5. DESCRIPTION OF THE ENVIRONMENT

5.1 Geology

Ordovician

The geological history of the study area dates back to the Ordovician period (around 480 million years ago) when sandstones, siltstones and shales were laid down in a deep marine basin. Marine sedimentation continued uninterrupted for approximately 180 million years and during this period up to 3000 m of sandstones and siltstones were laid down. Subsequent folding, uplifting and erosion of these sediments has formed part of the present land surface in the study area.

Devonian

The Late Devonian Period was characterised by volcanic activity which extruded pyroclastic material and rhyodacite lava over the southern part of the Shire. During this period granitic complexes intruded into the Ordovician sediments in the northern part of the Shire forming the granitic outcrop known as the Cobaw batholith, which is visible as the Cobaw Range.

Carboniferous - Cretaceous

The interval between the Carboniferous and early Cretaceous Period was a time of tectonic stability and prolonged erosion.

Tertiary

During the Tertiary Period, some 7 million years ago, volcanic activity recommenced. Trachyte was exuded at three localities forming the prominent domes of The Jim Jim and The Camels Hump, and the pinnacles of Hanging Rock.

In the central part of the Shire the valleys were infilled by basalt flows during the Late Tertiary Period. This formed the flat volcanic plains with several hills marking the points of eruption.

Quaternary

The most recent event has been alluvial deposition on the flood-plains of the creeks and rivers.

5.2 Geomorphology

The Shire of Newham & Woodend has a very distinctive character due to its complex geology and the geomorphic processes acting upon it. This has resulted in a wide variety of landforms, soils and vegetation.

Six broad geomorphic areas can be identified and it is on this basis that the soils and vegetation are discussed in the next sections.

Area No. 1 Central Macedon Massif

In the south-east high rainfall area of the Shire the Devonian rhyodacite has resisted erosion more than the surrounding sediments and now the Mount Macedon Range remains as a single prominent landscape feature. Maximum elevation is 1001 metres and the side slopes are moderate to steep, particularly on the northerly aspect. The flat summit of the Mount Macedon massif - one of the oldest recognisable land surfaces - probably dates back to the Mesozoic, (Jenkin, 1976).

Area No. 2 Cobaw Range

The Cobaw Range in the north of the Shire forms part of the granitic Cobaw Batholith, which extends from Kyneton to Pyalong. The Range is comprised of rolling hills with gentle, moderate and steep slopes. Dissection has produced long spurs with broad crests that are often strewn with large boulders.

Area No. 3 Volcanic plains

North-east of Woodend the level plains and gently undulating areas are of volcanic origin and have formed as a result of lava flowing out from several points of eruption. The Jim Jim is the largest trachyte done in the area, but Hanging Rock, standing only 711 m above sea level is the best and most impressive example of a volcanic mamelon in Victoria. The Camels Hump is also a prominent landmark in the area, occupying an elevated position on the Macedon Range - itself a remnant of an ancient plateau.

Area No. 4 Basalt plains

Basalt plains occur throughout the central part of the Shire. Golf Course Hill and Sugarloaf Hill are two prominent rises within this plain and consist of scoria cones from which the basalt emanated 6.8 million years ago (King 1984).

Area No. 5 Sedimentary areas

Ordovician sandstones and mudstones occupy the majority of the south-western area and a portion of the north-eastern area of the Shire. The undulating to rolling low hills landscape is unusually gentle given that the area forms the uppermost reaches of a major river system.

Area No. 6 Alluvial flats

Alluvial flats within the Shire are comprised of upper and lower terraces. The upper terrace represents an old flood plain and has more soil profile development and a lower flood risk than the lower terrace.

5.3 Climate

The climate in the Shire is characterised by cold, wet winters and warm, dry summers.

Rainfall

The Great Dividing Range, although relatively low in elevation (Mount Macedon, 1001 m), has a major influence on the climate and in particular the rainfall pattern across the Shire. Most of the precipitation falls as rain but it is not uncommon for light snowfalls to occur on Mount Macedon and the general area of Woodend.

The seasonal distribution of rainfall is one of winter-spring rain (June-October) and summer drought (December-March) (Table 5.1). The average annual rainfall decreases by approximately 10% to the north (Kyneton), south (Gisborne) and east (Lancefield) of Woodend.

As can be expected the number of rain days increases over the entire study area from 7 per month over the summer period to 18 per month over the winter period (Table 5.1).

Table 5.1 Mean monthly and annual rainfall (mm) and number of rain days

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
KYNETON													
Mean Rain	37	39	47	54	75	90	82	84	74	69	52	50	753
No. rain days	5	5	6	9	12	15	16	16	13	11	9	7	124
LANCEFIELD													
Mean Rain	40	43	46	55	69	79	76	81	75	69	52	48	733
No. rain days	6	6	7	10	13	16	17	16	14	13	10	8	136
MACEDON													
Mean Rain	47	52	57	68	79	84	85	88	88	85	65	57	855
No. rain days	7	7	9	11	14	15	16	16	14	14	11	9	143
WOODEND													
Mean Rain	42	55	46	71	79	79	92	91	79	79	58	57	828
No. rain days	7	7	8	12	14	15	18	18	15	15	11	9	149

Effective Rain

Effective rain can be defined as the amount of rain necessary to start germination and to maintain growth; it corresponds to the rainfall in excess of that lost through evapotranspiration. One factor determining the length of the growing season is the period when the probability of receiving rainfall greater than the effective amount exceeds 50%. For Kyneton and Macedon this represents a 7-month period from mid-autumn to early spring (Table 5.2).

Table 5.2 Percentage frequency of occurrence of rainfall equal to or greater than the effective amount

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
KYNETON	8	10	32	55	88	98	99	96	91	72	28	17
MACEDON	8	8	36	65	85	98	99	93	92	85	46	40

Figures in large bold type denote those months where plant growth is not restricted by insufficient moisture.

Temperature

The mean maximum and minimum monthly temperatures for Kyneton and Macedon Nursery are presented in Table 5.3. The highest temperatures are generally recorded during January/February whilst the lowest are usually in July. The mean range is between 25° C and 2° C.

Table 5.3 Mean maximum, minimum and average monthly temperatures (° C) for Macedon DCNR Nursery and Kyneton (17 & 9 years of records respectively)

STATION	ELEV (m)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MACEDON NURSERY	503													
Maximum		24.3	25.1	21.7	17.6	13.7	10.6	9.9	11.3	13.1	16.7	19.5	22.4	17.2
Minimum		10.4	11.0	9.3	7.1	5.3	3.2	2.1	2.9	3.7	5.6	7.3	8.6	6.4
Average		17.4	18.1	15.5	12.3	9.5	6.9	6.0	7.1	8.4	11.2	13.4	15.5	11.8
KYNETON	509													
Maximum		26.5	24.6	22.5	18.1	13.1	10.9	9.4	11.1	13.8	17.1	20.6	22.8	17.5
Minimum		10.3	10.5	9.2	5.5	3.8	2.9	1.9	2.8	3.4	5.4	6.9	8.6	5.9
Average		18.4	17.6	15.9	11.8	8.5	6.9	5.7	6.9	8.6	11.3	13.8	15.7	11.7

Frost

The highest incidence of frost occurs on the open basaltic plains around Kyneton. The average number of frost days per month (Table 5.4) show that normally December to March are frost-free months with July having the highest number of frost days per month (22 days).

Table 5.4 Frost data – Kyneton

		Number of days frost (<2.2°C) per month												
Range of Records	Years of Records	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Maximum	10 (1957-66)	-	-	5	14	24	40	332	27	29	12	8	4	185
Minimum	10 (1957-66)	-	-	-	1	3	8	15	11	6	-	1	-	45
Average	20 (1935-45) (1957-66)	-	-	1	5	14	20	22	18	15	6	4	2	106

Potential Evapotranspiration

Potential evapotranspiration is commonly defined as 80% of the evaporation from a free water surface and is an estimate of the amount of moisture lost by evaporation and transpiration from a fully vegetated area where soil moisture is not limiting.

There is insufficient evaporimeter data within the Shire to calculate evapotranspiration and so approximations, using Leepers modification to Thornthwaite's formula (1950), have been used instead. During the summer months at Mount Macedon the evapotranspiration exceeds the rainfall from mid-November to mid-February (Figure 5.1) and pastures dry off in early-mid December, depending on the rooting depth of the pasture and the quantity of available water in the soil profile. At Kyneton, the lower rainfall and higher evapotranspiration result in a longer dry period each year, from mid-October to mid-March.

Growing Season

Plant growth within the Shire is limited by inadequate soil moisture in summer and low temperatures in winter. The accepted temperature limit for active growth is 6oC mean monthly temperature with no significant growth at all below 6oC. The length of the growing season which can also be represented by the following equation:

Length of growing season = 12

minus No. of months where P (monthly Et > Av. monthly R) > 50% (Newham & Woodend = 5)
minus No. of months were ay. mean monthly temp. < 6°C (Newham & Woodend = 1)

where P : Probability
Et : Evapotranspiration
R : Rainfall

Wind

Wind data from the Commonwealth Bureau of Meteorology presented in Figure 5.2 compares afternoon wind speed and direction at Kyneton and Macedon Nursery.

At Macedon, winds come mainly from the SE during the summer-early autumn period and from N-NW direction during mid-autumn-spring period. Winds tend to be stronger in the afternoon during summer and mid-winter, the windiest month is October and the calmest month is June.

At Kyneton the wind comes predominantly from the south during summer and early autumn, but fluctuates between S and NNE during autumn and winter. In spring the winds tend to come from the northerly quarter. The average wind speed is between 1-20 kph and tends to be stronger in the afternoon all year round. The windiest months are July/August and the calmest months are February/March.

5.4 Soils

Soils within the Shire of Newham/Woodend have a complex distribution due to local variations in soil forming factors such as climate, topography, flora, fauna, time and parent material. The latter includes granites, granodiorites, rhyodacites, volcanics, basalt, sandstones/mudstones and alluvium.

Soil profiles have been assigned values in accordance with "A Factual Key for the recognition of Australian soils" (Northcote 1979). This method is based on textural change with depth, and categorises soils into three major groups.

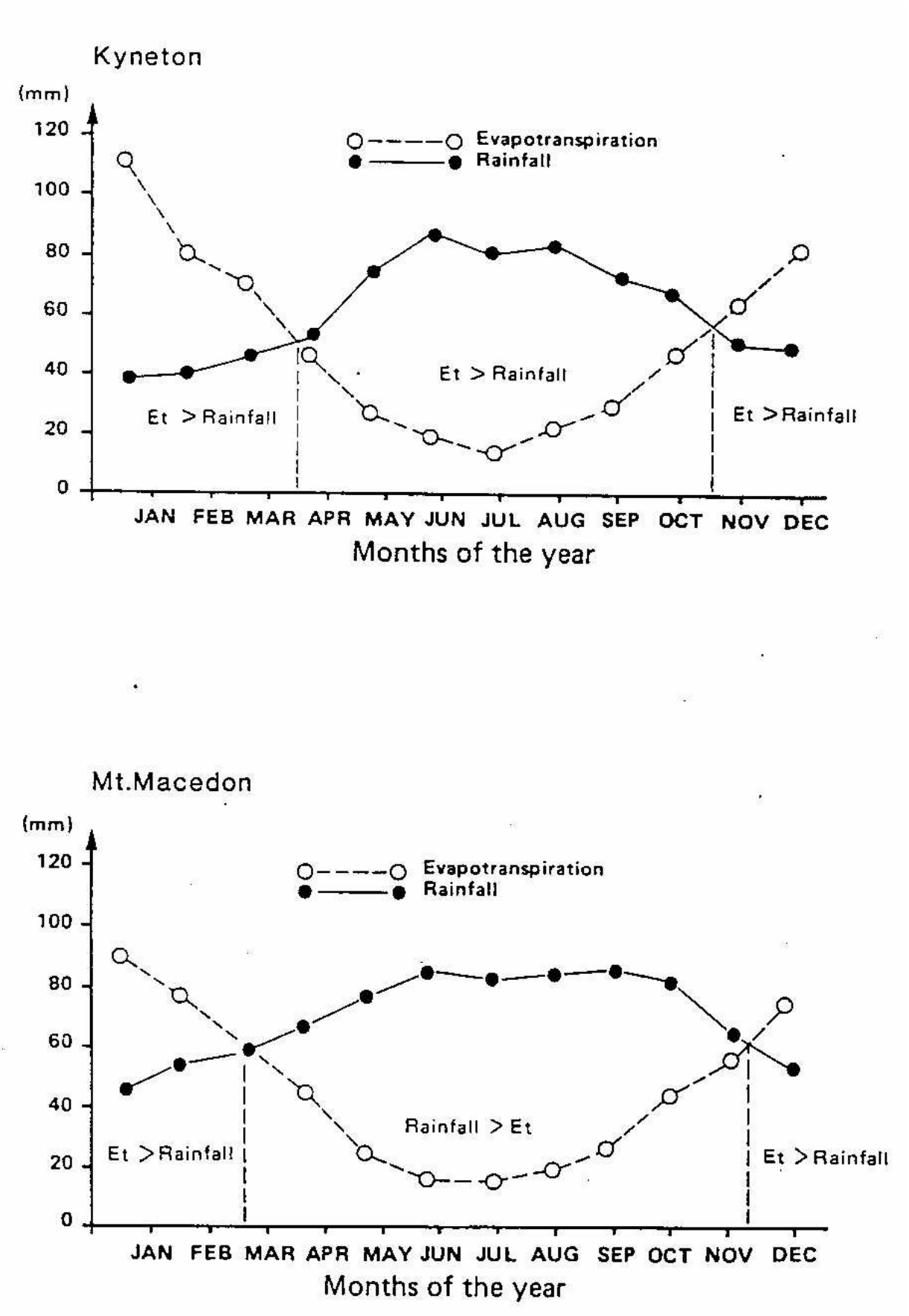

Figure 5.1 Relationship between rainfall and evapotranspiration for Kyneton and Mt Macedon.

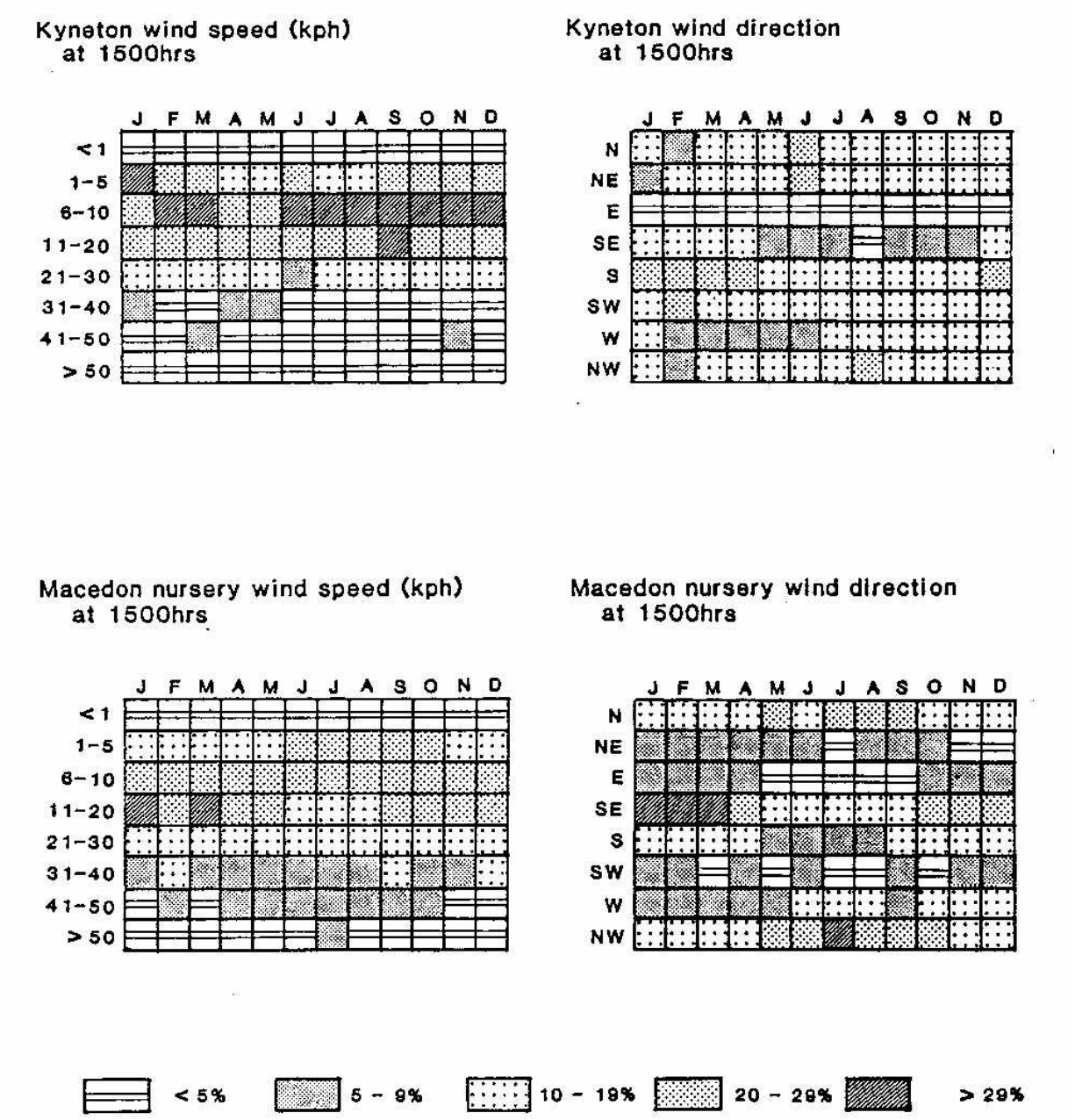

Figure 5.5 Monthly probabilities of wind speed and direction for Kyneton and the Macedon nursery.

(i) Uniform soils are dominated by the mineral fraction and have little, if any, textural change with depth.

(ii) Gradational soils become increasingly finer textured (greater clay content) with depth.

(iii) Duplex soils have a pronounced and clearly defined contrast in texture between the A + B horizons.

These three groups of soils are discussed below in relation to the main geomorphic areas of the Shire described in Section 5.2.

Central Macedon Massif

Uniform soils

Soils occurring on the crest/ridge and steep upper slope positions tend to be shallow and have a high stone content. It is common for there to be an A horizon of loam-clay loam overlying bedrock. The soil profile, although very shallow, has a uniform texture.

Gradational soils
The combination of weatherable minerals in the rhyodacite, high rainfall, rapid drainage and excessive permeability has resulted in the red gradational profile being the dominant soil type. Typically a dark brown loam or sandy loam topsoil overlies a red, well-structured subsoil. These soils are susceptible to erosion for short periods following bushfires or clearing and need the protective cover of vegetation and a deep litter layer. The soils are also susceptible to the leaching of nutrients because of the excessive permeability of the biologically-active profile. The most common profiles are the Gn3.22 and Gn3.04 on the moderate slopes with Gn3.74 occurring in the slightly moister areas of the gentle lower slopes.

Duplex soils
Brown and red duplex soils predominate on the lower, gentle slopes of Mount Macedon but vary in soil structure and nutrient status, according to the wetness of the area. The most common profile has a dark yellowish brown loam, fine sandy topsoil overlying a reddish brown, light medium clay subsoil. A2 horizons do occur but are certainly not bleached and the pH of the topsoil and subsoil lies between pH 6.0 and pH 7.0.

Cobaw Range Uniform soils

These profiles occur in two main landscape positions:

(i) on the crest/ridges and spurs as shallow soils. The coarse sandy profiles are very permeable and consequently have a low quantities of available water and a low nutrient status.

(ii) in the drainage depressions where eroded material has been deposited to form deep profiles. Layers of coarse sandy loams, loamy sands and coarse sands are visible with no pedological organisation other than an accumulation of organic matter in the AI horizon. Again, nutrient status is very low and permeability is very rapid, however a regular supply of water from either runoff or seepage into these deep sands supports a vigorous tree and understorey association.

Gradational soils
These profiles are not common, occurring only as a transitional form between the uniform and duplex profiles on the granitic slopes.

Duplex soils
Yellow mottled duplex soils predominate on the slopes and plateau of the Cobaw Range, however soil depth and proportion of stones/boulders vary depending on the position in the landscape. On the gentle lower slopes, colluvium from the adjacent high metamorphosed ridge of sedimentary material has covered the granite/granodiorite to variable depths, resulting in hardsetting, fine sandy loam topsoils with bleached A2 horizons overlying mottled light medium clays. The nutrient status is very low, the profiles are acidic and the harsh topsoil conditions are not conducive to plant growth.

Volcanic plains Uniform soils

Minor areas of uniform soils occur in two landscape positions;

(i) crests; these soils are shallow, fine sandy loams, rock outcrop is abundant, nutrient status and low quantities of available water. Organic matter can be high if the area is not over-grazed however the soils are very acid and the nutrient status is very low. Phosphorus deficiencies and aluminium toxicities are common. The soils are highly susceptible to sheet erosion.

(ii) flats; these soils are dark, self-mulching, non-cracking clays. They have a moderate nutrient status but tend to get very wet during the winter-spring months. When wet the clays become very sticky and difficult to work. The common soil is a Uf6.32.

Gradational soils
These soils are dominant on the sloping land but vary in depth and colour according to their position in the landscape. On the steeper slopes the profiles become shallower and the dark yellowish brown loams sometimes with an A2 horizon, overlie light clay subsoils. The soils are quite acid (Gn3.21) and have a low nutrient status. On the gentle slopes the deeper profiles include Gn3.24 and Gn3.74. The loamy topsoils have a weak structure and are very susceptible to sheet erosion once the protective vegetative cover is removed.

Duplex soils
Mottled yellow duplex soils (Dy3.41) with sandy loam - clay loam topsoils overlying a medium-heavy clay occur on the outwash slopes of Hanging Rock and The Jim Jim. The A horizons are hardsetting, have a conspicuously bleached A2 and have acidic pH values. In the drainage depressions, organic matter contents in the topsoil are higher, as is the nutrient status throughout the profile. Subsoils tend to be alkaline and the subsoil colour is usually a mottled greyish brown (Dy3.23, Db2.23).

Basaltic plains

Uniform soils
Shallow loamy predominate on the rocky crest positions of the landscape and land use is restricted to native forest or grazing of native pastures. The presence of such fertile well-drained soils has encouraged total clearing of these rocky areas, thereby increasing the hazard of sheet erosion unless the pastures are well managed. Nutrient status is variable however phosphorus is generally deficient. Golf Course Hill is an example of a recreational land use requiring (and receiving) a high level of management and minimising any form of land degradation.

Gradational soils
Basalt plains with gentle slopes are common within the Shire and red gradational soils (Gn3.11) predominate. The soils are not calcareous although the nutrient status is high. The topsoils are barns or clay loans and have a high organic matter content unless they have been cultivated on a regular basis. The pH of topsoil and subsoil tends to be acidic and the high free ferric oxide content is responsible for low available phosphorus levels. The profiles have high permeabilities which could restrict plant growth through lack of available moisture, however a high rainfall distributed over nine months from March to December alleviates that problem. These soils have the highest agricultural potential in the Shire.

Duplex soils
To a minor extent, yellow duplex soils (Dy3.42) occur in the drainage depressions of the basalt plains. The fine sandy loam topsoil indicates that eroded material from adjacent sedimentary country has been imported. Land use is generally limited to the grazing of native pastures because of the risk of flooding or the imperfect site drainage.

Sedimentary areas

Uniform soils are not present in this geomorphic unit.

Gradational soils
On the narrow crest/ridgelines and steep slopes of the metamorphic aureole in the north-east, shallow stony gradational soils (Gn3.94) predominate. These soils have a low nutrient status and are highly susceptible to sheet erosion if the organic litter layer or vegetative cover is disturbed or removed.

In the south-west, incorporating the Wombat Land System gradational soils with a deep loam topsoil merging into a clay loam or light sandy clay subsoil, have developed in the drainage depressions. These profiles are susceptible to gully erosion if runoff within the catchment increases and the flow is confined to narrow channels.

Duplex soils
Throughout the areas on sedimentary parent material, yellow duplex soils are common. On slopes of 10-15%, the profiles are moderately well drained and have whole-coloured subsoils but still have an A2 horizon On slopes of 4-10% the A2 horizons are bleached and mottling is sometimes apparent. With the very gentle slopes of less than 3%, mottling is prominent and common in the subsoil. All these duplex profiles are quite acid and have a very low nutrient status. Cleared land has an increased risk of sheet and gully erosion because of the weakly structured topsoils and high runoff potential of the land. Salt affected areas in the north-east of the Shire on the gentle slopes indicates that these soils are susceptible to a rising saline groundwater table.

Alluvial flats
The soils on alluvial terraces vary markedly because of the different parent materials in the catchment upstream and a depositional regime that is continually changing. In general terms the older upper terrace has more pedological development in the profile than the lower terrace. The soils have a uniform, clayey texture ranging from silty clay to medium-heavy clay, and the physical and chemical properties relate to a desirable agricultural soil. However the upper terrace comprises a very small area within the Shire.

The soils on the lower terrace are typically gradational although the topsoils vary from fine sandy loams through to clay loams. A2 horizons if present can be bleached and the clayey subsoils can be yellow, yellow and mottled or grey and mottled, and tend to be alkaline at depth. The low permeability and high flooding risk does restrict land use to the grazing of native and introduced pastures.

5.5 Native Vegetation

While 75% of the Shire's private land is classed as treeless (Allen 1985), the remaining private land and the extensive areas of public land are well vegetated.

Central Macedon Massif

At Mt. Macedon and on the Camel's Hump area small stands of tall Mountain Ash forest (*E. regnans*) and at Alpine Ash (*E. delegatensis*) can be found.

An isolated woodland of Snow Gum (*E. pauciflora*) exists on the rocky upper slopes and crests of Mt. Macedon and the Camel's Hump (LCC, 1978). A second lowland form of this species occurs as isolated specimens on the surrounding uplands.

Tall open forests of Messmate (*E. obliqua*) and less commonly Narrow-leaf Peppermint (*E. radiata*) are dominant on the mid to upper slopes.

On the lower slopes Manna Gum (*E. viminalis*) and Swamp Gum (*E. ovata*) occur, with Manna Gum preferring the more protected aspects.

On the exposed northerly and western slopes the understorey tends to be open and grassy, however a dense layer of low shrubs and ferns occur beneath the eucalypt canopy in the more protected drainage depressions (Lorimer and Schoknecht, 1987).

The Cobaw Range

On the Cobaw Range in the north of the Shire stands of Messmate (*E. obliqua*) and Manna Gum (*E. viminalis*) can be found, usually as an open forest with a shrubby or ferny understorey. "These species are confined to areas of higher rainfall and occur on moist but well drained sites. Swamp Gum (*E. ovata*) grows in the slightly moister drainage depressions where deep deposits of sandy alluvium/colluvium occur (Lorimer and Schoknecht, 1987).

Volcanic plains

On the crests and upper slopes of the extension points to these plains - Hanging Rock and The Jim Jim being the most obvious, there remain stands of Messmate (E. obliqua) and Narrow-leaf Peppermint (*E. radiata*) and isolated specimens of Snow Gum (*E. pauciflora*). However on the very gently undulating plains all trees have been cleared except for a number of individual Swamp Gums (*E. ovata*) occupying the poorly-drained depressions.

Basalt plains

The soils in the map units of this land system have a high capability for agricultural use and little remains of the original vegetation. Manna Gum (*E. viminalis*) is the dominant tree species on the plains, occurring only as individual trees, whereas Swamp Gum (*E. ovata*) is confined to the wetter depressions. Snow Gum (*E. pauciflora*) can be found on the better-drained, shallow soils of the rocky crests and scarps.

Sedimentary areas

The forested area is dominated by Messmate - the major sought for hardwood timber, and Narrow-leaf Peppermint (*E. radiata*) with Candlebark Gum (*E. rubida*) occupying the lower slopes and drainage depressions. A significant proportion of the Wombat land system has been planted to Pinus radiata however the area involved in this Shire is small. In the sedimentary areas to the north-east, where the rainfall is lower, Swamp Gum (*E. ovata*) and Red Gum (*E. camaldulensis*) occurs in the drainage depressions.

Alluvial flats

These areas have been totally cleared except for the trees lining the meandering stream courses. Narrow-leaf Peppermint (*E. radiata*) predominates however some Messmate (*E. obliqua*) still remain.

Significant plant species within the Shire

Black Gum (*E. aggregata*)
This species of eucalypt is quite rare in Victoria - the only localities being at Woodend where nine stands have been recorded. Regeneration of six of the stands is being hampered by cattle grazing and competition from other plant species such as Gorse, Hawthorn, Blackberries and Pine.

Creeping Grevillea (*Grevillea repens*)
This is another plant of significance that occurs within the Shire. It is found in the ranges of the Great Divide on N to NW facing slopes where the mean annual rainfall varies from 800-1200 mm. All of the populations occur within the Wombat forest.

5.6 Existing Land Uses

Forestry

Hardwood forestry is undertaken on 2782 hectares of public land within the Shire (Allen 1985). The major productive resource is located in the Messmate Gum stands of the Wombat State Forest. The Cobaw range in the north of the Shire is also a source for hardwood timber production. The primary species is Messmate (*Eucalyptus obliqua*) which is harvested for sawlogs, pulpwood, and poles. The easy internal access of Messmate forests and their proximity to markets at Melbourne, Bendigo and Ballarat enhances their value. Narrow-Leaf Peppermint (*E. radiata*), Manna Gum (*E. viminalis*) and some Candlebark (*E. rubida*) are also harvested.

Softwood forestry occurs on 392 hectares of the Shire (Allen 1985). Pinus radiata is the only commercial softwood species grown in the Shire, the first commercial planting being in 1880. Plantations of Pinus radiata can be found in the Wombat State Forest. All but 20 hectares of this is found on public land (Allen 1985). The plantations, dating from the 1920s, were all burnt in the 1983 bush fires but have since been replanted.

Grazing

Merinos for wool production and fat lambs from British short wool breeds over crossbreed ewes are grazed on the improved and native pastures throughout the shire. Beef cattle and horse grazing are also prevalent as part of hobby farming and breeding enterprises.

Cropping

The red basaltic soils throughout the shire are most favoured for cropping, with oats and barley being grown for grain and rape sometimes being grown as a feed supplement. To the north-east of Woodend potatoes are grown and an increasing number of vineyards are being established.

Apiculture

The Cobaw and Wombat State Forests are used by beekeepers as a source of nectar and pollen for honey production. Hives are placed in or adjacent to native species such as Candlebark Gum (*E. rubida*) or Manna Gum (*E. viminalis*) as these are the most prolific honey producing trees.

Recreation

Picnicking, sightseeing and bushwalking are popular recreation activities within the study area. Mount Macedon - a massif of rhyodacite is of special interest as it provides broad scenic views of Melbourne to the south and across the Coliban and Campaspe river catchments to the north.

Another popular destination and focal point within the Shire is Hanging Rock. Hanging Rock is a volcanic mamelon which has resulted from the extrusion of viscous lava. Strong vertical jointing and subsequent weathering along fracture lines has led to a variety of pinnacles, pillars and caves being formed. Visitors are drawn by the mysterious history of the rock and the recreational opportunities it offers, including two picnic race meetings a year.

Water supply

Five proclaimed water supply catchments within the Shire are listed below:

1 Eppalock (Falls and Smoker's Creeks) Catchment
2 Woodend Eastern (Falls and Smokers Creeks) Catchment
3 Woodend Western (Kavanaghs and Barbours Springs) Catchment
4 Lancefield Catchment, and
5 Monument Creek Catchment.

All five catchments have been proclaimed and all but Monument Creek have associated Land Use Determinations (LUD's).

The township of Woodend is supplied by two catchments on the northern and western slopes of Macedon Range, however during the summer period, water is pumped from a storage on the Campaspe River to supplement the supply. The lack of suitable, elevated, water storage sites is a major concern for the Shire Council. As the population and demand for water continues to increase, consideration needs to be given to water conservation measures, land use and land management practices and alternative methods of water treatment, to ensure a safe and reliable water supply.

The Macedon Region Water Authority was created in 1991 under the provision of the Water Act (1989) by the voluntary merger of five former Water Boards. Its function is described under Section 163 (1) (a) - (e) of the *Water Act* 1989 and applies to the whole Woodend Waterworks District.

5.7 Land Systems

The hierarchy of the Land System concept has been maintained in this study. At the broadest level - Land Systems of Victoria - Rowan 11990) identified six land systems in the Shire of Newham and Woodend at a scale of 1:250,000. At a more-detailed scale (1:100,000) Lorimer and Schoknecht (1987) identified seven land systems, which subdivided into a total of 28 land components.

In this study, at a scale of 1:25,000, 31 map units have been identified and in Table 5.5, the close relationship between the soils of the two more-detailed studies can be seen. Where clear relationships do not occur, the 1:25,000 land capability study has invariably been able to locate and map more accurately the dominant soil.

Table 5.5 Comparisons of scale and detail in land inventory studies

Land systems of Victoria [1] (1:250,000)	Land systems in Campaspe R. catchment [2] (1:100,000)			Map Units in the Shire Newham/Woodend [3] (1:25,000)	
Land System	**Land System**	**Comp[t]**	**Soil**	**Map Unit**	**Soil**
2.1 Sg7.2	Cobaw (Cw)	1	Ucl.43	Dga	Ucl.41
			-	Dgp	Dy3.21
		2	Dr2.41	Dgb	Dr2.41
			Dy2.41	Dgc	Dr2.21
			Dy3.41	Dge	Dy3.41
		3	Ucl.21	Dgg	Ucl.21
7.1 Pvf7.5	Diogenes (Ds)	1	Um	Tva	Uml.43
			-	Tvb	Gn4.31
		2	Dy3.41	Tvo	Dy3.41
		3	Gn3.92, Gn3.41	Tvg	Dd2.13, Db2.41
			Dd, Db		
		4	Dy3.41	Tvc	Gn3.24, Dy3.41
		5	Dy3, Db, Gn3	Tve	Gn3.84
				Tvf	Gn3.21
		6	Gn3.11	Tbe	Gn3.11 *
				Tvh	Uf6.32
	Kyneton (Kt)	1	Gn3.1, Gn3.2, Um	Tba	Um6.1 1
		2	Db2.1, Dy3.1, Dy3.2	Tbe	Gn3.11
			-	Tbf	Um5.42
		3	Gn3.1, Gn3.2, Dr3.2	Tbc	Dbl.12
		4	Uf6.32, Ug5.1	Tvh	Uf6.32 *
				Qal	Uf6.33 *
		5	Ug5.1 **	-	-
		6	Gn3.95, Dd3.1	Tbg	Dbl.42
				Qa2	Gn3.92
2.1 Sv7.1	Macedon (Mn)	1	Gn3.11, Gn3.14	Dra	Um6.21
			Gn4.11	Drb	Gn3.22
		2	Db2.41, Gn3.04	Drc	Gn3.04
			Dy3.21, Dr2.2	Dre	Dr2.22
2.1 Ss7.6	Koala (Ka)	1	Gn3, Ucl.23, Um	Osb	Gn3.94
		2	Uc, Um, Dy	Osg	Gn3.41, Dy3.21
		3	Gn3, Dy3.41	Osc	Dy2.21
2.1 Gs7.2	Wombat (Wt)	1	Gn4.1 1, Gn3.74	Osb	Gn3.94
		2		Osd	Dy2.41
		2	Gn3.74, Gn3.84, Dy3.41	Ose	Dy2.11
				Osf	Dy3.22
		3	Gn3.91, Gn4.71	Osg	Gn3.41, Dy3.21

* The more-detailed mapping scale has identified areas of different geologies within the land component.

* * This land component does not occur in the Shire

i) Rowan (1990)
ii) Lorimer and Schoknecht (1987)
iii) Lorimer and Singleton (1993)