

SOIL TYPES AND DESCRIPTIONS

General soil type descriptions

During the initial exploration of the catchments and subsequently fieldwork a number of soil types were identified. Firstly, there are the red gradational colluvial soils, mainly covered by the Mountain Ash vegetation association. In most cases these soils were located on southerly slopes, particularly lower slopes and drainage lines, and are associated with the moister areas within the catchments. These soils are characteristically well-structured. Due to the moist nature of the topography associated with this soil type, and the moist characteristics of this soil type compared with the other soils in the area, this soil type is designated as 'wet', reflecting the general moisture regime, the term 'wet' is used in the name of this group of soils.

Secondly, there are the brown gradational and forest brown soils which are generally juxtaposed to the red gradational soils, usually in slightly drier positions and as a transitional away from the wettest micro-climate in the area to the driest. These soils are generally well structured, due to their occurrence in a moist environment. However often there is less soil development, as indicated by soil depth, and therefore as part of a transition to drier soil/vegetation regime this soil type is described as (wet) transitional.

Thirdly, there are the skeletal stony soils with well-structured B horizons grading into the "parent material" occupying the ridge crests and northerly slopes. These soils have poorly developed shall A horizons and structure ranges from weak to moderately well structured. Due to topographical position and general moisture status these soils are designated as 'dry' soils.

Fourthly, there are the 'dry' transitional soils which occupy the slightly wetter northerly or westerly slopes, particularly the lower slopes and ridges. These soils are similar to the skeletal stony soils on the upper slopes but are usually deeper and exhibit greater profile development and oxidation and increased surface organic matter. The transition between the 'dry' transitional and brown gradational ('wet' transitional) soils is generally abrupt due to moisture and exposure (i.e. aspect) differences.

Other soils identified include organic colluvial soils with varying amounts of clay content, often found as deposits adjacent to and within gullies, as well as organic gley and gley soils which are restricted to gully floors nearer the weirs and much denser than the organic colluvial soils. See table 4.

Detailed soil type descriptions

1. Red gradational ('wet') soils

These soils are characterised by brown/red to red mineral horizons (Hue 7.5YR – 2.5YR) with brown organic a horizons of varying depth, depending on topographic position, slope, aspect and exposure. Those soils on gentler lower slopes have a greater accumulation of surface organic matter which is broken down faster than at drier sites. As an example site 70 (fig 6) has the next 20 cm is a mineral horizon with a high organic matter content which then grades into the mineral B horizon.

Soil depth

Though difficult to ascertain in the field, soil depth was an important classificatory factor between soil types. The red gradational soils often found on colluvium are the deepest soils in the area and sustain the tallest and densest vegetation cover. Depth ranges from at least 1 metre to in excess of 3 metres. It was not possible to determine maximum depths due to technical and time constraints.

Field texture and laboratory mechanical analysis

This soil type grades from an organic loam/silty loam with increasing fine particle content to clay loam, silty clay loam, light clay and light-medium to medium clay and silty clay. Occasional increases in silt content were noted.

Stoniness

Stoniness is generally low in these soils (<5%) appearing mainly as sub-angular pieces of fragmented fine sandstone, usually partially weathered. The siltstone and claystone appears to break down quite rapidly leaving the more resistant fragmented sandstone to weather in the already well-developed solum. Stoniness increases on those ridges and crests occupied by this soil type.

Structure

Nearly all soils within the study area have well-structured mineral horizons. The surface material has a crumb structure becoming fine blocky with increasing depth. The main a horizon is moderately well structured and the B horizons are well structured.

The structural form down the profiles changes from crumb to slightly sub-angular blocky to fine-medium sub-angular blocky to fine angular blocky (<5 mm) at depth. There is often a mixture between sub-angular and angular blocky peds in the B horizons.

A key characteristic of this soil type is the friability of the solum breaking up into fine peds. However, when moist and particularly in the B horizon, disturbance reduces this friability and breaks up structure. This effect is due to the increased 'stickiness' of the moist horizons.

As the structure changes down the soil profile so does the fabric, changing from 'earthy' on the surface and upper horizons to rough ped or smooth ped at depth depending on the type of soil structure and the proportion of clay.

The **consistency** of the soil ranges from loose to soft at the surface and slightly plastic to plastic in the denser B horizons at depth. The latter property is particularly noticeable with moist horizons.

Appendix 4 gives an indication of clay distribution in the representative soil profiles. The above properties are also shown in other indices to be discussed i.e. bulk density.

Drainage

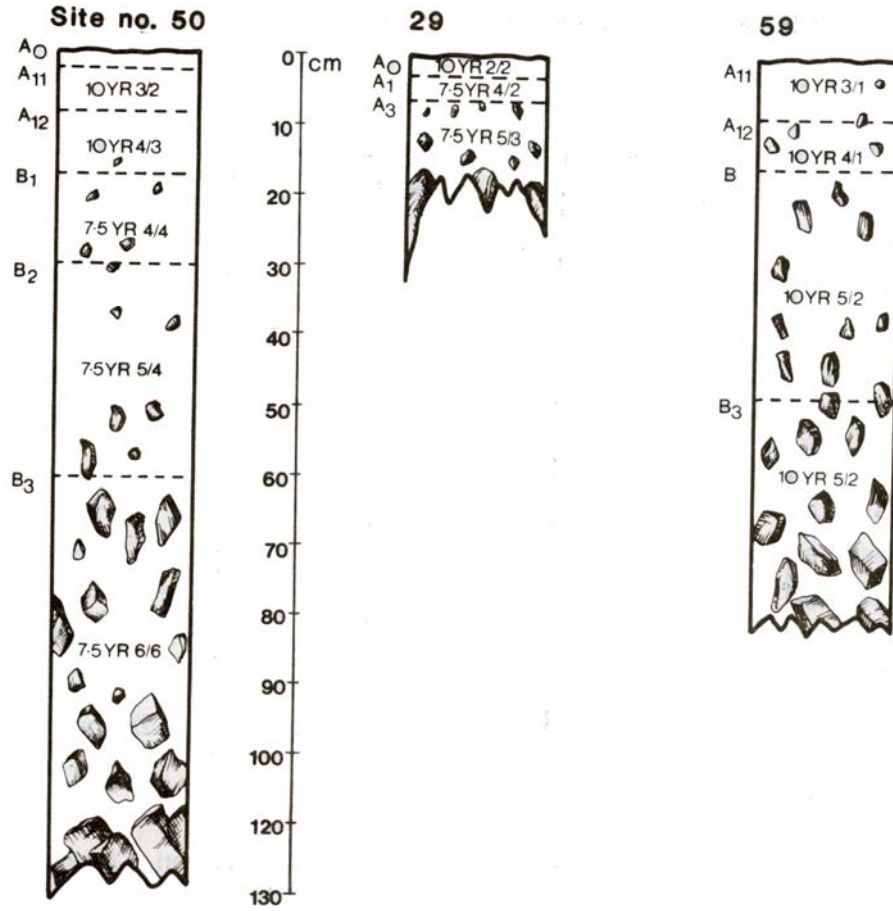
Site drainage refers to the ability of the soil to drain given its topographical position and is influenced by soil permeability, slope steepness and slope shape. Site drainage is poor in gullies and on gentler lower slopes but better on crests and upper slopes.

Permeability

Given the position of the soil site, the inherent ability of the soil to drain is also important. Assessment of permeability relies on visual inspection of the profile to determine the degree soil structure, the amount of organic matter and the presence of root channels and voids. Permeability is generally moderate, sometimes moderately rapid, in the 20-50 cm depth range. It decreases to moderately slow, occasionally slow or moderate lower in the profile (see Infiltration and Hydraulic Conductivity Section).

A number of factors are important in this assessment, notably structure, texture, pore space and the degree of mottling. The absence of mottles together with well-developed soil structure are important indicators of more rapid rates of permeability as is the presence of adequate pore space. Permeability in forest soils is also greatly affected by tree-root networks and biological activity, providing flow paths for water. Well developed soil structure has a similar effect. A more detailed survey of the inherent permeability for all soil types is given in the Infiltration and Hydraulic Conductivity Section.

(Dry) transitional soil : Yellow brown / brown gradational



Dry soil : Shallow, yellow brown gradational

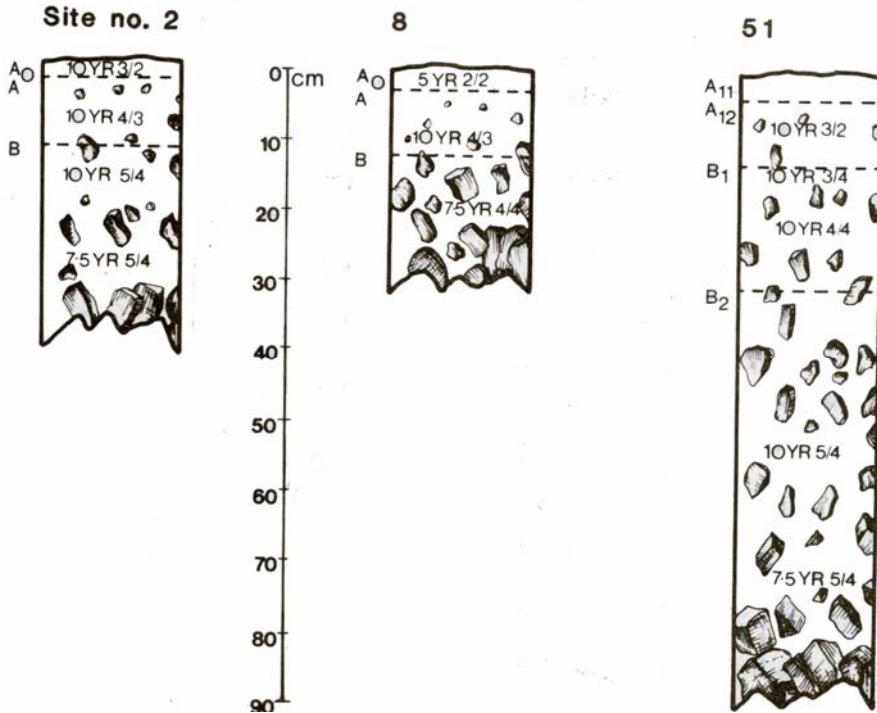
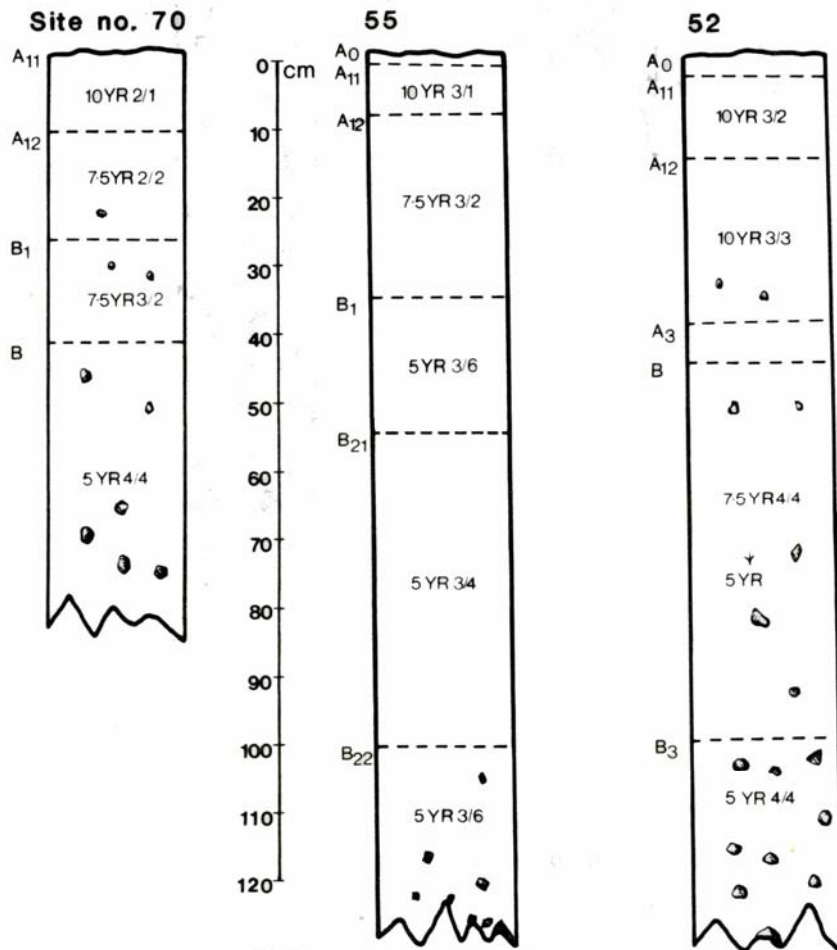


Figure 6 - Soil profile examples for each soil type

Wet soil : Red gradational



(Wet) transitional soil : Brown gradational

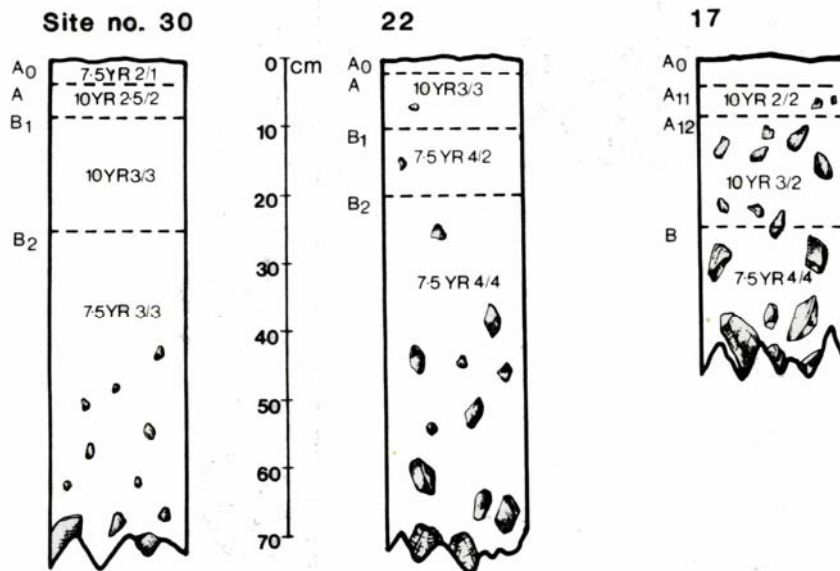


Figure 6 – Soil profile examples for each soil type

Table 4: Soil type characteristics summary

(i) Topographical characteristics

Soil type and moisture regime	Aspect	Topographical position
'Wet'	Southerly	Lower and mid-slopes.
('Wet') Transitional	Southerly, easterly, westerly	Middle, lower and upper slopes.
('Dry') Transitional	Northerly, westerly, easterly	Middle, upper and lower slopes.
'Dry'	Northerly	Upper slopes and crests.
Organic	Various	Lower slopes and drainage lines.
Gley		Drainage lines

(ii) Soil characteristics

Soil type and moisture regime	Total	Depth	Structure		Stone (%) B horizon	Colour B horizon
			A Horizon	horizon		
'Wet'	1-3m+	Deep		A; mod. Strong B; strong	Friable Friable	<8 5YR3/6
('Wet') Transitional	1-2m+	Mod. Deep.		A; mod. Strong B; mod. Strong	Friable Friable	<10 7.5YR4/4 5YR4/4
('Dry') Transitional	1m	Shallow-moderate		A; moderate B; strong	Friable Hardsetting	20 7.5YR5/4
'Dry'	<1m	Shallow		A; weak-moderate B; strong	Hardsetting Hardsetting	25-30 10YR5/4
Organic	0 2m	Deep		A; moderate B; strong	Friable Friable	variable 10YR2/1
Gley	0 2m+	Shallow-moderate		A; moderate B; moderate	Friable plastic plastic	<15 10YR5/4 +mottles (red/yellow)

The root and biological activity have left channels through the soil. As a result, organic matter and other material from higher in the profile has filled these channels, forming pseudokarsts and organic coatings on peds (cutans).

At depth (>2 m) it has been noted that mottling does occur within the B3 (B/C) horizon. This may be due to waterlogging but also can indicate weathering of primary minerals in the parent material.

Hazards

Due to the rough nature of the soil surface it is difficult to establish whether there are any widespread accelerated erosion on this soil type. On the steeper slopes there is evidence of slope wash and creep.

There seems to have been little mass movement, through evidence of at least one slip was noted. Accelerated movement of surface material seems partly due to past tree felling operations and was also noted near the roots of trees downed by wind-throw on steeper slopes. Surface movement of material on hill slopes is similar for all soil types through a greater depth of material occurs on the wetter sites which may be due to a more pronounced weathering conditions. Accumulation of surface material forms a superficial terracettes which act to absorb moisture and also trap moving soil material resulting from sheet erosion. These are often separated by bare soil exposures. Soil movement is also indicated by the vertical position of trees (particularly young trees) and the loss of soil at the downslope base of trees.

Soil material tested in the field exhibited very little dispersion but slaking of peds was noted. Refer to the Erodibility Section for further analyses.

2. Brown Gradational and Forest Brown ('Wet' transitional) soils

These soils are characterised by dark organic upper horizons (which may not be as well developed as on the red-gradational soils on wetter sites) and brown to reddish-brown sub soils are also characteristic (Hu 7.5YR). The typical Factual Key is Gn 4.31 and there is no significant mottling.

Typical Colour sequence; Site 30

Horizon	A ₀	A ₁	B ₁	B ₂
Hue	7.5YR2/1	10YR2.5/2	10YR3/3	7.5YR3/3

Depth

Soil depth varies but is generally shallower than the red gradational soils, due to weathering and topographic position. Profiles are usually about 1 metre deep and the soil may be deeper if topographic factors allow.

Field Texture

These are similar to the texture ranges of the red/brown gradational soils, the lower horizons are light clays tending to light-medium and therefore slightly lighter than the more developed ('wet') soil surface organic content is usually high.

Stoniness

These are a few stones in the upper horizons but stoniness increases down the profile. Stoniness is also influenced by the position of the soil site i.e. there are more stones in soils on ridges. The underlying rock strata are also a consideration and differences in soil structure and texture result from variation in rock types which ranges from moderately thick beds of sandstone to thinly bedded siltstone and claystone.

Structure

Surface horizons are weakly structured with an open tilth but the main A and B horizons are well-structured. The soil structure form is a sub-angular blocky, very occasionally tending to angular blocky with depth. The **fabric** consists of rough-faced peds.

The **consistency** ranges from loose at the surface to slightly hard and hard at depth, particularly when dry. However these soils still have the friable characteristic of the red gradational (wet) soils.

Drainage

Site drainage varies with the soil type and position in the landscape but generally is moderately well drained.

Permeability ranges from rapid at the surface to moderately in the 25-50 cm depth range, and moderately slow at depth. As there is little or no mottling except for some organic staining and soil structure is well-developed, these soils are generally well drained.

Hazards

The hazards for this soil group are similar to those for red gradational soils. Slope wash and creep or surface material and upper horizons are the most common forms of erosion, particularly on the steeper slopes. Field tests of soil stability indicate only slight dispersion increasing a little in the sub-soil. Slaking also increases with depth from slight to medium in the sub-soil. The B horizons break down into individual peds relatively rapidly, hence their medium slaking values. These soils are acidic with little change through the profile apart from the surface organic matter and the gradual textural change.

3. Skeletal, stony ('Dry', Lithosol) soils

These soils represent the dries extreme of soils in the study areas and are referred to as "Dry" soils.

Surface and organic horizons are normally very shallow overlie stony mineral horizons. The sub-soil (B horizon) has a brown/yellow brown hue when moist (7.5 YR – 10YR), paler than other soil types; typical colours are 7.5 YR/4YR and 10YR/4. Upper horizons usually have yellow brown hues (10YR).

Soil depth

Soil depth varies according to the position of the soil site and is usually between 40 cm - 1 metre in depth. The depth also depends on the degree of parent material weathering and the gradation between soil and rock. There is a thin organic surface horizon (2-3 cm) overlying a thin A horizon (10 cm thickness) which grades into the well structured B horizon to approximately 60 cm.

Field Texture

The surface horizon is an organic sandy loam. The A horizon are (silty) loams, grading to light clay loams and silty clay loams which grade into heavy clay loam, light clay or light-medium clay B horizons.

Stoniness

Stoniness generally increases with depth although a veneer of surface stone was fairly common. The A Horizons have a 'medium' stone content, about 15% by volume, of sub-angular sandstone up to 5 cm across. This increases with depth, usually to 30% by volume, sub-angular to angular sandstone up to 8 cm across. Stoniness is particularly marked in the

lower catchments (1, 2 and 3) where this soil is dominant (see profiles fig. 6). Ridges and crests in these catchments were particularly stony.

Structure

The surface horizon consists of a humus layer with little structure. The A horizons are weakly to moderately structured and B horizons are moderate to moderately strongly structured. Peds are usually larger for the A horizons whereas the B horizons have finer peds. The peds are sub-angular and blocky but occasionally angular. Peds are rough faced.

The **consistency** varies from loose at the surface, slightly hard when dry for the A horizon and hard when dry for the B horizon through there are minor variations. This soil type is more **hardsetting** than the other soil types, especially as the upper horizons have less structure and are often exposed. The lower (B) horizons are also hard when dry. The difference between the friability for the two extreme soil types in the area is illustrated by Fig 7 and plates 3 and 4. This is an examples of an upper drainage line where a 'dry' soil is overlying a developing 'wet' soil. The latter it is believed will eventually dominate downslope. It is also notable that the rock strata dip down giving this upper drainage head a deep profile despite its elevation.

Drainage

Site drainage for this type varies, but generally water is shed, often rapidly from areas with this soil type.

Permeability for the upper soil horizons was difficult to assess due to the thinness of the horizons but was estimated at between moderate and rapid, despite the weaker structure. The presence of stones gives possible lines of moisture penetration partly off-setting the lower level of biological activity.

The permeability of the lower horizons was estimated as moderate, helped by the greater soil structure and movement along stone faces. It is evident that water is penetrating the parent material and passing along and through the rock structure as clay skins on rock structure (cleavages) would indicate. However the large volume of stone and weathered parent material in the structured B horizon will significantly reduce the available water capacity in this soil.

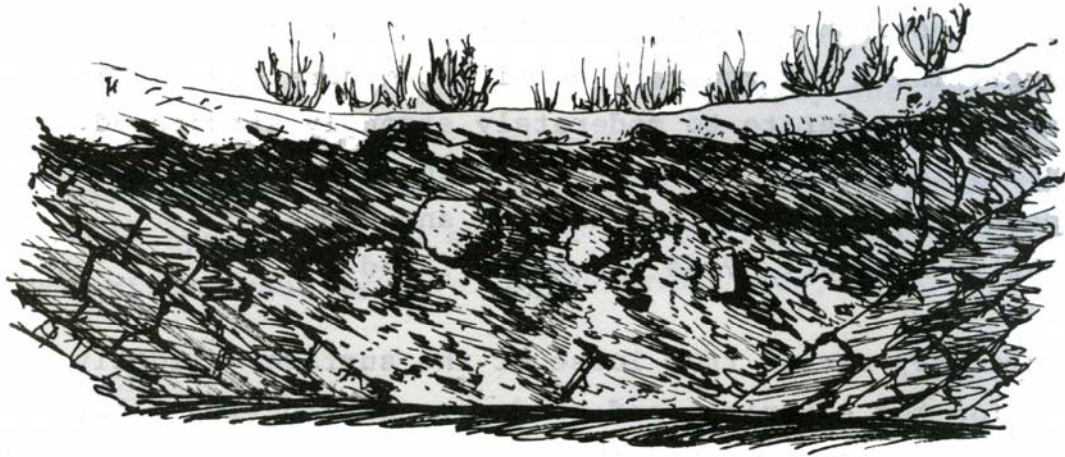
Hazards

Sheet-wash and creep are particularly noticeable on this soil type as evidenced by the shallow surface horizons, especially the steeper upper slopes. The B horizon is often exposed and presumably logging activities have aggravated this condition. Organic accumulation is much slower on this soil type than for the 'wet' soil. The degree of ground cover is also a significant hazard factor despite tree and shrub canopies. Dispersion and slaking are only slight for surface horizons but the soil is susceptible to detachment due to the velocity of run-off, the steep slopes and exposure. The lower (B) horizons have low dispersions and moderate slaking properties. For further analysis see the 'Erodibility' section.

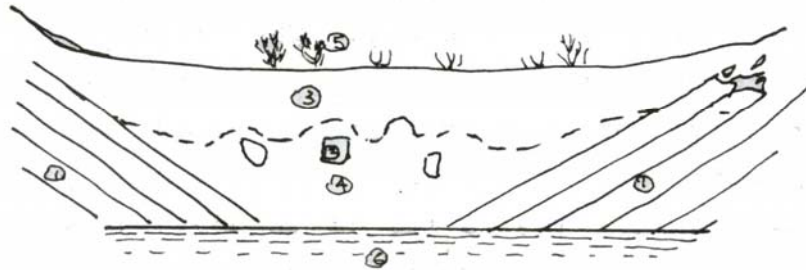
4. Yellow Brown/Brown Gradational ('Dry' transitional) soils

These soils are similar to the 'dry' soils but are usually more developed (i.e. deeper) and have lower topographical positions or are located on wetter ridges and crests, as in catchment 6. These soils are therefore called (dry) transitional soils in their relation to the total moisture regime of the area.

The upper horizons have a greater proportion of organic material and darker in colour i.e. 10YR2/2. The lower horizons have a brown hue (7.5YR) but are not as pale as the 'dry' soils. Factual keys are gradational; Gn 4.31, Gn 4.51.



see Plate 3



KEY

1. Dipping strata
2. Rock floaters.
3. Upper "dry" soil.
4. Developing "wet"
5. Dry vegetation.
6. Road.

Figure 7 – Road exposure, upper drainage line, catchment 5



Plate 3 – Site 31: Upper drainage line profile



Plate 4 – Site 31: Sample peds for each horizon

Depth

Apart from possible organic accumulation and possible greater oxidation in the sub-soil, a characteristic of the 'dry' transitional soil is that it is deeper and more developed than the 'dry' soil proper. The example quoted below (site 50, see fig. 6) has a deeper, more defined B horizon with a heavier texture which is more a characteristic of a 'wet' soil.

Texture (Field)

Textures range from a light organic loam, at the surface to silty clay at depth. For example, site 50: light organic loam – sandy clay loam, fine sandy clay loam grades into the lower horizons of light/medium clay – medium clay – silty clay. (see fig 6.)

There are other variants of this gradation especially the fine sand/silty component which is more characteristic of the drier soil than of the wet soils. The slight trend to a lighter texture for the lowest horizon of the given example is most likely due to the presence of less weathered parent material.

Stoniness

Stoniness is generally lower than that for the 'dry' soil but till high, particularly in the lower horizons where 20% by volume is common.

Structure

Structure varies from weak for the surface horizon to medium to strongly structured at depth, the peds being sub-angular blocky throughout though some angular blocky ped may occur. In most cases the soil **fabric** is rough ped except for the earthy fabric of the surface layer.

The **consistency** of the soil ranges from loose at the surface to slightly hard and hard at depth when the soil is dry. This soil type is also hardsetting.

Drainage

Site drainage for the type varies according to topographical position but is generally water-shedding and therefore well-drained to excessively drained.

Permeability is similar to the dry soil though a deeper A horizon would indicate a greater water holding capacity than for the 'dry' soil. Permeability ranges from rapid/moderately rapid near the surface to moderate and moderately slow at depth. There are no indications of waterlogging in the profile.

Hazards

Slope wash and creep are the main forms of erosion, the surface horizon being the most vulnerable horizon despite relatively stable behaviour of the soil in water. The action of fauna notable scratching by lyre birds and wombats in the area, influences surface soil movement.

5. Organic soil

These soils are high in organic matter with varying amounts of clay. They are located in the incised gullies or adjacent to them, wherever the topography has allowed deposition.

These soils are either uniform or gradational (Northcote classification), developing some structure with depth depending on the proportion of clay particles present. They are typically dark in colour i.e. 10YR2/1, and may lighten with depth and increasing mineral content.

These soils are particularly permeable in the upper horizons site drainage is poor as these sites are water receiving.

Stoniness is variable due to transportation of material downslope to these sites; gully areas normally have a high surface coverage of stones and other areas may have larger blocks of sandstone eroded from the drier ridges of rock outcrops.

These soils are generally light and transportable, though stable in water. Erosion occurs as a result of undercutting and detachment mainly along the sides and heads of gullies.

6. Gley Soils

There are a few occurrences of gley soils and these are restricted to gully floors near the weirs. There is only one mappable example to date, found in catchment 1.

This is the only deposit of significance and appears to be the result of the topography which has allowed significant deposition. The deposited material appears to be derived from the surrounding dry ridges (see soils map).

The deposits are dark and mottled, indicating a fluctuating and possibly perched watertable.

Though significantly different from the other soil types, this soil is not considered to be very significant in the hydrological performance of the study area because of its limited spatial distribution.

Distribution of soil types

The distribution of soil types for each catchment is given in table 5 and fig 8. This distribution was calculated from the soil map of the study area. Map 4.

Catchment 1 is the driest catchment having a very high proportion of 'dry' soil (over 50%). Together with the 'dry' transitional soil, total 'dry' soil accounted for over 75% of the catchment.

Only 13.6% is 'wet' soil. This varies markedly with catchment 2 where there is a sharp increase in 'wet' soil but in catchment 3 the proportion of 'wet' soil drops to nearly 20%.

'Wet' soil generally increases in distribution due to the proportion of southerly aspects and size of catchment. Catchment 6 has the highest proportion of 'wet' soil (46.7%) and combined with 'wet' transitional, the proportion under 'wet' soil increases to 60% of the catchment.

Apart from catchment 1 there is a similar proportion of organic soil in all catchments. This can be related to the gully areas in each catchment. The morphology of catchment 1 is basin shaped and there is a greater area of deposition and therefore retention of organic and mineral material from the surrounding slopes.

Catchments 4 and 5 have similar proportions of each soil type; see also aspect comparison.

Table 5. Proportions of soil type per catchment. (%)

Soil Type Catchment	'Wet'		Transitional		Organic	Gley
	'Wet'	'Wet'	'Dry'	'Dry'		
1	13.6	2.5	23.6	52.2	7.0	1.1
2	28.6	17.0	12.6	37.3	4.5	
3	19.8	21.6	21.2	33.4	4.1	
4	37.0	21.2	12.0	24.7	5.1	
5	33.8	18.4	17.3	25.6	4.9	
6	46.7	14.2	11.8	21.9	5.4	
Total area	37.7	15.7	14.3	27.0	5.2	0.08

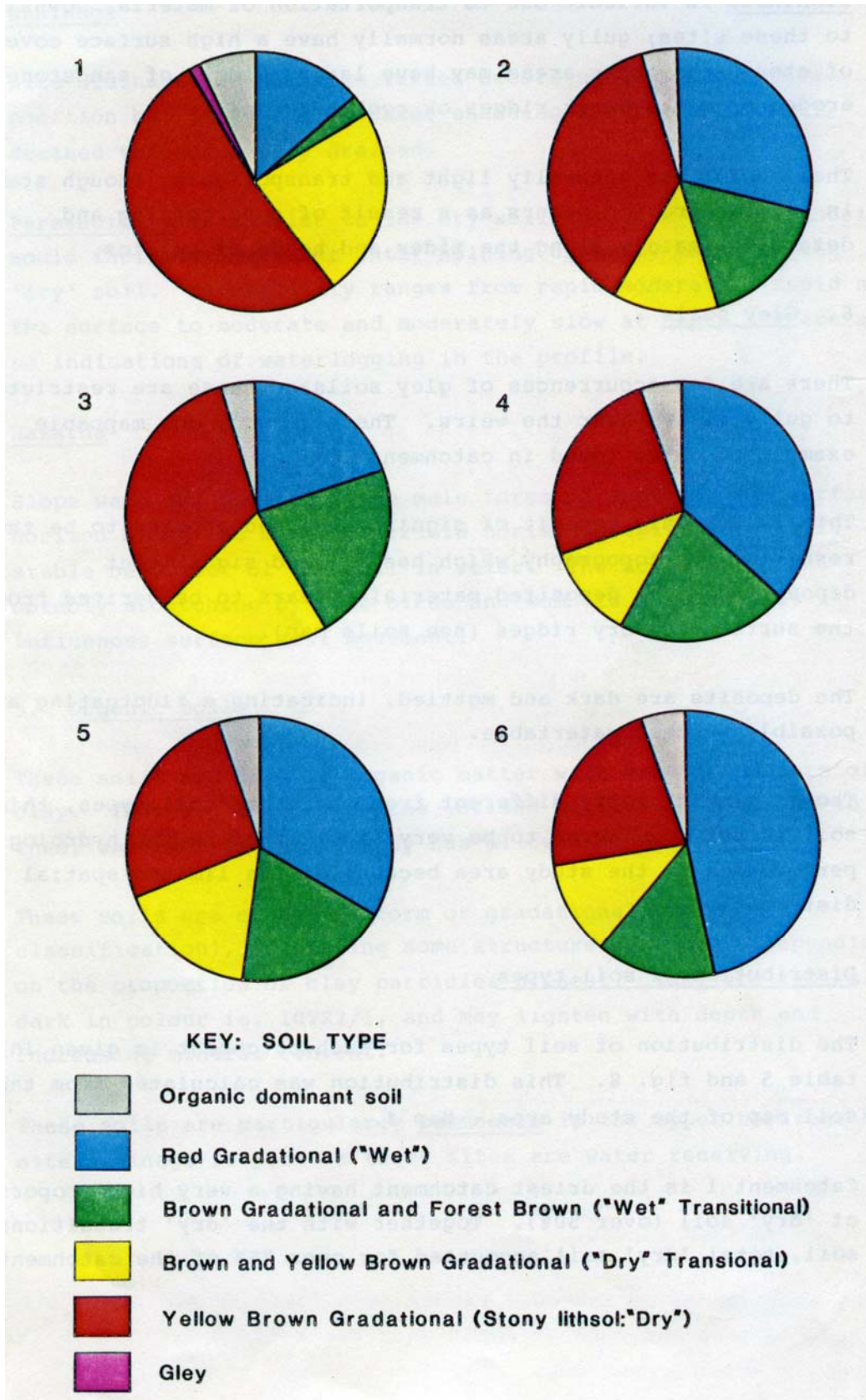


Figure 8 – Proportion of soil types in each catchment: Catchments 1-6