7. SOILS

7.1 INTRODUCTION

The following notes are extracted from Soils Landscapes of the Dubbo 1:250 000 Sheet (9).

Soils are a major, if sometimes forgotten, part of the environment. They play a major role in:
- The flow and movement of water across and through the landscape
- The distribution and movement of nutrients and chemicals (including salt) across the landscape
- The distribution of native vegetation
- The selection of land management practices and how these will affect the three critical environmental factors above.

7.1.1 Soils and the Water Cycle

Soils are an integral part of the water cycle. Rainfall is the source of water, but it is largely the soils and the land management practices on those soils, which determine how much and how quickly that water flows across or through the landscape. The soils regulate the flow of water and determine how much and how long water:
- is stored in the soil for plant growth
- flows overland into rivers and lakes
- flows as shallow groundwater to rivers and lakes, or
- flows deep into underlying rocks or sediments to become groundwater

Soil properties, which influence the distribution of water, include surface infiltration, waterholding capacity and subsoil permeability. Groundcover, which is determined very much by land management practices, will reduce runoff and overland flow, but plants will also reduce groundwater flows by evapotranspiration.

Key points are:
- clearing, cultivation and soil structure degradation increase the amount of rapid overland flow which leads to erosion, flooding and loss of water for plant growth. Water for plant growth is of economic value. For example, a general guide is that 10-20 kg/ha of wheat is produced for every mm of water transpired by the plant. This is $1.80 to $3.60/mm/ha, assuming wheat is $180/tonne.
- Clearing, cultivation, nutrient decline and soil acidification reduces water use by plants, which increase the amount of water flowing into the groundwater. This causes rising watertables and salinisation.

7.1.2 Soils and Fertility

Soils and their associated rocks have natural levels of nutrients, salts, other chemicals (sulfur, manganese) and organic compounds. These natural levels can be modified by land use practices such as:
- Nutrients added as fertilizers
- Herbicides and pesticides added to the soil
- Nutrients and chemicals present in effluent and related products that are added to the soil
- Plant growth, which can reduce or increase nutrient levels and may sometimes add organic chemicals to the soil.

The chemical composition of water flowing through the soil can be substantially modified and, therefore, water quality can be strongly influenced by soils.

Water quality may also be affected by erosion when soil particles or organic matter (manure, humus, vegetation fragments) become suspended in water, increasing turbidity. These soil particles and organic matter may carry nutrients and other chemicals, which adversely affect water quality. The addition of nutrients in water flows from surface sheet and rill erosion is most common in cropping areas where tillage makes surface soils more erodible. In tableland areas, where gully erosion is more common than surface erosion, much of the sediment in rivers will be from subsoils, which are not as high in nutrients as surface soils.

Clearing, cultivation and soil structure decline all increase erosion hazard and have an adverse affect on the amount of water flowing in the landscape and water quality. Salinisation of soils is of particular concern as it can lead to the salinisation of water flows.

7.1.3 Soils and Vegetation

The distribution of native vegetation is closely linked to soil distribution, with the location of species depending on the adaptation to different levels of fertility, drainage and soil structure.

Soil landscape mapping units can be a powerful tool to help determine original native vegetation cover, particularly understorey and herbaceous ground strata species, although at this early stage the relationships have not been adequately unraveled. This would allow for the selection of suitable native species to plant on different soil types.

7.1.4 Soils and Catchment Health

Soils are part of the assets of a catchment. It is necessary to maintain those assets in a suitable condition for the long-term sustainability of catchment health. Soil properties affect the best management practices that will maximize catchment health. Management practices that minimize erosion, acidification, salinisation, soil structure decline and rapid runoff will help maintain catchment productivity and environmental quality (catchment health). The soil landscape map units are a powerful tool to select the best management practices for areas of land.

7.1.5 Soil Formation

Geology, geological structures, geomorphology and climate influence the distribution of soil types within the Little River Catchment area. Climate result in gradual change across the landscape, noticeable mostly by the development of podzolics and solodics in the high rainfall areas, which on similar geology in the lower rainfall areas usually form non-calcic brown soils and red brown earths. Soil type changes due to geology, geological structures, and geomorphology are more readily apparent and the change in the landscape and formation processes is more specific, so these are the dominant forces influencing the distribution of soil types.

7.2 SOIL DESCRIPTIONS

The former Soil Conservation Service and now DLWC have completed Soil Landscape Unit mapping for the whole region. The maps are published at 1: 250 000, but data was collected on 1:50,000 topographic sheets and air photos. Soils Landscape mapping is a useful tool for larger scale surveys, as it provides for the amalgamation of a series of individual soil types, and takes account of landscape processes. It also provides a tool which can be used to predict the distribution of soil related characteristics i.e. as derivative maps to provide information about specific characteristic e.g. topsoil acidity.

Figure 7 shows the distribution of soils associations / soil landscape units across the catchment. These maps and the following information are taken from the Soils Landscape reports and maps for Dubbo, Bathurst, Narromine and Forbes (9-12.) Table 9 shows the relationship between soils, geology, and vegetation, and highlights their capability and limitations. Table 9A provides additional details of the limitations of each Great Soil Group.

7.2.1 Alluvial Soils

Alluvial soils are found on the floodplains in the north of the catchment and along some of the creek valleys and drainage depressions. These soils are related to the soils and parent materials from upstream or adjacent areas where they have been eroded off the hills (colluvial) or moved by river processes (alluvial). The parent rocks are Yeoval Granite, Quaternary alluvium and the Toongi Group to the west of the catchment. The parent rocks in some areas are from the Molong Rise and the Great Artesian or Oxley Basin.

The alluvial soils tend to be uniform sands or loams or show alluvial stratification ie. they show very little pedological organisation or development. Alluvial soils have a topsoil of loose dark brown, weakly structured fine sandy loam to loam with layers of loamy sand. The subsoil is brown loam and silt loam with thin layers of loamy sand and clayey sand with a platey structure.

Vegetation found on these soils includes yellow box, river red gum and she-oak, apple box, grey box and rough-barked apple. The land is used for cropping, grazing, improved pastures and irrigation.

The physical characteristics of the alluvial soils include moderate fertility, weakly structured surface soils, moderate to high waterholding capacity, salinity, flood hazard and streambank erosion. The land is suitable for cropping however some areas with steep slopes derived from colluvial processes are only suitable for grazing. There is a high erosion hazard when surface cover is low or river flows are concentrated. The land is not suitable for urban development due to flooding and streambank erosion.

7.2.2 Red Solodic Soils

Red solodic soils occur on intermediate to acidic parent materials. This soil type is found on mid and footslopes of the Dulladerry Volcanics. The parent rocks are red, black and white banded rhyolite. The soils are formed from alluvium and colluvium derived from parent rock.

Vegetation includes tumbledown red gum, red stringybark, red ironbark, Blakely's red gum, yellow box and white cypress pine. Landuse includes grazing on native and improved pastures, native timber and occasionally fodder crops in some areas.

These soils have relatively high levels of sodium in the subsoil and are commonly found on better drained mid slope positions. The sodium often causes the soil to have a hardsetting surface horizon. The topsoil is sandy loam to loam with massive or weakly developed structure. The subsoil is sandy clay loam to medium clay with moderate to strong structure. Red solodic soil is a duplex soil.

Limitations include low fertility, dispersible subsoils leading to gully erosion and the tunnelling of earthworks, seasonal waterlogging, low available waterholding capacity, acidity and salinity.

7.2.3 Red-brown Earths

These soils occur in the north eastern area of the Little River Catchment on intermediate parent materials. Soils are generally duplex or texture contrast soils with light textured surface soil over a clay subsoil. The surface horizon is hardsetting and the topsoil textures range from clayey sands to loams. Red-brown Earths have a weakly developed structure and are commonly apedal. The subsoil has a light to medium clay texture and a strongly developed blocky structure. The soils may be mottled and have carbonate segregations in the lower parts of the subsoil. The soils are moderately to well drained.

These soils are formed on the Cabonne, Cudal and Gregra limestones and sediments and colluvium derived from Catombal Group. Parent rocks include shale, chert, jasper, conglomerate, limestone, andesite, sandstone and tuff. The parent materials are formed in situ from colluvial-alluvial materials derived from the parent rocks.

Vegetation is open, dry sclerophyll woodlands with white box occurring on the ridges and upper slopes and grey box on the mid and lower slopes. The dry sclerophyll woodlands are dominated by black cypress pine – tumbledown red gum association. Yellow Box occurs along the drainage lines. Red-brown Earths are used for cropping, improved pastures and native/volunteer pastures. Cattle, prime lambs and wool are also grown on the soil unit.

Limitations include structurally degraded surface soils, high erosion hazards under cultivation and low surface cover, moderate acidification and toxicity, low to moderate fertility, small areas of salinisation, moderate to high waterholding capacity and low to moderate permeability. Earthworks are required to make the land suitable for cropping in order to control erosion. These soils are currently extensively cropped

7.2.4 Non-calcic Brown Soils

These soils occur on mid to lower slopes in the southern part of the Little River Catchment and in the Yeoval district. The surface soils are mainly hardsetting, brown to reddish-brown sandy loam with a weakly to moderately developed structure. The A_2 horizon is a dull sandy loam with massive structure. There is a clear change to the subsoil. The B horizon reddish-brown sandy clay to light medium clay with moderate to strong structure. Soils are moderately well drained.

Non-calcic Brown Soil is found on Naringla Granodiorites, Garra Formation, Cabonne and Cudal Formation and the Googoodery rhyolite. Parent rocks include granite, adamellite, diorite, siltstone, shale, chert, limestone, conglomerate, tuff and alluvium. Parent material is formed in situ from colluvial-alluvial material from parent rock.

Vegetation found on this soil type is a white box/grey box - yellow box community with Blakely's red gum, apple box, red stringybark and rough barked apple and white cypress pine. The land is used for dryland cropping and grazing on native and improved pastures.

Limitations include moderate fertility, high to very high erosion hazard under cultivation, moderate waterholding capacity, waterlogging, some acidification, salinity and toxicity. There are some areas with perched watertables during winter. The land is used for mixed cropping and requires earthworks and conservation farming techniques to control erosion.

7.2.5 Shallow Soils

Shallow soils occur on slopes of greater than 30% and usually have a depth of less than 50 centimetres above weathered rock. Shallow Soils have weak structured topsoil. The subsoil is sometimes present and is bleached loamy sand overlying weathered granite or hard bedrock. The soils are stony and rock outcrops are common. Shallow soils usually support native pastures on cleared land or uncleared native bush.

Shallow Soils are found on Yeoval Complex, Catombal Formation (Black Rock sub group), Tertiary trachyte of the Hervey Ranges and Canangle Subgroup. The parent rocks are granite, trachyte, sandstone, shale and conglomerate. The parent materials are formed in situ from colluvial-alluvial material derived from parent rock.

Vegetation found on this soil type includes black cypress pine, white cypress pine, and tumbledown red gum with Blakely's red gum on the ridges. The lower slopes are vegetated by red ironbark, white box and white cypress pine. The land is largely uncleared and used for native timber, reserves or grazing.

Limitations include steep slopes, very low fertility and waterholding capacity, high permeability, rock outcrops, shallow soils, seasonal waterlogging, erosion hazard and acidic surface soils. The land is not suitable for agriculture or urban development and it is recommended that the land is used for forest or timber purposes.

7.2.6 Siliceous Sands

Siliceous Sands are found on acidic parent material. Surface horizons are loose to hardsetting. Siliceous Sands have an A_1 horizon of dark reddish-brown loamy sand and an A_2 horizon of bleached loamy sand. There is a clear to gradual boundary between this and the B horizon. The B horizon is yellowish-red to dark brown sandy loam with very weak to single grained structure. The C horizon is a hard siliceous pan or weathered granite.

This soil type is generally found on the various components of the Yeoval Batholith. The parent rock is siliceous granite and the parent material is formed in situ from colluvial-alluvial material derived from parent rock.

Black cypress pine and tumbledown red gum are found on the upper slopes with grey box, white cypress pine, hickory wattle, Kurrajongs and Blakely's red gum on the lower slopes. The land is used for grazing with some areas of improved pasture and cropping and some areas of native timber.

Limitations include low fertility, salinity, acidification, very high erosion hazard under cultivation, high permeability, seasonal waterlogging, low available waterholding capacity, sodic subsoils. The land should only be used for grazing or native forest.

7.2.7 Red Podzolic Soils

These soils are found on intermediate to acidic parent materials. Surface horizons are mostly hardsetting. The A_1 horizon of the Red Podzolic is dark brown fine sandy loam with weak to moderate structure. The A_2 horizon is fine sandy loam, also weakly structured. There is a clear boundary to the subsoil, which is reddish-brown clay loam to medium clay with moderate structure.

This soil type is found on Cudal Formation including the Canowindra, Loombah Formation, Black Rock Sub-Group and, Garra Limestones. Parent rocks include chert, shale, granite, trachyte, tuff, conglomerate, sandstone, rhyolite and limestone. Parent materials are sourced in situ from colluvial-alluvial materials from parent rock.

Vegetation is dry sclerophyll woodland with grey box, white box, yellow box, Blakely's red gum, kurrajongs, tumbledown red gum and black and white cypress pine. The land is used for native timber and grazing with some cropping.

Limitations include low to moderate fertility, high to very high erosion hazard under cultivation due to slope and surface cover, moderate available waterholding capacity, seasonal waterlogging, soil structure decline, rock outcrops, some salinity and acidification.

7.2.8 Euchrozems

Euchrozems have a clay loam topsoil, which can be hardsetting or friable. The B_1 horizon is a light to medium clay with strong structure. The B_2 horizon is dark reddish-brown or brown medium clay with some calcium carbonate present.

This soil type is found on parent materials derived from the Toongi Group, including andesites, basalt, shale, tuff and siltstone. Parent materials are sourced in situ from colluvial-alluvial materials derived from parent rock.

Vegetation includes white box, yellow box and cypress pine. The land is used for dryland cropping and improved pastures.

Limitations include moderate fertility, moderate to high erosion hazard, high shrink-swell potential, moderate permeability and potential salinity. Erosion is the biggest hazard to agricultural production.

7.2.9 Terra Rossa Soils

These soils are associated with limestone and other associated calcareous rocks and are very variable. Terra Rossa soils are generally reddish-brown light clay with moderate to strong structure. Some of these soils have an A horizon of hardsetting reddish-brown loam with weak to moderate structure.

These soils are found on geological units including Garra Formation and Nubrigyn Formation. Parent materials are sourced in situ from colluvial-alluvial materials derived from parent rock.

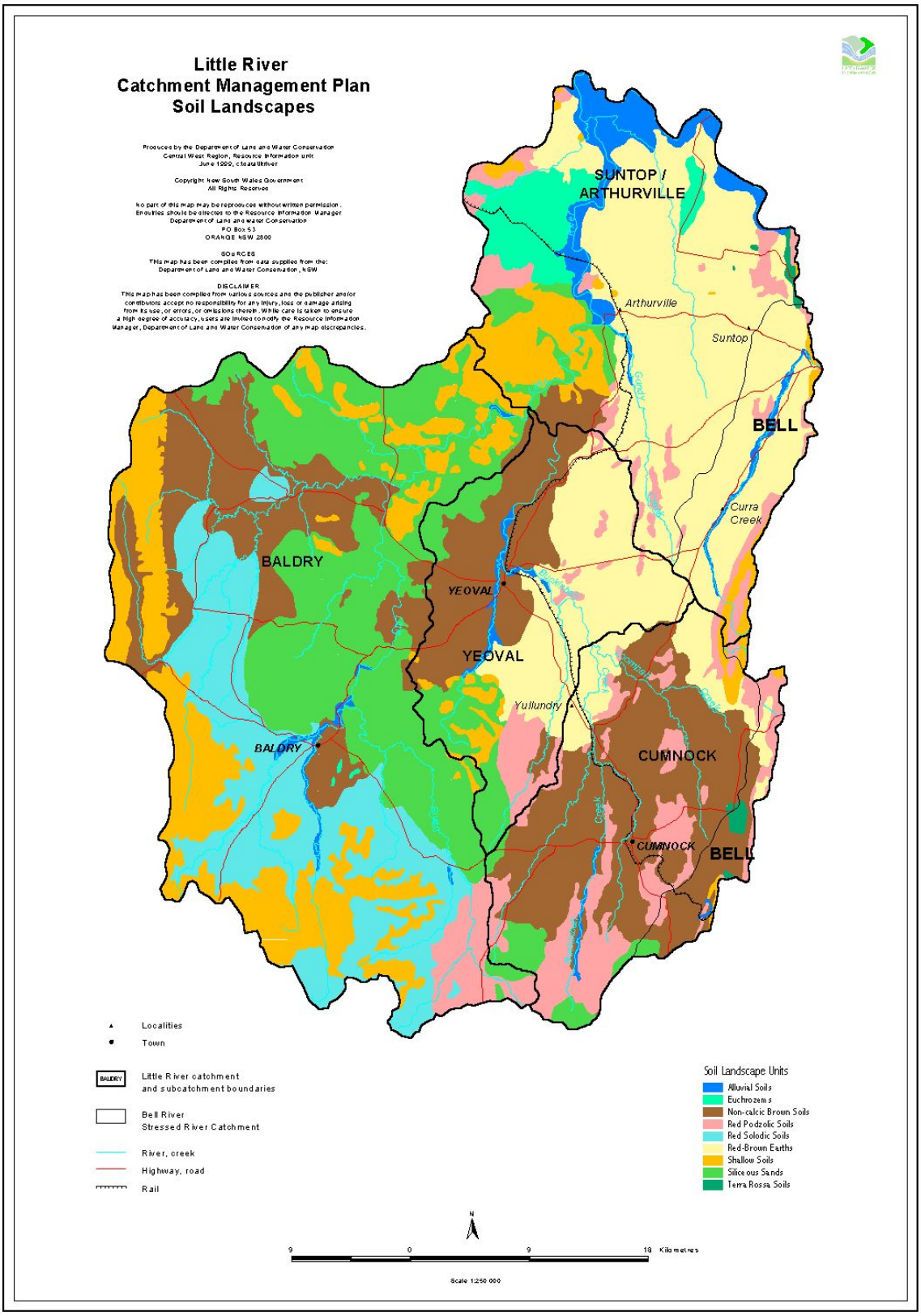
Vegetation includes white box, apple box, kurrajongs and rosewood. The land is used for grazing.

Limitations include moderate fertility, shallow soils, moderate to high erosion hazards and rock outcrops. These soils are generally well drained.

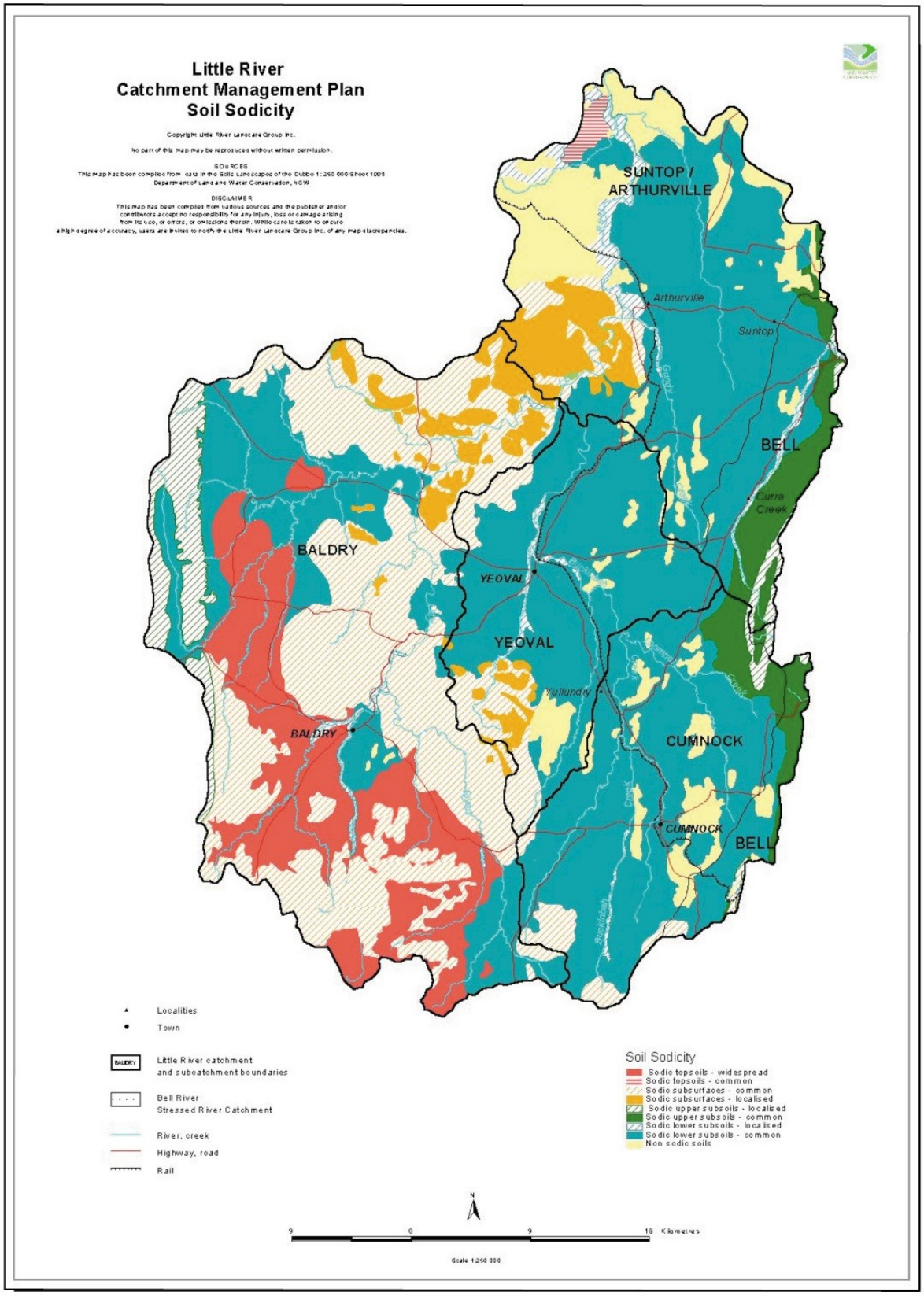
References:

(9) DLWC (1999) *Soil Landscapes of the Dubbo 1:250 000 Sheet and Report*
(10) DLWC (1999) *Soil Landscapes of the Narromine 1:250 000 Sheet and Report*
(11) SCS (1990) *Soil Landscapes of the Bathurst 1:250 000 Sheet and Report*
(12) DLWC (1999) *Soil Landscapes of the Forbes 1:250 000 Sheet*

Figure 7: Soils Associations Map



Potential Soil Sodicity as Predicted from Soils Landscape Unit Data



Potential Soil Permeability as Predicted from Soils Landscape Unit data

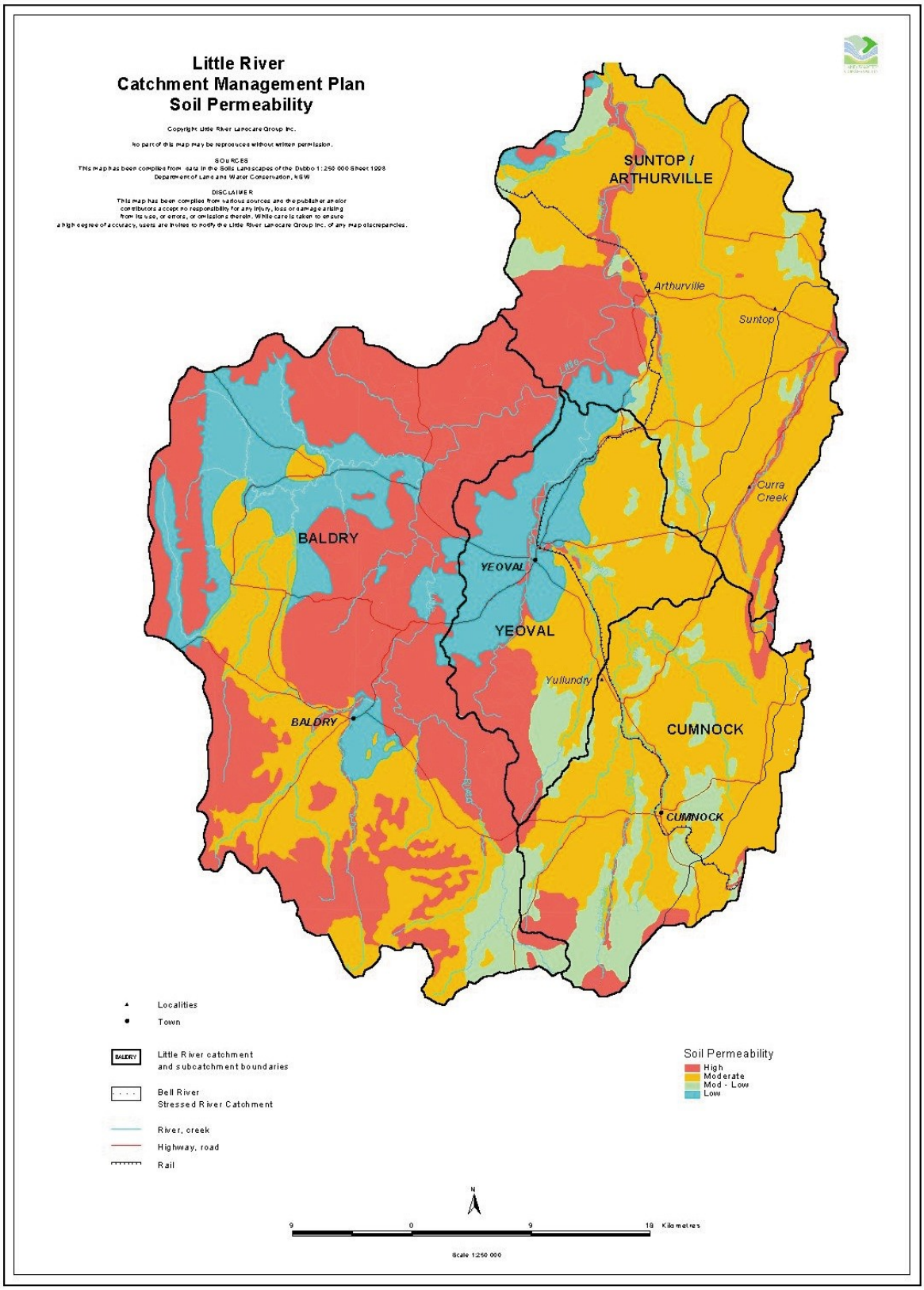


Table 9: Relationship of Great Soil Groups with Geology, Vegetation and Land Capability

Great Soil Group	Alluvial Soils	Red Solodic Soils	Red-brown Earths	Red Podzolic Soils	Non-calcic Brown Soils	Euchrozems	Shallow Soils	Terra Rossa Soils	Siliceous Sands
Soil Landscape Units	Mitchells Creek (mi), Little River (lr), Macquarie-Dubbo (md)	Dulladerry (du), Greydene (gd)	Arthurville (ar), Tillings Lane (tl)	Splitters Hill (sh), Belowrie (bi), Black Rock (br)	Yeoval (yv), Nangar (na), Manildra (mn)	Nubingerie (nb)	Glennie Ridge (gl), Yahoo Peaks (yp) Dowd dw), Mandagery(my) Catombal (cs)	Wellington Caves (wc)	Gullengambal (gg), Oxley (ox)
Soil Description	Sands or loams, weak structure, little pedological organisation	Duplex soils Topsoil - sandy loam to loam, massive or weak structure, Subsoil - sandy clay loam to medium clay, moderate to strong structure	Duplex soils Topsoil - Sands to loams, weak structure Subsoil- Clay, mottled, some carbonate segregations	Duplex soils Topsoil - hardsetting, sandy loam, weak-mod structure, Subsoil - clay loam to clay, moderate structure	Duplex soils Topsoil - sandy loam, weak-mod structure Subsoil - clay, mod-strong structure, smooth-faced peds, mottling	Topsoil - clay loam, Subsoil - medium clay, calcium carbonate	Topsoil - loamy sands, weak structure Subsoil - bleached loamy sands Weathered /hard rock, stony soils, rocky outcrops	Topsoil - light clay, mod-strong structure,	Topsoil - loamy sands, weak structure Subsoil - sandy loam, hard siliceous pan, weathered granite
Geology	Quaternary alluvium	Dulladerry Volcanics	Catombal Group - colluvium, Cabonne and Cudal	Garra, Dilga, & Loombah Formation	Yeoval granite, Garra & Cabonne Formation	Siluro-Devonian Toongi Group	Yeoval Batholith, Tertiary Trachyte, Black Rock subgroup	Garra & Nubrigyn Formation	Yeoval Batholith
Parent Material	Alluvium, colluvium	Red, black and white banded rhyolite	Shale, chert, jasper, sandstone, limestone, conglomerate	Chert, shale, granite, sandstone, limestone, conglomerate	Granite, shale, chert, limestone, conglomerate, alluvium	Andesites, basalt, shale, tuff, sandstone	Granite, trachyte, sandstone, shale, conglomerate	Limestone, calcareous rocks	Siliceous granite

Vegetation	Yellow box, river red gum, she-oak, apple box, grey box	Tumbledown red gum, red stringybark, red ironbark, Blakely's red gum, yellow box, white cypress pine	White box, grey box, black cypress pine, tumbledown red gum, yellow box	Grey box, white box, yellow box, black & white cypress pine, tumbledown red gum, Blakely's red gum	White box, yellow box, grey box, apple box, white cypress pine, red stringybark, Blakely's red gum	White box, yellow box, black & white cypress pine	Black & white cypress pine, tumbledown red gum, Blakely's red gum, white box, red ironbark	White box, apple box, kurrajongs, rosewood	Black & white cypress pine, tumbledown red gum, grey box, hickory wattle, kurrajong, Blakely's red gum
Landuse	Cropping, grazing, improved pastures, dairying, irrigation	Grazing on improved & native pastures, native timber, fodder crops in some areas	Cropping, improved & native pastures, grazing	Native timber, grazing, some cropping	Dryland cropping, improved & native pastures, grazing	Dryland cropping, improved pastures	Native timber, reserves, grazing	Grazing	Grazing, native timber, some improved pastures and cropping
Limitations	Streambank erosion, flood hazard, erosion hazard, weakly structured surface soil	Low fertility, sodic/ dispersible subsoils, seasonal waterlogging, acidity, salinity, low available waterholding capacity	Erosion hazards, acidity, toxicity, salinity, low-mod fertility, soil structure degradation	Low-mod fertility, high erosion, seasonal waterlogging, rock outcrops, salinity, acidity	Moderate fertility, erosion hazard, acidity, salinity, toxicity, waterlogging, perched watertable	Moderate fertility, erosion hazard, salinity	Steep slopes, erosion, very low fertility, very low waterholding capacity, waterlogging, acidity,	Moderate fertility, shallow soils, erosion, rock outcrops	Low fertility, salinity, acidity, erosion, seasonal waterlogging, sodic subsoils, low waterholding capacity

Table 9A: Capability and Limitations of Great Soil Groups

Great Soil Group	Alluvial Soils	Red Solodic Soils	Red-brown Earths	Red Podzolic Soils	Non-calcic Brown Soils	Euchrozems	Shallow Soils	Terra Rossa Soils	Siliceous Sands
Soil Landscape Units	Mitchells Creek (mi), Little river-lr Macquarie-Dubbo (md)	Dulladerry (du), Greydene (gd)	Arthurville (ar), Tillings Lane (tl)	Splitters Hill (sh), Belowrie (bi), Black Rock (br)	Yeoval (yv), Nangar (na), Manildra (mn)	Nubingerie (nb)	Glennie Ridge (gl), Yahoo Peaks (yp), Dowd (dw), Mandagery (my) Catombal (cs)	Wellington Caves (wc)	Gullengambal (gg), Oxley (ox)
Soil Fertility	moderate to high	low	Low to moderate	low	moderate	moderate	Low to very low	moderate	Very low
Risk of Acidification	Susceptible Neutral to slightly acid	Highly susc. Slightly acid	Susceptible Slightly acid	Susceptible Slightly acid	Susceptible Slightly acid to acid	Resistant Slightly acid	High- susceptible Slightly acid to strongly acid	Resistant Neutral	Highly susc. Strongly acid
Soil structure Decline	High	High	High	High	High	Moderate	High	Moderate	High
Permeability	High	Moderate	Moderate to slow	Slow to moderate	Slow to moderate	moderate	Moderate to high	Moderate	Very high to high
Run- off	Low to high	High	Moderate	Low	Low to mod	Moderate	Low	Moderate	Low
Erodibility – topsoil	Low	Low to moderate	Moderate	Moderate	Low to moderate	Low	Low	Low	Moderate
Erodibility – subsoil	Low	Moderate to high	Moderate	Low	Low to moderate	Low	Low to moderate	Low	Moderate
Erosion Hazard	Low	Mod. to high	High	Moderate	Moderate	Moderate	Moderate to high	Moderate	Mod. to high
Sodicity	Localised lower sodic subsoils	Widespread sodic topsoils	Common sodic subsoils	Localised to common sodic subsoils	Common lower sodic subsoils	Non sodic	Localised sodic subsurface soils	Non sodic	Common subsurface sodic soils
Shrink Swell	low	Moderate to low	moderate	Moderate	moderate	high	Very low	Mod. to low	Very low
Suitable for Earthworks	Sandy seams - leaky	Susceptible to tunnelling	Suitable	Suitable, some may leak	Suitable	Aggregated - leaky	Not suitable	Unsuitable – shallow and aggregated	Sandy - leaky