1993

Soils of the Northam Advisory District. Volume 3. The Darling Range and West Kokeby zones

Ian Fulton

Neil Clifton Lantzke

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Soils of the Northam Advisory District
The Darling Range and West Kokeby Zones

Compiled by
Ian Fulton and Neil Lantzke
Rainfall Isohyets

In the Department of Agriculture's

Soils of the Northam Advisory District

Figure 1

Northam Advisory District

Physiographic Regions and Rainfall Isohyets in the Department of Agriculture's

Figure 3

Darling Range Zone

and West Koorkaby Zone
1. Introduction

1.1 Aims of the manual

This manual describes the soils of the Department of Agriculture’s Northam advisory district. Information is provided on the characteristics of each soil, its capability is discussed and yield estimates for the major land uses are given.

Designed for use by farmers and Department of Agriculture staff, the manual’s primary aims are to:

- assist with the identification of the advisory district’s soil types;
- match land use with land capability;
- improve farm productivity and efficiency; and
- reduce the incidence of land degradation.

The manual provides a framework for the description and classification of the advisory district’s soils. The soil types described provide a basis for farm and catchment soil mapping from which land management plans can be developed.

General use of the manual will promote consistency and avoid confusion when referring to soil types. This will allow more accurate extension of farm management information and research results. Other applications include an introduction to the soils of the district for people new to the area and provision of a standardised method for describing Department of Agriculture trial sites.

The manual is divided into three volumes according to the broad physiographic regions within the advisory district (Figure 1). This volume (Volume 3) refers to the soil types that occur within the Darling Range and West Kokeby Zones. Volume 1 deals with the soil types that occur within the Zone of Ancient Drainage and Volume 2 with those soils in the Zone of Rejuvenated Drainage.
<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Vegetation</th>
<th>Soil Landscape Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kokeby (K)</td>
<td>Jarrah, Mani, White Gum</td>
<td>Maitland</td>
</tr>
<tr>
<td>Shedam (S)</td>
<td>Gum Powder, Bark Parrot</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Bush, Buckshot, Gravel</td>
<td>Williams</td>
</tr>
<tr>
<td>Mainland (Ma)</td>
<td>Yellow Gravely Loamy Sand</td>
<td>Williams</td>
</tr>
<tr>
<td>Dale (Da)</td>
<td>Alluvial Loam</td>
<td>Williams</td>
</tr>
<tr>
<td>Williams (W)</td>
<td>Yalanbee (Ya)</td>
<td>Williams</td>
</tr>
<tr>
<td>Maitland (M)</td>
<td>Pindalup (Ph)</td>
<td>Williams</td>
</tr>
<tr>
<td>Leaver (L)</td>
<td>Flooded Gum Rushes</td>
<td>Williams</td>
</tr>
<tr>
<td>Yalanbee (Ya)</td>
<td>Poorly Drained Sandy Loam</td>
<td>Williams</td>
</tr>
<tr>
<td>Williams (W)</td>
<td>Loamy Sand/Sandy Loam</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Grey Granitic Loamy Sand</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Rocky Red Brown Loamy Sand</td>
<td>Williams</td>
</tr>
<tr>
<td>Sheoak (S)</td>
<td>Stamford, Banksia Tree</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Flooded Gum Tea Tree</td>
<td>Williams</td>
</tr>
<tr>
<td>Williams (W)</td>
<td>Flooded Gum White Gum</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Flooded Gum Poorly Drained</td>
<td>Williams</td>
</tr>
<tr>
<td>Shallow (Sh)</td>
<td>Sandy Loam Duplex</td>
<td>Williams</td>
</tr>
<tr>
<td>Williams (W)</td>
<td>Yellow Gravelly Loamy Sand</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Marri White Gum</td>
<td>Williams</td>
</tr>
<tr>
<td>Kokeby (K)</td>
<td>Gum Rushes Low Scrub</td>
<td>Williams</td>
</tr>
</tbody>
</table>
1.2 The Darling Range and West Kokeby Zones

The Darling Range Zone occurs in the far west of the advisory district and extends into the State forest. In the west of this zone the landscape consists of an undulating, gravelly plateau with thin, swampy valley floors. To the east, predominantly eastward flowing watercourses and major streams such as the Dale River and Talbot and Clackline Brooks have cut into this plateau, creating steep, gravelly and rocky valleys. This area includes the dissected Dale district.

The Darling Range Zone is bordered to the east by the Zone of Rejuvenated Drainage (Avon Valley) and in the south-east by the West Kokeby Zone.

The West Kokeby Zone occurs as a small area in the south of the advisory district nestled between the Darling Range Zone and the Zone of Rejuvenated Drainage. The landscape is characterised by low lying, valley flats with gently undulating sideslopes. The soils are predominantly deep sands over clay and deep sands with areas of gravelly soils on the sideslopes. A number of swamps occur.

The Darling Range and West Kokeby Zones can be divided into broad soil groups that occur at certain positions in the landscape (soil landscape units). Figure 2 is a block diagram of this landscape showing the ten soil landscape units that occur and lists their soils and dominant vegetation.

These soil landscape units have been mapped at a scale of 1:100,000 over about 1500 km² within the Northam advisory district. This mapping, along with other mapping in the district, is published in a report titled ‘Land resources of the Northam region’ (Lantzke and Fulton 1993). The location of this and other surveys around the advisory district is shown in Figure 3.

Mapping at this scale is of limited use to the farmer and farm planner. However, the maps can be used to identify a soil landscape unit at a particular site, and from this a soil type can be keyed out using Table 1 on page 61. The major use of this broadscale mapping is regional planning.

The Yalanbee unit contains the undulating Darling Plateau uplands which have ‘buckshot gravel’ or ‘pea gravel’ soils. The Pindalup unit contains the shallow, minor, swampy valley floors that occur within the Darling Plateau.

Where the Darling Plateau has been dissected by streams, a different set of soil landscape units has developed. The Leaver unit contains gravelly, hillslope soils derived from the dissected lateritic profile. It includes the breakaway face, the steep, upper slopes and the moderately sloping, lower colluvial slopes.

The Michibin unit occurs on the hillslopes and contains duplex soils which often have granite or other rock within the profile. These soils are derived from fresh rock. The floodplains of the major streams and brooks that have dissected the eastern part of the Darling Range Zone occur within Williams unit.

The Kokeby unit occurs as gently undulating sideslopes in both the Darling Range Zone and West Kokeby Zone. It contains pale, sandy surfaced soils, over gravel or clay, with small areas of gravelly ridges. The Sheahan unit consists of deep, pale sands and is especially common in the West Kokeby Zone. The broad valley floors which contain deep sandy duplex soils that commonly occur in the West Kokeby and Dale River areas, occur within the Dale unit. The swamps and poorly drained areas that occur within the Dale unit belong to the Maitland unit.

7 Soils of the Northam Advisory District
Figure 3
Location of the Study Area, Other Survey Areas, Physiographic Regions and the Department of Agriculture's Northam Advisory District.

**LEGEND**

**Study Area**
- Lantzke and Fulton (1993)

**Other Surveys**
- Bettenay and Hingston (1961)
- MoArthur, unpublished.
- King and Wells (1990)
- Grealish, unpublished.

- Dept. of Agriculture's Northam Advisory District Boundary.
- Boundaries of Physiographic Regions.

Zone of Ancient Drainage
Darling Range Zone
Zone of Rejuvenated Drainage
West Kokeby Zone
Swan Coastal Plain

Merredin
Kellerberrin
Koolgoorin
Trayning
Wyalkatchem
Koordina
Nungarin

Perth
State Forest
Toodyay
Northam
Wundowie
York
Beverley
Quairading
1.3 Climate and land use

The average annual rainfall for the Darling Range Zone, within the Northam advisory district ranges from about 800 mm on the western edge to about 550 mm in the east. The average annual rainfall for the West Kokeby Zone is about 500 mm. About 80 per cent of the annual rainfall falls during the six-month growing season (May to October). Appendix 1 gives the mean monthly rainfall, mean daily maximum temperature and mean daily pan evaporation data for various locations within and around these zones.

The two main land uses are commercial farming and rural residential subdivisions.

Commercial farms usually range from 500 to 1000 ha. On average about 20 per cent of the land is cropped annually with the balance being pasture, carrying either sheep or cattle. The major crops grown are oats, wheat, barley and lupins. The five year average yields for these crops within these zones are; oats, 1.5 t/ha; wheat, 1.8 t/ha; barley, 1.7 t/ha; and lupins, 1.0 t/ha. The pasture is usually subterranean clover or medic based, with an average carrying capacity of about 10 DSE/ha (winter grazed).

There are about 3500 small holdings within the Northam advisory district. These holdings are used as hobby farms or rural retreats and usually have some form of dwelling on them. Local farmers are concerned that a significant and growing proportion of rural land is being alienated from agricultural use. A large percentage of these small holdings are in the Darling Range Zone and are often concentrated along the main arterial roads leading from Perth to Toodyay, Northam and York.

The main land degradation issues in the Darling Range and West Kokeby Zones are salinity, waterlogging and water erosion.

Many of the creeklines have become saline following clearing. Tree planting, growing crops and pastures with high water use, banks, drains and saltland agronomy are being used to manage or reduce the area affected by salinity.

Waterlogging is a major problem on the gentle lower slopes and valley floors which are especially common in the Dale River and West Kokeby areas.

Water erosion occurs on the steep, rocky hillslopes and breakaway country in dissected areas of the Darling Range Zone. The use of grade banks to control water erosion and waterlogging is widespread.

Other forms of land degradation affecting these zones are wind erosion, soil structure decline, non-wetting soils and the development of traffic compaction pans. Soil acidification is now becoming a problem on higher producing, sandy surfaced soils which have a low buffering capacity and high potential for leaching. Liming will be necessary on many soils in the future.
1.4 The structure of the manual

Each of the 15 major soil types are described in the following format:

- idealised soil diagram;
- identifying characteristics;
- position in the landscape;
- vegetation;
- land qualities;
- productivity and capability; and
- yield estimates and capability ratings table.

Where possible the soils have been given commonly used local names such as Buckshot gravel. In other cases the soil type was given a name which describes its main features. One or more Northcote (1984) Principle Profile Forms are given below the soil title. The soil series name is also given (Purdie, unpublished).

1.4.1 Idealised soil diagrams

The properties of each soil type are described by the use of an idealised soil diagram.

The soil diagrams show a slice of soil from the surface down to one metre. Each soil can be broken up into layers or horizons. These horizons are given different notations.

The A1 horizon is the darker topsoil layer where humified organic matter has accumulated. An A2 horizon may be present in some soils, occurring immediately below the A1 horizon. It is a paler, often bleached layer with less clay than the horizons above or below. A B2 horizon is the subsoil layer characterised by a concentration of clay, a structure and/or consistency unlike the soil above, and stronger colours. C horizons refer to the decomposing parent material or rock which occurs beneath the soil.

Note: A transitional A3 horizon may occur with characteristics of both the A and B horizons but closer in properties to the A horizons. A B1 horizon is a transitional horizon with characteristics between the A and B horizons but closer in properties to the B2 horizon.

For more information on describing soil horizons refer to McDonald et al. (1984).

The different horizons within the diagram are coloured in the most commonly occurring colour. The sloping line boundaries between horizons indicate the range of depths at which the boundary can occur. For example, the top of the A2 horizon in the Deep pale sand may occur from 10 to 15 cm and this horizon reaches to depths of 80 to greater than 100 cm. A dashed line indicates a diffuse boundary between the two horizons.

The properties of each soil horizon are given to the side of the soil diagram. The moist colours of each soil horizon are described and a Munsell colour code, such as 10YR 3/2, given in parentheses*.

* In some cases the Munsell colour was abbreviated for the sake of simplicity.
The texture of each horizon and the size of the sand fraction are given. Many farmers in Western Australia tend to over-estimate clay content. For example, the ‘Avon Valley loam’ is in fact generally a loamy sand but can be a sandy loam. Many soils locally referred to as ‘clays’ have a thin sandy loam or sandy clay loam topsoil. The standard definitions of each texture class are given in Appendix 2. Appendix 3 defines the three different sand grain sizes.

The condition of the surface soil, structure and fabric are described. Appendix 4 defines each of these characteristics.

The presence or absence of rocks, calcareous (lime) segregations and mottles is also noted. Mottles are spots, blotches or streaks of subdominant colours which are different from the general soil colour.

A typical pH (in water) of each horizon is listed. In some cases a range of pH values are given.

A colour photograph of a typical example of the soil profile is shown next to the soil diagram.

1.4.2 Identifying characteristics

This section contains a brief description of the soil type. Possible variations from the soil diagram that occur are given (soils never all fit neatly into specific soil types). The highlighting features which separate the soil type from other similar but different soils are provided. This information can help the user decide into which soil type a particular soil fits. Any locally used names for the soil are given.

1.4.3 Position in the landscape

The ‘Position in the landscape’ section describes where that particular soil occurs in the landscape. This can be helpful in identifying a particular soil. For example, the Buckshot gravel occurs above breakaways on an undulating plateau.

The soil landscape unit(s) in which the soil occurs is given. For example, the Yellow gravelly loamy sand occurs within the Leaver soil landscape unit.

1.4.4 Vegetation

The dominant, indicator vegetation species on each soil are included. However, care must be taken as the vegetation growing on a particular soil type may vary from area to area.

1.4.5 Land qualities

The land qualities of each soil type such as moisture availability, waterlogging and wind erosion hazard are rated from high to low. This section analyses the merits and limiting factors of each soil type. Appendix 5 defines the categories of each land quality.
The land qualities considered appropriate in this study were:

**Moisture availability (m)**

Moisture availability is the ability of a soil to retain moisture for plant growth. It is dependent on soil texture, soil depth and soil structure.

**Nutrient availability (n)**

Nutrient availability is the ability of a soil to retain and supply nutrients for plant growth. It depends largely on the clay content, clay type, organic matter content and pH.

**Waterlogging risk (i)**

Waterlogging occurs when a soil is saturated with water. Oxygen supply to the roots becomes limited affecting plant growth and vigour.

**Trafficability (t)**

Trafficability refers to the ability to use machinery on the soil type. Boggy and rocky soils and steep land all limit vehicle access.

**Rooting conditions (d)**

Rooting conditions refers to the physical impedance to root development and the amount of soil volume available for plant roots. Siliceous hardpans, shallow bedrock and dense clay layers all affect root growth.

**Soil structure decline risk (s)**

Soil structure decline can be divided into two categories: surface soil structure decline on heavy soils; and the development of traffic compaction pans below the surface on lighter soils.

**Salinity risk (y)**

Salinity is the build up of soluble salts, especially sodium chloride, within the soil profile. High salt levels in the soil water increase the osmotic pressure and affect the plant's ability to take up moisture.

**Wind erosion risk (w)**

Wind erosion risk is the potential for a piece of land to erode because of the action of wind. It is dependent on the soil's erodibility, the wind exposure, the type and amount of ground cover and land management practices.

**Water erosion risk (e)**

Water erosion risk is the potential for sheet, rill or gully erosion to occur. It is dependent upon soil erodibility, slope gradient, rainfall intensity, run-on received, the type and amount of ground cover and land management.

**Recharge hazard (g)**

Recharge hazard is the potential for a piece of land to recharge the deep groundwater and thus contribute to salinity.
1.4.6 Productivity and capability

This section describes the suitability of the soil type to support five different land uses. These uses are: annual pasture, cereals, lupins (*Lupinus angustifolius*), canola (*Brassica napus*) and tagasaste (*Chamaecytisus palmensis*). These land uses were chosen because they are commonly practised or because they have potential.

Annual pasture may consist of subterranean clover (*Trifolium subterraneum*), burr medic (*Medicago polymorpha*) or murex medic (*M. murex*) based pasture or grassy and broad-leaved pastures.

The most common types of cereals grown are oats (*Avena sativa*), wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*).

1.4.7 Yield estimates and capability rating table

Estimates of the achievable yields of selected land uses on each soil type are presented in tabular form. Included in the table is a capability rating for that particular soil to support the land use.

The yield estimates were obtained from discussions with farmers and Department of Agriculture staff. Pasture production is expressed as carrying capacity in dry sheep equivalents (DSE) per hectare (winter grazed), as estimates of pasture growth could not be obtained. A dry ewe or wether equals 1 DSE, a ram about 2 DSE and a ewe with a lamb 1.2-1.5 DSE. Grain yield estimates are given in tonnes per hectare (t/ha). Generally, 1 t/ha of oat grain will equate to 2 to 2.5 t/ha of oaten hay.

The ‘achievable average yield’ figures quoted are the average yields that the best farmers in the zone are obtaining now (1992) on that soil type with good management and up-to-date technology. For crop production this refers to factors such as early seeding, herbicide use, recommended variety and optimum economic fertiliser use. For pasture production this refers to grass control, insect control, correct stocking rate and adequate nutrient supply.

The ‘potential yield’ figure is an estimate of the potential yield of that soil given an average rainfall season.

Production figures have not been given for canola and tagasaste as there is little information available, only a capability rating is given.

Yield figures are estimates and will not be agreed to by every farmer in the district. However, they do give a general ‘ball park’ figure for yields on that soil and highlight the relative performances between soils.

There is considerable variation in the properties of some soil types. This variation has been accounted for in the discussion of each soil type and in some cases, by giving a range of yields in the yield table.

Different farmer practices and ability should be taken into account when using the yield figures. The type and length of rotation will also affect yield.
The three volumes of this manual covering the broad physiographic regions of the advisory district (the Zone of Ancient Drainage, the Zone of Rejuvenated Drainage and the Darling Range and West Kokeby Zones) divide the soils up into three climatic zones. However, within each zone there is some variation in rainfall, with the annual average decreasing to the east. The location of the farm within the zone and therefore its rainfall should also be taken into account when using the yield figures.

These yield figures will become dated with further advances in agriculture. They should be revised periodically.

Land capability, that is the ability of land to sustain a specific use without undesirable on-site or off-site effects, has been assessed by comparing the requirements of the five land uses with the physical attributes of the soil types described.

The land capability method used by the Department of Agriculture is the five class (I to V) system based on the land evaluation guidelines developed by the Food and Agriculture Organisation of the United Nations (FAO 1976, 1983). Where Class I land has the highest potential with the least limitations, for a specified use and Class V land has limitations so severe as to preclude it from the proposed land use (see Appendix 6 for details on the Department of Agriculture’s five class land capability rating system). The land qualities which are the most limiting for a particular land use are given as a letter subscript after the capability rating i.e. Class III land with a water (e) and wind (w) erosion risk is written as IIIew.

The capability ratings quoted relate to productivity of soils within the Department of Agriculture’s Northam advisory district only. Consequently productivity of Class I pasture land in the Northam advisory district will be different from Class I pasture land at Margaret River.

Section 2.2 defines eight minor soil types whose limited occurrence does not warrant their inclusion in the main body of the text.

Chapter 3 discusses the application of the manual to mapping soils for farm planning.

1.5 Methodology

The following procedures helped in the development of this soil manual.

- Broadscale soil landform mapping of 1500 km² of the Darling Range and West Kokeby Zones within the Northam advisory district. Three hundred and fifty soil profiles were described.
- The mapping of a ‘window farm’ to test the applicability of mapping the soils of the manual at farm scale (1:10,000). One hundred soil profiles were described.
- The manual’s soils or amalgamations of these were mapped by five catchment groups. Individual farmers mapped the soils of their farms with assistance from the authors of this manual.
- Discussions were held with the relevant Department of Agriculture staff on the land use requirements of each crop and pasture type.
- Discussions were held with farmers situated throughout the Darling Range and West Kokeby Zones in order to obtain comments and yield data for each soil.
- Yield estimates were obtained for each soil type from Department of Agriculture advisory and technical staff.
2. Soil types

2.1 Major soil types

The 15 major soil types that occur in the Darling Range and West Kokeby Zones are:

1. Buckshot gravel
2. Deep pale sand
3. Pale sand over gravel/loamy sand
4. Breakaway face and ironstone cap
5. Sandy loam over pinkish clay below breakaways
6. Yellow gravelly loamy sand
7. Rocky red brown loamy sand/sandy loam
8. Brownish grey granitic loamy sand
9. Stony soils
10. Deep sandy surfaced duplex
11. Poorly drained sandy loam duplex
12. Alluvial loam
13. Sandy surfaced valley duplex
14. Grey alluvial clay
15. Loamy sand surfaced valley duplex
1. Buckshot gravel

P.P.F. KS-Uc 4.21, Uc 5.11, KS-Uc 5.11, Uc 5.22, KS-Uc5.22.  
Yalanbee series

Identifying characteristics

This soil includes the very gravelly ‘buckshot’ or ‘pea’ gravel soils that commonly occur on the undulating plateau of the Darling Range.

The soil has a firm, dark grey to dark brown sand to loamy sand surface horizon. This overlies a brownish yellow sand or loamy sand subsoil. Fine, round ironstone gravel occurs throughout the profile and often comprises 60 to 80% of the soil volume. Ironstone boulders may occur on the soil surface and lateritic cap rock (duricrust) is often encountered at depth.

Variation from the idealised soil profile given include:

(i) poorer phases with a pale yellow to white (10YR 7/3), sandy gravel subsoil; and

(ii) soils similar to the diagram given but with large numbers of ironstone boulders on the soil surface which hinder cultivation (this rocky phase should be mapped out separately in intensive soil mapping).

Position in landscape

This soil occupies large areas of the undulating Darling Plateau (Yalanbee soil landscape unit). Slopes range from 1 to 8%.
Vegetation

The vegetation is typically a tall, open forest of jarrah (Eucalyptus marginata), marri (E. calophylla), white gum (E. wandoo) and the occasional powderbark wandoo (E. accedens). A shrub layer of Dryandra species and blackboys (Xanthorrhoea preissii) also occur.

Land qualities

<table>
<thead>
<tr>
<th>Quality</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>low-moderate*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>low</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>low</td>
</tr>
<tr>
<td>Trafficability</td>
<td>good-poor(^{(1)})</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy(^{(2)})</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>not susceptible</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>low-moderate</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>low-moderate</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>high</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Ironstone boulders on the surface may limit trafficability.

\(^{(2)}\) Depth to duricrust may limit rooting condition on some sites.

Productivity and capability

The **Buckshot gravel** is an average cropping and pasture producing soil that is limited by moisture availability in average to below average rainfall seasons.

The high reactive iron levels result in large amounts of applied phosphate being tied up and therefore unavailable for plant growth.

Subterranean clover pasture growth is average on this soil, with pastures dying off early in spring in many years. The loamy sand phases of this soil type are better able to retain moisture within the profile for plant growth.

Cereals can grow well in wetter years with good finishing rains, but in many years they are limited by moisture availability. Cereals are susceptible to manganese deficiency.

Lupins grow well as they are able to develop extensive root systems which are efficient at extracting moisture from this deep, sandy soil. In areas where the duricrust occurs within a metre of the soil surface, lupin growth is poorer.

Tagasaste, a perennial fodder shrub grows well and may warrant consideration as an alternative land use if salinity occurs within the catchment (tagasaste is a high water user and reduces the amount of recharge entering the regional groundwater).

Wind erosion is a problem on poorly managed areas of this soil. Water erosion rarely occurs on this deep permeable soil unless tracks or firebreaks concentrate run-off.

* Appendix 5 defines the categories of each land quality.*
Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>11-13 DSE/ha</td>
<td>15 DSE/ha</td>
<td>III-IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>1.5-2.0 t/ha</td>
<td>3.6 t/ha</td>
<td>III-IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>1.2-1.8 t/ha</td>
<td>2.1 t/ha</td>
<td>II</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td></td>
<td>IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>5. Tagasaste</td>
<td>Good growth</td>
<td></td>
<td>I-II</td>
<td>rooting conditions</td>
</tr>
</tbody>
</table>
2. Deep pale sand

P.P.F. Uc 1.21, Uc 2.12, Uc 1.22, Uc 5.11

Phillips series, Eaton series

Identifying characteristics

This soil type includes the loose, white and pale yellow sands which are commonly over 2 m deep and have a grey topsoil. The Deep pale sand can be distinguished from the Pale sand over gravel/loamy sand by the absence of ironstone gravel or a layer with a higher clay content (e.g. loamy sand) within the top 80 cm.

Position in the landscape

This soil occurs as isolated pockets on the mid and lower slopes (1 to 3%) in the West Kokeby area. The Deep pale sand also occurs as small areas, often within slight depressions on the Darling Plateau. These areas can be associated with areas of the Waterlogged sand (minor soil – Section 2.2). The Deep pale sand occurs within the Sheahan and Kokeby soil landscape units.

Vegetation

The vegetation typically consists of Banksia spp., Christmas tree (Nuytsia floribunda), tea tree (Leptospermum spp.), with scattered marri (Eucalyptus calophylla). Jarrah (E. marginata) and Dryandra spp. may also be present, especially if ironstone gravel occurs at depth.
Land qualities

<table>
<thead>
<tr>
<th>Land quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>very low*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>very low</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>low</td>
</tr>
<tr>
<td>Trafficability</td>
<td>moderate(1)-good</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>not susceptible</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>high</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>high</td>
</tr>
</tbody>
</table>

(1) Vehicles may get bogged in this loose sand.

Productivity and capability

This soil produces poor crops and pastures. The low moisture and nutrient availability greatly limits plant growth. In most years it is uneconomic to grow cereals or lupins on this soil. Subterranean clover fails to set seed in many years and rarely persists. Grass and broad-leaved pasture species are usually sparse.

The poor performance of pastures and crops is likely to leave much of the soil bare and exposed, increasing the risk of wind erosion. Areas of these sands within a paddock limit the grazing capacity of that paddock, as they are the first to blow, and dictate when stock should be moved.

The low water holding capacity and poor pasture and crop growth allows large amounts of rainfall to recharge the groundwater table.

Alternative land uses should be sought on this soil. Blue lupins and tagasaste generally grow well because their deep root systems are better able to extract moisture. They provide valuable grazing and protect the soil from wind erosion. Both are high water users and decrease the amount of water recharging the groundwater (see Western Australian Department of Agriculture Farmnote 45/88 for more information on tagasaste).

Another possible perennial option is acacia species such as *A. saligna* and *A. salicina* which can be used for sheep fodder.

Yellow serradella (*Ornithopus compressus*) may be a pasture legume option but the cost of establishment is currently prohibitive. French serradella (*Ornithopus sativus*) may be a cheaper option but no information is available on its long term persistence.

*Appendix 5 defines the categories of each land quality*
### Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>6-8 DSE/ha</td>
<td>9 DSE/ha</td>
<td>V</td>
<td>moisture availability, nutrient availability, recharge hazard</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>0.6-1.0 t/ha</td>
<td>2.4 t/ha</td>
<td>V</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>0.6-1.0 t/ha</td>
<td>1.5 t/ha</td>
<td>IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td></td>
<td>V</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>5. Tagasaste</td>
<td>Good growth</td>
<td></td>
<td>I-II</td>
<td>moisture availability</td>
</tr>
<tr>
<td>6. Blue lupins</td>
<td>Good growth</td>
<td></td>
<td>I-II</td>
<td>moisture availability, nutrient availability</td>
</tr>
</tbody>
</table>
3. Pale sand over gravel/loamy sand

Identifying characteristics

The **Pale sand over gravel/loamy sand** is a loose, pale sand with a greyish surface overlying an ironstone gravel layer and/or yellowish loamy sand subsoil usually between 40 and 70 cm. In some cases ironstone gravel, often of large diameter (10-20 mm), may occur close to, or at, the surface.

Deeper phases of the **Pale sand over gravel/loamy sand** grade into the **Deep pale sand**. If the gravel or loamy sand subsoil occurs below 80 cm then this soil should be classified as a **Deep pale sand**.

Position in the landscape

The **Pale sand over gravel/loamy sand** covers large areas of the gently sloping (1 to 3%) hillslopes in the West Kokeby area. This soil also occurs as small areas on the Darling Plateau. This soil is found within the Kokeby soil landscape unit.

Vegetation

The dominant upper story vegetation is marri (**Eucalyptus calophylla**), jarrah (**E. marginata**), and white gum (**E. wandoo**) with a shrub layer of **Dryandra** spp., tea tree (**Leptospermum** sp.), **Melaleuca** spp. and blackboys (**Xanthorrhoea preissii**).
Land qualities

Moisture availability   low*
Nutrient availability  low
Waterlogging risk      low
Trafficability         good
Rooting conditions     easy
Soil structure decline risk  low
Salinity risk          not susceptible
Wind erosion risk      high
Water erosion risk     low
Recharge hazard        high-moderate

Productivity and capability

This is a below average soil for pasture production and an average cropping soil, with the major limitation being moisture availability.

Subterranean clover growth is generally poor with grasses and broad-leaved species, such as capeweed, being the dominant pasture species. Shallow rooted pasture species are unable to exploit moisture reserves in the loamy sand subsoil.

Cereal growth varies depending on the depth to the loamy sand subsoil. When the subsoil is deep (70 cm), cereals commonly experience moisture stress early in spring. Cereal yields are average where the subsoil is closer to the surface and the surface horizons contain a slightly higher percentage of clay. Cereals are susceptible to manganese deficiency on these soils.

Lupins grow quite well, being suited to this deep, sandy, well drained soil. These soils need to be carefully managed to prevent wind erosion. Management practices such as stubble retention, minimum tillage and the planting of windbreaks can be used to reduce the risk of wind erosion.

Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>10-12 DSE/ha</td>
<td>13 DSE/ha</td>
<td>IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>1.5-2.0 t/ha</td>
<td>4.2 t/ha</td>
<td>III-IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>1.2-1.6 t/ha</td>
<td>2.6 t/ha</td>
<td>II-III</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td></td>
<td>IV</td>
<td>moisture availability, nutrient availability</td>
</tr>
<tr>
<td>5. Tagasaste</td>
<td>Good growth</td>
<td></td>
<td>I-II</td>
<td>rooting conditions</td>
</tr>
</tbody>
</table>

* Appendix 5 defines the categories of each land quality
4. Breakaway face and ironstone cap

IRONSTONE CAP
Laterite boulders with little or no soil

MOTTLED ZONE

PALLID ZONE
(White kaolin clay - "pipe clay")

SAPROLITE
(Decomposing bedrock)

BEDROCK

Soils of the Northam Advisory District
Identifying characteristics

The surface of the breakaway face consists of 5 to 30 cm of dark brown or grey sand to clayey sand. This layer has a dusty appearance and is severely non-wetting. Beneath the topsoil is a pinkish or white clay which often contains rock fragments. This clay is often exposed by water erosion.

The ironstone cap (duricrust) consists of large, ironstone boulders with minimal soil development.

Position in the landscape

Breakaways are found at the top of the landscape and are the retreating edge of the flat to gently undulating, lateritic plateau. However, in some cases the old lateritic profile has been almost completely removed to leave only a pointy, cone shaped ‘mallet hill’. The breakaway scarp can vary in height from 2 to 50 m and slopes range from 15 to 40%.

The ironstone cap is found on the soil surface at the top of the breakaway face. This area is generally flat to gently sloping and contains many ironstone boulders. Moving away from the scarp there is more soil development and the ironstone cap generally grades into the Buckshot gravel soil type.

Vegetation

On the breakaway face the native vegetation is powderbark wandoo (Eucalyptus accedens), white gum (E. wandoo), box poison (Gastrolobium parviflorum) and Dryandra species.

The ironstone cap contains powderbark wandoo, jarrah (E. marginata) and Dryandra sp.

Productivity and capability

The Breakaway face and ironstone cap are not suitable for agriculture.

If cleared, the breakaway face becomes a major water erosion hazard. The steep slopes, non-wetting topsoil and dispersive clay subsoil make this surface very prone to water erosion. Areas that have been cleared should be fenced off and revegetated. Often a large level bank or grade bank is required at the base of the breakaway to cut off water and prevent the erosion of soils further downslope.

The ironstone cap is too rocky and shallow for cropping and produces little pasture. These areas, if cleared, are believed to add significant volumes of recharge to the deep groundwater system.
5. Sandy loam over pinkish clay below breakaways

P.P.F. Dr 3.52.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Balkuling series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>Dark greyish brown (10YR 4/2) to brown (7.5YR 4/4), fine to medium grained sandy loam to sandy clay loam. Hardsetting surface. Ironstone gravel often present. Non-wetting. pH = 5.5</td>
</tr>
<tr>
<td>B2</td>
<td>Pink (5YR 7/4) to white (10YR 8/2) clay. Massive to moderately structured. Small amounts of ironstone gravel may be present. pH = 6.8</td>
</tr>
</tbody>
</table>

**Identifying characteristics**

The surface horizon is a shallow, dark greyish brown to brown sandy loam to sandy clay loam. A pinkish to white, dispersive, clay subsoil occurs at about 5-15 cm. The topsoil is often non-wetting and hardsetting but can be powdery close to the breakaway face. In some cases the topsoil has been completely eroded, exposing the clay subsoil. Angular ironstone gravel which is usually dark red to purple is often present.

This soil type can be distinguished from the Yellow gravelly loamy sand by its shallow, often non-wetting topsoil and by its pinkish to white dispersive clay subsoil. This soil is known in some areas as a ‘breakaway loam’.

**Position in the landscape**

The Sandy loam over pinkish clay below breakaways occurs as small areas immediately below breakaways and mallet hills. Slopes are generally 5 to 10% but can be steeper at around 20%. This soil is often associated with large, natural erosion gullies which have formed within the dispersive clay subsoil.

This soil occurs within the Leaver soil landscape unit.

**Vegetation**

The dominant vegetation is powderbark wandoo (*Eucalyptus accedens*) and white gum (*E. wandoo*).
Land qualities

<table>
<thead>
<tr>
<th>Quality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>low-moderate*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>moderate</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>low</td>
</tr>
<tr>
<td>Trafficability</td>
<td>moderate-poor(1)</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>moderate-difficult(2)</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>high</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>not susceptible</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>high</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>low</td>
</tr>
</tbody>
</table>

(1) In very steep areas with gully erosion.
(2) In areas where the topsoil has eroded.

Productivity and capability

The Sandy loam over pinkish clay below breakaways is often unsuitable for agricultural use and in many cases should not be cleared. The non-wetting topsoil, dispersive clay subsoil and steep slopes make this soil highly prone to water erosion. Removal of the topsoil exposes the hostile clay subsoil which has difficult rooting conditions and a poor soil structure. Crops and pastures perform very poorly on these areas. However, examples of this soil with a deeper topsoil, and which occur on gentle slopes, can produce average crop and pasture yields if not degraded.

Contour or grade banks are recommended to reduce the risk of erosion. Run-off from adjacent breakaway faces can initiate water erosion that may extend downslope onto more productive soils such as the Yellow gravelly loamy sand. Degraded areas should be fenced off and revegetated.

Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>3-13 DSE/ha</td>
<td>6-15 DSE/ha</td>
<td>III-V</td>
<td>water erosion, moisture availability</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>0.3-2.0 t/ha</td>
<td>1- 4 t/ha</td>
<td>IV-V</td>
<td>water erosion, moisture availability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>0.3-1.0</td>
<td>0.6-1.2 t/ha</td>
<td>IV-V</td>
<td>rooting conditions, water erosion</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td></td>
<td>IV-V</td>
<td>water erosion, moisture availability</td>
</tr>
</tbody>
</table>

Productivity varies widely on this soil. Degraded areas yield poorly.

* Appendix 5 defines the categories of each land quality
6. Yellow gravelly loamy sand

This soil includes all the gravelly, loamy sand soils that occur on the hillslopes within the Darling Range. The topsoil is a greyish brown to brown loamy sand which is often hardsetting. This overlies a yellowish brown sandy loam subsoil whose texture usually increases to a clay at depth. Large amounts of ironstone gravel and rocks occur throughout the profile. Ironstone boulders are common on the surface in some areas. When this soil occurs on the lower slopes it may have little or no ironstone gravel within the profile.

This soil can be distinguished from the Buckshot gravel by its heavier surface texture, larger, more angular ironstone gravel and the presence of clay or sandy clay loam at depth.

The Yellow gravelly loamy sand is known locally as a ‘gravelly loam’.

Position in landscape

This soil occurs on the dissected hillslopes below breakaways in the Darling Range Zone (Leaver soil landscape unit). It commonly occurs on ridges or spurs. Slopes range from about 15% on the upper slopes to 3% on the gentle lower slopes. This soil also occurs as gravelly ridges in the West Kokeby area (Kokeby soil landscape unit).
Vegetation

The dominant vegetation is white gum (*Eucalyptus wandoo*), marri (*E. calophylla*) and *Dryandra* species with the occasional jarrah (*E. marginata*) and powder-bark wandoo (*E. accedens*).

Land qualities

<table>
<thead>
<tr>
<th>Quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>moderate*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>moderate</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>low</td>
</tr>
<tr>
<td>Trafficability</td>
<td>good</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>not susceptible</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>moderate</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>low</td>
</tr>
</tbody>
</table>

Productivity and capability

Crops and pastures consistently perform well on the **Yellow gravelly loamy sand**. This soil has no major limitations, though in steep, rocky areas trafficability may be limited and water erosion may occur.

Subterranean clover based pastures grow well. The loamy sand surface horizon and loamy subsoils are well suited to supplying moisture to shallow rooted pasture species.

Cereals yield well over a range of season types. The soil rarely becomes waterlogged and the moisture availability is good. The phosphate requirement is high because high levels of reactive iron in the soil fix phosphorus thus making it unavailable for plant growth.

Lupins are well suited to this soil as the clay subsoil is usually quite deep allowing good root development. Lupin growth is poorer on shallower, gravelly ridges.

Contour or grade banks are required on the steeper slopes to reduce the risk of water erosion. When this soil occurs immediately below a breakaway or the **Sandy loam over pinkish clay below breakaways**, it is particularly susceptible to erosion, as large volumes of run-off are generated from these areas.

Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>17-19 DSE/ha</td>
<td>20 DSE/ha</td>
<td>II</td>
<td>moisture availability</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>2-3 t/ha</td>
<td>5.4 t/ha</td>
<td>I-II</td>
<td>moisture availability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>1.2-2.2 t/ha</td>
<td>3 t/ha</td>
<td>I</td>
<td>moisture availability</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Good growth</td>
<td></td>
<td>II</td>
<td></td>
</tr>
</tbody>
</table>

*Appendix 5 defines the categories of each land quality*
7. Rocky red brown loamy sand/sandy loam

P.P.F. Dr 2.12, Db 3.12, Uc 6.13

York series, Mulukine series, Seabrook series

**Horizon**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-100</td>
<td>A1 Brown (10YR 4/3) to dark reddish brown (5YR 3/3), medium to coarse grained loamy sand to sandy loam. Loose to hardsetting surface. Weakly structured to massive. pH = 6.0</td>
<td></td>
</tr>
<tr>
<td>10-100</td>
<td>A3/B1 Reddish brown (5YR 4/4) to yellowish brown (10YR 5/4) clayey sand to sandy loam. Weakly structured to massive. pH = 7.0</td>
<td></td>
</tr>
<tr>
<td>10-100</td>
<td>B2 Reddish brown (5YR 5/6) to brown (7.5YR 4/4) medium clay. Moderately structured. pH = 7.0</td>
<td></td>
</tr>
<tr>
<td>10-100</td>
<td>C Decomposing bedrock.</td>
<td></td>
</tr>
</tbody>
</table>

**Identifying characteristics**

This soil type contains all the red-brown, loamy soils that have formed from the breakdown of fresh rock.

The topsoil is a reddish brown to brown loamy sand to sandy loam. An intermediate horizon of yellowish brown to dark red loamy sand to sandy clay loam overlies a dark red to brown clay subsoil. Decomposing bedrock occurs at depth and rock fragments are common throughout the profile.

Differences in parent material and micro-relief result in variations within this soil. Variations include:

- heavy phases with a sandy loam topsoil over clay at about 10 to 20 cm;
- light phases with no clay subsoil but overlying bedrock;
- a red-brown surface horizon overlying a yellow clay subsoil.

This soil can be distinguished from the Brownish grey granitic loamy sand by its redder colour and often heavier textures. The Red brown doleritic clay loam (minor soil type – see Section 2.2) can be distinguished by its heavier, often cracking topsoil.

**Position in the landscape**

The Rocky red brown loamy sand/sandy loam generally occurs on the mid to lower slopes of dissected valleys where fresh rock has been exposed. This soil occurs in association with the Brownish grey granitic loamy sand with these soils occurring within the Michibin soil landscape unit. Slopes range from 3% to greater than 15%. Shallow, rocky phases of this soil occur within the Steep rocky hills soil landscape unit.
Vegetation

In the eastern part of the Darling Range Zone, such as at Clackline or West Dale, the dominant vegetation is York gum (*Eucalyptus loxophleba*) and jam (*Acacia acuminata*) with the occasional white gum (*E. wandoo*). Further west into the Darling Range, where the rainfall is higher, the vegetation changes to marri (*E. calophylla*) and white gum (*E. wandoo*).

Land qualities

<table>
<thead>
<tr>
<th>Land quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>moderate-high*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>high</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>low</td>
</tr>
<tr>
<td>Trafficability</td>
<td>moderate(1)</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>low</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>moderate(2)</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>low</td>
</tr>
</tbody>
</table>

(1) Surface rocks are common.
(2) Run-off from adjacent rocks can initiate erosion.

Productivity and capability

Pastures and crops perform consistently well on the *Rocky red brown loamy sand/sandy loam*. This soil is relatively free of the nutrient and moisture availability, waterlogging and salinity problems which beset many of the other soil types.

This is one of the best pasture growing soils within these Zones. Subterranean clover, broad-leaved species, grasses and medics all grow well. The soil retains enough moisture close to the surface to be accessible to these shallower rooted species. Some areas of this soil need to be left in continuous pasture because of their rockiness and steep slope.

Cereals and canola produce high yields. Lupins grow well, but on heavier phases, yields tend to be variable in dry years owing to drought stress in spring.

On the steeper and longer slopes, grade banks may be required to control water erosion. Minimum tillage practices are recommended as they leave the soil bare for shorter periods thus reducing the risk of erosion. Applications of lime may be necessary in the future to overcome soil acidification.

Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>18-21 DSE/ha</td>
<td>22 DSE/ha</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2. Cereals</td>
<td>2.2-3.2 t/ha</td>
<td>6 t/ha</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3. Lupins</td>
<td>1.2-2.2 t/ha</td>
<td>3 t/ha</td>
<td>I-II</td>
<td>waterlogging</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Good growth</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

* Appendix 5 defines the categories of each land quality
8. Brownish grey granitic loamy sand

P.P.F. Dy 5.22, Dy 5.12, Dy 5.42, Uc 5.22

Malebelling series, Boyadine series

Identifying characteristics

This soil includes all the brownish grey, sand to loamy sand surfaced soils that have developed from granitic rock. Beneath the topsoil is a yellowish brown to pale brown loamy sand to clayey sand horizon which overlies a mottled clay and/or bedrock. This is a variable soil type whose properties depend up on the exact nature of the parent rock from which it was formed.

- Heavier phases consist of a clayey sand to 10 cm over a sandy loam overlying clay at about 30 cm.
- Lighter phases consist of about 50 cm of sand grading into a weak clayey sand at depth over decomposing bedrock.

Granitic boulders and rock outcrop are common on the surface and rock fragments may occur throughout the profile. Deeper, better quality phases of this soil form on the lower slopes as a result of the colluvial movement of soil.

This soil can be distinguished from the Rocky red brown loamy sand/sandy loam by its greyer colours and generally lighter textures. If the depth of the coarse sandy topsoil is greater than about 60 cm the soil should be classified as a Coarse granitic sand (minor soil type – see Section 2.2).
Position in the landscape

The **Brownish grey granitic loamy sand** occurs on the upper through to lower slopes of dissected valleys where fresh granitic rock has been exposed. These soils occur in association with the **Rocky red brown loamy sand/sandy loam** within the Michibin soil landscape unit. Slope gradients range from about 8 to 15% on the steep, rocky upper slopes to about 3% on the less rocky, lower slopes. Shallow, rocky phases of this soil occur within the Steep rocky hills soil landscape unit.

Vegetation

In the eastern part of the Darling Range Zone the dominant vegetation is jam (*Acacia acuminata*), York gum (*Eucalyptus loxophleba*), white gum (*E. wandoo*) and sheoak (*Allocasuarina huegeliana*). Further west into the Darling Range, where the rainfall increases, the jam and York gum vegetation is replaced by marri (*E. calophylla*).

Land qualities

- **Moisture availability**: moderate*
- **Nutrient availability**: moderate-high
- **Waterlogging risk**: low-moderate\(^{(1)}\)
- **Trafficability**: moderate\(^{(2)}\)
- **Rooting conditions**: easy-moderate
- **Soil structure decline risk**: low
- **Salinity risk**: low
- **Wind erosion risk**: low
- **Water erosion risk**: moderate\(^{(3)}\)
- **Recharge hazard**: low

\(^{(1)}\) Seepage areas are common on this soil.
\(^{(2)}\) Seepage areas and rock outcrop can limit trafficability.
\(^{(3)}\) Run-off from adjacent rock outcrops can initiate erosion.

Productivity and capability

The **Brownish grey granitic loamy sand** is a good quality agricultural soil suitable for cereal, lupin and pasture growth. Limited moisture availability in dry periods, waterlogging in seepage areas and shallow rock areas, which limit root growth, result in reduced yields. The soil must be managed carefully to control water erosion.

Pasture growth is generally good, especially in heavier phases of this soil, however, subterranean clover tends to be affected by moisture stress earlier in spring than on the **Rocky red brown loamy sand/sandy loam**.

Cereal yields are above average for this zone. Moisture stress in dry periods and waterlogging in wet years reduce cereal yields. Rock outcrop and steep slopes hinder cropping in some areas.

* Appendix 5 defines the categories of each land quality.
Lupins grow well, especially when the soil is deeper. However, yields are poor in seepage areas owing to waterlogging and poor where the depth to bedrock is shallow (limited rooting depth).

On the steeper, longer slopes, grade banks are required to control water erosion. Minimum tillage practices are recommended as they leave the soil bare for shorter periods, thus reducing the chance of water erosion.

Applications of lime may be necessary in the future to overcome soil acidification.

Saline drainage lines within areas of this soil can be rehabilitated by planting dense stands of trees on their margins.

**Yield estimates and capability rating for various land uses**

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>17-19 DSE/ha 2-3 t/ha</td>
<td>20 DSE/ha 4.8 t/ha</td>
<td>II II</td>
<td>moisture availability moisture availability waterlogging waterlogging rooting conditions moisture availability waterlogging</td>
</tr>
<tr>
<td>2. Cereals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Lupins</td>
<td>1.0-1.8 t/ha</td>
<td>2.6 t/ha</td>
<td>II-III II</td>
<td>waterlogging rooting conditions</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Good growth</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. Stony soils

Idealised cross section of an area of Stony Soils

Soil types
- Rocky red brown loamy sand/sandy loam
- Brownish grey granitic loamy sand
- Red brown doleritic clay loam
- Coarse granitic sand
- Hardsetting gritty quartzitic soil

Granite, gneiss and migmatite

Quartzite dyke

Dolerite dyke
Identifying characteristics

The Stony soils is an association of a number of different soils. These soils are linked together to form one soil type because they occur together as one management unit on areas of steep rocky hills.

The soils in this association are:

- Rocky red brown loamy sand/sandy loam;
- Brownish grey granitic loamy sand;
- Red brown doleritic clay loam (minor soil - see Section 2.2);
- Hardsetting gritty quartzitic soil (minor soil); and
- Coarse granitic sand (minor soil).

These soil types are described elsewhere in the manual, however, when they occur on areas of steep rocky hills they are much rockier and the depth to bedrock is shallower. Areas of rock outcrop are very common.

Position in the landscape

These soils are most commonly found on the mid slopes, or upper slopes, where the underlying bedrock has been exposed. Slopes are generally greater than 10% and can be greater than 30%. The majority of this soil type occurs in the Steep rocky hills soil landscape unit.

Vegetation

In the eastern part of the Darling Range Zone the dominant vegetation is York gum (Eucalyptus loxophleba), jam (Acacia acuminata), sheoak (Allocasuarina huegeliana) and white gum (E. wandoo). Further west into the Darling Range, where the rainfall is greater, the vegetation changes to marri (E. calophylla), sheoak and white gum.

Productivity and capability

This land is too steep and rocky for cropping but does provide some grazing. Very steep and rocky areas do not warrant clearing because of the small amount of pasture that can be grown and because of the water erosion hazard.

Water erosion is common on these steep rocky areas and care is required when locating fencelines and firebreaks. Large amounts of run-off are produced by the many rock outcrops and sheep and wheel tracks can concentrate water flow. Contour or grade banks are required in some areas to control water erosion.

Seepage water is forced to the surface in some areas resulting in waterlogging.

Subterranean clover growth is good in areas that do not contain large amounts of surface rock. The carrying capacity of these rocky areas varies widely depending on the percentage of rock. If well managed, less rocky areas should carry 8-10 DSE/ha (winter grazed).
10. Deep sandy surfaced duplex

P.P.F. Dy 5.42, Dy 4.12

**Horizon**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Surface</th>
<th>A1</th>
<th>A2/A3</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Grey (10YR 5/1) to dark greyish brown (10YR 4/2), medium to coarse grained sand. Loose surface, single grains. pH = 6.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Light grey (10YR 7/2) to light yellowish brown (10YR 6/4) sand. Single grains. May contain small amounts of ironstone gravel. pH = 6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>Very pale brown (10YR 7/6) to yellowish brown (10YR 6/4) sandy clay to medium clay. Red and orange mottles are common. Moderately structured. pH = 6.5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Identifying characteristics**

This soil contains the deep sand over yellowish clay soils that occur on gently undulating hillslopes.

The topsoil is a loose, greyish brown sand. Beneath is a layer of pale sand which overlies a mottled, light grey to yellow clay subsoil at depths of greater than 45 cm. Ironstone gravel often occurs just above the clay layer.

This soil can be distinguished from the **Deep sandy surfaced valley duplex** as it occurs on the hillslopes and is better drained.

**Position in the landscape**

**Deep sandy surfaced duplex** occurs in the Dale and West Kokeby areas on the gently undulating hill slopes. Slopes usually range from 1 to 6%.

This soil occurs within the Kokeby soil landscape unit.

**Vegetation**

The dominant vegetation is white gum (**Eucalyptus wandoa**), marri (**E. calophylla**), tea tree (**Leptospermum sp.**) and sheoak (**Allocasuarina huegeliana**).
Land qualities

<table>
<thead>
<tr>
<th>Land quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>low-moderate*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>low-moderate</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>low-moderate</td>
</tr>
<tr>
<td>Trafficability</td>
<td>good</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy-moderate</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>low</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>moderate</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>moderate</td>
</tr>
</tbody>
</table>

Productivity and capability

The Deep sandy surfaced duplex produces average crops and pastures. The low water holding capacity of the deep, sandy surface horizon is generally the greatest limitation of this soil. Waterlogging can limit growth in wet years.

Subterranean clover and grasses grow fairly well but not as well as they do on soils with a loamy sand topsoil. These shallow rooted plants often have trouble reaching moisture in the clayey subsoil. Capeweed is a dominant pasture species.

Cereal growth is average with moisture stress being the major limitation.

Lupins grow well, because their root system is able to explore large volumes of soil. In wet years, lupins may be affected by waterlogging in some areas.

Waterlogging can be controlled by seepage interceptor banks. In many cases the depth to clay is too great to build reverse bank seepage interceptors with a grader, therefore dozer built banks, placed on a grade, are necessary.

Dense belts of trees planted above saline seepage areas have been successful in reclaiming/preventing the spread of these areas.

These soils need to be carefully managed to prevent wind erosion.

Lime may need to be applied in the future to overcome soil acidity.

Yield estimates and capability rating for various land uses

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>10-12 DSE/ha</td>
<td>14 DSE/ha</td>
<td>IV</td>
<td>moisture availability</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>1.6-2.2 t/ha</td>
<td>4.2 t/ha</td>
<td>III</td>
<td>wind erosion</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>1.0-1.6 t/ha</td>
<td>2.6 t/ha</td>
<td>II-III</td>
<td>moisture availability</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Average growth</td>
<td></td>
<td>III</td>
<td>waterlogging</td>
</tr>
</tbody>
</table>

*Appendix 5 defines the categories of each land quality*
11. Poorly drained sandy loam duplex

P.P.F. Dy 3.42, Dy 3.12, Dg 2.42

**Identifying characteristics**

This soil includes the poorly drained, often saline soils that occur on the floors of minor valleys on the Darling Plateau.

The topsoil is a dark grey to dark brown loamy sand to sandy loam. Beneath is a layer of light brownish grey to brownish yellow sandy loam to sandy clay loam which overlies a mottled, light grey to brownish yellow clay. Ironstone gravel may occur throughout the profile.

This soil is formed from alluvial and colluvial material and as a consequence it is quite variable. Variations include:

- a lighter phase with a sandy topsoil over clay;
- deeper more gradational profiles where the texture does not increase beyond a sandy clay loam or where the clay subsoil occurs at depths of about 80 cm.

**Position in the landscape**

The Poorly drained sandy loam duplex occurs on the floors of minor valleys on the Darling Plateau (Pindalup soil landscape unit) and may extend downstream into dissected valley floors (Williams soil landscape unit). These valley floors are often swampy and saline.
**Vegetation**

The dominant vegetation is flooded gum (*Eucalyptus rudis*), white gum (*E. wandoo*), paperbark (*Melaleuca spp.*) and rushes (*Juncus spp.*).

**Land qualities**

- **Moisture availability**: high*
- **Nutrient availability**: moderate
- **Waterlogging risk**: very high
- **Trafficability**: poor
- **Rooting conditions**: easy-moderate
- **Soil structure decline risk**: low
- **Salinity risk**: high
- **Wind erosion risk**: very low
- **Water erosion risk**: moderate
- **Recharge hazard**: low

**Productivity and capability**

Waterlogging and salinity are major limitations to agricultural production on this soil.

The base of the narrow, valley floor on which this soil occurs becomes severely waterlogged with the water-table remaining at, or close to, the surface for much of the year. Evaporation of water and concentration of salt has resulted in many of these swampy valley floors becoming saline.

In non-saline areas, subterranean clover pasture grows well, persisting into summer because of the high moisture availability. Alternative pasture species such as phalaris, tall wheat grass, saltbush and puccinellia may have a role on this soil.

This soil is unsuitable for cropping.

Attempts to reclaim saline and waterlogged land with deep drains have met with mixed success. Maintenance of the drains is critical to ensure good water flow.

**Yield estimates and capability rating for various land uses**

*For non saline areas*

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>6-16 DSE/ha 0-1 t/ha</td>
<td>6-18 DSE/ha 0.5-2 t/ha</td>
<td>II-V⁺</td>
<td>waterlogging</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>Very poor growth</td>
<td>0.3 t/ha</td>
<td>V</td>
<td>waterlogging trafficability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>Very poor growth</td>
<td>V</td>
<td>waterlogging trafficability</td>
<td></td>
</tr>
<tr>
<td>4. Canola</td>
<td>Very poor growth</td>
<td>V</td>
<td>waterlogging trafficability</td>
<td></td>
</tr>
</tbody>
</table>

* Depending on extent of waterlogging

*Appendix 5 defines the categories of each land quality*
12. Alluvial loam

P.P.F. Dy 3.12, Gn 3.12, Um 5.52.

<table>
<thead>
<tr>
<th>Surface</th>
<th>Horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A1 Greyish brown (10YR 3/2) to brown (7.5YR 4/2), fine grained clayey sand to loam. Hardsetting surface. Massive structure, earthy fabric. pH = 6.0</td>
</tr>
<tr>
<td></td>
<td>A3 Yellowish brown (10YR 5/4) to brown (7.5YR 4/6) sandy loam to clay loam. Massive or moderately structured. pH = 7.0</td>
</tr>
<tr>
<td></td>
<td>B2 Light yellowish brown (10YR 6/4) to reddish brown (5YR 4/4) sandy clay loam to medium clay. Moderately structured. Red, yellow and orange mottles may be present. pH = 7.0 to 8.5</td>
</tr>
</tbody>
</table>

**Identifying characteristics**

This is a variable soil type which contains all the brownish to yellowish, loamy, alluvial soils that occur on the floodplains of the major creeklines.

Variations of this soil include:

- phases which are redder throughout; and
- deeper, loamy phases where the texture does not increase beyond a sandy loam.

The Alluvial loam can be distinguished from the Poorly drained sandy loam duplex because of its better drainage and often by its brown to yellow rather than greyish colour of the clay subsoil.

**Position in the landscape**

The Alluvial loam occurs on the narrow floodplains of the rivers and brooks within the Darling Range Zone (e.g. Upper Dale River and Talbot, Warranine, Jimperding and Wooroloo brooks).

This soil type occurs predominantly within the Williams soil landscape unit.
**Vegetation**

Flooded gum (*Eucalyptus rudis*), white gum (*E. wandoo*) and marri (*E. calophylla*).

**Land qualities**

<table>
<thead>
<tr>
<th>Quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>high*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>high</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>moderate-high</td>
</tr>
<tr>
<td>Trafficability</td>
<td>moderate-poor</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>high</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>low</td>
</tr>
</tbody>
</table>

**Productivity and capability**

Subterranean clover based pastures grow very well. The loamy surface horizons can supply large quantities of moisture to shallow rooted pasture species. Seepage water provides additional moisture keeping the pasture green well into spring.

Good cereal yields can obtained but waterlogging and trafficability problems limit yields on the more poorly drained areas in many years. Lupin growth is generally poor owing to waterlogging.

Salinity affects many areas of this soil. Saline areas should be fenced off and planted to salt tolerant species such as puccinellia, tall wheat grass and saltbush.

**Yield estimates and capability rating for various land uses**

*For non saline areas*

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>18-20 DSE/ha</td>
<td>22 DSE/ha</td>
<td>I</td>
<td>waterlogging</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>1.3-2.2 t/ha</td>
<td>3-5 t/ha</td>
<td>II-IV</td>
<td>trafficability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>Poor growth</td>
<td>1.5 t/ha</td>
<td>IV</td>
<td>waterlogging</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td></td>
<td>IV</td>
<td>waterlogging</td>
</tr>
</tbody>
</table>

*Appendix 5 defines the categories of each land quality*
Identifying characteristics

This soil type includes the pale sand over yellowish clay soils that occur on the valley floors in the Dale/West Kokeby area.

The topsoil is a dark greyish brown sand with a loose surface. Beneath is a pale to light yellowish brown sand, which in turn overlies a mottled, brownish yellow to greyish clay subsoil at about 40 to 70 cm. A perched watertable forms on top of the clay layer during winter and, in low-lying areas, may persist into late spring. Ironstone gravel can occur above the clay layer.

Position in the landscape

This soil occurs on the broad valley floors in the West Kokeby/Dale area. Slopes are usually less than 1%. The **Sandy surfaced valley duplex** occurs on the Dale soil landscape unit. Associated with this soil are areas of poorly drained swamps (Maitland soil landscape unit).

Vegetation

The dominant vegetation is white gum (**Eucalyptus wandoo**), flooded gum (**E. rudis**) and tea tree (**Leptospermum** sp.). Rushes (**Juncus** sp.) grow in very wet areas.
### Land qualities

<table>
<thead>
<tr>
<th>Quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>moderate*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>low</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>high</td>
</tr>
<tr>
<td>Trafficability</td>
<td>moderate-poor</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy-moderate(1)</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>high</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>moderate</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>moderate</td>
</tr>
</tbody>
</table>

(1) Silcrete pan may occur at a depth of 0.6-0.8 m.

### Productivity and capability

This is a below average producing soil that is usually waterlogged in the winter months and has low moisture availability at the end of the season. Areas of this soil are affected by salinity.

Subterranean clover based pastures grow fairly well but become drought stressed later in the season when the perched water-table drops. The sandy surface horizon can not retain large amounts of moisture and shallow rooted pasture species often have trouble reaching moisture in the clayey subsoil.

Cereal yields can be good, but in many years waterlogging affects crop growth. Lupins grow poorly in many years owing to waterlogging.

Alternative perennial pasture species such as phalaris, tall wheat grass, balansa clover and puccinellia may have a role on wetter areas of this soil.

Waterlogging can be alleviated by building interceptor banks on the surrounding lower slopes in order to intercept seepage before it reaches the valley floor. Surface drains can be used on this soil to remove excess water.

### Yield estimates and capability rating for various land uses

*For non saline areas*

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>12-14 DSE/ha</td>
<td>15 DSE/ha</td>
<td>III-IV</td>
<td>moisture availability, waterlogging</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>1.2-2 t/ha</td>
<td>3.6 t/ha</td>
<td>III-IV</td>
<td>waterlogging, moisture availability</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>Poor growth</td>
<td>1.0 t/ha</td>
<td>IV</td>
<td>waterlogging</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td>Poor growth</td>
<td>IV</td>
<td>moisture availability, waterlogging</td>
</tr>
</tbody>
</table>

*Appendix 5 defines the categories of each land quality*
14. Grey alluvial clay

P.P.F. Db 1.13, Dy 2.13

Beverley series

Identifying characteristics

The Grey alluvial clay includes the heavy textured, grey alluvial soils. This is a variable soil type. The surface texture is most commonly a sandy loam or sandy clay loam, but can be a loamy sand. The grey clay subsoil is shallow, occurring at 10 to 20 cm.

This soil is often known as a 'grey clay'.

Position in the landscape

The Grey alluvial clay occurs on the floodplains of the Dale River, Talbot Brook and other similar creeks. Slope gradients are usually less than 1%. This soil occurs within the Williams soil landscape unit.

Vegetation

The dominant vegetation is flooded gum (Eucalyptus rudis), white gum (E. wandoo), rushes (Juncus spp.) and the occasional York gum (E. loxophleba) in eastern areas of this zone.
Land qualities

Moisture availability moderate-high*
Nutrient availability moderate-high
Waterlogging risk high
Trafficability poor
Rooting conditions moderate-difficult
Soil structure decline risk high
Salinity risk high
Wind erosion risk very low
Water erosion risk low
Recharge hazard low

Productivity and capability

This is a below average cropping soil and an average to above average pasture producing soil. Waterlogging and trafficability are major limitations. Some areas suffer from soil structural decline while other areas are affected by salinity.

Pasture growth is good except in very waterlogged areas. Both medics and subterranean clover perform well.

Cereals yield poorly in average to above average rainfall years. Waterlogging reduces root development while the boggy nature of this soil limits access for management. Soil structural decline can hinder seedling emergence and reduce rainfall infiltration. Lupin growth is poor owing to waterlogging, poor trafficability and the unfriendly rooting conditions.

Saline areas should be fenced off and planted to salt tolerant species such as tall wheat grass, puccinellia and salt bush.

Waterlogging may be alleviated by building grade banks on surrounding lower slopes in order to intercept surface and seepage water before it reaches the valley floor. Surface drains can be used on this soil to remove excess water. However, deep drainage on this soil is rarely successful at lowering saline water-tables owing to the permeability of the clay.

Yield estimates and capability rating for various land uses

For non-saline areas

<table>
<thead>
<tr>
<th>Land use</th>
<th>Achievable average yield</th>
<th>Potential yield</th>
<th>Capability rating</th>
<th>Limiting factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pasture</td>
<td>14-16 DSE/ha</td>
<td>17 DSE/ha</td>
<td>II-III</td>
<td>waterlogging</td>
</tr>
<tr>
<td>2. Cereals</td>
<td>1.2-2.0 t/ha</td>
<td>3.6 t/ha</td>
<td>III-IV</td>
<td>waterlogging</td>
</tr>
<tr>
<td>3. Lupins</td>
<td>Poor growth</td>
<td>0.6 t/ha</td>
<td>V</td>
<td>waterlogging</td>
</tr>
<tr>
<td>4. Canola</td>
<td>Poor growth</td>
<td></td>
<td>IV</td>
<td>waterlogging</td>
</tr>
</tbody>
</table>

* Appendix 5 defines the categories of each land quality
15. Loamy sand surfaced valley duplex

P.P.F. Dy 5.42

Horizon

A1 Greyish brown (10YR 4/2), fine to medium grained sand to clayey sand. Loose to hardsetting surface. Small quantities of ironstone gravel may be present. pH = 6.5

A2/A3 Very pale brown (10YR 7/3) to yellowish brown (10YR 5/4) loamy sand to sandy loam
Single grains or massive structure.
Some ironstone gravel may be present
pH = 6.5

B2 Very pale brown (10YR 7/3), yellowish brown (10YR 5/8) to grey (10YR 5/1) sandy clay to medium clay.
Red, orange and grey mottles are often present
Well structured.
pH = 6.5 to 8.5

Identifying characteristics

The Loamy sand surfaced valley duplex contains all the loamy sand surfaced, over yellowish clay soils which occur on the lower slopes or valley floor and have the potential to become waterlogged in wet years.

The surface horizon is a greyish loamy sand. The depth to the clay varies from 20 to 70 cm but is most commonly around 30 to 40 cm. If the clay occurs at less than 10 cm the soil should be classified as a Grey alluvial clay.

The Sandy surfaced valley duplex can be distinguished from the Loamy sand surfaced valley duplex by its deep, loose, sandy topsoil and poorer crop and pasture growth.

Position in the landscape

This soil occurs on the lower slopes and valley floor. However, it can occur further upslope in depressions and adjacent to water courses. Slope gradients are usually less than 2%. This soil type occurs on the Williams and Dale soil landscape units.

Vegetation

The dominant tree species on this soil are flooded gum (Eucalyptus rudis) and white gum (E. wandoo) on the better drained areas. Sheoak (Allocasuarina huegeliana) also occurs in some areas.
**Land qualities**

<table>
<thead>
<tr>
<th>Quality</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture availability</td>
<td>high*</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>moderate</td>
</tr>
<tr>
<td>Waterlogging risk</td>
<td>high</td>
</tr>
<tr>
<td>Trafficability</td>
<td>moderate-poor</td>
</tr>
<tr>
<td>Rooting conditions</td>
<td>easy-moderate</td>
</tr>
<tr>
<td>Soil structure decline risk</td>
<td>low</td>
</tr>
<tr>
<td>Salinity risk</td>
<td>high</td>
</tr>
<tr>
<td>Wind erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Water erosion risk</td>
<td>low</td>
</tr>
<tr>
<td>Recharge hazard</td>
<td>low</td>
</tr>
</tbody>
</table>

**Productivity and capability**

This soil can produce well in below average to average rainfall years, however, in wet years waterlogging is a major limitation. Salinity affects areas of this soil.

Subterranean clover based pastures grow very well. They are not greatly affected by waterlogging and thrive on the excess soil moisture. Pastures growing on this soil often remain green long into spring.

Cereals grow poorly in many years as they become severely affected by waterlogging. In drier years good cereal yields can be obtained.

Lupins grow poorly owing to waterlogging.

Saline areas can be planted to salt tolerant fodder species such as puccinellia, tall wheat grass and saltbush.

Seepage interceptors can be built on the lower slopes to intercept subsurface seepage flow before it reaches the valley floor and contributes to waterlogging. Rows of trees can be used to the same effect.

**Yield estimates and capability rating for various land uses**

*Appendix 5 defines the categories of each land quality*
2.2 Minor soil types

This section describes those minor soil types which because of their limited occurrence do not warrant detailed discussion. It should be noted, however, that these soils may occupy a significant percentage of some individual farms.

Minor soils

17. Deep yellow sand.
18. Red brown doleritic clay loam.
20. Waterlogged greyish loamy sand/sandy loam.
21. Orange alluvial loamy sand.
22. Waterlogged sand.
23. Loamy sand surfaced duplex.
16. Coarse granitic sand

This soil contains the very poor quality, coarse to very coarse pale sand that has formed from decomposed granitic rock.

Soil description

A loose, grey, coarse to very coarse sand overlying a loose, pale, coarse to very coarse sand which often becomes yellower at depth. Bedrock commonly occurs within the top 150 cm. A clay layer may occur above the bedrock. The pH throughout the profile is 6.0 to 6.5.

Northcote P.P.F. Uc 2.12.
Bobakine series, Needling series.

Position in the landscape

The Coarse granitic sand is usually found immediately adjacent to and overlying large sheets of granite or quartzite rock.

It is often found in association with, and grades into, the Brownish grey granitic loamy sand. This soil occurs within the Michibin or Steep rocky hills soil landscape units.

Vegetation

The dominant native vegetation is rock sheoak (Allocasuarina huegeliana), marri (Eucalyptus calophylla) and occasional jam (Acacia acuminata).

Discussion of capability

The Coarse granitic sand has a very low water holding ability. Added nutrients are rapidly leached out of this infertile soil.

Cereal and lupin crops grow very poorly and subterranean clover usually fails to persist. Harsher variations of this soil do not warrant clearing for agricultural use.

The very free draining nature of this soil and the low water use by poorly growing annual species results in a high percentage of rainfall passing through the root zone. This soil can add large amounts of recharge to the regional groundwater table. Large volumes of water can run off rock outcrops and also contribute to recharge. Poor ground cover often predisposes this soil to wind erosion.
17. Deep yellow sand

This soil type contains all the deep, yellow, sandy soils which commonly are over 2 m deep. They have a brown topsoil.

Soil description

The soil consists of a loose, brown sand overlying a loose, yellow sand subsoil. The texture may increase to a clayey sand at depths below 80 cm. The pH of the topsoil is commonly 6.5 and the subsoil is around 7.0.

Northcote P.P.F. Uc 5.11.
Cunderdin series.

Position in the landscape

The Deep yellow sand occurs as small pockets on gentle slopes and in slight depressions within the Sheahan, Kokeby and Yalanbee soil landscape units.

Vegetation

Banksia species, marri (Eucalyptus calophylla), tea tree (Leptospermum sp.) and sheoak (Allocasuarina huegeliana) are the dominant vegetation.

Discussion of capability

This is an average cropping and below average pasture producing soil; limited mainly by low moisture and nutrient availability.

Subterranean clover grows poorly and pasture growth is generally quite sparse. Lupins grow well and give high yields. Cereals can yield well in wetter seasons but in many years low moisture availability limits plant growth.

The wind erosion risk and recharge hazard are limitations to this soil. Tagasaste, a perennial fodder shrub grows well and should be considered as an alternative land use. It provides valuable grazing, as well as being a high water user which reduces the amount of recharge.
18. Red brown doleritic clay loam

This soil type contains all the red-brown, heavy textured soils that have formed from dolerite.

**Soil description**

The topsoil is a dark reddish brown sandy loam to clay which can either be hardsetting or self-mulching. This overlies a strongly structured, dark red clay. Bedrock often occurs within 1 m of the surface and rock fragments are commonly found throughout the profile.

This soil may appear similar to Rocky red brown loamy sand/sandy loam but can be distinguished by its heavier, often self-mulching topsoil. The pH of the topsoil is 6.0 to 7.0 and the subsoil is around 7.0 to 8.0.

Northcote P.P.F. Dr 4.12, Dr 2.12.
Northam series.

**Position in the landscape**

The Red brown doleritic clay loam generally occurs on mid to lower slopes of dissected valleys. It is often found as thin strips on and adjacent to dolerite dykes (dolerite is a fine grained, black rock). Slopes range from 3 to 15%.

This soil is mapped within either the Michibin or Steep rocky hills soil landscape units.

**Vegetation**

In the eastern part of the Darling Range Zone the dominant vegetation is York gum (Eucalyptus loxophleba) with some jam (Acacia acuminata). As you move further west into the Darling Range with increasing rainfall the vegetation changes to marri (E. calophylla) and white gum (E. wandoo).

**Discussion of capability**

This soil type consistently produces similar if not higher cereal and pasture yields than the Rocky red brown loamy sand/sandy loam.

It has few management limitations other than poor trafficability after heavy rains. The large amounts of surface rock and steep slopes may limit vehicle access for cultivation and harvesting.
19. Hardsetting gritty quartzitic soil

This soil type includes all the grey to brownish, gritty, hardsetting soils formed from quartzite.

Soil description

The topsoil is a shallow, grey to brownish, hardsetting clayey sand to sandy clay loam containing much quartz grit. A greyish brown clay subsoil occurs at about 10 cm. Red and yellow mottles often occur within the clay. The surface pH is most commonly 6 while the subsoil pH varies from 6 to 8.5.

Northcote P.P.F. Db 1.12, Db 1.23.
Bakewell series

Position in the landscape

Vegetation

The Hardsetting gritty quartzitic soil often occurs as a strip either side of a quartzite ridge. Large amounts of quartz rock are commonly seen on the surface. These soils occur within the Michibin or Steep rocky hills soil landscape units.

Vegetation

The dominant native vegetation consists of sheoak (Allocasuarina huegeliana), white gum (Eucalyptus wandoo), York gum (E. loxophleba) and jam (Acacia acuminata).

Discussion of capability

This is a below average quality agricultural soil with a poor soil structure. The tough rooting conditions greatly limit the availability of moisture for plant growth.

Cereal growth is below average and lupins perform poorly. Pasture growth is poor.

The low infiltration rate of these soils causes water to run-off, often resulting in water erosion.
20. Waterlogged greyish loamy sand/sandy loam

The Waterlogged greyish loamy sand/sandy loam includes the greyish brown loamy sand to sandy loam over clay soils that are prone to waterlogging and occur in and adjacent to midslope drainage lines.

Soil description

The topsoil is a dark greyish brown loamy sand to sandy loam and overlies a light brownish yellow loamy sand to sandy clay loam layer. A brownish clay subsoil occurs at depths from 15 to 50 cm.

This soil is often mistaken as a clay owing to its boggy nature. Some phases of this soil are brown to reddish.

Northcote P.P.F. Dy 3.22, Dy 2.12.
Hamersley series, Heal series.

Position in the landscape

The Waterlogged greyish loamy sand/sandy loam occurs as thin strips alongside midslope creeks and drainage lines. It generally occurs downslope from the well drained areas of Rocky red brown loamy sand/sandy loam or Brownish grey granitic loamy sand.

This soil type occurs within the Michibin soil landscape unit. Slope gradients are generally 2 to 8%.

Vegetation

The native vegetation on this soil is flooded gum (Eucalyptus rudis) with some York gum (E. loxophleba) and jam (Acacia acuminata) in the drier areas.

Discussion of capability

This is a poor cropping soil, prone to waterlogging in most years.

Subterranean clover based pasture grows well. The excess seepage water and run-on result in additional moisture being available later in the season for pasture growth. However, in severely waterlogged and/or saline areas pasture growth is poor.

Cereal, lupin and canola crops generally grow poorly owing to waterlogging. In wet years yields can be very low. In most cases these areas should not be cropped and are best left to continuous pasture. Access is greatly limited over the winter months.

Densely planted belts of trees can be grown above these areas to cut off seepage water and reduce waterlogging and subsequent salinity. Saline areas should be planted to salt tolerant fodder shrubs such as saltbush, puccinellia and tall wheat grass.

Erodible areas of this soil are best left as a grassed waterway. In other cases contour or grade banks can be used to control water erosion.
21. Orange alluvial loamy sand

This soil type contains the fine grained, alluvial sands.

**Soil description**

The soil profile consists of a brown, fine grained sand to loamy sand overlying a deep, orange to reddish brown loamy sand to sandy loam. An orange, reddish or yellowish brown clay may occur at depths of greater than 50 cm. The pH of the topsoil is 6.0 to 7.0 and the subsoil is around 6.5 to 7.5.

Northcote P.P.F. Uc 5.22, Dr 4.12, Dy 5.12.
Katrine series.

**Position in the landscape**

The Orange alluvial loamy sand occurs on the valley floor, immediately adjacent to stream channels. It often has a slightly raised position above the rest of the floodplain. Slopes are usually less than 1%. This soil occurs within the Williams soil landscape unit.

**Vegetation**

The dominant native vegetation is flooded gum (*Eucalyptus rudis*), York gum (*E. loxophleba*), sheoak (*Allocasuarina obesa*) and jam (*Acacia acuminata*).

**Discussion of capability**

This is an average pasture and cropping soil that is limited mainly by moisture stress in drier periods.
Salinity affects small areas of this soil.
22. Waterlogged sand

This soil type contains all the deep, pale sands that occur in seepage areas and become waterlogged from winter until late spring.

Soil description

The Waterlogged sand consists of a loose, pale sand with a grey surface. A mottled sandy clay is generally found at depths in excess of 70 cm. This clay horizon is often underlain by a siliceous hardpan (silcrete layer).

Northcote P.P.F. Dy 5.82, Uc 1.21.
Cularing series

Position in the landscape

The Waterlogged sand occurs as small areas in low lying depressions, seepage areas and drainage lines within the Sheahan and Kokeby soil landscape units.

Vegetation

Rushes (Juncus sp.) and tea tree (Leptospermum sp.) scrub are often present.

Discussion of capability

This is a poor quality soil for cereal and lupin cropping and subterranean clover based pasture.

Pasture growth is variable depending on the depth to the watertable. Areas that become severely waterlogged support poor pasture – being either bare or containing reeds and rushes. Areas that occur slightly above these very wet areas support good grass and sometimes subterranean clover pastures that remain green long into spring. Couch grass grows very well. Alternative pasture species such as phalaris, balansa clover and puccinellia may have a role on this soil.

In wet years, cereal, and especially lupin crops, can be greatly affected by waterlogging. Access can be limited in winter.

Tagasaste grows poorly on wetter areas of this soil as it is unable to tolerate the waterlogging. Tagasaste and other tree species grow very well on the margins of these areas where large amounts of moisture are obtainable at depth.

Sudax and lucerne may have potential on these sites as summer crops.

Areas of Waterlogged sand that are saline or have the potential to become saline can be dried up by planting trees at close spacings around the margins of such areas. In many cases, however, water in these areas is fresh and is required in soaks for stock use.
23. Loamy sand surfaced duplex

The **Loamy sand surfaced duplex** contains all the good quality, loamy sand over yellowish clay soils.

**Soil description**

The surface horizon is a grey loamy sand but can be a sand to clayey sand. A transitional, pale brown to yellowish loamy sand to sandy loam layer occurs below the topsoil. A yellowish brown clay occurs at about 20 to 60 cm. Small to moderate amounts of ironstone gravel are often found within the profile.

Northcote P.P.F. Dy 5.42.
Mortlock series, Morbinning series

**Position in the landscape**

The **Loamy sand surfaced duplex** occurs on the upper to lower slopes within the Kokeby soil landscape unit. Slope gradients range from 2 to 10%.

**Vegetation**

The dominant tree is white gum (*Eucalyptus wandoo*) with some marri (*E. calophylla*) and sheoak (*Allocasuarina* sp.).

**Discussion of capability**

The **Loamy sand surfaced duplex** produces good crops and pastures. In wet years, yields can be reduced in areas owing to waterlogging, though the extent of waterlogging is much less than on the **Loamy sand surfaced valley duplex**.

Subterranean clover based pastures grow well as the loamy sand topsoil and shallow (<45 cm) clay subsoil are able to supply shallow rooted pasture species with sufficient moisture.

Cereals perform well over a wide range of seasons and high yields can be obtained.

Lupins can grow quite well, especially where the clayey subsoil is deeper. In wet years they may be affected by waterlogging.

Reverse bank seepage interceptor banks can be used to remove excess water from the soil, thus reducing waterlogging. These banks or grade banks are required on the longer, steeper slopes to control water erosion.

Applications of lime may be required to overcome soil acidification.
The following table divides each soil landscape unit (map unit) into its respective soil types. The table can be used as a key to aid in the identification of a particular soil type. An estimate of the percentage area that each soil type occupies within the soil landscape unit is given.

<table>
<thead>
<tr>
<th>Map unit</th>
<th>Parent material</th>
<th>Landform</th>
<th>Dominant vegetation</th>
<th>Surface soil material</th>
<th>Sub surface soil material</th>
<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yalanbee</td>
<td>Deeply weathered laterite</td>
<td>Undulating upland plateau</td>
<td>Jarrah, marri, parrot bush with white gum in some areas.</td>
<td>Loose to firm, greyish brown sand to loamy sand. Abundant, fine, round ironstone gravel. Non-wetting.</td>
<td>Coherent, brownish yellow sand to loamy sand sometimes overlying lateritic cap rock. Abundant, fine, round ironstone gravel present.</td>
<td>1. Buckshot gravel (80%).</td>
</tr>
<tr>
<td>Pindalup</td>
<td>Alluvium and colluvium derived from the lateritic profile</td>
<td>Shallow, concave, thin valley floor found within the Darling Range Zone</td>
<td>Flooded gum and rushes. White gum grows on the margins of these valleys.</td>
<td>Dark grey to dark brown loamy sand to sandy loam.</td>
<td>Pale to yellowish sandy loam to sandy clay loam overlying a mottled, light grey to brownish yellow, structured clay. Ironstone gravel may be present.</td>
<td>11. Poorly drained sandy loam duplex (75%).</td>
</tr>
</tbody>
</table>

Other soils including

14. Grey alluvial clay
6. Yellow gravelly loamy sand
22. Waterlogged sand
<table>
<thead>
<tr>
<th>Map unit</th>
<th>Parent material</th>
<th>Landform</th>
<th>Dominant vegetation</th>
<th>Surface soil material</th>
<th>Sub surface soil material</th>
<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaver</td>
<td>Dissected lateritic material and associated colluvium.</td>
<td>Steep, upper slopes and moderately inclined, mid and lower slopes.</td>
<td>White gum, marri and powder bark wandoow.</td>
<td>Hardsetting, greyish brown to brown loamy sand. Abundant, ironstone gravel.</td>
<td>Coherent, yellowish brown sandy loam often increasing to a clay at depth. Abundant ironstone gravel present.</td>
<td>6. Yellow gravelly loamy sand (90%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Powder bark wandoow and white gum.</td>
<td>Shallow, grey to brownish sandy loam. Usually hardsetting and non-wetting. Can have a 'dusty' appearance.</td>
<td>At about 5-15 cm a pinkish to white, dispersive clay occurs (this subsoil is often exposed by erosion of the topsoil).</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Breakaway face, mallet hills and ironstone cap which occurs above the breakaway face.</td>
<td>5 to 30 cm of dark brownish grey sand to clayey sand. Has a ‘dusty’ appearance and is very non-wetting.</td>
<td>Pinkish to white dispersive clay.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderately inclined mid and lower slopes.</td>
<td>Marri, white gum, jarrah and a shrub layer of parrot bush, tea tree and blackboy.</td>
<td>Loose, pale greyish brown sand.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Moderately to steeply inclined upper slopes. Often found as a spur to the sides of breakaways.</td>
<td>Jarrah, marri and parrot bush with white gum in some areas.</td>
<td>Loose to firm, greyish brown sand to loamy sand. Abundant, fine, round ironstone gravel present. Often non-wetting.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Deeply weathered laterite.</td>
<td></td>
<td>Ironstone or lateritic caprock.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Loose, pale sand to a depth of about 40-60 cm overlying a gravel layer and/or a massive yellow loamy sand.</td>
<td>3. Pale sand over gravel / loamy sand (3%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coherent, brownish yellow sand to loamy sand, sometimes overlying lateritic caprock. Abundant, fine, round ironstone gravel present.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1. Buckshot gravel (2%).</td>
</tr>
<tr>
<td>Map unit</td>
<td>Parent material</td>
<td>Landform</td>
<td>Dominant vegetation</td>
<td>Surface soil material</td>
<td>Sub surface soil material</td>
<td>Soil type</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>Michibin</td>
<td>Predominantly gneiss, granite and migmatite.</td>
<td>Hillslopes containing scattered rock outcrop.</td>
<td>In the eastern Darling Range Zone — York gum, jam and sheoak. Further to the west — marri and white gum.</td>
<td>Firm to hardsetting, brownish grey sand to loamy sand. Granitic rocks often occur on the surface.</td>
<td>Pale to yellowish brown sand to clayey sand over a structured yellowish clay at about 50 cm overlying decomposing granitic rock.</td>
<td>8. Brownish grey granitic loamy sand (60%).</td>
</tr>
<tr>
<td></td>
<td>Dolerite and other similar, fine grained, basic rocks.</td>
<td>Hillslopes immediately adjacent to dolerite dykes.</td>
<td>In the eastern Darling Range Zone — York gum and jam. Further to the west — marri and white gum.</td>
<td>Hardsetting or self-mulching red brown loam to clay.</td>
<td>Well structured, dark red clay overlying decomposing dolerite.</td>
<td>7. Rocky red brown loamy sand (30%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18. Red brown doleritic clay loam (4%).</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Other soils including:

16. Coarse granitic sand
19. Hardsetting gritty quartzitic soil
20. Waterlogged greyish loamy sand/sandy loam

Rock outcrop (3%)
<table>
<thead>
<tr>
<th>Map unit</th>
<th>Parent material</th>
<th>Landform</th>
<th>Dominant vegetation</th>
<th>Surface soil material</th>
<th>Sub surface soil material</th>
<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Williams</td>
<td>Alluvium and some colluvium.</td>
<td>Thin, alluvial terraces of the major drainage lines within the Darling Range Zone.</td>
<td>Flooded gum, jam, York gum and white gum.</td>
<td>Firm to hardsetting, greyish loamy sand.</td>
<td>Coherent, pale to yellowish brown loamy sand to about 40 cm overlying a structured, yellowish brown, mottled clay.</td>
<td>15. Loamy sand surfaced valley duplex (30%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dark grey to dark brown loamy sand to sandy loam.</td>
<td>Pale to yellowish sandy loam to sandy clay loam overlying a mottled, light grey to brownish yellow, structured clay.</td>
<td>11. Poorly drained sandy loam duplex (25%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hardsetting, brownish, fine loamy sand to loam.</td>
<td>Brown to yellow loam often grading into structured clay at depth.</td>
<td>12. Alluvial loam (25%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hardsetting, grey sandy loam to clay loam to about 10 to 20 cm.</td>
<td>Structured, grey clay.</td>
<td>14. Grey alluvial clay (10%).</td>
</tr>
</tbody>
</table>

Other soils including:

- Orange alluvial loamy sand
- Brownish grey granitic loamy sand
- Rocky red brown loamy sand/sandy loam
<table>
<thead>
<tr>
<th>Map unit</th>
<th>Parent material</th>
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<th>Soil type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kokeby</td>
<td>Dissected lateritic profile.</td>
<td>Gently undulating hillslopes.</td>
<td>Marri, jarrah and white gum with a shrub layer of parrot bush, tea tree and blackboy. White gum, marri, sheoak and tea tree.</td>
<td>Loose, pale greyish brown sand.</td>
<td>Loose, pale sand to a depth of about 40-60 cm overlying a gravel layer and/or a massive, yellow loamy sand.</td>
<td>3. Pale sand over gravel / loamy sand (50%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gravelly ridges on gently undulating hillslopes.</td>
<td>Marri and white gum with jarrah in some areas.</td>
<td>Hardsetting, greyish brown loamy sand. Abundant, ironstone gravel.</td>
<td>Loose, grey sand.</td>
<td>6. Yellow gravelly loamy sand (10%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hollows and depressions within gently undulating hillslopes.</td>
<td>Banksia, Christmas tree and tea tree with scattered marri.</td>
<td></td>
<td>Loose white to pale yellow sand to a depth of 80 cm or greater.</td>
<td>2. Deep pale sand (8%).</td>
</tr>
</tbody>
</table>

Other soils including:

- Deep yellow sand
- Loamy sand surfaced duplex
- Waterlogged sand
### Sheahan Spillway

**Parent material:** Sand derived from the dissected lateritic profile.

**Landform:** Hollows and depressions on gently undulating hillslopes.

**Dominant vegetation:**
- Banksia, Christmas tree and tea tree with scattered marri.
- Marri, jarrah and white gum with a shrub layer of parrot bush, tea tree and blackboy.

**Surface soil material:** Loose, grey sand.

**Sub surface soil material:** Loose, pale greyish brown sand.

**Soil type:**
- Deep pale sand (85%).
- Pale sand over gravel / loamy sand (10%).

**Other soils including:**
- 17. Deep yellow sand
- 22. Waterlogged sand

### Maitland Alluvium

**Parent material:** Alluvium and colluvium.

**Landform:** Swamps and poorly drained areas that occur within the broad valley floors of the Dale unit.

**Dominant vegetation:**
- Paperbark, rushes and low scrub.

**Surface soil material:**
- Crop soil to a depth of 80 cm or greater.
- Loose, pale yellow sand to a depth of about 40-60 cm overlying a gravel layer and/or a massive, yellow loamy sand.

**Sub surface soil material:**
- Crop soil to a depth of about 80 cm or greater.

**Soil type:**
- A variety of swampy soils.
3. Application of the manual to mapping soils

3.1 Introduction

A major use of this manual will be to provide a framework for mapping soils at a scale suitable for farm and catchment planning. The soils defined or, if appropriate, associations of two or more soil types can be mapped at a scale of 1:10,000 over individual farms. These soil maps can then be used to develop a land management plan.

3.2 Mapping the soils of a catchment

Catchment soil maps provide a useful basis from which a land management plan for the catchment can be derived. They can help identify various target areas for specific action and familiarise all members of a catchment group with the soils of the catchment and their capacity. Dealing with catchments allows problems such as salinity, that go beyond farm boundaries, to be tackled effectively.

The following outlines a suggested method for mapping the soils of a catchment.

Step 1. Establish the ‘catchment group’. Catchment groups normally comprise of 5 to 20 landholders who farm in the same drainage catchment. The number of landholders should be limited to less than 20 to enable effective interaction amongst group members. Successful catchment groups are autonomous, that is, they are ‘farmer driven’ with Department of Agriculture back up support. This gives greater involvement and ownership to the farmer groups.

Step 2. The Department of Agriculture staff member assisting in the soil mapping should arrange a preliminary visit to the catchment to identify the major soil types. This will involve driving around the catchment with one or more of the landholders to identify sites for backhoe pits (to be used on the soil mapping field day). It is preferable to locate the backhoe pits of each soil type as close to each other as possible.

The soil types defined in the manual provide a basis for the selection of soil types.

To avoid confusion not more than 12 soil types should be selected. It may be considered appropriate to amalgamate two or more soil types from the manual as they have similar capabilities and/or occur together in too complex an association to map out separately. It is necessary to draw up a preliminary list of soil types to be mapped in order to present them for discussion at the soil mapping field day.

Step 3. The farmers arrange for the backhoe pits to be dug. Each pit should be dug to a depth of at least 1.5 m (if possible), 1 m wide and 2 m long. Fencing off the pits is recommended if they are to be left open for future reference.

Soil mapping field day

Step 4. The Department of Agriculture staff member holds a preliminary discussion with the group members to:

(i) introduce the aims of the day;
(ii) outline the procedures of the day;
(iii) provide copies of the soil manual or photocopies of the relevant sections to members.

The importance of the soil map as the basis for developing a catchment land management plan should be highlighted.

**Step 5.** The catchment group members undertake a field tour of the soil pits. The following attributes and characteristics are discussed at each pit.

- Describe the soil type and point out its important and distinguishing characteristics.
- Discuss the land use options, possible yields and conservation aspects.
- The dominant, indicator vegetation and position in the landscape should be highlighted.

The pits provide an avenue to promote discussion on each soil type (it is beneficial to have a general adviser present to assist with any other farming issues that may arise). Before leaving each pit, the group members must feel comfortable in identifying that soil type.

**Step 6.** After inspection of the soil pits the group re-convenes in a shed or house which has plenty of table space.

**Step 7.** A list of soil types to be mapped is finalised. Members of the catchment group need to consider if they:

- agree with the list of soil types;
- can think of any important soils that should be included; or
- believe some of the suggested soil types should be omitted.

As suggested previously, about 12 soil types is the maximum number that should be mapped. Commonly used local names may be used in preference to the soil type names defined in this manual.

**Step 8.** Before the soil mapping field day each farmer should have ordered an enlarged aerial photograph of their property to use as a base map for the soil mapping. A scale of 1:10,000 is usually the most suitable.

Note: Aerial photographs can be ordered directly from the Department of Land Administration or via the Department of Agriculture. It may take as long as two months for the photographs to arrive.

**Step 9.** Each member should obtain, or be provided with, a permanent marker pen and a sheet of clear plastic overlay. The overlay should be taped to the aerial photograph and the soil boundaries drawn in by the landholder with the marker pen. Farmers' knowledge of their soils, and time available, and the distribution of soils on the farm will affect the accuracy of each soil map. Many farmers know their soils well and can map their farm, to their satisfaction, with little or no field work. Others may need to dig holes with a spade and/or hand auger in areas of uncertainty.

Department of Agriculture staff should be available to answer any queries. Areas of soil types of less than about 2 ha should not be mapped unless they require a significantly different land use.

Soil peels of the major soil types found in the Department of Agriculture’s Northam Advisory District are stored at the Northam Office. The peels can be taken to such workshops to help clarify a soil type.
Step 10. When group members have finished their soil mapping, they should check their soil boundaries with their neighbours to make sure they coincide.

Step 11. Department of Agriculture staff collect the finished soil maps for digitising and production of the catchment soil map. Many farmers will need to take their soil maps home and conduct some field checking before completion. These maps will need to be collected at a later date.

Step 12. Members of the catchment group who could not attend the soil mapping field day should be shown around the soil pits and helped with the soil mapping by catchment group members who have completed their mapping.

3.3 Developing a land management plan

In addition to soil types, other information such as natural features, areas of degradation and man-made structures need to be taken into account when producing a land management plan. This information can be mapped on additional clear plastic overlays.

Natural features include ridges, drainage lines, rock outcrops, breakaways and remnant vegetation. Forms of degradation such as salinity (mild, moderate and severe), wind and water erosion and waterlogging should also be mapped. As should man-made structures such as fences, water points, banks, dams or any other features that the group feels are important.

A series of workshops need to be held to discuss degradation types and processes, land capability and the concept of a land management unit (a land management unit is single soil type or group of soil types which are linked together by factors influencing productivity, land use and degradation hazards).

Land management units for the individual farms within the catchment can then be defined by combining these different layers of information. It should be noted that land management units may differ from one farm to another depending on factors such as preference to cropping, rotations practiced, farming equipment and the occurrence of soil types.

The land management plan may suggest the implementation of options such as:

- re-fencing;
- different rotations;
- earthworks and drainage;
- tree planting; and
- salt-land agronomy.

Economic analysis of various land uses on each land management unit can now be evaluated using farm management models developed by the Department of Agriculture.

For more detailed information on farm planning refer to Hawkins et al. (1991).
4. Acknowledgements

The authors gratefully acknowledge the assistance of all those involved in this project. In particular to all the staff of the Northam Office of the Department of Agriculture who provided assistance and advice in their specialist fields, especially J. Blake, P. Nash, F. Frost, P. Metcalfe, T. Lacey and J. Holmes. We also wish to thank the farmers who spent time providing yield, soil conservation and capability information. To W. McArthur and G. Dimmock of CSIRO for their advice and allowing us to use CSIRO soil site cards to characterise some of our delineated soil types. To Simon Peters for his assistance in the field.
5. References


Munsell. Soil Colour Charts. Munsell Colour Co. Inc. Baltimore 18, Maryland 21218, U.S.A.


### 6.1 Appendix 1. Climatic data

<table>
<thead>
<tr>
<th>Station</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Beverley (1886-1988)</td>
<td>9</td>
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<td>17</td>
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<td>82</td>
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#### Mean daily maximum temperature (°C)

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<th>March</th>
<th>April</th>
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<td>16.1</td>
<td>15.1</td>
<td>15.6</td>
<td>17.5</td>
<td>21.4</td>
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#### Mean daily pan evaporation (mm)

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<th>October</th>
<th>November</th>
<th>December</th>
<th>Year</th>
</tr>
</thead>
<tbody>
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<td>8.2</td>
<td>4.9</td>
<td>2.9</td>
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<td>5.0</td>
<td>7.7</td>
<td>9.9</td>
<td></td>
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</tbody>
</table>
6.2 Appendix 2. Descriptions of texture grades

*(McDonald et al. 1984)*

Field texture is a measure of the behaviour of a small handful of soil when moistened and kneaded into a ball and then pressed out between thumb and forefinger.

Take a sample of soil sufficient to fit comfortably into the palm of the hand. Moisten the soil with water, a little at a time, and knead until the ball of soil, so formed, just fails to stick to the fingers. Add more soil or water to attain this condition, known as the **sticky point**, which approximates field moisture capacity for that soil. Continue kneading and moistening until there is no apparent change in the soil ball, usually a working time of 1 to 2 minutes. The soil ball, or bolus, is now ready for shearing manipulation, **but the behaviour of the soil during bolus formation is also indicative of its field texture.** The behaviour of the bolus and of the ribbon produced by shearing (pressing out) between thumb and forefinger characterises the field texture. Field texture grades may be defined by the behaviour of the moist bolus as set out in Table A.2. The approximate percentage content of clay (particles less than 0.002 mm in diameter) is given as a guide.

6.3 Appendix 3. Size of sand fraction

*(taken from Hamblin 1985)*

The following diagram can be used as an aid to determine the size of the sand fraction within a soil. The grain size has a large influence on the ability of a sandy soil to retain moisture.

![Diagram showing sand fractions](image)

**Fine** sand grains can just be seen individually with the naked eye and have a feel similar to coarse-flour or table salt.

**Medium** sand can easily be seen as individual grains and feels similar to white sugar.

**Coarse** sand is very distinctive; many medium sands may seem “coarse”. Similar to raw sugar.
<table>
<thead>
<tr>
<th>Field texture grade</th>
<th>Behaviour of moist bolus</th>
<th>Approximate clay content (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>Coherence nil to very slight, cannot be moulded; single sand grains adhere to fingers.</td>
<td>Always less than 10% and commonly less than 5%</td>
</tr>
<tr>
<td>Loamy sand</td>
<td>Slight coherence; can be sheared between thumb and forefinger to give minimal ribbon of about 5 mm.</td>
<td>5% to 10%</td>
</tr>
<tr>
<td>Clayey sand</td>
<td>Slight coherence; sticky when wet, many sand grains stick to fingers; will form minimal ribbon of 5-15 mm; discolours fingers with clay stain.</td>
<td>5% to 10%</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>Bolus just coherent but very sandy to touch; will form ribbon of 15-25 mm; dominant sand grains are of medium size and are readily visible.</td>
<td>10% to 15%</td>
</tr>
<tr>
<td>Loam</td>
<td>Bolus coherent and rather spongy; smooth feel when manipulated but with no obvious sandiness or 'silkiness'; may be somewhat greasy to the touch if much organic matter present; will form ribbon of about 25 mm.</td>
<td>about 25%</td>
</tr>
<tr>
<td>Sandy clay loam</td>
<td>Strongly coherent bolus, sandy to touch; medium size sand grains visible in finer matrix; will form ribbon of 25-40 mm.</td>
<td>20% to 30%</td>
</tr>
<tr>
<td>Clay loam</td>
<td>Coherent plastic bolus, smooth to manipulate; will form ribbon of 40-50 mm.</td>
<td>30% to 35%</td>
</tr>
<tr>
<td>Sandy clay</td>
<td>Plastic bolus; fine to medium sand grains can be seen, felt or heard in clayey matrix; will form ribbon of 50-75 mm.</td>
<td>35% to 40%</td>
</tr>
<tr>
<td>Light clay</td>
<td>Plastic bolus; smooth to touch; slight resistance to shearing between thumb and forefinger; will form ribbon of 50-75 mm.</td>
<td>35% to 40%</td>
</tr>
<tr>
<td>Medium clay</td>
<td>Smooth plastic bolus; handles like plasticine and can be moulded into rods without fracture; has some resistance to ribboning shear; will form ribbon of 75 mm or more.</td>
<td>45% to 55%</td>
</tr>
<tr>
<td>Heavy clay</td>
<td>Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; has firm resistance to ribboning shear; will form ribbon of 75 mm or more.</td>
<td>50% or more</td>
</tr>
</tbody>
</table>
6.4 Appendix 4. Condition of surface soil, structure and fabric

(McDonald et al. (1984)

**Condition of surface soil when dry**

Many surface soils have a characteristic appearance when dry. Surface conditions are often relevant to the use of the soil and indicative of particular kinds of soil. The following conditions are not necessarily mutually exclusive:

**Self-mulching** Highly pedal, loose surface mulch forms on drying.

**Loose** Incoherent* mass of individual particles or aggregates. Surface easily disturbed by pressure of forefinger.

**Soft** Coherent** mass of individual particles or aggregates. Surface easily disturbed by pressure of forefinger.

**Firm** Coherent** mass of individual particles or aggregates. Surface disturbed or indented by moderate pressure of forefinger.

**Hardsetting** Compact, hard, apparently apedal condition forms on drying. Surface not disturbed or indented by pressure of forefinger. Surface seal is not necessarily associated with hard setting.

* Incoherent means that less than two-thirds of the soil material, whether composed of peds or not, will remain united at the given moisture state without significant force.

** Coherent means that two-thirds of the soil material, whether composed of peds or not, will remain united at the given moisture state unless force is applied.

**Structure**

Soil structure refers to the distinctness, size and shape of peds. “A ped is an individual natural soil aggregate consisting of a cluster of primary particles, and separated from adjoining peds by surfaces of weakness which are recognisable as natural voids or by the occurrence of cutans” (Brewer 1960).

Soil structure can only be described reliably in a relatively fresh vertical exposure or relatively undisturbed soil core, not from an auger boring.

Grade of pedality is the degree, development and distinctness of peds. In pedal soils it expresses the relative difference between the strength of cohesion within peds and the strength of adhesion between adjacent peds.

Apedal soils have no observable peds and are divided into:

**Single grain** Loose incoherent mass of individual particles.

**Massive** Coherent. When disturbed, soil separates into fragments which may be crushed to ultimate particles.
Pedal soils have observable peds and are divided into:

**Weak**
- Peds indistinct and barely observable in undisplaced soil. When displaced, up to one-third of the soil material consists of peds.

**Moderate**
- Peds well formed and evident but not distinct in undisplaced soil. Adhesion between peds is moderate to strong. When displaced, more than one-third of the soil material consists of peds.

**Strong**
- Peds quite distinct in undisplaced soil. Adhesion between peds is moderate to weak. When displaced, more than two-thirds of the soil material consists of peds.

**Fabric**

Fabric describes the appearance of the soil material (under X10 hand lens). Differences in fabric are associated with the presence or absence of peds, the lustre or lack of lustre of the ped surfaces, and the presence, size and arrangement of pores (voids) in the soil mass. The descriptions given below apply primarily to B horizons.

**Earthy (or porous) fabric**
- The soil material is coherent and characterised by the presence of pores (voids), few, if any, peds, and a general floc condition throughout. Ultimate soil particles (sand grains, for example) are coated with oxides and/or clays and are arranged (clumped) around the pores.

**Sandy fabric**
- The soil material is coherent with few, if any, peds. The closely packed sand grains provide the characteristic appearance of the soil mass.

### 6.5 Appendix 5. Land quality definitions

**Moisture availability**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very low</strong></td>
<td>Deep, leached sands with a very low clay content (less than 3%).</td>
</tr>
<tr>
<td><strong>Low</strong></td>
<td>Deep yellow sands (with about 5% clay). Pale sand over gravel and/or loamy sand at depths of between 40 and 70 cm.</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Duplex soils with loamy sand topsoils. Clay generally occurs at less than 40 cm.</td>
</tr>
<tr>
<td><strong>High</strong></td>
<td>Deep, well structured loams or sandy loams which often grade into clay loams. Also includes areas of soils which receive additional moisture through seepage.</td>
</tr>
</tbody>
</table>

Note: The rooting conditions greatly affect the availability of moisture for plant growth.
Nutrient availability

**Very low** - Deep, sandy soils with a very low clay content. Mobile nutrients such as nitrogen are rapidly leached. Trace element deficiencies may need to be corrected.

**Low** - Soils with a deep, sandy topsoil but having a gravel or clay layer at depth. Mobile nutrients are rapidly leached from the topsoil. Trace element deficiencies may need to be corrected.

**Moderate** - Moderately fertile soils in which rapid leaching of nutrients out of the root zone does not occur. Includes many of the loamy sand and sandy loam over clay soils.

**High** - Soils with a relatively high fertility. Includes soils developed from fresh rock and alluvial soils. Generally have loamy or clayey textures and a pH close to neutral.

Waterlogging risk

**Low** - Waterlogging does not occur or very rarely occurs.

**Moderate** - Waterlogging occurs in wet years. Crop yields can be significantly reduced in these years.

**High** - Seepage areas and valley floor soils that become waterlogged in most winters. The watertable remains at or near the surface for at least a few weeks. Cropping is uneconomic in many years.

**Very high** - Drainage lines and swamps which remain wet into summer. Cropping not possible.

Trafficability

**Poor** - Surface rock or steep slopes (> 15%) prevent cultivation. Or the soil becomes boggy for long periods reducing vehicle access.

**Moderate** - Surface rock or steep slopes cause some hindrance to cultivation, and/or the soil is boggy for short periods of time after heavy rainfall.

**Good** - Nil to minor hindrance to cultivation owing to landform or rock. The soil does not or very rarely becomes boggy.

Rooting conditions

**Difficult** - Dense clay layers, pans or shallow bedrock limit the root growth of all agricultural species.

**Moderate** - Clay layers, pans or shallow bedrock limit the root growth of deep rooted, agricultural species.

**Easy** - The rooting conditions do not greatly limit the root development of agricultural species.

Soil structure decline risk

**High** - Topsoil structure adversely affected by cultivation and trampling by stock resulting in substantial yield penalties. Surface textures of a sandy loam or greater (i.e. at least 10-20% clay).

**Low** - Topsoil structure not greatly affected by cultivation and trampling by sheep. Or risk of structural decline unknown.
Salinity risk

Not susceptible - Salinity does not, or rarely, occurs.

Low - Salinity is not widespread, but can occur adjacent to drainage lines and where rock or clay barriers force laterally flowing water to the soil surface.

High - Soils found on the valley floor and in drainage lines, of which significant areas are at high risk of becoming saline.

Wind erosion risk

High - Erodible soils, supporting poor plant growth. Loose, sandy surfaced horizons, usually with less than 3% clay.

Moderate - Erodible soils, supporting average plant growth. Soils with a loose, sandy topsoil overlying a clay subsoil. Also includes sandy soils with a large percentage of surface gravel.

Low - Moderately erodible soils, i.e. firm to hardsetting loamy sands to sandy loams, supporting good plant growth.

Very low - Soils with a low erodibility supporting good plant growth. Includes hardsetting, clay soils and wet soils.

Water erosion risk

High - Highly erodible soils on steep slopes (often > 8%). Includes the dispersive, lateritic clays that often occur below breakaways.

Moderate - Moderately erodible soils that occur on hillslopes (generally 5-10%).

Low - Deep sands with a high infiltration rate. Water does not or rarely runs off. Valley floor soils with little or no relief (< 1% slope)

Recharge hazard

Low - Productive agricultural soils with a good water holding capacity within the top 30 cm. Rooting conditions are easy. Includes loamy and heavy textured soils.

Moderate - Deep sand over clay soils with a low water holding capacity in the top 30 cm. The clay subsoil retains moisture for use by deeper rooted agricultural species.

High - Highly permeable soils supporting below average plant growth. Includes:
- Deep sands with a low water holding capacity.
- Buckshot gravel soils.
- Coarse granitic soils overlying fractured rock (runoff from rock outcrops readily passes through the soil profile recharging the groundwater).
Table A.5.1. Summary of land qualities for the major soil types

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Moisture availability (m)</th>
<th>Nutrient availability (n)</th>
<th>Waterlogging risk (l)</th>
<th>Trafficability (t)</th>
<th>Rooting conditions (d)</th>
<th>Soil structure decline risk (s)</th>
<th>Salinity risk (y)</th>
<th>Wind erosion risk (w)</th>
<th>Water erosion risk (e)</th>
<th>Recharge hazard (g)</th>
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</thead>
<tbody>
<tr>
<td>1. Buckshot gravel</td>
<td>Low-moderate</td>
<td>Low</td>
<td>Low</td>
<td>Poor 1-good</td>
<td>Easy</td>
<td>Low</td>
<td>Not susceptible</td>
<td>Low-moderate</td>
<td>Low-moderate</td>
<td>High</td>
</tr>
<tr>
<td>2. Deep pale sand</td>
<td>Very low</td>
<td>Very low</td>
<td>Low</td>
<td>Moderate 2-good</td>
<td>Easy</td>
<td>Low</td>
<td>Not susceptible</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>3. Pale sand over gravel/loamy sand</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Good</td>
<td>Easy</td>
<td>Low</td>
<td>Not susceptible</td>
<td>High</td>
<td>Low</td>
<td>High-moderate</td>
</tr>
<tr>
<td>4. Sandy loam over pinkish clay below breakaways</td>
<td>Low 2-moderate</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate-poor 4</td>
<td>Moderate-difficult 3</td>
<td>High</td>
<td>Not susceptible</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>5. Yellow gravelly loamy sand</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Low</td>
<td>Good</td>
<td>Easy</td>
<td>Low</td>
<td>Not susceptible</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>6. Brownish grey granitic loamy sand</td>
<td>Moderate-high</td>
<td>High</td>
<td>Low</td>
<td>Moderate</td>
<td>Easy</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>7. Deep sandy surfaced duplex</td>
<td>Moderate-high</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Easy-moderate</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>8. Poorly drained sandy loam duplex</td>
<td>High</td>
<td>Moderate</td>
<td>Very high</td>
<td>Poor</td>
<td>Easy-moderate</td>
<td>Low</td>
<td>High</td>
<td>Very low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>9. Alluvial loam</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate-poor</td>
<td>Easy</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>10. Sandy surfaced valley duplex</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Easy-moderate</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>11. Grey alluvial clay</td>
<td>Moderate</td>
<td>High</td>
<td>Low</td>
<td>Moderate-poor</td>
<td>Easy-moderate</td>
<td>Low</td>
<td>High</td>
<td>Very low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>12. Loamy sand surfaced valley duplex</td>
<td>High</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate-poor</td>
<td>Easy-moderate</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

1. Ironstone boulders may limit trafficability in some areas.
2. Vehicles may get bogged in this loose sand.
3. In areas where the topsoil has been eroded.
4. In very steep areas with gully erosion.
6.6 Appendix 6. The land capability classification

The Appendix explains the Western Australian Department of Agriculture’s Land Capability System and how the capability ratings for the five land uses were produced.

Land capability is the ability of the land to sustain a specific use without undesirable on-site or off-site effects.

The capability classes

The classification used in this study is the standard five class system adopted by the Western Australian Department of Agriculture for land capability assessment. Class I land has the highest potential and fewest limitations for a specified use, while class V land is regarded as prohibitive for the proposed land use (see Table A.6.1).

Table A.6.1 Land capability classes

<table>
<thead>
<tr>
<th>Class I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land with a very high capability for the proposed use. Either there are no physical limitations to the specified land use, or the limitations are easily overcome. Risk of land degradation is low.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land with a high capability for the proposed use. Some physical limitations do occur, affecting either its use, or land degradation risk. These limitations can be overcome through careful planning or moderate application of conservation measures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land with a fair capability for the proposed use. Physical limitations do occur which will significantly affect land use or result in moderate risk of land degradation. Careful planning and/or extensive conservation measures are required.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land with a low capability for the proposed use. There is a high degree of physical limitation and a high risk of degradation which can only be overcome with expensive conservation measures or development costs. Future technology or economic circumstances may change this classification.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land with a very poor capability for the proposed activity or use. The severity of its physical limitation prohibits its use.</td>
</tr>
</tbody>
</table>

80 Soils of the Northam Advisory District
Deriving the classification

There were five stages in deriving the land capability classification.

1. Identifying and describing the soil

2. Selecting the land use types relevant to the region. These are annual pastures, cereal crops, lupins, canola, and tagasaste.

3. Identifying relevant land qualities of importance for plant growth, for farm management and for conservation requirements.

   Land qualities are those attributes of, or affecting, land which influence the suitability of land for a specific use. They render land either suitable for a specific use or, conversely, they become limiting factors for such use. The land qualities considered appropriate are listed in Appendix 5.

4. Holding discussions with Department of Agriculture staff and farmers to define how capable each soil is of supporting common agricultural landuses. The limiting factors (qualities) of each soil were identified.

5. Developing the overall land capability classification of the soil types for each land use (see Table A.6.2 on the following page). The overall capability is determined by the most limiting quality or qualities. In Table A.6.2 those land qualities which are most limiting are shown as letter suffixes. There may be more than one limiting land quality. No subscript is shown for soils rated as class I because there are no significant limiting factors.
Table A.6.2. Land capability assessment

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Pasture Capability</th>
<th>Potential yield</th>
<th>Cereal Capability</th>
<th>Potential yield</th>
<th>Lupin Capability</th>
<th>Potential yield</th>
<th>Canola Capability</th>
<th>Tagasaste Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Buckshot gravel</td>
<td>III-Vm,n</td>
<td>15 DSE/ha</td>
<td>III-Vm,n</td>
<td>3.6 t/ha</td>
<td>Ilm,n</td>
<td>2.1 t/ha</td>
<td>IVn,m</td>
<td>I-IIId</td>
</tr>
<tr>
<td>2. Deep pale sand</td>
<td>Vm,n,g</td>
<td>9 DSE/ha</td>
<td>Vm,n</td>
<td>2.4 t/ha</td>
<td>IVm,n</td>
<td>1.5 t/ha</td>
<td>Vm,n</td>
<td>I-IIIm</td>
</tr>
<tr>
<td>3. Pale sand over gravel/loamy sand</td>
<td>IVm,n</td>
<td>13 DSE/ha</td>
<td>III-IVm,n</td>
<td>4.2 t/ha</td>
<td>II-IIIm,n</td>
<td>2.6 t/ha</td>
<td>IVm,n</td>
<td>I-IIId</td>
</tr>
<tr>
<td>5. Sandy loam over pinkish clay below breakaways</td>
<td>III-Ve,m</td>
<td>6-15 DSE/ha</td>
<td>IV-Ve,m</td>
<td>1.0-4.0 t/ha</td>
<td>IV-Vd,e</td>
<td>0.6-1.2 t/ha</td>
<td>IV-Ve,m</td>
<td></td>
</tr>
<tr>
<td>6. Yellow gravelly loamy sand</td>
<td>Ilm</td>
<td>20 DSE/ha</td>
<td>I-IIIm</td>
<td>5.4 t/ha</td>
<td>I</td>
<td>3.0 t/ha</td>
<td>I</td>
<td>Ilm</td>
</tr>
<tr>
<td>7. Rocky red brown loamy sand/sandy loam</td>
<td>I</td>
<td>22 DSE/ha</td>
<td>I</td>
<td>6 t/ha</td>
<td>I-IIi</td>
<td>3.0 t/ha</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>8. Brownish grey granitic loamy sand</td>
<td>Ilm</td>
<td>20 DSE/ha</td>
<td>I-IIi</td>
<td>4.8 t/ha</td>
<td>II-III,d</td>
<td>2.6 t/ha</td>
<td>Ilm,i</td>
<td></td>
</tr>
<tr>
<td>10. Deep sandy surfaced duplex</td>
<td>IVm,w</td>
<td>14 DSE/ha</td>
<td>III-IVm,w</td>
<td>4.2 t/ha</td>
<td>II-IIIm,l</td>
<td>2.6 t/ha</td>
<td>IIIm,i</td>
<td></td>
</tr>
<tr>
<td>11. Poorly drained sandy loam duplex*</td>
<td>II-Vi</td>
<td>6-18 DSE/ha</td>
<td>VI,t</td>
<td>0.5-2.0 t/ha</td>
<td>VI,t</td>
<td>0.3 t/ha</td>
<td>VI,t</td>
<td></td>
</tr>
<tr>
<td>12. Alluvial loam*</td>
<td>I</td>
<td>22 DSE/ha</td>
<td>II-IVi,t</td>
<td>3.0-5.0 t/ha</td>
<td>IVi</td>
<td>1.5 t/ha</td>
<td>IVi</td>
<td></td>
</tr>
<tr>
<td>13. Sandy surfaced valley duplex*</td>
<td>III-IVi,m</td>
<td>15 DSE/ha</td>
<td>III-IVi,m</td>
<td>3.6 t/ha</td>
<td>IVi</td>
<td>1.0 t/ha</td>
<td>IVi,m</td>
<td></td>
</tr>
<tr>
<td>14. Grey alluvial clay*</td>
<td>II-III</td>
<td>17 DSE/ha</td>
<td>III-IVi</td>
<td>3.6 t/ha</td>
<td>VI</td>
<td>0.6 t/ha</td>
<td>IVi</td>
<td></td>
</tr>
<tr>
<td>15. Loamy sand surfaced valley duplex*</td>
<td>I-IIi</td>
<td>22 DSE/ha</td>
<td>IIIi</td>
<td>4.2 t/ha</td>
<td>IVi</td>
<td>1.5 t/ha</td>
<td>IVi</td>
<td></td>
</tr>
</tbody>
</table>

* Capability and potential yields for areas of these soils not affected by salinity.

Where:
m - moisture availability; n - nutrient availability; l - waterlogging risk; d - rooting conditions; t - trafficability; y - salinity risk; s - soil structure decline risk; e - water erosion risk; w - wind erosion risk; g - recharge hazard
### 6.7 Appendix 7. A correlation of the soil types with other studies in the area

<table>
<thead>
<tr>
<th>Soils of the Northam Advisory District (Fulton and Lantzke, 1993)</th>
<th>Darling Range Rural Land Capability Study (King and Wells 1990)</th>
<th>Landforms and Soils of the Murray River Catchment Area of Western Australia (McArthur et al. 1977)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Buckshot gravel</td>
<td>Soil type 1</td>
<td>L1, L1(b)</td>
</tr>
<tr>
<td>2. Deep pale sand</td>
<td>Soil type 2</td>
<td>L3</td>
</tr>
<tr>
<td>3. Pale sand over gravel/loamy sand</td>
<td></td>
<td>L3</td>
</tr>
<tr>
<td>4. Breakaway face and ironstone cap</td>
<td></td>
<td>L4</td>
</tr>
<tr>
<td>5. Sandy loam over pinkish clay below breakaways</td>
<td></td>
<td>S4</td>
</tr>
<tr>
<td>6. Yellow gravelly loamy sand</td>
<td>Soil types 5, 12</td>
<td>L7, S2</td>
</tr>
<tr>
<td>7. Rocky red brown loamy sand/sandy loam</td>
<td>Soil types 9, 10</td>
<td>S1, S7</td>
</tr>
<tr>
<td>8. Brownish grey granitic loamy sand</td>
<td>Soil types 9, 11</td>
<td>S6</td>
</tr>
<tr>
<td>9. Stony soils</td>
<td>Soil types 9, 10, 11</td>
<td>S8</td>
</tr>
<tr>
<td>10. Deep sandy surfaced duplex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Poorly drained sandy loam duplex</td>
<td>Soil types 6, 7</td>
<td>F2, L5</td>
</tr>
<tr>
<td>12. Alluvial loam</td>
<td></td>
<td>F3</td>
</tr>
<tr>
<td>13. Sandy surfaced valley duplex</td>
<td>Soil type 3</td>
<td>F4?</td>
</tr>
<tr>
<td>14. Grey alluvial clay</td>
<td>Soil type 4</td>
<td>F5</td>
</tr>
<tr>
<td>15. Loamy sandy surfaced valley duplex</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minor soils</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Coarse granitic sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Deep yellow sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Red brown doleritic clay loam</td>
<td>Soil type 10</td>
<td>S7</td>
</tr>
<tr>
<td>19. Hardsetting gritty quartzitic soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Waterlogged greyish loamy sand/sandy loam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Orange alluvial loamy sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Waterlogged sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Loamy sand surfaced duplex</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

83 Soils of the Northam Advisory District
6.8 Appendix 8. Rural residential lots

Rural residential subdivisions are one of the main land uses in the Darling Range. The holdings are larger than urban lots but smaller than commercial farms. The size is commonly between 1 and 5 hectares but may be as large as 50 hectares.

In most cases there is some form of dwelling on the properties. Generally there is a more intensive nature of land use and a greater likelihood of land disturbance with rural residential developments compared to commercial farming. Increased land disturbance is associated with the provision of access, housing and out building sites, water supply and effluent disposal.

A land capability assessment has not been done for this land use as most of the land can sustain some form of rural residential land use, provided there is a suitable house site and access way. Most of the Darling Range Zone would fall into Class I, II or III for a rural residential land use. The exceptions would be excessively waterlogged and flood prone valley floors, and steep and rocky hill slopes where house sites may exist but road access would cause a soil conservation hazard.

Areas with rapidly drained soils require careful planning as subdivision with associated vegetation clearance and land disturbance may cause off-site salinity problems. In cases where land is already cleared some revegetation may be required before subdivision is allowed on these rapidly drained soils.

The following aspects of conservation land use should be considered for rural residential developments.

- Need for soil conservation structures.
- Provision of an adequate water supply.
- Subdivision design.
- Lot sizes.
- Access.
- Development envelopes and set back distances.
- Fire management.
- Stocking limitations.
- Vegetation protection and revegetation.
- Effluent disposal ability.
- Existing water rights and controls.

For further reading refer to:

Development guidelines for small rural lots. Western Australian Department of Agriculture. Farmnote 17/86.