transitional between aeolian and alluvial landforms.

Land Unit - 6.1

GENERAL DESCRIPTION - Sandplain with blue mallee over spinifex.

GEOLOGY - Pleistocene aeolian deposits.

LANDFORM - Sandplain with level or slightly undulating surfaces, occasionally featuring broad low rises, circular depressions up to 20 mm in diameter, and poorly-defined drainage systems.

SOILS - Earthy sands (Uc 5.21). Profiles are deep and consist of a massive and earthy red clayey sand or sandy loam, pH 6.5-7.0, sometimes grading into slightly heavier textures at a depth of about 0.5 m. Surfaces are commonly crusted and veneered with coarse sandy deposits.

VEGETATION - An open shrubland of blue mallee in association with hard spinifex. Emu-bush, sandalwood and broombush are often present, and sparse tussocks of wire, woollyoat, eight-day and mulga mitchell grasses usually grow between the clumps of spinifex. Parakeelya may be present in response to storm rainfall.

LAND MANAGEMENT CONSIDERATIONS - No erosion hazard while the cover of spinifex remains intact, but surfaces will be subject to sand drift if remaining bare after a fire. This unit has an extremely limited grazing potential, but its productivity can be marginally improved by burning, which promotes the growth of herbage species provided that sufficient soil moisture is available.
The blue mallee-spinifex association that grows on this unit has an extremely limited grazing potential. Burning pastures may marginally improve its pastoral value.
Land Unit - 6.2

GENERAL DESCRIPTION - Sandplain with acacia and dogwood over spinifex.

GEOLOGY - Pleistocene aeolian deposits.

LANDFORM - Sandplain with level surfaces and very low relief. Drainage features are absent.

SOILS - Earthy sands (Uc 5.21). Profiles are massive and earthy, sandy loam in texture, pH 6.5-7.0, and grading from a reddish-brown at the surface to a red at a depth of about 0.2 m. Some profiles trend in texture to a sandy clay loam by a depth of 0.5 m. Surfaces are weakly crusted and partly veneered by coarse sandy deposits.

VEGETATION - A sparse cover of acacia, dogwood, ironwood, bloodwood and occasionally prickly wattle in association with hard spinifex. Woollybutt, kerosene grass and woolly oat grass are present in the open areas amongst the spinifex tussocks, together with chocolate bush and lamb's tails.

LAND MANAGEMENT CONSIDERATIONS - This country has very limited grazing value. Cool season burning should promote the growth of kerosene grass and herbage species for a couple of years until the spinifex regains its dominance.

The earthy sands have a moderate wind erosion hazard and will drift in the event of the spinifex cover being removed.

Land Unit - 6.3

GENERAL DESCRIPTION - Sandplain with whitewood over spinifex.

GEOLOGY - Pleistocene aeolian deposits.

LANDFORM - Sandplain with level surfaces and very low relief, similar to Unit 5.3. It forms a transition zone between sandplains of alluvial and aeolian origin.

SOILS - Earthy sands (Uc 5.21). These have deep profiles which are massive and earthy, sandy loam in texture, pH 7.0, with a trend in colour from dark red at the surface to red beneath about 0.2 m. Commonly soil texture trends to a sandy clay loam beneath a depth of 0.5 m, suggesting the presence of a buried soil. Surfaces are usually loose.

VEGETATION - A sparse open woodland of whitewood and supplejack in association with hard spinifex. Kerosene grass, woollybutt, occasionally oat grass and herbage species such as sida and caltrop occupy the open areas between the spinifex tussocks.
LAND MANAGEMENT CONSIDERATIONS - These pastures have very low productivity, although stock will selectively graze the most palatable species amongst the spinifex. When sufficient fuel is available, grazing potential may be enhanced by cool season burning. This should promote an increase in the growth of palatable herbage and kerosene grass for several seasons. The unit supports a valuable topfeed reserve.

The soils have a moderate wind erosion hazard and will be subject to wind-sheeting and sand drift if denuded. This may occur if the spinifex is burnt during a dry spell and ground-cover is slow to re-establish.

Land Unit 6.3 Useful pasture species grow in the open spaces between the clumps of spinifex (foreground) and the whitewood and supplejack provide a reserve of topfeed.
Land Unit - 6.4

GENERAL DESCRIPTION - Sandplain with colony wattle and corkwood over spinifex.

GEOLOGY - Pleistocene aeolian deposits.

LANDFORM - Sandplain with level surfaces and very low relief, similar to Unit 5.3. It comprises a transition zone between aeolian sandplain and alluvial plain.

SOILS - Earthy sands (Uc 5.21). Profiles are deep, consisting of massive and earthy red sandy loams, pH 7.0, to a depth of about 0.5 m. Surfaces are often weakly crusted.

VEGETATION - Sparse fork-leaved corkwood and dense thickets of colony wattle over a hummock-grassland of hard spinifex. Other species growing amongst the spinifex include kerosene grass, woollybutt, oat grass, caltrop and common sida.

LAND MANAGEMENT CONSIDERATIONS - These pastures have a very limited grazing value. Cool season burning may enhance the growth of moderately palatable species such as kerosene grass provided that follow up rains are received.

The soils have a moderate erosion hazard and will be subject to windsheeting and sand drift if denuded. This may occur if the spinifex is burnt during a dry spell and is slow to re-establish.
REFERENCES


### APPENDIX I
### SPECIFIC NAMES OF PLANTS MENTIONED IN TEXT

#### Grasses

<table>
<thead>
<tr>
<th>Grass Type</th>
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<tbody>
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<td>Kerosene grass</td>
<td>Aristida holathera</td>
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<td>Mulga grass</td>
<td>Aristida contorta</td>
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<td>Wire grass</td>
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<td>Rough Wire grass</td>
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<td>BarleyMitchell grass</td>
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<td>Desert blue grass</td>
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<td>Golden beard grass</td>
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<td>Button grass</td>
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<td>Umbrella grass</td>
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<td>Oat grass</td>
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<td>Limestone oat grass</td>
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<td>Woollyoat grass</td>
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<td>Curly windmill grass</td>
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<tr>
<td>Woollybutt</td>
<td>Eragrastis eriopoda</td>
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<td>Lovegrass</td>
<td>Eragrostis dielsii</td>
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<td>Woollybutt wanderrie</td>
<td>Eriachne helmsil</td>
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<tr>
<td>Wanderrie</td>
<td>Eriachne spp.</td>
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<td>Silky browntop</td>
<td>Eulalia fulva</td>
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<td>Eight-day grass</td>
<td>Fimbriystylis dichotoma</td>
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<td>Native panic</td>
<td>Panicum decompositum</td>
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<tr>
<td>Feather spinifex</td>
<td>Plectrachne actinoides</td>
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<td>Katoora</td>
<td>Sporobolus actinoides</td>
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<tr>
<td>Kangaroo grass</td>
<td>Themeda triandra</td>
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<tr>
<td>Hard spinifex</td>
<td>Triodia basedowii</td>
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<td>Purple plume grass</td>
<td>Triraphis mollis</td>
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<td>Sandhill canegrass</td>
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#### Forbs

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<tr>
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<td>Copperburr</td>
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<td>Lifesaver burr</td>
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<td>Potato bush</td>
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### Trees and Shrubs

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<td>Gidgea</td>
<td><em>Acacia sp. aff. cambegei</em></td>
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<td>Witchetty bush</td>
<td><em>Acacia kempeana</em></td>
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<td>Colony wattle</td>
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<td>Prickly wattle</td>
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<td>Fuschia bush</td>
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<td>Eru bush</td>
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<td>Bean tree</td>
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<td>River red gum</td>
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<td>Blue mallee</td>
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<td>Coolibah</td>
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<td>Sandalwood</td>
<td><em>Santalum lanceolatum</em></td>
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<tr>
<td>Supplejack</td>
<td><em>Ventilago viminalis</em></td>
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*SLR-A3139  53.*
## Appendix II: Land Unit and Paddock Areas

All areas expressed in square kilometres

| Land Unit | Paddock | 1.1 | 1.2 | 1.3 | 2.1 | 2.2 | 2.3 | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 5.1 | 5.2 | 5.3 | 5.4 | 5.5 | 6.1 | 6.2 | 6.3 | 6.4 | Total |
|-----------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| Acacia    | 11      | 11  | 17  | 22  | 20  | 27  | 46  | 5   | 10  | 8   | 177 |
| Mt Lloyd  | 7       | 10  | 5   | 5   |     |     |     |     |     |     | 33  |
| Black Diamond | 3  | 8   | 2   | 5   | 6   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 80   |
| Newmarket | 2       | 1   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 36   |
| Drone     | 2       | 2   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 22   |
| Brumby    | 8       | 6   | 3   | 12  | 14  | 11  | 10  | 16  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 123  |
| Brumby (North) | 2  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 32   |
| Gidja Bore | 1    | 125 | 9   | 9   | 36  | 1   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 526  |
| Brumby Bore | 3  | 15  | 56  | 112 | 13  | 25  | 6   | 1   | 1   |     | 1   | 39  | 6   | 26  | 45  | 5   | 1   | 3   | 30  | 107 | 4   | 3   | 502  |
| Epson No. 1 | 1    | 2   | 5   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 9    |
| Epson No. 2 | 1    | 6   | 10  | 1   | 1   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 28   |
| Epson No. 3 | 4    | 3   | 8   | 1   | 2   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 14   |
| Epson No. 4 | 2    | 1   | 10  | 16  | 3   | 7   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 44   |
| *North of Mackalla Cr | 6  | 29  | 26  | 55  | 11  | 20  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 789  |
| *South of Mackalla Cr | 20  | 53  | 28  | 3   | 2   | 15  |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     | 542  |
| **Total**   | 40    | 37  | 73  | 310 | 250 | 28  | 107 | 70  | 20  | 20  | 13  | 90  | 47  | 121 | 192 | 52  | 114 | 35  | 103 | 1111 | 72  | 29  | 7  | 2577** |

* Denotes unfenced areas

** Surveyed lease area 2991 sq. km.
Technical Memorandum
No. TM 89/10

THE PASTORAL LAND RESOURCES
OF MURRAY DOWNS STATION

A.R. Grant
Land Conservation Unit
Conservation Commission of the Northern Territory
ALICE SPRINGS N.T. 5750

September 1989

SLR-A0393
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SUMMARY

Twenty-six different types of country (land units) have been identified and mapped on Murray Downs Station, which occupies 5604 sq km, 300 km north of Alice Springs. This report provides a detailed description of each land unit in terms of its landform, soils and vegetation attributes and indicates the possible implications of pastoral land use on both soil stability and pasture growth.

The landscape of the study area consists of a mosaic of quartzite and sandstone range and hill country, plains of low relief on lateritic or freshly-weathered substrates, relict and active alluvial deposits, beds of calcrete and extensive aeolian sandplains. The most productive pastoral land consists of coolibah and bluebush swamps, although the shrub cover has been largely eliminated from the latter. Plains on partly-stripped laterite, and pediment plains on freshly-weathered parent materials, support mainly annual grasses and have a high capability for pastoral land use, but the extensive area of sandplain in the southern part of the station is of very limited grazing value.

The floodplains along Skinner Creek and other watercourses arising in the Davenport Ranges present specific management problems. They consist of drift-prone sandy sediments which partially veneer an older soil featuring strong surface crusting. Revegetation of the sandy soils only may be the best approach to improving the productivity of these areas since existing reclamation techniques have proven ineffective on the surface-crusting soils, which are relatively resistant to further sheet erosion anyway.

ACKNOWLEDGEMENTS

The cooperation and hospitality of Mr Terry Leigh of Murray Downs Station during the conduct of the field work for this survey is gratefully acknowledged.

Mr Trevor Filmer and Mrs Jill Dienelt provided dedicated technical support during the field work and compilation of the map and report, and their contribution is much appreciated.
THE PASTORAL LAND RESOURCES OF MURRAY DOWNS STATION

SECTION ONE: INTRODUCTION

A detailed knowledge of the different types of country on a station and their reaction to grazing is an essential precursor to good land husbandry and grazing management on arid rangelands. Most pastoralists gain a comprehensive first-hand appreciation of the land attributes of their station through living and working in that particular environment, observing the way in which stock use pastures and the response of the country to season.

A land resource inventory can complement local knowledge by formally documenting the types of country on a station, accurately mapping their distribution as well as indicating the potential productivity and land management hazards associated with each to such it provides a tangible basis for making property management and development decisions. Besides the station manager, land resource information is especially valuable to Government advisers in the fields of soil conservation, pasture management and livestock husbandry, and land administrators.

This land resource inventory documents the pastorally-different land types of Murray Downs Station, located 300km north of Alice Springs and occupying an area of 5604 sq km. The property occupies the south-western flank of the Davenport Ranges, extending well into sandplain terrain to the south.

The survey was initiated by Mr Terry Leigh, lessee of Murray Downs, who requested land inventory mapping providing sufficient detail to act as a basis for the planning of further development on the station, particularly soil conservation activities. To meet his requirements, the whole property has been mapped into land units with pastorally-different attributes (soil and vegetation type, grazing characteristics, stocking capacity and erosion hazard) at a scale of 1:100,000, and selected areas, productive floodouts with high management requirements, have been detailed at a scale of 1:25000.
SECTION TWO: THE PHYSICAL ENVIRONMENT MURRAY DOWNS STATION

A. PREVIOUS SURVEYS

The land resources of Murray Downs have been previously described at a reconnaissance level only by Perry et al (1962), who identified twelve land systems at a regional mapping scale of 1:1,000,000. A land system is a descriptive grouping of related land units, which define "an area, or groups of areas, throughout which there is a recurring pattern of topography soils and vegetation" (Christian and Stewart, 1953).

The land systems mapped on Murray Downs in this original survey include the following:

Davenport land system - sandstone ranges with bold relief, supporting mainly snappy gum with spinifex. Eight unmapped units are described, including strike ridges, rounded uplands, alluvial and colluvial fans and floodplains.

Hann land system - sandstone and quartzite strike ranges, usually as single ridges flanking the Davenport Range south-east of Skinner Creek. Includes seven unmapped units describing erosional slopes, colluvial and alluvial fans and flood plains.

Ibarumic land system - low sandstone hills supporting snappy gum and spinifex, mapped in the Fraeland Range area. Eight unmapped units are specified, the principal ones describing prominent ridges, bevelled uplands and flanking alluvial plains.

Cherry Creek land system - low plateaux of sandstone with spinifex in the southern part of the station. It consists of four units; the plateau surfaces, alluvial fans, valley floors and drainage channels.

Kurundi land system - hilly terrain on igneous rocks, mapped only in Skinner Pound. Seven unmapped units are outlined, describing ridges, uplands with rounded crests, alluvial fans and erosional slopes.

Wonorah land system - stony plains with spinifex, mapped adjacent to the Davenport Range near Skinner Creek. Of five unmapped units, the main land forms are level plains with scattered low strike ridges.

Aliinga land system - plains on sandstone supporting mulga in the central - eastern part of the station. Sandplain, low strike ridges, lateritic rises, swamps and calcrete platforms comprise minor units.

Barrow land system - open granite plains with annual grasses, only occurring north of Murray Downs homestead. Broad plains comprise the main unit, but narrow valley floors, creek channels and granite hills or mesas are also described.

Anmaroo land system - river plains and swamps mapped along Skinner Creek. A complex landscape of seven unmapped units is recorded, including levees, scalded surfaces, alluvial basins and distributary channels.
McGrath land system - river plains lacking large drainage channels, mapped along Amelia Creek. Of eight unit described, plains with scalded stony surfaces comprise the main landforms.

Adnera land system - small floodouts with mulga within the Davenport Ranges. Five unmapped units include active alluvial lobes, small basins alluvial fans and creek channels.

Singleton land system - sandplain with spinifex, throughout the southern part of the station. Subdivided into four unmapped units, comprising sandplain, swales, sandy rises and alluvial flats.

While this land system mapping is suitable for the purposes of regional planning and assessment, it provides insufficient detail to assist with pastoral management, and was not intended for this application.

Land systems, by definition, are compound map units, each encompassing several unmapped types of country. For station management purposes, mapping at a larger scale, based on simple land units, each with uniform pastoral characteristics, provides an appropriate level of detail.

B. GEOLGY

The geology of Murray Downs has been mapped at a scale of 1:250,000 by Smith and Milligan (1964) south of Lat. 21°00' (approximately Murray Downs homestead), and by Wyche and Simons (1987) north of this latitude. Geological mapping at a scale of 1:100,000 has been undertaken by Stewart and Blake (1986) in the Davenport Range area (north of Lat. 21°00', east of Long. 134°30'), and by Blake and Horsfall (1986) in the Froiland Range area (between Lat 21°00' and Lat. 21°27', east of 134°40'). Refer to these publications for a complete and detailed description of the geology of the area.

The oldest outcrop on the station consists of Proterozoic sedimentary and volcanic rocks associated with the Davenport province of the Tennant Creek Inlier, a basement exposure separating the Palaeozoic sediments of the Wiso Basin to the west from the Georgina Basin to the east and south. On Murray Downs, these are represented by rocks of the Hatches Creek Group, 1640-1810 million years old (m.y.o.), a sedimentary sequence deposited in a shallow marine environment consisting of arenites, felsic and mafic volcanics, siltstone, mudstone, shale, carbonates and possibly evaporites. The ridge-forming Coulter's Sandstone (quartz arenite) and Unimbra Sandstone (feldspathic, lithic and kaolinitic arenite) of the Wauchope Subgroup, and the Kurinelli Sandstone (feldspathic, lithic and quartz arenite, siltstone) of the Ooradidgee Subgroup are the principal materials comprising the hilly and mountainous terrain of the northern part of the station. The Murray Downs Dome, a structure east of Amelia Creek, was probably one of several centres of volcanism, and volcanic rocks together with less-resistant sedimentary materials are interbedded with the ridge-forming arenites.

Rocks of the Hatches Creek Group are intruded by bodies of granophyre, felsic porphyry, dolerite/gabbro and granite, are extensively folded and faulted, and have undergone low-grade metamorphism. Following uplift associated with tectonic activity, the region was subjected to erosion for the remainder of the Proterozoic, resulting in a mature peneplain landscape similar to that of the present by the early Cambrian (570 m.y. ago).
Fluvial and shallow marine sediments partly buried the Proterozoic rocks during the early-mid Cambrian (570-530 m.y.a), when the Davenport province was a land mass separating the shallow seas of the Georgina and Wiso Basins. The Andagera Formation, which outcrops as slopes, mounds and low hills usually adjacent to the ranges, consists of flat-bedded or gently-dipping Cambrian conglomerate and sandstone. It was laid down as alluvial fan and scree deposits, which formed terraces flanking the ridges of Proterozoic sandstone. In the southern part of the station, upper Cambrian (500 m.y.o) rocks of the Tomhawk Beds (brown silty sandstone, minor limestone and conglomerate) and upper Devonian (395 y.o). Dulcie Sandstone (cream and brown quartz sandstone), both sediments of the Georgina Basin, outcrop as low hilly terrain.

The Cainozoic geology (60 m.y.a-present) is of greatest relevance in considering those parts of the station used for pastoral purposes, but is only briefly documented in the available literature. During the Tertiary period (60 m.y.a-2 m.y.a), the landscape was subjected to warm humid climates conducive to the deep weathering and bleaching of surface rocks.

As a result, surfaces developed a laterite weathering profile, consisting of a cemented capping of lateritic material (ironstone gravel) overlying a pallid zone of kaolin, eventually grading into bleached bedrock typically at a depth of about 3m. This profile occurs throughout the plains country of Murray Downs, extensively buried by subsequent sand deposits and locally stripped by stream action. Either intact or partially stripped, it is the principal substrate of the red earth soils supporting pasture growth on the station.

Calcrete, consisting of sandy deposits cemented by calcium carbonate, occupies the broad depression between Chablew and Bluebush Bores, and probably formed as a result of the evaporation of groundwater outcrop during periods of increasing aridity in the late Cainozoic.

Aeolian sand blanketed much of the station area during periods of extreme aridity in the Quaternary (1.8 m.y.a-present), burying deeply weathered surfaces and prior drainage patterns. Present day floodplains and swamps probably date from the late Quaternary, sandy alluvial soils being deposited in the Holocene (10,000 y.a-present).

**C. LANDFORMS**

The landforms of Murray Downs have developed from two old lateritic land surfaces (Hays, 1967).

The oldest and more elevated land surface, the Ashburton Surface, was once an extensive gently-undulating plain, which was dissected prior to the Cretaceous (140 m.y.a.) and now persists only as the broad flat crests of ridges of Mid-Proterozoic metamorphic rocks in the Davenport Range. The younger land surface, the Tennant Creek Surface, is a peneplain - a featureless, nearly level erosional surface - which developed during the long cycle of geologic erosion that occurred in the Tertiary period (60-2 m.y.a.) This surface is characterized by a laterite profile and sheet flow drainage systems, and occurs throughout the lowland areas of Murray Downs, locally either dissected by subsequent erosional processes or buried by aeolian or alluvial sediments.
A laterite profile exposed by Skinner Creek south of No 1 Bore. A red sandy sand soil buries a zone of cemented laterite nodules 0.5 m thick, grading into a deep pallid zone of kaolinitic material. Bleached bedrock is visible at the base of the profile, at a depth of approximately 3 m from the soil surface.

The dissection of the lateritic peneplain is usually marked only by subtle changes in topography, but significant changes in soil and vegetation characteristics are always evident. Such changes are due to the exposure of different soil substrates, principally pallid zone clays and freshly-weathered rock. Bedrock plains, where the laterite profile of the peneplain has been completely stripped to reveal the freshly-weathered parent rocks, are termed pediment.

A broad depression in the peneplain falls to the north-west through the central part of the station, eventually draining towards the Hanson River floodout and a regional internal drainage basin west of Tennant Creek. The floor of the depression is marked by swamps at Bluebush and Chablow Bore, and

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on the Elkedra boundary, as well as beds of calcrete and relict alluvium. Major flooding occurred along this depression during the high rainfall years of the mid-1970's (T. Leigh, pers. comm.), but in average seasons surface drainage remains virtually inactive.

The floodouts of Skinner Creek, Conglomerate Creek and other watercourses draining catchments in the Davenport Ranges trend towards the peneplain depression where it crosses the north-western boundary of the station. These streams have partly stripped the laterite profile and deposited various alluvial sediments in a large and active floodout system, surface flows eventually ponding in terminal swamps. Cobble and gravel-sized colluvial deposits occur in limited areas adjacent to the ranges.

Throughout the southern part of the station, the peneplain is veneered with deposits of aeolian sand which probably originated as alluvial sediments. The aeolian landforms include sandplain, broad sandy rises and dunefields of longitudinal sandhills, each with a characteristic particle size distribution. Under the present climate, these landforms are essentially stable features.

D. SOILS

Soil properties reflect the geology of the parent material from which they are formed, the landform on which they occur, and the climatic regime that prevailed during their period of development. Many soils on Murray Downs have developed from highly-weathered materials and consequently have a low abundance of the freshly-weathered minerals that confer soil fertility. They developed in a relatively moist climate which prevailed before the onset of increasing aridity and sand movement 25,000 years ago.

In this report, the soils of Murray Downs are described in terms of their texture, colour, pH, fabric and structure, and are classified according to their Australian Great Soil Group (Stace et al, 1968) and Principal Profile Form (Northcote, 1979).

(i) Soil Characteristics

Texture is a property determined by the proportion of sand, silt and clay particles within the soil matrix, and is indicated by the behaviour of a moistened soil sample. Because most soils on Murray Downs are derived from highly-weathered parent materials, they have a very low silt content (less than 10%). The range of soil textures found on the property include clayey sands (5-10% clay), sandy loams (10-15% clay), sandy clay loams (20-30% clay), sandy clays (35-40% clay), and light clays (35-40% clay, up to 25% silt). Texture determines soil permeability and moisture-holding capacity, and influences fertility as most plant nutrients are bound to clay minerals. It is a major determinant of the type of pasture that grows on a particular area.

Soil colour is assessed in the field using a moist sample and a standard Munsell colour chart, which forms the basis of the colour names used in this report. The soils of Murray Downs predominantly red due to pigmentation by the iron oxide haematite, derived from the weathering of iron-rich clay minerals.

Soil pH indicates the acidity or alkalinity of the soil. A neutral soil has a pH value of 7.0, and a lower pH indicates acidity, a higher pH alkalinity. Most soils on Murray Downs have a neutral reaction trend, with a surface value of between pH 6.0 and pH 7.5, and a deep subsoil value between pH 6.5 and pH

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8.0.

Soil fabric refers to the arrangement of individual particles within the soil material. An earthy fabric is characterized by a porous, dusty appearance of the soil matrix and the absence of peds (soil aggregates which are distinctly separate). A sandy fabric has closely packed sand grains, also with few if any peds. When peds are present, they may have a porous, rough-face fabric, or smooth, lustrous surfaces.

Soil structure is determined by the size, shape and abundance of peds. Coherent soils with no distinct peds are considered to have massive structure, while highly pedal soils such as the cracking clays of bluebush swamps are strongly structured.

(ii) Soil Types

The following Australian Great Soil Groups (Stace et al, 1968) were recorded on the station:

Red earths – These are the most common soil type on the station, and vary considerably according to the nature of their parent material. Deep soils with low fertility have developed on laterite, while shallow, mineral-rich soils occur on freshly-weathered granite. They are medium-textured soils, red in colour with massive structure and an earthy fabric. Profiles feature a gradual increase in clay content with depth.

Yellow earths – Similar to the red earths, these soils are massive, porous and earthy soils with an acid to neutral reaction trend, gradually increasing clay content with depth and a yellow to yellow-brown colour. They are generally associated with areas of poorer drainage than the red earths, and on Murray Downs have developed from lateritic materials on swamp margins.

Duplex soils (solodic) – An abrupt boundary between a shallow, sandy A-horizon (topsoil) and a heavy-textured pedal B-horizon (subsoil) characterizes these soils, which occur in drainage floors in granite country. They are usually highly erodible.

Red calcareous soils – These are usually medium-textured soils which are highly alkaline, having developed directly from underlying calcareous rocks or calcrete.

Brown and grey clays – Occurring in seasonally flooded swamps, these are deep heavy-textured soils, strongly structured and drying with deep surface cracks. They have formed from fine alluvial sediments.

Alluvial soils – On Murray Downs these are characteristically reddish-brown sandy soils with a neutral reaction trend, massive structure and an earthy fabric. They occur as levee deposits and floodout lobes associated with active watercourse channels.

Lithosols – Present on slopes in excess of about 3% where natural erosion is active enough to limit soil development, these are shallow gravelly soils with limited profile development. They often consist of only pockets of soil amongst rock outcrop.

Earthy sands – These are similar to red earths, but have developed from
Pleistocene aeolian parent materials on sandplain areas. They have deep uniform profiles, usually loamy sand or sandy loam in texture, with little increase in clay content with depth. They are red in colour, with massive structure and an earthy fabric.

Siliceous sands - Dune soils consisting of predominantly sand-sized particles comprise this group. They are loose soils with a single-grain structure and sandy fabric.

The Principal Profile Form (Northcote, 1979) is a notation derived from a key based solely on the physical characteristics of the soil profile. The main divisions and subdivisions of the key are:

Uniform soils - profiles with uniform texture throughout.

- Uc - coarse textured
- Um - medium textured
- Uf - fine textured, non-cracking
- Ug - fine textured, cracking

Gradational soils - profiles with increasingly finer (more clayey) texture with depth.

- Gc - calcareous (limy) throughout
- Gn - non-calcareous throughout

Duplex soils - profiles with an abrupt texture boundary between the A-horizon (topsoil) and B-horizon (subsoil).

- Dr - red clay B-horizons
- Db - brown clay B-horizons
- Dp - yellow-grey clay B-horizons
- Dd - dark clay B-horizons
- Dq - grey clay B-horizons

Organic soils - not present in Central Australia.

These notations are accompanied by a numerical code to specify diagnostic characteristics of individual soil profiles, as defined in Northcote (1979). The Principal Profile Forms recorded on Murray Downs include -

Uc 1.23, Uc 1.43, Uc 5.21, Um 5.51, Um 5.52, Uf 6.13, Ug 6.2, Ug 6.3, Gn 2.11, Gn 2.12, Gn 2.13, Gn 2.22, Gn 4.52, Dr 4.52

(iii) Soil Erodibility

The potential for a soil to erode is termed its erodibility, and is influenced by the nature of its parent material and the landform on which it occurs as well as inherent soil factors. The latter may include texture, salinity, ease of dispersion (sodicity) and the presence or absence of surface crusts and gravels.

In general, only soils with textures of sandy loam or lighter are likely to experience significant wind erosion. Water erosion is unlikely to affect very light-textured porous soils or clays, but will affect sandy loam or sandy clay...
loam surfaces. Saline or sodic soil materials (such as the B-horizon of solodic soils) are susceptible to the formation of strong surface crusts (scalding) and shallow gullying.

Gullying is often initiated where sheet runoff flows are concentrated into a channel by a linear surface feature such as a grader windrow or stock pad. Deep gullying is usually restricted to alluvial landforms, while the soils of pediment or peneplain surfaces are more susceptible to sheet erosion and rilling. The soils that have developed from partially stripped deeply weathered rocks (the pallid zone of laterite profiles) are particularly susceptible to shallow gullying or scalding, possibly as a result of slightly saline or sodic conditions.

The role of inappropriately-located graded tracks in initiating gully erosion on alluvial soils cannot be overemphasized.
2. VEGETATION

The distribution, composition and pastoral value of the various vegetation types on Murray Downs directly reflect the geology, landform and soil types of the country as outlined in the preceding pages. In particular, soil texture seems to have a major influence on the composition of pastures through its effect on nutrient availability and moisture-holding or infiltration characteristics. Within each vegetation type, the actual species composition of pastures can vary according to the effects of fire, seasonal rainfall pattern and grazing history.

In terms of pastoral land use, the vegetation types can be categorized into several broad pasture groups.

(i) Annual grass pastures

Annual grass pastures, consisting predominantly of oat, woollyoat, mulga, eight-day and five-minute grasses grow on medium-textured soils which have developed on freshly-weathered parent rocks or pallid zone clays. They have high palatability and feed value, mainly due to the abundance of oat and woollyoat grasses. Other species such as mulga grass may be quite acceptable to stock while green, but palatability and nutritional value decline with maturity. Limestone oat grass, which occurs on red calcareous soils, has poor palatability, even when green.

Since these pastures attract selective grazing pressures, and their viability is subject to annual seed setting, they are susceptible to change in composition with excessive grazing use. However, they are likely to respond to spelling during the summer growing season.

The top feeds associated with annual pastures are generally palatable to stock, and valuable perennial grasses such as umbrella and curly windmill grasses often grow as scattered tussocks beneath the topfeed canopy.

(ii) Kerosene grass and woollybutt pastures.

Kerosene and woollybutt grasses grow on soils of low to moderate fertility and usually in association with sandy loam surface textures. On Murray Downs they are present on alluvial soils and also on earthy sands as a recovery phase following the burning of spinifex.

Although these species are moderately palatable when green, their acceptability and feed value declines significantly with maturity and haying off. Minor pasture components such as oat grass and herbage are selectively grazed after summer rains, and stock turn to the kerosene grass and woollybutt as other feed becomes scarce. The impact of grazing on the composition of these pastures is relatively minor and special management other than the maintenance of moderate stocking rates is not necessary.

(iii) Eight-day grass pastures

Pastures consisting predominantly of eight-day grass grow on certain medium-textured red earths on Murray Downs.

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Eight-day grass is a 'resurrection' species which can survive long periods of drought and rapidly resprout after light rains. It is highly palatable and nutritious while green, but its value is limited by low bulk and poor persistence. The leaf material rapidly disintegrates with the onset of dry conditions.

Pastures dominated by this species therefore provide only opportunistic grazing, with a moderate carrying capacity after rains, but a very low carrying capacity at other times.

(iv) Perennial tussock grass pastures

These consist of tall growing perennial grasses such as desert bluegrass, silky browntop, Queensland bluegrass, kangaroo grass and neverfail and grow on medium to heavy-textured soils, principally the brown and grey clays and some red earths, particularly on landforms where runoff collects.

These pastures produce a large bulk of feed which is palatable and nutritious while green and shooting, but acceptability and protein levels decline as growth becomes rank and dries off. If tussocks are maintained in a closely-cropped condition, they will continue to produce green shoots and remain attractive to stock.

The composition of these pastures remains relatively stable under grazing use.

(v) Wire grass pastures

Pastures dominated by wire, mulga mitchell and woollybutt grasses grow on infertile medium-textured red earths developed on highly-weathered substrates, principally laterite. The pastoral productivity of these pastures is very low. Wire grass is virtually inedible to stock, and the associated topfeed, usually mulga, is also unacceptable. Woollybutt and mulga mitchell grasses, which are often only minor pasture components, provide sparse, opportunistic grazing.

(vi) Spinifex pastures

Hummock grasslands of hard spinifex grow in association with a range of shrub and mallee communities on the aeolian earthy sands and certain lithosols. This type of country has very limited pastoral value except during seasons when parakeelya is abundant.

However, burning may induce short-term desirable changes in plant composition, including an initial phase of kerosene grass and herbage growth given suitable seasonal conditions.

Soft spinifex pastures grow on slightly heavier textured soils, usually sandy red earths, and include a component of relatively palatable species such as mulga mitchell grass. The spinifex itself is sparingly grazed by stock, and acceptability can be improved by regular burning. However since stock selectively graze the more palatable grasses, they can be slowly depleted by prolonged grazing pressure.

Buck spinifex grows on medium-textured red earths on highly weathered substrates. It has no grazing value.
(vii) Further information

Additional information concerning the feed value and response to grazing of pasture species can be found in the Central Australian Range Herbarium (McColl and Ulyatt, 1982). Specific advice relating to pasture management may be obtained from the Department of Primary Industries and Fisheries in Alice Springs or Tennant Creek.
SECTION THREE - LAND UNITS OF MURRAY DOWNS STATION

A. SURVEY METHODOLOGY

Murray Downs has been mapped into twenty five land units on the basic of the stereo-interpretation of aerial photography and extensive on-ground survey.

The available air photography included a complete cover of black and white contact prints flown in 1971 at a scale of 1:80,000, which was used to map the sandplain area in the south-western part of the station. Colour aerial photography flown in 1980 at a scale of 1:25000 provided coverage of the Davenport Range and Skinner Creek floodout areas, and 1:50000 scale colour photos flown in 1981 covered the Froiland Range and country between No 11 and Bluebush Bore. High contrast 1983 black and white aerial photography at 1:80000 scale was available north of Lat. 21°00'. Tentative land unit boundaries were mapped onto the photography prior to the conduct of ground survey, and suitable sites for field examination were identified according to this preliminary classification.

Field survey work occupied approximately four weeks in late 1986 and consisted of vehicle traverses between recording sites, which were selected at an average intensity of 3.5 sites per 100sq km.

Since the southern half of the station is underdeveloped, access presented a major constraint to ground survey. Extended cross-country travel using puncture-proof types was necessary to record land attributes in this area.

At each recording site, landform, soil and vegetation characteristics were documented according to the criteria of McDonald et al (1984) and representative areas photographed. Soil profiles were examined using a Jarrett hand auger, usually sampling to a depth of about 0.6m, below which the dry condition of the soil rendered further penetration impractical.

Final amendments to land unit boundaries were made during a comprehensive re-examination of the aerial photography subsequent to the field survey. The boundaries delineated on the three different scales of photography were then collated onto orthophotomaps at a scale 1:100,000 using a Bausch and Lomb zoom transferscope, then transferred to base maps covering the northern and southern parts of the station at this scale. Maps of the main floodout along Skinner Creek, together with smaller areas on Conglomerate Creek and near No 13 Bore, were collated from the 1:25000 scale photography to provide maximum detail for these areas, which are likely to be the foci of soil conservation activities.

B. LAND UNITS

Each land unit described in this report delineates areas with relatively uniform landform, soil and vegetation attributes, which are reflected in its stocking capacity, response to grazing, attractiveness to cattle and erosion potential. Slight variability will be evident within each unit, consistent with the degree of resolution possible at mapping scales of 1:100,000 or 1:25,000. The units have been grouped according to the following landform categories:

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1. Range and hill country
2. Peneplain
3. Partially - stripped peneplain
4. Pediment
5. Limestone plains
6. Floodplains and floodouts
7. Swamps
8. Sandplains and dunefields

The description of each unit is structured according to the following format:

GENERAL DESCRIPTION - a brief statement of the main features of the landscape.

GEOLOGY - an indication of surface geology.

LANDFORM - a description of the terrain in terms of the landform pattern (eg floodplain, dunefield) and its relief, slope and drainage features.

SOILS - includes Great Soil Group classification (Stace et al, 1968) and Principal Profile Form (Northcote, 1979). The profile description covers horizon boundaries, field texture, Munsell colour name and notation of the moist soil, fabric structure, pH, the presence or absence of calcium carbonate and the occurrence of gravel and surface features.

VEGETATION - an outline of the structure of the vegetation community (eg open woodland, grassland) with a listing of the main species present. Where the original vegetation has been altered, both the existing and former components are indicated.

LAND MANAGEMENT IMPLICATIONS - a comment on any land management problems likely to be encountered with pastoral use of the land unit, including susceptibility to erosion and pasture degradation, and its grazing potential. Desirable land management practices are indicated where applicable.
C. LAND UNIT DESCRIPTIONS

1. RANGE AND HILL COUNTRY

These land units are characterized by moderate to strong relief and slopes of greater than 3% with a shallow soil cover. Runoff rates are high, but the erosion potential is negated by the stoniness of the land surface. Grazing potential is negligible.

This unit encompasses the hilly terrain of the Davenport and Froiland Ranges. Unit 3.1, the gravelly surface with mallees in the foreground, occupies lower slopes and valley floors.

LAND UNIT - 1.1

GENERAL DESCRIPTION - Ranges, hills and outcrops of quartzite; lithosols; sparse snappy gum with hard spinifex.

GEOLOGY - Mid-Proterzoic metamorphic rocks of the Hatches Creek Group, consisting mainly of quartzites and sandstones (predominantly Coulters, Unimba and Kurinelli Sandstones).

LANDFORM - Prominent strike ridges with relief to 150m, together with lower hilly terrain (to 30m) and reef outcrop. Large areas of this unit exhibit a trellis drainage pattern of minor creek channels.

SOILS - Lithosols (Uc 1.43). Where soil is present it is shallow and very stony.

VEGETATION - A sparse hummock grassland of hard spinifex snappy gum. A sparse cover of low shrubs, including holly grevillea, Acacia hilliana and Cassia glutinosa.
LAND MANAGEMENT IMPLICATIONS - No erosion hazard. These areas have negligible pastoral value, but areas of high relief may act as a barrier to the movement of stock. Small springs in the Davenport Range may hinder stock control.

LAND UNIT - 1.2

GENERAL DESCRIPTION - Hills and outcrops of sandstone; lithosols; sparse ghost gum, acacias and hard spinifex.

GEOLOGY - Flat-bedded quartz sandstones, consisting mainly of upper Devonian Dulcis Sandstone, with minor occurrences of Cambrian Tomohawk Beds.

LANDFORM - Low hills with rounded crests and relief to 50m, often closely dissected by a network of narrow gullies.

SOILS - Lithosols (Uc 1.43). Soils are extremely shallow and stony, or absent.

VEGETATION - A sparse hummock grassland of hard spinifex with an open shrub cover including holly grevilleas, blue-leaf cassia, fuschia bush and acacias, together with isolated specimens of ghost gum and long-leaved corkwood. The Tomohawk Beds, which are of limited extent, support an open woodland of Georgina gidgee and scant cover of annual grasses.

LAND MANAGEMENT IMPLICATIONS - No erosion hazard other than the possibility of minor scouring if cleared lines are bulldozed up slopes. Pastoral value is negligible.
2. PENEPLAIN SURFACES

A peneplain is a featureless, level or very slightly undulating surface with poorly-defined drainage, runoff usually dispersing as sheet flow. In Central Australia, these surfaces are the end product of an extremely long cycle of geological erosion of the mid-Tertiary, and are deeply weathered, consisting of an intact laterite profile.

Pastures on this type of mulga country have low feed value and are generally ignored by stock. The mulga is slumped into a characteristic 'grove' pattern which intercepts surface runoff from the sparsely treed intergrove areas.

LAND UNIT - 2.1

GENERAL DESCRIPTION - Level plains; red earths; groved mulga woodland with wire, mulga mitchell and woollybutt grasses.

GEOLOGY - Tertiary lateritic deep-weathering profile.

LANDFORM - Level or very gently undulating plains, with slopes of less than 1%. Runoff drains by sheet flow, and defined drainage channels are absent.

SOILS - Red earths (Gn 2.12), usually as deep soils. Profiles grade from a dark red (2.5YR3/6) sandy clay loam, pH 6.0-6.5 at the surface to a red (2.5 YR4/6) light clay, pH 6.5-7.0, at a depth of 0.5m. They have a massive structure with an earthy fabric throughout. Gravel is usually absent from the profile, but fine laterite nodules are often present on the soil surface and at a depth of 0.3-0.6m. The soil surface usually has a weak crust, and termite mounds are common.

VEGETATION - Groved mulga woodland, with occasional witchetty bush and native currant. Open intergrove areas support mulga mitchell, wire and woollybutt grasses, lifesaver burr and seasonally abundant white paper daisy. Buck
wanderrie, bandicoot and woollyoat grasses are also often present. Cotton panic, silky browntops, woollyoat and mulga grasses occur with wire grass beneath the mulga canopy.

**LAND MANAGEMENT IMPLICATIONS** - This landscape has a low potential for erosion, but storm runoff may initiate rilling and gullying where surface flows are concentrated by graded lines, tracks or similar earthworks. This has occurred south of No 2 Bore. If possible, new roads should be planned on aerial photos to avoid low lying areas where runoff flows will be greatest.

Pastures include few palatable species and are usually avoided by stock even when feed is scarce elsewhere. Mulga mitchell grass, the most acceptable feed present in any quantity, appears to disappear with prolonged grazing pressure. Similar country is known to induce the "pegleg" phosphorus/protein deficiency syndrome in cows. Hot summer wildfires tend to promote a dense growth of unpalatable wire grass which has no grazing value.

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A thick growth of mulga is characteristic of this unit. The groundcover consists mainly of eight day grass, which disintegrates during dry conditions such as at the time of this survey.

**LAND UNIT - 2.2**

**GENERAL DESCRIPTION** - Level drainage floors; red earths; mulga woodland with eight-day grass.

**GEOLOGY** - Cainzoic lateritic deep-weathering profile and Quaternary alluvium.

**LANDFORM** - Drainage floors up to 1km in width, either level or with very gentle slopes, usually associated with Land Unit 2. Run-on water is conveyed as a sheet flow, and defined drainage features are absent.

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SOILS - Red earths (Gn 2.12, Um 5.52). Typical profiles graduate from a dark reddish brown (5.0YR3/4) sandy clay loam, pH 6.0-6.5, at the surface, to a red (2.5YR4/6) sandy clay, pH 6.5, at a depth of 0.6m, although at some sites no appreciable increase in clay content was recorded with depth. They are massive with an earthy fabric, and gravel is usually absent. Surfaces are weakly crusted and termite mounds usually present.

VEGETATION - A woodland of mulga, with solitary coolibah, bloodwood, ironwood and native currant. Surfaces supported sparse cover when inspected, dominated by eight-day grass. Other species present included hairy native couch, lifesaver burr, wire grass and woolly oat grass. Dense canopy cover often precludes grass growth.

LAND MANAGEMENT IMPLICATIONS - Soils have a low erodibility, but major gullies can develop where large runoff flows are channelled by poorly located tracks, such as near No 1 and No 3 Bores. Tracks are best located off this land unit, but if unavoidable, require adequate formation and drainage. Soils will remain boggy after rains.

Pastures are palatable and will be moderately productive after summer rainfall. However, the eight-day grass will rapidly disintegrate with the onset of dry conditions, and grazing capacity will be dependent on the abundance of woolly oat grass.
The gravelly rises of this unit support pastures of soft spinifex and mulga mitchell grass which attract only light grazing use.

**LAND UNIT - 2.3**

**GENERAL DESCRIPTION** - Broad rises with gentle slopes; gravelly lateritic red earths; mulga, witchetty bush and red-bud mallee with soft spinifex.

**GEOLOGY** - Tertiary lateritic deep-weathering profile.

**LANDFORM** - Broad low rises with very gently undulating surfaces, often with relief up to 15m above the surrounding landscape and marginal slopes of 5-10%. Drainage features are absent and runoff is dispersed through sheet flow.

**SOILS** - Shallow, gravelly red earths (Um 5.51, Gm 2.12). Profiles are dominated by laterite gravel 5-50mm in diameter and comprising a surface cover of 20 - 80%, where soils are present they are usually less than 0.4m deep, consisting of a dark red (2.5YR3/6) sandy clay loam, pH 6.0, turning red (2.5YR4/6) and pH 6.5 depth. Soil fabric is earthy throughout, and structure massive.

**VEGETATION** - A groved shrubland of mulga, witchetty bush and red-bud mallee with umbrella bush, sandhill wattle, native fuschia and occasionally long-leaved corkwood. The open intergrove areas, usually about 20m in width, support sparse soft spinifex with mulga mitchell and woollybutt grasses, and smokebush.

**LAND MANAGEMENT IMPLICATIONS** - These areas have a very slight erosion hazard. Tracks cleared up steep marginal slopes may be subject to rilling during storm rainfalls.

Pastures have a low palatability and limited grazing capacity. The most productive species present is mulga mitchell grass, which is sensitive to grazing pressure and will tend to disappear if overgrazed. The soft spinifex is very sparingly grazed, although burning will improve its acceptability.

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Abundant dome-shaped termite mounds are often a feature of this landscape. In contrast to Unit 3.1, the intergrove areas are broad and support annual grasses.

LAND UNIT - 2.4

GENERAL DESCRIPTION - Very gently-sloping plains; slightly stony red earths; widely spaced groves of mulga or witchetty bush and neverfail and annual grasses.

GEOLOGY - Lightly stripped Tertiary lateritic deep-weathering profile.

LANDFORM - Very gently-inclined plains with a slope of 1% and no surface relief, usually on the margins of drainage floors or swamps. Drainage is by sheet flow and watercourse features are absent.

SOILS - Red earths (Gn 2.12). These soils are similar to those of Unit 2.1, but have gravelly surfaces. Profiles graduate from a dark reddish brown (2.5YR 3/4) sandy clay loam surface, pH 6.5, to a dark red (2.5YR3/6) or reddish brown (2.5YR4/4) light clay, pH 7.0, at a depth of 0.7m, and are massive and earthy throughout. East of Chablow Bore, surface textures are slightly heavier, approaching a sandy clay. Surfaces are crusted and usually carry a 5% cover of laterite nodules and quartz gravel. Laterite nodules are present throughout most profiles.

VEGETATION - A groved woodland of mulga or witchetty bush with open intergrove areas of between 50m and 100m in width. The open areas support sparse tussocks of neverfail with mulga, woollyoat and wire grasses and lifesaver burr. Under the mulga canopy, wire, neverfail, mulga mitchell and woollyoat grasses are present, and occasionally silky browntop and umbrella grass.

LAND MANAGEMENT IMPLICATIONS - Active sheet erosion is often present on this land type, more as a consequence of natural slope processes than land use. Areas in the southern part of the station 40km from permanent water exhibit similar erosion features to grazed areas. Soil loss is characterized by an
erosion scarp 5cm high and up to 10m in width progressing upslope, exposing a sealed, gravelly surface. To avoid the channelling of runoff and subsequent scour, the siting of graded tracks diagonally across the slope of this unit should be minimized.

Pastures are of moderate quality and palatability. The abundance of woollyoat grass and presence of umbrella grass provides an indication of the state of pastures as these species are selectively grazed and consequently disappear when grazing pressures are excessive.

Sheet erosion on land Unit 2.4 in the Proland Ranges area. Small erosion scarps progress slowly upslope, exposing a sealed gravelly surface. These features were observed on this land type in both grazed country and areas totally isolated from livestock, suggesting that they may reflect natural slope processes.
SOILS - Red earths (Gn 2.12, Gn 2.13). Surface soils are red (2.5YR4/6) or reddish brown (5.0YR4/4) sandy clay loams, pH 6.0-6.5, graduating to a red (2.5YR4/6) fine sandy clay loam or light clay, pH 6.5 at 0.35m, and profiles are massive and earthy throughout. South of Chablow Bore, profiles were alkaline (pH 9.0) and gypseous at 0.7m. Surfaces are crusted and usually veneered with a lag deposit of quartz, silcretes and laterite gravel and pebbles. In the vicinity of upland areas (Land Unit 1.1) an extensive colluvial deposit of quartzite pebbles and cobbles is also present.

VEGETATION - A sparse mallee shrubland of Sturt Creek mallee and scattered Normanton box over buck spinifex. Other species often present include sandhill wattle, curry wattle, Acacia hillyana and caustic vine.

LAND MANAGEMENT IMPLICATIONS - The landscape has only a slight erosion hazard, extensive areas being well-protected by surface gravels. However, earthworks which disturb the gravely mantle and channel runoff flows are likely to initiate rilling. Minor gullying sometimes occurs in localized areas on the margins of this land type where it abuts other units, usually as a result of natural processes. Since surfaces are medium-textured and crusted, they have a low susceptibility to wind erosion.

The spinifex community has negligible grazing value.

Small areas of gidyea country occur in the Freeland Range area. They are attractive to grazing stock, but soils are erodible, demanding careful siting of tracks and other improvements.

LAND UNIT - 3.2

GENERAL DESCRIPTION - Level plains; gravelly red earths; an open woodland of Georgia gidyea with annual grasses.

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GEOLOGY - Partially stripped Cainozoic lateritic deep-weathering profile.

LANDFORM - Level of gently-sloping plains with very low relief, sometimes broken by reef outcrops of deeply-weathered rock. Defined drainage systems are generally absent and runoff drains as a sheet flow into broad shallow depressions.

SOILS - Red earths (Gn 2.12). Surface soils are dark reddish brown (5.0YR3/4) sandy clay loams, pH 6.5-7.0, with an earthy fabric, overlying a coarse gravelly layer of silcrete fragments at 0.25m, which hindered deeper inspection. Surfaces have a moderately strong crust, and localized areas have a cover of coarse silcrete gravel.

VEGETATION - An open woodland of Georgina gidyea with a sparse shrub cover of green-leaf cassia, native fuchsia and conkleberry. Pastures consist predominantly of eight-day grass with woollyoat, mulga and mulga Mitchell grasses, smokebush and seasonal herbage, mainly buckbush. Curly windmill grass and ruby saltbush are common beneath the gidyea canopy.

LAND MANAGEMENT IMPLICATIONS - The landscape exhibits similar sheet erosion features to Unit 2.4. Small erosion scarps, up to 5cm in height and 5m in width, progressing upslope and exposing a sealed, gravelly surface, are occasionally present. The role of current grazing practices in initiating these scarps is unclear, and they possibly reflect natural slope processes alone, at worst only aggravated by soil disturbance due to stock. Surfaces may be subject to minor gullying if runoff is channelled by tracks or graded lines, so grading should be avoided or adequate drainage provided. These soils have a very low wind erosion hazard.

Pastures are of good quality and palatability. The eight-day grass will provide a rapid flush of growth after rainfall, but will rapidly disintegrate with the onset of warm weather. Sustained productivity is provided by woollyoat and curly windmill grasses and to a lesser extent mulga grass. The former two grasses will be grazed out if long-term stocking rates are too high, but should respond to summer spelling.

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The surfaces of this unit feature abundant quartz gravels and scattered granite outcrops. Only limited areas of this type of country were identified, but they were attracting heavy grazing use.

**LAND UNIT - 3.3**

**GENERAL DESCRIPTION** - Gently undulating rises; stony red earths; a sparse shrubland of witchetty bush, northern witchetty bush and mulga with annual grasses.

**GEOLOGY** - Partially-stripped Cainozoic deep-weathering profile and outcrops of Proterozoic granites.

**LANDFORM** - Gently undulating terrain with slopes of 1% and relief to 10m, featuring scattered low rocky outcrops and occasionally prominent granite tors to 30m in height. Surfaces drain into closely spaced network of narrow watercourses, which occupy scalded drainage floors in their lower reaches.

**SOILS** - Stony red earths (Gn 2.12). Surface soils consist of a red (2.5YR4/6) sandy clay loam, pH 6.0-7.0, containing up to 50% of coarse quartz gravels, and graduate to a red (2.5YR4/6) sandy clay, pH 7.0 by 0.3m, with about 5% fine quartz gravel. Profiles are massive and earthy throughout. Surfaces are crusted and have an abundant lag deposit of quartz gravel and cobbles on the surface.

Fine gravelly red earths (Gn 2.11) flank granite tors and rocky outcrops. Profiles graduate from a dark reddish brown (5.0YR3/4) sandy clay loam, pH 7.0, with up to 50% fine gravel to a dark red (2.5YR3/6) sandy clay, pH 6.5, containing 30% of fine gravel at a depth of 0.45m. Profiles are massive and earthy, with a weakly crusted surface veneered with fine gravel.
The drainage floors have duplex soils (Dr 4.52). A-horizons consist of an earthy red (2.5YR4/6) sandy loam, pH 7.0, to 0.3m deep, overlying a massive B-horizon, a red (2.5YR4/6) sandy clay loam, pH 7.0. Gravel is absent from the profile and surfaces are weakly crusted. The margins of the drainage floors are usually partially scalded and shallow gully ing is often active.

VEGETATION - The red earths support a sparse shrubland of northern witchetty bushes with scattered mulga, blue-leaf and green-leaf cassias and harlequin emu bush. Pastures are sparse, consisting mainly of woollycoat and eight-day grasses with mulga and five-minute grasses, scattered tussocks of common sida, kangaroo and wire grasses, smokebush and lifesaver burr.

The drainage floors have an open shrubland of harlequin emu bush with conkleberry, blue-leaf and green-leaf cassias and scattered mulga. Pastures consist of neverfail with mulga, woollycoat, eight-day, curly windmill and desert bluegrassess and seasonal herbage.

LAND MANAGEMENT IMPLICATIONS - Stony pavements protect most of the red earths from sheet erosion, but soils with fine gravelly surfaces adjacent to outcrops will wash when denuded Grader operations, particularly the flat grading of tracks, that disturb surface pavements and channel surface runoff should be avoided. Minor scalding and gully ing is characteristic of the drainage floors, but disturbance by stock can rapidly accelerate these processes when pasture cover is poor.

Although sparse, pastures on the stony soils are of high quality and attractive to stock. Similarly, the drainage floors are productive areas and a focus of grazing pressure. Overgrazing over a number of years will result in declining abundance of the most productive grasses, and an increase in short-lived species. Moderate grazing pressures and summer spelling should minimize this trend.
This unit can be identified by the abundance of termite mounds on yellow-grey coloured soils with a pink sandy surface veneer. Deeply-weathered rock outcrop is occasionally present.

LAND UNIT - 3.4

GENERAL DESCRIPTION - Swamp margins; yellow earths; an open woodland of coolibah and mulga with neverfail.

GEOLOGY - Partially-stripped Cainozoic deep-weathering profile.

LANDFORM - Level or very gently sloping plains with featureless surfaces, usually as swamp margins or drainage floors adjacent to Units 2.1 and 2.4, and subject to infrequent flooding. Minor outcrops of deeply-weathered rock are occasionally present.

SOILS - Yellow earths (Gn 4.52, Uf 6.13). Profiles commonly graduate from a reddish grey (5.0YR5/2) sandy clay loam, pH 6.0-6.5 at the surface to a pinkish grey (5.0YR6/2) medium clay, pH 6.5-7.5, at 0.35m, with occasional light red (2.5YR6/8) mottles at this depth. Most profiles are earthy throughout but weak pedality may be evident. Gravel is usually absent. Surfaces are crusted and partly veneered with loose deposits of red (2.5YR5/8) coarse sand. Termite mounds are common on some areas.

VEGETATION - An open woodland of coolibah with scattered mulga or witchetty bush, often juvenile. Groundcover is usually absent or very sparse, consisting of tussocks of neverfail with sensitive plant, woolly oat grass and wire grass.

LAND MANAGEMENT IMPLICATIONS - Surface soils generally have a high clay content and low erodibility. The localized movement of sandy surface deposits by wind action should not be regarded as a significant soil loss process.

Grazing capacity is limited by the extent of bare ground. The sparse tussocks of neverfail provide a small quantity of palatable feed of intermediate quality.

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