Soil information sheets for the northern agricultural areas

Natural Resources Assessment Group, Agriculture Western Australia

Landcare Western Australia

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Natural Resources Assessment Group, Agriculture Western Australia, and Landcare Western Australia. (1997), Soil information sheets for the northern agricultural areas. Department of Agriculture and Food, Western Australia, Perth. Report 13/97.
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SOIL
INFORMATION SHEETS
FOR THE NORTHERN AGRICULTURAL AREAS
1997
Introduction

These soil information sheets are produced for farmers in the Northern Wheatbelt.

The use of this information by the farming community, land use planners, research officers and those providing technical advice to land users should assist in the development of sustainable agricultural systems for rural production in the area. It should be used as a guide, and encourage users to seek further information through relevant people and organisations.

The sheets have been prepared by the Natural Resources Assessment Group, Agriculture Western Australia and based on information in the Geraldton region land resources report by L. Gary Rogers. They were compiled by Daya Patabendige in Northam, with contributions from Caroline Peek, Wayne Proudlove, Mike Clark (revegetation) and Digby Growns (floriculture) in the Geraldton District Office.

Information on the soil sheets

Each sheet summarises information on a particular soil’s characteristic properties and associated land use suitability and management. A photograph of a representative profile is provided for each soil. Technical terms are defined in the glossary. Information is presented under the following headings:

Soil series and groups: The use of soil series is being adopted over Western Australia as a means of identifying particular soils. Each series is identified by a unique name, usually from the locality where it was first described. A series links a range of soils with similar profile characteristics and management requirements which have common agricultural uses. Soils have also been placed in groups based on simple, descriptive factors e.g. pale deep sand. A local name (in brackets) is also supplied and followed by a brief description to aid identification.

Occurrence: This describes the distribution of the soil over the agricultural areas, followed by a description of the landscape positions in which it may occur. Where possible likely soil-landscape systems are indicated.

Native vegetation: A brief description of either indicator vegetation or common natural vegetation is presented. Where possible, both the common name and corresponding botanical name are included.

Soil profile description: Identification, classification and the main soil features are described. Soil colour, structure, and other technical terms are explained in the glossary.

Characteristic soil properties: This summarises the main features including some chemical and physical attributes which may be relevant to land use. Comment is made on the drainage, water repellence, pH (acidity or alkalinity), nature of surface, stones, sodicity of the subsoil, dispersive nature, possible subsoil salinity and perched watertable.

An effective rooting depth is estimated. This is an approximation, usually to the depth of an impediment to plant roots, such as a dense clay layer, dense ferruginous (ironstone) gravel or bedrock.

Soil classification: This is an extra for the scientist who may be using this information to understand and evaluate the soil. Two systems are used: the Australian Soil Classification and the Northcote Principal Profile Form (PPF). Both are defined in the glossary.
**Agricultural land use and management**

This briefly describes the agricultural system that may best suit the soil based on soil properties and limitations for sustainable production and minimal land degradation.

Recommended crops, trees, annual and perennial pastures are described and discussed. Each land use may be specific for particular crops, rotations or species. This information is based on the soil properties and limitations only and should be taken as a guide. It should also act as a catalyst to encourage land managers to seek further information.

**Soil characteristics and land conservation:** This lists factors that might limit production and affect management. Headings such as acidity, salinity, waterlogging or wind erosion are preceded by a ranking of high, moderate, low or very low, or may just include a statement on suitability.

**The Northern Agricultural area**

The Northern Agricultural area falls within the medium and low rainfall areas of the Northern Sustainable Rural Development program of Agriculture Western Australia. This area comprises approximately 2 million hectares including about 1300 farms which range from small horticultural holdings near Geraldton and Northampton, to extensive grazing and cropping properties. It includes all of the shires of Greenough, Irwin and Mingenew, and parts of Chapman Valley, Morawa, Mullewa, Northampton and Yalgoo.

Geologically, the district can be divided into two major areas: east of the Darling Fault (running in a line extending through Mullewa and Three Springs) which is primarily granites of Precambrian Age (older than 2,500 million years); and west of the Darling Fault which is underlain by a variety of younger marine and continental deposits, mainly sandstones and siltstones.

The east of the district has a mature landscape drained by very low gradient salt lake channels. In the Geraldton-Northampton area, erosion of the sedimentary rocks has produced a distinctive landscape of flat-topped hills with extensive areas of gently sloping land and mature valleys. The western half of the district is drained by a number of rivers, the main ones being the Hutt, Bowes, Chapman, Greenough, Irwin and Lockier.

The soils east of the Darling Fault are dominated by extensive areas of red loamy earths and yellow deep sands. West of the Darling Fault there are very extensive areas of undulating sandplain comprising pale deep sands and yellow deep sands. More dissected country is associated with the active river systems and provides a variety of duplex soils and red earths on the valley sides and river flats.

The annual rainfall is highest just inland from the coast, near Geraldton and Dongara, where it reaches 500 mm per year. It declines rapidly with increasing distance inland to less than 300 mm east of Mullewa on the fringes of the agricultural areas.

Much of the soil is very sandy, both near the coast and over large stretches of inland sandplain. These soils are very vulnerable to wind erosion and water repellence and require fertiliser inputs and correct rotations for successful agriculture. More fertile soils are generally close to rivers, but tend to be smaller in area.
The dominant land uses include cropping, and grazing of sheep for wool. Lupins are grown extensively on light land. Other legumes such as chickpeas and faba beans are being grown on the heavier soil types. Canola is currently finding its niche in the system.

Floriculture involving native species (wildflowers) is a niche industry on some properties. Most well drained soils with a neutral to acid pH (to 5.5) are suitable although banksias do not like loamy soil.

Some soils are suitable for horticulture, but guaranteed availability of water for initial or continued irrigation would be a determining factor. Groundwater maps and other information are available through the Water and Rivers Commission.

Where water is available, annual crops such as seed potatoes can be grown on most well drained sandy or loamy soils. Many soils are unsuitable for horticulture through lack of water, being too far inland, or having poor drainage caused by the presence of a lime layer, hardpan, cemented laterite or rock within the rooting depth. Soils exposed to a high risk of wind erosion or wind exposure will also limit suitability for horticulture.

Olives and nut crops are a suggestion for loamy-textured, well drained slightly alkaline soils, but further expert advice should be sought.

Location of areas covered by these soil information sheets.
### Soil type summary

<table>
<thead>
<tr>
<th>Soil series</th>
<th>Soil group</th>
<th>Common name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allanooka</td>
<td>Pale deep sand</td>
<td>Gutless grey sand</td>
<td>Loose to soft, grey over pale brown over yellow sand</td>
</tr>
<tr>
<td>Balline</td>
<td>Pale deep sand</td>
<td>Grey sandplain</td>
<td>Loose, grey coarse sand over pale brown to white coarse sand</td>
</tr>
<tr>
<td>Bluewell</td>
<td>Shallow gravel</td>
<td>Gravelly sand on laterite</td>
<td>Firm to hardsetting, brown gravelly clayey sand over laterite</td>
</tr>
<tr>
<td>Bookara</td>
<td>Calcareous shallow sand</td>
<td>Black wattle sand</td>
<td>Loose, dark brown calcareous sand over limestone</td>
</tr>
<tr>
<td>Bootenal</td>
<td>Red sandy earth</td>
<td>Red sandy loam</td>
<td>Firm to hardsetting, reddish brown loamy sand grading to sandy clay loam with depth</td>
</tr>
<tr>
<td>Bowes</td>
<td>Red loamy earth</td>
<td>Red loam</td>
<td>Firm to hardsetting, reddish brown sandy loam grading to clay at depth</td>
</tr>
<tr>
<td>Casuarina</td>
<td>Pale deep sand</td>
<td>Sand over gravel</td>
<td>Loose to soft, grey to pale brown sand over sandy gravel</td>
</tr>
<tr>
<td>Eradu</td>
<td>Yellow deep sand</td>
<td>Yellow sandplain</td>
<td>Loose to soft, yellowish brown loamy sand over brownish yellow clayey sand</td>
</tr>
<tr>
<td>Eurangoa</td>
<td>Yellow deep sand</td>
<td>Pale yellow sand</td>
<td>Loose to soft, grey to greyish brown sand over yellow clayey sand</td>
</tr>
<tr>
<td>Grima</td>
<td>Red shallow sand</td>
<td>Jam soil</td>
<td>Firm to hardsetting, red-brown stony clayey sand on granite</td>
</tr>
<tr>
<td>Heaton</td>
<td>Grey deep sandy duplex</td>
<td>Sandy duplex</td>
<td>Loose to firm, dark brown to greyish brown sand over reddish yellow sandy clay</td>
</tr>
<tr>
<td>Indarra</td>
<td>Yellow deep sand</td>
<td>Deep yellow sand</td>
<td>Loose, yellowish brown sand grading to brownish yellow sand</td>
</tr>
<tr>
<td>Irwin</td>
<td>Hard cracking clay</td>
<td>Cracking clay</td>
<td>Dark brown to reddish brown cracking clay.</td>
</tr>
<tr>
<td>Kelly</td>
<td>Yellow sandy earth</td>
<td></td>
<td>Firm, yellowish brown clayey sand over gravelly light sandy clay loam</td>
</tr>
<tr>
<td>Mindage</td>
<td>Red-brown hardpan shallow loam</td>
<td>York gum country</td>
<td>Hardsetting, reddish brown sandy loam over sandy clay loam with a red-brown or calccrete hardpan at moderate depth</td>
</tr>
<tr>
<td>Morawa</td>
<td>Red loamy earth</td>
<td>Red loam</td>
<td>Hardsetting, red sandy loam grading to clay loam over red-brown hardpan at 60 to 140 cm</td>
</tr>
<tr>
<td>Northampton</td>
<td>Red shallow sandy duplex</td>
<td>Red loam</td>
<td>Hardsetting, red-brown stony sand over sandy clay loam on granulite</td>
</tr>
<tr>
<td>Northern Gully</td>
<td>Red deep sandy duplex</td>
<td></td>
<td>Hardsetting, gritty loamy sand over clay on granite</td>
</tr>
<tr>
<td>Pindar</td>
<td>Yellow deep sand</td>
<td>Wodjil sand</td>
<td>Soft to firm, dark yellowish brown acid clayey sand</td>
</tr>
<tr>
<td>Tardun</td>
<td>Red shallow sandy duplex</td>
<td>Rocky outcrop country</td>
<td>Hardsetting, dark reddish brown gritty clayey sand over clay on granite</td>
</tr>
<tr>
<td>Teakle</td>
<td>Yellow deep sand</td>
<td>Limestone yellow sand</td>
<td>Yellowish brown sand over yellow clayey sand over limestone</td>
</tr>
<tr>
<td>Wipanga</td>
<td>Shallow gravel</td>
<td>Gravelly loam</td>
<td>Hardsetting, yellowish brown gravelly sandy loam over cemented laterite</td>
</tr>
</tbody>
</table>
Soil sheet glossary

Acid: The soil has an acidic reaction or pH. The pH measured in a dilute solution of calcium chloride is less than 6.0. When a soil is strongly acid (pH_{Ca} less than 4.5) there is a large increase in the solubility of aluminium in the soil, which can be toxic to plants.

Alkaline: The soil has an alkaline reaction or pH. The pH measured in a dilute solution of calcium chloride is more than 7.0. An alkaline soil alters the availability of some nutrients for plant growth and will affect the growth of certain crops (e.g. narrow-leafed lupins). If a soil is strongly alkaline (pH_{Ca} more than 8.5) it can indicate unfavourable conditions for most plants.

Australian Soil Classification: A system developed by Ray Isbell (CSIRO Division of Soils) to classify Australian soils. This system is being adopted as a national standard.

Coarse fragments: Particles coarser than 2 mm including rock, shell or any other fragments that are not the result of soil forming processes.

Cracking clay: Clay soils that develop vertical cracks when dry.

Dispersion or clay dispersion: The complete breakdown of aggregates into sand, silt and clay-sized particles when wet. This usually occurs slowly, often taking hours to complete. The dispersed clay can block pores, reducing rainfall infiltration and gas exchange. A characteristic sign of dispersion is muddy or cloudy water, the cloudiness being dispersed clay in suspension.

Dispersion is a mainly chemical process that can occur in soils with low stability. Some soils disperse immediately on wetting, while others need an input of energy through raindrop impact, cultivation or stock trampling. Dispersive behaviour is largely governed by the exchangeable sodium percentage (ESP) and the electrolyte (salt) concentration. A straightforward test for dispersion is described in Farmnote No. 57/90.

Duplex soil: A soil that has an abrupt change of texture between the topsoil and subsoil. The typical example is a sand over clay.

EC or Electrical Conductivity: A measure of soluble salts present in soil or water. For soils it is commonly the electrical conductivity of a soil-water suspensions (1 part soil to 5 parts water). The unit of measurement is milliSiemens per metre (mS/m) and is rated as follows:

- 0-20 mS/m: very low salinity
- 21-40 mS/m: low salinity
- 41-80 mS/m: moderate salinity
- 81-160 mS/m: high salinity
- Over 161 mS/m: very high salinity

MilliSiemens per metre can be converted to grains per gallon (gr/g) by multiplying the value in mS/m by 0.385.

Effective rooting depth: Refers to the rooting depth of the soil in which plants may have an unimpeded path until an obstruction such as a dense layer of clay or rock is encountered. It is only approximate, as subsoil structure may allow more root penetration.

Erosion: The wearing away of the land surface and removal of soil by running water, rain, wind, frost or other geological agents.

Granite: A coarse-grained igneous rock, that underlies much of the landscape.

Gravel: Any coarse mineral material or fragments from 2 to 60 mm in diameter. These could be ironstone, quartz, other rock fragment or any concretions or nodules.
**Horizon:** A soil layer more or less parallel to the land surface which differs from the layers below and/or above it in properties such as colour, texture and structure.

**Landscape:** Part of an area of land that is characterised by processes of erosion, weathering, sedimentation, and movements in the earth’s crust. It includes all identifiable and measurable features such as climate, geology, soils and land use.

**Lime** (or calcium carbonate): Usually found in heavier soils that are alkaline. Lime can be present as soft segregations or nodules, or finely mixed through the soil. Its presence can be detected with a simple test using dilute acid (1M hydrochloric). Drops of acid are placed on a clod of soil and if lime is present it effervesces immediately (i.e. bubbles of gas appear), due to release of carbon dioxide.

**Mottles:** Patches of red, brown or orange or blue-grey spots in a soil horizon. Mottles form when there are fluctuating watertables, therefore often indicate periodic or seasonal waterlogging. However, some mottling is a carryover from when south-western Australia had a tropical climate. This is the same geological period as when most of the gravel and cemented ironstone also formed.

**Northcote PPF:** Stands for Principle Profile Form. It is a coded description derived by working through a soil diagnostic key developed by K. Northcote. An example may be Dy5.43 where D stands for duplex, y stands for yellow and the numbers are further descriptions of soil characteristics. It is being replaced by the Australian Soil Classification.

**Peds:** Distinct structural features within the soil. Sand, silt, clay and iron minerals within a soil bind together to form aggregates having shapes such as columnar (described in the sheets as domed), prismatic, blocky or horizontally layered (platy). The spaces between the peds act as pathways for air, water and roots. The opposite to structured soil is *apedal* or structureless.

**pH:** Measures the concentration of hydrogen ions in the soil. The pH is measured on a logarithmic scale (i.e. pH = negative logarithm of concentration of hydrogen ions). A soil with a pH of 5 contains 10 times as many hydrogen ions as a soil with a pH of 6.

Two systems are commonly used to measure pH, one in calcium chloride solution and the other in a soil-water suspension. As a general rule, to convert from pH\(_w\) to pH\(_{Ca}\), subtract 0.8, although the difference can range between 0.6 and 1.2, and in extreme cases from 0 to 2. It is of most concern when the soils are either strongly acid or strongly alkaline. Most of our soils are becoming more acid over time due to removal of agricultural produce (i.e. grain, hay, wool) and through the use of nitrogen fertilisers.

<table>
<thead>
<tr>
<th>Soil reaction</th>
<th>pH(_{Ca})</th>
<th>pH(_w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly acid</td>
<td>Less than 4.5</td>
<td>Less than 5.5</td>
</tr>
<tr>
<td>Acid</td>
<td>4.5-6.0</td>
<td>5.5-6.5</td>
</tr>
<tr>
<td>Near neutral</td>
<td>6.0-6.5</td>
<td>6.5-7.5</td>
</tr>
<tr>
<td>Alkaline</td>
<td>6.5-7.5</td>
<td>7.5-8.5</td>
</tr>
<tr>
<td>Strongly alkaline</td>
<td>More than 7.5</td>
<td>More than 8.5</td>
</tr>
</tbody>
</table>

**Profile:** A soil profile is a vertical exposure of soil extending from the surface to the decomposing rock or other underlying consolidated material. It could be in a soil pit or an existing vertical exposure such as the side of a road cutting. The illustrations on these soil information sheets are examples of soil profiles.

**Relief:** The difference in elevation between the high and low points of a land surface.
Salinity: The presence of high concentrations of soluble salts in the soil. The dominant salt in WA soils is sodium chloride, but others such as sodium carbonate are sometimes present. High salinity adversely affects plant root growth and the ability of roots to extract water from the soil. It is estimated from the electrical conductivity (EC).

Segregations: Gravels or other accumulations of material which occur in the soil. They are formed by the concentration of some constituent by chemical or biological action.

Slaking: Slaking is the disintegration of aggregates (clods) into minute pieces when wet rapidly, because they cannot tolerate the stresses imposed by rapid water intake. Slaking causes the soil to slump and then it either sets hard on drying into a compact mass (hardset surface) or forms a surface crust. Slaking is a mechanical rather than a chemical process, compared with dispersion which is mainly chemical. It occurs in soils with weak structural development, particularly when the soil contains some exchangeable sodium and little organic matter.

Slope: An incline either upward or downward from the horizontal. Its angle is measured as a percentage. Observations span an area of about 20 m, so as not to be influenced too much by features of microrelief.

Sodicity: A measure of exchangeable sodium in the soil. Soils that are sodic have a high percentage of cation exchange sites occupied by sodium ions. Sodicity adversely affects the stability of the soil and increases the likelihood of the soil dispersing. Problems with sodic soils include difficult seedbed preparation, reduced rainfall infiltration, reduced seedling emergence and poor root growth in sodic subsoils.

Soil strength: Resistance to breaking or deformation. It is determined by the force just sufficient to break a 20 mm aggregate (or fragment of soil), when pressed between the thumb and forefinger. Strength is classed according to the force required:

- **Loose**: No force required e.g. sands.
- **Very weak**: Very slight force required.
- **Weak**: Small but significant force.
- **Firm**: Moderate to firm force.
- **Very firm**: Strong force but within the power of thumb and forefinger.
- **Strong**: Beyond the power of thumb and forefinger. Can be crushed underfoot on hard flat surface with small force.
- **Very strong**: Can be crushed underfoot on hard flat surface with full body weight applied slowly.
- **Rigid**: Cannot be crushed underfoot by full body weight.

Structure: Describes the distinctness, size and shape of the soil aggregates or peds. The surface structure in many agricultural soils reflects recent management practices, especially the amount and frequency of cultivation. The soil aggregates are largely created by cultivation rather than being an inherent soil property. The soil structure described in the soil information sheets therefore concentrates on subsoil structure which is an intrinsic soil property. Four soil structural forms or shapes are mentioned:

- **Columnar**: The soil aggregates or particles are arranged in a large column, with a well defined dome on the top. Often the dome has been cut off through cultivation. Sand seams are usually found extending down the soil profile between the columns. Columns can be composed of smaller peds.
- **Prismatic**: The soil particles are arranged in a large prism or triangle-like shape with well defined flat surfaces. Small sand seams often occur between the ped faces.
**Blocky**  
Soil particles are arranged in a near cubic or rectangular shape. Blocky structure can also be expressed as either angular blocky (adjoining faces are mostly angular) or subangular blocky (adjoining faces can be subrounded).

**Polyhedral**  
The soil aggregates are arranged in an approximately interlocking cubic shape, but the adjoining soil aggregates often have many sides and angles. The name is derived from Latin where poly means many and hedral means faces or sides. A soil layer with a polyhedral structure often appears to crumble when manipulated.

A moderate or strongly structured soil allows roots to grow through even if it contains a large amount of clay. The exception is with ‘domed’ or columnar structured subsoils where the top of the clay layer is rounded into a distinct dome shape (more common in mallee soils). There is limited root growth into the domes and crop roots are essentially restricted to the sand seams between the clay columns.

**Subsoil:** Refers to a soil layer with certain properties, usually higher clay content and/or brighter colours, rather than a given depth. For instance, in ‘duplex’ soils the subsoil corresponds to the clay layer and the depth to this layer can vary from 10 to 80 cm.

**Surface condition:** Usually assessed when dry. Can be:

- **Cracking**  
  Deep cracks at least 5 mm wide in summer due to shrink-swell clay minerals.

- **Firm**  
  Hard, but can be indented by pressure of the forefinger.

- **Hardsetting**  
  Hard when dry. A pencil cannot easily be pushed into the surface. The artificial aggregates formed after tilling slake when wetted rapidly and the soil mass slumps and sets very hard on drying. Hardsetting soils often become slippery and boggy when wet.

- **Loose to soft**  
  Easily disturbed by forefinger pressure and does not hold together (e.g. loose sand).

- **Surface crust**  
  Distinct layer ranging from a few millimetres to a few centimetres thick, which is hard when dry and can be separated from and lifted off the soil below. If the soil dries out during winter the crust becomes hard and obstructs seedling emergence, but underneath the crust the soil is usually moist and not hard.

**Texture:** A measure of the proportion of sand, silt and clay-sized particles in a soil. The coarsest soils are sands which contain less than 5% clay. Medium textures such as loam contain about 25% clay, and heavy clays have more than 50%. The ‘field’ (or hand) 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 to form a ribbon. The behaviour of the soil during bolus formation and the ribbon length determine the field texture (also refer to TopCrop Soil field texture card). Soil texture is important because it affects water storage and erodibility, two very important soil properties in our Australian environment. It is important in relation to other properties including water repellence, nutrient deficiencies, nutrient leaching, subsoil compaction and structure decline.

**Waterlogging:** Excess water in the root zone either present as a perched watertable or ponded on the soil surface. This water inhibits gas exchange with the atmosphere, and as microbes use the available oxygen the soil becomes anaerobic (i.e. deficient in oxygen). The tolerance of crops and pastures to waterlogging varies considerably and also depends on the stage of growth. Prolonged waterlogging can reduce crop yields by more than 25%.

**Water repellence:** A condition which affects the wetting pattern of soils, especially sandy soils, and results in an uneven wetting pattern in autumn. In the paddock, patches of wet soil alternate with patches of dry soil which results in poor germination of crops and pasture. It is caused by the build-up of organic coatings on the sand grains. Water repellence can be demonstrated by a water droplet placed on the soil surface. If a soil is water repellent the water droplet will form a bead and not penetrate quickly.
Weathering: The physical and chemical disintegration, alteration, and decomposition of rocks and minerals at or near the earth’s surface by atmospheric and biological agents.

Water availability: Describes the amount of moisture in the soil that is available to be absorbed by plant roots.

Acknowledgments

The authors gratefully acknowledge the contributions made by Gottfried Scholz (Natural Resources Assessment Group), Caroline Peek, Wayne Proudlove, Mike Clark and Digby Growns from the Geraldton District Office who assisted with the compilation of these soil information sheets.

Further reading


van Gool, D. (In prep.) Land and water resources for horticulture. Agriculture Western Australia.
Best way to use the sheets

1. Compare the field site with the landscape description on the soil information sheet.  
   ![Checkmark] go to step 2.

2. Dig a hole! Use the soil description and the representative photograph to determine whether the soil in the field matches the soil type illustrated on the sheet.  
   If the soil matches the description and colour photograph, go to step 4.  
   If the soil does not roughly resemble the soil description or the photograph, go to step 3.  
   ![Checkmark]

3. Record the site location and details and contact the nearest Agriculture Western Australia office with either a Soil Resource Officer or a Land Conservation Officer.

4. If the soil matches the description and colour photograph, refer to the reverse of the sheet for all land use information and management considerations for the soil.

It is important to understand that:

- Because the scale of mapping for the Geraldton region land resource survey, is 1:250,000, it is possible that any one of the described soils could occur in a different landscape from that indicated and on the farm being planned without being delineated on the final soil-landscape map.

- Matching the soil information sheet to the actual field site does not imply that they must be identical, rather that they should be similar in most aspects.
Soil information sheet for the Northern Wheatbelt

Allanooka Soil Series

Pale deep sand
(Gutless grey sand)

Loose to soft, grey over pale brown over yellow sand.

**Occurrence:** Long gentle slopes of dissected sandplain west and south-west of Ajana and inland from the coast between Horrocks and Port Gregory; also between Irwin and Mingenew to both north and south.

**Native vegetation:** Scrub heath which includes wattles (*Acacia* spp.), sheoaks (*Allocasuarina* spp.), dryandras etc.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Loose to soft.</td>
</tr>
<tr>
<td>0-15</td>
<td>Dark greyish brown loamy medium to coarse sand; loose single-grained structure; weakly acid; gradual boundary.</td>
</tr>
<tr>
<td>15-50</td>
<td>Pale brown medium to coarse sand; loose single-grained structure; acid; diffuse boundary.</td>
</tr>
<tr>
<td>50-100+</td>
<td>Yellow medium to coarse sand; single-grained structure; near neutral pH.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Very dark grey to dark greyish brown topsoil
- Single-grained, loose sandy soil
- Non-wetting surface
- Pale brown subsoil grading to yellow
- Weakly acid to neutral pH

**Soil classification**

*Australian Soil Classification:* *Arenic Bleached-Orthic Tenosol* (Isbell 1996)

*Northcote PPF:* Uc4.21

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Allanooka Soil Series

Pale deep sand
(Gutless grey sand)

This is a sandy soil of very low capability, which requires careful management to prevent wind erosion. It is also non-wetting, especially early in the season.

Land use

The best option would be continuous pasture with plantations of tagasaste or black wattle (Acacia saligna). Continuous blue lupins are also suitable. It may be suitable for floriculture.

Crops: It may be possible to grow narrow-leafed lupins and cereals on better areas of this soil, if adequately fertilised. A pasture phase will be necessary if disease builds up. However, cropping should be between rows of tagasaste and stubble should be retained to prevent wind erosion. Where water repellence is a serious problem, furrow sowing on the contour will allow early and more uniform crop establishment.

Annual pastures: Paros and Santorini varieties of yellow serradella or Cadiz French serradella are recommended.

Grazing management: Care during summer and autumn is essential to minimise wind erosion.

Revegetation: Mallees can be grown including sand mallee (Eucalyptus eremophila), malallie (E. eudesmioides), Yuna mallee (E. jucunda) and Dongara mallee (E. obtusiflora). Acorn banksia (Banksia prionotes), rock oak (Allocasuarina huegleiana), Acacia spathulifolia, Acacia blakelyi, Grevillea candelabroides and one-sided bottlebrush (Calothamnus quadrifidus) are also useful shrubs.

Soil characteristics and land management

Acidity

May become acid, therefore periodic monitoring of surface and subsurface pH is recommended.

Dams & catchments

Not suitable for dams or roaded catchments.

Nutrient availability

Most major and micronutrients are limiting, as this soil has very limited capacity to retain nutrients. Nitrogen, phosphorus, potassium and trace elements should be applied to maintain fertility.

Root growth

No impediments to root growth.

Salinity

Low risk.

Structural decline

Moderate risk of traffic pan developing. If so, crops and pastures will respond to deep ripping.

Water availability

Very low due to poor water-holding capacity and patchy infiltration of early rains caused by water repellence.

Water erosion

Low risk as infiltration is high, although patchy early in the season.

Water repellence

High risk, especially early in the season until the soil wets up.

Waterlogging

Rapidly drained, so not a problem.

Wind erosion

High risk. Stubble retention, restricted grazing in summer and autumn and establishment of wind breaks are necessary.

Workability

Good.
Soil information sheet for the Northern Wheatbelt

**Balline Soil Series**

**Pale deep sand**

*(Grey sandplain)*

Loose, grey coarse sand over pale brown to white coarse sand.

**Occurrence:** Level to very gently undulating sandplain, mainly inland from the coast from around Port Gregory northward and scattered areas south-east of Dongara.

**Native vegetation:** Low sandplain scrub heath consisting of *Banksia*, *Acacia*, *Calothamnus* and *Nuytsia* species.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>Dark grey coarse sand; water repellent; loose structure; very few quartz grit fragments; acid; abrupt boundary.</td>
</tr>
<tr>
<td>15-35</td>
<td>Light brownish grey coarse sand; loose structure; very few quartz grit fragments; near neutral reaction; gradual boundary.</td>
</tr>
<tr>
<td>35-80</td>
<td>Very pale brown coarse sand; loose structure; very few quartz grit fragments; near neutral pH; diffuse boundary.</td>
</tr>
<tr>
<td>80-130</td>
<td>Very pale brown heavy coarse sand; loose structure; very few quartz grit fragments, medium rounded gravels; near neutral pH; clear boundary.</td>
</tr>
<tr>
<td>130+</td>
<td>Brown coarse sand; massive structure; very few quartz grit fragments; fine subrounded gravels; acid.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Very dark grey to grey topsoil
- Pale brown or white subsoil, sometimes grading to yellow
- Coarse sandy texture throughout
- Non-wetting surface
- Weakly acid to near neutral pH

**Soil classification**

*Australian Soil Classification:* Basic Arenic Rudosol (Isbell 1996)

*Northcote PPF:* Uc2.23, Uc1.21

*Reference profile:* GTN1404

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
**Agricultural land use and management**

**Balline Soil Series**  
Deep pale sand  
(Grey sandplain)

This is a coarse sandy soil of extremely low capability, which requires careful management to prevent wind erosion. It is also non-wetting.

**Land use**

The best option would be continuous pasture with plantations of tagasaste. Continuous blue lupins are also suitable. It may also be used for floriculture.

**Crops:** Cropping is usually not economical or ecologically sustainable but successful results have been achieved using no-till techniques after three years of continuous blue lupins with grass manipulation in the third year.

**Annual pastures:** Paros and Santorini serradellas are recommended legumes or Cadiz French serradella in areas with more than 400 mm rainfall.

**Grazing management:** Care during summer and autumn is essential to minimise wind erosion.

**Revegetation:** Mallee, banksias, acacias and understorey species can be grown. Species include river red gum (*Eucalyptus camaldulensis*), sand mallee (*E. eremophila*), Yuna mallee (*E. jucunda*), Dongara mallee (*E. obtusiflora*), sceptre banksia (*B. sceptrum*), acorn banksia (*B. prionotes*), sandplain cypress (*Actinostrobus arenarius*), rock oak (*Allocasuarina huegeliana*), spoon-leaved wattle (*Acacia spathulifolia*), *A. blakelyi*, pine-like grevillea (*Grevillea pinaster*), *G. candelabroides* and one-sided bottlebrush (*Calothamnus quadrifidus*).

**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Acidity</th>
<th>Prone to acidification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dams and catchments</td>
<td>Not suitable for dams or roaded catchments.</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>Most major and micronutrients will be limiting. Very limited capacity to retain nutrients.</td>
</tr>
<tr>
<td>Root growth</td>
<td>No impediments to root growth.</td>
</tr>
<tr>
<td>Salinity</td>
<td>Low risk.</td>
</tr>
<tr>
<td>Structural decline</td>
<td>This is a loose, single grained structureless soil.</td>
</tr>
<tr>
<td>Water availability</td>
<td>Low to moderate due to very poor water-holding capacity and patchy infiltration of early rains caused by water repellence.</td>
</tr>
<tr>
<td>Water erosion</td>
<td>Generally low risk, but higher where run-off comes from non-wetting gravel outcrops upslope.</td>
</tr>
<tr>
<td>Water repellence</td>
<td>High risk, especially early in the season until the soil wets up.</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Rapid drainage, so not a problem.</td>
</tr>
<tr>
<td>Wind erosion</td>
<td>High risk. Establishment of tagasaste and serradella-based pasture or blue lupins will protect this soil.</td>
</tr>
<tr>
<td>Workability</td>
<td>Good.</td>
</tr>
</tbody>
</table>
Soil information sheet for the Northern Wheatbelt

**Bluewell Soil Series**

*Shallow gravel*  
*(Gravelly sand on laterite)*

Firm to hardsetting, brown gravelly clayey sand over cemented ironstone (laterite).

**Occurrence:** Higher positions in the landscape of gently undulating weakly dissected sandplain north-east of Northampton, east of Port Gregory and scattered areas south-east of Dongara.

**Native vegetation:** Low scrub heath of *Acacia, Allocasuarina* and *Hakea* species.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Soil Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Firm to hardsetting.</td>
</tr>
<tr>
<td>0-13</td>
<td>Dark greyish brown loamy medium to coarse sand; massive structure; subrounded ironstone gravel and quartz grit; acid; abrupt boundary.</td>
</tr>
<tr>
<td>13-45</td>
<td>Yellowish brown light sandy clay loam; massive; abundant subrounded to subangular ironstone gravels; acid; abrupt boundary.</td>
</tr>
<tr>
<td>45+</td>
<td>Cemented laterite gravel.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Brown, greyish brown or yellowish brown colour
- Gravelly throughout, increasing with depth
- Loamy to clayey sand topsoil
- Heavier texture with depth

**Soil classification**

*Australian Soil Classification:* Ferric-Petroferric Orthic Tenosol (Isbell 1996)

*Northcote PPF:* Uc5.11

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Bluewell Soil Series

Shallow gravel
(Gravelly sand on laterite)

Suitability for cropping depends on the depth to the cemented gravel layer and its degree of packing. Where the gravel is tightly packed and the cemented gravel is close to the surface, soil capability is very low.

Land use

Crops: Lupins and cereals can be grown where the cemented gravel layer is not too close to the surface. In deeper, more fertile and less gravelly areas, canola may be possible.

Annual pastures: Dalkeith and Nungarin subterranean clover s are recommended.

Grazing management: Care during summer and autumn is essential to minimise wind erosion.

Revegetation: Tamma (Allocasuarina campestris), black tamma (A. acutivalvis), pink pokers (Grevillea petrophiloides), wodjils (Acacia stereophylla, A. neurophylla), Hakea pyconeura, honeybush (H. lissocarpha), graceful honeymyrtle (Melaleuca radula), wiry honeymyrtle (M. ficifolia), M. cordata, parrot bush (Dryandra sessilis), D. ashbyi and one-sided bottlebrush (Calothamnus quadrifidus).

Soil characteristics and land management

Acidity
May become acid several years after clearing. Periodic monitoring is recommended if pHw has fallen below 5.0.

Dams & catchments
Not suitable.

Nutrient availability
Most nutrients, including trace elements, may be limiting. Phosphorus is commonly deficient and manganese deficiency may be common. Very limited capacity to retain nutrients.

Root growth
Cemented gravel restricts root growth.

Salinity
Low risk.

Structural decline
Porosity may decline with cultivation. Crops and pastures may respond to deep ripping.

Water availability
Low, due to poor water-holding capacity and the shallow depth to cemented gravel.

Water erosion
Low risk as the soil is well drained and infiltration rates are high. Gravel retards surface flow which causes erosion. May become a problem during summer storms if the soil has been loosened.

Water repellence
Usually low, but may occur in some areas early in the season until the soil wets up.

Waterlogging
Low risk.

Wind erosion
Moderate risk. Restricted grazing in summer and autumn is necessary to protect this soil. Abundant gravel and a firm surface will reduce problems.

Workability
Moderate, but may pose problems where the cemented gravel is within cultivation depth.
Soil information sheet for the Northern Wheatbelt

**Bookara Soil Series**

**Calcareous shallow sand**
*(Black wattle sand)*

Loose, dark brown calcareous sand over limestone.

**Occurrence:** Moderate to steep slopes and undulating low hills parallel to the coast.

**Native vegetation:** Black wattle (*Acacia rostellifera*), tangling melaleuca (*Melaleuca cardiophylla*), chenille honey myrtle (*M. huegelli*), other acacias and several mallee eucalypts such as illyarrie (*E. erythrocorys*), malallie (*E. eudesmioides*), giant mallee (*E. oleosa*) and Dongara mallee (*E. obtusifloræ*).

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Loose</td>
</tr>
<tr>
<td>0-15</td>
<td>Very dark brown loamy sand; weak granular structure; few limestone fragments; alkaline; gradual boundary.</td>
</tr>
<tr>
<td>15-60</td>
<td>Very dark brown loamy sand; weak granular structure; few limestone fragments and some soft lime; alkaline; clear irregular boundary.</td>
</tr>
<tr>
<td>60-90</td>
<td>Brown clayey sand; weak granular structure; common limestone rubble and soft lime; alkaline; sharp boundary.</td>
</tr>
<tr>
<td>90+</td>
<td>Massive limestone with travertine capping.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Very dark brown to brown
- Loamy to clayey sand
- Limestone at variable depth
- Loose single grained structure
- Calcareous throughout

**Soil classification**

**Australian Soil Classification:** *Paralithic Chernic Tenosol* (Isbell 1996)

**Northcote PPF:** *Uc5.11, Uc1.14*

**Reference profile:** REFGTN8

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Bookara Soil Series**

**Calcareous shallow sand**
*(Black wattle sand)*

This is a sandy soil of low to medium capability, depending on the slope and depth to limestone. It requires careful management to prevent wind erosion and is also non-wetting.

**Land use**

The best option would be continuous pasture with careful grazing management to prevent wind erosion. Rocky and steep areas should be fenced off and revegetated with mallees and understorey species.

**Crops:** Cereals can be grown on flatter areas if protected by wind breaks. Stubble should be retained to minimise wind erosion. Where water repellence is a serious problem, furrow sowing on the contour will allow early and more uniform crop establishment. Faba beans and chickpeas can be grown, but the soil is unsuitable for lupins.

**Annual pastures:** Parabinga and Caliph barrel medics are recommended. When seed becomes available, Herald strand medic will be preferred.

**Grazing management:** Care is essential to minimise wind erosion from mid-spring to early winter.

**Revegetation:** Suggested species include Illyarrie (*Eucalyptus erythrocorys*), Dongara mallee (*E. obtusiflora*), Abrolhos Island mallee (*E. oraria*), tangling melaleuca (*Melaleuca cardiophylla*), chenille honeymyrtle (*M. huegelii*), *M. lanceolata*, black wattle (*Acacia rostellifera*), *A. scirpifolia*, spoon-leaved wattle (*A. spathulifolia*), silvery leaved grevillea (*Grevillea argyrophylla*), olive grevillea (*G. olivacea*), cockies tongues (*Templetonia retusa*) and common woollybush (*Adenanthos cygnorum*).

**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity</td>
<td>Not a problem as the soil is alkaline.</td>
</tr>
<tr>
<td>Dams &amp; catchments</td>
<td>Not suitable for dams or roaded catchments.</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>Limited capacity to retain nutrients and most major and micronutrients will be limiting. Nitrogen, phosphorus, potassium and trace elements should be applied.</td>
</tr>
<tr>
<td>Root growth</td>
<td>Depth to limestone will determine root growth.</td>
</tr>
<tr>
<td>Salinity</td>
<td>Low risk.</td>
</tr>
<tr>
<td>Structural decline</td>
<td>Low risk.</td>
</tr>
<tr>
<td>Water availability</td>
<td>Low to moderate due to poor water-holding capacity and poor and patchy infiltration of early rains.</td>
</tr>
<tr>
<td>Water erosion</td>
<td>Low risk because of rapid through drainage. Some problems on steep slopes because of water repellence which promotes run-off.</td>
</tr>
<tr>
<td>Water repellence</td>
<td>High risk, especially early in the season.</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Well drained, so waterlogging is not a problem.</td>
</tr>
<tr>
<td>Wind erosion</td>
<td>Very high risk because of the high fine sand content and proximity to the coast where winds are strong. Careful grazing management and wind breaks are necessary.</td>
</tr>
<tr>
<td>Workability</td>
<td>Good. Trafficability on dry soil may sometimes be poor.</td>
</tr>
</tbody>
</table>
Soil information sheet for the Northern Wheatbelt

**Bootenal Soil Series**  
**Red sandy earth**  
*(Red sandy loam)*

Firm, dark brown to reddish brown loamy sand grading to sandy clay loam with depth.

**Occurrence:** On alluvial terraces, flats and lower slopes of the Irwin, Greenough and Chapman River systems.

**Native vegetation:** Black wattle (*Acacia rostellifera*), jam (*A. acuminata*) and other acacias, hakeas and cassias.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Soil Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Firm.</td>
</tr>
<tr>
<td>0-55</td>
<td>Dark brown humic clayey fine sand; massive structure; acid; gradual boundary.</td>
</tr>
<tr>
<td>55-90</td>
<td>Yellowish red clayey fine sand, with humic material in nests; massive structure; acid; gradual wavy colour boundary, clear wavy texture boundary.</td>
</tr>
<tr>
<td>90-120</td>
<td>Reddish brown (80%), light yellowish brown (20%) mottled fine sandy light clay; coarse prisms parting to coarse blocks; dry, tough consistence; near neutral soil reaction.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Loamy to clayey sand topsoil
- Dark brown, reddish brown or yellowish red
- Moderately acid to neutral pH
- Clay content increases with depth

**Soil classification**

*Australian Soil Classification:* *Mesotrophic Red Kandosol* (Isbell 1996)

*Northcote PPF:* Gn2.12

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Bootenal Soil Series  
*Red sandy earth*  
*(Red sandy loam)*

This is a fertile soil that must be managed carefully to prevent wind erosion. With care, using judicious fertiliser application, minimum tillage and stubble retention, it is suitable for continuous cropping.

**Land use**
Crops, pastures and floriculture are suitable.

**Crops:** Suited to continuous cropping if minimum tillage or no-till establishment technique is followed. Crops include cereals, albus lupins, field peas, chickpeas, faba beans and canola. Faba beans tolerate transient waterlogging.

**Annual pastures:** Dalkeith subterranean clover, Serena and Santiago medics are recommended.

**Grazing management:** Careful management during summer and autumn is very important to prevent wind erosion.

**Revegetation:** Trees, mallees and understorey species can be grown, but because of the wide range of climatic zones covered by this soil (Geraldton to north-east of Mullewa) it is not possible to develop a generic list. Contact your local District Office for more details.

**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acidity</strong></td>
<td>Moderate risk. Periodic monitoring is recommended.</td>
</tr>
<tr>
<td><strong>Dams &amp; catchments</strong></td>
<td>Suitable for soaks if the sides can be sealed with clay.</td>
</tr>
<tr>
<td><strong>Nutrient availability</strong></td>
<td>Fair to good. Retention of applied fertiliser is also fair to good depending on soil texture and organic matter content. With continuous cropping, correct fertiliser application will be necessary.</td>
</tr>
<tr>
<td><strong>Root growth</strong></td>
<td>No restrictions as the soil is porous and permeable to about 1 m.</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Structural decline</strong></td>
<td>Possible with excessive cultivation at too high or too low moisture levels or at high speeds. Soil can respond to deep ripping if cropped continuously.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Moderate to good water storage depending on texture (sandier soil has only moderate capacity). Where surface condition has been maintained by minimum tillage and stubble retention, water infiltration and retention will be better.</td>
</tr>
<tr>
<td><strong>Water erosion</strong></td>
<td>Low risk because of the low gradient and good infiltration rates.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Moderately well drained, except in depressions where waterlogging can be a problem during prolonged wet periods.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>High risk. Careful grazing management and stubble retention are necessary.</td>
</tr>
<tr>
<td><strong>Workability</strong></td>
<td>Good.</td>
</tr>
</tbody>
</table>
Soil information sheet for the Northern Wheatbelt

**Bowes Soil Series**

**Red loamy earth**  
(***Red loam***)

Firm to hardsetting, reddish brown sandy loam grading to clay at depth.

**Occurrence:** Alluvial flats and lower slopes, along the Greenough and Irwin River systems.

**Native vegetation:** Jam (*Acacia acuminata*), black wattle (*A. rostellifera*), kurara (*A. tetrogonophylla*), djarnokmur (Hakea recurva) and needlebush (*H. preissii*), with scattered York gum (*Eucalyptus loxophleba*) and river red gum (*E. camaldulensis*) along creeklines.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Firm to hardsetting.</td>
</tr>
<tr>
<td>0-13</td>
<td>Yellowish red clayey sand; massive structure; acid; abrupt boundary.</td>
</tr>
<tr>
<td>13-37</td>
<td>Red clayey sand; massive structure; acid; clear boundary.</td>
</tr>
<tr>
<td>37-50</td>
<td>Dark red heavy sandy clay loam; massive structure; acid; clear boundary.</td>
</tr>
<tr>
<td>50-130+</td>
<td>Dark red sandy clay; massive structure; near neutral pH.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Loamy sand to sandy loam topsoil over sandy clay
- Firm to hardsetting surface
- Reddish brown, red or yellowish red
- Moderately acid to neutral pH

**Soil classification**

**Australian Soil Classification:** Mesotrophic Red Kandosol  
(Isbell 1996)

**Northcote PPF:** Dr4.52

**Reference profile:** GTN1401

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Bowes Soil Series

Red loamy earth
(Red loam)

This is a fertile soil that needs to be managed carefully to prevent wind and water erosion. With minimum tillage, stubble retention and judicious fertiliser application, it has high potential for continuous cropping.

Land use

Crops: Suited to continuous cropping if minimum tillage or no-till establishment technique is followed. Suitable crops include cereals, albus lupins, field peas, chickpeas, faba beans and canola. Faba bean is the preferred legume where transient waterlogging is a problem.

Annual pastures: Dalkeith subterranean clover, Serena and Santiago medics are recommended.

Grazing management: Care during summer and autumn is very important to prevent wind erosion.

Revegetation: Trees, mallees and understorey species can be grown. York gum (Eucalyptus loxophleba), jam (Acacia acuminata), broombush (Melaleuca uncinata), kurara (Acacia tetragonophylla), manna wattle (A. microbotrya), needlebush (Hakea preissii) and djarnokmur (Hakea recurva) are recommended. Swamp sheoak (Casuarina obesa) is good in wet depressions.

Soil characteristics and land management

Acidity
Moderate risk. Monitoring is recommended.

Dams & catchments
Not suitable as the water drains away and sealing would be difficult.

Nutrient availability
Good. Retention of applied fertiliser is fair to good depending on soil texture and organic matter. With continuous cropping, correct fertiliser application will be necessary.

Root growth
No obvious restrictions as the soil is porous and permeable.

Salinity
Low risk.

Structural decline
Possible with excessive cultivation at too high or too low moisture levels or at high speeds. Excessive cultivation when too wet will lead to hardsetting surface.

Water availability
Moderate to good water storage depending on texture (sandier soils have only moderate water-holding capacity). Where surface condition has been maintained by minimum tillage and stubble retention, water infiltration and retention will be better.

Water erosion
Moderate risk on lower slopes receiving run-off. Grade banks may be necessary to lead the run-off to a dam or waterway.

Water repellence
Low risk.

Waterlogging
Generally well drained, except in depressions where transient waterlogging can be a problem during wet periods.

Wind erosion
Careful grazing management and stubble retention are necessary.

Workability
Good.
Soil information sheet for the Northern Wheatbelt

Casuarina Soil Series

Loose to soft, grey to greyish brown sand over sandy gravel.

Occurrence: On gently undulating sandplain, from south of Northampton to north of Mingenew.

Native vegetation: Scrub heath of Acacia, Allocasuarina and Grevillea species.

Soil profile description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Loose to soft.</td>
</tr>
<tr>
<td>0-10</td>
<td>Loose, water repellent grey sand; few quartz grit fragments and fine lateritic gravels; acid; abrupt boundary.</td>
</tr>
<tr>
<td>10-50</td>
<td>Loose, very pale brown sand; few fine and some medium lateritic gravels; acid; abrupt boundary.</td>
</tr>
<tr>
<td>50-90</td>
<td>Very pale brown sand; massive structure; many fine and medium lateritic gravels; acid; abrupt tongued boundary.</td>
</tr>
<tr>
<td>90+</td>
<td>Yellowish red sandy clay loam; massive structure; many fine lateritic gravels; acid.</td>
</tr>
</tbody>
</table>

Characteristic soil properties

- Sand to loamy sand topsoil
- Grey, greyish brown or pale brown sand over sandy gravel at 30-80 cm
- Loose single grained structure
- Cemented laterite layer with tongued boundary at 80-140 cm

Soil classification

Australian Soil Classification: Ferric-Petroferric Bleached-Orthic Tenosol (Isbell 1996)

Northcote PPF: Uc2.21

Reference profile: GTN1426

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Casuarina Soil Series**

*Pale deep sand (Sand over gravel)*

This is a sandy soil with increasing ironstone gravel over a soft laterite layer. It needs to be managed carefully to prevent wind erosion, and fertilised correctly to maintain its fertility. It is non-wetting early in the season.

**Land use**

Suitable for crops, pastures and floriculture.

**Crops:** Lupins and cereals can be grown. Canola is also possible on loamy sand. Stubble retention is very important to minimise wind erosion. Furrow sowing on the contour will allow early and more uniform crop establishment where water repellence is a problem.

**Annual pastures:** Dalkeith subterranean clover is recommended.

**Grazing management:** Restricted grazing during summer and autumn is essential to minimise wind erosion.

**Revegetation:** Malallie (*Eucalyptus eudesmioides*), Oldfield’s mallee (*E. oldfieldii*), golden wreathe wattle (*Acacia saligna*), long-leaved wattle (*A. longiphyllodinea*), *A. blakelyi*, scrub sheoak (*Allocasuarina humulis*), rock oak (*A. hugeliana*), *Grevillea candelabroides*, one-sided bottlebrush (*Calothamnus quadrifidus*), graceful honeymyrtle (*Melaleuca radula*) and rough honeymyrtle (*M. scabra*) can be grown. Acorn banksia (*Banksia prionotes*) will suit deeper soils.

**Soil characteristics and land management**

**Acidity**

May become acid, therefore periodic monitoring of surface and subsurface pH is needed.

**Dams & catchments**

Not suitable.

**Nutrient availability**

Most nutrients, including trace elements, may be limiting. Limited capacity to retain nutrients.

**Root growth**

Gravel will restrict growth depending on the content and degree of packing.

**Salinity**

Low risk.

**Structural decline**

Traffic pan could develop where the gravel layer is deep. If so, crops and pastures are likely to respond to deep ripping.

**Water availability**

Low, because of poor and patchy infiltration of early rains due to water repellence and poor water-holding capacity. The tongued laterite layer will hold some water, but root access to this depends on the degree of packing of the gravel.

**Water erosion**

Low risk except where run-off is generated from non-wetting surfaces.

**Water repellence**

High risk early in the season until the soil wets up.

**Waterlogging**

Well drained, so low risk.

**Wind erosion**

Stubble retention, restricted grazing in summer and autumn, and wind breaks are necessary to protect this soil.

**Workability**

Good.
Soil information sheet for the Northern Wheatbelt

**Eradu Soil Series**

**Yellow deep sand**

*(Yellow sandplain)*

Loose to soft, yellowish brown loamy sand over brownish yellow clayey sand.

**Occurrence:** Extensive gently undulating to level sandplain areas in a central band from east of Northampton to south-east of Mingenew.

**Native vegetation:** Banksias, hakeas, grevilleas, acacias and other scrub heath species.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Loose to soft.</td>
</tr>
<tr>
<td>0-12</td>
<td>Yellowish brown light loamy sand; massive structure; acid; abrupt boundary.</td>
</tr>
<tr>
<td>12-28</td>
<td>Yellowish brown loamy sand; massive structure; acid; clear boundary.</td>
</tr>
<tr>
<td>28-65</td>
<td>Brownish yellow light clayey sand; massive structure; alkaline; gradual boundary.</td>
</tr>
<tr>
<td>65-125</td>
<td>Brownish yellow clayey sand; massive structure; alkaline; gradual boundary.</td>
</tr>
<tr>
<td>125+</td>
<td>Brownish yellow clayey sand; massive structure; slightly calcareous; strongly alkaline.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Loamy sand topsoil grading to clayey sand subsoil, possibly to sandy loam
- Loose single grained structure
- Yellowish brown, brown or brownish yellow topsoil
- Slightly acid topsoil and neutral or alkaline subsoil

**Soil classification**

*Australian Soil Classification:* *Regolithic Orthic Tenosol* (Isbell 1996)

*Northcote PPF:* *Uc5.11, Uc5.22, Uc4.21*

*Reference profiles:* REFGTN5, GTN1405, GTN1423

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Eradu Soil Series

Yellow deep sand
(Yellow sandplain)

This is a sandy soil, prone to wind erosion, which requires careful management. Judicious fertiliser application is essential to maintain fertility.

Land use
Crops, pastures and floriculture are possible with careful management.

Crops: Lupins and cereals can be grown. If disease builds up, a pasture phase may be needed. Stubble should be retained to minimise wind erosion. Triazine-tolerant canola has potential.

Annual pastures: Dalkeith and Nungarin subterranean clover and Paros serradella are recommended.

Grazing management: Care during summer and autumn is essential to minimise wind erosion.

Revegetation: Banksias, mallees, grevilleas, hakeas and wattles are generally suitable. Species include slender banksia (Bankia attenuata), acorn banksia (B. prionotes), sceptre banksia (B. sceptrum), malallie (Eucalyptus eudesmioides), Yuna mallee (E. jucunda), Oldfield’s mallee (E. oldfieldii), sandplain mallee (E. ebbanoensis), river red gum (E. camaldulensis), Grevillea candelabroides, flame grevillea (G. eriostachya), grass leaf hakea (Hakea multilinata), pink spike hakea (H. coriacea), H. scoparia, spoon-leaved wattle (Acacia spathulifolia) and A. blakelyi.

Soil characteristics and land management

Acidity
High risk. Where pH is low, periodic monitoring is advisable and liming is recommended. Continuous wheat/lupin rotation has resulted in very low pH at 15-25 cm e.g. 3.8-4.0 in pHca.

Dams & catchments
Not suitable for dams or roaded catchments.

Nutrient availability
Most major and micronutrients are limiting. Very limited capacity to retain nutrients. Nitrogen, phosphorus, potassium and trace elements should be applied to maintain fertility.

Root growth
No restrictions.

Salinity
Slight risk.

Structural decline
Possibility of traffic pan developing. If so, crop and pastures will respond to deep ripping.

Water availability
Moderate. Although water-holding capacity of the sandy topsoil is poor, the clay content increases with depth to a clayey sand which can retain reasonable quantities of water.

Water erosion
Low risk because of rapid drainage.

Water repellence
Moderate risk and probably increasing.

Waterlogging
Low risk.

Wind erosion
Very high risk. Stubble retention, restricted grazing in summer and autumn and wind breaks are necessary.

Workability
Good.
Soil information sheet for the Northern Wheatbelt

**Eurangoa Soil Series**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Soil description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>Loose to soft, very dark grey loamy sand; loose, single-grained structure; acid; abrupt boundary.</td>
</tr>
<tr>
<td>10-20</td>
<td>Brown loamy sand; loose structure; acid; clear boundary.</td>
</tr>
<tr>
<td>20-40</td>
<td>Very pale brown sand; loose structure; acid; gradual boundary.</td>
</tr>
<tr>
<td>40-60</td>
<td>Light yellowish brown clayey sand; loose structure; strongly acid; gradual boundary.</td>
</tr>
<tr>
<td>60-80</td>
<td>Pale yellow clayey sand; massive structure; acid; gradual boundary.</td>
</tr>
<tr>
<td>80-110+</td>
<td>Brownish yellow clayey sand; massive structure; acid; gradual boundary.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Dark grey, greyish brown to brown topsoil changing to pale brown to brownish yellow subsoil
- Loose single-grained topsoil
- Loamy sand topsoil
- Clayey sand subsoil with massive structure

**Soil classification**

**Australian Soil Classification**: Arenic Bleached-Orthic Tenosol (Isbell 1996)

**Northcote PPF**: Uc2.21, Uc4.21

**Reference profile**: GTN1425

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Eurangoa Soil Series**

**Yellow deep sand**

(Pale yellow sand)

This is a sandy soil of low to moderate capability, prone to wind erosion and acidification, which requires careful management. It is non-wetting, especially early in the season.

**Land use**

Suitable for crops, pastures and floriculture.

**Crops:** Lupins and cereals can be grown. If disease builds up, a pasture phase will be necessary. New triazine-resistant canola varieties are possible on better areas, especially in good seasons. Stubble should be retained to minimise wind erosion. Where water repellence is a serious problem, furrow sowing on the contour will allow early and more uniform crop establishment.

**Annual pastures:** Dalkeith and Nungarin sub. clovers, and Paros and Santorini or Cadiz French serradella are recommended.

**Grazing management:** Care during summer and autumn is essential to minimise wind erosion.

**Revegetation:** Mallees and understorey species can be grown. Suggestions include sandplain cypress (*Actinostrobus arenarius*), slender banksia (*Banksia attenuata*), acorn banksia (*B. prionotes*), sceptre banksia (*B. sceptrum*), black tamma (*Allocasuarina acutivalvis*), rock oak (*A. hugeliana*), Yuna mallee (*Eucalyptus jucunda*), Oldfield’s mallee (*E. oldfieldii*), river red gum (*E. camaldulensis*), *Grevillea candelabroides*, spoon-leaved wattle (*Acacia spathulifolia*), *A. blakelyi* and one-sided bottlebrush (*Calothamnus quadrifidus*).

**Soil characteristics and land management**

**Acidity**

Prone to acidification therefore, regular monitoring of surface and subsurface pH is needed. Where pHca has fallen below 4.5, application of lime is recommended.

**Dams & catchments**

Not suitable for dams or roaded catchments.

**Nutrient availability**

Very limited capacity to retain nutrients, most major and micronutrients will be limiting. Nitrogen, phosphorus, potassium and trace elements should be applied to maintain fertility.

**Root growth**

No impediments to root growth.

**Salinity**

Low risk.

**Structural decline**

Possibility of traffic pan developing. If so, crops and pastures will respond to deep ripping.

**Water availability**

Low, due to poor water-holding capacity and poor and patchy infiltration of early rains.

**Water erosion**

Low risk usually because of rapid through drainage.

**Water repellence**

High risk early in the season until the soil wets up.

**Waterlogging**

Well drained so low risk.

**Wind erosion**

High risk. Stubble retention, restricted grazing in summer and autumn and establishment of wind breaks are necessary.

**Workability**

Good.
Soil information sheet for the Northern Wheatbelt

**Grima Soil Series**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Soil description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Firm to hardsetting.</td>
</tr>
<tr>
<td>0-7</td>
<td>Dark yellowish brown heavy clayey fine sand; massive structure; few fine to medium quartz and granite gravels; slightly acid; abrupt boundary.</td>
</tr>
<tr>
<td>7-22</td>
<td>Strong brown heavy clayey fine sand; massive structure; few fine to medium quartz and granite gravels; acid; clear boundary.</td>
</tr>
<tr>
<td>22-40</td>
<td>Strong brown heavy clayey fine sand; massive structure; many fine quartz and granite gravels; acid to neutral.</td>
</tr>
<tr>
<td>40+</td>
<td>Decomposing granite.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Reddish brown to brown topsoil
- Variable red, reddish brown, yellowish red to yellowish brown subsoil
- Loamy sand to clayey sand
- Shallow depth to granite
- Quartz and granite fragments increasing with depth
- Acid to neutral pH

**Soil classification**

**Australian Soil Classification:** *Paralithic Orthic Tenosol* (Isbell 1996)

**Northcote PPF:** *Uc.11, Uc5.2*

**Reference profile:** GTN1409

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Grima Soil Series**

**Red shallow sand**
*(Jam soil)*

This is a very shallow soil, usually less than 80 cm to the underlying bedrock. It must be managed with care to prevent erosion.

**Land use**

**Crops:** Wheat and barley are the recommended cereals. Canola and narrow-leafed lupins are possible on deeper soils. Chickpeas and field peas may be possible on slightly heavier and deeper soils. No-till crop establishment is recommended to build organic matter and minimise soil erosion.

**Annual pastures:** Dalkeith sub. clover is recommended in the higher rainfall areas and Nungarin in the lower rainfall areas.

**Grazing management:** Restrict grazing in summer and autumn to prevent loosening of the soil making it prone to erosion by wind and water.

**Revegetation:** York gum *(Eucalyptus loxophleba)*, granite rock box *(E. petraea)*, Ewart’s mallee *(E. ewartiana)*, tamma *(Allocasuarina campestris)*, rock oak *(A. hugeliana)*, jam *(Acacia acuminata)*, A. andrewsii, kurara *(A. tetragonophylla)*, broombush *(Melaleuca uncinata)*, graceful honeymyrtle *(M. radula)*, *M. eleuterostachya*, needlebush *(Hakea preissii)* and djarnokmurd *(H. recurva)*.

**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acidity</strong></td>
<td>Generally not a problem, but may need monitoring if pH&lt;sub&gt;w&lt;/sub&gt; is below 5.5.</td>
</tr>
<tr>
<td><strong>Dams &amp; catchments</strong></td>
<td>Not suitable as the soil is too shallow.</td>
</tr>
<tr>
<td><strong>Nutrient availability</strong></td>
<td>Limited by the volume of soil available to plant roots above bedrock. Retention of applied fertiliser is fair to good depending on the clay and organic matter content of the soil.</td>
</tr>
<tr>
<td><strong>Root growth</strong></td>
<td>Depth to bedrock will determine root growth.</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>Usually low risk, unless there is a seep due to a bedrock high.</td>
</tr>
<tr>
<td><strong>Structural decline</strong></td>
<td>Possible with excessive cultivation at too high or too low moisture levels or at high speeds. Excessive cultivation when too wet may lead to hardsetting or crusting.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Low where soils are shallower and lighter textured. In deeper soils, availability is good where texture increases to loam or light sandy clay loam.</td>
</tr>
<tr>
<td><strong>Water erosion</strong></td>
<td>High risk on sloping land, especially with run-off from rock outcrops upslope. Grade banks to lead the surface run-off to a dam or waterway, and working on the contour would be necessary.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Generally well drained.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>High risk if the soil is loosened by stock when dry. Stubble retention and restricted grazing in summer and autumn are necessary.</td>
</tr>
<tr>
<td><strong>Workability</strong></td>
<td>Good.</td>
</tr>
</tbody>
</table>
**Soil information sheet for the Northern Wheatbelt**

**Heaton Soil Series**

*Grey deep sandy duplex*  
*(Sandy duplex)*

Loose to firm, dark brown to greyish brown sand over reddish yellow sandy clay.

**Occurrence:** Long gentle slopes and open depressions on dissected sandplain between Mingenew and Dongara, and scattered areas inland from Horrocks to Port Gregory.

**Native vegetation:** Extensively cleared; scrub heath on lateritic sandplain.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Loose to firm.</td>
</tr>
<tr>
<td>0-15</td>
<td>Dark greyish brown gritty medium sand (with some coarse sand); massive structure; acid; clear boundary.</td>
</tr>
<tr>
<td>15-50</td>
<td>Pale brown gritty medium sand (with some coarse sand); massive structure; strongly acid; clear boundary.</td>
</tr>
<tr>
<td>50-90+</td>
<td>Yellow (80%), red (15%), brownish yellow (5%), mottled gritty medium sandy clay; domed to coarse prismatic structure with depth; tongues of sandy material to 80 cm; clay of domes dispersive; acid.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Dark brown to dark greyish brown topsoil
- Yellow, red and brownish yellow mottled subsoil
- Medium to coarse sand topsoil
- Acid to strongly acid
- Sandy clay subsoil with domed to coarse prismatic structure

**Soil classification**

*Australian Soil Classification:* Dystrophic Yellow Chromosol (Isbell 1996)  
*Northcote PPF:* Dy4.62, Dy4.82  
*Reference profile:* GTN1422

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Heaton Soil Series**

**Grey deep sandy duplex (Sandy duplex)**

This is a deep sandy duplex soil of moderate potential, which needs to be managed with care to prevent wind erosion. It is non-wetting and prone to surface and subsurface acidification.

**Land use**

Crops, pastures and floriculture are possible.

**Crops:** Lupins and cereals can be grown and triazine tolerant canola may be possible. Stubble retention is very important to minimise wind erosion. Where water repellence is a problem, furrow sowing on the contour will allow early and more uniform crop establishment.

**Annual pastures:** Dalkeith subterranean clover is recommended.

**Grazing management:** Restricted grazing during summer and autumn is essential to minimise wind erosion.

**Revegetation:** Because of the wide range of climatic zones covered by this soil series, it is not possible to develop a generic list. Contact your local District Office for recommended species.

**Soil characteristics and land management**

- **Acidity:** Prone to acidification, therefore periodic monitoring of both surface and subsurface pH is needed.
- **Dams & catchments:** Soaks may be possible, if the sides can be sealed with clay.
- **Nutrient availability:** Most nutrients, including trace elements, may be limiting. The topsoil has limited capacity to retain nutrients but the subsoil is better.
- **Root growth:** The sandy clay layer will restrict root growth. Some roots will grow through the space between structural units.
- **Salinity:** Low risk generally, but could be a problem where sandplain seeps occur.
- **Structural decline:** Possible traffic pan development, but crops and pastures are likely to respond to deep ripping.
- **Water availability:** Moderate because of poor water-holding capacity of the sandy topsoil and poor and patchy infiltration of early rains. The domed sandy clay layer slows water flow and retains it for crops.
- **Water erosion:** Low risk.
- **Water repellence:** High risk, especially early in the season until the soil wets up.
- **Waterlogging:** Usually low risk, but during prolonged wet periods water will accumulate above the sandy clay layer. Sandplain seeps can occur on this soil.
- **Wind erosion:** High risk. Stubble retention, restricted grazing in summer and autumn and establishment of wind breaks are necessary.
- **Workability:** Good.
Soil information sheet for the Northern Wheatbelt

**Indarra Soil Series**

**Yellow deep sand**
*(Deep yellow sand)*

Loose, yellowish brown sand grading to brownish yellow sand.

**Occurrence:** Low rises and dune ridges in areas of gently undulating sandplain, west of Mullewa to both north and south.

**Native vegetation:** Scrub heath of sandplain cypress (*Actinostrobus arenarius*), spectre banksia (*Banksia scepitrum*), Ashby’s banksia (*B. ashbyii*), grevillea (*Grevillea gordoniana*) and sandplain woody pear (*Xylomelum angustifolium*).

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>Dark yellowish brown loamy sand; massive structure; sandy fabric; strongly acid; sharp boundary.</td>
</tr>
<tr>
<td>9-27</td>
<td>Yellowish brown sand; massive structure; sandy fabric; acid; clear boundary.</td>
</tr>
<tr>
<td>27-110</td>
<td>Brownish yellow sand; massive structure; sandy fabric; acid; gradual boundary.</td>
</tr>
<tr>
<td>110+</td>
<td>Yellowish brown sand; massive structure; sandy fabric; acid.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Medium to coarse sand texture
- Yellowish brown to brownish yellow
- Very deep sandy profile
- Moderately acid pH

**Soil classification**

*Australian Soil Classification:* Arenic Orthic Tenosol (Isbell 1996)

*Northcote PPF:* Uc1.22, Uc4.21

*Reference profile:* GTN1413

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Indarra Soil Series

Yellow deep sand
(Deep yellow sand)

This is a sandy soil of low capability, prone to wind erosion and acidification, which requires careful management. It is non-wetting, especially early in the season.

Land use

The best option would be continuous pasture with plantations of tagasaste or black wattle (Acacia saligna). Continuous blue lupins are also suitable. Floriculture is possible, depending on soil depth.

Crops: Poor prospects in general but better if no-till and stubble retention systems are used. Lupins and cereals may be possible on better areas, if protected by wind breaks or tagasaste. If disease builds up a pasture phase will be necessary. Stubble should be retained to minimise wind erosion, and where water repellence is a serious problem, furrow sowing on the contour will allow early and more uniform crop establishment.

Annual pastures: Paros serradella is recommended. Santorini and Cadiz can also be grown in areas receiving more than 400 mm rainfall.

Grazing management: Care during summer and autumn is essential to minimise erosion.

Revegetation: Sandplain cypress (Actinostrobus arenarius), slender banksia (Banksia attenuata), acorn banksia (B. prionotes), golden wreath wattle (Acacia saligna), spoon-leaved wattle (Acacia spathulifolia), sandplain woody pear (Xylomelum angustifolium), black tamma (Allocasuarina acutivalvis), rock oak (A. hugeliana), Yuna mallee (Eucalyptus jucunda).

Soil characteristics and land management

Acidity
Prone to acidification therefore regular surface and subsurface monitoring is needed. Where pHCa has fallen below 4.5, lime is recommended but may not be economical.

Dams & catchments
Not suitable for dams or roaded catchments.

Nutrient availability
This soil has very limited capacity to retain nutrients and most major and micronutrients will be limiting. Nitrogen, phosphorus, potassium and trace elements should be applied to maintain fertility.

Root growth
No impediments, however, if the subsurface pHCa is less than 4.5 (rare for this soil) aluminium toxicity will restrict root growth.

Salinity
Low risk.

Structural decline
Possibility of traffic pan developing. If so, crop and pasture growth will respond to deep ripping.

Water availability
Very low due to poor water-holding capacity and poor, patchy infiltration of early rain.

Water erosion
Usually low risk because of rapid through drainage.

Water repellence
High risk early in the season until the soil wets up.

Waterlogging
Well drained, so low risk.

Wind erosion
Very high risk. Stubble retention, restricted grazing in summer and autumn and establishment of wind breaks are necessary.

Workability
Good.
Soil information sheet for the Northern Wheatbelt

Irwin Soil Series

Dark brown to reddish brown cracking clay.

Occurrence: On the alluvial flats, gentle slopes and undulating rises near the Lockier and Irwin Rivers north, east and south of Mingenew.

Native vegetation: Jam (Acacia acuminata) shrubs with scattered York gum (Eucalyptus loxophleba).

Soil profile description

Depth (cm)

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Firm to hardsetting.</td>
</tr>
<tr>
<td>0-8</td>
<td>Dark reddish brown loam; massive structure; alkaline; clear boundary.</td>
</tr>
<tr>
<td>8-18</td>
<td>Reddish brown clay loam; massive structure; firm; alkaline; sharp boundary.</td>
</tr>
<tr>
<td>18-40</td>
<td>Yellowish red medium clay; strong fine polyhedral structure (3-5 mm); firm; alkaline; gradual boundary.</td>
</tr>
<tr>
<td>40-60</td>
<td>Yellowish red medium clay; strong coarse polyhedral structure (20-30 mm); very firm; cutans present; alkaline; gradual boundary.</td>
</tr>
<tr>
<td>60-80</td>
<td>Yellowish red medium clay; strong coarse polyhedral structure (30-50 mm); very firm; alkaline; sharp boundary.</td>
</tr>
<tr>
<td>80-100+</td>
<td>Red medium clay; strong coarse polyhedral structure (30-50 mm); very firm; cutans present; strongly alkaline.</td>
</tr>
</tbody>
</table>

Characteristic soil properties

- Dark reddish brown, dark brown, red, or yellowish red soil
- Slippery and boggy when too wet
- Loam to light clay topsoil
- Neutral to strongly alkaline pH increasing with depth
- Surface cracks when dry

Soil classification

Australian Soil Classification: Epipedal Red Vertosol (Isbell 1996)
Northcote PPF: Ug5.33
Reference profile: REFGTN12

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Irwin Soil Series

Hard cracking clay
(Cracking clay)

This is a cracking clay which has to be worked at specific times as the workable moisture range is very narrow. On sloping land erosion can be a problem, especially if there is run-on from upslope, as it is dispersive. If properly managed by improving the drainage and adopting reduced tillage crop establishment it will yield well, except in dry years.

Land use

Crops: Wheat, and faba beans can be grown. On better drained areas barley, chickpeas, field peas and lentils are possible. Minimum till or no-till crop establishment is recommended.

Annual pastures: Caliph barrel medic is recommended in preference to Cyprus for its aphid resistance.

Grazing management: Deferred grazing until good ground cover is established is recommended. Removal of stock or reduced stocking in wet periods will prevent pugging.

Revegetation: York gum (Eucalyptus loxophleba), jam (Acacia acuminata), golden wreath wattle (A. saligna), manna wattle (A. microbotrya), kurara (Acacia tetragonophylla), A. andrewsii, broombush (Melaleuca uncinata), M. adnata, M. eleuterostachya. Swamp sheoak (Casuarina obesa) suits wet areas and river red gum (E. camaldulensis) will grow along drainage lines.

Soil characteristics and land management

Acidity Not a problem as soil is alkaline.

Dams & catchments Dams may be possible only where there is no saline groundwater.

Nutrient availability Limited by alkalinity. Availability of phosphorus may be poor. Manganese, copper and zinc may be deficient. Retention of applied fertiliser is good.

Root growth Difficult through the dense clay, although cracks make it easier.

Salinity Usually low but could be a problem in low lying areas with rising groundwater.

Structural decline Possible with excessive cultivation at extreme moisture levels or at high speeds. Excessive cultivation when too wet may lead to hardsetting or crusting. May respond to gypsum.

Water availability Moderate, but depends on soil structure. Moderate to fairly good where the surface condition has been maintained by conservation tillage and stubble retention. Swelling of clay when wet closes cracks and exposure of tilled soil to rain drop impact causes dispersion and clogging. Cultivation when too wet causes hardsetting surface. This will result in reduced infiltration of water and lower availability. High clay content makes it difficult for plants to extract water from drying soil.

Water erosion Low risk because of the low gradient. May be a problem on sloping land as the soil is dispersive.

Water repellence Low risk.

Waterlogging Can be a problem in some areas.

Wind erosion Low risk.

Workability Limited by workable moisture range. Poor trafficability when too wet.
Soil information sheet for the Northern Wheatbelt

**Kelly Soil Series**

Firm, yellowish brown clayey sand over gravelly light sandy clay loam.

**Occurrence:** On long gentle slopes of broad valleys east of the Darling Fault around Morawa and east of Mullewa.

**Native vegetation:** Acacia–casuarina scrub including jam (*Acacia acuminata*), tamar (*Allocasuarina campestris*), sheoak (*A. acutiyalvis*) with malallie (*Eucalyptus eudesmioides*), Tammin mallee (*E. leptopoda*) and giant mallee (*E. oleosa*).

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Surface</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>Firm</td>
<td>Brown sandy loam; massive structure; strongly acid; abrupt boundary.</td>
</tr>
<tr>
<td>10-28</td>
<td>Strong brown light sandy clay loam; massive structure; few quartz grit and few medium ironstone gravels; strongly acid; clear boundary.</td>
<td></td>
</tr>
<tr>
<td>28-50</td>
<td>Strong brown light sandy clay loam; massive structure; few fine and many medium ironstone gravels; acid; clear boundary.</td>
<td></td>
</tr>
<tr>
<td>50-82+</td>
<td>Strong brown sandy clay loam; massive structure; few fine and abundant medium to coarse laterite gravels; acid.</td>
<td></td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Loamy sand to clayey sand topsoil
- Clayey sand to sandy clay loam subsoil with abundant gravel
- Topsoil may contain gravel
- Weakly acid to strongly acid pH
- Yellowish brown, strong brown and dark brown
- Cemented laterite at depth

**Soil classification**

**Australian Soil Classification:** *Ferric-Petroferric Orthic Tenosol* (Isbell 1996)

**Northcote PPF:** *Uc5.22*

**Reference profile:** G TN1416

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Kelly Soil Series

The potential value of this soil depends on the depth to the cemented gravel layer and the degree of packing. Where gravel is tightly packed and close to the surface, capability for cropping is low.

Land use
Suitable for crops and pastures; floriculture may be possible depending on the depth to gravel.

Crops: Lupins and cereals can be grown where the cemented gravel is not too close to the surface. In deeper, less gravelly areas, canola is possible.

Annual pastures: Nungarin subterranean clover is recommended.

Grazing management: Care during summer and autumn is essential to minimise wind erosion.

Revegetation: Malallie (Eucalyptus eudesmioides), Tammin mallee (E. leptopoda), tamma (Allocasuarina campestris), black tamma (A. acutivalvis), jam (Acacia acuminata), wodjils (A. stereophylla, A. neurophylla), wiry honeymyrtle (M. ficifolia), M. cordata.

Soil characteristics and land management

Acidity
Periodic monitoring is recommended if pHCa has fallen below 4.5.

Dams & catchments
Not suitable.

Nutrient availability
Limited capacity to retain nutrients. Most nutrients are limiting including trace elements, phosphorus and manganese.

Root growth
The cemented gravel will restrict and retard root growth.

Salinity
Low risk.

Structural decline
Possibility of decreased porosity. Crops and pastures respond to deep cultivation.

Water availability
Low, due to the poor water-holding capacity of the sandy and gravelly soil. Where texture is loamy and the cemented ironstone is deeper than 50 cm availability will be moderate.

Water erosion
Usually low risk as the soil is well drained, infiltration rates are high and gravel retards surface flow. May become a problem during summer storms if the soil has been loosened.

Water repellence
Low risk usually, but may increase in some areas early in the season until the soil wets up.

Waterlogging
Low risk.

Wind erosion
Moderate risk. Restricted grazing in summer and autumn is necessary. Risk is less if there is abundant surface gravel and a firm surface.

Workability
Good to moderate, depending on the gravel content within cultivation depth.
Soil information sheet for the Northern Wheatbelt

Mindage Soil Series  Red-brown hardpan shallow loam
(York gum country)

Hardsetting reddish brown sandy loam over sandy clay loam with a red-brown or calcrete
hardpan at moderate depth (30-60 cm).

Occurrence: Level to very gently inclined lower slopes and gentle valley slopes from the
limit of the agricultural areas north of Mullewa southward to near Mingenew.

Native vegetation: York gum (Eucalyptus loxophleba) woodland.

Soil profile description

Depth (cm)

<table>
<thead>
<tr>
<th>Surface</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>Dark reddish brown light sandy clay loam; massive structure; few quartz grit fragments and fine subrounded manganese gravels, acid; abrupt boundary.</td>
</tr>
<tr>
<td>9-26</td>
<td>Dark reddish brown clay loam; massive structure; few quartz grit fragments and fine subrounded manganese gravels; alkaline; abrupt boundary.</td>
</tr>
<tr>
<td>26-40</td>
<td>Dark reddish brown light sandy clay loam; massive structure; few fine and many medium to coarse angular calcarenite gravels; alkaline; sharp broken boundary.</td>
</tr>
<tr>
<td>40+</td>
<td>Platy to massive, strongly cemented calcrete hardpan.</td>
</tr>
</tbody>
</table>

Characteristic soil properties

- Sandy loam to sandy clay loam topsoil
- Dark reddish brown, dark red and red
- Sandy clay loam to clay loam subsoil
- Red-brown or calcrete hardpan at 30-60 cm
- Moderately acid to neutral or slightly acid to alkaline pH

Soil classification

Australian Soil Classification: Duric Red Kandosol (Isbell 1996)
Northcote PPF: Gn2.1, Dr4.5  Reference profiles: GTN1407, REFGTN6

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Mindage Soil Series**
**Red-brown hardpan shallow loam**
*(York gum country)*

This is a shallow, but moderately fertile soil that needs to be managed carefully to prevent hardsetting and water erosion. With minimum tillage, stubble retention and judicious fertiliser application, it has potential for continuous cropping.

**Land use**

Crops: Cereals, faba beans, field pea and chickpeas. Canola is possible in western areas. Where the topsoil is heavier than a loam and the pH is higher than 6.0, lentils are possible in the western parts. Suited to continuous cropping if minimum tillage or no-till crop establishment is followed.

Annual pastures: Caliph barrel medic is recommended.

Grazing management: Care during wet periods is important to prevent pugging.


**Soil characteristics and land management**

**Acidity**
Can be a surface problem.

**Dams & catchments**
Dams may be constructed where the hardpan can be dug out. Test drilling for groundwater salinity is recommended.

**Nutrient availability**
Moderate to good, depending on the depth available to plant roots. Retention of applied fertiliser is also good. In a continuous cropping regime, correct fertiliser application will be necessary.

**Root growth**
Restricted by the depth to hardpan.

**Salinity**
Usually low risk, however risk increases in valley floors with rising groundwater.

**Structural decline**
Possible with excessive cultivation at too high or too low moisture levels or at high speeds. Excessive cultivation when too wet will lead to a very hardsetting surface.

**Water availability**
Low to moderate water storage depending on the depth to red-brown or calcrete hardpan. Where surface condition has been maintained by minimum tillage and stubble retention, water infiltration and storage will be better. Tillage will lower infiltration by clogging the soil pores with dispersed clay.

**Water erosion**
Moderate risk on sloping land, especially with run-on from upslope. Grade banks may be necessary to lead run-off to a dam or a waterway. Working on the contour is recommended.

**Water repellence**
Low risk.

**Waterlogging**
Generally well drained. May be a problem on valley floors.

**Wind erosion**
Low risk, as the surface is firm to hardsetting.

**Workability**
Moderate, as the workable moisture range is narrow, especially where surfaces are hardsetting.
Soil information sheet for the Northern Wheatbelt

Morawa Soil Series

Hardsetting, red sandy loam grading to clay loam over red-brown hardpan at 60 to 140 cm.

Occurrence: Level plains to very gently inclined lower slopes at the base of broad valleys around Morawa and Mingenew, particularly to the east.

Native vegetation: Tall open woodland of salmon gum (Eucalyptus salmonophloia) and York gum (E. loxophleba).

Soil profile description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Hardsetting.</td>
</tr>
<tr>
<td>0-15</td>
<td>Dark red clayey fine sand to fine sandy loam; cloddy, breaking into medium crumb structure; dry, brittle consistence; acid; wavy gradual boundary.</td>
</tr>
<tr>
<td>15-60</td>
<td>Dark red fine sandy clay loam; massive structure; alkaline; gradual boundary.</td>
</tr>
<tr>
<td>60-85</td>
<td>Red fine sandy clay loam; massive structure; alkaline; gradual to clear boundary.</td>
</tr>
<tr>
<td>85+</td>
<td>Red (60%), reddish black (40%), mottled dusky red clay; surface coatings on layers of hardpan.</td>
</tr>
</tbody>
</table>

Characteristic soil properties

- Clayey sand to sandy loam topsoil
- Sandy clay loam to clay loam subsoil
- Dark reddish brown to dark red
- Firm to hardsetting surface
- Red/brown hardpan at 60-140 cm depth
- Moderately acid to slightly alkaline pH

Soil classification

Australian Soil Classification: Duric Red Kandosol (Isbell 1996)
Northcote PPF: Dr2.5, Um5.31
Reference profiles: GTN1334, REFGTN13

Note: Wilroy Soil Series is very similar to Morawa but the soil is shallower and supports lower vegetation.

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Morawa Soil Series**

This is a fertile soil that needs to be managed carefully to prevent hardsetting surfaces and water erosion. With minimum tillage, stubble retention and judicious fertiliser application, it has potential for continuous cropping.

**Land use**

**Crops:** Cereals, field peas, faba beans, chickpeas and canola can be grown. It is suited to continuous cropping if minimum tillage or no-till crop establishment technique is followed.

**Annual pastures:** Caliph barrel medic is recommended.

**Grazing management:** Care during wet periods is important to prevent pugging of the soil.

**Revegetation:** Trees, mallees and understorey species can be grown. Examples include York gum (*Eucalyptus loxophleba*), salmon gum (*E. salmonophloia*), jam (*Acacia acuminata*), kurara (*A. tetragonophylla*), *A. andrewsi*, manna wattle (*A. microbotrya*), broombush (*Melaleuca uncinata*), *M. eleuterostachya*, needlebush (*Hakea preissii*), djarnokmurd (*H. recurva*).

**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acidity</strong></td>
<td>Surface acidification may be a problem with continuous cropping and nitrogen fertiliser application.</td>
</tr>
<tr>
<td><strong>Dams &amp; catchments</strong></td>
<td>Dams may be constructed where the hardpan can be dug out. Test drilling for groundwater salinity is recommended.</td>
</tr>
<tr>
<td><strong>Nutrient availability</strong></td>
<td>Good. Retention of applied fertiliser is also good. In a continuous cropping regime, correct fertiliser application will be necessary.</td>
</tr>
<tr>
<td><strong>Root growth</strong></td>
<td>Restricted by the depth to the hardpan between 60 and 140 cm.</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>Moderate risk in valley floors with rising groundwater.</td>
</tr>
<tr>
<td><strong>Structural decline</strong></td>
<td>Possible with excessive cultivation at too high or too low moisture levels or at high speeds. Excessive cultivation when too wet will lead to hardsetting surfaces.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Moderate to good depending on the surface condition. Where the surface has been maintained by minimum tillage and stubble retention, water infiltration and storage will be better. Tillage will reduce water infiltration by forming a surface seal or crust which may set hard.</td>
</tr>
<tr>
<td><strong>Water erosion</strong></td>
<td>Moderate risk on sloping land, especially with run-off from upslope. Grade banks may be necessary to lead the run-off to a dam or a waterway. Working on the contour is recommended.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Generally well drained, except for valley floors which may need drains.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>Usually low risk as the soil surface is firm to hardsetting.</td>
</tr>
<tr>
<td><strong>Workability</strong></td>
<td>Moderate, as the workable moisture range is narrow, especially where hardsetting surfaces are a problem. Poor trafficability when too wet.</td>
</tr>
</tbody>
</table>
Soil information sheet for the Northern Wheatbelt

Northampton Soil Series

Red shallow sandy duplex
(Red loam)

Hardsetting, red-brown stony loamy sand over sandy clay loam on granulite. Rock outcrop is common, often with many quartz and rock fragments on the surface.

Occurrence: Hillcrests and ridges in an undulating landscape around Ajana and Northampton.

Native vegetation: Jam (Acacia acuminata) scrub with kurara (A. tetragonophylla), needlebush (Hakea preissii) and rock sheoak (Allocasuarina huegeliana).

Soil profile description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>Hardsetting. Dark reddish brown clayey medium to coarse sand; crumb structure; dry, brittle consistence; acid; clear boundary.</td>
</tr>
<tr>
<td>10-18</td>
<td>Reddish brown clayey medium to coarse sand; weak crumb to massive structure; strongly acid; gradual boundary.</td>
</tr>
<tr>
<td>18-55</td>
<td>Red coarse sandy clay loam; crumb to weak fine blocky structure; acid; some stones; wavy gradual boundary.</td>
</tr>
<tr>
<td>55-70</td>
<td>Red (90%), reddish brown (10%) mottled coarse sandy clay loam to clay (with at least 10% weathered rock); massive and very coarse blocky structure; moderately moist; weakly acid; quartz stones and weathered granite.</td>
</tr>
</tbody>
</table>

Characteristic soil properties

- Loamy sand to sandy loam topsoil
- Sandy clay loam subsoil
- Dark reddish brown, red to dark red soil
- Moderately acid to neutral pH
- Decomposing bedrock within 40-80 cm
- Quartz and rock fragments on and beneath the surface

Soil classification

Australian Soil Classification: Mesotrophic Red Kandosol (Isbell 1996)
Northcote PPF: Dr2.52, Gn2.12

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Northampton Soil Series  Red shallow sandy duplex
(Red loam)

This is a shallow, but fertile soil that needs to be managed carefully to prevent further soil loss from wind and water erosion. With minimum tillage, stubble retention and judicious fertiliser application, this soil has high potential for continuous cropping.

Land use
Suitable for various crops and pastures plus floriculture where depth is sufficient.

Crops: Suited to continuous cropping with minimum tillage or no-till crop establishment. Cereals, field pea, faba beans, chickpeas and canola.

Annual pastures: Dalkeith subterranean clover and Santiago are recommended legumes.

Grazing management: Care during summer and autumn is very important to prevent loosening the soil by stock which will lead to wind erosion.

Revegetation: Trees, mallees and understorey species can be grown. York gum (Eucalyptus loxophleba), black-stemmed mallee (E. arachnaea), Dongara mallee (E. obtusiflora), jam (Acacia acuminata), kurara (A. tetragonophylla), A. andrewsii, broombush (Melaleuca uncinata), M. eleuterostachya, needlebush (Hakea preissii), djarnokmurd (H. recurva) and bird hakea (H. orthorrhyncha).

Soil characteristics and land management

Acidity  Generally low risk, but may need monitoring.
Dams & catchments  Not suitable for dams as the bedrock is within 40 to 80 cm.
Nutrient availability  Good. Retention of applied fertiliser is also good. Correct fertiliser application will be necessary with continuous cropping.
Root growth  No obvious restrictions except for the shallow depth to bedrock.
Salinity  Low risk.
Structural decline  Possible with excessive cultivation at too high or too low moisture levels or high speeds. Excessive cultivation when too wet will lead to hardsetting surfaces.
Water availability  Moderate to good water storage depending on the depth to bedrock and surface condition. Where the surface has been maintained by minimum tillage and stubble retention, water infiltration and storage will be better. Hardsetting will lower water infiltration which will result in lower water availability.
Water erosion  Moderate. Grade banks may be necessary to lead run-off to a dam or a waterway. Working on the contour is recommended.
Water repellence  Low risk.
Waterlogging  Generally well drained.
Wind erosion  Moderate risk. Careful grazing management and stubble retention are necessary.
Workability  Fair; surface rocks cause problems.
Soil information sheet for the Northern Wheatbelt

**Northern Gully Soil Series**  
*Red deep sandy duplex*

**Hardsetting, gritty loamy sand over clay on granite.**

**Occurrence:** On undulating landscape with low hills and granite outcrops stretching from about 10 km from the coast inland to Naraling and south to the lower reaches of the Greenough River

**Native vegetation:** Acacia and hakea scrub (*Acacia acuminata, A. tetragonophylla, Hakea preissii, H. recurva*) with few scattered York gums (*Eucalyptus loxophleba*) and river red gums (*E. camaldulensis*) in drainage lines.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>Reddish brown clayey medium to coarse sand; massive structure; slightly acid; gradual boundary.</td>
</tr>
<tr>
<td>15-35</td>
<td>Red medium to coarse clayey sand; massive; slightly acid; some quartz stones (5%, less than 3 cm in diameter); gradual boundary.</td>
</tr>
<tr>
<td>35-65</td>
<td>Red gritty, gravelly medium sandy clay; weak medium blocky structure; slightly acid; weathered rocks and stones at 65 cm; clear boundary.</td>
</tr>
<tr>
<td>65-90+</td>
<td>Yellowish red and strong brown mottled gritty clay; weak platy (rock structure) to medium blocky structure; neutral pH.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Loamy sand to sandy loam topsoil  
- Sandy clay to medium clay subsoil  
- Dark reddish brown, red, dark yellowish brown and yellowish brown subsoil colours  
- Moderately acid to alkaline pH  
- Decomposing granite at 60-120 cm

**Soil classification**

*Australian Soil Classification:* *Sodic Eutrophic Brown Chromosol* (Isbell 1996)  
*Northcote PPF:* *Dy2.1, Dy2.5*

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Northern Gully Soil Series

This is a fertile soil that needs to be managed carefully to minimise hardsetting, wind and water erosion. With minimum tillage, stubble retention and judicious fertiliser application, it has high potential for continuous cropping.

Land use

Suitable for crops, pastures and floriculture depending on depth of soil.

Crops: Suited to continuous cropping if minimum tillage or no-till crop establishment is followed. Cereals, albus lupins, field peas, chickpeas, faba beans and canola.

Annual pastures: Dalkeith subterranean clover and Santiago are recommended.

Grazing management: Care during summer and autumn is very important to prevent wind erosion.

Revegetation: Trees, mallee and understorey species can be grown. York gum (Eucalyptus loxophleba), black-stemmed mallee (E. arachnaea), Dongara mallee (E. obtusiflora), jam (Acacia acuminata), kurara (A. tetragonophylla), A. andrewsii, broombush (Melaleuca uncinata), M. eleuterostachya, needlebush (Hakea preissii), djarnokmurd (H. recurva) and bird hakea (H. orthorrhyncha).

Soil characteristics and land management

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acidity</td>
<td>Generally low risk.</td>
</tr>
<tr>
<td>Dams &amp; catchments</td>
<td>Shallow dams may be possible where the granite bedrock is deeper.</td>
</tr>
<tr>
<td>Nutrient availability</td>
<td>Good. Retention of applied fertiliser is good. In a continuous cropping regime, correct fertiliser application will be necessary.</td>
</tr>
<tr>
<td>Root growth</td>
<td>No obvious restrictions as the soil is porous and permeable down to the decomposing bedrock.</td>
</tr>
<tr>
<td>Salinity</td>
<td>Low risk.</td>
</tr>
<tr>
<td>Structural decline</td>
<td>Possible with excessive cultivation at too high or too low moisture levels or at high speeds. Excessive cultivation when too wet will lead to hardsetting surfaces.</td>
</tr>
<tr>
<td>Water availability</td>
<td>Good water storage. Where surface condition has been maintained by minimum tillage and stubble retention, water infiltration and retention will be better. Hardsetting surfaces lower water infiltration which will result in lower availability.</td>
</tr>
<tr>
<td>Water erosion</td>
<td>Moderate risk on mid to lower slopes where there is run-on from upslope. Grade banks may be necessary to lead run-off to a dam or a waterway. Working on the contour is recommended.</td>
</tr>
<tr>
<td>Water repellence</td>
<td>Low risk, except for early in the season.</td>
</tr>
<tr>
<td>Waterlogging</td>
<td>Generally well drained.</td>
</tr>
<tr>
<td>Wind erosion</td>
<td>Moderate risk. Careful grazing management and stubble retention are necessary.</td>
</tr>
<tr>
<td>Workability</td>
<td>Good.</td>
</tr>
</tbody>
</table>
Soil information sheet for the Northern Wheatbelt

**Pindar Soil Series**

Soft to firm, dark yellowish brown acid clayey sand.

**Yellow deep sand (Wodjil sand)**

Occurrence: Sandy soils on long gentle slopes around Pindar.

Native vegetation: Acacia shrubland including bowgada (*A. ramulosa, A. linophylla*) and jam (*A. acuminata*).

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Soft to firm.</td>
</tr>
<tr>
<td>0-6</td>
<td>Dark yellowish brown light loamy sand; water repellent; massive structure; very few fine subrounded gravels; acid; abrupt boundary.</td>
</tr>
<tr>
<td>6-16</td>
<td>Dark yellowish brown loamy sand; massive structure; acid; clear boundary.</td>
</tr>
<tr>
<td>16-27</td>
<td>Yellowish brown loamy sand; massive structure; strongly acid; clear boundary.</td>
</tr>
<tr>
<td>27-57</td>
<td>Yellowish brown light clayey fine sand; massive structure; very few fine subrounded gravels; strongly acid; gradual boundary.</td>
</tr>
<tr>
<td>57-100+</td>
<td>Yellowish brown clayey fine sand; massive; very few fine subrounded gravels; strongly acid.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Sand to loamy sand topsoil
- Clayey sand subsoil
- Strongly acid pH
- Dark brown, yellowish brown, brownish yellow or brown

**Soil classification**

**Australian Soil Classification:** Arenic Orthic Tenosol (Isbell 1996)

**Northcote PPF:** Uc5.22

**Reference profile:** GTN1408

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Pindar Soil Series

Yellow deep sand
(Wodjil sand)

This is an acid, yellow earthy sand which needs careful management to prevent wind erosion.Liming will raise the pH and prevent aluminium toxicity, however may not give an economic return. It should be fertilised judiciously to maintain fertility.

Land use

Crops: Yellow lupins, rye and triticale can be grown. It may be possible to grow wheat and narrow-leaved lupins on the better areas if fertilised adequately with nitrogen, phosphorus, potassium and trace elements, especially molybdenum. The economic option would be to grow acid-tolerant crops until machinery can be developed to apply lime evenly to the subsoil.

Annual pastures: In areas receiving more than 300 mm rainfall, Paros serradella could be grown. Unfortunately, this soil is mainly found in areas which receive less rainfall.

Grazing management: Care during summer and autumn and stubble retention are essential to minimise wind erosion.

Revegetation: Mallees, grevilleas, hakeas and wattles are generally suitable. Species include malallie (Eucalyptus eudesmioides), Tammin mallee (E. leptopoda), Oldfield’s mallee (E. oldfieldii), river red gum (E. camaldulensis), Grevillea obliquistigma, flame grevillea (G. eriostachya), pink spike hakea (H. coriacea), H. invaginatum, wodjil (Acacia neurophylla), sugarbrother (A. coolgardiensis), white cypress pine (Callitris columellaris), wiry honeymyrtle (Melaleuca nematophylla) and M. cordata.

Soil characteristics and land management

Acidity
Strongly acid. Where pHc is below 4.5 application of lime, especially to the subsoil, will be required, but may not be economic. Grow only acid-tolerant crops.

Dams & catchments
Not suitable.

Nutrient availability
Most nutrients, including trace elements, will be limiting. Phosphorus and molybdenum are commonly deficient.

Root growth
Limited by aluminium toxicity in the subsoil.

Salinity
Slight risk.

Structural decline
Possible traffic pan development.

Water availability
Low, because of poor water-holding capacity, and poor and patchy infiltration of early rains.

Water erosion
Non-wetting nature causes poor infiltration of early rains leading to run-off, especially during thunderstorms, which can cause erosion.

Water repellence
A problem early in the season until the soil wets up.

Waterlogging
Low risk as well drained.

Wind erosion
High risk. Stubble retention, restricted grazing in summer and autumn and establishment of wind breaks are necessary.

Workability
Good.
Soil information sheet for the Northern Wheatbelt

**Tardun Soil Series**  
*Red shallow sandy duplex  
(Rocky outcrop country)*

Hardsetting, dark reddish brown gritty clayey sand over clay on granite.

**Occurrence:** Hillcrests and gentle slopes of gently undulating rises with occasional rock outcrop scattered south and east of Mullewa, particularly near Tardun.

**Native vegetation:** Jam (*Acacia acuminata*) scrub and *Allocasuarina–Melaleuca* thickets.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Firm to hardsetting.</td>
</tr>
<tr>
<td>0-15</td>
<td>Reddish brown clayey medium gritty sand; crumb structure; moderately friable consistence; slightly acid; gradual boundary.</td>
</tr>
<tr>
<td>15-40</td>
<td>Dark yellowish brown gritty coarse to medium sandy clay loam; crumb structure; dispersive clay; acid; wavy gradual boundary.</td>
</tr>
<tr>
<td>40-60+</td>
<td>Dark yellowish brown stony (20%) and gravelly (10%) coarse and medium sandy clay loam; fine crumb structure; slightly acid.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- Clayey medium to coarse gritty sand topsoil
- Coarse and medium sandy clay loam to sandy to gritty clay subsoil
- Dark reddish brown, dark yellowish brown, red, yellowish red and brown
- Moderately acid to neutral pH

**Soil classification**

*Australian Soil Classification:* Mesotrophic Red, Grey and Brown Chromosol  
*Northcote PPF:* Dr, Dy, Db

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Tardun Soil Series**

Tardun Soil Series Red shallow sandy duplex
(Rocky outcrop country)

This is a shallow, but fertile soil that needs to be managed carefully to prevent wind and water erosion. With minimum tillage, stubble retention and judicious fertiliser application, it has potential for continuous cropping.

**Land use**

**Crops:** Suited to continuous cropping if minimum tillage or no-till crop establishment technique is followed. Possible crops include cereals, field peas, chickpeas and canola where the bedrock is deeper. Rocky surfaces are unsuitable for chickpeas.

**Annual pastures:** Nungarin subterranean clover and Serena and Santiago burr medics are recommended.

**Grazing management:** Care during summer and autumn is very important to prevent erosion.

**Revegetation:** Suggestions include York gum (Eucalyptus loxophleba), granite rock box (E. petraea), Ewart’s mallee (E. ewartiana), tamma (Allocasuarina campestris), rock oak (A. hugeliana), jam (Acacia acuminata), A. andrewsii, kurara (A. tetragonophylla), broombush (Melaleuca uncinata), graceful honeymyrtle (M. radula), M. eleuterostacha and djarnokmurd (H. recurva).

**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acidity</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Dams &amp; catchments</strong></td>
<td>Not suitable for dams as the bedrock is within 30 to 80 cm.</td>
</tr>
<tr>
<td><strong>Nutrient availability</strong></td>
<td>Moderate. Retention of applied fertiliser is good. In a continuous cropping regime, correct fertiliser application will be necessary.</td>
</tr>
<tr>
<td><strong>Root growth</strong></td>
<td>No restriction except for the shallow depth to bedrock.</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>Usually low risk.</td>
</tr>
<tr>
<td><strong>Structural decline</strong></td>
<td>Possible with excessive cultivation at too high or too low moisture levels or high speeds. Excessive cultivation when too wet will lead to hardsetting.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Low to moderate water storage depending on the depth to bedrock. Where surface condition has been maintained by minimum tillage and stubble retention, water infiltration and storage will be better. Soil is dispersive after tillage which lowers water infiltration as the dispersed clay clogs the soil pores. Where depth to bedrock is greater than 50 cm availability will be moderate to good.</td>
</tr>
<tr>
<td><strong>Water erosion</strong></td>
<td>Moderate to high, as the clay is dispersive which slows infiltration by clogging soil pores and increasing run-off. Grade banks may be necessary to lead run-off to a dam or waterway. Working on the contour is recommended. Run-off occurs from granite outcrops.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Generally well drained, but ponding can occur where soil is shallow.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>Moderate risk. Careful grazing management and stubble retention are necessary.</td>
</tr>
<tr>
<td><strong>Workability</strong></td>
<td>Good.</td>
</tr>
</tbody>
</table>
Soil information sheet for the Northern Wheatbelt

Teakle Soil Series

Yellow deep sand
(Limestone yellow sand)

Loose to soft, yellowish brown sand over yellow clayey sand over limestone.

Occurrence: On gently undulating sandplain; limestone outcrops and low hills, just inland from the coast from the limit of the agricultural areas southward.

Native vegetation: Acacia–banksia scrub. Dominant species are black wattle (*Acacia rostellifera*) and acorn banksia (*Banksia prionotes*).

Soil profile description

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Loose to soft.</td>
</tr>
<tr>
<td>0-20</td>
<td>Dark greyish brown humic clayey medium to fine sand; structureless; near neutral pH; gradual boundary.</td>
</tr>
<tr>
<td>20-35</td>
<td>Dark yellowish brown clayey medium to fine sand; weakly acid; calcareous pinnacles occur at 30 cm and widen with depth; gradual boundary.</td>
</tr>
<tr>
<td>35-90</td>
<td>Reddish yellow clayey medium to fine sand; near neutral pH; clear boundary.</td>
</tr>
<tr>
<td>90+</td>
<td>White coarse crystalline limestone and grey sandy limestone.</td>
</tr>
</tbody>
</table>

Characteristic soil properties

- Loamy sand to clayey sand topsoil
- Clayey sand subsoil
- Loose single grain structure
- Limestone at variable depth
- Slightly acid to neutral pH
- Dark greyish brown, dark brown, yellowish brown, brownish yellow or reddish yellow colours

Soil classification

Australian Soil Classification: *Arenic Orthic Tenosol* (Isbell 1996)
Northcote PPF: Uc4.21
Reference profile: GTN1403

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

Teakle Soil Series

Yellow deep sand
(Limestone yellow sand)

This is a sandy soil of low capability, which requires careful management to prevent wind erosion.

Land use

Suitable for crops and pastures; and for floriculture depending on depth to limestone.

Crops: Cereals can be grown. If disease builds up a pasture phase will be necessary. On gently undulating sandplain, canola may be possible if the limestone layer is more than 100 cm deep. Lupins are not suitable if the soil is shallow and the pH is above 6.5.

Annual pastures: Dalkeith subterranean clover and Paros serradella are recommended.

Grazing management: Care during summer and autumn is essential to minimise wind erosion.

Revegetation: For coastal plantings only try illyarrie (Eucalyptus erythrocorys), Dongara mallee (E. obtusiflora), Abrolhos Island mallee (E. oraria), tangling melaleuca (Melaleuca cardiophylla), chenille honeymyrtle (M. huegelii), Rottnest tea-tree (M. lanceolata), black wattle (Acacia rostellifera), A. scirpifolia, spoon-leaved wattle (A. spathulifolia), silvery-leaved grevillea (Grevillea argyrophylla), olive grevillea (G. olivacea), acorn banksia (Banksia prionotes), cockies tongues (Templetonia retusa), and common woollybush (Adenanthos cygnorum).

Soil characteristics and land management

Acidity Low risk because of the presence of limestone.
Dams & catchments Not suitable.
Nutrient availability Most major and micronutrients will be limiting. Very limited capacity to retain nutrients. Nitrogen, phosphorus, potassium and trace elements should be applied.
Root growth Depth to limestone pinnacles will determine root growth.
Salinity Low risk.
Structural decline Possibility of traffic pan developing. If so, crops and pastures will respond to deep ripping.
Water availability Low, due to poor water-holding capacity and shallow depth to limestone. In deeper phases water availability will be moderate as the clay increases with depth.
Water erosion Usually low risk because of rapid through drainage.
Water repellence Usually low risk but possible under lupins and legume-based pasture.
Waterlogging Well drained so low risk.
Wind erosion High risk. Stubble retention, restricted grazing in summer and autumn and establishment of wind breaks are necessary.
Workability Good, except where limestone is at or very close to the surface.
Soil information sheet for the Northern Wheatbelt

**Wipanga Soil Series**

*Shallow gravel (Gravelly loam)*

Hardsetting, yellowish brown gravelly sandy loam over cemented laterite.

**Occurrence:** On gently undulating low rises and upper slopes east of Mingenew.

**Soil profile description**

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>Hardsetting.</td>
</tr>
<tr>
<td>0-9</td>
<td>Strong brown light sandy clay loam; massive structure; many fine and few medium laterite gravels; acid; abrupt boundary.</td>
</tr>
<tr>
<td>9-75</td>
<td>Strong brown sandy clay loam; massive structure; common fine and medium laterite gravels; strongly acid; gradual boundary.</td>
</tr>
<tr>
<td>75+</td>
<td>Strongly cemented laterite.</td>
</tr>
</tbody>
</table>

**Characteristic soil properties**

- 10-40% laterite gravels in topsoil increasing with depth
- Weakly acid to strongly acid
- Sandy clay loam topsoil and subsoil
- Dark brown or yellowish brown
- Cemented laterite at 30-80 cm

**Soil classification**

*Australian Soil Classification:* Petroferric Brown Kandosol (Isbell 1996)

*Northcote PPF:* Gn1.21, Gn2.21

*Reference profile:* GTN1414

Daya Patabendige and Gary Rogers, Natural Resources Assessment Group, Agriculture Western Australia, 1997
Agricultural land use and management

**Wipanga Soil Series**

*Shallow gravel (Gravelly loam)*

The potential for cropping depends on the depth to the cemented gravel layer and its degree of packing. Where the gravel is tightly packed and the cemented laterite layer is close to the surface, capability is low to moderate.

**Land use**

Crops: Lupins and cereals can be grown where the cemented gravel layer is not too close to the surface. In deeper, less gravelly areas, canola is possible.

Annual pastures: Nungarin subterranean clover is recommended.

Grazing management: Care during summer and autumn is essential to minimise wind erosion.


**Soil characteristics and land management**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acidity</strong></td>
<td>Moderate risk. Monitoring is recommended if pH has fallen below 5.0.</td>
</tr>
<tr>
<td><strong>Dams &amp; catchments</strong></td>
<td>Not suitable.</td>
</tr>
<tr>
<td><strong>Nutrient availability</strong></td>
<td>Generally good because of the loamy matrix. Phosphorus is commonly deficient and manganese deficiency may also be common. Moderate capacity to retain nutrients.</td>
</tr>
<tr>
<td><strong>Root growth</strong></td>
<td>The cemented gravel layer and degree of packing restrict root growth.</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Structural decline</strong></td>
<td>Loss of organic matter and excessive cultivation when too wet may lead to a hardsetting surface.</td>
</tr>
<tr>
<td><strong>Water availability</strong></td>
<td>Moderate due to the gravel content and moderate depth to the cemented gravel layer. Gravel effectively reduces the volume of soil from which plant roots can extract water.</td>
</tr>
<tr>
<td><strong>Water erosion</strong></td>
<td>Usually low risk as the soil is well drained and the infiltration rates are high. Surface gravel will retard surface flow of water which causes erosion. It may become a problem during summer thunderstorms if the soil has been loosened. If there is run-on from upslope, level banks should be constructed to collect the water. Grade banks may cause gully erosion.</td>
</tr>
<tr>
<td><strong>Water repellence</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Waterlogging</strong></td>
<td>Low risk.</td>
</tr>
<tr>
<td><strong>Wind erosion</strong></td>
<td>Restricted grazing in summer and autumn is necessary to protect this soil. If there is abundant gravel on the surface or the surface is firm, wind erosion may not be a problem.</td>
</tr>
<tr>
<td><strong>Workability</strong></td>
<td>Good to moderate, depending on gravel content within the depth of cultivation.</td>
</tr>
</tbody>
</table>