4. SOILS

Material presented in this chapter was used in the preparation of the soils chapters of two Land Conservation Council reports (Land Conservation Council 1974 and 1977b). A detailed soil survey by Newell (1970) also assisted understanding of the soil patterns on the alluvial landscapes in the Ovens valley downstream of Bright and along the Buffalo River downstream of Dandongadale.

The study area contains a great variety of soils, because of the wide range in topography and elevation and therefore in climate. The great diversity of soil parent materials in this area adds to the range of soils present and also complicates their classification. Some profiles lack some of the characterising features of the group to which they seem most similar. Although the groupings used are not mutually exclusive, it is believed that groups with differing behaviour have been separated.

The soils have been grouped into texture-profile forms (Northcote 1979), and further subdivided on the basis of differences in consistence, colour and structure. They have been given descriptive names. A further useful subdivision of such groups may be achieved by recognition of the differences attributable to different parental rock types. Table 8 shows the relations between the descriptive groups and the classifications of Northcote and Stace *et al.*

Details of physical and chemical characteristics and morphological descriptions of representative profiles are presented in Appendices I and III.

Soils of uniform texture

Soils with uniform texture profiles have small, if any, textural differences throughout: no clearly defined textural boundaries occur, except possibly for surface crusts 2.5 cm or less in thickness, and the range of texture throughout the profile does not exceed the span of one texture group (North-cote 1979).

Some of the groups within this division may have some erratic variation in texture trends due to the persistence of depositional bedding, but in general they conform to the above definition.

1. Stony loam soils (none sampled). Rock fragments more than 2 cm across make up at least 50% of the volume of these soils. The stones are little weathered and usually angular. Because of the low proportion of fine earth, usually of loam texture, they have low water-holding capacity but high permeability. Bedrock is usually present at shallow depth. Stony loams do not occupy large areas, but are typical of steep slopes and narrow ridge crests, particularly on well-fractured rocks.

2. Gravelly loam soils (profiles 502, 503) have a matrix of loam or clay loam and, although they are usually relatively uniform in texture throughout, may change gradually with depth, possibly related to depositional rather than pedogenetic influence. Both increases and decreases in clay with depth have been recorded (see profile 502).

The top few centimetres of the A horizon is typically darkened by organic matter, and the rest of the profile is usually brown increasing to red-dish brown.

Particularly at the foot of long steep slopes, the gravelly loams often exceed 3 m depth. They are formed in colluvial deposits, usually derived from Ordovician sedimentary rocks. The soils sampled are acidic (pH 5.3 and lower), but with only moderate base unsaturation. The dominant ex-changeable cation throughout is calcium, although magnesium may also be relatively abundant. Cation exchange capacities decrease with depth from about 20 milliequivalents per 100 g at the surface to less than 10 milliequivalents per 100 g below 1 m.

Although not extensive, these soils are relatively common in mountainous areas and particularly at the base of steep slopes.

3. Coarse sand soils (profiles 510, 561, 562) are derived from coarse-grained parent materials and occur commonly on lower parts of steep slopes.

The A horizon is typically a dark greyish brown sandy loam, which gradually becomes pale brown or stronger brown with increasing depth. The soils have no apparent structure and, despite poor coherence when moist, may be hard when dry. Depths are typically more than 1 m and may exceed 2 m.

Profiles 510 and 561 have higher base unsaturation and lower pH than 562, possibly because the latter comes from a lower-rainfall area. They are generally quite acid soils and have relatively poor water-holding capacity.

4. Undifferentiated sand and loam soils (none sampled). This group comprises the soils designated by Newell (1970) as Group 0 soils and include his Porepunkah, Myrtleford and Wangaratta Series. They are commonly referred to as alluvial soils (see, for example, Rowe *et al.* 1978).

As sediment deposition is related to stream characteristics, a broad relation exists between the predominant texture and the stream with which they are associated. For example, on the lower reaches of the Ovens River within the survey area, soils are mainly fine sandy loams derived from sedimentary rocks, whereas the soils along the steeper-gradient streams flowing off granitic Mount Buffalo are coarse-textured.

Along some of the major streams, notably the Ovens and the Buckland Rivers, these soils have been grossly altered as a result of dredging for gold.

5. Brown and grey loam soils (profiles 518, 525, 529) include soils from Group 1 of Newell (1970) and specifically the Oxley Flats Series.

Generally these medium-textured soils of alluvial origin have gravel at moderate depths (80-120 cm). They are dark brown or black in the surface few centimetres and gradually become lighter-coloured with depth. Structure of the surface is very strongly developed fine to medium granular, changing to subangular blocky and becoming less well developed below 10-15 cm.

Stratification resulting from depositional bedding is still obvious below the biologically active zone and is a characteristic of these soils. They are usually associated with gravel and shingle along streams, and may overlie gravel at shallow depths.

Textures range from silty loams to coarse sands, but are predominantly coarse. Colours are typically greyish brown or brown. Darkening of the A_1 horizon by organic matter may extend some distance below the surface, and segregation of iron oxides may have produced rusty mottling, particularly along root channels in poorly drained soils. Little or no structural development is apparent.

Being formed in young alluvial deposits, and in most instances still subject to periodic flooding, they still receive additional material at the surface.

Because of the lack of a consistent profile form it is difficult to generalise about the physical or chemical properties of these soils. General comments on the fertility of the series within this Group (Newell 1970) indicate great variability in available moisture capacity and in nutrient status.

Depositional bedding may still be apparent below about 50 cm. Soils are acidic, with reactions from about pH 5.6 down to 4.8 recorded in sampled profiles. They have moderately high cation exchange capacities, with calcium as the most abundant ion, and in general are among the most fertile in the survey area.

Brown and grey loam soils occur on the lowest stream terraces on the main streams and, although generally above flood level, may occasionally be inundated. They are often used for growing hops, tobacco and pasture.

6. Organic loam soils (profiles 369, 371, 504, 505, 511, 512, 532). A thick black organic-mineral A horizon characterises these soils. It may merge into weathering rock, abruptly overly unweathered rock, usually at shallow depths (less than about 60 cm), or merge into a non-organic loam that may extend to more than 2 m depth. The structure in the surface is strong, fine crumb (less than 2 mm) to granular, with high porosity and loose to very friable consistence. Where a non-organic B horizon is present its structure is usually only weakly developed and the porosity is less than in the organic-mineral horizon.

Textures are influenced by the parent rock; for example, on granite or granodiorite, coarse sandy loams are characteristic, but loams usually predominate on shales.

The soils are highly acid, as exemplified by profile 505 on Ordovician shales, which had reactions as low as pH 3.8, but the remainder of the profiles sampled had reactions of pH 4.3-5.5 with most about pH 4.7.

Table 8 – Classification of the soils

Number	Description	Parent material	Classification	
			Northcote (1979)	Stace *et al* 1968
Soils of uniform texture				
1	Stony loam soils	Various	-	Lithosols
2	Gravelly loam soils	Colluvium from sedimentary rocks	Um 5.52	Red earths
3	Coarse sand soils	Colluvium from coarse-grained acid igneous rocks	-	Alluvial soils
4	Undifferentiated sand and loam soils	Alluvium	-	Alluvial soils
5	Brown and grey loam soils	Alluvium	Um 6.21	Alluvial soils
6	Organic loam soils	Various	Um 7.11	Alpine humus soil
7	Dark clay soils	Basalt	Ug 5.1-	Black earths
Gradational soils				
8	Reddish brown gradational soils on alluvium	Alluvium	Gn 1.14	Red earths
9	Yellowish brown gradational soils on alluvium	Alluvium	Gn 4.31	Yellow earths
10	Weakly bleached reddish brown gradational soils	Various; mainly Palaeozoic sedimentary rocks	Gn 2.-	Red podzolic soils
11	Weakly bleached yellowish brown gradational soils	Various; mainly Palaeozoic sedimentary rocks	Gn 2.64/Gn 2.74	Yellow podzolic soils
12	Friable brown gradational soils	Various	Gn 4.31	Brown earths
13	Reddish brown gradational soils with rough ped fabric	Various; mainly Palaeozoic sedimentary rocks	Gn 4.14	Brown earths
14	Reddish brown gradational soils with smooth ped fabric	Various	Gn 3.14	Krasnozems
15	Red gradational soils on basalt	Basalt	Gn 3.14	Krasnozems
Duplex soils				
16	Red duplex soils with smooth ped fabric	Various	Dr 2.21	Red podzolic soils
17	Red duplex soils with rough ped fabric	Various; usually alluvium	Dr 2.21	Red podzolic soils
18	Yellowish brown duplex soils	Various; usually alluvium	Dr 2.21	Yellow podzolic soils
Organic soils				
19	Wet peat soils	Organic matter	-	Acid peats
20	Dry peat soils	Organic matter	-	Acid peats
21	Humified peat soils	Organic matter	-	Alpine humus soils

Levels of organic matter are usually high in the surface (up to 25%), but seldom high enough for these soils to be regarded as organic (Northcote 1979).

Despite fairly high cation exchange capacities, particularly at the surface (30-40 milliequivalents per 100 g), these soils are predominantly base unsaturated. The dominant metal cation is calcium, but none of the exchangeable cations usually determined in the laboratory (Ca^{++} Mg^{++}, K^{+}, Na^{+}) is present in significant amounts. The highest concentrations are in the surface 10 cm. Organic loams are the most characteristic soils at the highest elevations within the study area.

Organic loams, usually shallow soils, are widespread in the alpine areas.

They develop on a wide range of parent materials — such as the Hotham shales, Mount Buffalo granite, the basalt of Burnt Hut Knob, granodiorite of the Mount Stirling area and the Carboniferous conglomerates of Mount Cobbler. Their predominant pedogenetic factors are apparently low winter temperatures and high rain-falls, which are a feature of the high mountains where they are found.

Because of their high porosity, these soils are a valuable component of the high mountain environment, where high rainfall and rapid snow-melt are features of the climate and a high infiltration rate is necessary to prevent harmful surface run-off.

7. **Dark clay soils (none sampled)** are black or very dark brown light clay in the surface few centimetres, becoming lighter-coloured but heavier-textured with increasing depth. The structure is well developed, medium (5-15 mm) subangular blocky at the surface, but less well developed and finer (less than 5 mm) below about 30 cm. Lime was not found in the profiles examined, although it may have occurred at greater depth.

The soils are derived from basalt and occur on flat or very gently sloping surfaces in the Myrrhee land system. They are of limited extent and have not been sampled for analysis.

Gradational soils

All the gradational soils become increasingly finer (more clayey) in texture passing down the profile; in each successive horizon the texture changes gradually from the one above into the one below. The boundaries between horizons, although usually gradual or diffuse, may less commonly be clear. The texture difference between consecutive horizons should not be more than one and a half texture groups; but the range of texture throughout the entire soil should exceed the equivalent of the span covered by one texture group (Northcote 1979).

Gradational soils are by far the most difficult to classify because, as well as the gradual variation in features down the profile, many of their properties vary gradually between profiles. They are also the most widespread soils in the mountainous areas and occur in a great diversity of environments.

Included are soils that have been referred to variously as acid brown earths, cryptopodzols, amphipodzols, chocolate soils and leptopodzols (for example, Rowe 1967, Gibbons and Downes 1964, Costin 1954).

8. Reddish brown gradational soils on alluvium (profiles 552, 517) include soils defined as the Merriang Series (Newell 1970) and other soils of Newell's Group 2.

Surface soils are greyish brown fine sandy loams or silty loams about 15 cm deep, which may be moderately structured but are more usually apedal. Below the paler A_2 horizon the colour gradually becomes reddish brown and the texture becomes more clayey. The B horizons are typically apedal, but may be weakly structured, and are earthy and porous. Gravel may occur at relatively shallow depth (for example, at 55 cm in profile 552).

Reactions are moderately to strongly acid. Analytical data for Merriang and Eurobin Series soils are presented by Newell (1970).

The parent materials are usually medium-textured alluvium along the main streams and on low-gradient alluvial fans along the valley sides. Because their distribution is widespread but fragmentary, these soils seldom cover a large area in any one locality. They are used for tobacco-growing or pastures.

9. Yellowish brown gradational soils on alluvium (profile 501). The general morphology of these soils resembles that of the reddish brown gradational soils on alluvium, but they have paler A horizons and yellowish brown B horizons, which are typically mottled. They represent the more hydromorphic form of that group and are more commonly found on alluvial fans in areas of coarse-textured parent materials such as granite and rhyolite. They have a relatively limited distribution.

10. Weakly bleached reddish brown gradational soils (none sampled) are generally apedal throughout and have only slightly heavier-textured B horizons. The A_1 horizon is typically greyish brown loam or sandy loam about 10 cm thick and the A_2 horizon is distinctly paler, but not usually bleached, as defined by Northcote (1979). The change to the clay loam to light clay B horizon may take place through-an A_3 horizon in which both texture and colour are intermediate to the adjacent horizons. The B horizon has a hard consistence when dry and is moderately porous.

These soils occur on the steeper slopes of the foothills in moderate-rainfall areas in the north of the study area, mainly on Ordovician sedimentary rocks or their metamorphosed variants.

11. Weakly bleached yellowish brown gradational soils (profile 524) have similar morphology to that of the previous group, but for the yellowish brown colour of the B horizon. They are usually associated with low slopes and drainage lines; thus, they are generally less well drained than the reddish brown soils, and in the wettest situations have mottled B horizons. They also appear to be more dispersible.

The profile sampled is strongly acid and has moderate base unsaturation.

12. Friable brown gradational soils (profiles 367, 368, 506, 509, 514, 553, 556). Soils in this group, together with the next, constitute the most widespread in the mountainous higher-rainfall parts of the study area. They occur on a range of rock types but their most consistent expression is on the predominantly fine-grained Ordovician sedimentary rocks. On the Carboniferous rocks, variation in lithology seems to be the cause of variation from the modal profile form, the most common being a lack of B horizon pedality and in some situations mottling in the B horizon.

A typical profile has a prominent layer of forest litter overlying a dark brown friable loam A horizon with a strong, fine crumb to subangular blocky structure and loose to friable consistence. The organic darkening decreases with depth, and the characteristic brown colour is usually well developed by about 15 cm. The texture increases gradually to clay loam or light clay and the structure remains weak to moderate, fine subangular blocky throughout. The moist consistence is typically friable, although it may sometimes be slightly firm, particularly in soils on Carboniferous `red bed' mudstones.

In some profiles, texture increases only slightly with depth. Colours may be more yellowish but are rarely mottled, and then usually because of a local drainage impedance.

Fragments of parent material are commonly present and may be abundant — the profile is then more properly termed a stony loam soil. Depth is usually between 1 and 2 m, but the bedrock junction may be very irregular.

These soils have high surface porosity and high permeability throughout, which results in a high capability to absorb run-off. Studies in adjacent areas (Rowe 1967) have shown that they have relatively high available water capacity and total water capacity.

They are relatively poor chemically, with most of the plant nutrient ions concentrated in the surface. Reaction is acid to very acid throughout.

13. Reddish brown gradational soils with rough ped fabric (profiles 515, 516, 522, 527, 528, 531, 534, 554, 555, 563). Morphologically, these soils differ from those of the previous group mainly in the colour of the B horizon, which in this case is reddish brown to red. They are chiefly associated with less-steep slopes in areas of moderate rain-fall, particularly the alluvial fans and colluvial footslopes of the upper valleys and dissected plateaux.

Although occurring on most of the rock types in the study area, the soils are most common on colluvium derived from Ordovician mudstones and shales. They are rare on coarse-grained rocks.

The typical profile consists of a dark greyish brown loam up to 10 cm deep with loose consistence and strong fine structure, below which the colour changes through brown to dark reddish brown, red or yellowish red and the texture gradually increases to clay loam or light clay. The structure of the B horizon is usually weak to moderate, fine to medium subangular blocky and consistence slightly firm to firm. Rough ped fabric distinguishes these soils from those of the next group.

Profile depths are typically greater than 1.5 m and may exceed 2 m. Fragments of parent rock may occur throughout the profile and become more abundant with depth.

Although permeability is high, these soils probably do not drain as freely as the friable brown gradational soils and appear to compact more readily.

Chemically, the reddish brown gradational soils seem to be slightly more fertile than the previous group as they have higher base saturation, although similarities are apparent in their acidity and most of the plant nutrient ions are concentrated in the surface soil.

14. Reddish brown gradational soils with smooth ped fabric (profiles 557, 559) have a more strongly developed B horizon structure relative to the previous group, and smooth ped faces predominate. The consistence of the B horizon is also usually firm.

They are associated with relatively old surfaces such as plateaux and relict fans in areas of moderately high rainfall, and occur on well-weathered parent materials. In the study area they have been recorded on Ordovician sedimentary rocks, rhyodacite and Carboniferous mudstone.

The typical profile has a texture gradation from a clay loam to a light clay. Organic matter darkens the colour of the A horizon to very dark brown or dark reddish brown, while the B horizon colour is typically dark reddish brown to dark red. The structure is moderate to strong throughout and in the B horizon is fine to medium subangular blocky. The porosity is generally low, although permeability is probably moderately high because of the good structure.

These acid soils have moderately high base unsaturation, and appear to have similar levels of plant nutrient ions to the reddish brown gradational soils with rough ped fabric.

Red duplex soils are widespread on the gently sloping landscapes in northern valleys.

15. Red gradational soils on basalt (profiles 508, 513, 560). Although these soils are similar morphologically to those of the previous group, they are separated because of their higher chemical fertility. The surface soil to about 10 cm depth is usually dark brown clay loam with strongly developed fine subangular blocky structure and firm consistence. The colour gradually changes with increasing depth to reddish brown or even dark red (2.5 YR 3/6) and the texture becomes a clay. The structure in the B horizon is well developed, fine to medium subangular blocky, and consistence is firm. Typically the peds are dense and have smooth surfaces. Weathered rock is seldom encountered at depths less than 1.5 m, although floaters of rock may occur at shallower depths.

Soil reaction is very acid, with pH values as low as 4.4 recorded in profile 513. They have relatively high cation exchange capacity and moderately high base saturation. Calcium is the dominant ex-changeable cation and magnesium is also present in appreciable amounts. Levels of phosphorus in the HCl extract are relatively high, as is common in soils formed on basalt.

These soils mainly occur on areas of basalt in the south-west of the catchment at intermediate elevations where rainfall is generally moderately high and summer temperatures are mild. They are used mainly for pastures, although some are used for potato-growing.

Duplex soils

Duplex soils have a textural contrast of one and a half texture groups or greater between the A and B horizons. The horizon boundary should be clear to sharp, with change from the bottom of the A horizon to the top of the main B horizon occurring over a vertical interval of 10 cm or less (Northcote 1979).

Soils of this division are sometimes referred to as texture-contrast soils and have been variously termed podzolic or solodic soils (for example, Rowe 1967, Gibbons and Downes 1964).

Within the survey area, the three main groups listed below have been recognised, two with predominantly reddish brown clay subsoils and the other with yellowish brown clay subsoils.

16. Red duplex soils with smooth ped fabric (pro-files 507, 520, 521, 530) are distinctive because of the contrast in colour, texture and structure between the A and B horizons. Surface textures are usually loams or sandy loams, and the top 10 cm is darkened with organic matter. The A_2 is characteristically much paler, although seldom bleached according to Northcote (1979). The A-B boundary commonly lies at about 25 to 30 cm and is clear to abrupt.

The structure of the B horizon is typically strongly developed fine to medium subangular blocky, with a tendency for smooth ped surfaces to predominate. Some soils may have a mottled zone at the base of the profile where drainage is impeded.

These soils are most common on deep alluvial-colluvial deposits, and are therefore usually fairly deep. However, weathered rock may occur at depths of 1 m or less in soils on steeper hill-slopes.

Profiles are acid throughout, with pH values usually slightly lower in the subsoil than at the surface. Cation exchange capacity is moderate in the A_1 horizon but low in the A_2 and increases again in the B horizon. Base saturation is usually higher than 50% at the surface, but may be down to 30^{0}7o in the B horizon, where values for phosphorus in the HCl extract are about the average level for the other soils in the catchment (other than basaltic soils) but where potassium values are relatively high.

A notable feature is the pronounced increase in the proportion of exchangeable magnesium in the lower part of those profiles sampled.

Red duplex soils are the most widespread soils in the rolling to hilly valley landscapes in the north of the survey area, where annual rainfall ranges from about 700 to 900 mm. They occur on a range of rock types and particularly on alluvial-colluvial fans and high terraces in the valleys.

They are used extensively for agriculture — mainly for pasture production but sometimes also for tobacco-growing.

The Randelong and Buffalo Series of Newell (1970) are included with these soils.

17. Red duplex soils with rough ped fabric (profile 558) differ from the former group in that the texture contrast between the A and B horizons is less pronounced, the structure of the B horizon is less well developed and the peds have predominantly rough surfaces.

They occur on intermediate-level terraces and alluvial fans of presumably similar age in the north.

The only profile sampled has an acid reaction and moderate base saturation in the B horizon.

Some of the Series 2 soils of Newell (1970) are included with these soils.

18. Yellowish brown duplex soils (profiles 519, 523) have similar general profile morphology to those of group 17, except for the yellowish brown B horizon. Occasionally they may have mottled yellowish brown subsoils. They are typically associated with areas of impeded drainage, which may be due to the topographic setting but may also be influenced by the presence of a substratum of low permeability, such as weathered massive igneous rock.

Reactions are usually quite acid in the upper horizons, but may be neutral to alkaline at depth, and small concretions of lime may occur in the more alkaline subsoils. These soils occur mainly in the valley landscapes, where they are associated with drainage lines and other areas of impeded drainage.

They are not very extensive, and are usually used for pastures or remain unused. The coarse-structured yellowish brown gradational soils with acid to neutral subsoil in the Kiewa valley described by Rowe (1972) and referred to by Rowe *et al.* (1978) do not appear to extend as far south as the study area.

Organic soils

These soils are dominated by plant remains: the surface 30 cm contains 20% or more organic matter if the clay content of the fine earth is 15% or lower, or 30% or more if the clay content of fine earth exceeds 15%. The organic matter should equal or exceed the stated amounts at all depths down to and including 30 cm (Northcote 1979).

The three groups recognised in this study are all peaty soils and none are of very great extent.

19. Wet peat soils (profile 535) consist of decomposed and partly decomposed plant remains. Generally, they still show the fabric of the plant material, but where decomposition is well advanced may be dark-coloured and have a greasy feel. They are very acid soils and are high in organic matter.

Their distribution in this catchment is limited to permanently wet areas at high elevation.

20. Dry peat soils (profile 537) are dark, highly organic soils in which plant roots and other plant remains form a major component. They occur on shelving rock and are therefore relatively shallow. They usually contain a mineral fraction, which appears to have accumulated by accession rather than by incorporation from the substrata.

The data from the one profile sampled indicate low pH values and generally low chemical fertility, but high organic matter content.

Dry peats have a limited occurrence on areas of shelving rock, such as are common in areas of rhyolite and granite but also in areas of Carboniferous sedimentary rock. They are generally found at intermediate elevations that receive moderate rainfall (1000 to 1500 mm). These soils serve the useful function of absorbing rainfall on areas that would otherwise produce rapid surface run-off. Their stability depends on the anchorage of the roots of shrubs growing in them.

21. Humified peat soils (profiles 370, 533). In these soils, little of the original plant material remains apparent. They resemble the organic loams in that they are black and highly organic, and have a highly developed crumb structure. However, they have higher organic matter content and occur in situations where wet peat could have been expected. They may have stream gravel, sand or silt at the base of the profile. Humification has presumably occurred following the lowering of a local water table.

Data for the profiles sampled indicate that they are very acid and generally of low chemical fertility.

The peats have limited extent and occur only at high elevations, where the nature of the climate and the physiographic setting appear to be the main pedogenetic influences.