INTRODUCTION

The material presented in this report has been extracted from land and resource information gathered by the Soil Conservation Authority during their study of the land in the catchment of the Otways. This interim report outlines all the information collected on those land systems which lie within the Heytesbury Settlement Scheme. The tabular descriptions, and in many cases the text itself, refer to each land system as a whole, however, and not just that part which lies within the present study area.

This internal report has been compiled for the Field Division of the Soil Conservation Authority. It is intended to be of use for landholder surveys in the Settlement area, and in classifying land for more effective erosion control and catchment protection.

The methodology and theory leading to the concept of land systems has been well documented elsewhere. In brief, however, a and component is an area of land where the independent variables, climate, geology and topography and the dependant variables, soils and vegetation are constant within narrow limits. A repeatable pattern of these components in a landscape constitutes a land system, and where this pattern changes, the land system changes. The mapping units, the land systems, have been compiled in order to minimise on site difficulties in ascertaining to which component a particular piece of land belongs. However, inevitably there must occasionally be transitions and anomalies encountered at some sites.

Some explanation of the land system tabular descriptions may be in order:-

1. Areas listed have been calculated as that part of the land system lying within the Heytesbury Settlement area.
2. Component proportions have been estimated from the total area of the land system and not just part within the Heytesbury Settlement area.
3. All rainfall figures are averages and the ranges listed for annual rainfall refer to the variation within the land system.
4. All temperature figures are monthly averages derived by averaging the mean maximum and the mean minimum temperature for each month. Thus the monthly range lists the average daily temperature for the coldest month (usually July) and the average daily temperature for the warmest month (usually February).
5. Elevation lists the highest and lowest points in the land system.
6. Local relief lists the average difference in elevation between the crests of a hill and the nearest drainage lines.
7. Soil groups have been named according to a verbal Northcote description developed by the Soil Conservation Authority.
8. Permeability and Northcote classifications have only been listed where available. Further information will be collected on these parameters.
9. The last two headings – soil deterioration and management practices may need additions and alterations as more material becomes available.

It is hoped that this report will be of assistance to officers working in the Heytesbury Settlement area. Any additions or suggested alterations should be directed to the Land Studies Section.

FERGUSONS HILL LAND SYSTEM

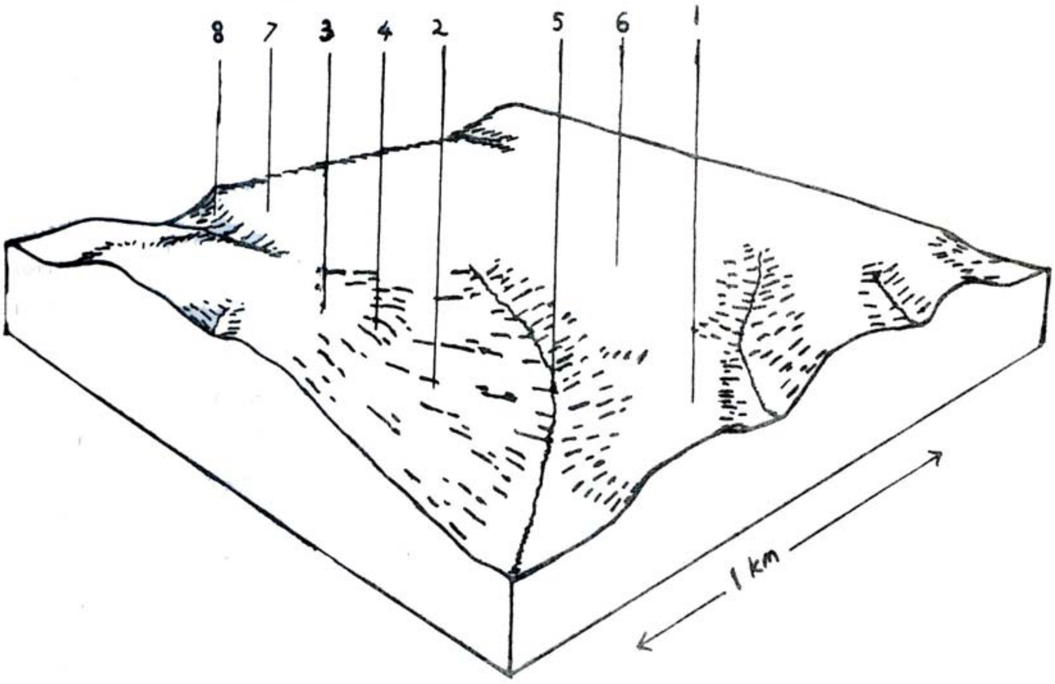
Gently dissected hills and ridges developed on outcrops of mainly finer sediments of Paleocene Age have been grouped into the Fergusons Hill land system. The soil and vegetative association have much in common with the Mt. Mackenzie land system but the topography is more subdued, and as a result management of this area presents fewer problems.

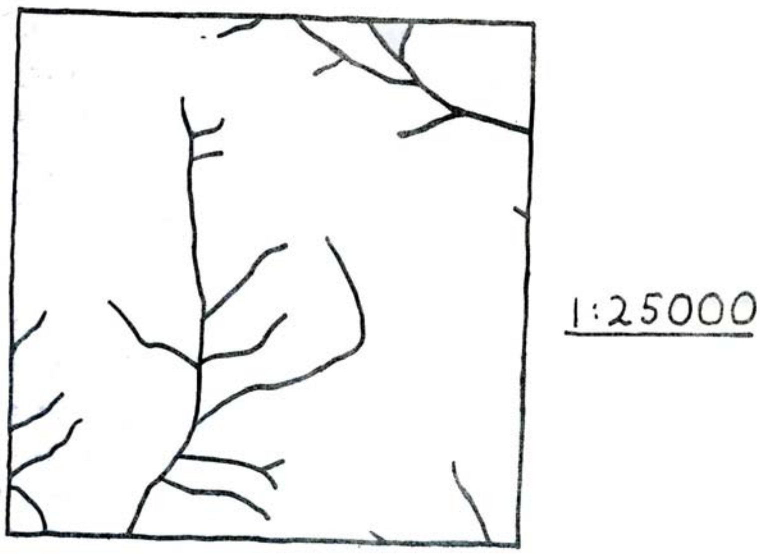
The land system is comprised of two major areas – those at Fergusons Hill and along the ridge of Pipeline Road, and several other small areas on ridges through the study area. The geomorphic history of these areas is generally similar in that they are areas of Paleocene marine sands, clays and silts of the Wangerrip Group that have escaped the deep dissection of the Mt. Mackenzie land system. The geological beds are somewhat variable and the coarseness of the material outcropping at the surface is a strong determinant of the soil that has formed on each part of the landscape. The geology has been complicated by various subsequent marine transgressions leaving variable beds of sand and clay in adjacent land systems and also occur occasionally as remnants in this land system. The absence of fossils makes interpretation of exact geological ages somewhat tentative but it is probable that some of the sands of component 3 and the clays of component 1 belong to more recent marine transgressions than the bulk of the material in the land system.

While having landscape and general land capability features in common, the separate mapped areas of the land system do exhibit different combinations and extent of the separate components. At Fergusons Hill itself component 6 dominates the landscape with components 2 and 3 being common and component 1 occupying most of the land around the periphery of the hill. Component 6 soils are members of the group of relict soils belonging to former humid and possibly warmer climates discussed elsewhere. The appearance and properties are similar to the dominant soils of the nearby Simpson land system, but only rarely are they underlain by lateritic ironstone. Thus it appears probable that at one stage these fine structured red and yellow mottled soils covered most of this landscape (except the areas where parent material is mainly sand) and subsequent geological erosion has only left remnants on the gentler parts of the landscape. The indigenous vegetation on these soils is an open forest of messmate and brown stringybark with widespread hybridisation between these two species. Bushy needlewood seems to be a strong indicator species of these soils in the understorey. Similar fertility problems are encountered here as are found in the nearby Simpson land system.

On steeper slopes coming away from these areas of component 6, younger and sandier yellow gradational soils are encountered. These are equivalent to the dominant soils of the Mt. Mackenzie land system but are found on less severe slopes in this land system. Due to the weak structure and light texture they are prone to deterioration by sheet and rill erosion and require more careful management than the previous soils. The vegetation is similar to that found in the often adjacent component 6 but brown stringybark becomes more dominant and there is frequent encroachment of peppermint species into the association.

BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE FERGUSON HILL LAND SYSTEM





Ferguson's Hill Land System

AREA: 52 Km^2

Component		1	2	3	4	5	6	7	8
Proportion %		15	20	25	4	8	15	10	2
Climate	**Rainfall mm**	Annual: 1000 – 1100 mm Monthly Range: 40 mm (Jan) – 130 mm (Aug)							
	Temperature °C	Annual: 13.0 Monthly Range: 7.5° July – 19° Feb							
	Seasonal Growth Factors	Period When Average Monthly Temperature < 10°C June → August Period When Precipitation < Potential Evapotranspiration: mid November → March							
Geology	**Age Lithology**	Marine sand, clays & silts of Paleocene age. Some small areas of Pleistocene lateritic ironstone.							
Topography	**Landscape**	Undulating hills & ridges							
	Elevation M	30 – 230							
	Local Relief M	40							
	Drainage Pattern	Dendritic							
	Drainage Density	2.4 km/km^2							
	Landform	Undulating hills							Scarps
	Position	Lower slope	Slopes	Crests	Midslopes	Swales	Crest upper slope	Crests	
	Average Slope (Range)	4% (1% - 7%)	14%(5%-37%)	5% (2% - 9%)	11%	4% (2%-9%)	4% (0% - 11%)	4% (0% - 7%)	29% (25- 37%)
	Slope Shape	Straight	Straight	Convex	Straight	Concave	Convex	Straight	Concave
Native Vegetation	**Structure Dominant Stratum**	Open forest	Open forest	Low woodland	Open forest	Open fore.	Open forest	Tall woodland	Open forest
	Species	Messmate, Swamp Gum	Brown Strin-Gybark Shin-Ing Peppermi-Nt Messmate	Shining Peppermint, Brown Stringybark	Stringybark Narrow Leav-Ed Peppermint Grey Gum Messmate	Messmate, Brown Stringy-Bark	Brown Stringybark, Messmate	Brown Stringy-Bark Messmate	Messmate, Stringybark Swamp Gum Blackwood
	Other Common Species	Red Fruit Saw Sedge, Prickly Tea Tree, Prickly Moses		Scented Paperbark Wiry Bauera Pouched Coral Fern Prickly Tea Tree S Aw Sedge, Heath Bush Pea Blackboy	Narrow Leaved Wattle, Prickly Moses, Prickly Tea Tree		Myrtle Wattle, Banksia, Bushy Needlewood, Prickly Moses, Furze Hakea, Mountain Correa, Tea Tree	Myrtle Wattle, Silver Banksia, Dusty Miller Bushy Needlewood	Prickly Moses, Dogwood, Narrow Leaved Wattle, Blanket Leaf
Soil	**Parent Material**	Unconsolidated clays & silts	Unconsolidated clays silts & sands	Unconsolidated sand	Unconsolidated sand silt & clay	Alluvial sand silt & clay	Unconsolidated clay & soil	Unconsolidated clay & silt	Colluvial lateritic ironstone
	Group	Greyish brown grad. Soils	Yellow grad. soils, weak structure	Grey sand soil with hardpan uniform text.	Red sandy loam soils uniform text.	Grey gradational soils	Mottled yellow red grad. Soil fine structure	Red grad. soil weak structure	Stony red gradational soils
	Surface Texture	Fine sandy loam	Sandy loam	Loamy sand	Sandy loam	Peaty sandy loam	Sandy loam	Sandy loam	Gravelly loamy sand
	Permeability	Moderate	Rapid	Very slow	Rapid	Slow	Moderate	Rapid	Rapid
	Av. Depth M	> 2	> 2	> 2	> 2	> 2	> 2	0.9	> 2
	Northcote Class		Gn 4.64	Uc 3.32	Uc 5.21		Gn 3.84	Gn 2.11	Gn 2.41
Land Use		Uncleared areas: hardwood forestry production, domestic water supply protection, nature conservation, gravel extraction. Cleared areas: beef cattle grazing, dairy farming, domestic water supply protection							
Hazards Of Soil Deterioration		Low hazard of erosion	Moderate hazard of sheet erosion			Low haz. gully erosion soil pugging	Low hazard of erosion		Mod. Hazard of erosion
Management Practices For Soil Conservation		Maintenance of adequate ground cover at all times of the year. Wintering of stock away from badly drained areas when waterlogged. Replacement of surface soil over disused extraction sites & revegetation with indigenous vegetation.							

Where the exposed beds contain almost exclusively sand, grey sand soils with a hardpan develop. This hardpan is normally encountered at about 0.9 metres from the surface and is usually between 0.2 metres and 1.5 metres thick. It is also variable in the degree of limitation it imposes on water and root movement into the yellow sand layer below but generally larger roots do seem to penetrate this layer quite well. These soils are generally encountered on ridges and crests in the landscape so that they are mostly well drained by water moving sideways through the bleached horizon above the somewhat impermeable hardpan. Low woodlands of peppermints and brown stringybark have usually developed on these sites despite the extremely low fertility and often excessive drainage. The ridge coming away from Fergusons Hill usually possess these soils and the accompanying vegetative associations but the sand on these sites probably originates from a later deposition than that comprising the bulk of the sediments of Fergusons Hill. The position of some of these deposits seems to suggest that they may be remnants of old beach dunes left behind as the final transgression of the Tertiary sea receded in successive stages (somewhat comparable to the recession ridges in Western Victoria and South Australia). This successive retreat of the Tertiary Sea may have been responsible for determining the NW / SE orientation of drainage line across this coastal plain – the drainage lines developing from the estuarine swamps frequently formed behind coastal dune systems.

On some of the easterly orientated ridges emanating from Fergusons Hill, uniform red sandy soils are often encountered just below the crests of the ridges. These occurrences are minor and the soils have not been studied in detail. However they support open forests of brown stringybark and other species and are probably similar in nutrient status and water holding capacity to the yellow gradational soils, weak structure. Their occurrence probably coincides with a change in the nature of the geological beds.

Around the apron of Fergusons Hill are found heavier textured soils with gradational profiles, yellow, pale red and grey mottles, medium to fine structure, a high porosity in the subsoil and an acid reaction throughout. These soils also are not widespread and this is the only part of the survey area they have been observed. It is possible that they belong to another ancient climatic regime as with the mottled yellow, red gradational soils, fine structure, which occurred somewhere between this latter regime and present time, but their equivalents to other less complicated land systems in the study area have not been correlated. Thus they have been listed as a separate soil group until more detailed surveys may correlate this group with others in nearby land systems. Drainage is moderately good and originally open forests dominated by messmate used to grow on these soils. Saw sedges in the understorey are an indication of their good water holding capacity.

In the drainage lines and on the outwash slopes of Fergusons Hill are found grey gradational soils. These young soils have moderately light textures grading from a sandy loam at the surface to a sandy clay loam at about 1 metre. Vegetation is variable depending on site drainage but generally open forests or messmate and brown stringybark persist on most sites. Soil structure is generally weak, organic matter is abundant in the surface horizons and the soil reaction is acid. The subsoils are generally quite stable so deterioration is uncommon.

Successive geological erosional periods have led to removal of large quantities of poorly structured sand material from Fergusons Hill and deposition of it in neighbouring landscapes over the top of heavier clay soils. If time has permitted sufficient weathering and leaching, hardpan layers have formed between the two different materials as described elsewhere and these soils have impeded drainage with closed scrub vegetation. Thus Fergusons Hill has also played an important part in determining the soils and vegetative association of neighbouring land systems.

The large area along Pipeline Road differs in a number of respects from Fergusons Hill. Lateritisation has taken place across this landscape and several remnants of the surface still exist. In some cases these are overlain by mottled yellow, red gradational soils, fine structured as in the Simpson land system and the adjacent Tomahawk Creek land system but generally weaker structured red gradational soil is found with lateritic ironstone forming an almost penetrable layer at about 1.5 metres below the surface. Water and roots penetrate this ironstone layer only down fissures and other irregularities, and cannot form their own paths through it as with the hardpans discussed above. These soils support quite good stands of native hardwoods which approach 30 metres height. Thus fertility levels must be moderate and drainage good.

In the north eastern part of this ridge, sandy yellow gradational soils are encountered on gentle slopes while elsewhere component 3 is encountered. There are some areas here where these sands possess very thin layers of coffee rock so that the soils are excessively drained. As such, grasstree, prickly tea tree and shining peppermint form the association with a low open woodland or open scrub structure, and these areas have a very low productivity for any form of land use other than nature conservation. Also in some areas the sediments include very coarse sands and gravel and extraction pits in very slow unless the organic surface horizons are replaced over stripped areas to provide a medium for germination. Generally these soils are highly acid, excessively drained, low is almost all plant nutrients, and easily subject to sheet and rill erosion.

On the southern side of this ridge, steep slopes lead away to the Gellibrand River some hundred metres below. Where this has exposed any lateritic ironstone remnants at the top of the hill, red gravelly gradational soils have developed and these areas have been included in this land system as component 8. These soils are equivalent to the red gravelly gradational soils of the Tomahawk Creek land system and similarly possess open forests of messmate, brown stringybark and swamp gum. They have in some areas been developed for gravel extraction and these sites also present some problems for revegetation after the sites are abandoned – topsoil layers are very thin and difficult to replace while subsoil layers provide a poor medium for germination.

Restrictions to plant growth occur during the winter months due to low temperature. Restrictions due to moisture stress vary with the widely varying moisture holding capacities of the different soils. For example the sands of component 3 would have practically no moisture holding capacity except for that water held up above the hardpan layer following rain. Thus growing seasons on these sands are likely to end fairly shortly after mid November when precipitation falls below estimated potential evapotranspiration. On the more porous and heavily textured soils of component 1, however, carryover of soil moisture is likely to extend the growing season to early January.

Some of the areas in this land system have been cleared for agriculture, but generally they are not as suitable as surrounding areas of land for more intensive uses such as dairy farming. As such most of the cleared land is used for grazing of beef cattle and it is likely that the more fertile components of the ridge along Pipeline Road will be converted into pine plantations or maintained for hardwood forestry in the future. As this ridge is within a domestic water supply catchment this is probably a more desirable form of land use than agriculture.

In summary this land is not as potentially useful for highly productive enterprises as neighbouring land systems. The economics of supplying large quantities of fertilisers to soils with low water holding capacities make them less appealing than other areas for agricultural development. The variation in site potential over short distances makes it awkward to manage the areas for forestry production.

KENNEDY'S CREEK LAND SYSTEM

Below the level of the Simpson surface and to the south of the Tomahawk Creek land system lies a moderately extensive area where evidence of any former lateritic plateau is almost completely absent. The landscape is an undulating plain with rounded crests and long straight slopes. Most of the area has been cleared for agriculture and dairy farming is the main land use. This area has been mapped as the Kennedy's Creek land system.

The geology is somewhat confused and further study is needed to decipher the exact age and formation to which these sediments belong. The area has been mapped as part of the Gellibrand marl but both the soils and the parent material are acidic. These marls are more confined to the Waarre land system where they appear to overly the acidic clays. The age of the acidic clays has been listed as Miocene in the table but they could possibly be older. Soils are in general gradational, in addition to being acidic, and have medium to heavy clay subsoils. The uncleared parts of the landscape support good quality hardwood forests.

Four separate components have been recognised in the landscape and they each appear to coincide with different periods of soil formation. Component 1 includes soils with similar physical characteristics to the most commonly encountered soil of the Simpson surface (similar structure, mottling, colour etc.). Unlike those on the Simpson surface, they overly unconsolidated marine clays, and not lateritic ironstone[*]. They are encountered on rounded convex slopes on the upper parts of the landscape and appear to coincide with one of the earlier periods of soil formation. These clays are generally prone to slaking, but have low dispersibilities and so are fairly stable to rilling and gullying. Sheet erosion can occur however in the light textured topsoils. The long periods of weathering and leaching that these soils have undergone during formation have resulted in the removal of many plant nutrients so that low level of nitrogen, phosphorus, potassium, copper and molybdenum are common.

Due to rejuvenation and dissection of this landscape most of these older soils have been removed and on long straight slopes coming away from these convex upper surfaces yellowish brown gradational soils with heavy clay subsoils have developed. In most cases, the top metre of the profile is occupied by a moderately structured younger soil reforming out of a deeper strongly structured heavy clay. These heavy clays are undoubtedly the B horizons of another group of relict soils which have formed in a climatic cycle subsequent to the one responsible for red and yellow mottled fine structured gradational soils. They are distinguished by large slickensided ped faces and shiny surfaces in a grey heavy clay with yellow mottles.

Permeability of these soils appears to be much slower than those of component 1 as is revealed by the marked increase in the number of minor drainage lines present in this part of the landscape. In addition, the heavy clay subsoils are quite dispersable and gully and tunnel erosion are quite common in these minor drainage lines. Minor landslipping is also observed on the steepest slopes, particularly in the southern parts of the land system around Valley-view road and Wiridjil road.

Good quality open forests of messmate, manna gum and scent bark are found on the uncleared areas of this component. Scent bark seems to prefer these heavy textured and slowly permeable soils and is a strong indicator species this land system. The additional occurrences of swamp gum and narrow leaved peppermint help to distinguish this component from others in the land system but these species are not always present.

On lower concave slopes, particularly in the southern parts of the land system, are found more stable and finer structured soils which appear to coincide with yet another period of soil formation subsequent to that responsible period of soil formation subsequent to that responsible for the heavy clay subsoils above. Being limited in occurrence these soils have not been examined in detail. They do not appear to pose the same management problems as the soils of component 2 although gullies may be initiated if water is artificially concentrated down minor drainage lines.

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[*] The exception to this generalisation is on the slopes north of the junction of Kennedy's Creek and the Gellibrand River. Here a layer of lateritic ironstone some 10 cm thick is commonly encountered about 1.8 metres below the surface of soils about halfway down these convex slopes. The topographic situation here is quite unlike remnants of the Simpson surface found in the Tomahawk Creek land system and it is proposed that these this remnants of lateritic ironstone may coincide with sloping extremities of the former Simpson surface.

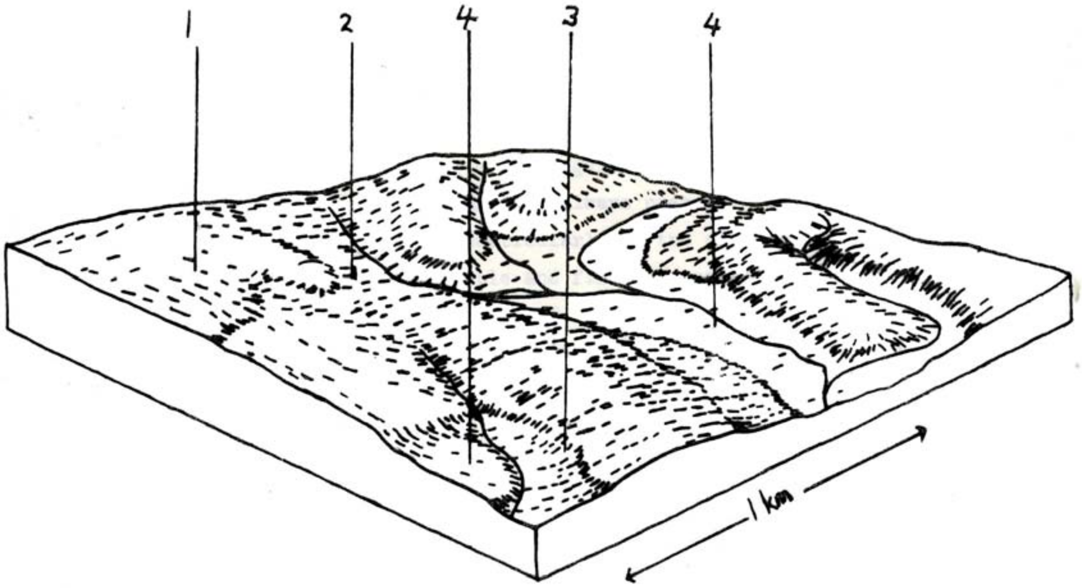
Component 4 includes all the slightly broader drainage lines with an alluvial infill. In addition, minor areas of older, alluvial terraces along the margins of Kennedy's Creek have been included in this component. There is a certain amount of variation between soils of the different terraces surrounding the major and minor creeks. These differences are again probably due to slightly different ages and periods of soil formation. However the differences are not considered to be important enough to warrant separation at this level of mapping. The soils are generally gradational and exhibit a coarse weak structure in the subsoil. Some examples of shallow gullies can be seen in the southern parts of the land system. Due to the position in the landscape, waterlogging is often a problem in winter and spring and stock should be kept away from these areas during the wet parts of the year.

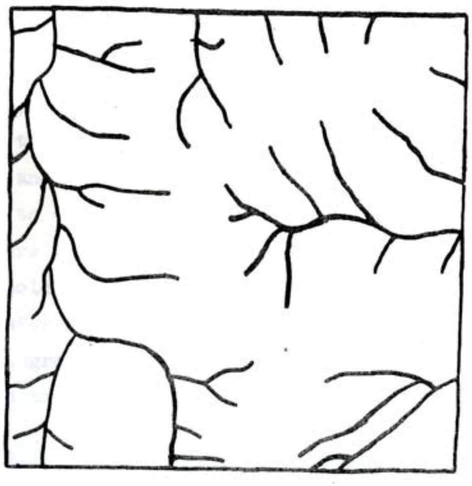
Growing seasons are difficult to estimate because of the lack of full climatic data in this vicinity. However extrapolating from the three nearest stations and making allowances for slight maritime influences, growth restrictions due to cold should be limited to June, July and August when the average temperature falls below 10^{o}C. As the soils have moderately deep clay subsoils, water holding capacities should be good. Allowing 100 mm of water for an average water holding capacity, the carryover moisture from spring into summer means that growth should be restricted by available moisture from late January till the end of March. The period of unrestricted plant growth is for the remaining 6½ months of the year.

Generally this land system has a moderate to high capability for agriculture. As previously mentioned dairy farming is the major form of land use and beef cattle grazing is common. Some areas have been reserved for hardwood forestry production.

Problems arise from the susceptibility of component 2 soils to gully erosion and the fairly low nutrient status of most of the soils. However the moderately long period of non restricted plant growth helps to maintain a high level of production from this area.

BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE KENNEDY'S CREEK LAND SYSTEM





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Kennedy's Creek Land System

AREA: 82 km^2

		1	2	3	4
Component		1	2	3	4
Proportion %		20	65	6	9
Climate	**Rainfall mm**	Annual: 950 – 1050 Monthly Range: 40 (Jan) – 130 (Aug)			
	Average Temperature °C	Annual: 12.5 Monthly Range: 8.5 – 18.0			
	Seasonal Growth Factors	Period when average monthly temperature < 10°c June – August Period when precipitation < potential evapotranspiration: November - March			
Geology	**Age** **Lithology**	Unconsolidated marine clays, silts and sands of Miocene age.			Recent alluvium
Topography	**Landscape**	Undulating plain			
	Elevation M	15 – 150			
	Local Relief M	70			
	Drainage Pattern	Predominantly dendritic with some trellis			
	Drainage Density Km/Km^2	4.0			
	Landform	Undulating plain			Alluvial terraces
	Position	Upper slopes, crests	Middle slopes	Lower slopes	
	Average Slope (Range)	9% (4-15%)	10% (4-20%)	10% (7-35%)	5% (1-9%)
	Slope Shape	Convex	Straight	Concave	(Variable-mostly straight)
Native Vegetation	**Structure** **Dominant Stratum**	Open forest	Open forest	Open forest	Woodland
	Species	Messmate, Manna Gum, Occas, Swamp Gum	Scent Bark, Manna Gum, Messmate, Narrow Leave-D Peppermint, Swamp Gum	Messmate, Narrow Leaved Peppermint, Occas, Manna Gum	Swamp Gum, Messmate, Manna Gum
	Other Common Species	Narrow Leaved Wattle, Prickly Tea Tree, Prickly Moses	Narrow Leaved Wattle, Dusty Miller, Prickly Moses, Wiry Bauera, Myrtle Wattle	Narrow Leaved Wattle, Dusty Miller, Wiry Bauera, Prickly Moses, Silver Banksia	Scented Paperbark, Prickly Tea Tree, Red Fruit Saw Sedge, Wiry Bauera
Soil	**Parent Material**	Unconsolidated clays and silts	Unconsolidated clays and silts	Unconsolidated clays and silts	Alluvial clay, Silt and sand
	Group	Mottled yellow red gradational soils, fine structure	Yellowish brown gradational soils, coarse structure	Greyish brown gradational soils	Yellowish grey gradational soils, coarse weak structure
	Surface Texture	Fine sandy loam	Fine sandy loam	Fine sandy loam	Sandy loam
	Permeability	Moderate	Slow	Moderate	Slow
	Av. Depth M	> 2	> 2	> 2	> 2
	Northcote Class	Gn 3.94	Gn 4.71		
Land Use		Cleared areas: dairy farming, beef cattle grazing, domestic water supply protection Uncleared areas: domestic water supply protection, hardwood forestry production, nature conservation			
Hazards Of Soil Deterioration		Low hazard of sheet erosion	Severe hazard of gully and tunnel erosion. Mod hazard of landslips	Low hazard of gully erosion	Mod. Haz. Of waterlogg-ing & soil pugging. Low haz. Of gully erosion.
Management Practices For Soil Conservation		Planting or maintenance of original vegetation in drainage lines disposal of dairy effluent away from existing unstable drainage lines wintering of stock away from poorly drained sites. Road batters kept to less than 1 in 3 slopes			

MT. MACKENZIE LAND SYSTEM

Surrounding the flood plain of the lower reaches of the Gellibrand River are steeply dissected hills with young weak structured soils. Most of the hills have remained uncleared and support open forests of messmate, brown stringybark and other eucalypts. These areas have been mapped as the Mt. Mackenzie land system.

The geology of the land system is unconsolidated deposits of sand, clay and silt of Paleocene age. The sediments have been included in the Dillwyn formation, but they are of quite a different nature to the marine sands found along the western margin of the Otway Ranges. Quite a moderate amount of finer material in these unconsolidated beds leads to moderately textured gradational soil profiles with sandy clay or sandy clay loam textures deep in the profiles with sandy clay or sandy clay loam textures deep in the profile below pedological influences.

The most commonly encountered soils are those of component 1 – yellow gradational soils, weak structure. Closely related are those of component 4 – red gradational soils, weak structure and together these two components comprise 65% of the land system. These soils are quite young and pedologic processes have been restricted to accumulations of organic matter at the surface, moderate leaching to produce slight but definite textural changes down the profile, and minimum weathering of the parent material to smaller clay particles. The textures normally range from loamy sands or sandy loams at the surface to sandy clay loam or light sandy clays in the subsoil. Chaotic floaters of colluvial ironstone ranging to 1 metre in diameter are common. This ironstone is though to have its source in precipitation and cementation by iron from groundwater rather than being remnants of former lateritic periods. In the southern parts of the land system, quarries exist mining extensive deposits of in situ ironstone which is far deeper than that normally former under the pedological processes in laterisation. These soils are generally well drained but fertility levels are not expected to be very high. The steep slopes on which they usually occur, pose serious problems for management, as the poor structures in the surface horizons together with moderate dispersibility means that they are easily sheet eroded.

The difference between the red and yellow forms of these closely related soils is mainly due to minerals present in the parent material. However, the red group does often seem to have a better structure and slightly more texture contrast suggesting that pedological processes have possibly been acting on these soils for longer periods of time.

In the higher position of the landscape are often found areas of coarser sediments and uniform textured sand profiles have developed. These areas are represented by components 3 and 5. They are typical of the soils and vegetation commonly found on the infertile marine sands closer to the Otway Ranges and in this land system are common only in the western parts. No observation of these components in this land system have been made within the Heytesbury Settlement area.

Component 2 represents the flatter hilltops and spurs where somewhat older soils have escaped the geological erosion responsible for the youthful soils and topography characteristic of this land system. These soils are heavier textured with medium clay B horizons and thus have higher moisture holding capacities than those discussed above. They are similar in many structural features to the dominant soils of the Kennedy's Creek land system and probably belong to the same soil forming cycle. Most of these areas outside the present study area have been cleared and sown to improved pasture for dairy farming of beef cattle grazing.

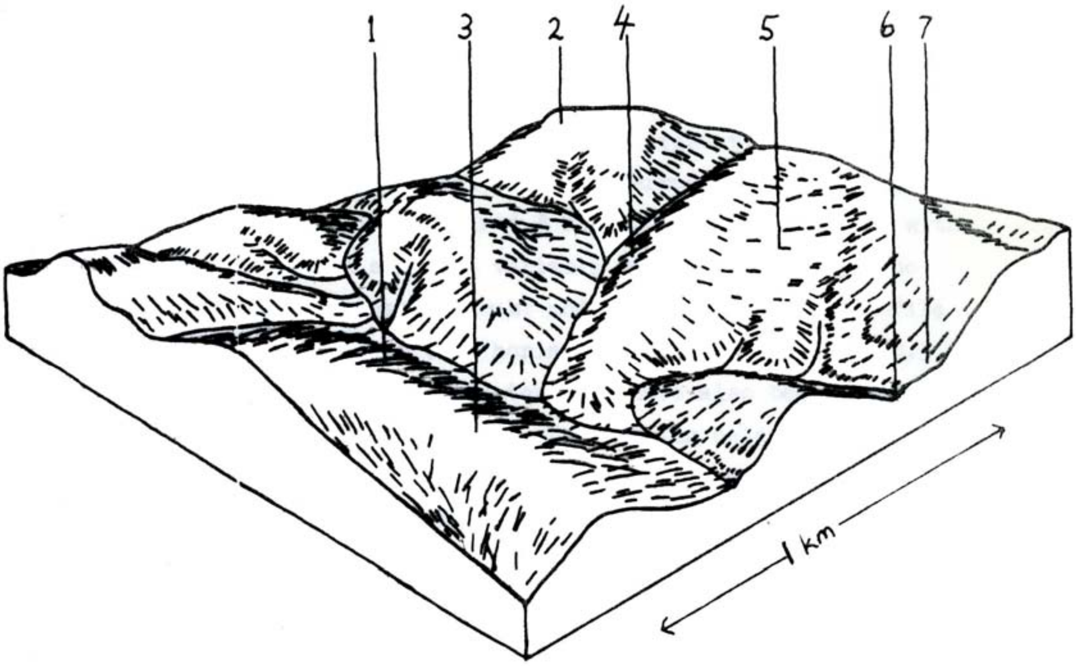
Similar soils are also found bordering the present flood plain of the Gellibrand River on dissected ancient alluvial terraces as represented by Component 7. Coarse strongly structured B horizons are again found with slickensided ped faces below somewhat variable surface horizons. The dissection of these terraces has no doubt modified the original profile quite considerably and the depth to C horizon material varies from 0.9 metre to 1.6 metre. Most of these dissected terraces have also been cleared for agriculture and often form a useful part of a farming enterprise in providing better drained areas for wintering stock away from the more fertile but often waterlogged or inundated flood plain of the Gellibrand River. The original vegetation on these heavier textured relict soils of component 2 and 7 was an open forest dominated by messmate in association with swamp gum and brown stringybark. This is in contrast to the steep hillside open forests which have brown stringybark as the dominant species.

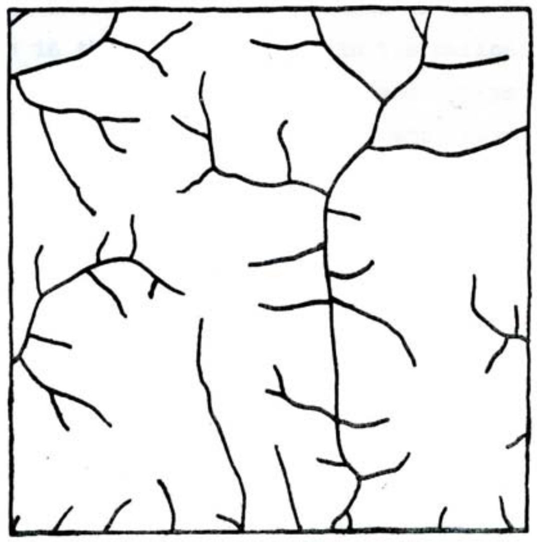
The drainage lines in this land system are generally filled with a mixture of plant remains and alluvial wash from the surrounding hills. In the steep and narrow upper reaches they usually possess yellow gradational soils, weak structure. Component 6 refers more to the lower reaches where wider and less steep drainage lines are waterlogged for most of the year and the plant remains in the solum are unable to humify. These peaty sands are not as high in organic matter as the peaty sands of the Porcupine Creek land system, though, or as in the drainage lines in the marine sand areas closer to the Otway Ranges. The peaty sands in this land system are also less acid and growth restrictions less severe as messmate and brown stringybark have often colonised these drainage lines as emergents from the open forests on adjacent slopes.

Growth restrictions from cold temperatures in this land system occur in the winter months. Growth restrictions due to moisture deficiency depend again on the moisture holding capacity of the soil. Precipitation normally falls below estimated potential evapotranspiration in mid November and the uniform sands would become dry shortly after this (except for any perched water tables maintained by hardpan layers). The weak structured gradational profiles would probably remain above field capacity until late December, but the best growing season would be found on the heavily textured coarse structured soils of components 2 and 7. Moisture restrictions on these soils would be normally confined to late January, February and March so that the total period of unrestricted plant growth would be 12-3-2½ = 6½ months of the year.

Of the total area of the Heytesbury Settlement Scheme, only very small parts lie within this land system. These have mostly been cleared and have often suffered severe sheet erosion. Of the rest of the land system, the ruggedness of the terrain renders most areas unsuitable for agricultural development. The exceptions to this are the most gentle and fertile areas represented by components 2 and 7. These are mostly cleared and used for dairy farming and some beef cattle grazing. In recent years there has been an increase in clearing of the steep hillsides for pine conversion programs. This is often initiated some serious sheet erosion and siltation problems on these poorly structured soils. As parts of the northern extremities of this land system lie within a domestic water supply catchment, any clearing operations will have a detrimental effect on water quality. Road construction on the weak structured soils of components 1, 3, 4 and 5 also presents some problems. The poor structure of the material means that small rills can quickly develop into large gullies and undermine fill batters if adequate provision is not made for disposing of runoff water. Ironstone quarries in the south do not seem to present serious problems, but some access tracks constructed straight up long steep slopes are now not trafficable due to severe rilling. Thus in general, care is needed in managing these areas and an adequate vegetation cover should be maintained wherever possible.

BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE MT. MACKENZIE LAND SYSTEM





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Mt. Mackenzie Land System

AREA: 7 Km^2

		1	2	3	4	5	6	7
Component		1	2	3	4	5	6	7
Proportion %		40	8	9	25	8	7	3
Climate	**Rainfall mm**	Annual: 950 – 1100 Monthly Range: 45 (Jan) – 120 (Aug)						
	Temperature °C	Annual: 12.5 Monthly Range: 8.0 – 18.0						
	Seasonal Growth Factors	Period When Average Monthly Temperature < 10°C June → August Period When Precipitation < Potential Evapotranspiration: Mid November → March						
Geology	**Age Lithology**	Unconsolidated marine sands, clays and silts of paleocene age						
Topography	**Landscape**	Deeply dissected hills						
	Elevation M	15 – 180						
	Local Relief M	100						
	Drainage Pattern	Dendritic with some radial						
	Drainage Density Km/Km²	3.3						
	Landform	Hills					Swales	Terraces
	Position	Slopes, crest	Crests, spurs	Crests, slope	Slopes, crest	Lower slopes		
	Average Slope (Range)	33% (4% - 63%)	14% (4% - 19%)	32% (22% - 45%)	37% (31% - 49%)	14% (2% - 21%)	4% (0% - 7%)	5% (1% - 9%)
	Slope Shape	Convex	Convex	Convex	Convex	Concave	Concave	Convex
Native Vegetation	**Structure Dominant Stratum**	Open forest	Open forest	Low woodland	Open forest	Low woodland	Woodland	Open forest
	Species	Messmate, Brow-N Stringybark, Shining Peppermint, Narrow Leaved Peppermint	Messmate, Brown Stringybark, Manna Gum, Swamp Gum	Brown Stringybark, Shining Peppermint	Brown Stringybark, Messmate	Shining Peppermint, Brown Stringybark	Messmate, Brown Stringybark	Messmate, Swamp Gum, Brown Stringybark
	Other Common Species	Occas, Manna Gum, Bracken Prickly Tea Tree Christmas Bush, Sweet Bursaria,		Prickly Tea Tree, Silver Banksia, Austral Grass Tree	Mountain Correa, Prickly Tea Tree, Bracken, Christmas Bush	Black Sheoak, Austral Grasstree	Scented Paperbark, Prickly Tea Tree, Saw Sedge	
Soil	**Parent Material**	Unconsolidated clay, silt & sand	Unconsolidated clay silt & sand	Unconsolidated sand	Unconsolidated clay silt & sand	Colluvial sand unconsolidated sand,	Plant Remains, Alluvial Sand & Clay	Alluvial Clay, Silt & Sand
	Group	Yelow grad. Soils, weak structure	Yellowish brown coarse structured grad. Soil	Grey sand soils, uniform texture	Red grad. Soils, weak structure	Grey sand soil with hardpan, uniform texture	Peaty sands	Yellowish brown grad. Soil, coarse structured
	Surface Texture	Sandy loam	Sandy loam	Loamy sand	Sandy loam	Loamy sand		Sandy loam
	Permeability	Rapid	Slow	Rapid	Rapid	Very slow	Rapid	Slow
	Av. Depth M	> 2	> 2	> 2	> 2		> 2	> 2
	Northcote Class			Uc 2.31				
Land Use		Uncleared areas: hardwood & softwood forestry production, town water supply protection, nature conservation, quarrying of ironstone. Minor cleared areas: dairy farming, beef cattle grazing.						
Hazards Of Soil Deterioration		Severe hazard of sheet erosion & rilling on steepest slopes when cleared					Mod. haz. of water logging & soil pugging. Minor sheet erosion & / or sedimentation	
Management Practices For Soil Conservation		Maintenance of complete vegetative cover of soil at all times of year. Wintering of stock away from poorly drained areas. Fence construction away from sensitive areas such as drainage lines or along line of steepest slope. Tracks & roads constructed with adequate table drains & with slopes less than 1 in 10.						

PORCUPINE CREEK LAND SYSTEM

Along the eastern margins of the Heytesbury Project area, are found undulating to rolling landscapes which are dominated by the presence of infertile marine sands. This land system is quite extensive in the upper reaches of the Gellibrand River catchment but only three fairly small separate areas have been mapped in this study area. The two areas to the east of Princetown are effectively very similar and will be treated as being identical. The third area is in the north of the study area along the upper reaches of Tomahawk Creek. All of these areas and also the other parts of the land system outside the present study area have different arrangements of the six separate components, but the overall potential uses and hazards of the landscapes are very similar.

Common to all these areas are sources of in situ marine sand. At the exposures of this sand, soils of components 1 and 2 have developed. They are typical of the soils found elsewhere on exposures of marine sand found closer to the Otway Ranges. In the areas to the east of Princetown, most of these in situ exposures of unconsolidated marine sand have grey sand soils with hardpans developed on them. Thus component 2 dominates these exposures although some areas of the better drained component 1 soils are found. In the other area near Tomahawk Creek, the exposures are of very limited occurrence but again component 2 is more common. These soils are naturally quite infertile, have high surface soil acidities with pH values between 4 and 4 ½ and quickly dry out in summer to induce moisture stresses on the vegetation that manages to grow on these sites.

Over most of the landscapes however, the most commonly encountered soils are those of components 3, 4 and 5. These soils are of polygenetic origin and their widespread occurrence is the distinguishing feature of this land system. During previous erosional cycles the in situ beds of unconsolidated marine sand have provided the source for the distribution of veneers of sand over the adjacent lower parts of the landscape. This sand material has been subsequently weathered and leached so that iron oxides and humic acids have been migrated down to the surface horizon of the older soils below. Cementation by these organic acids and iron has resulted in the formation of hardpan layers in what was formerly part of the solum of the buried relict soil below the sand veneer. The hardpan are normally about 20 cm thick and below this are found invariably structured and mottled clays of the B horizons of the relict soils. These hardpan layers impede water movement through the profile so that internal drainage of the soil is slow. The natural vegetation is thus limited to species tolerant of waterlogging in winter with possibilities of moisture stresses in the loamy sand surface horizons in summer.

The position in the landscape of each of components 3, 4 and 5 is essentially a property of the clay underlay or remnant of the relict soil below the sand veneer. This position and the resulting slope has in turn determined the proneness of the soil to waterlogging. Thus there is a strong correlation between the vegetative association and the nature of the clay beneath the hardpan and this has been the basis for separating these three components.

Component 3 possesses clay underlays whose structures, textures and colours are identical to the B horizons of the mottled yellow and red fine structured gradational soils so often encountered in neighbouring land systems. The properties of good stability but low fertility also applies to these polygenetic equivalents in this land system. They are generally found on very gentle slopes on the upper parts of the landscape that have escaped dissection for long periods of time. As such drainage of these soils is poor and the vegetation is usually restricted to shrub layers of waterlogging tolerant species with occasional peppermints and swamp gum in an open woodland formation. Component 3 is commonly encountered in the Tomahawk Creek area, but is absent from the Princetown areas.

Component 4 possesses clay underlays with yellow and grey mottled clays, weak structures and sandy clay textures. They belong to much younger profiles than those of the previous component and have not been so intensively weathered and leached as those of component 3. As such they usually have comparatively higher levels of plant nutrients in the root zone. The slopes on which they have occurred are generally steeper than those of component 3 and site drainage is improved. Native vegetation is usually a woodland about 15 metres average height with narrow leaved peppermint, shining peppermint and swamp gum dominating the association. In the Princetown areas this component is found on most parts of the landscape and scent bark joins the vegetative association. Elsewhere this component is often present as the erosional scarp of the remnants of mottled yellow and red fine structured clay underlays where stream dissection has removed these older parts of the landscape. As such it is only a minor component of the landscape.

Component 5 soils have clay underlays with yellow and grey mottles, medium to heavy clay textures and coarse structures. They are usually found on landforms which are high level river terraces. The degree of cementation of the hardpan is extremely variable as is also the depth of sand material washed over the top of the profile. Correspondingly the vegetative formation ranges from open forests to closed scrub depending on just how severe the restriction is to drainage caused by the hardpan layers.

Most of the drainage lines in the land system are broad and gentle so that drainage is slow. Soils are normally peaty sandy loams with surface textures being dominated by organic matter. The acidity of these peats is often very high and the water table is usually at the surface at the surface in winter and spring thus rendering them unsuitable for pasture establishment. The value of these peats in maintaining perenniality of the creeks which run through them is very high as many of these areas are within domestic water supply catchments which don’t have storage reservoirs.

The climate over these areas is generally quite favourable for long periods of plant growth. Moisture stresses are however frequently encountered during the period when precipitation is less than potential evapotranspiration due to the low moisture holding capacity of the loamy sand surface horizons. This, combined with the low fertility and the frequently encountered bad winter drainage of many of these soils, makes the land system fairly marginal for agricultural uses. These areas do not offer the same economic incentives for dairy farming as do adjacent land systems and it is unlikely that they will ever be managed intensively for agriculture. It also appears likely that some of these areas may be used for conversion to pine plantations by the Forests Commission. Pines generally do not react favourably to winter impending layers within 50 cm of the surface of the soil and so careful investigation will be needed if any parts of this land system are suitable for pine establishment. Some occasional scars exist where previous sand and gravel extraction pits (hardpan layers of component 2 soils have in places been mined) have not been properly reclaimed for natural revegetation to occur.

In general, no further development of these areas for production seems at present economical and they should generally be kept in their natural state to maintain nature conservation and water supply catchment values where appropriate.

Pocupine Creek Land System

AREA: 20 km^2

Component		1	2	3	4	5	6
Proportion %		30	25	15	15	4	10
Climate	**Rainfall mm**	Annual: 800 – 100 Monthly Range: 40 (Jan) – 120 (Aug)					
	Temperature ^{o}C	Annual: 12.5 Monthly Range: 8.0 – 18.0					
	Seasonal Growth Factors	Period When Average Monthly Temperature < 10^{o}C June – August Period When Precipitation < Potential Evapotranspiration: Late October – March					
Geology	**Age** **Lithology**	Paleocene Unconsolidated Marine Sands		Paleocene Unconsolidated Marine Clays, Sands & Silts			
Topography	**Landscape**	Undulating plain					
	Elevation M	60 – 230					
	Local Relief M	45					
	Drainage Pattern	Trellis					
	Drainage Density Km/Km^2	3.8					
	Landform	Hills				Terrace	Drainage Line
	Position	Crests, slopes	Upper slopes	Mid slopes	Lower slopes		
	Average Slope (Range)	21% (9% - 38%)	9% (2% - 21%)	5% (2% - 11%)	16% (5% - 33%)	2% (0% - 5%)	0% (0% - 1%)
	Slope Shape	Convex	Convex	Linear	Convex	Linear	Linear
Native Veg	**Structure Dominant Stratum**	Woodland	Low woodland	Open woodland	Woodland	Open forest	Closed scrub
	Species	Narrow Leaved Peppermint, Shining Peppermint	Narrow Leaved Peppermint, Shining Pepper-Mint, Occasional Brown Stringybark	Narrow Leaved Peppermint, Shining Peppermint Occasional Swamp Gum	Narrow Leaved Peppermint, Shining Peppermint, Swamp Gum	Swamp Gum, Manna Gum, Narrow Leaved Peppermint, Brown Stringybark, Occasional Messmate Occasional Scent Bark	Scented paperbark, black sheoak, common aotu-s, occasional swamp gum
	Other Common Species	Blackboys, Prickly Tea Tree, Smooth Parrot Pea Silver Banksia	Prickly Tea Tree, Scented Paperbark Black Sheoak	Black Sheoak Prickly Tea Tree	Prickly Tea Tree, Common Heath	Prickly Moses, Prickly Tea Tree, Black Sheoak, Rapier Sedge	Coral fern, swamp heaths, swamp clubmoss
Soil	**Parent Material**	Unconsolidated sands	Unconsolidated sands	Colluvial sand on unconsolidated clays & soils	Colluvial sand on unconsolidated silts, sand & clays	Colluvial sand on alluvial clays, silts & sands	Plant remains alluvial sand, silt & clay
	Group	Grey sand soils uniform text.	Grey sand soil w/h hardpan uniform text.	Grey sand soils, compact clay underlay	Grey sand soils compact clay underlay	Grey sand soils compact clay underlay	Peaty sands
	Surface Texture	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam	Sandy Loam	Silty loam
	Permeability	Extremely Rapid	Very Slow	Very Slow	Slow	Very Slow	Rapid
	Av. depth M	> 2	0.8	> 2	> 2	> 2	> 2
	Northcote Class	Uc 2.31	Uc 4.33				0
Land Use		Uncleared area: nature conservation, town water supply protection, sand & gravel extraction Minor cleared areas: beef cattle grazing					
Hazards Of Soil Deterioration		Moderate-severe hazard of sheet erosion on the steeper slopes				Mod. haz. of waterlogging & soil pumping	
Management Practices For Soil Conservation		Maintenance of adequate ground cover at all times of the year. Wintering of stock away from badly drained areas. Establishment of deep rooted perennial pasture species if developed for agriculture (liming often required for germination). Revegetation of disused gravel extraction sites with indigenous species. Replacement of topsoil over extraction site.					

SIMPSON LAND SYSTEM

This gently undulating surface is the remnant of a former lateritic plateau which used to extend over a large part of what is now the Tomahawk Creek Catchment and the Scotts Creek Catchment. Small remnants found through these areas are evidence of the former extent of this surface. Where these remnants are continuous and wide enough to be mapped at this scale of survey they have been included in the Simpson land system.

The plateau surface dates from the late Tertiary period when the climate over Victoria is thought to have been vastly different from what is at present experienced. The typical lateritic profile forming in tropical rainforest environments today consists of a thin mineral horizon of sandy material overlying deep horizons of lateritic ironstone. Below this is found a mottled zone of haematite and kaolinite clays which gradually changes to a pallid zone of kaolinite clay. These profiles are several metres deep and are considered to be the end product of deep extensive weathering of soil in tropical environments.

The soil profiles on the Simpson plateau are somewhat unlike this. Instead of a thin mineral layer being present above the laterite, a full soil horizon overlies the ironstone which is encountered at between 1.5 and 2.0 meters below the surface. This could be due to a redistribution of material over the lateritic landscape, or to reweathering and pedological reorganisation of the lateritic material in subsequent drier temperate climates. Whatever the cause of these atypical lateritic soil profiles, the only places where lateritic ironstone is found close to the surface is on the scarps of the plateau in the neighbouring Tomahawk Creek land system.

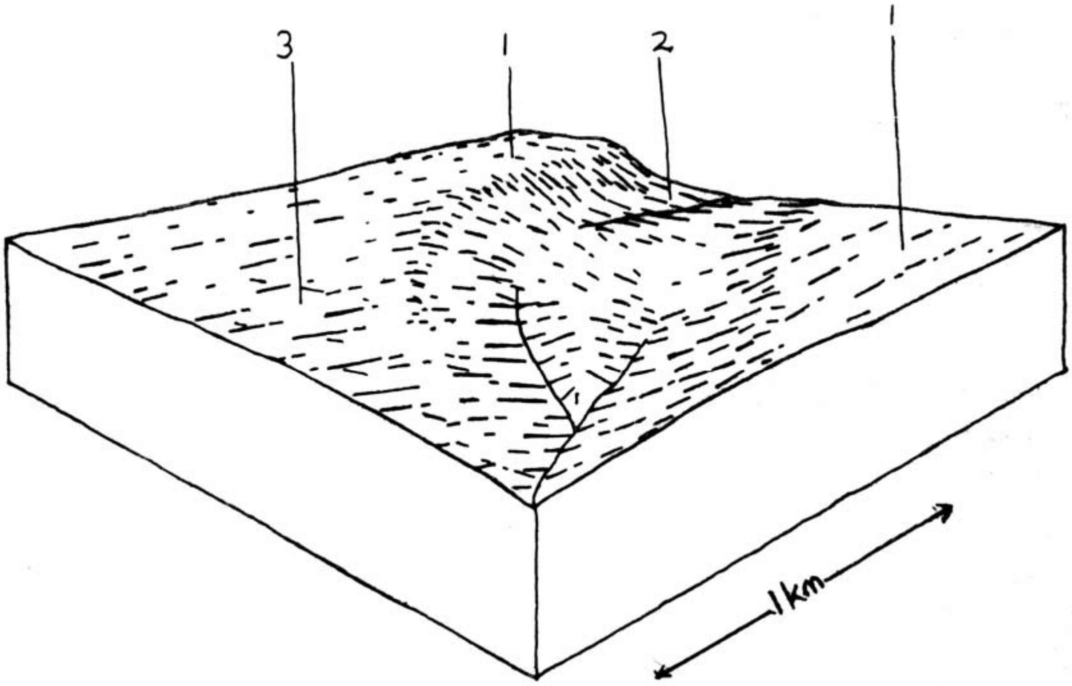
Component 1 includes the most widespread soils found overlying the lateritic ironstone. The soils are acid and are low in most plant nutrients. They are found on such gentle slopes as to appear almost flat. Drainage of the soils is often impeded by the presence of the ironstone at about 1.7 meters below the surface. Almost all of these soils have been cleared as part of the Heytesbury Settlement Scheme but they formerly supported open forests of messmate and brown stringybark with widespread hybridisation between these two species.

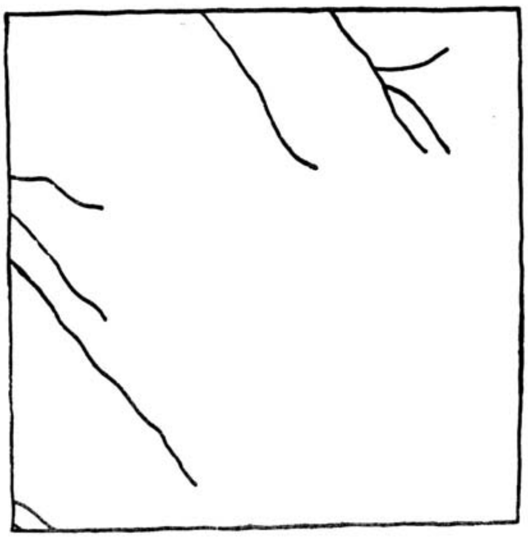
Before deep dissection of the Simpson surface took place, wandering creeks and streams deposited layers of sand over the top of these soils described above. Due to weathering of this sand, a thin hardpan frequently develops due to iron cementation between the sand deposit and the older clay subsoil underneath giving rise to the soils of component 2. This phenomenon is quite common in the Tertiary sediments surrounding the Otways and is described in detail in the chapter on soils. The presence of the hardpan and the rapid decrease in permeability below the sand horizons of these soils leads to frequent perched water tables in winter and generally waterlogged conditions conductive to the growth of heathlands or scrublands in place of open forests. Numerous treeless plains used to delineate the presence of these areas of poorly drained soils but have now all been cleared and sown to pastures.

Closer to the minor depressions of the present drainage system are found coarse structured soils with heavy clay subsoils somewhat similar to the soils of component 4 in the Tomahawk Creek land system. They are underlain by lateritic ironstone in some places but often alluvial sand, clay and lateritic detritus continue indefinitely below the solum. It seems probable that these soils were formed during the same climatic period responsible for the formation of their counterparts in the Tomahawk Creek land system. The subsoils are slowly permeable, highly dispersible and often contain up to thirty percent colluvial ironstone gravel. The vegetation is normally an open forest of messmate and brown stringybark but occasionally on badly drained sites it may be restricted to a low woodland or closed scrub with black sheoak dominating the association.

The drainage pattern of this landscape is unusual – the drainage lines are parallel and straight and orientated in a NW/SE direction with little or no branching. Furthermore this pattern has in turn determined the pattern of secondary drainage lines in the neighbouring Tomahawk Creek land system being similarly straight and parallel with the primary drainage coming down the slopes and intersecting them at right angles. The reason for this pattern is obscure. It has been suggested that it may be due to successive stages in the retreat of the Tertiary area with parallel sand dunes and accompanying swamps being left behind. The swamp subsequently became the drainage lines of the lateritic landscape and also became instrumental during the rejuvenation which formed the Tomahawk Creek land system. Little evidence of former sand dunes on this landscape remains however, although it is possible that they become the source of the sand for component 2 soils.

The main problems associated with use of this land for agriculture are the low nutrient status of the soils, and the exposure of the landscape to severe wind storms. These problems can be overcome by applying fertilisers and planting shelter belts – productivity from these areas should be quite high. At present, most agricultural land is used for dairying. Some conflicts are likely to arise due to the use of the area as a water supply catchment to supplement the domestic supply for Warrnambool and other population centres. However, with proper management the conflicts between these uses and dairy farming should be resolved.





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Simpson Land System

AREA: 78 Km^2

Component		1	2	3
Proportion %		65	25	10
Climate	**Rainfall** mm	Annual: 800 – 950 Monthly Range: 35 (Jan) – 110 (Aug)		
	Temperature °C	Annual: 13.0 Monthly Range: 8.0 – 18.5		
	Seasonal Growth Factors	Period when average monthly temperature < 10°C June → August Period when precipitation < Potential evapotranspiration: Late October → Early April		
Geology	**Age Lithology**	Lateritised Sands and clays of Pliocene Age	Veneer of Quaternary Sands	
Topography	**Landscape**	Very gently undulating plateau with arms extending N.W. and S.E.		
	Elevation M	150 – 170		
	Local Relief M	10		
	Drainage Pattern	Parallel		
	Drainage Density Km/Km^2	1.0		
	Landform	Undulating plain		
	Position	Most slopes, crests	Slopes	Swales
	Average Slope (Range)	4% (0% - 14%)	0% (0% - 3%)	5% (0% - 9%)
	Slope Shape	Straight (some convex)	Straight	Concave
Native Vegetation	**Structure Dominant Stratum**	Open forest	Closed scrub	Open Forest
	Species	Messmate, Brown Stringy-Bark Occas, Manna Gum	Prickly Tea Tree, Scented Paperbark Shining Peppermint Black Sheoak	Brown Stringybark, Swamp Gum
	Other Common Species	Large Leaf Bush Pea, Dusty Miller, Prickly Tea Tree, Silver Banksia, Mountain Correa, Myrtle Wattle	Pink Swamp Heath, Swamp Clubmoss, Coral Fern, Slender Rice Flower	Narrow Leaved Wattle, Dusty Miller Silver Banksia, Furze Hakea
Soil	**Parent Material**	Weathering lateritic remnants	Lateritic remnants covered by varying depths of sand	Sandy Clay Alluvium
	Group	Mottled Yellow Red Gradational Soils with Ironstone	Grey sand soils compact clay underlay	Yellowish Brown Coarse Structured Gradational Soils
	Surface Texture	Sandy loam	Peaty sandy loam	Sandy Loam
	Permeability	Moderate	Slow	Slow
	Av. Depth m	1.70	> 2	> 2
	Northcote Class	Gn 3.94		
Land Use		Cleared Areas: Mainly Dairy Farming some Beef Cattle Grazing Domestic Water Supply Protection. Minor Uncleared Areas: Hardwood Forestry Production Domestic Water Supply Protection		
Hazards of Soil Deterioration		Low hazard of sheet erosion on steepest slopes	Some waterlogging and hazard of soil plugging on poorly drained sites	
Management Practices for Soil Conservation		Wintering of stock away from waterlogged areas		

SWAN MARSH LAND SYSTEM

During the Quaternary Period, volcanic activity has been widespread over Western Victoria and lava flows emerging from cones and vents have extensively modified the landscape. Many of the inland lakes and swamps owe their formation to the blocking of drainage systems by lava flows. One such example is the flat poorly drained area to the north of the Simpson surface mapped as the Swan Marsh land system.

Exactly which basalt flow is responsible for blocking and damming a drainage system is often hard to determine. The drainage lines coming north from the Simpson and Wonga land systems in the vicinity of the Carperdeit road appear to be roughly orientated in the direction of the upper reaches of the Curdie River. The stony rise basalt flow across to Carperdeit appears to have blocked their north westerly course and formed an internal drainage basin. This basin filled and eventually found an outlet to the north west along the edge of the stony rise basalt into Lake Corangamite. The Alluvial sediments derived from the surrounding areas of Tertiary sands, clay and laterite and Quaternary basalts were deposited in the basin.

The soils of the land system vary according to the nature of the alluvium on which they are formed. Thus on areas close to the stony rise basalts, higher proportions of basaltic alluvium result in black cracking clay soils while further south on Hansons plain, weak structured, yellowish grey gradational soils have developed with ironstone present throughout the profile. Naturally, there are numerous examples of soils which are gradations between these two extremities. The soil formed depends on the relative proportions of basaltic alluvium and alluvium from the Tertiary sediments present at each site. Component 1 represents one end of this spectrum.

These black cracking clay soils are typical of the soils developed on alluvium from basalt. They are usually quite fertile with moderate to high levels of organic matter and most other plant nutrients. The surface horizons are heavily textured and hard to work but are often used for cropping. The main problem for management are associated with drainage rather than fertility levels.

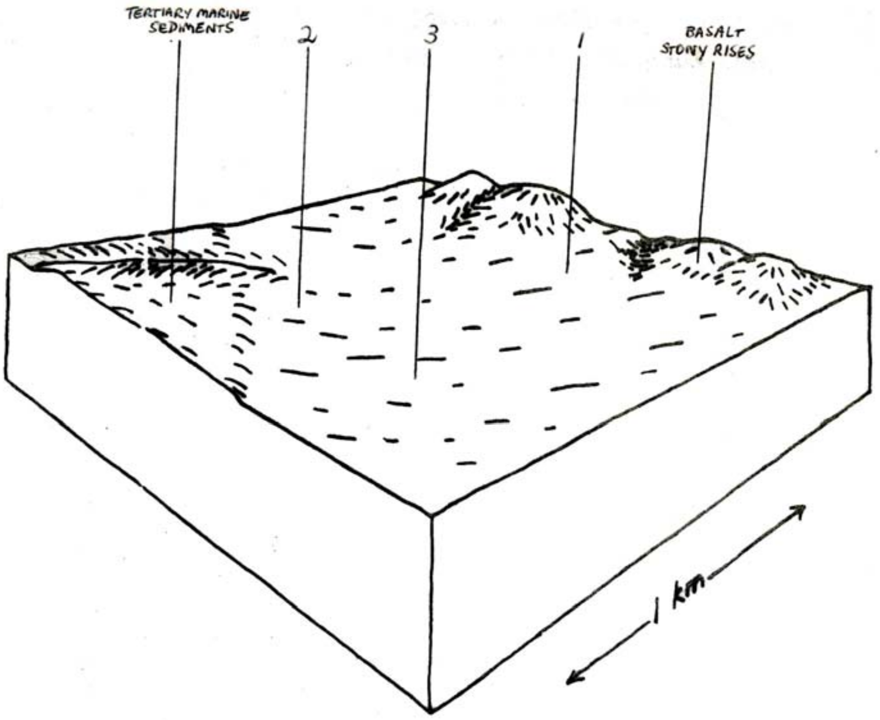
The component pattern in further complicated by site drainage. Most areas of the yellowish grey gradational soils receive water from surrounding land systems and are thus water-logged for large parts of the year. As such the vegetation is restricted to a closed scrub of species tolerant of waterlogging with occasional emergents such as swamp gum in a taller stratum. Where the site drainage is improved, open forests of swamp gum dominate and there is usually less organic matter found in the surface horizons. There two drainage conditions are represented by components 3 and 2 respectively.

As mentioned above these soils are formed on alluvium derived from Tertiary sediments and as such would possess similar problems of low nutrient levels. On badly drained sites, surface acidity may also become restrictive to the germination of pasture species.

Restrictions to plant growth due to cold temperatures occur during the winter months. Restrictions due to moisture availability again depend on the water holding capacity of the soil which should be moderately high. Allowing for 120 mm available soil moisture retention on these soils, it is estimated that moisture restrictions to plant growth would normally only occur after the end of December. Moisture stress would then normally be experienced until the season breaks again in early April. Thus the period of active plant growth suffers restrictions for three months in winter and a little over three months in late summer and early autumn.

Except for some of the southern parts of component 3, this land system has been mainly cleared for agriculture. The black cracking clay soils often support good quality pastures and are quite productive. Other areas are not quite as suitable for agriculture but nevertheless could support good pastures under suitable management. However, Hanson’s plain remains as the only large area of the closed scrub vegetation in this part of Victoria which has not yet been cleared. Although it has a slightly different geomorphological history than the closed scrubs of the Simpson and Wonga land systems, it appears to be a suitable area to reserve as a representative community of these once more widespread vegetative association.

BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE SWAN MARSH LAND SYSTEM



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Swan Marsh Land System

AREA: 3 Km^2

Component		1	2	3
Proportion %		40	20	40
Climate	**Rainfall mm**	Annual: 750 – 850 Monthly Range: 35 mm (Jan) – 110 mm (Aug)		
	Temperature ^{o}c	Annual: 12.5 Monthly Range: 8.0 – 18.5		
	Seasonal Growth Factors	Period when average monthly temperature < 10^{o}C June – August Period when precipitation < potential evapotranspiration: Mid October – Early April		
Geology	**Age Lithology**	Alluvium of quaternary age derived from surrounding outcrops of basalt, tertiary sands and clays, and laterite.		
Topography	**Landscape**	Flat plain		
	Elevation M	150		
	Local Relief M	1		
	Drainage Pattern	Centripetal		
	Drainage Density Km/Km^2	0.4		
	Landform	Flat plain		
	Position	Northern parts	Southern parts	Lower areas
	Average Slope (Range)	0 (0 – 1)	0 (0 – 1)	0 (0 – 1)
	Slope Shape	Linear	Linear	Linear
Native Vegetation	**Structure**	Open woodland	Open forest	Closed scrub
	Dominant Stratum Species	Swamp Gum	Swamp Gum	Black Sheoak, Scented Paperbark, Prickly Tea Tree, Prickly Moses, R-Ed Fruited Saw Sedge Silky Tea Tree
	Other Common Species	Blackwood, Dogwood	Prickly Tea Tree, Scented Paper-Bark, Prickly Moses, Red Fruited Saw Sedge, Blackwood, Rushes	Swamp Gum Sporadically Occurs As A Higher Stratum
Soil	**Parent Material**	Alluvium from predominantly basalt	Alluvium from predominantly siliceous sediments	Alluvium from predominantly siliceous sediments
	Group	Black uniform clays	Yellowish grey gradational soils, coarse weak structure	Yellowish grey gradational soils, coarse weak structure
	Surface Texture	Medium clay	Sandy clay loam	Clay loam
	Permeability	Very slow	Slow	Slow
	Av. Depth M	> 2	> 2	> 2
	Northcote Class	Ug 5.16	Gn 4.51	Gn 4.51
Land Use		Cleared areas: dairy farming, beef cattle grazing, some cropping minor cleared areas: nature conservation		
Hazards Of Soil Deterioration		Moderate hazard of soil pugging and waterlogging		
Management Practices For Soil Conservation		Wintering of stock away from badly drained areas		

TOMAHAWK CREEK LAND SYSTEM

To the east, south and west of the Simpson land system, deep dissection by creeks has created a steeply undulating or rolling landscape, with long slopes coming away from flat plateau remnants to well developed drainage lines. This is the area mapped as the Tomahawk Creek land system. Six components have been recognised in this land system.

Component 1 represents areas of lateritic plateaux which are either too small or too discontinuous to be mapped in with the Simpson land system. This includes both the narrow parallel ridges extending south east and north west from the Simpson land system, and the small isolated remnants found on the south east side of Tomahawk Creek. The soils encountered in this component are almost invariably equivalent to those of component 1 of the Simpson land system, with a similar vegetative association.

Component 2 represents the edges of these plateau remnants where they end abruptly in a steep concave scarp with outcrops of lateritic ironstone weathering to shallow skeletal soils. Eroding and weathering of the lateritic ironstone layer has produced ironstone gravel particles averaging about 15 mm in diameter and these dominate the soil profile. These soils are thus excessively drained and have poor moisture holding capacities as well as low natural fertility. The colluvial ironstone usually extends some distance down the scarp below the thickness of the ironstone layer in the lateritic plateau, and is often present in the solum of middle and lower slope soils. Many gravel extraction pits exist on both freehold and Crown land as the material is popular for road and track construction. The vegetative associations on these soils do not reflect the extremely low fertility and excessive drainage. This is related to the narrow width of these soils such that the roots of eucalypt can penetrate to sandy aquifers just below and thus provide plentiful moisture supplies.

The base of the lateritic profile is underlain in most areas by a nearly horizontal bed of siliceous sand. This bed acts as an excellent aquifer as mentioned above. Recharge is from the Simpson land system through occasional outcrops of the bed or from water moving through the lateritic profile to the sand below. Discharge is through exposures of these beds on the hillsides which thus often coincide with the emergence of springs. These areas tend to become easily pugged and boggy in winter. These are the areas represented by component 3 and the soil and vegetative associations are somewhat similar to those found in the large areas of marine sands on the western periphery of the Otway Ranges. Similarly soils with deep indurated layers are sometimes encountered. These have not been recognised as a separate component here because of their limited occurrence and similar vegetative association in this land system. The emergence of springs through these soils has meant that the main limitation to the growth of eucalypts is fertility of these acid sands, and not moisture deficiency.

Below these fairly narrow beds of siliceous sand lie much less permeable beds of marine clays and silts. Their exposure at middle and lower positions of the slopes is represented by components 4 and 5. Pedological processes on these deposits have led to the development of yellow and grey mottled gradational profiles with large shiny peds in the subsoil. Close examination of these profiles reveals that in most cases the top one metre is occupied by a new soil forming on the remains of a deeper older profile. These heavy clay subsoils are moderately dispersible and evidence of present and past landslips are common. Gully erosion is not common but these soils would be quite susceptible to gully erosion once initiated. Drainage of profiles is somewhat impeded and species such as swamp gum, rushes and saw sedges become common in the vegetative association.

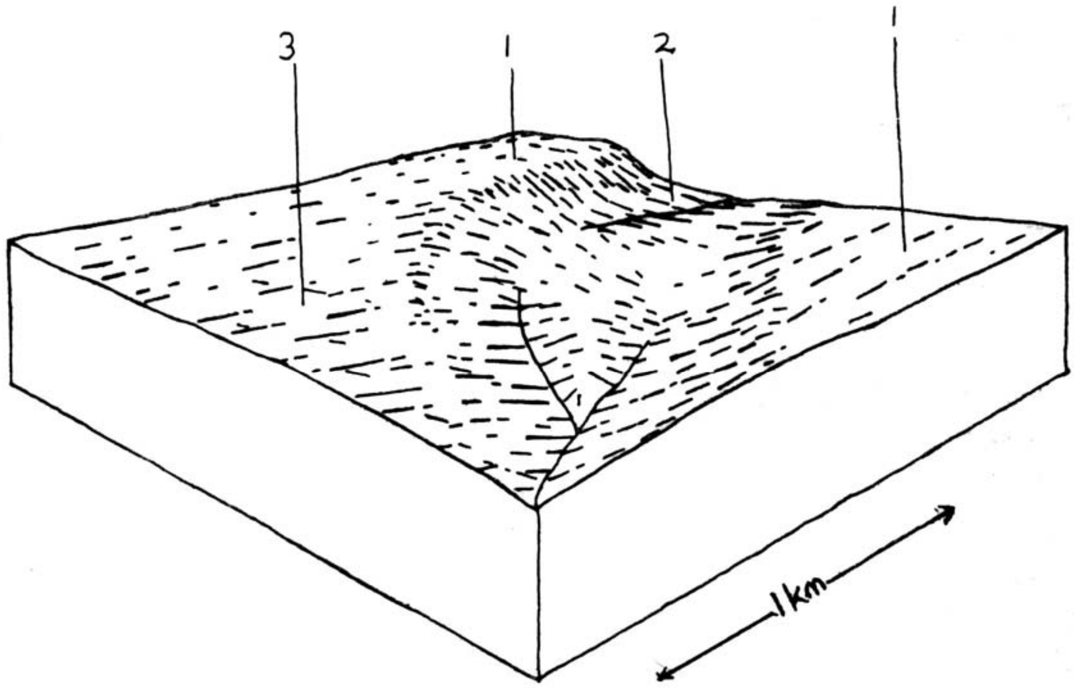
On gentler areas of these soils, layers of colluvial/alluvial sand have been washed over the top of these gradational profiles with heavy clay subsoils. Where these deposits of sand are deep and old enough, a hardpan layer has developed between the sand and the less permeable clay by cementation by iron and organic matter. This process has occurred most commonly on the gentler lower slopes on the south side of Tomahawk Creek, and these soils are represented by component 5. The presence of the hardpan is usually associated with a perched water table and somewhat anaerobic conditions in the topsoil during winter. Thus, more stunted vegetation is usually encountered on component 5 than on component 4. Also included in this component are areas of dissected terraces lying along the valley of Tomahawk Creek. The subsoils of these soils are not as heavily textured and as strongly structured as those described above and are thought to be of more recent origin. However, as they almost invariably have the same deposit of sand with an accompanying hardpan above the subsoil they have very similar properties for plant growth and have been included with the profiles with heavy clay subsoils. Slopes of the dissected terraces are in the range of 1-5% and vegetation is normally a woodland of swamp gum. On the rare areas of dissected terraces that don't have a sand overlay, open forests of swamp gum and narrow leaved peppermint are found.

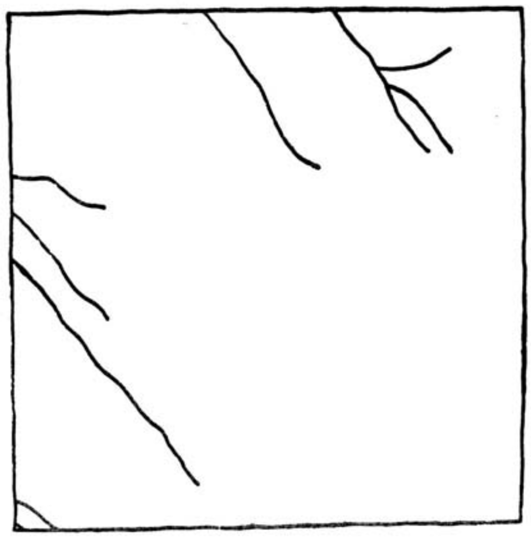
Component 6 essentially comprises the present flood plain of Tomahawk Creek and all other drainage lines which are large enough to have developed an alluvial infill. The soils are young and have only weak structures, are moderately permeable, but are in topographic positions such that the water table is close to the surface for a large part of the year.

Restrictions to the period of active plant growth occur for three months during winter and for between 2½ and 3 months in late summer and early autumn. The duration of this latter restriction depends on the water holding capacity of the soil. The sands of component 3 would be expected to dry out below wilting point well before the heavy clay subsoils of component 4, although the local effect of springs emerging along parts of these components often provides green pick at the base of the lateritic plateaux for the duration of almost the whole of summer. The hardpan layers of component 5 soils have the advantage of holding the moisture from intermittent summer showers close to the surface for use by plants.

Conflicts of land use in this land system appear likely to increase in the future. Dairy farming practices are often incompatible with the use of an area as a domestic water supply catchment and much extension work will be needed to establish satisfactory management practices to minimise contamination of water supplies.

Additional problems could arise from changes in the hydrological balance of this land system. Other landscapes similar to this one in other parts of Australia, where dissection has been deep into an ancient lateritic land surface, are often associated with high quantities of cyclic salt. Clearing of the native vegetation decreases the amount of water lost through transpiration and the groundwater table rises, bringing with it soluble salts. Examples of where this process has happened are in the Dundas Tablelands of Victoria and the Darling Ranges of Western Australia. Due to the high rainfall in this area, soil salting problems are unlikely to become significant, but the expected rise in salinity of runoff water has serious consequences for the future suitability of the area as a domestic water supply catchment.





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BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE TOMAHAWK LAND SYSTEM

Tomahawk Creek Land System
AREA: 84 Km^2

Component		1	2	3	4	5	6
Proportion %		15	6	10	50	9	10
Climate	**Rainfall** mm **Temperature** °C **Seasonal Growth Factors**	Annual: 850 – 1050 Monthly Range: 40 (Jan) – 125 (Aug) Annual: 13° Monthly Range: 8.0° – 18.5° Period when average monthly temperature < 10°C June → August Period when precipitation < Potential evapotranspiration: November → March					
Geology	**Age** **Lithology**	Lateritised sands and clays of Pliocene Age (Moorabool Viaduct Formation)		Unconsolidated sands, silts and clays of miocene age (gellibrand marl)			
Topography	**Landscape**	Deeply dissected remnants of the Simpson Plateau					
	Elevation M	50 – 160					
	Local Relief M	70					
	Drainage Pattern	Trellis predominantly but with some dendritic					
	Drainage Density Km/Km²	2.9					
	Landform	Plateau Remnants	Scarp				Valley bottom
	Position **Average Slope (Range)**	1% (0% - 3%)	Upper slope 28% (13% - 40%)	Upper slope 12% (8% - 18%)	Mid slope 12% (8% - 20%)	Lower slope 5% (1% - 8%)	0% (0% - 2%)
	Slope Shape	Straight	Concave	Straight	Straight	Straight	Concave
Native Vegetation	**Structure**	Open forest	Open forest	Woodland	Open forest	Low woodland	Woodland
	Dominant Stratum Species	Messmate, Brown Stringybark	Messmate, Occasional Manna Gum	Narrow Leaved Peppermint Brown Stringybark, Manna Gum	Swamp Gum, Messmate Narrow Leaf Peppermint Brown Stringybark	Narrowed Leaved Peppermint, Swamp Gum	Manna Gum, Swamp Gum
	Other Common Species	Large Leaved Bush Pea Dusty Miller, Prickly Tea Tree, Silver Banksia, Mountain Correa Myrtle Wattle	Prickly Tea Tree, Dusty Miller, Silver Banksia	Silver Banksia, Blackboys, Prickly Tea Tree	Narrow Leaved Wattle Prickly Tea Tree Prickly Mosses, Silver Banksia, Dusty Miller, Rush	Prickly Tea Tree	Black Sheoak, Scented Paperb-Ark, Smooth Parrot Pea, Prickly Tea Tree
Soil	**Parent Material**	Weathering lateritic remnants	Colluvial lateritic ironstone	Siliceous sands	Sandy clays (in situ)	Colluvial/alluvial sand over sandy clays	Sand and clay alluvium
	Group	Mottled yellow red gradational soils with ironstone	Stony red gradational soils	Grey sand soils, uniform texture	Yellowish brown gradational soils coarse structure	Grey sand soils, compact clay underlay	Grey gradational soils
	Surface Texture	Sandy loam	Gravelly sandy loam	Coarse sandy loam	Sandy loam	Sandy loam	Sandy loam
	Permeability	Moderate	Extremely rapid	Extremely rapid	Slow	Very slow	Very slow
	Av. Depth M	1.6	1	> 2	> 2	> 2	> 2
	Northcote Class	Gn 3.94		Uc 2.36	Gn 3.54		Gn 2.92
Land Use		Cleared areas: mainly dairy farming, some beef cattle grazing, town water supply production uncleared areas: hardwood forestry production gravel extraction fauna protection, town water supply production					
Hazards Of Soil Deterioration		Low hazard of sheet erosion	Mod. Hazard sheet erosion	Moderate hazard of landslips, rilling & slumping of road batters soil pugging on poorly drained site			Low hazard of gully erosion
Management Practices For Soil Conservation		Wintering of stock away from poorly drained areas & fencing out of sites where springs occur on hillslopes. Disposal of dairy effluent away from existing unstable drainage lines, sowing of deep rooted perennial grass species on excessively drained sites. Road batters on component 4 soils kept to less than 1 in 3 slopes. Wherever possible – original vegetation kept in drainage lines					

WAARRE LAND SYSTEM

Widespread through the catchments of Cooriemungle and Scotts Creek and in the lower reaches of the Gellibrand River catchment are the calcareous clays and marls of the Gellibrand marl formation. The rolling coastal plain developed over these deposits comprises this Waarre land system.

The most commonly encountered soils are the brown coarse structured calcareous gradational soils. They generally have heavy textures throughout the profile with a heavy clay in the B horizon. These soils are represented by component 2. They are somewhat atypical of the normal soils encountered in limestone and marl parent material. It is thought that their coarse structure and large slickensides indicate a very long period of soil formation and possibly belong to a previous climatic period – their structural properties are very similar to the coarse structured soils of the Tomahawk Creek and Kennedy's Creek land system. Permeability of these heavy clay subsoils is somewhat impeded but when they do become saturated then they are prone to landslips and many of the road batters exhibit varying degrees of slumping.

Although most of these areas have been cleared, remnants of the original vegetation indicate that the structure was originally a woodland and the association included swamp gum, shining peppermint, manna gum and messmate. It is interesting to note the wide tolerance to soil acidity of shining peppermint. It competes well against other native vegetation on the most acid sands with a surface pH of around 4, and also forms part of the association on those soils where the pH goes from around neutral at the surface to around 8½ at 1 metre below the surface in this component.

Beneath these beds of highly calcareous clays and marls lie the sediments which comprise the Kennedy's Creek land system to the north. They are frequently exposed on the lower slopes of this landscape as represented by component 3. Profiles are generally fairly young without strong structural development and permeability is moderate to good. These soils are much more stable than the others in the land system and do not possess the same erosional hazards. However, due to their low position in the landscape waterlogging can become a problem during the wetter parts of the year.

The original vegetation is in turn dependant on the drainage of the site. The better drained areas formerly supported woodlands of swamp gum, messmate and other eucalypts. However in some areas the sites are waterlogged by the emergence of springs along exposure of these more permeable beds and the natural vegetation is restricted to closed scrublands and heathlands of black sheoak, scented paperbark and other moisture loving species.

Large drainage lines in the southern parts of this land system often consist of lagoonal deposits in a broad river valley drowned by the last Holocene minor marine transgression. As such these areas are poorly drained with peat, clay and other deposits comprising the soil parent material. Vegetation is restricted to a closed scrub formation by the bad drainage. These areas are represented by component 4.

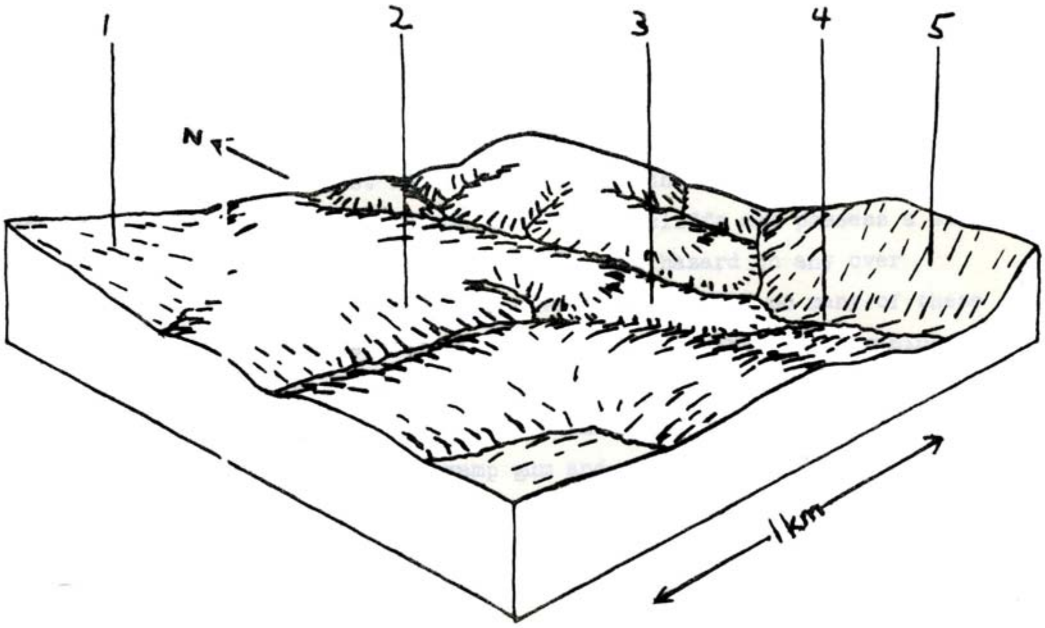
Close to the coast in the southern parts of the study area, the duplex profiles with red and yellow mottled, coarse structured subsoils of component 1 are encountered. These soils are somewhat acid at the surface becoming neutral at about 1 metre and it is not until about 1 ½ metres below the surface that the pH becomes quite alkaline. The marls and clays here have been weathered much more deeply so that the bottom of the B horizon continues past 2 metres. Dispersibility of these soils is high and they are quite prone to gully erosion. There are several examples of gullies adjacent to the study area that seemed to have been initiated by long straight tracks channelling surface runoff water straight down a slope. On coastal cliffs where these soils have been exposed, raindrop action has washed most of the clay out of the subsoil exposures leaving behind ironstone gravel. Thus the coastal cliffs all possess a steep gravelly slope on their uppermost reaches which is a hazard to any over enthusiastic sightseers. Because of the severe exposure of so many of these sites to coastal winds, the vegetation if often stunted from salt pruning so that only an open scrub of prickly tea tree, sea box, dropping sheoak, and other coastal species develops. Further inland in the study area on more sheltered sites, an open forest of messmate, swamp gum and scent bark is more commonly encountered.

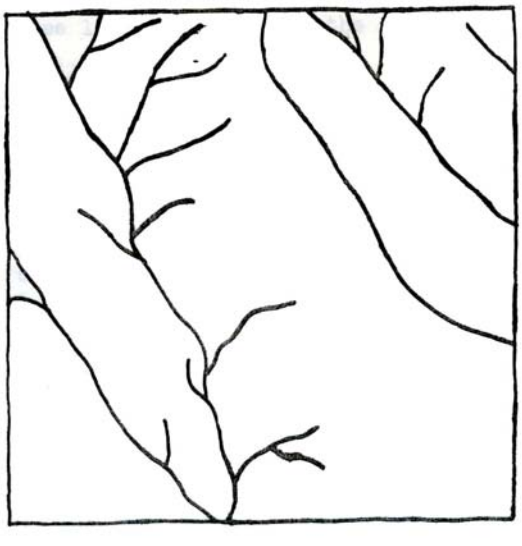
On steep slopes, and particularly along the scarps of Curdies fault, more typical soil profiles of the groups commonly encountered on highly calcareous parent material are found. These shallow black light clays or clay loams of component 5 belong to the great soil group referred to as rendzinas. The severe slopes on which they have usually formed leads to them being prone to sheet erosion and minor landslips (stock terracettes are common). However, they are of very limited occurrence, being observed only in the southern parts of the land system. In some areas these soils have also developed on colluvial wash material which may overlie the brown coarse structured gradational profiles of component 2. Thus these latter sites have the appearance of component 2 soils but with exceptionally deep A horizons.

The lower parts of the landscape in the upper reaches of the Cooriemungle Creek Catchment have been overlain by alluvial material originating from Fergusons Hill. These sandy deposits up to 30 cm deep can give the soil profile a duplex appearance. Recent clearing of Fergusons Hill may explain these deposits and the observed drainage line siltation. Severe gully erosion also seen in some parts of the Cooriemungle catchment has probably resulted from the increased runoff and hence higher maximum peak flow associated with the clearing of this catchment.

Growing seasons in this land system are quite favourable for agriculture. Plant growth would be restricted from the winter months by cold temperatures. Allowing for 120 mm available soil moisture retention on these heavily textured soils, it is estimated that moisture restrictions to plant growth would normally only occur during late January, February and March, shortening to only February and March in the more humid coastal areas. Thus generally this land system is well suited to agriculture and in particular dairying. However, some care is needed to prevent deterioration of the soil and maintain long term productivity.

BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE WAARRE LAND SYSTEM





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Waarre Land System

AREA: 105 Km^2

Component		1	2	3	4	5
Proportion		4	65	20	8	3
Climate	Rainfall mm Temperature °C Seasonal Growth Factors	Annual: 900 – 1000 mm Monthly range: 40 mm Jan – 120 mm Aug Annual: 13.5° Monthly range: 9° July – 18° Feb Period when average monthly temperature < 10°C June – August Period when precipitation < potential evapotranspiration: Nov - March				
Geology	Age Lithology	Marine clays, marls and limestone of miocent age.				
Topography	Landscape	Undulating hills with some fault scarps				
	Elevation m	0 – 165 m				
	Local Relief m	45 m				
	Drainage Pattern	Dendritic				
	Drainage Density km/km²	2.9				
	Landform	Undulating plain				Fault scarps
	Position	Upper slopes crests	Midslopes, crests	Lower slopes	Broad drainage lines	STEEP SCARPS
	Average Slope (Range)	5% (2% - 9%)	11% (4% - 21%)	4% (1% - 7%)	0% (0% - 1%)	33%
	Slope Shape	Linear	Convex	Concave	Linear	Linear
Native Veg	Structure	Open forest	Woodland	Woodland	Closed scrub	Woodland
	Dominant Stratum Species	Messmate, Swamp Gum Scent Bark	Swamp Gum, Shining Peppermint Occasional Messmate	Messmate Swamp Gum	Scented Paperbark Woolly Tea Tree	Manna Gum Blackwood
	Other Common Species	Not possible to assess as very few remnants of original complete vegetative community exist.				
	Parent Material	Unconsolidated clays, sands	In situ, marl, limestone	Unconsolidated clays, sands	Plant remnants alluvial sand & clay	In situ, marl, limestone
	Group	Brown duplex soils, coarse structure	Brown calcareous coarse structured gradational soils	Yellowish grey gradational soils coarse weak structure	Grey gradational soils	Black calcareous gradational soils
	Surface Texture	Fine sandy loam	Loam	Sandy loam	Peaty sandy loam	Clay
	Permeability	Slow	Slow	Moderate	Rapid	Moderate
	Av. Depth M	> 2	1.7	> 2	> 2	> 2
	Northcote Class	Db 4.43	Gc 2.21		Gn 2.92	Uc 6.12
Land Use		Cleared areas: grazing for beef cattle, dairy farming, grazing for sheep minor uncleared areas: nature conservation, landscape conservation (includes Port Campbell national park coastline)				
Hazards Of Soil Deterioration		Mod hazard of gully erosion severe hazard of sheet erosion from foot traffic	Mod hazard of landslips & slumping of rd batters. Low hazard gully erosion	Low hazard of gully erosion & sheet erosion	Low hazard of gully erosion mod. Hazard of soil pugging	Severe hazard of minor landslides stock terracett-es low hazard of sheet erosion
Management Practices For Soil Conservation		Road & track construction with adequate table drains & culverts. Road batters designed with no slopes greater than 1 in 3. Drainage from roads, dairys, etc. Taken away from existing minor drainage lines on hillslopes. At least partial tree cover maintained on all slopes exceeding 8% stock wintered on paddocks away from poorly drained areas				

WONGA LAND SYSTEM

In the northern reaches of the Gellibrand River watershed, an undulating plain is found on the highest parts of the landscape and these areas have been mapped as the Wonga land system. Although existing now more as broad ridge cappings, this land system must have originally covered all the upper reaches of the Tomahawk Creek catchment and across to Loves Creek. Movement along the Loves Creek and Bunker Hill faults have uplifted this block and the resulting geological erosion has left fairly narrow remnants of this undulating plaint along the ridge lines. Some of these remnants fringe the north eastern borders of the Heytesbury Settlement area.

The geology consists of unconsolidated beds of sand and clay belonging to the Dillwyn formation. Large areas of coarse marine sands, however, are uncommon, and the material is fairly similar to the sandy clays of the Mt. Mackenzie land system. This area differs from this land system in that it does not possess a steep, youthful topography but rather an older landscape with relict soils.

Component 1 comprises almost half of the total area of the land system. The mottled yellow red gradational soils encountered here are thought to belong to a previous climatic period which was responsible for the formation of these fine strongly structured mottled clays throughout the study area. Due to the long cycles of leaching they have experienced, they are deficient in many plant nutrients. Although they are well drained and have good water holding capacities, they are not extensively used for agriculture. They support open forests dominated by messmate which are suitable for some scantling timber but are generally only used for posts and poles.

During previous erosional periods there has been some redistribution of sand over the surface of these soils. In many places it does little more than alter the surface texture but where it has accumulated to about 40 cm deep, subsequent weathering and leaching of iron and organic acids to the base of this sand layer has resulted in cementation of the former surface horizon of these red and yellow mottled gradational soils into a hardpan. These areas are represented by component 3. This hardpan thus lies between the sandy surface horizons and the strong fine structured red and yellow mottled clays of the relict soils and has the effect of restricting water movement through the soil. Thus these polygenetic soils are not as well drained as those of component 1, and this is exemplified by a change in the vegetative association to dominance by brown stringybark and an increased occurrence of swamp gum, saw sedge and other moisture loving species. However the drainage impedance is not strong enough to change the structure of the association.

In parts of this landscape, small colluvial fans have formed from redistribution of this material and on these sites deeper deposits of sand, silt and some clay have been formed into somewhat different profiles with hardpans. These areas are represented by component 2. The surface horizons are sandy loams or loamy sands, but below the hardpan layers are found poorly structured sandy clay loams or light sandy clays. They have been included in the same group as the soils of component 3 because many of their physical and chemical properties are similar. The main reason for making this a separate component is that they are generally in poorly drained positions in the landscape and are easily distinguished by the structure of the vegetative association – usually an open woodland or less commonly a closed heath on these soils, in contrast to the open forests elsewhere in the land system. Thus these areas normally have the water table close to the surface in winter and support non commercial stands of timber.

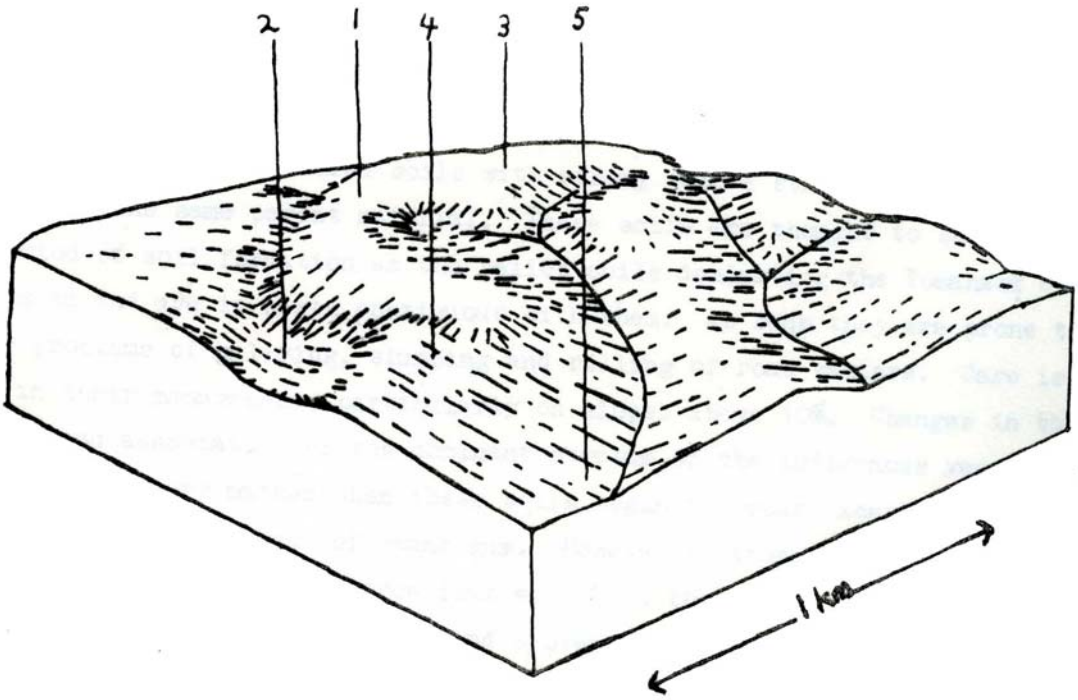
On straight gentle slopes adjacent to the convex rises with mottled yellow red gradational soils and their polygenetic variants are often found slightly more heavier textured soils with strong coarse structured B horizons developed on the same parent material. These soils are thought to belong to the same period of soil formation as the relict soils dominating the Tomahawk Creek land system and are in parts contiguous with them. As such they are prone to similar problems of gullying, slumping and rilling of road batters. Care is needed in their management, particularly on slopes above 10%. Changes in the structure and association of the dominant stratum of the indigenous vegetation are not usually very marked when these soils begin to occur except for the usual increase in abundance of swamp gum. However a strong vegetative indicator is the dramatic increase in narrow leaf wattle in the understorey.

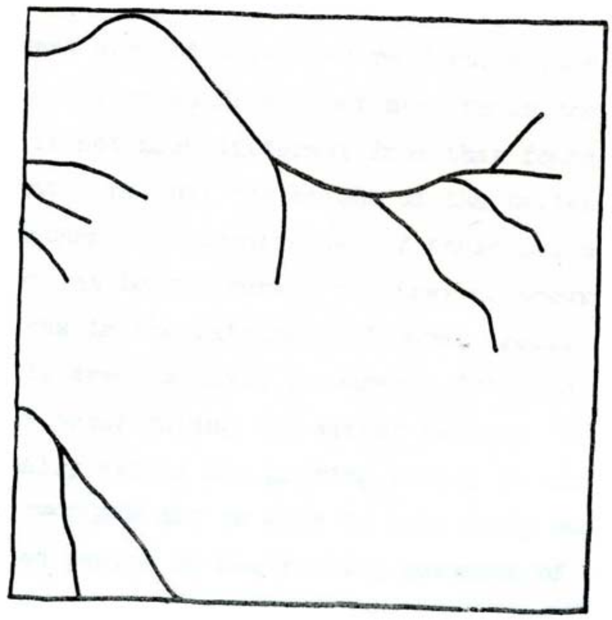
In the eastern parts of this land system closer to the Loves Creek fault, the Paleocene sediments of the Dillwyn formation only shallowly overly the Lower Cretaceous sediments of the Albion formation as exposed in parts of the Otway Ranges further south. As such the shallow dissection has often cut down to this basement of felspathic sandstones. These sandstones are somewhat different from the bulk of the sandstones comprising the Otway Ranges and weather to a soil with more sand size particles than are normally found. The soils developed upon these exposures again have strong coarse structures and are thought to belong to the same climatic period as the soils of the previous component and their equivalents. However being on different and potentially more fertile parent material these soils exhibit different properties from other members in the group. The vegetative association is not much different from that found on component 4 except for the addition of scent bark, but the height of the tallest stratum is generally slightly greater on component 5. Occurrences of these soils in the Heytesbury Settlement area have not yet been observed but they do occur immediately adjacent to the study area in the catchment of Muree Creek.

The climate in this area is quite favourable for plant growth. Restrictions due to cold temperatures occur during the winter months. Water holding capacities of the soils would normally extend the growing season to about late December although the soils with hardpans may be able to make early summer rainfalls available for an extended period by restricting movement of the water through to the clay underlay. The soils in lower slope positions would also probably remain moist for a slightly longer period. The period of active plant growth would normally be for a total of (12-3-3+) = slightly less than 6 months of the year.

As already mentioned, most of the areas in this land system at present remain under natural forest, but naturally those parts which lie within the Heytesbury Settlement area have in places been cleared and developed for agriculture. In view of the high requirement for fertilisers by most soils, agricultural development is not likely to expand in the near future. Conflicts of land use may arise in parts of Tomahawk Creek catchment where domestic water supply catchment areas have been cleared for agriculture. Softwood plantations may be reasonably well suited to these soils and this land use would be more compatible with water supply catchment protection.

BLOCK DIAGRAM AND DRAINAGE PATTERN FOR THE WONGA LAND SYSTEM





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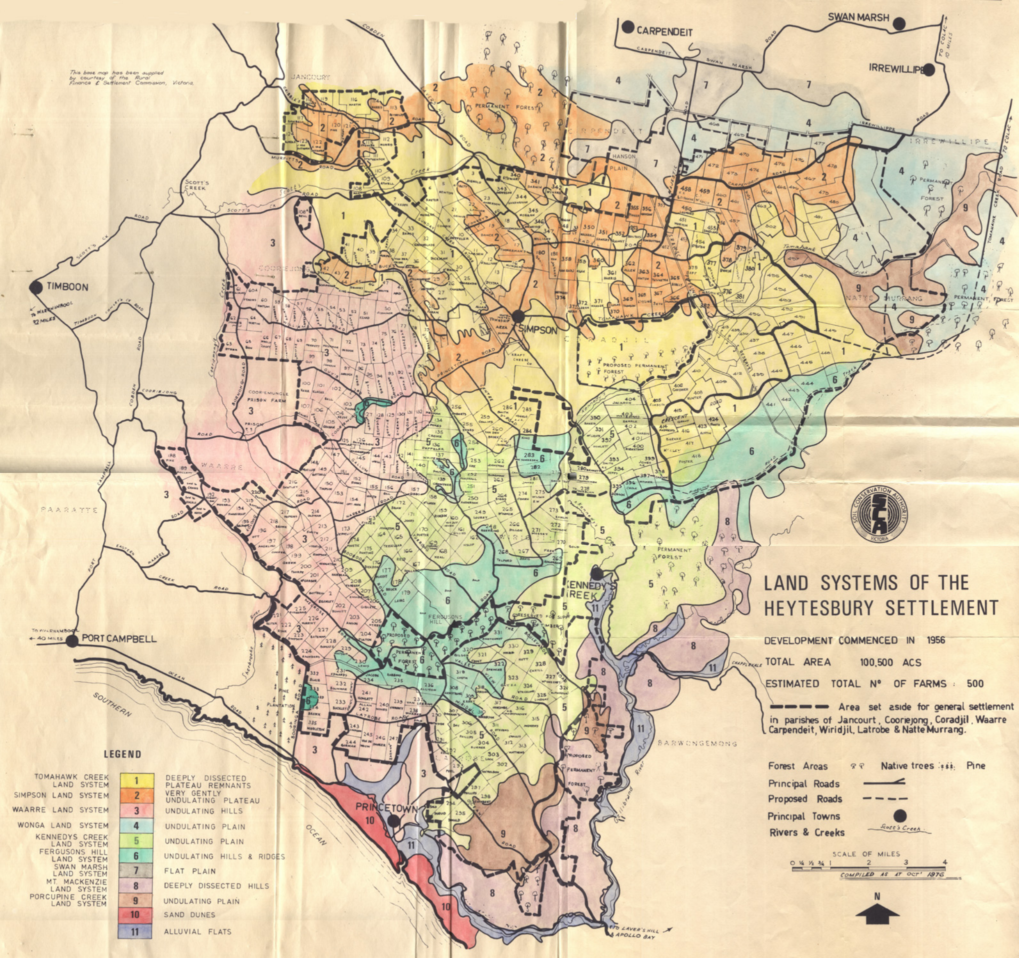
Wonga Land System

AREA: 24 km^2

Component		1	2	3	4	5
Proportion		45	7	25	15	8
Climate	**Rainfall mm**	Annual: 850 – 950 Monthly Range: 40 (Jan) – 120 (Aug)				
	Temperature ^{o}C	Annual: 12.5 Monthly Range: 8.0 – 18.0				
	Seasonal Growth Factors	Period When Average Monthly Temperature < 10^{o}c June – August Period When Precipitation < Potential Evapotranspiration: Late October – March				
Geology	**Age** **Lithology**	Paleocene marine unconsolidated clays, silts and sands				Lower cretaceous felspathic sandstone and siltstone
Topography	**Landscape**	Undulating plain				
	Elevation M	120 – 340				
	Local Relief M	30				
	Drainage Pattern	Parallel and dendritic				
	Drainage Density Km/Km^2	1.2				
	Landform	Undulating plain				
	Position	Crests, upper slopes	Colluvial fan, swale	Slopes	Lower slopes	Lower slopes
	Average Slope (Range)	7% (0% - 12%)	4% (0% - 7%)	7% (1% - 16%)	10% (4% - 14%)	10% (4% - 14%)
	Slope Shape	Convex	Concave	Convex	LINEAR	Linear
Native Vegetation	**Structure Dominant Stratum**	Open forest	Open woodland	Open forest	Open forest	Open forest
	SPECIES	Messmate, Narrow Leaved Peppermint, Brown Stringybark, Occasional Swamp Gum, Manna Gum, Scent Bark	Brown Stringybark Swamp Gum Shining Peppermint	Brown Stringybark Narrow Leaved Peppermint, Swamp Gum, Occasional Scent Bark, Messmate	Messmate, Narrow Leaved Peppermint Swamp Gum, Brown Stringybark	Messmate, Swamp Gum, Narrow Leaved Peppermint Scent Bark
	Other Common Species	Prickly Tea Tree, Myrtle Wattle, Silverbanksia	Prickly Tea Tree, Scented Paperbark, Black Sheoak	Prickly Tea Tree, Narrow Leaved Wattle, Silver Banksia, Red Fruit Saw Sedge, Bracken	Narrow Leaved Wattle, Prickly Tea Tree, Prickly Moses, Myrtle Wattle	Narrow Leaved Wattle, Prickly Moses
Soil	**Parent Material**	Unconsolidated clay, silt & sand	Colluvial sand on unconsolidated sand, silt & clay	Colluvial sand on unconsolidated clay, silt & sand	Unconsolidated clay, silt & sand	In-situ weathered rock
	Group	Mottled yellow, red gradational soils, fine structure	Grey sand soils, compact clay underlay	Grey sand soils, compact clay underlay	Coarse structured yellowish brown gradational soils	Coarse structured yellowish brown grad. Soils
	Surface Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy clay loam
	Permeability	Moderate	Slow	Slow	Slow	Slow
	Av. Depth M	2	2	2	2	1.5
	Northcote Class	Gn 3.84				Gn 4.71
Land Use		Uncleared areas: hardwood forestry, domestic water supply protection, wildlife conservation, gravel extraction. Minor cleared areas: beef cattle grazing, dairy farming				
Hazards Of Soil Deterioration		Low hazard of sheet erosion on the steeper slopes	Moderate hazard of waterlogging		Moderate hazard of gully erosion & rilling of road batters	
Management Practices For Soil Conservation		Maintenance of deep rooted vegetation in drainage lines on lower slopes. Roads & tracks to be designed for good drainage with adequate culverts & table drains. Gravel pits reclaimed with top 40 cm soil when disused.				


LAND SYSTEMS OF THE HEYTESBURY SETTLEMENT
DEVELOPMENT COMMENCED IN 1956
TOTAL AREA 100,500 ACS
ESTIMATED TOTAL Nº OF FARMS : 500
Area set aside for general settlement in parishes of Jancourt, Cooriejong, Coradjil, Waarre Carpendeit, Wiridjil, Latrobe & Natte Murrang.
Forest Areas
Native trees
Pine
Principal Roads
Proposed Roads
Principal Towns
Rivers & Creeks
Scott's Creek
SCALE OF MILES
0 ¼ ½ ¾ 1 2 3 4
COMPILED AS AT OCT' 1976
N
SOIL CONSERVATION AUTHORITY VICTORIA
SCA
This base map has been supplied by courtesy of the Rural Finance & Settlement Commission, Victoria.
LEGEND
TOMAHAWK CREEK LAND SYSTEM 1 DEEPLY DISSECTED PLATEAU REMNANTS
SIMPSON LAND SYSTEM 2 VERY GENTLY UNDULATING PLATEAU
WAARRE LAND SYSTEM 3 UNDULATING HILLS
WONGA LAND SYSTEM 4 UNDULATING PLAIN
KENNEDYS CREEK LAND SYSTEM 5 UNDULATING PLAIN
FERGUSONS HILL LAND SYSTEM 6 UNDULATING HILLS & RIDGES
SWAN MARSH LAND SYSTEM 7 FLAT PLAIN
MT MACKENZIE LAND SYSTEM 8 DEEPLY DISSECTED HILLS
PORCUPINE CREEK LAND SYSTEM 9 UNDULATING PLAIN
10 SAND DUNES
11 ALLUVIAL FLATS
CARPENDEIT
SWAN MARSH
IRREWILLIPE
TO COLAC 10 MILES
TO COLAC
JANCOURT
TIMBOON
TO WARRNAMBOOL 32 MILES
SIMPSON
KENNEDYS CREEK
PORT CAMPBELL
TO WARRNAMBOOL
40 MILES
PRINCETOWN
TO LAVER'S HILL & APOLLO BAY
SOUTHERN OCEAN
PAARATTE
WAARRE
COORIEJONG
CORADJIL
NATTE MURRANG
BARWONGEMONG
HANSON PLAIN
COORIEMUNGLE PRISON FARM
FERGUSONS HILL
PERMANENT FOREST
PROPOSED PERMANENT FOREST
PINE PLANTATION
KRAFT CHEESE CO.
Tomahawk Creek
Scott's Creek
Gellibrand River
Sherbrooke River
CHAPPLE VALE
COBDEN