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A STUDY OF THE LAND IN THE TYERS RIVER CATCHMENT

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FOREWORD

This survey was made in 1963 but has not been published in the "Study of the Land" series because of the relatively small size of the catchment area.

However, the area is similar to adjacent catchments to the east of Melbourne which are of increasing importance for water supply, forestry, nature conservation and recreation. The future conservation and management of that land for these various, sometimes competing, forms of use should be assisted by this land study.

For these reasons the Authority decided that this reports, which contains basic information about the land and its use in the Tyers River area, should be published.

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SUMMARY

The land covered by this survey is considered in two ways. Firstly, for the area as a whole, an account is given of the major features of the environment significant for land use, namely climate, parent material, topography, soils and native vegetation. Secondly, an integrated assessment of the environmental features allows the recognition of various land-units. These are areas of land each with its characteristic pattern of features, uses and management problems.

The Tyers River Catchment is a small part of the extensive mountainous region in eastern Victoria, and it lies towards the southern boundary of the region in West Gippsland. There is a wide range in altitude, from 1550 m (5,100 ft.) above sea level at the northern end of the catchment down to about 150 m (500 ft.) at the southern end. The climate therefore ranges from sub-alpine with winter snow to warm temperature with hot summers and cool winters.

Basically the catchment is made up of the dissected remnants of two ancient plateaux, and the erosional slopes below each of them. The older and higher plateau (the Baw Baw plateau) and the slopes below it have been formed on granodiorite. The second plateau (the Moondarra plateau) and its slopes have been formed on a series of sedimentary rocks. Also, parts of the Moondarra plateaus are capped with basalt and unconsolidated sediments. Several soil groups are represented and they are all acidic and of moderate to low chemical status. Most the soil depths have gradational profiles, that is, the clay content steadily increases with depth.

Six land-units have been mapped and described to provide a basis for considering uses, potentials and management problems.

Wet and dry sclerophyll forests cover most of the catchment and they support an important forestry industry that provides good quality timber for milling and pulpwood for paper manufacture. However, the chief product from the catchment is water for industrial and domestic consumers in the Latrobe Valley. The area is also significant for recreation and nature conservation. Dairying, beef production and potato growing, with small amounts of other summer crops, are practised to a limited extent on those areas where both the topography and soil readily favour agriculture. There is a limited potential for increasing the areas used for agriculture and softwood forestry.

INTRODUCTION

Purpose of the Survey

Since World War II there has been a great expansion of secondary industry and population in the Latrobe Valley, centred in the cities and towns of Moe, Yallourn, Morwell and Traralgon. With this change came the need for assessing the water resources of the Valley and its capacity to meet the requirements of water supply for both the industrial and domestic consumers, and the disposal of industrial wastes.

In 1954, the Latrobe Valley Water and Sewerage Board was constituted by Act of Parliament, and one of its early projects was to utilize the Tyers River as the main source of water for industries and towns in the Latrobe Valley. First a pumping station was built on the Tyers River to utilize its natural flow. Later the Moondarra Dam was constructed to provide a reservoir of 34 440 megalitres (28,000 acre feet) capacity on the Tyers River and its main tributary, Jacobs Creek. Further utilisation of the river is provided for by the selection of a second storage site upstream from the present reservoir.

The maintenance of optimum values, and the determination of a policy of land use to achieve this aim, are matters of prime concern to the L.V.W.S.B., which requested that the provision of sections 22 and 23 of the Soil Conservation and Land Utilisation Act (1958) be used to protect the catchment area. As a result the catchment was proclaimed as the "Tyers Water Supply Catchment" in the Victoria Government Gazette of 6th March, 1973. Under Section 23 of the Act: -

> "The Authority, after consultation with the Land Conservation Council, shall determine –
>
> (a) the most suitable use in the public interest of all lands in catchment areas;
>
> (b) which of such lands may, without deterioration of or detrimental effect to water supply catchments, be used for forest, pastoral, agricultural or any other purpose or for any one or more purposes; and
>
> (c) the conditions under which various forms of land use may be permitted."

In order to meet the obligations placed on it by the Act, the Authority carried out this survey to obtain basic information about features of the natural environment and their interactions.

Location and Description of the Area

Tyers River is one the main northern tributaries of the Latrobe River, entering its middle reaches near Maryvale. Its headwaters rise on Mount Erica and the Baw Baw plateau at elevations of 1370-1550 m (4,500-5,100 ft.), and then make a rapid descent off the Mount Erica massif as the West Tyers, Middle Tyers and East Tyers branches. These three streams unite at Tyers Junction whence the river flows in a south-south-easterly direction to the Latrobe River. Moondarra Dam is located a short distance below the confluence of the Tyers and its biggest tributary, Jacobs Creek, and the reservoir extends up both streams to form two arms.

The catchment of the Tyers River is forty kilometres (twenty-five miles) long, average eight kilometres (five miles) in width and covers an area of 322 square kilometres (124 square miles). Its boundary on the north is the watershed along the Baw Baw plateau between Mount Baw Baw and Mount Erica, thence descending the eastern flank of Mount Erica to a point near the site of the former Ezard's No, 1 Mill. The eastern boundary ridge between this mill and the pumping station is generally coincident with the Thompson Valley road to Parkers Corner and then the Walhalla-Traralgon road to within a few miles of Tyers township. The Tanjil Bren forest road, which goes in a north-westerly direction from the Moe-Erica road, closely follows the western boundary ridge, whereas between this road junction and the pumping station the ridge passes through largely unroaded country.

The area is well served by forest roads maintained by the Forests Commission, and is crossed by the main road linking Moe to Walhalla and Woods Point. Erica and the Moondarra Reservoir are the only townships, and there are also small groups of houses at West Tyers and Parkers Corner.

The whole catchment, except for a small part around the mouth of the river, is hilly to mountainous and covered with forests, so that the main industry is forest management and timber extraction. Three saw mills operate at Erica and one at West Tyers. Agriculture, in the form of dairying, beef production and potato growing, is restricted to the country around Moondarra, Erica and Parkers Corner and along a few river flats.

This report deals with the proclaimed catchment to the pumping station, situation at the point where the Tyers River leaves the hills and flows for a short distance across a broad alluvial plain to the Latrobe River.

1. CLIMATE

Elements of the Climate

Few climatic records are available for the catchment. The only long term records are for monthly and annual rainfall at Erica. In recent years, pluviometers have been installed at Erica and Moondarra Reservoir, and also measurements of temperature are made at these two stations.

To obtain a better coverage over the catchment, climatic data much also be used of places outside the catchment. Rainfall records have been used for Walhalla and Toongabbie to the east, for Tanjil Bren, Vesper, Fumina South, Hill End and Willow Grove to the west, and for Moe, Yallourn, Morwell and Traralgon to the south of the catchment. Daily temperatures are recorded at Tanjil Bren, Yallourn and Maryvale, but only the figures for Yallourn have been taken for a lengthy period.

Precipitation

Average annual and monthly rainfall.

Records for a number of rainfall stations are listed in Table 1, and these have been used to construct the isohyet map of average annual rainfall in Figure 1.

TABLE 1. – Average Annual Rainfall for Selected Stations.

Station	Number of years of records	Average annual rainfall mm
Erica	41	1199
Moondarra Reservoir	16	1039
Walhalla	79	1219
Toongabbie	34	705
Tanjil Bren	23	1757
Vesper	30	1385
Fumina South	29	1170
Hill End	33	998
Willow Grove	20	961
Moe	66	989
Yallourn	15	965
Morwell	53	820
Traralgon	62	758

The lowest average rainfall is about 840 mm (33 ins) at the southern end of the catchment, and it steadily increases towards the mountains at the northern end. Moondarra Reservoir has an average of 990 mm (39 ins) and Erica has an average of 1,180 mm (46.5 ins). There are no rainfall records for the Mount Erica-Mount Baw Baw massif and an approximate figure of 1,900 mm (75 ins) (including snowfall) is suggested. This takes into account the fact that the land rises to 1550 m (5,100 ft.) above sea level, and that Tanjil Bren, with an average rainfall of 1,757 mm (69 ins), is at an altitude of 670 m (2,200 ft.).

In figure 2 the seasonal distribution of rain throughout the year is given graphically by the use of average monthly rainfall figures for four stations with long term records. A feature common to all the station is the more or less even distribution of rain throughout the year without a marked seasonal maximum and minimum. Three of the stations have a slight maximum in October, and all have a slight minimum during February or March. This minimum does not indicate that a dry summer is a feature of the climate, because all stations average more than 150 mm (6 ins) of rain during the three summer months, and Erica averages more than 250 mm (10 ins).

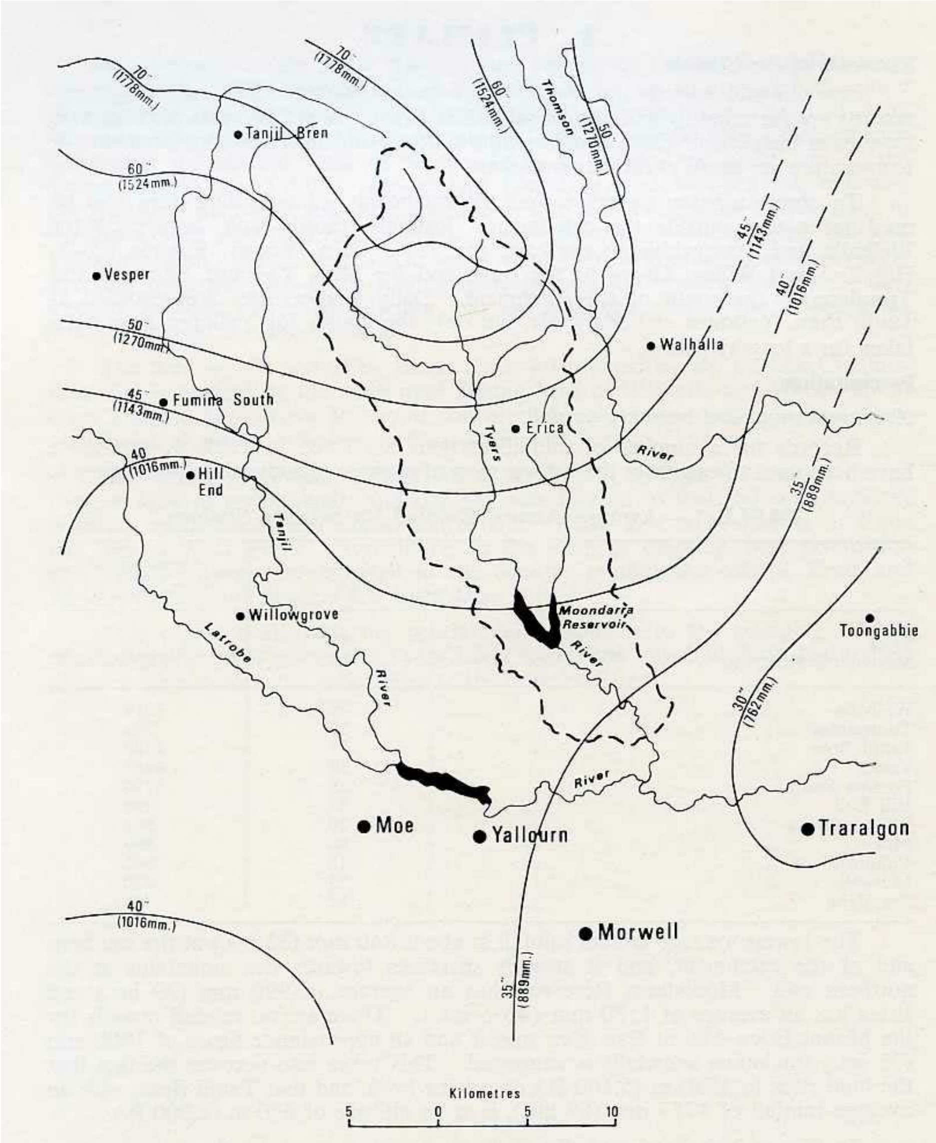


Figure 1 – The average annual isohyets

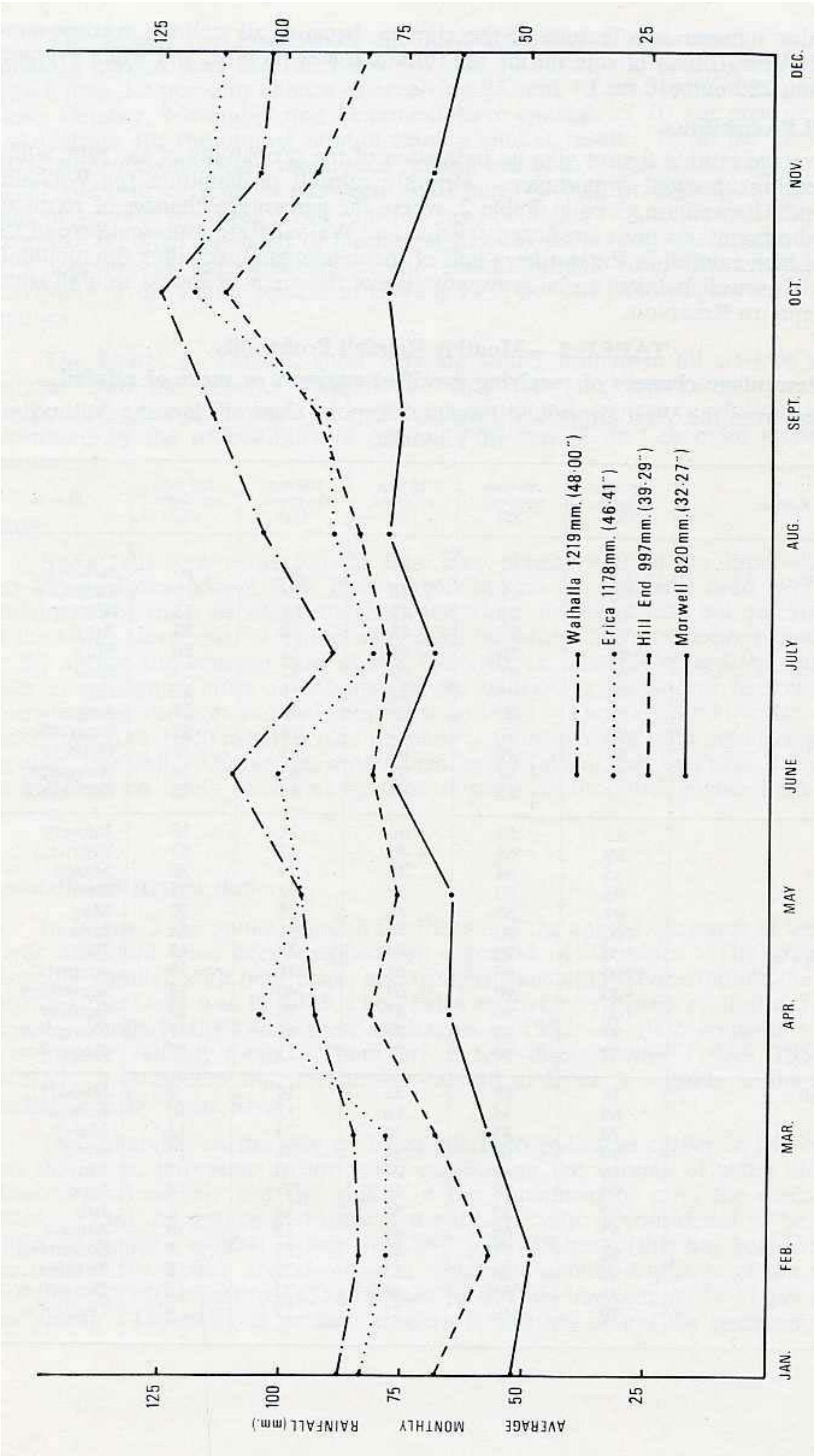


Figure 2 – Average annual and monthly rainfall at selected stations

Rainfall Probabilities

Average rainfall figures give no indication of the probability of the rain, which is something of equal importance. Monthly rainfall probabilities for Walhalla, Erica and Morwell are given in Table 2, where the percentage chances of receiving specified amounts or more are listed. Erica and Walhalla are representative of the areas of high rainfall in the northern half of the catchment, excluding the mountain massif. Morwell is taken to be representative of the areas of lowest rainfall south of Moondarra Reservoir.

TABLE 2. – Monthly Rainfall Probability
Percentage chances of receiving specified amounts or more of rainfall.
(Taken from the West Gippsland Regional Report, Central Planning Authority of Victoria.)

Station	25 mm or more (%)	50 mm or more (%)	75 mm or more (%)	100 mm or more (%)	125 mm or more (%)	Month
Walhalla	89	73	57	34	16	January
	80	57	42	29	19	February
	94	72	47	35	23	March
	95	75	48	30	20	April
	94	70	48	33	20	May
	97	87	69	37	23	June
	98	82	52	31	17	July
	98	90	68	41	21	August
	99	97	82	54	28	September
	98	94	86	63	36	October
	98	84	62	43	24	November
	94	82	68	46	25	December
Erica	85	63	46	28	18	January
	89	65	43	23	13	February
	85	64	45	29	20	March
	95	80	59	42	33	April
	87	65	49	33	20	May
	100	92	70	31	14	June
	100	73	44	28	15	July
	100	86	65	36	18	August
	100	90	63	40	18	September
	100	96	85	70	53	October
	99	95	78	1	31	November
	97	94	72	51	28	December
Morwell	76	48	22	14	9	January
	65	34	16	12	10	February
	78	45	34	23	13	March
	90	64	34	21	13	April
	88	49	24	10	7	May
	96	78	50	25	8	June
	97	57	30	13	8	July
	92	68	44	18	10	August
	98	75	43	22	7	September
	94	84	55	29	8	October
	93	56	36	22	12	November
	79	59	32	17	8	December

The figures for Erica show the high reliability of its rain. The average monthly rainfall does not fall below 75 mm (3 ins.), and seven months have a better than 50 per cent change of receiving 75 mm (3 ins.) or above. Of these, June, October, November and December have chances of 70 per cent or higher. Calculations for the annual rainfall show a similar result. In 90 per cent of the years since records began, the annual rainfall has been 890 mm (35 ins.) or higher. In 77 per cent of years it has been 1020 mm (40 ins.) or higher, and in 52 per cent of years it has been 1140 mm (45 ins.) or higher.

Another calculation that expresses the reliability of the rain at Erica is the percentage variability, which is a measure of the departure of the annual rainfall from the average. The variability of the annual rainfall at Erica is 14.5 per cent, a low figure for Victorian stations.

The figures in Table 2 show that the winter rainfall at all station is more reliable than the summer rainfall and that the reliability for all months of the year is higher in the areas of higher annual rainfall. These conclusions are well illustrated by the probabilities of receiving 50 mm (2 ins.) or more at the three stations.

Snow

Snow falls each winter on the Baw Baw plateau and on the upper slopes of the Mount Erica-Mount Baw Baw massif, but no records have been kept of the amount. The snow persists throughout the winter on the plateau but quickly thaws at the lower elevations. Melting snow is an important but unmeasured contributor to the spring and summer flow of the Tyers River. In this regard the numerous bogs of sphagnum moss on the plateau are thought to be natural reservoirs that slowly release the accumulated snow-melt and rain. The suggested average annual precipitation of 1900 mm (75 ins.) or more is an estimate of total precipitation that includes snowfall. During winter months the falls of rain at Tanjil Bren would be matched on many occasions by falls of snow on the much higher land on the plateau.

Rainfall and stream flow

In Figure 3 the annual rainfall for Erica and the annual discharge of the Tyers River at Gould have been graphed for a period of 28 days. The graphs are generally parallel, with both peaks and troughs coinciding. For example the lowest recorded discharge was in 1938 when Erica received its lowest rainfall during the period. Similarly the two highest discharge in 1952 and 1935 coincide with the two highest rainfall totals. These are a few discrepancies (1933, 1959) but generally it is evident that the annual rainfall at Erica is a guide to the annual discharge of the Tyers River.

The reliability of the rain at Erica has been indicated earlier in the chapter, and this is an important factor when considering the volume of water stored in Moondarra Reservoir and the ability of the catchment to meet the demand for water. From the graphs in Figure 3 a very dry year is considered to be one in which the annual rainfall is less than 890 mm (35 ins.), (this has been so in 10 per cent of the years), and also one in which the annual discharge of the river is less than 92 250 megalitres (74,000 acre feet), (this has been so in 100 per cent of the years). The point of greatest concern is whether or not the reservoir, with a capacity of 34 440 megalitres (28,000 acre feet), can be brought to full supply level each year by the Tyers River and Jacobs Creek. From the data presented it can be seen that the precipitation over the catchment is high enough and reliable enough to guarantee a full storage every year.

Temperatures

Daily air temperatures within the catchment are recorded at Erica and Moondarra Reservoir and outside the catchment at Tanjil Bren, Yallourn and Maryvale. Yallourn and Erica have the longest records (Table 3), and their figures may be applied to the southern and central parts of the catchment respectively.

An important factor controlling temperatures within the catchment is altitude, and because this varies from about 150 m (500 ft.) above sea level to 1550 m (5,100 ft.) it is to be expected that a wide range of temperatures occurs across the area. Using the figures for Yallourn it can be said that the southern part experiences warm to hot summers with average daily maximum temperatures of 25°-26°C (77° to 79°F). The winters are cold, the average daily minimum being 4°-4.5°C (39°-40°F). By contract the Baw Baw plateau experiences mild summers where ain all probability the maximum temperature seldom reaches 32°C (90°F). The winters of the plateau are very cold but no records are available to show the severity.

An indication of the likely temperature regime on the Baw Baw plateau is obtained from records for Hotham Heights 1700 m (6,100 ft.), and Mount Buffalo 1330 m (4,370 ft.) which are the only places at comparable elevations in Victoria with long-term temperature records (Table 3). It is probable that the average temperatures on the plateau are between those for Hotham Heights and Mount Buffalo. However two facts much be taken into account when making this assessment. The Baw Baw plateau is approximately one degree of latitude further south than the other two places and it is situated on the southern edge of the Victorian Highlands with no land of equal or higher elevation between it and the Southern Ocean. Because of the combined influence of latitude and exposure the temperatures on the plateau may be lower than those suggested by the simple comparison with Hotham Heights and Mount Buffalo.

TABLE 3. – Average daily temperatures at selected stations (°C).

Station	Altitude	Average Daily Temps	Temperatures in Degree Celsius											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Yallourn	150 m	Maximum	25.5	25.2	23.6	18.8	16.1	12.9	12.8	13.9	16.6	19.1	21.2	24.1
		Mean	18.8	18.8	17.4	13.9	11.3	8.9	8.3	9.3	11.2	13.3	15.4	17.7
		Minimum	12.1	12.5	11.3	9.0	6.5	4.8	3.8	4.7	5.8	7.6	9.6	11.3
Erica	425 m	Maximum	23.0	21.9	20.4	16.1	13.2	10.6	10.5	11.3	14.2	15.9	17.8	20.9
		Mean	17.2	16.8	15.6	12.1	9.8	7.6	7.2	7.7	9.8	11.4	12.8	15.3
		Minimum	11.3	11.7	10.6	8.0	6.4	4.6	3.9	4.1	5.4	6.8	7.8	9.7
Mount Buffalo	1340 m	Maximum	19.5	18.9	16.3	11.3	8.2	4.8	3.6	4.7	7.6	10.9	14.5	17.4
		Mean	15.2	14.9	12.7	8.2	5.6	2.4	1.4	2.2	4.6	7.4	10.6	13.3
		Minimum	10.8	11.0	8.9	5.1	2.8	0.1	-0.7	-0.3	1.6	3.8	6.7	9.2
Hotham Heights	1860 m	Maximum	15.9	15.4	13.4	8.4	4.7	1.7	0.2	1.1	3.6	7.3	11.1	14.1
		Mean	11.3	11.1	9.5	4.9	1.9	-0.7	-2.0	-1.3	0.7	2.8	7.0	9.7
		Minimum	6.6	6.8	5.6	1.6	-0.7	-3.2	-4.2	-3.8	-2.1	0.4	2.9	5.3

The average mean monthly air temperature is a convenient guide to plant growth. Trumble (1939) suggested than in southern Australia an average mean monthly temperature of 10.0°C (50°F) is a point of separation between vigorous and slow growth, when no other factor is limiting, and that 7.2°C (45°F) is a point if separation between slow growth and no growth. Figure 4 shows that growth at Yallourn is retarded during the three winter months. The lower figures for Erica reflect its higher altitude and they indicate that growth in the central part of the catchment is adversely affected by cold for a longer period than at the southern end nearer Yallourn.

Potential Evapo-Transpiration

Thornthwaite (1948) introduced the concept of potential evapo-transpiration, which is defined as the maximum amount of water that would be transpired and evaporated, provided there is a full leaf cover in the plant community and unlimited water available within the root zone. It is controlled from day to day by the weather but its long term value may be calculated from certain elements of climate which are temperature, saturation vapour pressure and duration of sunlight.

This concept can be used to provide an estimate of the water status of the soil by considering the balance between rainfall and potential evapo-transpiration. During months of low rainfall and high temperatures potential evapo-transpiration exceeds rainfall and causes of a soil water deficit, that is a drier soil. During the cooler and wetter period of the year the opposite situation occurs so that the soil is at its maximum water content and the surplus is lost as runoff and underground exchange. Allowance is made for soil water storage which can extend the growing season beyond the point where potential evapo-transpiration first exceeds rainfall.

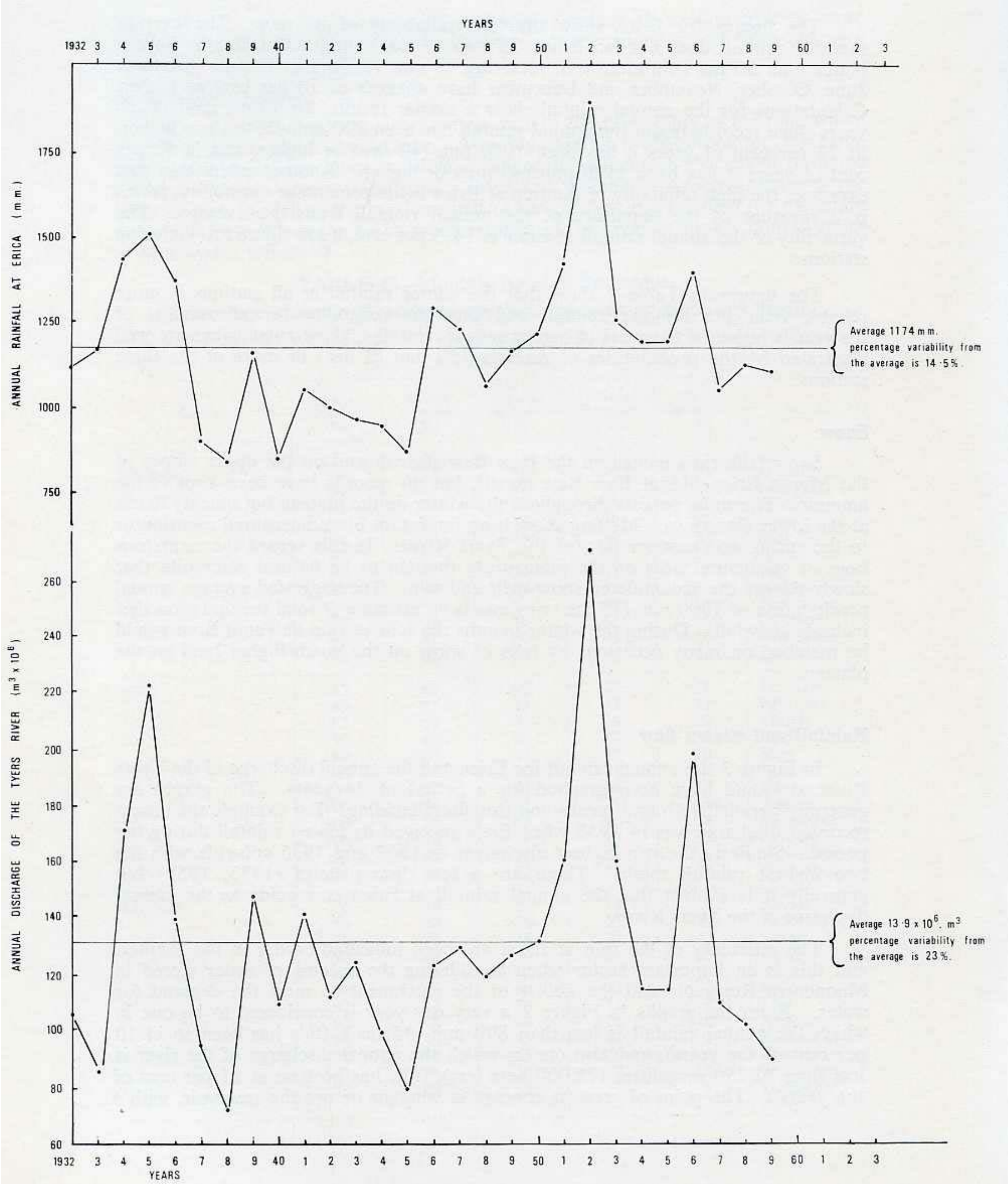


Figure 3 – Comparison between rainfall and river discharge

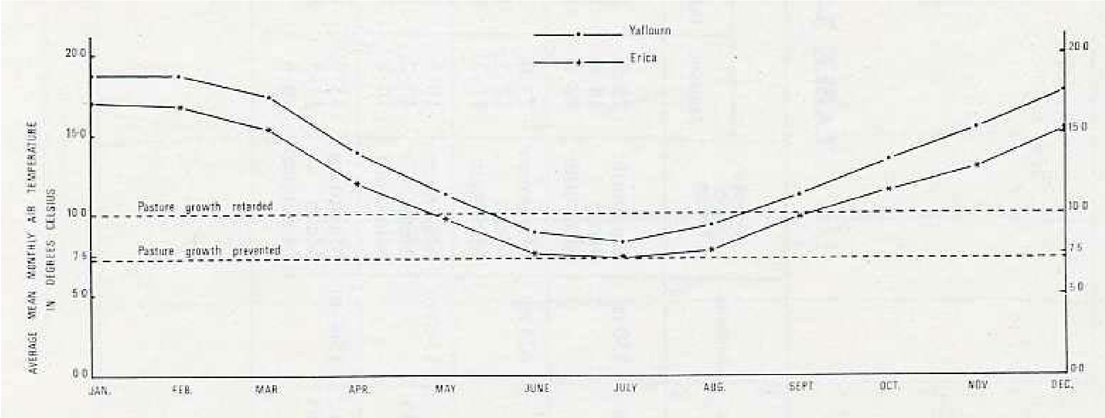


Figure 4 – Relationship between pasture growth and air temperatures

Potential evapo-transpiration has been calculated on an average monthly basis for Erica by using Leeper's (1950) simplification of Thornthwaite's method. The graphs of average monthly rainfall, estimated average monthly potential evapo-transpiration and estimated average monthly storage of soil water are given in Figure 5. January is the only month when potential evapo-transpiration exceeds rainfall, but the amount is so small that the water accumulated in the soil during December is sufficient to sustain growth until February, when rainfall again exceeds potential evapo-transpiration. This carry-over of soil water is illustrated in Figure 5 where January is shown to have 23, 48 and 73 mm (0.93, 1.93 and 2.93 ins.) of soil water, which is derived by subtracting the net loss of soil water 2 mm (0.07 pts.) from three arbitrary storage capacities. The calculation indicated that moisture is usually available for plant growth throughout the year in the Erica district. This agrees with estimates of the chances of receiving effective rainfall at Walhalla taken to be representative of the central part of the catchment Table 4). Values for Morwell indicate that summer rainfall would frequently be inadequate to sustain growth in the southern part of the catchment.

TABLE 4. – Percentage chances of receiving rain equal to or greater than the effective amount for two stations.

(Taken from the West Gippsland Regional Report, Central Planning Authority of Victoria.)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Walhalla	75	69	90	95	96	99	100	100	100	97	95	86
Morwell	53	49	64	92	91	98	100	96	99	93	79	70

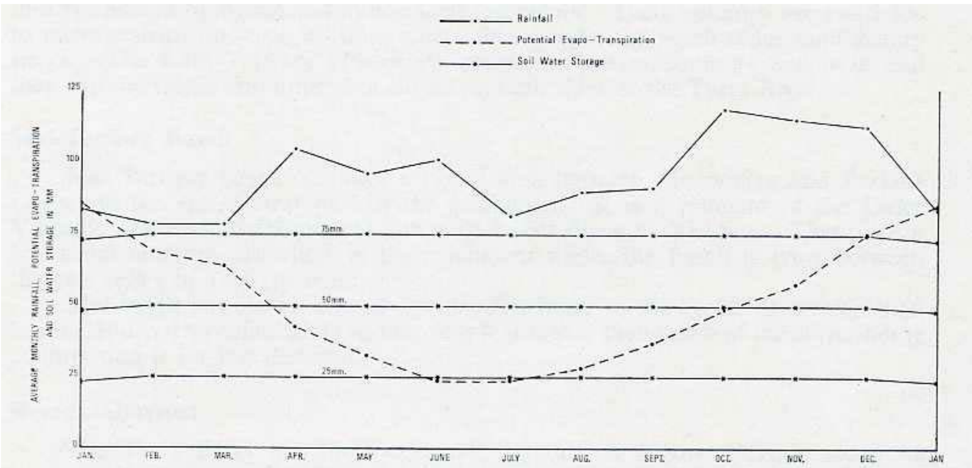


Figure 5 – Estimated quantities of water in the soil at Erica

2. GEOLOGY AND GEOMORPHOLOGY

GEOLOGY

Silurian-Devonian Sediments

Mudstones, shales and fine sandstones form a thick succession of sedimentary rocks estimated to age of Silurian and Devonian age (Thomas 1942, Phillip 1958, 1962). Conglomerates and limestones of the same age are of lesser occurrence. They are strongly folded with high angles of dip and they have been maturely dissected and eroded by the Tyers River and its tributaries so that in many places they are now at lower topographic levels than neighbouring younger rocks.

Upper Devonian Granodiorite

The Mount Erica-Mount Baw Baw massif is formed of granodiorite. It is younger than the Siluro-Devonian sedimentary rocks into which it intruded and has been given an age of Upper Devonian (anon. 1968). It stands out as an erosion residual high above the surrounding sedimentary rocks, having shown a much greater resistance to the agents of geological erosion.

Jurassic Sediments

There are restricted exposures of Jurassic rocks at the southern end of the proclaimed catchment (Phillip 1958). The exposures show a sequence of sedimentary rocks in which coarse conglomerates lie at the base of the sequence, and these are overlain by a succession of sandstones classified as greywackes, protoquartzites and arkoses. These rocks overlie the Siluro-Devonian strata and have low angles of dip. They in turn are covered by Tertiary sediments.

Early and Late Tertiary Sediments

Unconsolidated clays, sands and gravels of both Early and Late Tertiary age occur in the southern half of the catchment. The Early Tertiary deposits are mostly covered by basalt and by the later sediments. Their outcrops are restricted to narrow strips n some hillsides where they overlie the much older sedimentary rocks. The Late Tertiary (Pliocene) sediments are much more extensive and they cap the ridge and upper hill slopes on both sides of the Tyers River.

Mid-Tertiary Basalt

Mid-Tertiary basalt occupies a broad area between Moondarra and Parkers Corner in the east-central part of the catchment. It is a remnant of the Older Volcanic (Eocene to Oligocene) series of basalt flows in Victoria. There are a few small outcrops elsewhere in the catchment where the basalt is lying between the two series of Tertiary sediments.

The basalt has shown a much greater resistance to the agents of erosion than has the Siluro-Devonian strata so that now it is higher than much of the surrounding country and is far less dissected.

Recent Alluvium

The Tyers River has built up small deposits of recent alluvium along its course. These river “flats” are new in number and most of them are found along the middle reaches of the river from Tyers Junction to Phillips Bridge.

GEOMORPHOLOGY

The basic geomorphological features of the Tyers River Catchment are two dissected plateaux and the erosional slopes below each of them. Before dissection the plateaux were uplifted erosional plains. The older and higher plateau surface is the Baw Baw Plateau at elevations of 1370 m (4,500 ft.) to 1550 m (5,100 ft.). It is probably a remnant of a land surface that has extensive in Victoria in Mesozoic (Triassic) times and is now represented in the Eastern Highlands by isolated “high plains” at elevations of between 1370 m (4,500 ft.) and 1800 m (6,000 ft.) above the sea level (Hills 1955, 1959). The Baw Baw plateau is moderately dissected, with a rolling to hilling topography, and it is separated from the second dissected plateau, the Moondarra plateau, by the mountain slopes of the Mount Erica-Mount Baw Baw massif.

The Moondarra plateau lies to the immediate south of the Baw Baw plateau and it occupies the central and southern parts of the catchment (Anon. 1968). It extends far beyond the boundaries of the catchment, to the west and north west. It is younger, possibly of Eocene age, and is at lower elevations of about 150 m (500 ft.) and 450 m (1,500 ft.) above sea level. It starts at about 150 m *500 ft.) at the northern edge of the Latrobe Valley where the Yallourn monocline has given a sudden and clearly defined uplift in the land surface above the alluvial plain of the Latrobe River. The plateau rises steadily in elevation to 400 m (1,300 ft.) at Moondarra and to 450 m (1,500 ft.) around the south western base of the mountain massif. Most of the Moondarra plateaus, that is the area of Siluro-Devonian sedimentary rock, is maturely dissected by the Tyers River and its tributaries so that the plateau is preserved only as narrow ridge tops below which there are comparatively short erosional slopes forming steep-sided valleys. The Mod-Tertiary basalt has resisted erosion more strongly than the sedimentary landscape at higher elevations than many of the ridge of sedimentary rock. In some of the central and southern areas of the plateau there are deposits of Late Tertiary unconsolidated sediments capping the ridge and forming the present land surface. These ridges are broader than those to the north formed from the sedimentary rocks.

A minor geomorphological feature not directly associated with the plateaux is the few small deposits of recent alluvium built up by the Tyers River. For most of its length the river flows in a narrow valley cut into the Moondarra plateau and there are no extensive alluvial plains. The largest of the alluvial "flats" are at Tyers Junction where the West, Middle and East Tyers Rivers join, and at Phillips Bridge where Hotel Creek and its tributaries join the Tyers River.

The catchment is divided into geomorphological units (Table 5) and these provide the basis for recognising and delineating the chief mapping units of the survey, the land units. The initial subdivision is into destructional land surfaces (those surfaces that owe their present shape principally to geological erosion) and constructional land surfaces (those surfaces that owe their present shape principally to building-up processes such as depositions and extrusion).

TABLE 5. – Geomorphological Units in the Tyers River Catchment.

Destructional land surfaces	Dissected plateaux remnants	Baw Baw plateau
		Moondarra plateau
	Steep erosional slopes below the plateaux	Long mountain slopes
		Short hill slopes
Constructional land surfaces	Unconsolidated sediments	Late Tertiary sediments
		Recent alluvium
	Volcanic extrusion	Mid-Tertiary basalt

From the foregoing a summary of the topography of the catchment can be given. Most of the catchment, comprising the central and southern parts, is occupied by steep, forested hills and narrow ridges. The northern sections consists of long mountain slopes rising to a sub-alpine plateau. Undulating and rolling landscapes with moderate slopes are restricted to the basaltic area in the centre and to the broad ridges overed with Tertiary sediments in the centre and south. There are no extensive areas of flat land and small deposits of alluvium along the Tyers River comprise most of this type of land.

3. SOILS

SOIL CLASSIFICATION AND DISTRIBUTION

Several sources have been used to classify soils in the catchment. Table 6 shows the important soil groups, their authorities where possible, and some of the environmental features associated with the groups. Some are grouped together for convenience in the following discussion because of their similarities. Profile descriptions of typical examples and a comprehensive range of analytical results are given in Appendices IA and IB.

Bog Peats and Humified Peats

The bog peats are organic soils made up of the decomposing and decomposed residues of sphagnum moss and to a lesser extent of sedges. They have low mineral contents. The surface layers have spongy yellowish brown raw peat and below this the deeper layers gradually become more compact and brown and then black as the decomposition of the peat increases. In the deepest payers the peat is a compact, black, greasy and structureless mass. The profile is saturated with profile. Underneath the peat is a gleyed mineral horizon of clayey sand and gravel. The peat is moderately to highly acid, usually about pH 4.5 at the surface, rising to pH 5.5 in the deepest layers.

The bog peats are confined to the permanently wet sphagnum bogs that are found on valley floors and in hillside drainage lines on the Baw Baw plateau.

The humified peats resemble the bog peats in being organic soils, but they differ from bog peats in that the organic matter is broken down to a colloidal form. Also they have higher amounts of the mineral fractions, namely sand, silt and clay, and an aggregation of the soil material into structural units. The soil is a black silty or silty clay loam with a greasy feel, and the pH values are within the same range as in the bog peats.

The humified peats also occur on the Baw Baw plateau where they have developed from bog peats after the bog peats have dried out and become aerated. The drying-out process is started by a prolonged lowering of the water table such as follows the entrenchment of the water courses in the valley bogs, or the onset of a warmer and drier climate. On the valley floors the humified peats fringe the sphagnum bogs and occur in entrenched, desiccated bogs, and they are also found on plateau hillsides. The humified peats support communities of snow grass, sedges and heaths, and snow gum woodlands.

Transitional Alpine Humus Soils and Acid Brown Earths.

The transitional alpine humus soils are mineral soils but their upper horizons are rich in organic matter with a consequent favourable structure and consistence. These organo-mineral horizons are dark brown clay loams and loams which generally occupy the top 20 to 50 cm (9 to 20 ins.) of the profile. Beneath them are yellowish brown horizons of high sand content and low clay content. The field textures vary from coarse sandy loams to clayey coarse sand depending on the amount of clay. These horizons in turn pass into decomposing granodiorite at variable depths. Boulders of granodiorite occur throughout most of the profile. The pH values are between 4.5 and 5.0 at the surface rising slightly to between 5.0 and 5.5 in the deepest horizons.

These soils occur at elevations of between 1000 m (3,500 ft.) and 1550 m (5,100 ft.) on the slopes and plateau of the Mount Erica-Mount Baw Baw massif. On the mountain slopes the organo-mineral horizons are deeper and have more organic matter than the equivalent horizons on the Baw Baw plateau. This is probably a result of the denser and more luxuriant vegetation on the mountain slope.

The acid brown earths are similar to the transitional alpine humus soils in most features and the main difference is in the amount of organic matter in the upper horizons. The acid brown earths have less organic matter and this is shown by the lower percentages of organic carbon in the laboratory analyses (about half) and the shallower depths and poorer structure of the organo-mineral horizons. Other differences are in the colours and clay contents of the mineral subsoil horizons. In the acid brown earths these horizons are generally strong brown (7.5YR hue, Munsell Colour Chart) with 20 to25 per cent clay, whereas in the transitional alpine humus soils they are generally yellowish brown (10 YR hue) with 10 to 11 per cent clay. This may an indication that the downward movement of ferric oxide and clay is stronger in the acid brown earths and therefore than incipient podzolisation is occurring. The textures, pH values and levels of exchangeable metal cations in both soil groups are of the same order.

The acid brown earths occur on the slopes of plateau of the Mount Erica-Mount Baw Baw massif at elevations of between about 750 m (2,500 ft.) and 1500 m (5,100 ft.). On the mountain slopes they occur between 750 m (2,500 ft.) and 1000 m (2.500 ft.), that is, below the transitional alpine humus soils. On the Baw Baw plateau they occur on steep, rocky hillslopes and exposed ridges where apparently organic matter has not accumulated to any great depth. In the same area the transitional alpine humus soils occur on sheltered aspects and on lesser slopes where the rock does not outcrop so abundantly and organic matter has accumulated to greater depths.

Red Earths

Like the two previous soil groups the red earths have comparatively deep surface and subsurface horizons containing larger amounts of organic matter. The depth of influence of organic matter is about 60 cm (24 ins.), the same as in the other two soil groups. These horizons are dark brown and dark reddish brown loams with good structure and consistence. At depth the profile becomes more red and more clayey so that below 75 cm (30 ins.) the soil is a reddish brown clay. The profiles are very deep and floaters of parent rock are rare. The pH values down the profile vary slightly around 5.0.

Thee soils have many properties similar to the acid brown earths, for example the pH values; levels of exchangeable cations; amount of organic matter and the depth of its influence on the profile. The characteristic properties of the red earths are found in the subsoil below the horizons influenced by organic matter. The subsoil is redder and has much higher levels of clay and less sand than the subsoils of the acid brown earths.

The red earths occur on granodiorite on the lower slopes of the Mount Erica-Mount Baw Baw massif, below the zone of acid brown earths, and they are the lowest member of the altitudinal sequence on granodiorite that includes the acid brown earths on the middle slopes and the transitional alpine humus soils on the upper slopes and plateau.

Krasnozems

The krasnozems are deep, well structured and friable red clayey soils. The surface horizon I a dark reddish brown loam and below this the amount of organic matter quickly decreases while the clay content increases, the colour reddens and the soil becomes a friable, well structured red clay. The pH values are slightly acid, generally 6.0 approximately.

Compared with the other soil groups in the catchment the krasnozems have the reddest colours, their subsurface and subsoil horizons have relatively good structure without the influence of organic matter, they are the least acid and they have the highest levels of plant nutrients such as the exchangeable metal cations and phosphorus.

These soils occur mainly on basalt in the central part of the catchment between Moondarra and Parkers Corner. They also have a limited occurrence at the base of the Mount Erica-Mount Baw Baw massif on the Siluro-Devonian mudstones, shales and fine sandstones, where these rocks are in contact with the granodiorite. These krasnozems on the metamorphosed sedimentary rocks are similar in their textural and structural properties and chemical analyses to the krasnozems on basalt but they are not as red nor as saturated with the metal cations (sodium, calcium, magnesium and potassium).

Brown Acidic Clayey Soils

The brown acidic clayey soils have uniformly strong brown colours (7.5 YR hue) in the subsurface and subsoil horizons and a moderately good structure throughout the profile. Profiles do no exhibit strongly differentiated horizons. The clay content gradually increases with depth so that the field texture at the surface is a loam or silty loam, a clay loam in the middle horizons and a clay in the subsoil. The pH values vary between 5.0 and 5.5 and the levels of the exchangeable metal cations are comparatively high.

These soils are similar to the acid brown earths in their pH values and in the colours of the profile below the horizons influenced by organic matter. However, the clay content is higher and it increase with depth instead of decreasing, the levels of the exchangeable metal cations and their percentage saturation of the exchange complex are higher, and the amount of organic matter and the depth of its influence down the profile are less. Compared with the krasnozems the brown acidic clayey soils have similar clay contents and field textures but their colour is brown, they are more acid, they have a poorer structure and they have lower levels of the exchangeable metal cations and phosphorus.

These soils are found on broad undulating ridges along the eastern boundary of the catchment where unconsolidated Tertiary gravels and clays are deposited.

Clay Leptopodzols

The clay leptopodzols are weakly structured, pale yellowish brown soils in which the clay content and the strength of colour gradually increase with depth. The upper horizons are loams and in the deeper horizons there is a gradual change to lay loams and then clays. There is very little organic matter in the surface soil and it has no marked influence on structure. Almost the entire profile is weakly structured; hard when dry and firm when moist. The soil is very acidic, with pH values at the surface around 4.5 rising slightly with depth to around 5.0. The chemical analyses show low levels of exchangeable metal cations and phosphorus, and high levels of exchangeable hydrogen throughout the profile.

These soils have developed on Siluro-Devonian mudstones, shales and fine sandstones and they are widespread in the catchment on the steep hills formed by mature dissection of those rocks.

Sandy Clay Leptopodzols

The sandy clay leptopodzols have a similar appearance to the clay leptopodzols having similar colour and structures. However there are significant analytical differences. Sandy clay leptopodzols are generally slightly less acidic (pH 5.0-5.5) although some overlap in pH values does occur between individual profiles of the two groups. Also the sandy clay leptopodzols have more sand, less clay and less silt in the fine earth fractions, and this is reflected in field textures which are dominated throughout the profile by the sand fraction and which are coarser in the upper horizons (loamy coarse sands and coarse sandy loams) than the corresponding horizons in the clay leptopodzols. The two groups of soils have similar contents of the exchangeable metal cations but the sandy clay leptopodzols have lower amounts of total phosphorus and total potassium.

The soils of this group occur within the areas of unconsolidated Tertiary gravels, sands and clays where they intermingle in complex fashion with podzolised duplex soils.

Podzolised Duplex Soils

In this group of soils the profile is sharply divided into contrasting A and B horizons. The A horizon is sandy and loose or soft. Its depth is usually within the range of 25-40 cm (10-15 ins.), colour is medium grey to dark grey and texture varies from sand to sandy loam. In many sites the colour and texture are influenced by grains of white quartz sand. The bottom of the A horizon is usually bleached white. There is an abrupt change to the B horizon which differs markedly in colour, clay content, consistence and permeability. At the top of the B horizon there is commonly a narrow zone of cemented dark brown sandy loam called “coffee rock”. Below this the colour is predominantly yellowish brown, the clay content increases by variable amounts to give sandy clay loams, sandy clays or clays, and the consistence is hard when the soil s dry. The B horizon is weakly structured, cemented, and of relatively low permeability so that the lower part of the A horizon is waterlogged during the winter and early spring. Underneath the B horizon there is a mottled red and white lateritic clay with variable amounts of large quartz stones, sometimes arranged into bands. This material is often exposed in road cuttings.

These soils are highly acidic, with pH values in the A horizon of 4.0-4.5 and in the B horizon from 4.5-5.5. Except for the surface horizon the soils have very low exchangeable metal cations and phosphorus contents.

The podzolised duplex soils occur in the southern half of the catchment on broad undulating ridge tops that are capped with unconsolidated Tertiary deposits of gravels, sands and clays. These soils therefore occur in similar areas and on similar parent materials to the brown acidic clays and the sandy clay leptpodzols.

In a few sites there are humus and iron nomopodzols (sensu Hallsworth, Costin and Gibbons 1953) that are regarded as deep variants of the podzolised duplex soils. The A horizons are loose grey sands 75-90 cm (21/2-3 ft.) in depth, and the B horizons are orange sands or cemented clayey sands and sandy loams. “Coffee rock” at the top of the B horizon is of variable occurrence.

LABORATORY ANALYSES

Water-holding properties

Cores of undisturbed soil were taken from replicated profiles of the two most widespread soil groups, the clay leptopodzols and transitional alpine humus soils. The cores were subjected to laboratory tests to measure their water holding properties. The averaged results are given in Table 7 and shown diagrammatically in Figure 6. Details of the test are given in Appendix 1c. The sampling sites for the transitional alpine humus soils were under wet sclerophyll forests of shining gum on the slopes of the Mount Erica-Mount Baw Baw massif. A description of one of the profiles is given in Appendix 1a. The sampling sites for the clay leptopodzols were under dry sclerophyll forests of messmate and silvertop on the hills of sedimentary rock, and a description of one of the profiles is given in Appendix 1a.

The results show that throughout the profile the transitional alpine humus soils have higher capacities for available water and air field capacity than the clay leptopodzols. The former soils are more important contributors to the flow of the Tyers River than the latter. This theme is developed in more detail in Chapter Six.

Chemical Properties

In this section only those soils of the lower country used, or possibly suitable for agriculture and pine growing will be considered; namely the krasnozems, brown acidic clayey soils, clay leptopodzols, sandy clay leptpodzols and podzolised duplex soils. Selected analytical features of these groups are given in Table 8. The other soil groups occur on the Mount Erica-Mount Baw Baw massif where hardwood forestry and water supply are the main forms of land use. A comprehensive table of analyses for all these soil groups is given in Appendix 1b.

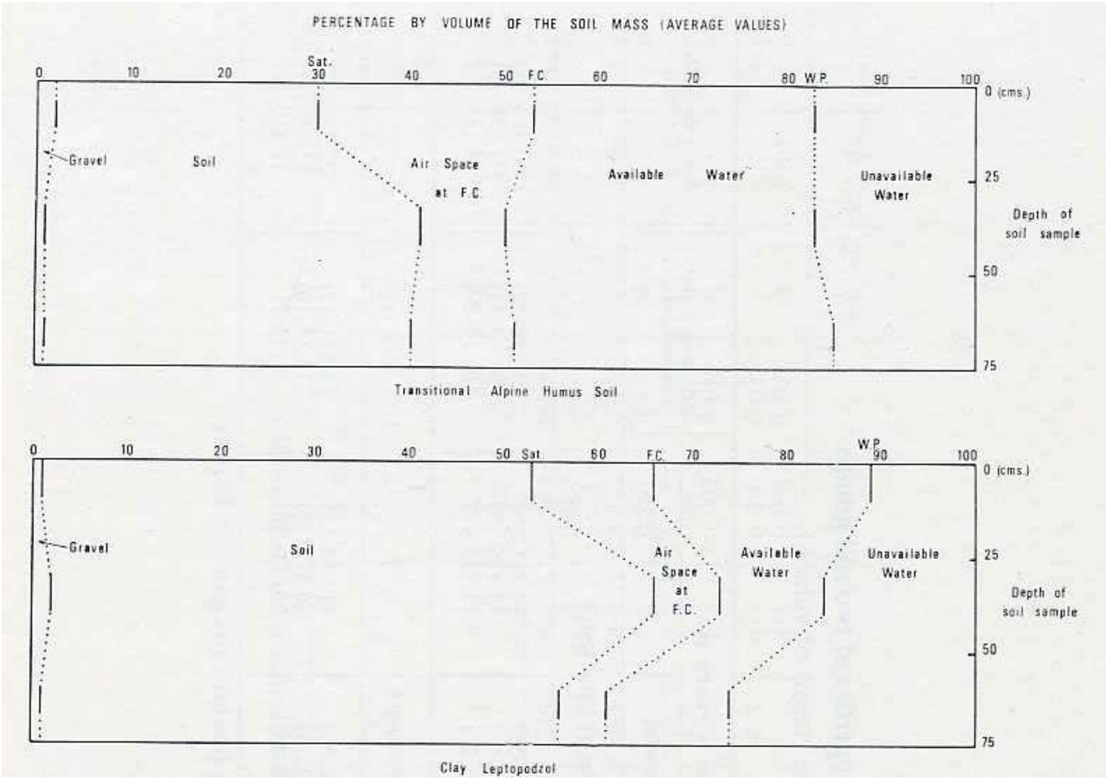


Figure 6 – Moisture characteristics of soils.

TABLE 6. – The soil groups in the Tyers River Catchment

Soil Group	Northcote's Factual Key (1960)	Environmental Factors			
		Parent Material	Rainfall	Altitude Above Sea Level	Topographic Position and Distribution
Bog Peat (Costin (1954)		Mosses and sedges	About 2000 mm inc. snow	1370 m-1520 m	In bogs on the Baw Baw plateau
Humified Peat (Costin 1954)		Bog peats	About 2000 mm inc. snow	1370 m-1520 m	Adjacent to bogs and on hillsides on the Baw Baw plateau
Transitional Alpine Humus Soil (Costin 1954)	Um 7.11	Granodiorite	About 1500-2000 mm inc. snow	1000 m-1550 m	On hillsides on the Baw Baw plateau and on the upper slopes of the Mt. Erica-Mt. Baw Baw massif
Acid Brown Earth	Um 7.11	Granodiorite	About 1500-2000 mm inc. snow	750 m-1550 m	On hillsides on the Baw Baw plateau and on the upper slopes of the Mt. Erica-Mt. Baw Baw massif
Red Earth	Gn 2.11	Granodiorite	About 1250-1500 mm	490 m-750 m	On lower slopes of the Mt. Erica-Mt. Baw Baw massif
Krasnozem (Stephens 1962)	Gn 3.11 or Gn 4.11	Basalt and metamorphosed sedimentary rocks	1000-1250 mm	270 m-490 m	At all positions on a basaltic upland plain and at the base of the Mt. Erica-Mt. Baw Baw massif
Brown Acidic Clayey Soil	Gn 4.31	Tertiary clays and gravels	About 1150 mm	370 m-430 m	On undulating ridge tops along the eastern boundary of the catchment
Clay Leptopodzol (Hallisworth, Costin and Gibbons 193)	Gn 2.8 and Gn 2.21	Siluro-Devonian mudstones,	840 mm-1250 mm	180 m-430 m	At all positions on steep hills of severely dissected sedimentary rocks
Sandy Clay Leptopodzol	Gn 2.8	Tertiary gravels, sands and clays	840 mm-1090 mm	180 m-300 m	On undulating ridge tops in the central and southern parts of the catchment
Podzolised Duplex Soil	Dy 4.61	Tertiary gravels, sands and clays	840 mm-1090 mm	180 m-300 m	On undulating ridge tops in the central and southern parts of the catchment

TABLE 7. – Water holding properties of two soil groups
(Average values and the ranges of values)

Depth of Sampling (cm)	Bulk Density	Percentage of water by volume at			Air Space at F.C. (Sat.-F.C.)	Available Water (F.C.-W.P.)
		Saturation	Field Capacity	Wilting Point		
TRANSITIONAL ALPINE HUMUS SOILS.						
5-12 (5 samples)	0.66 (0.54-0.73)	70 (67-74)	47 (40-53)	17 (15-20)	23 (16-27)	30 (23-34)
32-43 (5)	0.95 (0.88-1.06)	59 (52-64)	50 (41-56)	17 (16-19)	9 (7-11)	33 (25-39)
63-70 (5)	0.97 (0.81-1.10)	60 (56-66)	49 (46-53)	15 (12-17)	10 (6-20)	34 (31-38)
CLAY LEPTOPODZOLS						
2-10 (6)	1.26 (1.12-1.48)	47 (37-51)	34 (26-37)	11 (8-15)	14 (11-17)	22 (17-27)
30-40 (6)	1.69 (1.58-1.81)	34 (28-43)	27 (22-30)	16 (12-20)	7 (4-10)	11 (6-14)
60-70 (3)	1.53 (1.46-1.59)	44 (40-48)	39 (33-44)	26 (20-30)	5 (4-7)	13 (10-16)

TABLE 8. – Selected analytical features for five soil groups
(Each figure is the average of two profiles of the soil group)

Soil Group	Depth cm	Field Texture	Clay %	Org. C. %	pH	Conc. HCL Extract		Exch. Ca. m.e. %	Exch. K. m.e. %	Sum of exch. met. cations m.e. %
						Total P.	Total K.			
Krasnozems	0-2.5	Loam	18	4.7	6.4	0.045	0.23	13.8	2.1	20
	8-23	Clay loam to clay	32		6.1	0.027	0.14	9	0.6	11.6
Brown Acidic Clayey Soils	0-8	Clay loam	21	2.6	5.4	0.009	0.079	3.7	0.3	6.1
	15-30	Clay loam	25		5.2	0.007	0.075	1	0.3	2.6
Clay Leptopodzols	0-5	Loam	14	3.7	4.7	0.010	0.18	1.8	0.2	3.2
	15-30	Loam	18		4.8	0.007	0.19	0.3	0.2	1.1
Sandy Clay Leptopodzols	0-10	Sandy loam	7	1.9	5	0.003	0.021	0.7	0.1	1.1
	15-30	Sandy loam	9		5.3	0.002	0.018	0.5	0.1	0.7
Podzolised Duplex Soils	0-8	Sandy loam	9	8.3	4.3	0.010	0.023	2.2	0.3	5.3
	15-30	Loamy sand	5		4.1	0.003	0.007	0.3	0.05	0.7
Common surface values for soils in southern Victoria						0.02-0.03		3.5-5.0	0.3-0.5	

In the surface and subsurface horizons the krasnozems have the lowest acidity and the highest levels of total phosphorus, total potassium, exchangeable calcium, exchangeable potassium and the sum of the exchangeable metal cations (calcium, magnesium, sodium and potassium). The analytical results of the brown acidic clayey soils are generally lower than those of the krasnozems and higher than those of the other three soil groups. This is true for percentage clay, some of the exchangeable metal cations, exchangeable calcium and exchangeable potassium. The podzolised duplex soils and sandy clay leptopodzols generally have the lowest values for the subsurface horizon and the latter have the lowest figures for the surface horizon.

The levels of the metallic elements on the exchange complex, as well as phosphorus, appear to be related in part to the degree of acidity and the amounts of clay an organic matter. All the soil groups in Table 8 have higher levels of the elements in surfaces than in subsurfaces, indicating a return of nutrients to the surface from the subsoil by way of plant litter. The krasnozems have the highest clay content in the subsurface horizon. The slightly lower clay content in the surface horizon compared with the brown acidic clay is offset by the lower acidity and the higher amount of organic matter. The podzolised duplex soils have the most acid profiles and the lowest clay content in the subsurface horizon, where the levels of the metallic elements and of phosphorus are the lowest for all horizons and all soils. In these soils organic matter apparently raises the fertility of surface horizons to levels similar to those of the clay leptopodzols and brown acidic clayey soils. The sandy clay leptopodzols have the lowest clay and organic matter contents in the surface where values for the metallic elements and phosphorus are the lowest of all the soil groups examined.

Apart from the krasnozems the soils all have very low nutrient status in comparison with soils in many other parts of Victoria, as indicated by the inclusion in Table 8 of a range of surface values commonly found in soils in southern Victoria.

4. NATIVE VEGETATION

Emphasis was placed during field work on the dominant species in each plant community and, except in the cold air drainage valleys on the Baw Baw plateau, this has meant recording the eucalyptus. Species in subordinate layers within a few communities were recorded because they had some relevance to the main object of the survey, namely the relationship between the features of the natural environment and the various forms of present and potential land-use in the catchment. A list of species is given in Appendix II.

The numerous plant communities in the catchment occur in the following sub-formations (as defined by Beadle and Costin 1952): sod tussock grassland, bog, sub-alpine woodland, short woodland, dry sclerophyll forest and wet sclerophyll forest.

Sod tussock grassland

This sub-formation is dominated by snow grass (*Poa australis*) almost to the exclusion of other species. The grasslands are restricted to the sub-alpine environment of the Baw Baw plateau where they occur sporadically as narrow zones between the snow gum woodlands on the valley slopes and the bogs on the valley floors. The snow grass grows in tussocks which provide an almost continuous cover over the ground.

Bog

The bog vegetation is dominated by sphagnum moss (*Sphagnum cristatum*), spreading rope-rush (*Calorophus lateriflorus*) and richea (*Richea continentis*). Sphagnum is dominant where it is actively growing but the other two species are dominant elsewhere in the bogs where there is less moisture and lower acidity. The bogs are confined to valley floors and hillside drainage lines on the Baw Baw plateau where accessions of melting snow and drainage water maintain a habitat of permanent wetness and high acidity.

Sub-alpine woodland

The sub-alpine woodlands are found on the Baw Baw plateau and the uppermost slopes of the Mount Erica-Mount Baw Baw massif. Snow gum (*Eucalyptus pauciflora*) is generally the only tree species although at the lowest elevations of this sub-formation there are a few sheltered gullies with myrtle beech (*Nothofagus cunninghamii*) and also a narrow transitional zone where snow gum mixes with shining gum (*E. nitens*). The ground flora under the snow gums consist mostly of heath species but snow grass is dominant in some areas.

Although the snow gum community is placed in the woodland formation the trees do not have a single main trunk, as woodland trees usually do, but rather they have several main stems arising from the same root stock to give a mallee-like habit. Costin (1954) says that snow gum (in his case *E. niphophila*) is very sensitive to fire and that the mallee-like habit is a result of coppice regrowth from the old root stock following recurrent bushfires.

Short woodland

The short woodland does not appear in Beadle and Costin's classification. It has been recognised here to accommodate those woodlands in which the crowns of the trees are loosely interlacing or slightly discontinuous, in which the trees are short 6-9 m (20-30 ft.) in height and in which the depth of the crown greatly exceeds the length of the bole. Red box (*E. polyanthemos*) is the dominant tree in most areas although butt butt (*E. bridgesiana*) and yertchuk (*E. consideniana*) are sometimes co-dominants or sub-dominants. Beneath the trees there is a sparse and often a negligible ground layer of native grasses and acacia shrubs. The short woodlands occur above the lower reaches of the Tyers River on very steep and exposed slopes with a north-easterly to south-westerly aspects.

Dry sclerophyll forest

They dry sclerophyll forests are dominant in the central and southern parts of the catchment, that is, on the hills of Silurian sedimentary rocks, on the deeply weathered basalt and on the unconsolidated Tertiary sediments. The most common and most widespread eucalyptus are silvertop (*E. sieberiana*), messmate (*E. obliqua*) and yertchuk. Mountain grey gum (*E. cypellocarpa*) is common in certain localities but is absent elsewhere in the general area. Brown stringybark (*E. baxteri*), white stringybark (*E. scabra*), narrow leaf peppermint (*E. radiata*), butt butt, apple box (*E. aromaphloia*) and red box are scattered throughout the area but are seldom dominant.

On the Silurian hills the dry sclerophyll forests occur on the ridges and exposed aspects, that is from north-east to south-west. Silvertop and messmate are generally the dominant species. In many sites they are the only eucalyptus and often silvertop is in almost pure stands. Mountain grey gum is absent from these forests but the other eucalypts listed above are widespread, mostly as sub-dominant or minor members of the eucalypt communities.

On the basaltic areas there are fewer eucalypt species. Yertchuk, apple box, butt butt and red box were not recorded. The dominant species are silvertop, messmate and mountain grey gum, with narrow-leaf peppermint, white stringybark and brown stringybark as minor species.

On the unconsolidated Tertiary sediments, the dry sclerophyll forests are composed of yertchuk, silvertop, messmate and brown stringybark, of which yertchuk is the most common species and the other three are generally of lesser occurrence. Exceptions to this general rule are a few places where silvertop is dominant, for example along the Boola Road, and also where the three latter species are co-dominant with yertchuk, for example along the Tyers-Erica Road.

Plate 1 – A dry sclerophyll forest of silvertop and messmate

Plate 2 – A wet sclerophyll forest of mountain grey gum and messmate

Wet sclerophyll forest

The wet sclerophyll forests cover the mountain slopes of the Mt. Erica-Mt. Baw Baw massif, except for the uppermost slopes where there are snow gum woodlands. Also they occur on sheltered slopes in the sedimentary hills and along the banks of the Tyers River and its tributaries.

On the slopes of the mountain massif there is the following altitudinal sequence of species: on the lowest slopes, at elevations of about 300-450 m (1,000-1,500 ft.) the forests are largely composed of manna gum (*E. viminalis*) with also messmate and mountain grey gum commonly found. At higher elevations, from about 450-900 m (1,500-3,000 ft.) mountain ash (*E. regans*) grows in pure stands. Along the banks of creeks that flow down the mountain slopes there are narrow zones of myrtle beech where mountain ash more or less mixes with and overtops the beech. Between the mountain ash forests and the snow gum woodlands on the highest slopes there is a zone of wet sclerophyll forest dominated by shining gum, with scattered stands of woolybutt (*E. delegatensis*) and Tingiringi gum (*E. glaucescens*) also present. Myrtle beech grows along the creek on the mountain side.

Plate 3 – Thinning a forest of silvertop and messmate in the foothills of sedimentary rock

Wet sclerophyll forests grown in the sedimentary hills in sheltered positions, that is in gullies and on slopes facing east and south. Here the forest communities are predominantly of mountain grey gum although messmate and narrow-leaf peppermint are also widespread. Wet sclerophyll forests also grow along the banks of the Tyers River and on the alluvial flats built up the river. In some of these places, for example at Tyers Junction, manna gum is either the only eucalypt or the dominant one. In other localities, dominance is shared by manna gum, mountain grey gum and messmate, for example where the Moe-Erica road crosses the Tyers River.

5. LAND UNITS

Six land units have been mapped within the catchment. These provide a framework for considering the distribution and interaction of environmental features, and the effects of this interaction on land use. Within Victoria, the principles and method of this type of survey were developed by the Soil Conservation Authority and they were first described by Downes *et al* (1957) and later in detail by Gibbons and Downes (1964).

The criteria used for recognising the land units are mainly the geomorphological units outlined in Chapter Two. Soil is also a criterion used to separate the two land units on Late Tertiary unconsolidated sediments. Table 9 and figure 7 outline the rationale.

TABLE 9.- Geomorphological basis of the land units.

GEOMORPHOLOGICAL UNITS		LAND UNITS
Dissected plateaux remnants	Baw Baw plateau	Baw Baw
	Moondarra plateau	Incorporated into Lower Tyers, Erica Leslies Tract and Coopers Turnoff land units
Steep erosional slopes	Long mountain slopes	Upper Tyers
	Short hill slopes	Lower Tyers, Erica
Unconsolidated sediments	Late Tertiary sediments	Leslies Track
		Coopers Turnoff
	Recent alluvium	Incorporated into Lower Tyers unit
Volcanic extrusion	Mid-Tertiary basalt	Erica

The Moondarra plateau geomorphological unit is sub-divided into the four land units shown in Figure 7. It exists only as narrow ridges which are the tops of the hills in Lower Tyers land unit. Also parts of the plateau are covered and preserved by the basalt (mapped as Erica land unit) and by the Late Tertiary sediments (mapped as the Leslies Track and Coopers Turnoff land units). The areas of recent alluvium along the Tyers River are too small and too few to map separately at the scale of mapping used and they are therefore included within Lower Tyers land unit.

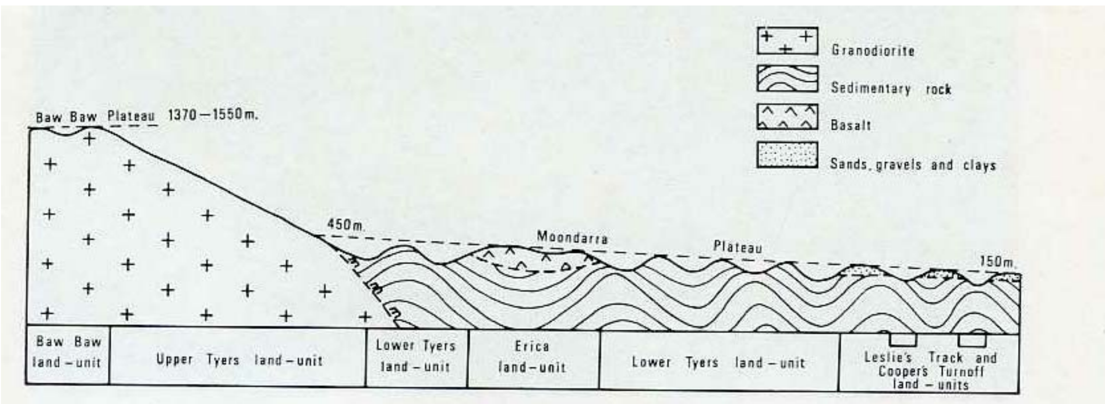


Figure 7 – Geomorphological Basis of the Land Units

BAW BAW LAND UNIT

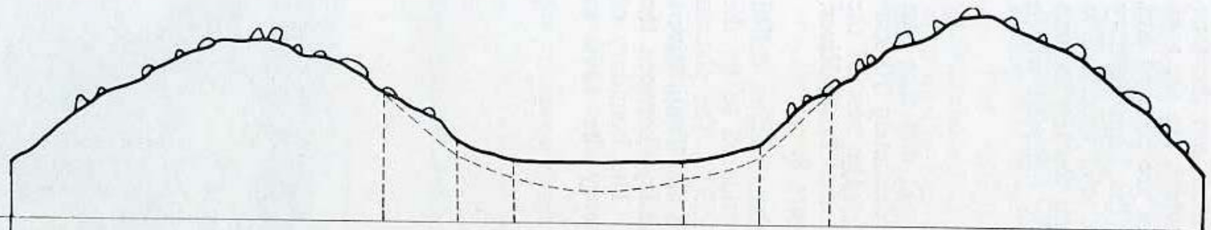
The Baw Baw plateau is mapped as the Baw Baw land unit and that part of the plateau within the Tyers River Catchment covers approximately 10 km^2 (4 square miles) or 3 per cent of the proclaimed catchment. The rest of the plateau lies within the catchments of the Thomson River and the Tanjil River. The environmental and land use features are summarised in Figure 8.

Plate 4 – On the Baw Baw plateau, looking along the main ridge to Mount Erica

The Baw Baw plateau is one of a number of uplifted erosional plains, called high plains, in the eastern highlands of Victoria that are considered to be remnants of an extensive Mesozoic land surface (Hills 1955, 1959). The plateau is moderately dissected by the headwater of the Tyers, Thomson and Tanjil Rivers so that its topography s rolling to hilly with flat-bottomed valleys between the hills. The hills are generally 60-90 m (200-300 ft.) high. The boundary of the plateau cannot be delineated precisely, and in this survey the 1370 m (4,500 ft.) contour is taken as a more or less arbitrary boundary. The highest points are Mount St. Phillack, 1556 m (5,140 ft.) and Mount Baw Baw 1542 m (5,062 ft.). The central ridge of the plateau from Mount St. Phillack to Mount Erica, a distance of 7 km ($4^{1/2}$ miles), separates the catchments of the Thomson and Tyers Rivers.

The climate on the Baw Baw plateau cannot be described accurately because there are no measurements of the climatic elements. Only suggested values for total precipitation and temperature can be given by reference to other climatological stations. Using the rainfall records for Erica and Tanjil Bren as guides, an average annual precipitation of rain and snow of about 1900 mm (80 in.) over the plateau is suggested. A guide to the probably range of temperatures is given in Table 3 in which the records for Mount Buffalo 1340 (4,400 ft.) and Hotham Heights 1860 m (6,100 ft.) are shown. Snow lies on the ground throughout the winter and the minimum daily temperature is likely to be below freezing point on many days. It is doubtful of the maximum daily temperature in the summer ever exceeds 32°C (90°F) except perhaps on a few days of exceptionally hot north winds.

The soils on the plateau can be divided broadly into mineral soils on the rocky hills and organic soils (peats) in the valleys, although the organic soils are found also in hillside drainage lines and they extend up the lower slopes of the hills.



Climate		Sub-alpine, with very high precipitation including continuous winter snow. No recordings taken but 1800 to 2000 mm is suggested for the average annual precipitation						
Geology		Granodiorite	Peat, formed from moss and sedge, overlying rock at variable depth					Granodiorite
Topography		Rocky Hill		Valley			Rocky hill	
Soil		Transitional alpine humus soil and acid brown earth	Humified peat		Bog peat over humified peat	Humified peat		Transitional alpine humus soil and acid brown earth
Vegetation	Structure	Sub-alpine woodland		Sod tuss. grass.	Bog	Sod tuss. grass.	Sub-alpine woodland	
	Species	Snow gum with understorey of heath species and snow grass		Snow grass	*Sphagnum*, *Richea*, Calorophus	Snow grass	Snow gum with understorey of heath species and snow grass	
Land Use	Present	Water supply area, limited use for skiing, hiking and beef cattle grazing						
	Potential	To regard the land unit as a prime source of water and to ensure that any other activity does not impair this function						
Erosion	Hazard	Severe gullying along watercourses, sheeting on disturbed slopes						
	Actual	Most bogs damaged by entrenchment of watercourses						

Figure 8 – Baw Baw land unit

The peats are classified as bog peats and humified peats and they are described in more detail in Chapter Three. The bog peats are restricted to the permanently wet bogs of sphagnum moss located on the floors of the valleys and in hillside drainage line. These peats are composed of layers of raw and decomposing bog vegetation. In the humified peats the plant remains have lost their identity as the change to homogenous mass of colloidal organic matter has proceeded. Those peats are black and greasy. They are found on the sloping edges of the bogs, in eroded desiccated bogs and on the lower slopes of the hills, that is, in sites where the water table is low enough to allow the bog peats to dry out and become aerated. On the sloping edges of the bogs the humified peats support sod tussock grasslands and health communities, and on the lower slopes of the rocky hills they support sub-alpine woodlands of snow gums and heath understorey species.

The sub-alpine woodlands grow on the rocky hills where the form and height f the snow gums vary with the degree of exposure. On the lower and middle slopes the trees are tall 12-15 m (40-5 ft.), straight, and close enough to form a closed canopy. On the ridges they are 4-6 m (15-20 ft.) in height, twisted and in open formation. In both areas many trees have a mallee-like habit with several main trunks arising from the one roots stock. Costin (1954) considers that this a result of coppice re-growth cause by recurrent bushfires that have most certainly increases in frequency since white settlement of eastern Victoria. Generally there is a well-developed heath understorey and some of the dominant genera in it are alpine daisy bushes (*Olearia* spp.), mountain peppers (*Drimys* spp.*),* alpine orites (*Orites* sp.) and alpine bottle brush (*Callistemon* sp.). In some areas snow grass forms a grassy forms beneath the trees.

The vegetation in the bogs is dominated by sphagnum moss, spreading rope rush and *Richea*. Sphagnum is dominant where it is actively growing but the other two species are dominant elsewhere in the bogs where there is less moisture and lower acidity. Heath species invade these bog communities towards the edges of the bogs and wherever the bogs are eroded and desiccated.

The sod tussock grassland is composed of snow grass and it occurs sporadically as a narrow zone between the woodlands on the hillslopes and the bogs on the valley floors.

Water is the main product from the Baw Baw land unit. The winter snow immobilises an unmeasured quantity of water until the snow melts during the spring months when the stream flow is at its highest level for the year. The snowfield therefore is an important regulator of the seasonal discharged of water into the Tyers River, because the delayed drainage of water to the streams helps to maintain the subsequent level of the river during the summer, when the discharge is lowest.

The bogs are also important in providing a steady and sustained flow by their ability to hold and slowly release large amounts of water. However most of the bogs are damaged, as shown by the entrenchment of the water courses to form narrow, steep-sided channels, and by the consequent changes in the composition of the bog vegetation as the water able dropped and the bogs started to dry out. Whereas of actively growing sphagnum moss have decreases as the areas dominated by the sedge and heath species have increases. Fortunately most of the affected bogs are not seriously damaged but some have been destroyed beyond reclamation. The part played by cattle in bog degeneration has been the subject of investigation and controversy in recent years, but it is now widely agreed that trampling by cattle is the main cause of bog degeneration. Beef cattle have been grazed for many years on the plateau, although their numbers are now small.

The snow gum woodlands have no commercial value as sources of timber but they act as protective forests to assist in maintaining the regularity and quality of the stream flow.

It has been shown in the Snowy Mountains that the presence or absence of a tree cover, and the density and continuity of the tree cover, greatly influence the distribution of the snowfall, its depth of accumulation and its rate of melting (Costin *et al*. 1961). Timbered areas hold more snow than treeless areas, stands of living trees hold more snow thane stands of dead trees, and more snow accumulates under a discontinuous tree canopy than under a continuous canopy. A mature, unburnt snow gum woodland provides a discontinuous tree canopy whereas a woodland of dense, fire-induced coppice regrowth is more like a continuous canopy. The work in the Snowy Mountains showed that in dense stands of snow gum regrowth the snowfall was deeper within small artificial clearings than under the surrounding trees. Also it was found that the snow in the clearings persisted longer than the snow under the trees because of the greater quantities and the more favourable volume/area ratio of the deposits.

The implications for the Baw Baw plateau are that in future bushfires must be prevented because either the trees will be killed of the dense regrowth will be simulated once more. If bushfires are excluded the woodlands will slowly thin out by natural processes and this should lead to deeper localised deposits of snow, a longer snow-melt and a higher summer flow in the Tyers River. Meanwhile serious thought could be given to the creation of numerous clearings in the snow gum woodlands to hasten the achievement of these objectives.

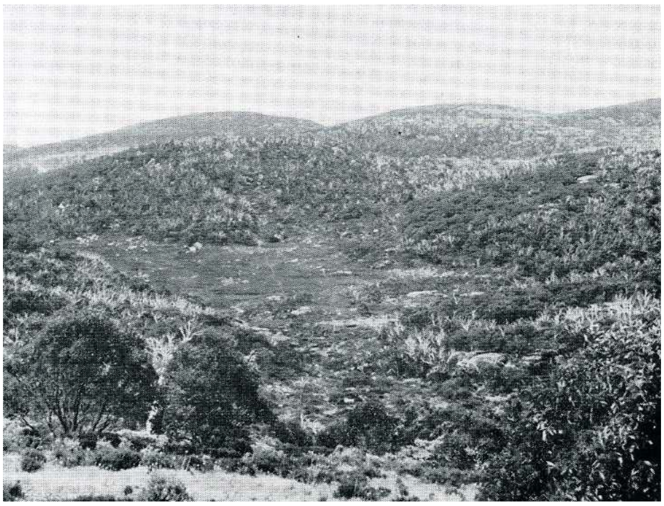


Plate 5. The Baw Baw land unit is made up of low hills covered by snow gum woodlands, and flat

UPPER TYERS LAND UNIT

The mountain slopes of the Mount Erica-Mount Baw Baw massif have been mapped as the Upper Tyers land unit, which has an area of 87 square kilometres (33½ square miles) or 27 per cent of the proclaimed catchment. The diagram in Figure 9 shows the features of environment and land use.

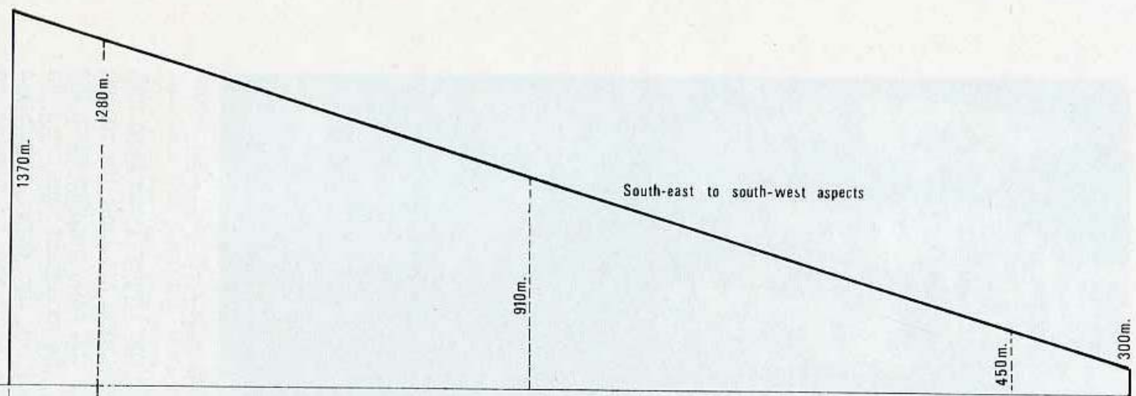
The mountain slopes of the massif represent erosional slopes below the Baw Baw plateau. The massif is therefore an erosion residual of granodiorite that has resisted the agents of geological erosion more strongly than the Siluro-Devonian strata into which it intruded as an igneous mass. The base of the massif is defined by the West Tyers and East Tyers Rivers, and the range of elevation of its slopes is from 300 m (1, 00 ft.) above sea level to 1370 m (4,500 ft.) over a horizontal distance of 4-7 km (3-5 miles). The lowest hundred metres or so of the massif is composed of metamorphosed Siluro-Devonian sedimentary rocks.

There is an altitudinal sequence of soils on the granodiorite, with red earths on the lower slopes, acid brown earth s on the middle slopes and transitional alpine humus soils on the higher slopes of the massif. The descriptions and water-holding properties of these soil groups are given in chapter three and their chemical analyses are given in appendix 1b. Briefly these soils are characterised by thick layers of decomposing plant litter at the surface which overlie deep excellent structure. Beneath these horizons there are mineral horizons with coarse sand with smaller amounts of clay. These mineral horizons have a poor structure but an open, friable, earthy fabric. The soils of all three soil groups have large proportions of air space and up to 70% of their volume is available for water storage (see Table 7 and Figure 6).

On the lowest slopes of the massif there are krasnozems developed on the metamorphosed sedimentary rocks. These soils are similar in their textural and structural profiles and in their chemical analyses to the krasnozems on basalt but they are not as red. Also they lack the deep organo-mineral horizons of the soils at higher elevations on the massif.

Wet sclerophyll forests cover the massif except for sub-alpine woodlands of snow gum on the highest slopes below the Baw Baw plateau. In the forest communities there is the following altitudinal sequence of species. On the lowest slopes, at elevations of about 300 – 450 m (1,000 – 1,500 ft), the forests are largely composed of manna gum. Messmate and mountain grey gum are also commonly found. At higher elevations, from about 450 – 900 m (1,500 – 3,000 ft), mountain ash grows in pure stands, and from about 900 – 1,280 m (3,000 – 4,200 ft), the forests are composed of shining gum mainly, with small stands of woolly-butt and Tingiringi gum. Myrtle beech grows in narrow zones in gullies where creeks flow down the mountain side towards the three branches of the Tyres River. A tall, dense and continuous understorey of small trees, shrubs and ferns grows beneath the eucalypts, and some of the dominant species are silver wattle (*Acacia dealbata*), hazel pomaderris (*Pomaderris apetala*), blanket leaf (*Bedfordia salicina*) and soft tree-fern (*Dicksonia Antarctica*).

As discussed in the next chapter the northern section of the Tyres River Catchment above Tyers Junction contributes most of the water entering Moondarra Reservoir, particularly during the summer period of lowest stream flow. Upper Tyres land unit makes up 63% of the northern section. The following environmental features combine to give the high yield of water. First, because of the elevation of the massif, the land unit receives very heavy precipitation in the forms of rain and snow. No measurements have been made of the amount but, using the records for Tanjil Bren and Erica as a guide, an average annual figures in excess of 1,900 mm (75 ins) is suggested for the upper slopes, and 1,270 mm (50 ins) for the lowest slopes. Second, the potential evapotranspiration is less than in the land units to the south because the elevations are higher, therefore the temperatures are lower. Thus in the Upper Tyers land unit there is more water in excess of potential evapo-transpiration available for stream flow. This is particularly important during the summer and early autumn when the flow of the Tyers River is at its lowest level. Finally, the mountain soils can hold large quantities of water and this is partly a result of the dense vegetation contributing large amounts of organic matter to the soils and so playing an important part in their aggregation and in the storage of water. The high water holding capacity and permeability of the soils are important in maintaining continuity of drainage to the streams so that the summer trough of low flow in the seasonal rhythm of stream discharge is minimised.



Climate		Sub-alpine	Higher rainfall (about 1900 mm or more), lower temperatures, occasional winter snow		Lower rainfall (about 1250 mm), higher temperatures, no snow
Geology		Mostly granodiorite, metamorphosed sedimentary rock at the base of the massif			
Topography		Very long mountain slopes passing through about 1070 m of elevation			
Soil		Transitional alpine humus soils, acid brown earths and red earths form an altitudinal sequence Krasnozems occur on the metamorphic rock			
Vegetation	Structure	Sub-alpine woodland	Wet sclerophyll forest		
	Species	Snow gum	Shining gum mainly, also woollybutt and Tingiringi gum	Mountain ash	Manna gum messmate
Land-use	Present	The main source of water for the Tyers River. Valuable stands of hardwood are managed for forestry purposes			
	Potential	Further development of water and timber resources to attain optimum yield of each			
Erosion	Hazard	Sheeting on steep slopes following fires			
	Actual	Low			

Figure 9 – Upper Tyers Land Unit

Plate 6. A wet sclerophyll forest of mountain ash in the Upper Tyers land unit

For these reasons there is more water per unit volume of soil for drainage to the streams than in the more southerly and lower land units, and the yield of water to the Tyers River is higher both in total amount and per acre of catchment. For example the catchment of the West Tyers River at Morgan's Mill is 80 km^2. (31 square miles) which is 39 per cent of the catchment of the Tyers River at Browne's, just above Moondarra Reservoir. However the amount of water passing through the river gauge at Morgan's Mill during a three-year period was 67 per cent of the amount of water at Browne's for the same period. Also the average monthly discharge of water per square kilometre of catchment at Morgan's Mill is 178 megalitres (143 acre feet), which is ten times higher than for the Jacobs Creek Catchment, which is a typical part of the southern section of the catchment.

Upper Tyers land unit has a high potential for producing ash-type milling timbers from its forests of mountain ash, shining gum and woollybutt, provided forestry practices are compatible with the primary use of water supply. Most of the trees are immature regrowth from the 1939 bushfires. In addition to loss of timber, bushfires destroy the deep layers of plant litter and organic matter in the soils, resulting in deterioration of soil structure and water holding capacity. This would hasten the drainage of water to the streams and give rise to wider fluctuations in the monthly and seasonal flows of the Tyers River.

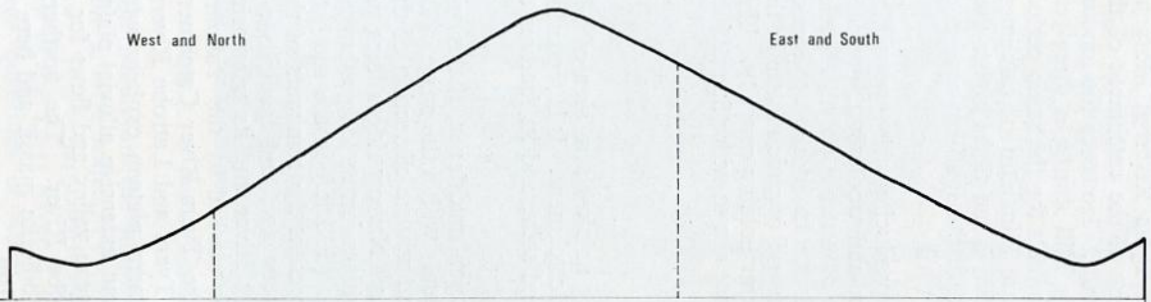
LOWER TYERS LAND UNIT

The Lower Tyers land unit is the largest mapping unit with an area of 140 km^2. (54 square miles) or 44 per cent of the proclaimed catchment. It is separated from the other land units by its geology, topography and soils, and its features of environment and land use are summarised in Figure 10.

The land unit comprises the hills of Siluro—Devonian mudstones, shales and fine sandstones. The hills are steep, with slopes commonly within the range of 30 to 40 per cent, and they have formed by the deep and mature dissection of the sedimentary rocks by the Tyers River and its tributaries. Narrow ridges form the tops of the hills and, when viewed from a distance, the ridges form a long unbroken skyline that rises gently in elevation from about 150 m (500 ft.) in the south to about 450 m (1,500 ft.) in the north. The ridges represent the remnants of the Moondarra plateau, a relic land surface of about Eocene age, and the hills are erosional slopes formed below the plateau as the Tyers River and its tributaries cut into it. The southern boundary of the Plateau is marked by the Yallourn monocline, which passes across the southern end of the Tyers River Catchment between the pumping station and the junction of the Tyers and Latrobe Rivers. The presence of the Yallourn monocline and Moondarra plateau explains why the Tyers River is entrenched in a narrow valley without extensive alluvial plains along its course, until it leaves the confines of the plateau valley and flows for a short distance across the alluvial plain of the Latrobe River. The northern boundary of the Siluro—Devonian strata abuts the granodiorite massif and here a narrow zone of the strata has been altered by metamorphism.

The dominant soils throughout the land unit are clay leptopodzols which have been described in detail in Chapter Three where their morphology, chemical analyses and water holding properties are discussed. Briefly, clay leptopodzols are highly acidic, poorly structured, pale, yellowish-brown soils in which the clay content and strength of colour gradually increase with depth. They also hold smaller quantities of water, both for plant growth and stream flow, than the soils on the mountain massif and on the basalt. Krasnozems have developed in the zone of metamorphosed rock.

Plate 7. Overlooking the narrow ridges and steep hills of the Lower Tyers land unit.



Climate		Average annual rainfall varies from about 840 mm in the south to about 1250 mm in the north	
Geology		Siluro-Devonian mudstones, shales and fine sandstones	
Topography		Steep hills with slopes commonly 30–40 per cent., narrow ridges	
Soil		Mostly clay leptopodzols, also krasnozems next to the granodiorite massif	
Vegetation	Structure	Dry sclerophyll forest	Wet sclerophyll forest or wet variant of dry sclerophyll forest
	Species	Mainly silvertop and messmate, also yertchuk, brown and white stringybark, butt butt, narrow-leaved peppermint, apple box	Mountain grey gum, messmate, narrow-leaved peppermint
Land-use	Present	Hardwood forestry for milling and paper pulp. Significant for water quality more than quantity	
	Potential	Water supply and forestry to be developed together with careful management to maintain water quality	
Erosion	Hazard	High hazard because of steep slopes and erodible soils	
	Actual	Generally no erosion although it can be locally serious along roads	

Figure 10 – Lower Tyers land unit

Dry and wet sclerophyll forests cover the hills. The dry sclerophyll forests grow on the ridges and exposed slopes, that is the north-east to south-west aspects. Silvertop and messmate are generally the dominant eucalypts. In many sites they are the only eucalypts and often silvertop grows in almost pure stands. Elsewhere these two species are dominant in a mixtures of eucalypts that also includes brown stringybark, yertchuk, white stringybark, apple box, narrow-leaf peppermint and, in the southern part of the land unit, butt butt and red box. The wet sclerophyll forests grow in sheltered sites such as gullies and slopes facing east and south. Here the forest communities are mainly of mountain grey gum, although messmate and narrow-leaf peppermint are also widespread. Tree-ferns, hazel pomaderris and blanket leaf are characteristic members of the lower layers that help to distinguish these moister communities from the dry sclerophyll forests.

The amount of water reaching Moondarra Reservoir from the land unit has not been measured. However from the records of gauging stations at Morgan's Mill and Browne's on the Tyers River, and at O'Toole's on Jacobs Creek, it is clear that most of the water in the reservoir comes from the Baw Baw and Upper Tyers land units. The Lower Tyers land unit is a relatively unimportant source of water, both from the entire land unit and from per unit area of it. For example the average monthly discharge of Jacobs Creek per square kilometre of catchment is 20 megalitres (42 acre feet per square mile) which is one-tenth of the equivalent figure for the catchment of the West Tyers River at Morgan's Mill which drains parts of the Baw Baw and Upper Tyers land units. The lower rainfall and the lower water storage capacity of the clay leptopodzols provide a likely explanation of this situation.

The land unit does have a greater potential than the other land units to influence the deposition of sediment in Moondarra Reservoir, and the quality of the water in terms of the amount of suspended soil material arising from erosion. The following features give the land unit this potential. First, the land unit surrounds the reservoir and the Tyers River flows through it for most of its length. Thus the land unit is the closest source of soil material. Second, the clay leptopodzols are more prone to erosion than most of the other soil groups because of their weak structure and poor coherence. Third, the steep slopes increase the erosive power of running water on bare ground. For these reasons, particularly careful management is required in this land unit to minimise soil erosion.

In addition to water supply the land unit is used for hardwood forestry. Here the aim is to raise the present level of productivity by silvicultural methods that will encourage a vigorous regeneration of young trees of the desired density and shape. Generally the forests are overstocked with comparatively young regrowth and bushfires have damaged many trees in all age classes. The immediate task is to thin the forests by removing undamaged mature and over-mature trees for milling, and removing the unwanted re-growth and damaged trees for conversion to paper pulp. The eucalypt species of value for milling are silvertop, messmate, brown stringybark and mountain grey gum. Yertchuk makes good firewood.

In spite of the hazard there is little soil erosion under the forest cover. It is restricted to mild sheet erosion on steep, exposed hillsides where the ground cover is sparse and open. There are individual examples of roadside gully erosion, and riling does occur on log landing areas before the shrub regrowth covers them. Although the land unit has the potential to lower the quality of the river water by erosion, it is considered that the forestry operations have had no significant adverse effect on the water quality because of careful management.

There are two small areas within the Lower Tyers land unit which differ in sufficient detail from the description given to warrant their separation as sub-units.

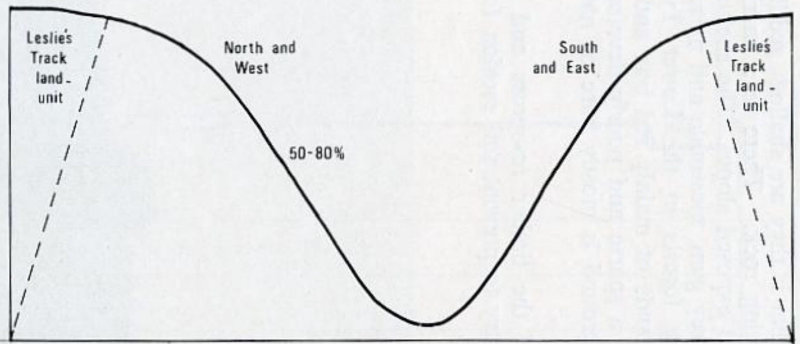
Blairs Hill Sub-unit

The Blairs Hill sub-unit is located at the southern end of the proclaimed catchment and it covers approximately 10 square kilometres (4 square miles). Its features of environment and land use are outlined in Figure 11.

Like the Lower Tyers land unit there is a series of Siluro—Devonian sedimentary rocks but the distinctive geological feature of the sub-unit is an overlay of Jurassic sedimentary rocks which consist of coarse conglomerates and a series of sandstones lying above them. Unconsolidated gravels, sands and clays of Late Tertiary age that are mapped as Leslies Track land unit overlie the Jurassic rocks. The dissection of the Jurassic rocks by the Tyers River has resulted in the development of a deep gorge with walls about 90 m (300 ft.) in height and slopes up to 80 per cent. The soils are skeletal, that is they are shallow, reddish-brown clay looms set in broken and decomposing rock. There is a marked difference in vegetation between the sheltered and exposed slopes. The sheltered slopes have wet sclerophyll forests of mountain grey gum, messmate and narrow-leaved peppermint similar to the corresponding forests in the Lower Tyers land unit. The exposed slopes have short woodlands of mainly red box and to a lesser extent butt butt and yertchuk. There is a sparse and poorly developed understorey of scattered acacia bushes and the ground is mostly bare of native grasses.

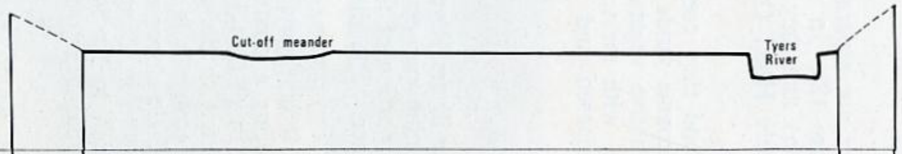
The steep slopes prevent any utilisation of the timber resources and the only suitable form of land use is protective forestry to prevent soil erosion from lowering the quality of the water in Tyers River.

Plate 8. This scene at Tyers Junction is typical of the alluvial deposits making up the Tyers Junction sub-unit.



		North and West	South and East
Climate		Average annual rainfall is about 840 mm	
Geology		Jurassic sedimentary rocks overlying Siluro-Devonian sedimentary rocks	
Topography		River gorge with very steep slopes	
Soil		Skeletal soils	
Vegetation	Structure	Wet sclerophyll forest	Short woodland
	Species	Mountain grey gum, messmate, narrow-leaved peppermint	Red box mainly, also butt butt and yertchuk
Land–use	Present	Vegetation & Lard Use should not be confused	
	Potential	Too steep for timber removal, but a protection forest to safeguard the water supply	
Erosion	Hazard	A high hazard	
	Actual	No erosion	Sheet erosion

Figure 11.—Blairs Hill subunit.



Climate		Average annual rainfall is about 1140 mm
Geology		Recent alluvium
Topography		Flat alluvial plain
Soil		A mixture of clay and sand layers, mostly clays
Vegetation	Structure	Originally a wet sclerophyll forest, now mostly cleared
	Species	In some sites manna gum is dominant, elsewhere it is co-dominant with messmate and mountain grey gum
Land-use	Present	Beef and dairy farming
	Potential	Improvement in techniques to raise the levels of production
Erosion	Hazard	Low
	Actual	Isolated undercutting and slumping along river banks

Figure 12.—Tyers Junction sub-unit.

Tyers Junction Sub-unit

The few small alluvial deposits along the Tyers River are separated from the sedimentary hills as the Tyers Junction sub-unit (Figure 12). In aggregate they make up roughly two km^2. (less than one square mile) and they occur at Tyers Junction and in the vicinity of Phillips Bridge where Hotel Creek and its tributaries join the Tyers River.

The alluvial deposits are regarded as Recent in age and they consist of a succession of riverine layers ranging in composition from coarse sands to clays. Generally the surface soils are brown clay loams. The native vegetation was originally a wet sclerophyll forest, mainly of manna gum, with messmate and mountain grey gum in some areas. Now it is mostly cleared and used for grazing.

ERICA LAND UNIT

The Erica land unit comprises the basaltic land in the Tyers River Catchment. It has an area of 28 km= (11 square miles), or nine per cent of the proclaimed catchment, and it is situated in the east-central portion of the catchment from south of Moondarra to north of Parkers Corner. The diagram in Figure 13 shows the features of environment and land use.

The parent rock is Mid-Tertiary basalt and most of it is situated on the divide between Tyers River and Jacobs Creek where it forms a comparatively broad and rolling upland plain at elevations from 300-425 m (1,000-1,400 ft.) above sea level. The basalt has evidently been more resistant to the agents of geological erosion than the surrounding sedimentary rocks because it is at higher elevations and is much less dissected, with comparatively gentle slopes of 12-14 per cent. It forms part of the Moondarra plateau referred to in Chapter Two and in the description of Lower Tyers land unit. In addition to the main area of basalt just described there are several much smaller areas nearby that cap the tops of hills of sedimentary rock.

The soils throughout the land unit are krasnozems which are readily identified by their dark, reddish-brown clay loam at the surface and their well structured red clay in the subsoil. Their physical and chemical properties have been discussed in Chapter Three. Briefly, they are friable, well structured and comparatively stable when wet. The pH values are between 6 and 7 which means that they are less acid than all the other soil types in the catchment and they have greater amounts of plant nutrients. Their fertilizer requirements are therefore not as great as the other soil types.

Much of the native vegetation has been cleared and that which remains consists of dry sclerophyll forests of silvertop, messmate, mountain grey gum and narrow-leaved peppermint in predominance, and also brown stringybark and white stringybark as minor species. The dominant understorey species are two bush-peas *(Pultenaea spp.).*

These forests are moister variants of the dry sclerophyll forest sub-formation than those of the Lower Tyers land unit. Mountain grey gum occurs as a dominant species on all positions of the landscape, and the species in the understorey are less xeromorphic. The forests in both land units have similar average annual rainfall so that the probable causes of the moister habitats in the basaltic land unit are the deeper profiles and higher available moisture capacities in the krasnozems, and the much lower degree of exposure on the gentle slopes of the rolling plain.

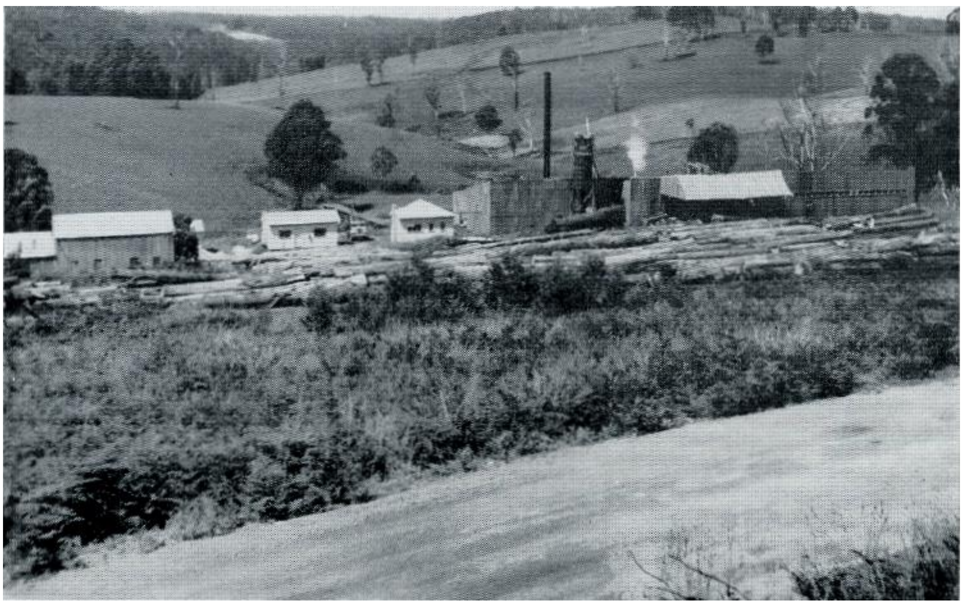
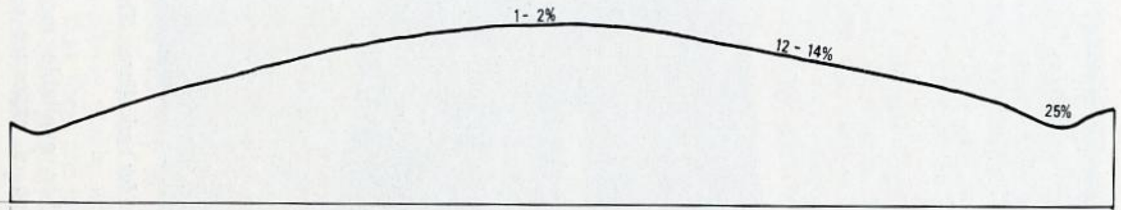


Plate 9. The Erica land unit is a rolling basaltic plain, largely cleared for agriculture. The State Mill at Erica is in the foreground.

The cleared land makes up most of the agricultural land in the catchment. It is used mainly for cattle grazing and potato growing. The topography is gentle and the soils are fertile in contrast to the surrounding hills of sedimentary rock. These are very steep and unsuitable for farming.

The climate in the land unit is suitable for growing introduced pastures of perennial species. In Chapter One it was shown that Walhalla, taken to be representative of the land unit, has an estimated average period of moisture availability of twelve months. Thus rainfall is not a limiting factor to pasture growth as much as cold during the winter months. Figure 4 in Chapter One indicates that pasture growth in the Erica district is retarded by cold from May to September inclusive and that, in colder-than-average periods, growth is likely to cease during June, July and August.

The pasture species and fertilizers used on the farms and the role of the krasnozems in dairying and potato growing are discussed in Chapter 6.



Climate		Average annual rainfall ranges from 1020 mm to 1200 mm
Geology		Mid-Tertiary basalt
Topography		Mostly long, moderate slopes forming a rolling basaltic plain at elevations of 300 m to 425 m
Soil		Krasnozems at all positions on the landscape
Vegetation	Structure	Originally a moist variant of dry sclerophyll forest, now mostly cleared
	Species	Silvertop, messmate, mountain grey gum, narrow-leaved peppermint are dominant
Land-use	Present	Beef and dairy farming and potato growing mainly, also some hardwood forestry
	Potential	The farms are capable of higher productivity and the tendency to monoculture on the potato farms could be replaced by longer and more varied rotations
Erosion	Hazard	Little hazard under forest and grassland. A hazard of rilling and sheet erosion on the areas used for potatoes
	Actual	Confined to rilling and sheet erosion on potato paddocks and alongside roads and tracks

Figure 13.—Erica land unit.

LESLIES TRACK LAND UNIT

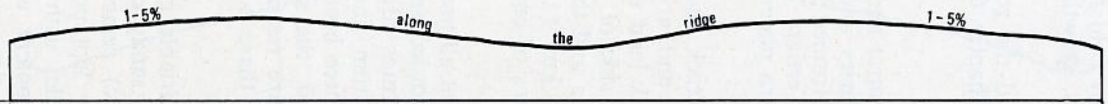
The Late Tertiary gravels, sands and clays occur in the central and southern parts of the catchment along the eastern and western boundaries and towards the Tyers River. They cap the ridges and upper hillslopes' formed from the Siluro-Devonian sedimentary rocks. The boundary of the Tertiary sediments is determined by the extent of the dissection of the Moondarra plateau by the Tyers River and its tributaries.

The area covered by the sediments is mapped as Leslies Track and Coopers Turnoff land units. The basis of separation is mainly the soils and, arising from that, the type and quality of the eucalypt forests. Leslies Track land unit is the larger of the two and it occurs in two sections, one on each side of the Tyers River. The eastern section is 13 km^2 (5 square miles) in area and the western section is 32 km^2 (12+ square miles) making a total area of 45 km^2 (17+ square miles) or 14 per cent of the proclaimed catchment. The features of environment and land use are indicated in Figure 14.

There is a variety of soils in the Leslies Track land unit but all profiles have two features in common. First, they overlie red and white mottled sandy clays that often have bands of quartz stones. Second, field textures are strongly influenced by large amounts of free quartz ranging in size from fine sand to gravel. The range of soils encountered has been divided into three broad groups, and of these the podzolised duplex soils are most widespread, the sandy clay leptopodzols are of lesser occurrence, and the nomopodzols are restricted to a few small areas. The descriptions and chemical analyses of these soil groups are given in Chapter Three and Appendix I.

Briefly, the podzolised duplex soils have loose grey sands to friable grey sandy foams overlying a hard cemented subsoil of yellowish brown sandy clay loam, generally with a thin irregular zone of dark brown (organic) cemented sand at the boundary between the two horizons. The sandy clay leptopodzols are pale yellowish brown to yellowish grey throughout the profile, with a coarse sandy loam at the surface and a gradual increase in clay content with depth to a sandy clay in the deep subsoil. The nomopodzols are deep sands with light grey subsurface horizons and orange subsoils, and irregular patches of dark brown (organic) sand at the boundary be ween the two horizons. All three groups of soils are moderately to highly acid and they had low levels of phosphorus, nitrogen and the exchangeable metal cations.

Dry sclerophyll forests cover the Tertiary deposits and they are composed of yertchuk, silvertop, messmate and brown stringybark, of which yertchuk is generally the most common species. Exceptions to this general rule are along the Boola Road and parts of the eastern section of the land unit, where silvertop is dominant in some areas and co-dominant with yertchuk in others.



Climate		Average annual rainfall varies between about 840 mm in the south and about 1090 mm in the north
Geology		Late Tertiary gravels, sands and clays
Topography		Broad, gently undulating ridges with short slopes. Steeper slopes across the ridges
Soil		Podzolised duplex soils most common. Also sandy clay leptopodzols and nomopodzols
Vegetation	Structure	Dry sclerophyll forest
	Species	Yertchuk is generally dominant ; silvertop, messmate and brown stringybark are less frequent. Heath species in the understorey
Land-use	Present	Protection forest for the catchment. Low quality forest generally unsuitable for milling and used for limited supplies of paper pulp and firewood
	Potential	Hardwood potential is low. Softwood potential is low to moderate. A moderate potential for dairy farms but protection of the catchment is the most important consideration
Erosion	Hazard	Low to moderate depending on the slope. Only likely to occur when the soil is bare
	Actual	No erosion

Figure 14.—Leslies Track land unit.

Plate 10. A dry sclerophyll forest in Leslies Track land unit. It is malformed through fire,previous clearing and poor site quality.

Both the eucalypt species and the species in the heath understorey serve as rough indicators of each of the soil groups. The nomopodzols are indicated by a low quality forest in which yertchuk is the only eucalypt, the trees are short and badly formed, and the understorey is dominated by silver banksia and yacca.

The podzolised duplex soils and sandy clay leptopodzols are not individually correlated so readily with the vegetation and only rough guides are available to distinguish between the two groups. The eucalypts are generally the same in both soils, that is, yertchuk is usually dominant, but occasionally is matched by silvertop, messmate and brown stringybark. In some areas of the podzolised duplex soils yertchuk is the only eucalypt but the trees are taller and straighter than those growing in the nomopodzols. Species in the heath understorey are valuable as indicators. Thatch saw-sedge grows in both soil groups—an indication of their poor internal drainage—however a rough separation of the two is obtained

by looking at the assemblage of understorey species in each case. On podzolised duplex soils the understorey is dominated by some or all of the following species ; prickly tea-tree, silky tea-tree, thatch saw-sedge, common heath, hook sallow-wattle, shining cassinia, bracken and silver banksia. In the sandy clay leptopodzols the number of species tends to be fewer, and shining cassinia, silky tea-tree and bracken are absent or sparsely scattered.

The forests in the land unit are at present serving as protective forests to prevent soil erosion and regulate the flow and quality of the water in small creeks that send water into Tyers River and directly into Moondarra Reservoir. The forests are of little commercial value at present because they are not producing large quantities of usable timber, nor is there a high potential to do so. Compared with trees of mature age growing on the basalt and on the hills of sedimentary rock the trees on the Tertiary sediments in this land unit are short and inferior. Also the density of mature trees is less and the density of regrowth saplings is greater. The causes of these differences are considered to be the poorer habitats for tree growth and the greater frequency and severity of bushfires in Leslies Track land unit. The conditions for tree growth are poor because the soils are of lower fertility and poorer drainage. They become waterlogged during winter and spring because their profiles are relatively impermeable to water and also the ridges in many places have gentle slopes and water does not drain freely. A contributing factor to the greater severity and frequency of bushfires is that the trees are a more combustible fuel than those on the basalt and on the sedimentary hills. The reasons for this are the lower moisture content of the wood and the higher proportion of trees with rough barks. Because of all these factors, and also because yertchuk rather than silvertop is dominant, the forests in Leslies Track land unit are of lower quality, and lower potential as sources of millable hardwood, than the forests containing the same species in Lower Tyers and Erica land units. They are used to supply small quantities of firewood and billets for paper pulp.

The potential of Leslie Track land unit for plantations of *Pinus radiata* varies from low to moderate. The main limiting factors are the infertile soils, the generally poor drainage and the waterlogging during winter and spring. The areas of moderate potential are restricted to places where comparatively tall silvertop is dominant. On this basis the eastern section of the land unit has a higher potential for pines than the western section, although a limiting factor in the eastern section would be the lack of areas of sufficient size and regular shape to warrant planting.

The land unit may have some potential to support improved pastures. The main limiting factor is the infertility of the soils but if an adequate range of fertilizers were to be applied and maintained, vigorous pastures could be grown. However the high costs of clearing the forests and fertilizing the pastures would need to be offset by steady levels of productivity and revenue.

About 200 hectares (500 acres) at the head of the catchment of Blairs Creek have been cleared and sown to perennial pastures for dairying. The species used are white clover, red clover, perennial ryegrass and Mt. Barker subterranean clover. The fertilizers used are superphosphate, potash, copper sulphate and lime.

Any successful replacement of the forests by softwood plantations and dairy farms would increase the revenue derived from the land unit. However this consideration should be secondary to the desire not to impair the functioning of the land unit as a part of the catchment to Tyers River. A careful assessment of the likely effects on the pattern of stream flow and on the quality of the water would be needed before any large scale conversion to plantations and farms were undertaken.

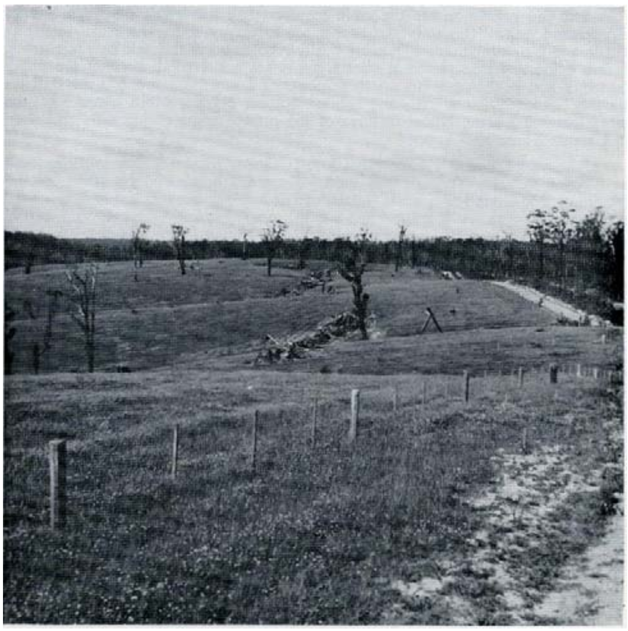


Plate 11. Parts of Leslies Track land unit have been cleared and pastures have been sown for dairy farms. An example of the undulating ridges forming the land unit is also shown in this scene.

COOPERS TURNOFF LAND UNIT

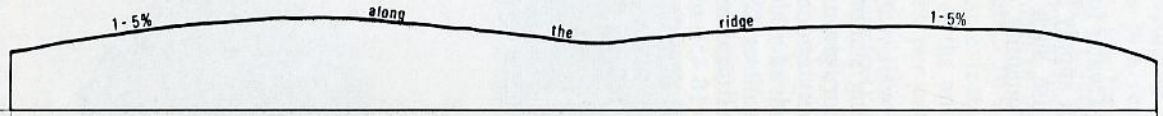
Coopers Turnoff land unit is the second and smaller land unit included in the area of Tertiary sediments. It occurs along the eastern boundary of the catchment and has an area of 4 km^2 (1½ square miles). The features of the environment and land use are shown in Figure 15.

Soil and vegetation are the main features that distinguish this from Leslies Track land unit. The soils are brown acidic clayey soils which are relatively fertile and well structured. They are easily recognized in the field by their strong brown colour. Large pieces of quartz gravel are scattered throughout the upper horizons, and in the deep subsoil there are considerable amounts of quartz stones roughly banded within red and white mottled clays. More details of the morphological and analytical features of the brown acidic clayey soils are given in Chapter Three and Appendix I.

Moist variants of dry sclerophyll forests similar to the forests in Erica land unit cover Coopers Turnoff land unit. They are dominated by silvertop and messmate. Mountain grey gum is widespread as a sub-dominant, and narrow-leaved peppermint grows as a minor species in some parts. Yertchuk and brown stringybark were not observed and are probably absent. The understorey shrubs are dominated by hook sallow-wattle and shining cassinia, and also by two species of bush-pea *(Pultenaea spp.),* which are rare or absent in the soils of Leslies Track land unit. Heath shrubs like silver banksia, yacca, common heath and the tea-trees that are dominant in the more acidic, sandier soils are absent.

The quantity of the forests and their value as a source of milling timber are higher than in the Leslies Track land unit. The reasons for this are the dominance of superior milling species (silvertop, messmate and mountain grey gum), the higher density of sound, mature trees, and the taller and straighter form of the trees. The land unit evidently provides better habitats for tree growth than does Leslies Track land unit and this is most likely because of the more fertile soils, their superior internal drainage and the probable higher rainfall. Rainfall is not recorded but the widespread occurrence of mountain grey gum and the proximity of the land unit to the rainfall recording station at Erica both suggest an average annual rainfall of about 1140 mm (45 ins.).

The soils and climate of the land unit are suitable for potatoes and perennial pastures but continued management as a productive source of hardwood is more compatible with the primary use of water supply to the catchment of Jacobs Creek.



Climate		Average annual rainfall is unknown, probably about 1150 mm
Geology		Late Tertiary gravels and clays
Topography		Broad, gently undulating ridges with short slopes along the ridges. Steeper slopes across the ridges
Soil		Brown acidic clayey soils
Vegetation	Structure	A moist variant of dry sclerophyll forest
	Species	Mostly silvertop and messmate, also mountain grey gum and narrow-leaved peppermint
Land-Use	Present	Hardwood forestry providing milling timber
	Potential	To raise the yield of timber by silviculture
Erosion	Hazard	A low hazard because of moderate slopes and porous clayey soils
	Actual	No erosion

Figure 15.—Coopers Turnoff land unit.

6. LAND USE

The development of the Tyers River as the major source of water for industrial and domestic consumers in the Latrobe Valley has made water supply the primary form of land use within the catchment. Other forms of land use, such as forestry, agriculture or recreation, must be managed to ensure that the quantity, quality and regularity of stream flow is not impaired.

Water Supply

Measurements of the quantity of water in the Tyers River were made at Gould from 1932 to 1959, prior to the submergence of the gauging station upon the completion of Moondarra Reservoir. The figures for these years given an average annual discharge of 131 487 megalitres *(106,900 acre feet) and a minimum annual discharge of 72 201 megalitres (58,700 acre feet), both of which are well in excess of the reservoir's storage capacity of 34 440 megalitres (28,000 acre feet). The average monthly discharges are given in graphical form in Figure 16 to show the yearly rhythm of maximum discharge in October (18 450 megalitres 15,000 acre feet) and minimum discharge in March (6150 megalitres-5,000 acre feet). The peak in October reflects the contribution made by melting snow on the Baw Baw Plateau, and the low point for March reflects the fact that February and March are usually the driest months of the year.

* All annual figures of river discharge are for calendar years, not water years. All river data are taken from "Victorian River Gaugings to 1960", published by the State Rivers and Water Supply Commission.

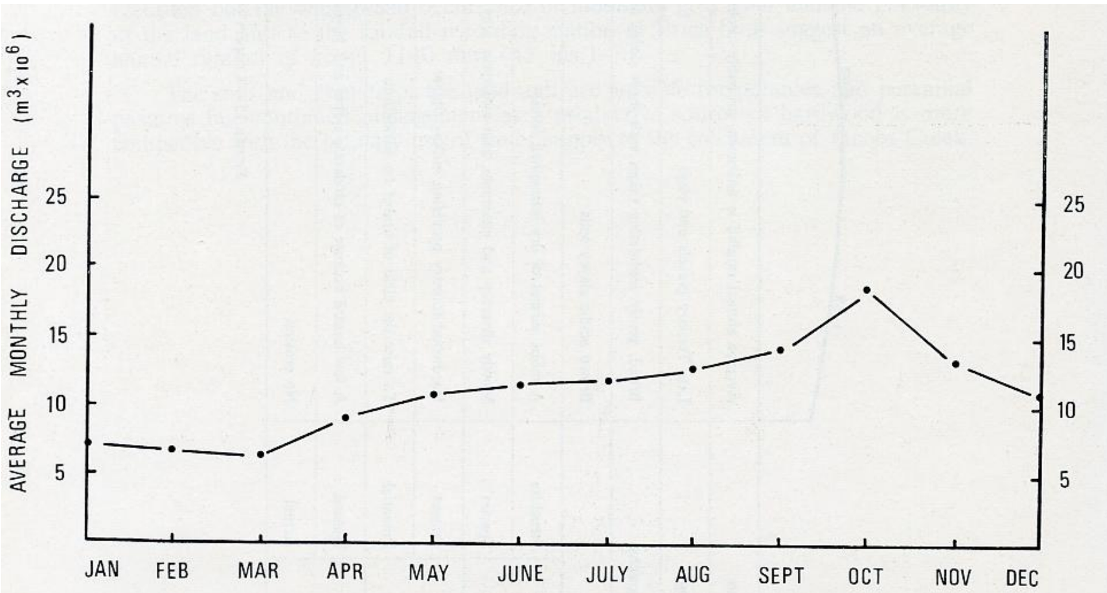


Figure 16.—Seasonal Discharge of Tyers River.

The regularity (or variability) of river volume is an important consideration when there is a reservoir to be filled annually in order to meet the needs of consumers. For the same period of records (1932 to 1959), the discharge has been greater than 71 340 megalitres (58,000 acre feet) every year. In 79 per cent of years the annual discharge has been 92 250 megalitres (75,000 acre feet) or more. In 43 per cent of years the discharge has been 123 000 megalitres (100,000 acre feet) or more. In 21 per cent of years the discharge has been 153 250 megalitres (125,000 acre feet) or more. Another calculation that seeks to measure the variability of the annual discharge of the Tyers River is the percentage variability, which is 23 per cent, a low figure for Victorian rivers. That is, the average deviation of yearly discharge from the average annual figure of 131 487 megalitres (106,900 acre feet) is 30 381 megalitres (24,700 acre feet).

Water quality is particularly important if the water is used for human and industrial consumption. The quality of the water in Tyers River and Moondarra Reservoir is measured regularly and it is high. The levels of suspended solids, dissolved salts and turbidity are low while the level of dissolved oxygen is high (Annual Reports, Latrobe Valley Water and Sewerage Board).

Plate 12. Active stream bank erosion along the West Tyers River. A loose stone embankment built to provide a summer swimming hole has directed flows on to the unprotected bank.

The catchment of the Tyers River can be divided into northern and southern sections according to the proportion of water contributed by each to the total amount in the river.

Most of the water in Tyers River comes from the northern section of the catchment above Tyers Junction, and most of this area comprises the Baw Baw plateau and the slopes of the Mount Erica—Mount Baw Baw massif (the Baw Baw

and Upper Tyers land units). The northern section covers 137 km^2 (53 square miles) which is 50 per cent of the catchment to the reservoir and 43 per cent of the proclaimed catchment to the pumping station. At Tyers Junction the West, Middle and East Tyers Rivers join, and of these the West Tyers is by far the biggest stream. It has a catchment area of 85 km^2 (35 square miles) or 33 per cent of the catchment to the reservoir, and it drains the western half of the mountain massif and most of the plateau including the winter snowfield. The other two branches of the river drain the eastern half of the massif and they are much smaller streams than the West Tyers.

River gauges are operating on the West Tyers branch at Morgan's Mill and on the Tyers River at Browne's a short distance upstream from the reservoir. Taken over a three-year period of records the total volume of water in the West Tyers River at Morgan's Mill has been 195 951 megalitres (159,310 acre feet) which is 67 per cent of the total volume of water in the Tyers River at Browne's (291 976 megalitres-237,379 acre feet). This percentage would be considerably higher if the discharges of the Middle and East Tyers branches were known. The average monthly discharge per square kilometre of catchment at Morgan's Mill is 176 megalitres (143 acre feet) which is ten times higher than the figure given below for an area typical of the southern section of the catchment.

Plate 13. Excessive clearing of steep slopes and soil disturbance by machines in the drainage lines has caused this high volume of turbid runoff.

The importance of the northern section in providing the bulk of the river water comes from certain environmental features of the mountain massif. There are very large amounts of precipitation as rain and snow, with an average annual figure probably higher than 1900 mm (80 ins.) (Chapter One). Also the soils on

the mountain slopes and the sphagnum bogs on the plateau can hold large amounts of water and they can be regarded as natural reservoirs from which water drains slowly and steadily to the watercourses leading to the three branches of the Tyers River (see Chapter Three for more information on the water holding properties of the mountain soils, that is, the transitional alpine humus soils and acid brown earths). In this way the Tyers River maintains its permanent flow, particularly during the summer months when the small tributaries in the southern section of the catchment contribute negligible amounts.

The southern section of the catchment is below Tyers Junction and it has an area of 181 square kilometres (70 square miles) or 57 per cent of the proclaimed catchment. The part that drains into the reservoir is 137 square kilometres (53 square miles) or 50 per cent of the catchment to the reservoir. The southern section comprises small catchments of short creeks flowing into the Tyers River and into the reservoir from the east and west boundary ridges and the upland area of basalt around Erica. Some of the creeks flow into the Tyers River below the reservoir. Most of the southern section is mapped as the Lower Tyers land unit and the remainder is included in the Erica, Leslies Track and Coopers Turnoff land units.

The combined discharge of water into the Tyers River from all of these small streams is something considerably less than the volume of water from the three branches of the river above Tyers Junction but no figures can be given to show the actual amount. Thirty-six square kilometres (14 square miles) of the southern section is the catchment to Jacobs Creek, which is the largest tributary of the Tyers River and flows directly into the reservoir. The average monthly discharge is 731 megalitres (594 acre feet) and the average monthly discharge per square kilometre of catchment is 51.7 megalitres (42 acre feet). Two features of the environment are likely causes of the comparative unimportance of the southern section as a contributor of water to the reservoir. The precipitation is much lower than in the northern section, ranging from 840 mm (33 ins.) to 1140 mm (45 ins.) of average annual rainfall across the area. Second, the soils over most of the area are clay leptopodzols which have a poor structure and hold considerably less water than the soils on the mountain massif (see Chapter Three). For these reasons the creeks in aggregate carry less water and are more inclined to flash flows after prolonged periods of rain than the West, Middle and East Tyers Rivers.

FORESTRY

About 94 per cent of the proclaimed catchment is covered with eucalypt forests and woodlands. These eucalypt communities vary in their suitability for timber production but there is enough good quality forest to make the catchment a valuable source of hardwood timber.

The stands of commercial timber fall naturally into two groups according to the species present and the type of hardwood they produce. The first group contains the ash-type forests that produce high quality milling timber for flooring, architraves and other kinds of finishing timber in building construction. These forests grow on the slopes of the Mount Erica—Mount Baw Baw massif (Upper Tyers land unit) where mountain ash, shining gum and woollybutt grow in wet sclerophyll forest communities. Mountain ash and shining gum are the predominant species and woollybutt is restricted to a few small stands. Most of the forests are immature regrowth from the 1939 bushfires and are dense and overstocked. Natural thinning is taking place but there is a need to hasten this by silvicultural treatment in order to ensure the maximum yield of high quality hardwood from trees of even age, large size and good form. There are small stands of mature trees that escaped the 1939 fires, mainly near Christmas Creek and East Tyers River, and these have been harvested for milling. The greatest potential in these forests lies with the mountain ash because its regeneration is faster than that of shining gum and there is a greater area, estimated to be about 2400 hectares (6,000 acres). If the mountain ash forests remain unharmed it is estimated that when they are 50 years old they will represent a standing volume of approximately 9000 cubic metres (300 million super feet) of timber.

The second group of commercial timber grows on the foothills of sedimentary rock (Lower Tyers land unit), small areas of uncleared basaltic land (Erica land unit) and the best of the areas of unconsolidated Tertiary sediments (Coopers Turnoff land unit). These forests contain a number of eucalypts of which the commercial species are silvertop, messmate, mountain grey gum and brown stringybark which are felled for milling timber (scantling) and pulpwood. All age classes are represented although there is a preponderance of mature to overmature trees and there is also a considerable proportion of trees damaged by recurrent bushfires. The long term policy of the forest authorities is to bring these forests to their maximum productive capacity by silvicultural methods that will encourage uniform stands of millable trees. To achieve this, seedling regrowth of the forests is encouraged by removing the sound mature trees for milling and removing damaged trees, and also young trees thinned out of dense stands of regrowth, for pulpwood.

Plate 14. Tyers Junction sub-unit. Road through small drainage line. Regularly used tracks require regular maintenance. A blocked culvert may render tracks impassable.

Forest management should be tailored towards the primary use of the catchment for water supply. By consultation the forest, soil and water authorities have sought to improve the methods of tree felling and removal to eliminate all possible sources of contamination of the river water. The important aspects considered are as follows: The cessation of all wet weather logging, particularly between the late autumn and early spring, to prevent the movement of soil into the streams ; the need to reconcile the year-round extraction of pulpwood for the paper industry with the necessity of preventing soil erosion ; the determination of the width and length of buffer strips along the streams and the maximum slopes to be allowed for timber extraction ; the siting and construction of roads, access tracks and log landings ; the treatment of log landing areas and snig tracks after operations have ceased, to prevent soil erosion and hasten regrowth.

The techniques of silviculture, as well as the methods of timber extraction, have been reviewed. The techniques of regenerating the forests are studied to encourage a rapid and successful regrowth and to prevent soil movement towards the streams. Statements of instruction, called prescriptions, have been issued to ensure that the results of these considerations are put into effect.

Consideration has been given to replacing hardwood forests of low productivity by softwoods in the south-western corner of the catchment, in an area draining mostly to the south of the Moondarra Reservoir. This should not be undertaken until the effects of conversion to pines are understood in terms of quality, quantity and regulations of waters.

AGRICULTURE

Six per cent of the proclaimed catchment (1700 ha-4,400 acres) is cleared for agriculture and used mainly for dairying, cattle grazing and potato growing. The farms are grouped into three areas, namely, on the basaltic land between Moondarra and Parkers Corner (Erica land unit), on small alluvial "flats" along the Tyers River (included in the Lower Tyers land unit), and at the southern end of the catchment at the head of Blairs Creek (included in the Leslies Track land unit).

Most of the farms run cattle for beef and dairy production. The climate favours the use of perennial pastures and some of the farms, particularly the newest ones in the Blairs Creek Catchment, use white clover *(Trifolium repens)*, red clover *(T. pratense)*, perennial ryegrass *(Lolium perenne)* and also an annual species, Mount Barker subterranean clover *(T. subterraneum)*. The fertilizer requirements of the pastures depend to some extent on the soils, of which there are three types, namely, red clay loans on the basalt (krasnozems), brown clays on the alluvial flats and grey sandy loans in Blairs Creek Catchment. Superphosphate is a basic requirement on all the soils, both at pasture establishment and regularly thereafter. Also for pasture establishment the red clay loans require a molybdenum fertilizer and the grey sandy loans require copper and potassium fertilizers and lime. The brown clays are the most fertile and superphosphate is the only essential amendment, although lime may be added as a safeguard at pasture establishment. After some years, regular applications of potash are necessary on all the soils if there is a continual removal of potassium from the soils in the form of farm products such as cream, milk, hay and meat.

Much of the land is periodically cultivated to grow potatoes and other crops such as oats and turnips for stock fodder. A common fertilizer treatment is 900 to 1250 kg of 5-2-1 superphosphate–potash–ammonium sulphate per ha (7 to 10 cwt/acre). The krasnozems or red clay loams are particularly suited to potato growing because their friability does not impede the growth of the tubers, their porosity and good structure in the lower horizons give them good internal drainage and they are easier than the brown clays to cultivate after rain. On a number of small potato farms there is a tendency towards potato monoculture.

Erosion on the farms is generally negligible although individual examples can be active. The dairy farms on the alluvial flats have little erosion, except for a number of isolated sites where undercutting and slumping of the banks of the Tyers River are active. Also the newly developed dairy farms in Blairs Creek Catchment have little erosion once the slopes are covered with perennial pasture. Effluent from dairy sheds is a source of stream pollution, as also are stock watering from and trafficking through streams.

Plate 15. Lower Tyers land unit. Dairy farming operation. This badly located stock track causes direct pollution to the adjacent Tyers River.

The farms on the krasnozems are greater potential contributors to colloidal matter in the river, despite the fact that the soils have well structured and permeable profiles. This is because the farms are on undulating to rolling land where the slopes are often 12-14 per cent and in some cases as much as 25 per cent. Coupled with this is the widespread practice of ploughing up and down the slope, a technique that encourages soil erosion, particularly for a row crop like potatoes with clean cultivation between the rows. Also the tendency to monoculture on some potato farms has weakened the coherence and structure of the surface soil, thus increasing the danger of sheet and rill erosion. Unsurfaced farm tracks and roads and cultivated paddocks are probably the greatest source

of stream pollution by siltation, particularly when they are close to the creeks. Most of the farming land on the krasnozems is within Jacobs Creek Catchment. This stream therefore needs more protection from farm based soil erosion than does the Tyers River.

NATURE CONSERVATION AND RECREATION

The catchment is an important area for nature conservation, containing relatively undisturbed environments ranging from sub-alpine, woodlands and herbfields through humid forests to heathy woodlands at the lower elevations. Several rare plant species are known to occur in the area, and the wide range of habitats provides an interesting diversity of fauna (Anon. 1973).

The scenic attractions of the catchment and its closeness both to Melbourne and industrial centres in the Latrobe Valley result in high and rapidly increasing recreational pressures. Most tourists use the main road to visit Walhalla, an old gold mining town which is being continually developed to encourage visitors. Many of these tourists use roadside parking areas such as that at the Tyers River bridge.

The Baw Baw plateau is a popular snowfield and an alpine village has been established there. Activities are regulated by a committee of management for the Baw Baw Alpine Reserve set up under the Forests Act. However only a small part of the reserve lies within the Tyers River Catchment and here there is relatively little activity. During the winter a large number of tourists use the Thomson Valley Road as an eastern approach to the Baw Baw snow plains. There is pressure to connect this eastern approach to the ski village. There is equal pressure against the proposal on environmental grounds. The Mount Erica to Mount Baw Baw section of the Tri-State Walking Track is being upgraded and provides excellent views. The Erica township is regarded as a potential resort with access to the snowfields. Construction of dams in the Thompson River project will also increase pressure from tourism.

The catchment is popular for scouting, particularly around the Caringal Scout Camp near the confluence of the three branches of the Tyers River, and the Connan Park Scout Camp off Boola. Road. The streams in the catchment are well known for good trout, eels and freshwater crayfish, and damage to stream banks is occasionally caused by fishermen. Some deer shooting takes place in the upper reaches of the catchment.

Trail bikes and four wheel drive vehicles have caused damage, particularly along forest tracks during the winters.

There are many hideaway blocks in the bush used mainly at weekends and during holidays. Pressure for the subdivision of larger freehold blocks can be expected to increase.

These forms of recreation and associated constructional activities all require careful regulation to minimise deterioration of the land and waters.

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APPENDIX 1 A - TYPICAL PROFILES OF THE SOIL GROUPS.

Soil colours are given Munsell notations and the descriptions of soil structure and consistence follow the system outlined in the U.S.D.A. Soil Survey Manual 1951.

Transitional Alpine Humus Soil.—Profile described on the mountain slopes of the Mt. Erica-Mt. Baw Baw massif in the Upper Tyers land unit ; elevation 1040 m (3,400 ft.); average annual rainfall estimated to ***be*** between 1500-1780 mm (60-70 ins.); vegetation is a wet sclerophyll forest of *E. nitens* and *E. gigantea* ***;*** parent rock is granodiorite.

Profile 375

0-33 cm (0-13 ins.) very dark brown (10 YR 2/2 moist) loam to clay loam ; strong fine subangular blocky peds when dry and moderate when moist ; soft consistence when dry and friable when moist.

33-50 cm (13-20 ins.) very dark brown (10 YR 2/2 moist) loam ; moderate fine subangular blocky peds when dry and weak when moist ; soft consistence when dry and friable when moist.

50-74 cm (20-29 ins.) dark yellowish brown (10 YR 3/4 moist) loam to loamy sand ; apedal ; slightly hard consistence when dry and friable when moist.

74-90 cm (29-36 ins.) mottles of yellowish brown and strong brown (10 YR 5/4, 7.5 YR 5/6 moist) clayey sand ; apedal ; slightly hard consistence when dry and friable when moist.

90-107 cm (36-42 ins.) mottles of yellowish brown and brownish yellow (10 YR 5/4 and 6/6 moist) clayey sand ; apedal ; loose consistence when dry and very friable when moist.

Rocks of granodiorite lie throughout the profile.

Acid Brown Earth—Profile described on the mountain slopes of the Mt. Erica-Mt. Baw Baw massif in the Upper Tyers land unit ; elevation 790 m (2,600 ft.); average annual rainfall estimated to be between 1500-1780 mm (60-70 ins.); vegetation is a wet sclerophyll forest of *E. regnans* ***;*** parent rock is granodiorite.

Profile 373

0-38 cm (0-15 ins.) very dark brown (10 YR 3/2 moist) clay loam ; moderate fine subangular blocky peds when dry and weak when moist ; soft consistence when dry and friable when moist.

38-58 cm (15-23 ins.) dark greyish brown (10 YR 4/2 moist) clay loam ; apedal ; slightly hard consistence when dry and friable when moist.

58-122 cm (23-48 ins.) yellowish brown to strong brown (10 YR 5/6 to 7.5 YR 5/6 moist) clay loam changing to sandy loam with depth ; apedal ; slightly hard consistence when dry and friable when moist.

120-137 cm (48-54 ins.) strong brown (7.5 YR 5/8 moist) sandy loam ; apedal ; slightly hard consistence when dry and friable when moist.

A few rocks of granodiorite in the profile.

Red Earth—Profile described on the lower mountain slopes of the Mt. Erica-Mt. Baw Baw massif in the Upper Tyers land unit; elevation 670 m (2,200 ft.); average annual rainfall estimated to be between 1270 to 1500 mm (50 to 60 ins.) ; vegetation is a wet sclerophyll forest of *E. regnans* **;** parent rock is granodiorite.

Profile 374

0-33 cm (0-13 ins.) very dark brown (10 YR 2/2 reddish, moist) silty loam to clay loam ; strong fine subangular blocky peds when dry and moderate when moist ; soft consistence when dry and friable when moist.

33-56 cm (13-22 ins.) dark brown (10 YR 2/2 to 7.5 YR 3/2 moist) loam to silty loam • moderate fine subangular blocky peds when dry and weak when moist ; slightly hard consistence when dry and friable when moist.

56-76 cm (22-30 ins.) dark brown (7.5 YR 3/2 moist) loam to silty loam ; apedal ; hard consistence when dry and friable when moist.

76-150 cm (30-60 ins.) reddish brown (5 YR 4/4 moist) clay loam gradually changing to clay with depth ; apedal ; hard when dry and friable when moist.

Krasnozem.—Profile described at Erica in the Erica land unit ; elevation 400 m (1,300 ft.) ; average annual rainfall 1180 mm (46+ ins.) ; native vegetation was originally a moist variant of a dry sclerophyll forest of *E. sieberiana, E. obliqua, E. cypellocarpa* ; it is now removed and bracken and blackberry cover the area ; parent rock is basalt.

Profile 377

0-3 cm (0-1 ins.) dark brown (7.5 YR 3/2 moist) silty loam ; strong, very fine subangular blocky and fine granular peds when moist ; very friable consistence when moist.

3-18 cm (1-7 ins.) dark reddish brown (5 YR 3/3 moist) silty clay strong, very fine subangular blocky peds when dry and moderate when moist ; loose consistence when dry and very friable when moist.

18-40 cm (7-16 ins.) dark red (2.5 YR 3/4 moist) clay ; strong, very fine subangular blocky peds when dry and moderate when moist ; soft consistence when dry and very friable when moist.

40-122 cm (16-48 ins.) dark red (2.5 YR 3/6 moist) clay ; moderate fine angular blocky peds when dry and weak when moist ; slightly hard consistence when dry and friable when moist.

Brown Acidic Clayey Soil.—Profile described on the Tyers-Walhalla Road in the Coopers Turnoff land unit ; elevation 400 m (1,300 ft.) ; average annual rainfall estimated to be 1141 mm (45 ins.) ; vegetation is a moist form of dry sclerophyll forest of *E. sieberiana* and *E. cypellocarpa;* parent material is Tertiary clay and gravel.

Profile 391

0-15 cm (0-6 ins.) dark brown (10 YR 3/3 moist) loam ; weak, very fine subangular blocky peds when moist ; firm consistence when moist ; scattered small stones of quartz.

15-90 cm (6-35 ins.) brown (7.5 YR 4/4 moist) clay loam ; weak, very fine subangular blocky peds when moist ; friable consistence when moist ; scattered small stones of quartz. Soil gradually changes to strong brown (7.5 YR 5/6 moist) clay ; moderate, very fine subangular blocky peds when moist ; friable ; large stones of quartz.

90-150 cm (35-60 ins.) mottles of light yellowish brown and dark red (10 YR 6/4 and 10 R 3/4 moist) clay ; weak, very fine angular blocky peds when moist ; friable consistence when moist ; large stones of quartz.

Clay Leptopodzol.**—**Profile described near Jacobs Creek in the Lower Tyers land unit ; elevation 304 m (1,000 ft.) ; average annual rainfall estimated to be 1041 mm (41 ins.) ; vegetation is a dry sclerophyll forest of *E. obliqua* and *E. radiata* ***;*** parent rock is Siluro-Devonian mudstones, shales and fine sandstones.

Profile 371

0-3 cm (0-1 ins.) dark greyish brown (10 YR 4/2 moist) silty loam ; moderate fine subangular blocky peds when moist ; friable consistence when moist.

3-15 cm (1-6 ins.) light yellowish brown (10 YR 6/4 moist) silty loam ; apedal ; slightly hard consistence when dry.

15-33 cm (6-13 ins.) light yellowish brown (10 YR 6/4 moist) silty clay loam ; apedal ; slightly hard consistence when dry.

33-53 cm (13-21 ins.) light yellowish brown (10 YR 6/4 to 7/4 moist) silty clay loam to silty clay ; apedal ; hard consistence when dry.

53-74 cm (21-29 ins.) very pale brown (10 YR 7/4 moist) with mottles of yellow (10 YR 7/8 moist) silty clay ; apedal ; hard consistence when dry ; pieces of mudstone strata.

Sandy Clay Leptopodzol.**—**Profile described along Early Road in the Leslies Track land unit ; elevation 240 m (800 ft.) ; average annual rainfall 940 mm (37 ins.) ; vegetation is a dry sclerophyll forest of *E. obliqua, E. consideniana, E. baxteri* ***;*** parent material is Tertiary sand and clay.

Profile 392

0-6 cm (0-2+ ins.) dark greyish brown (10 YR 4/2 to 2.5 Y 4/2 moist) loamy sand ; weak, very fine subangular blocky peds when moist ; friable consistence when moist.

6-25 cm (2+-10 ins.) weak mottles of light yellowish grey (5 Y 6/3 moist), light brownish grey (2.5 Y 6/2 moist) and pale brown (10 YR 6/3 moist) loamy sand ; apedal ; firm consistence when moist.

25-60 cm (10-24 ins.) light yellowish brown (10 YR 6/4 moist) with mottles of yellowish brown (10 YR 5/6 moist) sandy loam ; apedal ; firm consistence when moist.

60-75 cm (24-30 ins.) light yellowish brown (10 YR 6/4 moist) sandy clay loam ; apedal ; firm consistence when moist.

75-100 cm (30-39 ins.) mottles of light brownish grey (10 YR 6/2 moist) and light yellowish brown (10 YR 6/4 moist) sandy clay ; apedal ; firm consistence when moist.

Podzolised Duplex Soil.—Profile described on the Tyers-Walhalla Road in the Leslies Track land unit; elevation 340 m (1,100 ft.) ; average annual rainfall 940 mm (37 ins.) ; vegetation is a dry sclerophyll forest of *E. consideniana, E. obliqua ;* parent material is Tertiary sand and clay.

Profile 378

A1 0-27 cm (0-10+ ins.) black (10 YR 2/1 moist) with white grains, sandy loam ; 0-25 cm (0-1 in.) moderate fine granular peds, 2.5-27 cm (1-101 ins.) apedal ; friable consistence when moist.

A2 27-37 cm (10+-14+ ins.) dark grey (10 YR 4/1 moist) sandy loam ; apedal ; friable consistence when moist.

B_2 37-45 cm (14+-17 and 18 ins.) dark brown (7.5 YR 3/2 moist) cemented sandy loam ; apedal : very firm consistence when moist ; " coffee rock ".

B2 45-110 cm (17 and 18-43 ins.) brownish yellow (10 YR 6/6 to 5/6 moist) with mottles of strong brown (7.5 YR 5/8 moist) clay ; apedal ; firm consistence when moist.

C, 110-130 cm (43-51 ins.) mottles of light grey and red (10 YR 6/1 and 2.5 YR 4/6 moist) clay ; weak, very fine angular blocky peds ; firm consistence when moist.

Stones of quartz are throughout the profile, particularly in the B and C horizons.

APPENDIX 1 B – ANALYTICAL DATA FOR INDIVIDUAL SOIL PROFILES.

In the particle size analysis, the figures for gravel are expressed as a percentage of the air-dry field sample and the figures for coarse sand, fine sand, silt and clay are expressed as a percentage of the oven-dry fine earth sample. For field texture, s = sandy, S = sand, l = loamy, L = Loam, si = silty, cl = clayey, C = clay. A blank space means that no determination was made.

Soil Group	Depth of Sample Cm	Field texture	Particle Size Analysis					pH	Cl	Org C	Total N	1.3C N	Total P	Total K	Exchangeable Cations									
			Gravel %	Coarse sand %	Fine sand %	Silt %	Clay %		%	%	%		%	%	Milli-equiv per cent					Per cent of TEC				
															Ca	Mg	K	Na	Total Exchange Capacity	Ca	Mg	K	Na	H
Transitional Alpine Humus Soil Profile 375	0-8 cm	L to CL	0	29	21	13	25	4.9	0.007	11.0	0.61	24	0.037	0.11	0.7	0.3	0.5	<0.05	24.3	3	1	2	0	94
	15-33	L to CL	0	32	22	19	18	5.1	0.005	7.7	0.43	23	0.33	0.11	0.3	<0.05	0.4	<0.05	18.4	2	0	2	0	96
	50-74	L to lS	4	37	28	20	10	5.1	0.004	2.9	0.14	27	0.032	0.16	0.1	<0.05	0.3	<0.05	14.0	1	0	2	0	97
	90-107	clS	6	59	22	12	3	5.2	0.002	..	..	..	0.037	0.18	0.1	<0.05	0.1	<0.05	10.1	1	0	1	0	98
Acid Brown Earth Profile 373	0-8	CL	0	35	20	11	28	4.9	0.005	8.9	0.57	20	0.033	0.16	0.6	0.3	0.4	<0.05	20.0	3	2	2	0	93
	15-38	CL	0	35	20	11	28	4.9	0.004	6.0	0.37	21	0.032	0.12	0.7	1.6	0.3	<0.05	17.5	4	9	2	0	85
	58-90	CL	0	37	20	10	29	5.2	0.003	3.6	0.22	21	0.027	0.12	0.2	0.1	<0.05	<0.05	15.2	1	1	0	0	98
	122-137	sL	0	64	18	8	8	5.5	0.002	..	..	..	0.035	0.25	0.1	<0.05	<0.05	<0.05	10.6	1	0	0	0	99
Red Earth Profile 374	0-8	CL	0	..	..	..	..	4.9	0.005	8.9	0.57	20	0.033	0.16	0.6	0.3	0.4	<0.05	20.0	3	2	2	0	93
	15-33	siL to CL	0	19	24	25	25	5.0	0.006	5.8	0.38	20	0.025	0.18	0.2	0.2	0.4	<0.05	15.2	1	1	0	0	98
	56-76	L to siL	0	17	33	24	20	5.0	0.004	..	0.21	..	0.020	0.19	0.2	<0.05	0.4	<0.05	14.7	1	0	3	0	96
	122-152	C	0	20	20	16	41	5.0	0.003	..	..	..	0.016	0.20	0.2	<0.05	0.3	<0.05	13.2	2	0	2	0	96
Krasnozem Profile 377	0-3	siL	5	17	28	27	21	6.8	0.035	4.6	0.32	19	0.067	0.32	15.3	4.2	3.0	<0.05	28.8	53	15	10	0	22
	3-18	siC	0	4	17	28	44	6.1	0.011	3.1	0.23	18	0.035	0.18	9.4	2.5	0.8	<0.05	24.6	38	10	3	0	49
	40-61	C	0	2	11	13	68	5.2	0.010	..	0.09	..	0.036	0.17	0.8	2.9	0.4	<0.05	17.8	21	16	2	0	61
	91-122	C	0	1	12	15	71	5.2	0.005	..	..	..	0.034	0.16	1.7	3.0	0.2	<0.05	15.9	11	19	1	0	69
Brown Acidic Clayey Soil Profile 391	0-8	L	6	21	33	24	19	5.6	0.014	2.4	0.12	26	0.009	0.08	5.4	2.0	0.3	0.1	14.4	37	14	2	1	46
	15-30	L to CL	4	19	32	22	25	5.2	0.010	1.3	0.07	26	0.007	0.08	1.1	1.0	0.3	0.1	8.7	13	11	3	1	72
	46-61	CL	6	16	31	20	32	5.0	0.008	0.7	0.04	23	0.007	0.09	0.7	1.4	0.2	0.1	10.3	7	14	2	1	76
	90-122	C	7	14	20	12	53	5.1	0.012	..	..	..	0.008	0.14	0.9	0.9	0.3	0.3	13.1	7	7	2	2	82
Clay Leptopodzol Profile 371	0-3	siL	4	4	29	38	24	4.5	0.009	5.8	0.26	29	0.018	0.25	2.0	2.4	0.4	0.1	26.0	8	10	2	<1	80
	15-33	siCL	0	3	28	39	28	4.8	0.003	..	..	..	0.007	0.35	0.3	0.2	0.2	0.1	10.7	3	2	2	1	93
	53-74	siC	0	3	18	29	46	5.0	0.003	..	..	..	0.010	0.70	0.3	0.7	0.1	0.2	13.0	2	5	1	2	90
Sandy clay Leptopodzol Profile 392	0-6	lS	0	46	29	13	7	4.7	0.008	1.9	0.07	38	0.004	0.03	0.6	0.4	0.1	0.1	10.0	6	4	1	1	82
	15-25	lS	0	44	33	15	8	5.2	0.005	0.4	0.02	35	0.002	0.02	0.4	0.1	0.1	<0.05	3.1	13	3	3	0	81
	46-60	sL	0	41	31	15	13	5.1	0.005	0.4	0.01	37	0.003	0.03	0.3	0.2	0.1	<0.05	3.4	9	6	3	0	82
	75-100	C	0	26	21	8	42	5.0	0.007	..	..	..	0.004	0.09	0.4	1.4	0.1	<0.05	7.1	6	20	1	0	73
Podzolised Duplex Soil Profile 378	0-8	sL	0	39	32	19	10	4.8	0.010	7.8	0.35	29	0.013	0.04	3.4	3.7	0.3	<0.05	27.7	12	13	1	0	74
	15-27	lS	0	31	36	23	6	4.3	0.005	3.7	0.14	34	0.004	0.01	0.5	0.7	0.1	<0.05	20.1	2	3	<1	0	95
	37-45	sL	0	33	26	17	17	5.0	0.005	3.7	0.13	37	0.005	0.05	1.87	0.2	0.1	<0.05	25.6	7	1	<1	0	92
	61-110	C	2	22	21	13	40	4.5	0.004	..	..	..	0.003	0.12	0.4	0.3	0.1	<0.05	12.5	3	2	1	0	94

APPENDIX 1 C - MEASUREMENT OF THE WATER-HOLDING PROPERTIES.

Field Capacity (1/10 atmosphere percentage).

The intact-structure cores of soil were saturated with water at zero tension and weighed. Then, still in their brass sleeves, they were placed on a ceramic tension table and allowed to reach equilibrium at a tension of 100 cm water (two days) before being re-weighed. They were then dried at 105°C to determine their dry weight. The 1/10 atmosphere percentage is the percentage of water held by the soil against a tension of 100 cm water.

Wilting Point (15 atmosphere percentage).

Samples of fine earth (<2 mm) were saturated with water at zero tension and then brought to equilibrium in a pressure-membrane apparatus set at 15.5 kg per square centimetre (15 atmospheres). The samples were then weighed, dried at 105°C and re-weighed. The 15 atmosphere percentage is the percentage of water held against an equivalent tension of 15 atmospheres.

APPENDIX II.

The common names and scientific names of native plants recorded in the Tyers Survey.

EUCALYPTS.

Apple box	*Eucalyptus aromaphloia*
Brown stringybark	*E. baxteri*
Butt butt	*E. bridgesiana*
Manna gum	*E. viminalis*
Messmate	*E. obliqua*
Mountain ash	*E. regnans*
Mountain grey gum	*E. cypellocarpa*
Narrow-leaved peppermint	*E. radiata*
Red box	*E. polyanthemos*
Shining gum	*E. nitens*
Silvertop	*E. sieberi*
Snow gum	*E. pauciflora*
Tingiringi gum	*E. glaucescens*
White stringybark	*E. globoidea*
Woollybutt	*E. delegatensis*
Yertchuk	*E. consideniana*

Trees and tall shrubs in wet sclerophyll forests.

Myrtle beech	*Nothofagus cunninghamii*
Blanket leaf	*Bedfordia salicina*
Hazel pomaderris	*Pomaderris apetala*
Silver wattle	*Acacia dealbata*

Common species in the understorey of moist variants of the dry sclerophyll forests.

Bush-pea, large leaf	*Pultenaea daphnoides*
Bush-pea, prickly	*P. juniperina*
Cassinia, shining	*Cassinia longifolia*
Sallow-wattle, hook	*Acacia mucronata*

Common species in the understorey of dry sclerophyll forests growing in sandy podzolised soils.

Banksia, silver	*Banksia marginata*
Bracken	*Pteridium esculentum*
Cassinia, shining	*Cassinia longifolia*
Grass-tree, small	*Xanthorrhoea minor*
Heath, common	*Epacris impressa*
Sallow-wattle, hook	*Acacia mucronata*
Saw-sedge, thatch	*Gahnia radula*
Tea-tree, prickly	*Leptospermum juniperinum*
Tea-tree, silky	*L. myrsinoides*

C. H. RIXON, Government Printer, Melbourne.