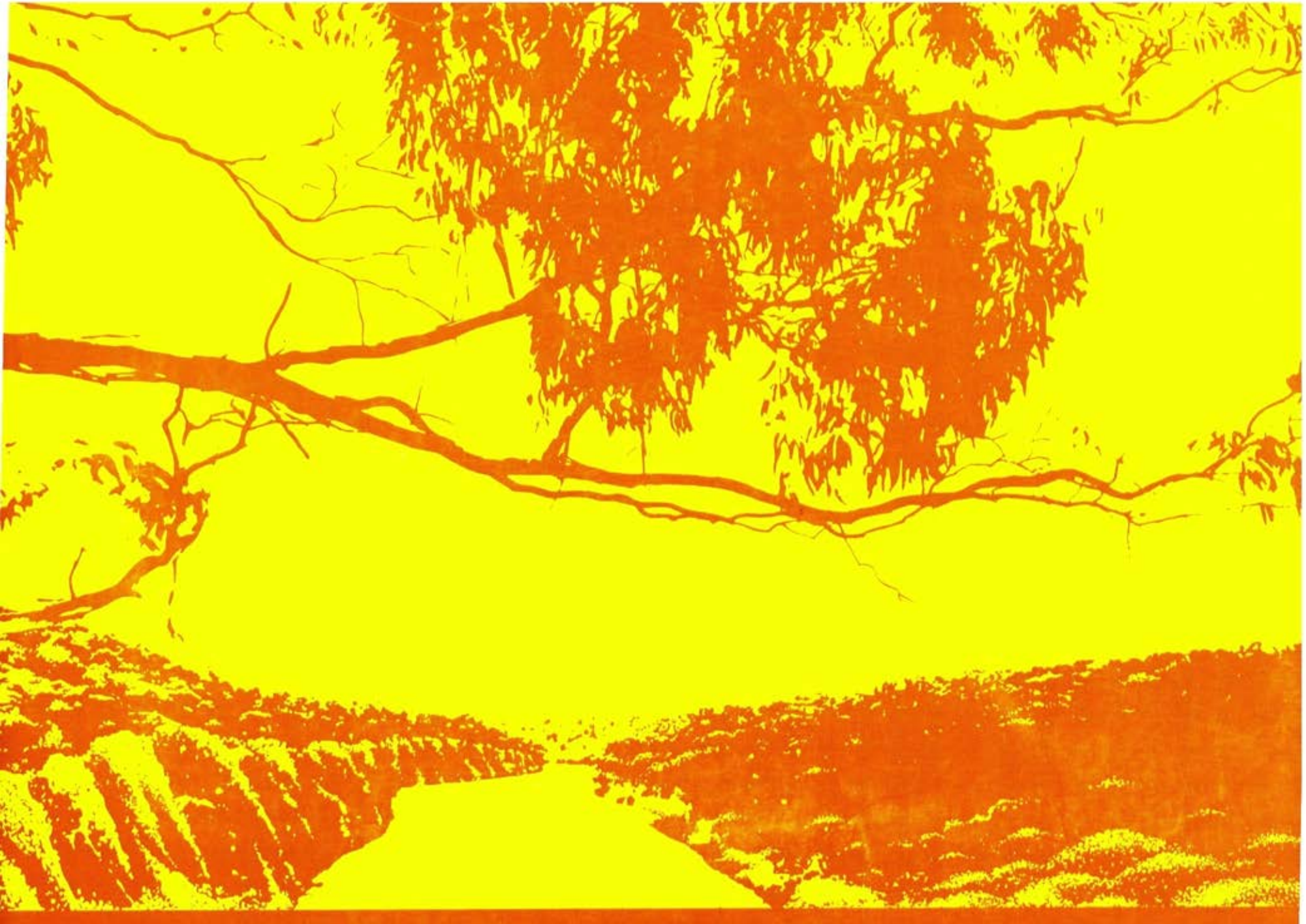

**Land Conservation Council Victoria**

North-Eastern Study Area, District 2.

Price $2.00

# REPORT

# on the

# NORTH EASTERN AREA

# (district 2)

Land Conservation Council, Victoria
Melbourne: August 1973

5762/73-PL

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# FOREWORD

The Land Conservation Act, 1970 established the Land Conservation Council whose function is to "carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of land in Victoria".

This report sets out to describe and assess the natural resources of the public land in the North Eastern Area, District 2 and provides a factual basis on which members of the community may base their submissions to the Council. It ensures that all those persons and bodies who have an interest in the future use of public land in this area can obtain and study the basic information, which the Council will itself study, and so make informed and constructive suggestions to the Council for its consideration.

In making this report available the Government hopes that all interested parties will be able to participate in an informed fashion in the process of considering how public lands should be used. It is hoped that in making submissions, members of the community will use as a basis the information provided by this study. The Council will make its recommendations only after due consideration of these submissions.

Demands for land for various purposes are many and varied, some of which are compatible and some conflicting or competitive. It is therefore important that decisions made are based on factual evidence, not on subjective criteria.

Submissions are now invited and should reach the Secretary of the Land Conservation Council within 60 days of the publication of this report, as notified in the Victoria Government Gazette.

S.G.McL. DIMMICK
Chairman

Land Conservation Council,
464 St. Kilda Road,
MELBOURNE. 3004.

# LAND CONSERVATION ACT 1970

## EXTRACT

### Public Land

Section 2.

(1) "Public land" means -

(a) land which is not within a city town or borough and is -

(i) unalienated land of the Crown including land permanently or temporarily reserved under section 14 of the *Land Act* 1958 and State forest;

(ii) vested in any public authority (other than a municipality or a sewerage authority within the meaning of the *Sewerage Districts Act* 1958); or

(iii) vested in the Melbourne and Metropolitan Board of Works; and

(b) any other land which the Governor in Council declares under sub-section (2) to be public land for the purposes of this Act

"Reserved forest" and "State forest" have the same meanings as in section 3 of the *Forests Act* 1958.

(2) The Governor in Council may on the recommendation of the Minister made after consultation with -

(a) any Minister of the Crown in whom any land is vested; or

(b) the Minister responsible for a public authority in which any land is vested -

by proclamation published in the *Government Gazette* declare any such land to be public land for the purposes of this Act.

### Functions of the Council

Section 5.

(1) The Council shall -

(a) carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of land in Victoria;

(b) make recommendations to the Governor in Council as to the constitution and definition of water supply catchment areas under the *Soil Conservation and Land Utilization Act* 1958; and

(c) advise the Soil Conservation Authority concerning policy on the use of land (whether public land or any other land however vested) in any water supply catchment area.

(2) In making any recommendation the Council shall have regard to the present and future needs of the people of Victoria in relation to -

(a) the preservation of areas which are ecologically significant;

(b) the conservation of areas of natural interest beauty or of historical interest;

(c) the creation and preservation of areas of reserved forest;

(d) the creation and preservation of areas for national parks;

(e) the creation and preservation of areas for leisure and recreation, and in particular of areas close to cities and towns for bushland recreation reserves;

(f) the creation and preservation of reserves for the conservation of fish and wildlife;

(g) the preservation of species of native plants; and

(h) land required by government departments and public authorities in order to carry out their functions.

(3) Where the Council recommends the alienation of any land the recommendation shall include the Council's opinion as to the best method of alienating the land to ensure the most satisfactory use and management of the land in the public interest.

(4) Any person or body may make submissions to the Council as to how any public land can be better used to meet the needs of the people of Victoria and the Council shall consider any such submissions before making any recommendation under paragraph (a) of sub-section (1).

Investigations, Notices and Reports

Section 9.

(1) The Council shall not make any recommendation under this Act in relation to any district or area without a prior investigation of the district or area.

(2) Before commencing any investigations under paragraph (a) of sub-section (1) of section 5 the Council shall publish a notice in the Government Gazette, in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district to be investigated stating that an investigation of the district or area described in the notice is to be carried out for the purposes of this Act.

(3) On completing an investigation of a district or area under paragraph (a) of sub-section (1) of section 5 the Council shall -

(a) publish a report of the investigation;

(b) give notice in the Government Gazette of the publication of the report, the address where copies of the report may be obtained or inspected and stating that any submissions to the Council in relation to such report will be considered by the Council if they are made within 60 days of such notice; and

(c) publish notice in a newspaper circulating throughout the State and in a newspaper circulating particularly in or in the vicinity of the area or district investigated of the publication of the report, the address where copies of the report may be obtained or inspected and stating that submissions may be made to the Council and the date before which they should be made.

(4) The Council shall consider any submissions in relation to such report made by any person or body within 60 days of notice being given under paragraph (b) of sub-section (3).

Notice to be given to public departments and authorities in certain cases.

Section 10.

(1) Not earlier than 60 days after notice being given under paragraph (b) of sub-section (3) of section 9, the Council shall send a copy of its proposed recommendation to -

(a) the Council of any municipality in the municipal district to which the recommendation relates is situated;

(b) any other public authority or government department that in the opinion of the Council has an interest in the area of the proposed recommendation; and

(c) any person or body who made a submission under section 9 -

and shall consider any submissions received within 60 days of the sending of such copy to the Council, authority, department, person or body or in the case of a public authority or government department within such longer period as may be agreed upon between the Minister and the Minister administering that department or responsible for that authority.

(2) Where any recommendation is made to the Minister under this Act it shall be accompanied by a copy of any submissions received from any person body department authority or council pursuant to the provisions of sub-section (4) of section 9 or sub-section (1) of this section.

(3) Where the Council has made a recommendation to the Minister under paragraph (a) of sub-section (1) of section 5 the Minister may, after he has given not less than fourteen days notice of his intention so to do to the Minister administering a government department or responsible for a public authority recommend to the Governor in Council that notice of the recommendation or that part of the recommendation that affects the government department or public authority concerned and where notice of that recommendation or part is so given by the Governor in Council it shall be the duty of the government department or public authority to use all diligence and dispatch to give effect to such recommendation so far as it affects any land vested in or controlled by it.

Copy of every Recommendation and of Proposals to be Tabled in Parliament

Section 11.

A copy of every recommendation of the Council made under sub-section (1) of section 5 and of the proposals of the Council submitted to the Minister pursuant to section 7 shall be laid before both Houses of Parliament within fourteen days of the making thereof if Parliament is then sitting and if Parliament is not then sitting within fourteen days after the meeting of Parliament.

A copy of the *Land Conservation Act* 1970 can be obtained from the Government Printing Office, 7a Parliament Place, Melbourne, 3002.

# ACKNOWLEDGEMENTS

Many Government departments, organizations, and individuals assisted the Council's staff to compile this report by supplying information and photographs, checking drafts, and contributing discussion and advice.

The generous assistance given by the Soil Conservation Authority is gratefully acknowledged. A report (in press) of the Authority, "A Study of the Land in the Catchment of the Broken River", was a major source of information for this report.

The Forests Commission gave much assistance in the field work and supplied the information for the chapters on hardwoods and softwoods (including data on the timber industry). The vegetation map was compiled from maps drawn up by the Commission's staff.

The State Rivers and Water Supply Commission contributed the water and water utilization chapters. The Mines Department provided information on geology, economic minerals and groundwater supplies, and the Department of Agriculture provided information on agricultural pursuits and capabilities.

The Department of Crown Lands and Survey prepared maps showing public land boundaries for the Council's use and assisted the Council with the drawing of maps in this report. The Army Department (Survey) provided topographical maps for some areas.

The National Museum, Fisheries and Wildlife Division, and the National Parks Service contributed information on fauna.

The following departments also assisted with the compilation of the report - the National Herbarium, the State Electricity Commission, the Central Planning Authority, the Education Department of Victoria (special services), the Keith Turnbull Research Station (Department of Crown Lands and Survey), and the Commonwealth Bureau of Meteorology.

The assistance given by the following persons and organizations is gratefully acknowledged: Mr. E.P. Backen, Mr. H.G. Bleakley (National Parks Association), Mr. M.A.H. Marsden (Melbourne University), Mrs. M. Maxwell (Royal Historical Society), Mrs. R.G. Ritchie, Mr. P.A. Rawlinson (Latrobe University), Mr. B.

Weston, Mr. J.H. Willis, the North-Eastern Apiarists' Association, and the Mammal Survey Group. Members of the Benalla Field Naturalists Club were particularly helpful in providing information on flora and fauna

The Council is indebted to the following people who made their photographs available for the report: Mr. A.J. Coventry (reptiles), Mr. L. Cummings (apiculture), Mr. A.E. Howard (mammals), Mr. D.P. Nicel (apiculture), Mr. T.W. Pescott (birds and mammals), Mrs. W.F. Street (historical), and Mr. W. Roy Wheeler (birds). Aerial photographs are reproduced with the permission of the Department of Minerals and Energy.

# PART I

# INTRODUCTION

# AIMS AND METHODS

This report sets out to present all available information relevant to making decisions on the future use of public land in the study district. It describes the nature of the environmental features, together with the character and distribution of the plant communities and animals in the area. It also examines the forms of land use that will make demands on public land, and attempts to assess their impact. It does not contain land use recommendations for public land, but rather provides a factual basis on which land use recommendations can be formulated.

Existing information collected from published reports, government departments, public authorities, private organizations, and individuals has been supplemented by short-term surveys of mammals, reptiles, and amphibians. However, our knowledge of the environment, and of the interactions between land management practices and the environment, is still far from complete.

Many people who are interested in the future use of public lands may lack a technical background in some of the relevant fields. Thus, while complex issues are not avoided, non-technical language has been used as far as possible.

The four parts

Part I sets out the aims of the study and outlines the conservation and ecological principles followed. A brief description of the district precedes a short history, including an account of its Aboriginal inhabitants and subsequent development by the early settlers. A locality plan is attached.

Part II describes the nature of the main features of the environment for the whole study district. Maps included show physiography, geology, and topography and rainfall. Another map in a pocket at the back of this report delineates plant communities. Mammal, bird, and reptile habitats are described in terms of these communities. Finally, this part considers the features of the land together, describes them in tabular form, and maps 15 units (termed land systems) in which distinctive environmental patterns occur.

Part III deals with the main forms of land use that are likely to make demands on public land. After describing

the hazards that occur in the region, such as erosion and fire, it discusses any deterioration in the condition of public lands that may occur as a result of changes in land use. Then, for each form of land use, this part considers the present level of activity in the district, the likely future demand, and the capability of public land to meet such demand. Finally, it deals with the relations between the various types of land use. Maps showing recreation resources, minerals, and the present forms of primary production are attached.

In Part IV the public land is divided into 12 blocks for ease of description and consideration. A map showing these blocks and public land is attached. Additional public land not shown on the map includes five parcels in the Ryans block purchased by the Benalla Water Trust, one purchased by the Forests Commission north of Boho South in the Warrenbayne block, and various stream frontages and road reserves. (On this map and others in the report, the district boundary has been erroneously drawn to include the portion of the City of Benalla south of the Hume Highway, whereas this in fact is not part of the study district.) Part IV then describes the nature of the public land in each block and assesses its potential for the various forms of land use and associated hazards and conflicts. These descriptions and assessments are set in a consistent format of headings and sub-headings so that the reader can readily find specific information for any block and compare it with others.

A map of public land, in the pocket at the back of the report, may be useful in preparing submissions.

Appendix I contains tables of climatic data.

Appendix II lists common native plants of the district.

Appendix III lists native birds, mammals, and reptiles recorded for the district, and indicates the habitat type and biological characteristics for each species.

Also included is a list of the probable and recorded amphibians of the district and a list of native fishes.

# CONSERVATION

Conservation is concerned with Man's relation to his environment. It is often said to be the wise or balanced use of resources. Because wisdom and balance are not absolute terms, the principles set out here attempt to explain this concept.

Conservation can be considered as an endeavour to anticipate and resolve conflicts between the individual and society about the present and future use of resources, and between competing uses of the same resource. The conservationist is aware of long-term needs and recognizes that a community requires land for recreational, scientific, and aesthetic purposes as well as for the production of food, timber, and minerals, or for urban and industrial use.

## Natural Resources

Two broad classes of natural resource may be distinguished, according to whether they are renewable.

### Non-renewable resources

The quantity of these resources does not increase significantly with time, and use consumes them. The expansion of Victoria's economy last century was based on the exploitation of gold - a non-renewable resource. The oil and gas fields of Bass Strait provide another example.

Conservation of a non-renewable resource requires the best techniques for exploration, recovery, and processing, and the efficient use of the end product.

### Renewable resources

The quantity of a renewable resource such as timber or pasture may increase or decrease over time. Animal and plant communities and landscape fall within this class. Abuse of these resources may reduce them to such a poor condition that the practical opportunity to restore them to a desired state is lost for many generations.

Conservation of renewable resources requires a thorough understanding of ecological principles and the development of sound management techniques based on those principles. An ecosystem typically contains many components that are interrelated. A change in any one

of these will have effects elsewhere in the system. In general, an ecosystem with a diverse range of species will be better able to adapt and absorb the impact of sudden change - such as that caused by fire, disease, or Man's activities - than a simple ecosystem with few species.

Man is part of the ecosystem and, like every other organism, influences and is influenced by the other parts. The development of new technology has increased his ability to modify the environment. Many new techniques have both advantages and disadvantages. Often the disadvantages are not obviously linked to the new technique and only emerge in the long term - the use of insecticides can increase the production of food or fibre dramatically, but may also reduce the populations of predatory birds and insects and so encourage the build-up of other insect pest populations.

## Relations between Resource Uses

Many uses of a resource are compatible. They may be supplementary and add to each other, or complementary in that one use benefits from the other, but they may also be competitive when an increase in one leads to a decrease in the other.

For example, the relation between timber production and picnics within a forest may be complementary in the sense that picnickers gain access along tracks and use open spaces created during timber operations. It may become competitive if logging makes the forest an unsuitable picnic area, and at other times picnickers may present a considerable fire risk. In general, decisions on land use will involve selecting major land uses for a particular area, and determining other uses compatible with these and the intensity of use above which they become incompatible.

## The Principles of Land Use

In the past our society has grown (and the economic welfare of the people improved) through mining, farming, timber production, and industrial development. These industries have been given prime importance, and the use of natural resources has often been decided in relation to short-term advantage when conflict arose. The deleterious effects of this type of development have been recognized and there is now a popular demand for attention to the total long-term needs of the community.

The concept of balance involves equal consideration of the needs of all sections of society, on both regional and State bases, as well as the needs of this and future generations. These needs should be clearly stated as aims.

The intangible values of recreation, aesthetics, and preservation must not be ignored. In addition to actively providing land for these purposes, we must also consider the impact of other land

uses upon them. Outstanding natural features should be preserved.

Where several land uses are compatible, land should be available for the most beneficial combination of such uses. It may be necessary to define major aims and to assess levels above which secondary uses are unacceptable.

Where land has been committed to a particular use, it should be managed so that its capability for that use is not impaired. Uncommitted land should be maintained in a condition that will allow the widest possible choice of future uses.

Policy measures should stimulate the best use of partly developed lands and discourage significant changes in natural areas.

Review and reassessment of land will become necessary as society and technology change.

# THE STUDY DISTRICT

The district consists of land in the Shires of Benalla, Goulburn, Euroa, Mansfield, and Violet Town. It is bounded by the Hume Highway and the southern boundary of Benalla City on the north-west, the Benalla and Mansfield Shire boundaries on the east, and the Maroondah Highway and the Goulburn and Euroa Shire boundaries on the south (see the locality plan facing this page).

The total area within the district is 350,000 ha, of which approximately 84,600 ha is public land, mainly in four consolidated parcels. These are located in the eastern part of the Strathbogie Ranges, Tolmie highlands (north Blue Range and Toombullup plateau), the headwaters of the Broken River and Evans Creek, and the Reef Hills near Benalla.

The Lake Nillahcootie and Ryans Creek catchments have been proclaimed as water supply catchments under the *Soil Conservation and Land Utilization Act* 1958. Both are within the Broken River catchment. Others include part of Lake Eildon catchment, and those of Evans Creek (for Lake William Hovell), Seven Creeks, and Honeysuckle Creek.

The topography varies from the flat Benalla and Mansfield plains to steep slopes and undulating uplands. The uplands are mainly formed from granites and acid volcanic rocks, with some sedimentary rocks near Tolmie. Sedimentary rocks and alluvial deposits occur mainly at lower elevations.

The climate ranges from hot dry summers and cool winters at the lower elevations to mild summers and cold winters at the higher ones. Average annual rainfall varies from less than 630 mm near Benalla and Euroa to more than 1,270 mm in the Strathbogie Ranges and Tolmie highlands.

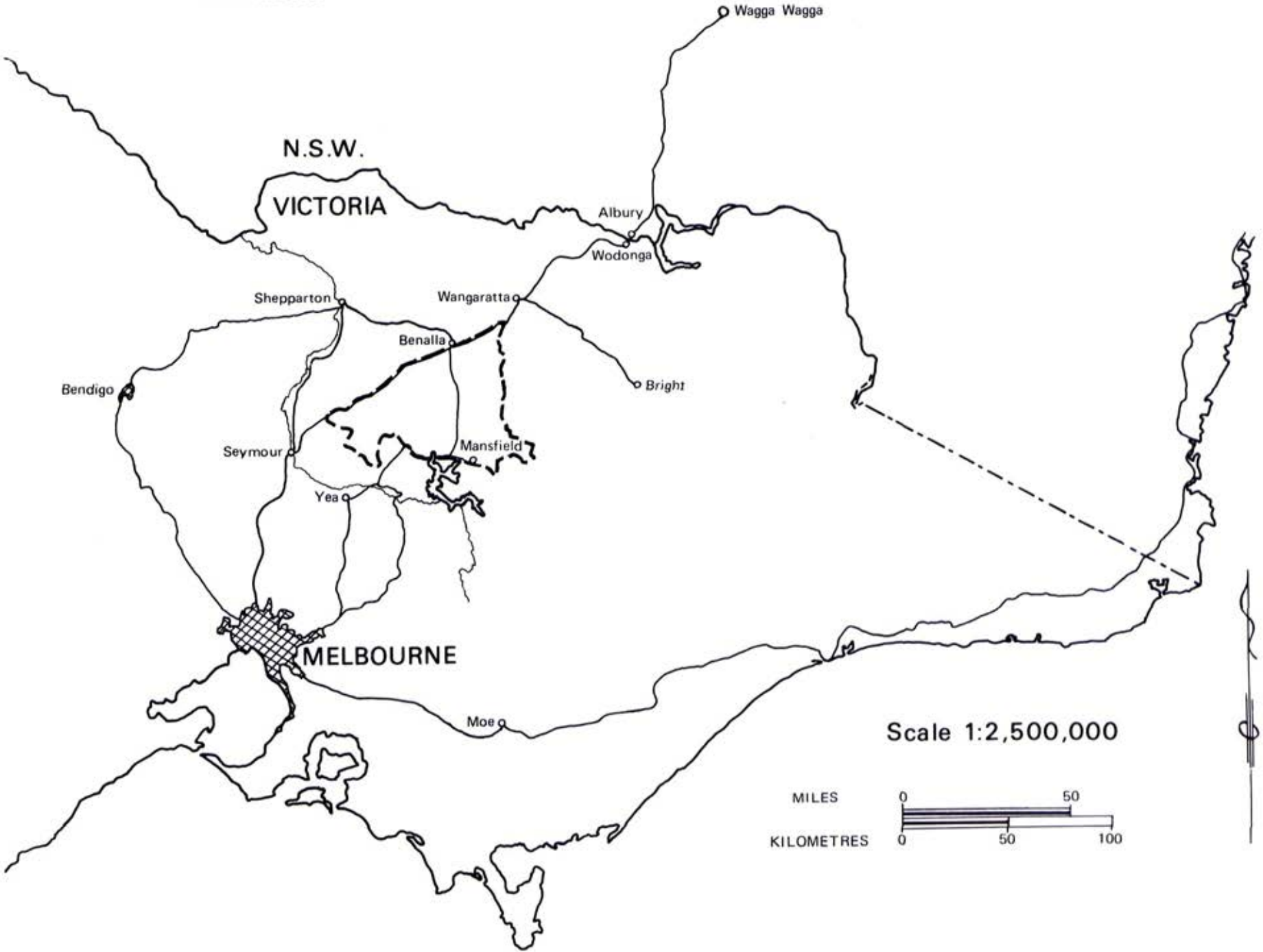
Native vegetation varies - from stunted candlebark gum and snow gum stands at the highest elevations, on exposed sites, to river red gum forests in low-lying situations on the plains. Forests of narrow-leaf peppermint with its associated eucalypts grow on the uplands, and the steep slopes carry forests of red stringybark and associates. Most of the private property has been cleared.

The main soils of the uplands are friable reddish gradational, friable brownish gradational, and reddish duplex

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 2

# LOCALITY



soils. Yellowish duplex soils predominate on the lowlands.

Population

The main towns within the district are Euroa - situated on the Hume Highway 120 km from Melbourne - and Mansfield - situated on the Maroondah Highway 190 km from Melbourne. Benalla city - outside the district - is centred on the Hume Highway 190 km from Melbourne.

Portions of the Shires of Benalla, Violet Town, Euroa, Mansfield, and Goulburn are included in the study district. Populations in all of them, with the exception of Goulburn, have declined slightly in the last 5 years. Figures for the City of Benalla have remained stable during this period (see Table 1).

*Benalla public gardens*


*Mansfield main street*

Urban centres

Benalla is an attractive centre on the Broken River. It is well served by road and rail and is noted for its magnificent gardens, both public and private. Secondary industries include a chain factory, seed-processing enterprise, knitting mill, clothing manufacturers, and three sawmills. Service industries, both private and public, provide the most employment, as Benalla serves as a centre for a number of Government Departments and is a shopping centre for the region.

Wood-processing and stock-marketing are the main industries in Euroa. Mansfield

TABLE 1

Population Statistics

| | 1947 | 1954 | 1961 | 1966 | 1971 |
|---|---|---|---|---|---|
| Benalla City* | 5,504 | 6,800 | 8,234 | 8,224 | 8,235 |
| Benalla Shire | 2,973 | 3,652 | 3,718 | 3,728 | 3,323 |
| Euroa Shire | | | | | |
| Urban (Euroa) | 2,175 | 2,657 | 3,040 | 2,789 | 2,680 |
| Rural | 1,753 | 1,915 | 1,874 | 1,800 | 1,512 |
| TOTAL | 3,928 | 4,572 | 4,914 | 4,589 | 4,192 |
| Mansfield Shire | | | | | |
| Urban (Mansfield) | 1,068 | 1,861 | 1,944 | 2,019 | 1,951 |
| Rural | 2,577 | 3,162 | 2,479 | 2,256 | 2,279 |
| TOTAL | 3,645 | 5,023 | 4,423 | 4,275 | 4,230 |
| Violet Town Shire | 1,454 | 1,424 | 1,360 | 1,236 | 1,184 |
| Goulburn Shire | 1,948 | 2,012 | 1,900 | 1,842 | 1,987 |

*Not within the study district

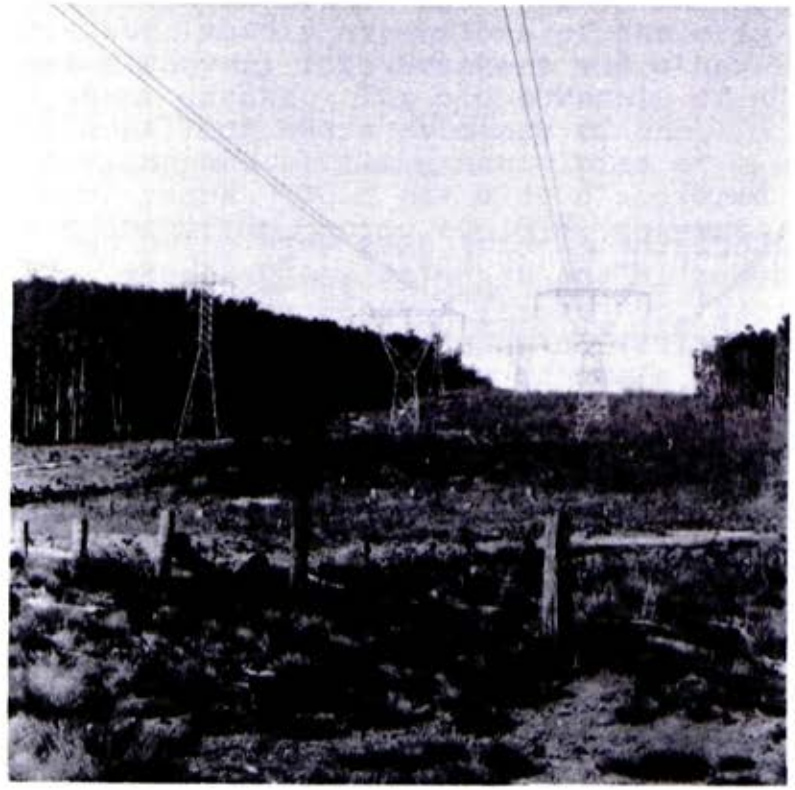
has several sawmills, and serves the farming community and also the tourist traffic bound for Lake Eildon or the snowfields at Mt. Buller.

Access

Major access to the district and between the main population centres is excellent, the main routes being the Hume, Maroondah, and Midland Highways. The main Sydney-Melbourne railway line parallels the Hume Highway and a line from Tallarook links Mansfield with this rail system *via* Merton and Yea. Benalla has airport facilities. The small towns and farm homesteads are well served by good secondary roads, and access into public land is also good.

Power

Three power lines (two single-circuit 330-KV and a double-circuit 220-KV) on a 165-m easement from the Snowy Mountains and Kiewa Hydro-electric schemes converge near Whitfield and continue on to Tolmie before diverging. Then the two single-circuit lines cross the Mansfield plain north of Mansfield on a 135-m easement and the double-circuit line crosses to the south of Mansfield on a 44-m easement. A single-circuit 220-KV line also traverses the district in an east-west direction between Glenrowan and Benalla. A 66-KV sub-transmission line connects Mansfield with Benalla along the Broken River valley.



*Transmission lines near Tolmie*

# HISTORY

Aboriginal inhabitants were never numerous in the district and probably totalled several hundred at the time of the first European settlement. They lived close to water, where game was plentiful, and so were concentrated on the Benalla and Mansfield plains and in the broad river valleys. A sub-tribe of the Pangeran tribe occupying the Broken River catchment was known as the Irun-illam-baluk. Their hunting grounds, on the plains and in the broad river valleys, were covered with open grassy forests and woodlands. The watercourses of the Broken River and other main streams were swampy meanders, fringed with reeds and interspersed with water holes, which provided excellent habitat for water fowl and other birds.

The advent of squatters intending to settle on Aboriginal territories led to killings of settlers and their stock and to reprisals in return. This occurred in both the Benalla area and the Delatite (Devil's River) country about Mansfield. Some 20 years after the arrival of the first settlers the number of Aborigines in the district had greatly declined. Some evidence of their occupation remains in the form of "canoe" trees near Violet Town, and the stone implements that are occasionally ploughed up.

## Discovery and early settlement

Hume and Hovell's party passed through the district *en route* from Lake George in New South Wales to Corio Bay in 1824. They crossed the northern end of the Toombullups and Blue Range, proceeded along the Broken River to Barjarg Gap, and thence skirted the south-eastern edge of the Strathbogie Ranges before turning south towards the Goulburn River. Their return journey took them to the north of these Ranges, along the route of the present Hume Highway.

Sir Thomas Mitchell also passed this way in 1836 on his return to Sydney from the Portland region.

This same year saw the advent of the overlanders who, with their stock, were in search of suitable unoccupied land. Some of the earliest of these to set foot in the area were members of the Faithful party, who arrived in the district in 1838. They were driven off by Aborigines at the present site of Benalla, so George Faithful established his run on the Ovens River. In the same

year, Mrs. J. Templeton had a run on the Seven Creeks just south of present-day Euroa. William McKellar arrived on the Broken River at Benalla in 1839, but moved to the Lima Run further up the River because of harassment by Aborigines. The Warrenbayne and Killeen runs were also taken up in this year. By 1840 most of the Benalla plain was under some form of occupancy, with the establishment of the Benalla and Kilfera Runs. Settlement had spread up the Hollands and Ryans Creeks and onto the Strathbogie Plateau by 1846.

Settlement in the Mansfield Valley began in 1839, when the Scottish Pastoral Company took a vast run stretching about 20 miles across the Mansfield plain from the Broken River to the Delatite. These leaseholds were affected by low wool prices, and parts were subsequently sold in 1846.

Runs were further broken up in 1860 when the leases terminated. In 1865, Grant's Act gave the impetus to selection. In the 1860s shepherds were replaced by brush-fenced paddocks, with boundary riders to control stock, and farmers were clearing the forests for cultivation where the land was suitable. This type of development was in full swing during the 1870s.

Early mining

The first discovery of gold in the district occurred at Hell's Hole Creek and Glen Creek in 1851. Later finds in this area were mostly extensions of the original discovery into Brankeet and other adjacent creeks. The old township of Tallangallook bears evidence of the quarrying and sluicing activities of former years. Gold was also discovered near Archerton, prior to 1858, on what became known as the Toombullup goldfield and at the Reef Hills near Benalla in June 1860, but these goldfields did not support many miners.

During 1869-70, the quiet village of Merton became a diggings centre, but the rushes were short-lived. However, they did bring people into the district, and some remained to take up land when the gold petered out.

Transport and communications

The present Hume Highway became the established route between Melbourne and Sydney, and 1838 saw the advent of a mail run between the two growing centres. Drays and bullock wagons were the earliest means of transport. The Broken River valley provided an easy means of passage between Benalla and Mansfield, and pack-horse supplies from Benalla for the mining towns of Jamieson and Woods Point took this route. The coach route to Jamieson from Melbourne *via* Euroa crossed the Strathbogie Ranges and descended to Merton.

Topography had a greater influence on railway routes. The earliest rail link

between the district and Melbourne was provided by the railway to Wodonga, *via* Avenel and Benalla, completed in 1872/73. Various branch lines were constructed shortly after. The line to Mansfield *via* Yea and Merton branches off at Tallarook. Another line that went south-east from Benalla to Tatong has now been dismantled.

The bushranging era

This district has many ties with those who clashed with the law in the early days. In the late 1850s, Daniel Morgan moved about the district. Harry Power also operated in this area and at one point held up the Mansfield-Jamieson coach. He was captured at his hide-out on the King River, south of Whitfield, in 1870. The famous bushranging Kellys also had connections here. Mrs. Kelly and her eight children settled at Greta on Eleven Mile Creek, some 5 miles south of Glenrowan. The original home was replaced by a later homestead, the remains of which still occupy the site. Other localities connected with the Kelly saga are Stringybark Creek on the Toombullup goldfield and the centres of Mansfield, Euroa, Benalla, and Glenrowan.

Towns and secondary industry

The township of Benalla was laid out in 1846, but was of small account until about 1854, when it became the centre of an agricultural community based on wheat and oats.

Early development of secondary industry was confined to processing primary products to satisfy local needs. Flour, milk, and butter factories were erected as the need arose, and heavy industry was confined mainly to mining and sawmilling. Mansfield township was surveyed and laid out in 1851.

Local government

The present shires had all been proclaimed by 1895, in which year the Violet Town Shire was created by the severance of Warrenbayne Riding from Benalla Shire and parts of the north, south, and central ridings from Euroa Shire.

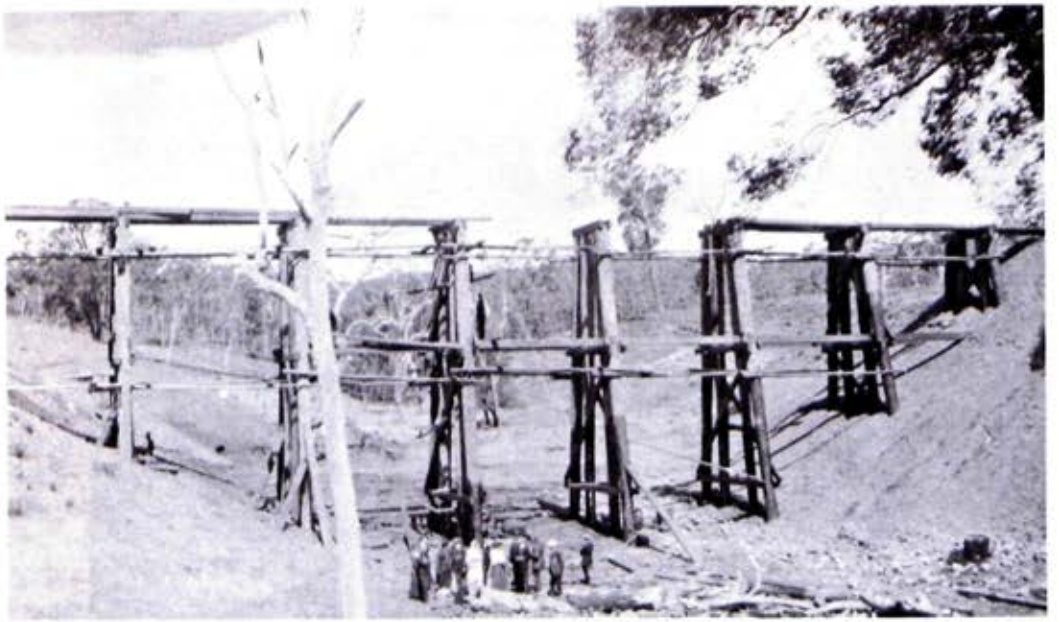
Since then, the main changes have been to the boundary separating the Shire of Benalla from those of Wangaratta and Oxley and the creation of the Borough of Benalla from its central riding in 1948. In 1956, parts of other ridings in the Shire were annexed to the Borough, which was proclaimed the City of Benalla in 1965. In 1963 portion of Alexandra Shire was severed and annexed to Euroa Shire.

## Land Use

Pastoral activities

Most of the early settlers grazed sheep on native pastures, but cattle were progressively introduced with improvement of pastures. A temporary agric-

*Swanpool and Moorngag butter factory, established 1891*



*Bridge under construction on the Tatong railway line, 1914*

ultural boom on the Mansfield plain in 1891 caused widespread plantings of oats and wheat, but it soon subsided and the area went back to wool-growing.

Agriculture

In the early days of settlement, wheat and oats were grown on small areas and transported to population centres to meet local needs, with some of the grain being taken to flour mills at Kilmore and Benalla. Most of the settlers grazed sheep and cattle, later (in the early 1890s) engaging in dairying and cultivation as well.

Forestry

According to early records, 200-300 men worked in the forests of the Strathbogie Ranges and Tolmie Highlands in the 1890s. They used the pit saw, adze, and broad axe to produce bridge timbers, sleepers, split timbers (palings and shingles), and fencing materials, chiefly of messmate.

Sawmills were established during 1916-18. Until about 1936 log haulage was by horse and bullock teams, and also steam winches associated with wooden tramways. In 1914 a railway to Tatong

was opened, and tramlines transported sawn timber from mills in the forest to the rail siding.

Low-intensity logging has continued up to the present. Since 1960, some unproductive hardwood stands and former farmlands have been converted to radiata pine plantations.

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# PART II

# NATURE OF THE LAND

# PHYSIOGRAPHY

Uplands in the west-central and eastern sections form the greater part of the district. The remainder consists of rolling hills in the far north and valleys and plains in the north-west and southern sections.

## Tolmie highlands

This well-defined structural unit lies roughly between the Broken River to the west and south, the King River to the east, and Ryans Creek to the north. It contains several plateaux. A broad surface extends north-west from Archerton (elevation 980 m) towards Tatong, forming broad north-south divides (at about 600 m) between deeply incised streams (Hollands, Ryans, Watchbox, and Sams Creeks). The gentle southern slope at the upper reaches of Hollands Creek near Tolmie forms a plateau surface ranging from 680 to 920 m. Smaller surfaces to the south-east of Tolmie range up to 1,100 m.

An extensive plateau also lies south-east of Mount Samaria at about 800 m. The North Blue Range on the eastern and northern sides of this plateau is an elevated rim, with flat summits at about 920 m, including Mount Samaria. The plateau ramparts are well dissected in the north and west, where the minor streams have steep grades. There are high waterfalls on Wild Dog and Back Creeks.

Between Bridge Creek/Barwite and Tolmie, the highlands rise from the margin of the Mansfield plain as long gentle

*Cleared plateaux at Archerton in the Tolmie highlands*

slopes. The headwater basins of the Broken River and Evans Creek are strongly dissected, with a number of small flat ridges perched between steep valleys.

Most of the highlands are forested, with the exception of small cleared areas in the higher country around Archerton, Tolmie, and Bunstons Hill and along some of the valley floors.

Strathbogie massif

The massif, part of the north-western edge of the Eastern Highlands, occupies almost the whole western portion of the district. This broad plateau has a mature undulating surface, apart from a dissected northern section that results from the erosion of volcanic rocks and contrasts with the undulating surface of the granite. The bulk of it lies above 480 m, with substantial areas above 600 m, in the region of Mount Strathbogie. An elevated rim at about 600 m forms part of the eastern edge of the plateau near Terip Terip, and, together with the associated fault scarp to the west of Godfrey Creek, forms the Black Range. To the north of Terip Terip, the plateau narrows considerably between Merton and Seven Creeks and then broadens out to the north-west, where it is drained by the Seven Creeks system. Steep slopes drop to the lowlands on the north-east and south-west. At the southern edges of the plateau the undulating surface changes into escarp-

*Undulating surface of the Strathbogie massif near Boho South*

ments of dissected, symmetrical ridges sloping towards Lake Eildon. The massif is largely cleared, but the higher plateaux and steep escarpments are forested.

Benalla plain

A riverine plain of low relief has an elevation of about 150 m at Benalla,

*Benalla plain and dissected edge of Strathbogie massif near Lima*

grading back to the foothills and tributary valleys at about 230 m. It is separated from the Goulburn plain by low hills in the Baddaginnie and Goorambat-Chesney areas. Its surface is relatively smooth, and the low stream gradients give rise to several swamps and to meandering courses on the major streams. Remnant foothill outliers, such as the Reef Hills near Benalla, remain in some places.

Lurg hills

A maturely dissected area to the north of Ryans Creek is known as the Lurg hills. The hills are mainly cleared for agriculture, with the exception of isolated areas of high relief reaching elevations of 440 m.

Mid Goulburn terrain

This major unit extends from Merton eastwards to Mansfield and the Broken River. It is part of a much larger stretch of land to the south. The unit has a variety of surfaces, from rolling hills on the divide between the Broken River and Ford Creek to steep hills north of Bonnie Doon. It is separated from the Benalla plain by the Barjarg Gap.

Mansfield plain

The plain has a smooth surface at an elevation of about 280-430 m.

## Drainage Systems

Broken River catchment

The drainage pattern is controlled by the location of the Strathbogie massif and Tolmie highlands. The Broken River flows westwards along the southern edge of the Tolmie highlands then north from Nillahcootie to Benalla between the highlands and Strathbogie massif. The tributary streams along its westward course have steep and narrow valleys in the headwaters and northern fall, but mature valleys on the southern fall. Tributary streams along its northward course flow to the north for most of

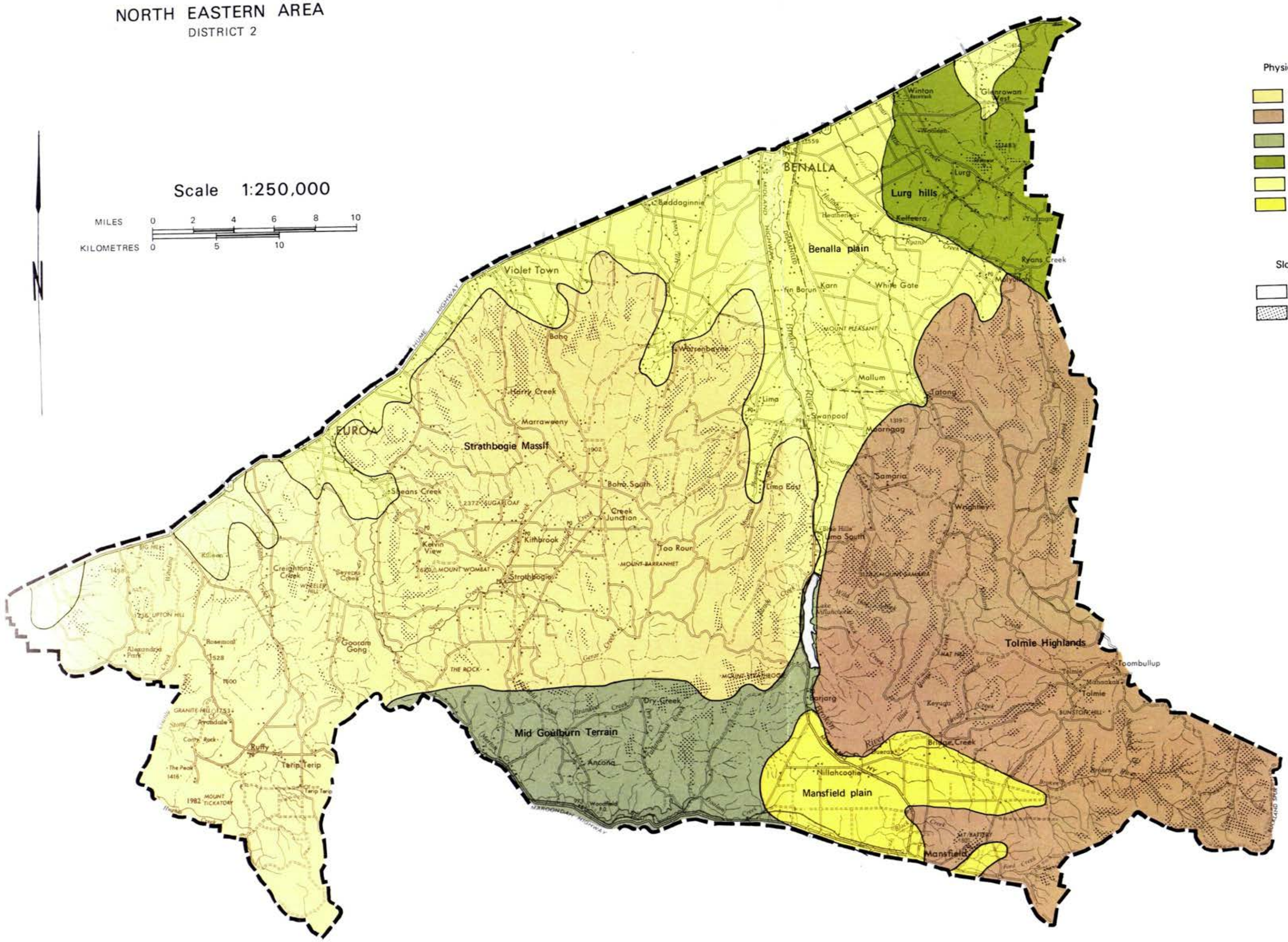
LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 2

# PHYSIOGRAPHY

Scale 1:250,000

MILES 0 2 4 6 8 10
KILOMETRES 0 5 10




## LEGEND

Physiographic Unit

- Strathbogie Massif
- Tolmie Highlands
- Mid Goulburn Terrain
- Lurg hills
- Benalla plain
- Mansfield plain

Slopes

- Slopes less than 20 degrees.
- Slopes greater than 20 degrees.

their length and then break to the west to join it near Benalla. Hollands and Ryans Creeks, the major tributaries from this physiographic unit, rise in the heart of the Tolmie highlands. Watchbox, Sams, and Stockyard Creeks are shorter tributaries draining the northern slopes.

The only large tributary on the western side of the Broken River, Moonee Moonee Creek, rises near Mount Strathbogie and drains a deeply dissected area in the north-east of the Strathbogie massif. The Five Mile Creek rises near Boho South and drains the Warrenbayne area.

Lake Eildon catchment

The southern part of the district forms part of the Lake Eildon catchment. Ford and Black Creeks drain moderately dissected terrain near Mansfield. Other streams drain the plateau and southern escarpments of the Strathbogie massif. The major tributaries are Gerars Creek - rising at Mount Barranhet (Mount Piper), Hayfield, Brankeet, Dry, Tallangalook, and Glen Creeks. The stream pattern of some of these creeks is rectangular, reflecting the angular jointing of the granite.

Lower Goulburn catchment

Most of the Strathbogie massif is drained to the north-west by creek systems flowing across the Goulburn plain into the Goulburn River. The major stream, Seven Creeks, flows south-west through Strathbogie then turns north-west at Gooram Gong and flows *via* Euroa to the Goulburn River. Other streams include Honeysuckle, Castle, Creightons, Faithful, and Pranjip Creeks.

The south-western portion of the massif that lies within the study district is drained by Hughes Creek, which flows west towards Avenel.

King River catchment

The headwaters of Evans Creek drain the south-eastern corner of the district.

# GEOLOGY

Three phases of geological activity had major effects on the geological history of the region.

In the early Palaeozoic era, a long period of essentially marine geosynclinal sedimentation culminated - at the end of the Lower Devonian period - in folding of the sedimentary beds.

Uplift formed a land surface supplying terrestrial sediments, and was accompanied by volcanic activity together with some granite intrusion during the Upper Devonian to Lower Carboniferous periods.

Subsequently, erosion, relatively minor and local sedimentation, and volcanic activity have occurred. This includes the development of erosion surfaces of low relief, and Tertiary and Quaternary sedimentation.

History and landscape development

The earliest known event was submarine basic volcanic activity of Cambrian age, but little is known of its nature and extent. These Cambrian rocks outcrop along a north-nor-west-trending belt in which tectonic movements have occurred during the subsequent history of the region.

In the Ordovician period, thick deep-sea sediments of muds and sands were deposited. Towards the end of the Ordovician, earth movements occurred in eastern Victoria and subsequent igneous activity is evidenced by Silurian granite intrusions, which altered the adjacent Ordovician sediments.

However, central Victoria remained submerged during much of the Silurian period. Thick sands, muds, and silts, with some fossiliferous limestones, were deposited in the Silurian and Lower Devonian. Towards the end of the Lower Devonian period, the major trend was a gradual withdrawal of the sea. A major period of folding was followed by emplacement of dykes. Associated quartz reefs represent the main focus of gold mineralization in this region.

Downwarping produced a long, relatively narrow, intermontane trough 40-55 km wide, in which thick masses of volcanics and sediments accumulated. The present-day Tolmie highlands were formed from the northern part of this trough, which extended to Gippsland.

At the northern end of the Tolmie highlands, intermittent subsidence resulted in a sequence of deposition of sediments and interbedded acid volcanics to a thickness of 1,200 m. Following erosion, progressive large-scale crustal collapse occurred in the Strathbogie area and also in the Tolmie area, resulting in two volcanic cauldrons. Intermittent eruptions built up large thicknesses of volcanics - the Violet Town volcanics 450 m thick and those of the Tolmie highlands, which, it has been suggested, may be up to 2,400 m thick.

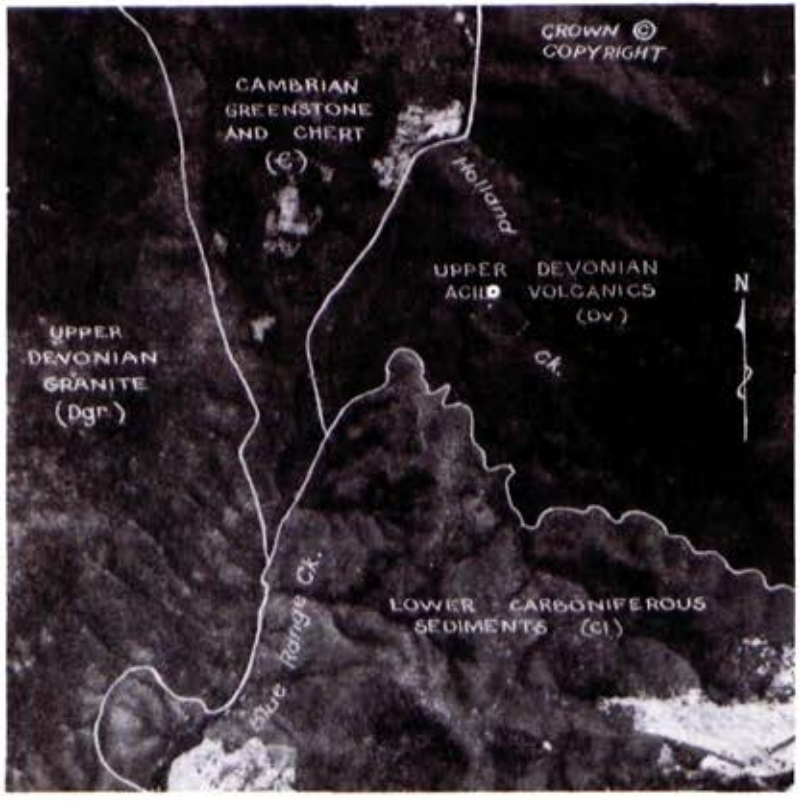
Associated with these major volcanic eruptions was the emplacement of granitic rocks, which have been exposed to form the bulk of the North Blue Range at Mount Samaria and the Strathbogie Ranges. This caused alteration (including gold mineralization at Tallangalook) of the rocks in a zone adjacent to the contact. Minor associated intrusions took place in the contact zone between the Violet Town volcanics and the Strathbogie granite.

While most of the district remained as an eroding land mass during the rest of the Devonian and the early part of the Carboniferous periods, the intermontane trough gradually filled with fluviatile and lacustrine sediments. The basal deposits of pebbles have subsequently consolidated to form resistant conglomerates. Downwarping of the beds and tilting to the south-sou-west formed the Mansfield plain.

The district probably remained as dry land throughout the Permian period. During this time a world-wide climatic change culminating in a great ice age resulted in intense glaciation over southern Australia. Melting of the ice left glacial deposits that have subsequently been eroded away within this district, although remnants are still known in the Ovens Valley.

During the Mesozoic era the area was probably gradually eroded to a peneplain. Uplift of this surface during the early Tertiary period resulted in a landscape of broad mature valleys and extensive plains bearing numerous swamps. Above the plain rose monadnocks and plateaux of resistant rocks, such as the Devonian granites. In the early to middle Tertiary period, earth movements - including sagging, warping, and faulting - gave rise to many fractures, from which poured basaltic lavas. These flowed into the valleys and out across the plains, forming a laval plain in the Tolmie-Toombullup area with thicknesses up to 30 m. Closely associated with these lavas are the deep leads. These are gravels and alluvium of the old stream courses, which were buried and preserved beneath the lava.

Earth movement and erosion continued into the Miocene and Pliocene epochs and produced a mature topography. The last great event of the Pliocene was the Koscuisko Uplift, which, accompanied by a tilt to the north, has been respon-




*This aerial photo shows patterns of vegetation and topography developed on different rock types*

sible for most of the present topography.

Rejuvenation of streams during the early Quaternary period caused erosion to accelerate on the uplifted areas. The streams have cut back headwards to form deep valleys that broaden out upstream into the original mature tracts.

The major features of the highlands, the northern plains, and the Mansfield lowlands resulted from the differential erosion of the more-resistant granites and volcanics and the softer, older sediments.

The ledged topography around Mansfield has been produced by differential erosion of interbedded Carboniferous mudstones and resistant sandstones. In recent times the rivers have cut broad valleys and filled these with alluvial deposits. At present the rivers flow in broad alluvial flats cut into these older alluvial deposits.

## Stratigraphy

Many rock types - varying in age, structure, texture, and composition - outcrop in the district. These are described briefly below. A geology map is included at the back of this report.

Isolated exposures of Cambrian rocks outcrop from Moorngag southwards to the head of Blue Range Creek. For the most part these are altered fine-grained basaltic lavas, called greenstones (or diabases). They are the oldest rocks in the area and have been exposed by faulting. Also, minor occurrences of hard, black, siliceous cherts and cherty shales have apparently been formed by the introduction or replacement by silica of clayey sediments, or in some cases of volcanic tuffs, and are closely jointed and banded.

The only known fossils are rare brachiopods in the fine-grained cherty shales.

Ordovician rocks form the bulk of the Lurg hills, but other isolated outcrops occur around Tatong, in the Watchbox Creek, and near Nillahcootie. They consist of a thick, closely folded series of alternating sandstones, greywackes (a type of sandstone), shales, and mudstones.

Brachiopod fossils have been collected near the Tiger Hill road east of Tatong. Middle Ordovician graptolites have been located in shale just north of Tatong, and Upper Ordovician graptolites in the Ryans Creek - Middle Creek divide.

Silurian and Lower Devonian rocks form the dissected hills around Merton and Bonnie Doon. Low hills south of Benalla and inliers in igneous rocks near Boho South and Mount Sugarloaf are also of this age. All the sediments are closely folded and much jointed.

Gold is found in quartz reefs within the country rock at the Reef Hills, and near Merton. Silurian granites, which comprise the Warby Range, also occur as isolated hills near Lurg.

Most rocks of Upper Devonian age in this area are igneous in origin.

The bulk of the Tolmie highlands and the northern section of the Strathbogie massif consist mainly of acid lavas

*Quarry at Nillahcootie, exposing junction of Devonian-Silurian sedimentary rocks with Upper Devonian granite*

(rhyolites and rhyodacites). They have a porphyritic texture (larger crystals set in a microcrystalline groundmass) and although superficially similar to granites they weather quite differently to produce a distinctive topography.

Granites form the bulk of the Strathbogie massif and the North Blue Range

*Granite tors on the Strathbogie massif*

The master jointing of the granite gives rise in many places to a characteristic rectangular stream pattern. A large exposure of aplite (a light-coloured rock with fine-grained granitic texture) occurs south-west of Kelvin View. Small occurrences of granodiorite porphyrite may be found near Kelvin View, Archerton, and Molyullah.

Limited outcrops of conglomerates, sandstones, and shales (containing rare fish remains at one locality) are found on the Sams-Holland Creek and Holland-Samaria Creek divides.

The Barjarg-Mansfield-Tolmie area to the south of the igneous massifs is characterized by purple to red sandstone, siltstones, and shales overlying peripheral exposures of basal conglomerates from the King River headwaters to the Blue Range Creek. These are Lower Carboniferous in age. Some beds contain rare fish remains and plant fossils. The beds are nearly flat or dip gently - generally to the south-west - producing a topography characterized by gentle dip slopes. The boundary between the Lower Carboniferous sediments and the acid igneous lavas is marked by abrupt changes in soils and vegetation.

*Lower Carboniferous sandstones exposed in a road cutting near Tolmie*

Table 2

STRATIGRAPHY

| | |
|---|---|
| Quaternary (Recent to Pleistocene) | Alluvial flats<br>Terrace deposits |
| | *Erosion and development of drainage* |
| Tertiary | Gravels, silts, sands, basalts |
| | *Angular unconformity. Erosion to peneplain* |
| Lower Carboniferous | Purple, red, and green sediments; sandstones, mudstones, and conglomerates |
| Upper Devonian | Granitic rocks |
| | Massive acid volcanics (rhyolite followed by rhyodacite with associated minor intrusives) |
| | *Angular unconformity* |
| | Interbedded coarse sediments and rhyodacites |
| | *Angular unconformity* |
| Silurian-Lower Devonian | Sediments: sandstone, mudstone, and shales |
| Silurian | Granitic rocks |
| Ordovician | Sediments: sandstone, mudstone, shales, and slates |
| Cambrian | Greenstones and cherts |

The Tertiary rocks of the area consist of basalts and associated sub-basaltic lignites, clays, and gravels. The most extensive areas of these old lava flows form the plateaux in the Tolmie-Archerton area and have all been cleared.

Gallows Hill near Tolmie - a volcanic plug composed of phonolite - has been regarded as Tertiary but is possibly older. A series of ridges and small hills in the Seven Creeks valley consist of a basalt-like rock (limburgite), which exhibits columnar jointing.

Pleistocene deposits of clays, silts, and sands form alluvial plains, lake, and stream levee deposits, high river terraces, and alluvial fans. The Benalla plain is mainly of Pleistocene deposits.

Recent clays, silts, sands, and gravels are found in alluvial terraces and lake and swamp deposits.

## Soil Parent Materials

Many factors influence soil development: one is the parent material on which it is formed.

The Cambrian diabases near Wrightley weather in a very similar fashion to the Tertiary basalts at Archerton, to form friable reddish gradational soils with well-structured subsoils. Cambrian, Ordovician, Silurian, and Lower Devonian sedimentary rocks - which include cherty shales, sandstones, silt stones, and mudstones - form similar soils. These include undifferentiated stony loams, reddish duplex soils, and weakly bleached friable gradational soils. The characteristic soils on the Upper Devonian acid lavas are yellowish duplex soils grading to friable yellowish gradational soils and friable brownish gradational clay loams. While not uniform in composition Upper Devonian granites give rise to reddish duplex, friable reddish gradational, and friable brownish gradational soils. Lower Carboniferous rocks produce very characteristic yellowish duplex and weakly bleached friable gradational soils.

The most extensive soils developed on Quaternary alluvium are the yellowish duplex and reddish duplex soils.

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# WATER

## Surface Water Resources

### Source of supply

The amount of water a catchment yields as stream flow depends on how much falls as precipitation and how much is lost as evaporation, transpiration, and deep seepage below stream levels or impounded in off-stream storages. Because average precipitation and evapotranspiration vary over the catchment, some parts have higher yields of run-off than others. The Soil Conservation Authority report on the Broken River catchment has attempted to demonstrate the relative importance of different parts of the catchment with respect to water yield.

Estimated figures for this catchment, which covers more than half the district and contains about 85% of the public land, indicate that the high-rainfall areas (Tolmie highlands and eastern Strathbogie Ranges) yield 5-6 times as much run-off per unit area as does the drier, northern part. About 40% of the total water yield may be expected from the 18% of the catchment receiving more than 1,140 mm annual rainfall.

Although the district is in a moderate-rainfall region, most of the unregulated streams are unreliable during summer.

### Major streams

The study district contains the following major streams:

* Broken River - from source to Benalla
* Hollands, Ryans, Moonee Moonee, and Five Mile Creeks (Broken River tributaries)
* Evans Creek - most of this King River tributary
* Seven Creeks, Creightons, Castle, Honeysuckle, and Faithful Creeks from source to Hume Highway (Lower Goulburn tributaries)
* Hughes Creek - headwaters (Lower Goulburn tributary)
* Brankeet and Ford Creeks (Eildon tributaries)

### Gauging stations

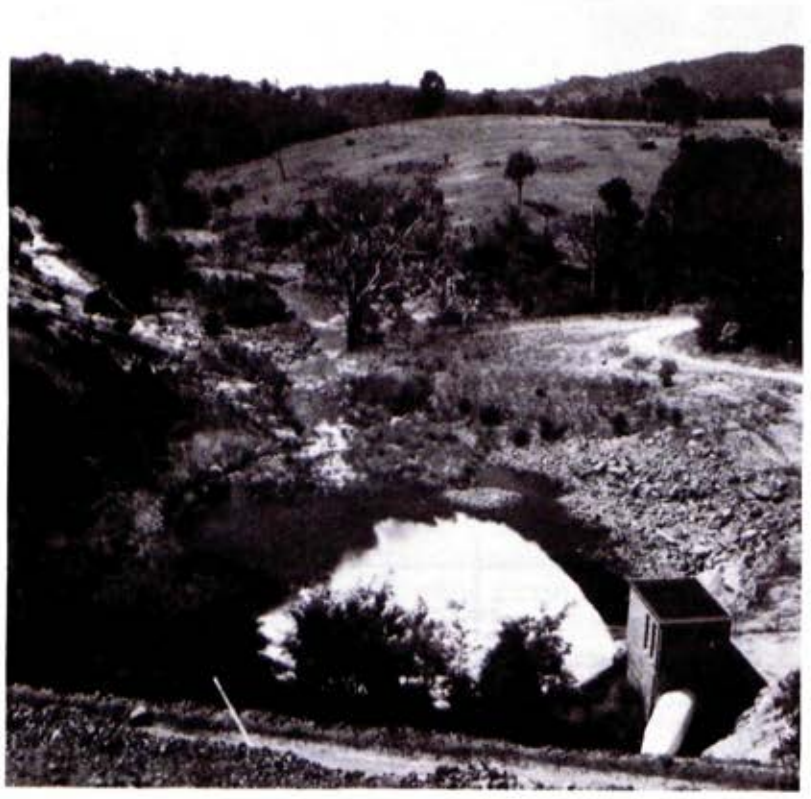
A number of gauging stations have been established in this district. Table 3

Table 3

Gauging Stations

| Station | Operation | Annual discharge (megalitres)* | | | Mean salinity (mg/l**) |
|---|---|---|---|---|---|
| | | Maximum | Minimum | Mean | |
| Broken River - Moorngag | 57/58-71/72 | 127,960 | 6,660 | 67,100 | 93 |
| Hollands Creek - Kelfeera | 60/61-71/72 | 139,750 | 11,840 | 81,660 | 83 |
| Moonee Moonee | 63/64-71/72 | 25,080 | 6,600 | 16,790 | 43 |
| Seven Creeks - Polly McQuinns | 65/66-69/70 | 81,670 | 20,340 | 49,670 | N.A. |
| Hughes Creek - Tarcombe Road # | 59/60-69/70 | 161,080 | 20,410 | 13,840 | 146 |
| Seven Creeks - Euroa | 46/47-63/64 | 200,390 | 17,500 | 69,980 | 93 |
| Euroa township | 63/64-69/70 | 120,340 | 26,210 | 73,810 | 89 |

* 1 megalitre (Ml) = 0.81 acre-foot
\# Outside the district
** Milligrams per litre



*Water released from storage at Nillahcootie into the Broken River*

presents records for six of these and a station on Hughes Creek in terms of water years (May to April inclusive).

Flow characteristics

Most of the unregulated streams in the district have low summer flows and thus cannot be used for large-scale irrigation. This includes the Eildon and Goulburn River tributaries, Holland Creek, and Moonee Moonee and Five Mile Creeks.

Water quality

The quality of surface water is mainly satisfactory for domestic purposes. The Benalla water supply is generally excellent, despite relatively high colour at times (20-80 units - platinum cobalt scale). The supply to Euroa is generally satisfactory. However, it has very high colour content at times (20-200 units) and bacterial counts may be high after overland flows in the catchment. The supply to Violet Town is unsatisfactory due to high bacterial counts at all times. The Mansfield water supply is good due to chlorination treatment. Glenrowan derives its water from the Fifteen Mile creek, which is outside the district. This water is usually good but some high bacterial counts occur at times, particularly during low creek flows. Water quality for irrigation, industrial usage, and as fish habitat is also generally satisfactory.

Existing storages

Lake Nillahcootie on the Broken River has 39,500-megalitre (Ml) capacity.

Lake Mokoan to the north of the district is an off-river storage fed by a take-off channel from the Broken River at Yin Borun. This relatively shallow storage

has a large surface area and a capacity of 407,000 Ml.

Lake William Hovell - with a present capacity of 12,300 Ml, which can be increased with further construction to 148,000 Ml - is sited on the King River outside this district. However, its catchment includes Evans Creek watershed, the headwaters of which are within the study district.

Storages on streams for domestic water supplies comprise the Loombah Weir on Ryans Creek (680 Ml), Polly McQuinn's reservoir on Seven Creeks (137 Ml), Mountain Hut dam (14 Ml), and two small dams on Honeysuckle Creek (46 and 4.6 Ml).

The largest off-stream storages are 46-Ml and 4.6-Ml service basins at Mansfield and a 4.6-Ml service basin near Benalla.

## Groundwater Resources

This area lies in the Central Highlands, to the immediate east of the plains of the Murray Basin, where the rocks are mainly highly indurated Palaeozoic sediments, intrusives, and extrusives. In general these rock types cannot yield large quantities of groundwater because of their low effective porosity.

The basement rocks of most of the uplands (Strathbogie massif and Tolmie highlands) consist of Upper Devonian granite, rhyolite, and rhyodacite, with gently dipping Lower Carboniferous conglomerate, sandstone, and mudstone to the east of Barjarg.

Numerous springs on the uplands are fed by groundwater, which contributes to stream base flow. Many of them provide stock and domestic supplies. All known bores, sunk to no more than 45 m, tap the weathered zone of granite, rhyolite, or rhyodacite. Their yields range from 23 to 227 litres per second, usually of good-quality water with salinities of less than 400 mg/l. Groundwater probably does not exist in usable supplies beneath the rhyolite and rhyodacite weathered zone, but may occur in granite in master joints deeper in the non-weathered zone.

Groundwater also occurs in the weathered zone of the Ordovician sediments of the Lurg Hills, but bores usually yield less than 76 litres per second, and the salinity exceeds 2000 mg/l.

Of the remaining Palaeozoic rocks, the gently dipping Lower Carboniferous sediments offer the greatest potential for groundwater. As yet only a few shallow bores have been sunk. These have provided low yields of good-quality water, but larger yields could probably be obtained by deeper drilling.

Unconsolidated colluvial and fluvial silts, sands, and gravels occupy the plains, the lower reaches of streams,

and the western flanks of the Strathbogie massif. Outside the district these sediments often yield very high supplies of groundwater, but within it they are shallow and fine-grained. Consequently groundwater resources from these sediments, which are best developed in the Broken River Valley north of Karn, are little better than those of the Palaeozoic rocks.

## Groundwater recharge

A proportion of the precipitation in the district infiltrates the alluvial deposits and forms part of the recharge of the underground water of the Murray Basin. At present there does not appear to be any threat to the quality of the recharge water, as a result of the generally low levels of fertilizer and pesticide applications. Any such potential threats should be considered when contemplating change in the land use.

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# CLIMATE

The study district is one of the higher-rainfall areas of the State. It lies at the western end of the Upper North-East District (as defined by the Bureau of Meteorology), which, with an average annual rainfall of 769 mm, ranks fifth-highest among the 15 in Victoria. Variability of annual rainfall from the average is also important, particularly in some agricultural areas. One measure, the coefficient of variation, indicates that it is relatively high in this meteorological District, being exceeded only by those of the Northern and Mallee North Districts.

The climate within the study district varies widely, due mainly to the effect of topography. With increase in elevation, rainfall generally increases and temperatures decrease. Topography also has a great influence on other aspects of climate, such as wind characteristics and the amount of solar radiation received.

## Precipitation

Precipitation is mainly in the form of rain. However, light snowfalls occur fairly regularly in winter above about 750m, as, for example, around Mount Strathbogie and at Tolmie. Hail and dew do not contribute significantly to annual totals.

### Distribution

Most of the Benalla plain has an average annual rainfall between 635 mm and 760 mm, but towards the foothills the amount increases. A rain shadow extends the 760-mm zone up the valley from Swanpool to Barjarg, and thence to the Mansfield plain. Rainfall gradients are steep in the foothills, but the pattern varies less over the plateaux, most of which receive more than 1,140 mm annually.

The topography and rainfall map facing page 34 shows annual isohyets, taken from Rundle and Rowe's 1973 study. Figure 1 indicates standard-period monthly rainfalls at representative stations, while Table A in Appendix I gives the actual amounts for these and other stations.

The seasonal patterns show a marked winter incidence, with June the wettest month at most stations. The driest month is usually February - only the highest and wettest plateau areas, such

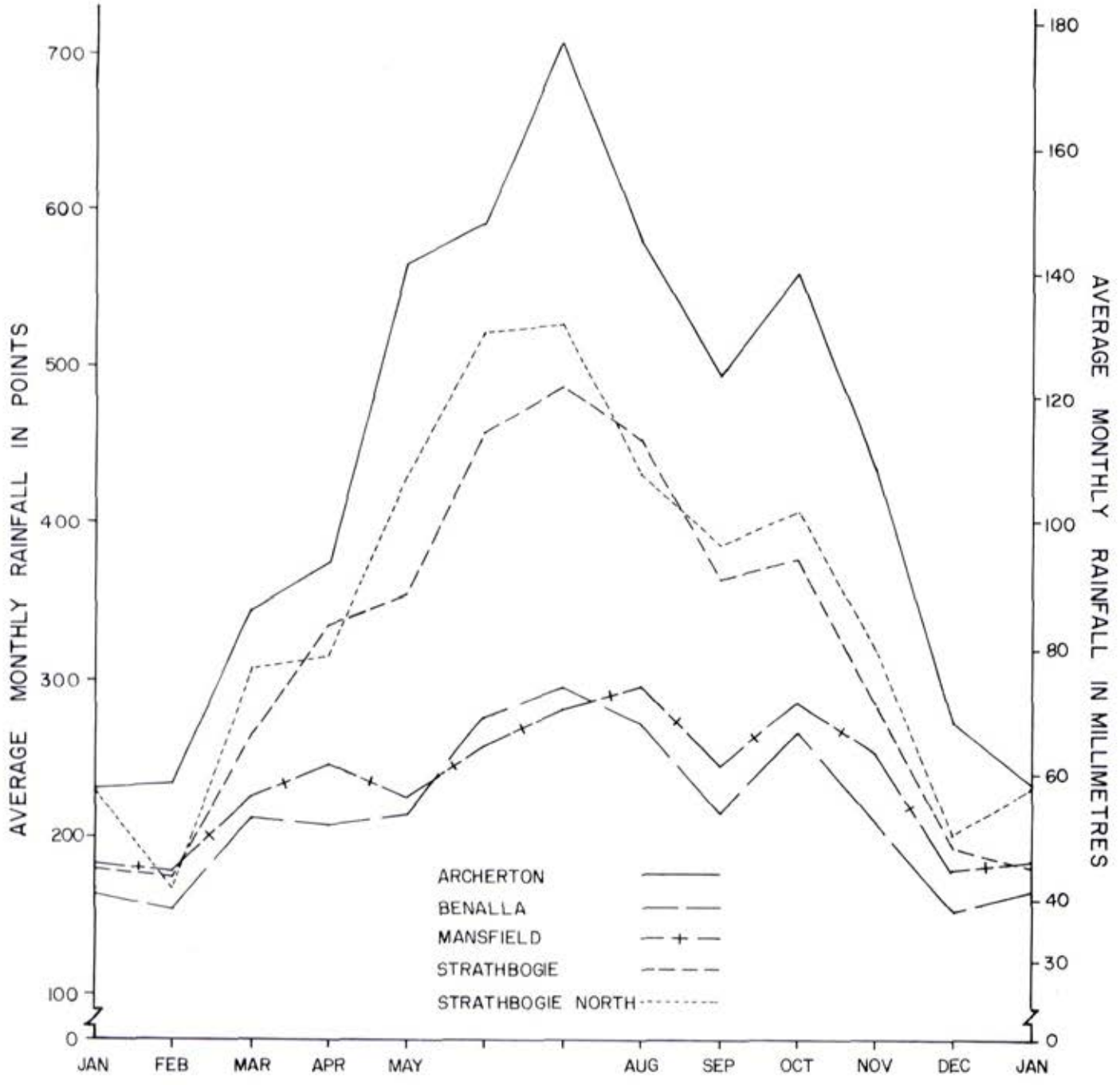



Figure 1 AVERAGE MONTHLY RAINFALL

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA

DISTRICT 2

# TOPOGRAPHY AND RAINFALL

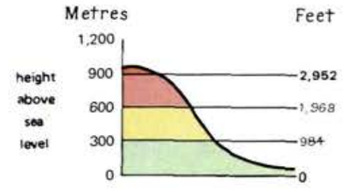
Scale 1:250,000

MILES 0 2 4 6 8 10

KILOMETRES 0 5 10

## LEGEND

### TOPOGRAPHY

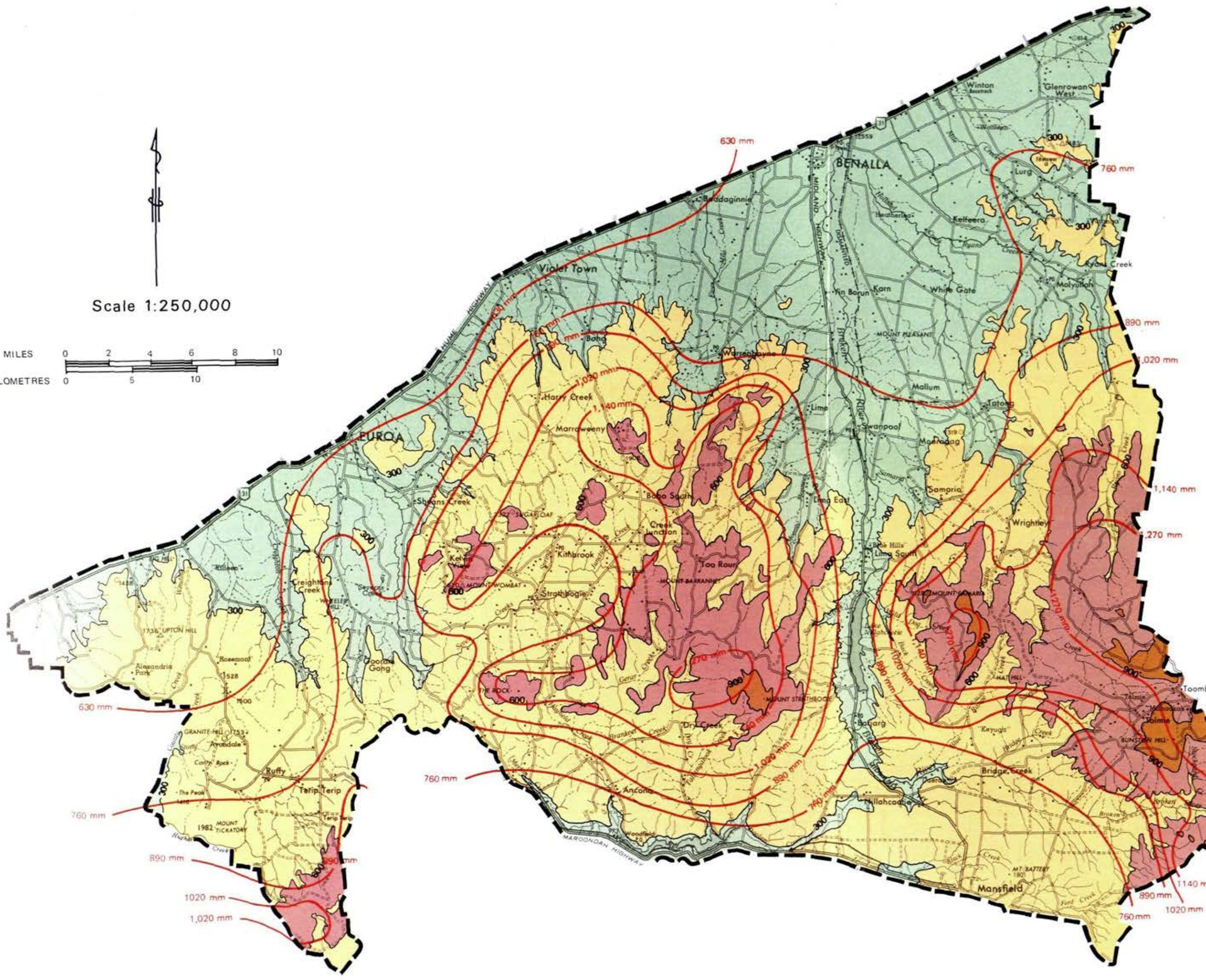



### AVERAGE ANNUAL RAINFALL

Isohyet — 630 mm —

| Millimetre | Inch (nearest) |
|---|---|
| 1270 | 50 |
| 1140 | 45 |
| 1020 | 40 |
| 890 | 35 |
| 760 | 30 |
| 630 | 25 |

Rainfall isohyets from unpublished S.C.A. reports.



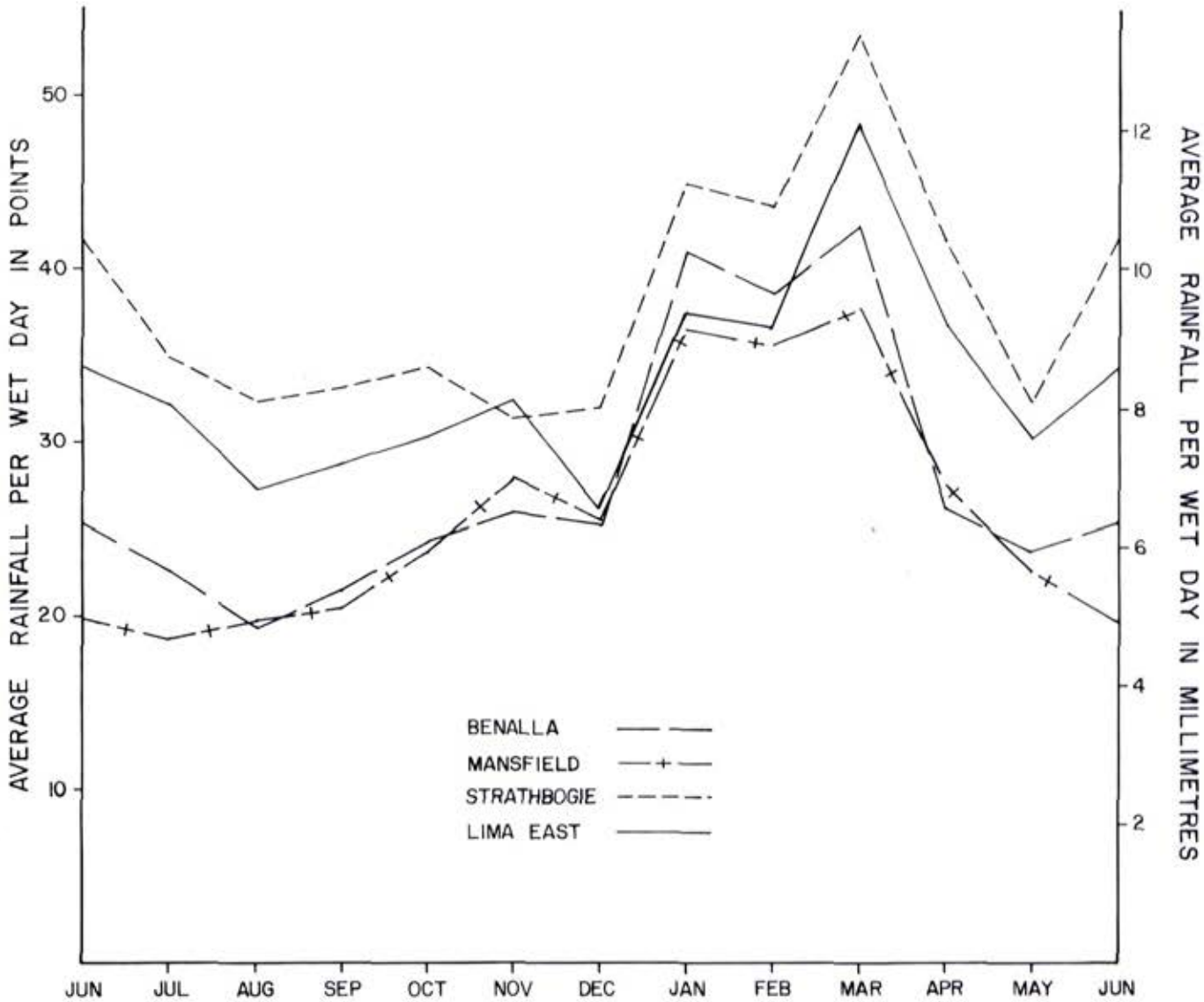



Figure 2. AVERAGE RAINFALL PER WET DAY

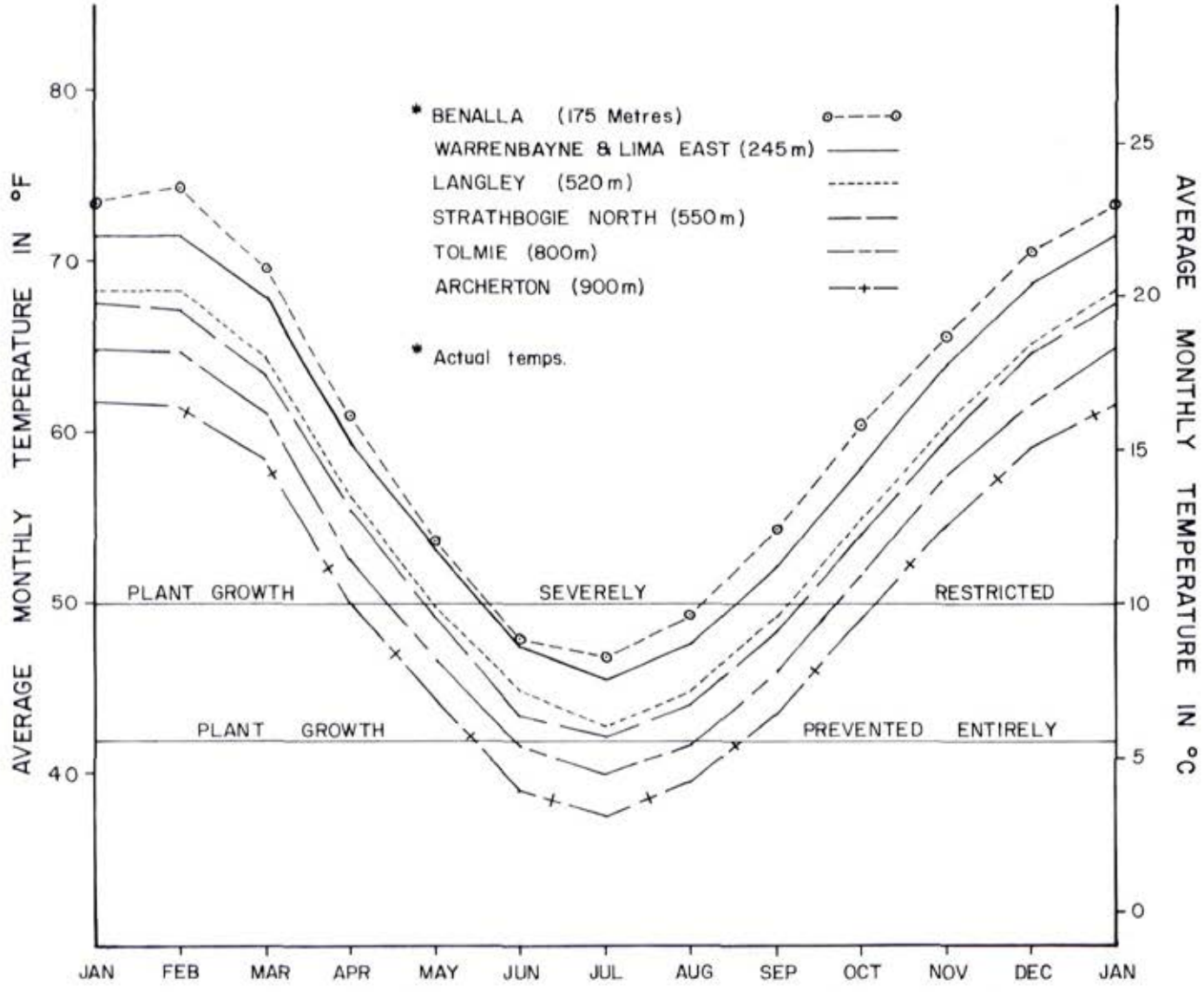



Figure 3. ESTIMATED AVERAGE MONTHLY TEMPERATURES

as Archerton, receive more than 50 mm per month in the summer - and rainfall generally increases fairly sharply in the autumn.

Rainfall intensity and thunderstorms

The intensity of a storm - i.e., the rate at which rain falls - and the time of year in which it occurs are important for a number of reasons. For example, high storm intensities in summer, when ground cover may be sparse, can lead to serious erosion.

A report by the Soil Conservation Authority in January 1970 analysed rainfall intensities at Archerton and Ryans Creek. At Archerton, high-intensity storms account for 46% of the 1,346-mm average annual rainfall. They reach peak intensity in March, when the average fall in a storm is 48 mm following immediately after the driest month of the year. At Ryans Creek, 24% of the 762-mm annual average falls in high-intensity storms. These reach peak intensities in May, with an average of 55 mm in each one, and a second peak in March with an average of 43 mm per storm.

Figure 2 presents calculated values of average rain per wet day, indicating rainfall intensities for each month for selected stations, and a table of the data appears as Appendix I Table B.

At all the stations graphed, the highest rainfall intensities occur during summer and autumn, when the bulk of rain falls as localized thunderstorms. Air streams in winter are cool and moist and come mainly from the south-west and north-west. They are more general in coverage and produce less intense rain.

Some indication of the occurrences of high-intensity rainfall is also given by the incidence of thunder days-- calendar days on which thunder is heard at least once. Thunderstorms may or may not be accompanied by rain or hail. They are always accompanied by lightning, which in some cases starts fires. Mansfield has an average of 20 thunder days a year, or which 17 occur between October and March, with the highest frequency in January. The average annual number in the district - 15-30 days - indicates the frequency of thunderstorms. This figure is fairly common for much of the eastern highlands. Higher frequencies occur east of the study district. Hailstorms affect small areas in the summer months, and showers of small hail are not uncommon during cold outbreaks in winter and spring.

Temperature

The only stations keeping temperature records within the district are Benalla, Euroa, and Mansfield, and the data are presented in Appendix I, Table C. Rundle has estimated temperatures for other localities from correlations of temperature with elevation for stations

throughout north-eastern Victoria (Rowe 1967).

Figure 3 shows average monthly temperatures for six stations. Lines have been drawn at 10°C (below which plant growth is severely restricted) and at 5.6°C (below which it is prevented entirely.) January and February are the warmest months of the year and July the coldest.

Average maximum and minimum temperatures

Although summer mean maximum temperatures are warm to hot on the Benalla plain and in the Lurg hills in the north of the district, maximum temperatures can be very high. For example, at Benalla the summer maximum has a mean of about 30°C, but can exceed 44°C for several days. Temperatures above 38°C may occur from October to the end of March. Generally these extremes coincide with dry, turbulent northerly or north-westerly winds, and create conditions of high fire risk.

In the northern parts of the district, at altitudes around 300 m, 600 m, and 900 m, the normal maxima during the warmest month are estimated to be around 28°C, 26°C, and 22°C respectively. These drop to about 12°, 9.5°, and 7°C respectively during July.

Minimum temperatures can vary greatly from locality to locality because of the influence of topographic features (such as valleys and depressions) on night temperatures. Average minimum temperatures during the hottest month are between 13° and 16°C in areas below 300 m (except where local topography causes cooler conditions) and are probably between 7° and 10°C at altitudes above 900 m.

In July, the normal minimum temperatures are mainly between 3° and 4.5°C over the lowlands and about -1° at 900 m elevation.

Frost

At Benalla, the first frost is likely about mid May, and the first severe frost in mid June. The last severe one is generally in early August, and the last light ones often come in September, although they may continue until mid November (see Table 4). Frosts at Euroa begin later than at Benalla, but severe frosts extend over a longer period and light ones persist later into spring.

Most of the public land that is not too steep for agriculture is found on the plateaux at over 600 m. There are no temperature recording stations at or near these areas, but some estimation of temperature is necessary.

The estimation of frost incidence is made difficult by the phenomenon of cold-air drainage, which may result in severe frost conditions in hollows or clearings at high elevations while the slopes remain frost-free. A rough rule

Table 4

Occurrence of Frost*

| Station | First 2.2°C | | | First 0°C | | | Last 0°C | | | Last 2.2°C | | | Average frost-free period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | Days |
| Benalla | May 13 | 13 | Mar 9 | Jun 17 | 21 | May 6 | Aug 5 | 17 | Sept 4 | Sept 21 | 18 | Nov 11 | 283 |
| Euroa | May 16 | 19 | Mar 21 | May 28 | 18 | Apr 26 | Aug 26 | 14 | Oct 22 | Oct 4 | 18 | Nov 20 | 223 |

1. Average date of first or last frost (1930-39)
2. Mean deviation from average date (days)
3. First or last date of occurrence

* 2.2°C in the meteorological screen indicates a light frost at ground level and 0°C a heavy frost.

developed after inspection of the available data indicates that the frosty period extends from late April to early October at intermediate elevations such as at Strathbogie North and from late March to early November at the highest elevations, around Archerton.

## Wind

No wind records are available, which is unfortunate because of the importance of wind effect on the rate of evapotranspiration, and because of its relation to fire danger weather. Most of the rain falls when westerly or south-westerly winds prevail, and occasionally with very strong, cold, southerly or south-easterly winds in mid-winter. Easterlies are rare, except for local effects, such as the common down-slope or down-valley winds that occur in the valleys when the night sky is clear. Tornadoes, including the full development of the hose or funnel cloud, are probably more common in the area than is usually appreciated. The funnel is frequently hidden in low scud or rain, but the

Table 5

Average Index of Mean Relative Humidity

| Month | J | F | M | A | M | J | J | A | S | O | N | D | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | | | | | | | | | | | | | |
| Beechworth | 49 | 50 | 55 | 64 | 72 | 75 | 75 | 72 | 64 | 60 | 55 | 53 | 60 |
| Myrtleford | 56 | 62 | 65 | 70 | 70 | 76 | 76 | 72 | 72 | 73 | 68 | 60 | 67 |
| Seymour | 56 | 55 | 62 | 68 | 76 | 80 | 79 | 76 | 73 | 68 | 61 | 58 | 66 |
| Wangaratta | 41 | 43 | 52 | 61 | 71 | 77 | 75 | 73 | 66 | 60 | 50 | 43 | 56 |

from: "Climatic Averages of Australia."
(Commonwealth Bureau of Meteorology: Melbourne 1956.)

narrow swath cut across the country is clearly marked by uprooted or broken trees and poles. These storms rarely cause injury, but do account for significant annual damage.

## Humidity

The figures from the nearest meteorological stations recording humidity are presented in Table 5.

The average index of mean relative humidity has been derived from the ratio of the average 9 a.m. vapour pressure to the saturation vapour pressure at the average mean temperature. Being thus related to the mean temperature, this value of relative humidity is a good approximation to the daily mean.

Wangaratta presents a similar pattern to that expected on the Benalla plain. Beechworth conditions would resemble those expected at the higher elevations, and Myrtleford would correspond to some of the valleys south of Molyullah.

## Evaporation

Estimated evaporation from January 1967 to April 1968 and actual evaporation measurements taken from May 1968 on an A-class American-type evaporimeter have been used to estimate the evaporation from Lake Nillahcootie (see Table 6).

Table 6

Evaporation from Lake Nillahcootie (millimetres)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 183 | 160 | 131 | 68 | 37 | 23 | 23 | 34 | 58 | 103 | 136 | 184 | 1,140 |

Table 7

Estimated Tank Evaporation (millimetres)

| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Benalla | 205 | 165 | 150 | 80 | 50 | 30 | 30 | 45 | 65 | 100 | 140 | 190 | 1,250 |
| Mansfield | 180 | 140 | 115 | 75 | 45 | 25 | 25 | 40 | 50 | 75 | 115 | 150 | 1,035 |

*from Commonwealth Bureau of Meteorology Tank Evaporation Maps

Table 7 gives estimates of tank evaporation for Benalla and Mansfield. Values of 750 to 900 mm could be expected over some areas at higher elevations.

## Climate and Plant Growth

### Effective rainfall

A widely accepted measure of the availability of moisture to plants as affected by rainfall and evaporation is effective rainfall. This is the amount of rain necessary to start and maintain plant growth. It has been calculated for each month for four stations within the district and for Whitfield (26 km to the east of Tatong), together with the probability of receiving rainfall equal to or exceeding the effective amount based on long-term records (see Appendix I Table D). This is a measure of rain-

fall reliability. On the northern lowlands (as represented by Benalla), effective rainfall in January and February can be expected only about 2 years in 10. The chances increase in successive months until it is virtually assured in June and July, then decrease until December, when effective rain can be expected in 3 years out of 10.

The same general pattern holds for the other stations. Mansfield has markedly greater chances than Benalla throughout the year, with an almost assured supply of effective rain from June to September. Euroa has similar conditions to Benalla. Strathbogie - representative of the Strathbogie Ranges - has a better chance of receiving effective rain in spring and autumn than has Benalla, but its summer conditions are similar, except that the dry period is a few weeks shorter. It has less chance in spring and summer than Mansfield, in spite of its higher annual rainfall. Whitfield - representative of the moist eastern valleys - is assured of effective rain from June till September.

Growing season

One commonly used measure of the length of the growing season is the number of consecutive months when the chance of effective rainfall equals or exceeds 50%. On this basis, Benalla and Euroa have growing seasons of 7 months (from April to October), Strathbogie 8 months, and Mansfield 9 months.

However, other factors such as soil moisture storage and low temperatures (the two most important factors in this district) also affect the growing season. In addition, it depends on the type of plant and its management. For example, clean cultivation of vineyards conserves soil moisture. Again, plants with large root systems such as trees, or deeply-rooted ones such as lucerne, have an advantage over shallow-rooting plants with small root systems.

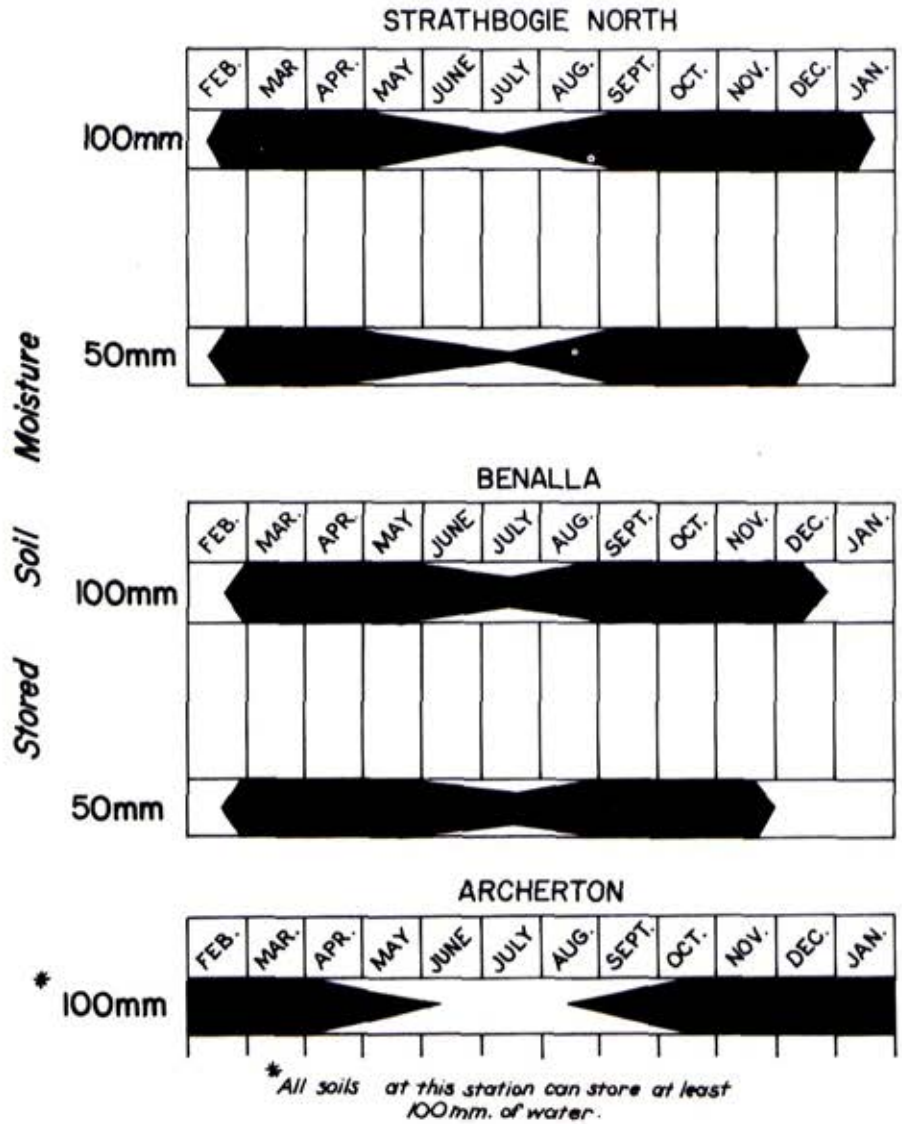
A Soil Conservation Authority report (Rundle and Rowe-in press) estimated the growing season for pastures in the area -- using average monthly temperatures, average monthly additions (precipitation) and losses (estimated evapotranspiration) of soil moisture, and moisture storage capacities of the typical soils.

Based on these estimates, Figure 4 depicts the patterns of growth for perennial pastures at three representative stations, Benalla, Strathbogie North, and Archerton.

A comparison of these indicates that the autumn break is some weeks earlier at Strathbogie North than at Benalla, and growth continues into the summer for an extra 2 to 4 weeks. However frosts curtail growth earlier at Strathbogie North, where continuing low temperatures also delay the spring flush.

At Archerton the situation is quite different. The growing season begins in

FIG. 4 PATTERNS OF GROWTH AT THREE REPRESENTATIVE STATIONS



spring and continues through the summer months into autumn. All but shallow-rooted species should suffer only very short periods of moisture stress in mid-summer. It should be noted that perennial pastures at Benalla and Strathbogie would respond to adequate summer showers.

## Drought Frequency

The frequency of droughts may be estimated on the basis of effective rainfall: a drought is considered to have occurred over the period where monthly rainfalls did not reach the respective effective amounts.

The frequency of winter drought is extremely low for Benalla and Mansfield and for the whole district. During the summer, Benalla will probably have droughts in December in 55% of years, during January in 60%, and in February in 46%. Corresponding figures for Mansfield are 48%, 57%, and 45% respectively. Chances of a 2-month, 3-month or 4-month drought beginning in January are 23%, 20%, and 14% respectively at Benalla and 23%, 21%, and 11% respectively at Mansfield.

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Anon. Climate. In "Victorian Year Book 1971." (Government Printer: Melbourne 1972.)

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Rowe, R.K. "A Study of the Land in the Victorian Catchment of Lake Hume." (Soil Conservation Authority: Melbourne 1967.)

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# SOILS

Soils are bodies of unconsolidated mineral or organic material at the earth's surface, formed as a result of the interaction of climate, parent materials, living organisms (including both plants and animals), and topography over varying periods of time. They are a basic resource that cannot be replaced. The profitable and wise uses to which they may be put depend to a large extent on their characteristics.

## Soil classification

Most classifications of soils are general-purpose. That is, soils are distinguished by a number of obvious features rather than by a few features preselected according to their relevance to a particular form of land use. At the same time, many of these obvious characteristics are known by experience to be relevant to a range of uses or to be correlated with those that are.

This is a fortunate circumstance where the suitability of land for alternative uses is being considered.

A Soil Conservation Authority report covering the Broken River catchment (Rundle and Rowe in press) provided the data on which this chapter is based. The general-purpose classification used in that report has been modified for use in this one (see Table 8).

The soils have been divided into three classes on the basis of the texture pattern of the profile: uniform, gradational, and duplex (Northcote 1971).

Uniform soils may exhibit some changes down the profile, but these fall within the span of one texture group. For example a loam may change to a sandy clay loam. Gradational soils become more clayey with depth, but do so gradually and the total texture change is greater than the span of one texture group - for example, from a loam to sandy clay.

Duplex soils, on the other hand, change sharply to a clayey subsoil. Northcote's classification has not been carried further than this primary distinction because of its complexity and because the soils have not been described in a way that would permit this.

Table 8

SOIL GROUPINGS

| Principal Profile Form (Northcote) | Descriptive names |
|---|---|
| Uniform texture | Undifferentiated stony loams<br>Coarse sandy loams<br>Dark, structured, calcareous clays<br>Dark, structured, non-calcareous clays*<br>Alluvial brownish loams and greyish loams with gleyed subsoils*<br>Undifferentiated sandy loams* |
| Gradational texture | Friable brownish gradational soils<br>Friable reddish gradational soils<br>Weakly bleached friable gradational soils<br>Weakly bleached massive gradational soils*<br>Alluvial reddish gradational soils*<br>Alluvial yellowish-brown gradational soils* |
| Duplex texture | Reddish duplex soils<br>Yellowish duplex soils |

* Soils developed on recent alluvium

Each class contains a number of soil groupings, which correspond to the groups described by Rundle and Rowe. These groupings have been given descriptive names, shown in Table 8, using features that can be readily observed in the field.

## Soil Descriptions

### Explanation of terms

The text describes soils of each group and indicates their distribution patterns. The names of soil colours

are taken from the Munsell soil colour chart, and textures have been estimated in the field and later checked by particle-size analysis. This section briefly explains some terms used in the soil descriptions.

Soil structure refers to the combination or arrangement of primary soil particles into secondary particles, or peds, and may be graded according to the distinctness, cohesion, and stability of these peds (or to their absence).

A soil horizon is a layer of soil material that lies approximately parallel to the surface and differs from other layers. A profile is a vertical section through all the soil horizons and extends into the parent material.

An important feature of a soil is its capacity to absorb flood rains. This is a function of its permeability and storage capacity. Another term used in the descriptions, available water, refers to the amount of water that the soil can store in a form available to plants. Such stored water may prolong plant growth after losses due to evapotranspiration exceed gains from precipitation.

Of course too much water in the soil can affect plant growth as adversely as too little, and in this case the important soil feature is its air porosity (the proportion of the bulk soil volume: filled by air) when wet.

The carbon:nitrogen ratio indicates the amount of available nitrogen. Ratios of less than 12 seem to be desirable for the satisfactory growth of most crops and pastures, but in virgin soil the ratio is often greater than 20.

Soil pH is its degree of acidity (or alkalinity) - the higher the pH the more alkaline the soil.

The cation exchange capacity (C.E.C.) of a soil is a measure of its ability to hold nutrients in a form available to plants. It bears a close relation to the organic matter and clay fraction of the soil. Ions such as phosphate or calcium can be exchanged for other ions in the soil and may thus be available for plant growth.

A. Soils not developed on recent alluvium

Uniform texture

Undifferentiated stony loams occur on ridges and steep upper slopes. They are very acid soils and have little water-holding capacity.

Coarse sandy loams occur only on isolated granitic hills between Lurg and Glenrowan in this district and so are not important to this report.

Dark, structured, calcareous clays occur along drainage lines on the Mansfield plain and in swampy areas on the

*Friable brownish gradational soil on a broad ridge near Stockyard Creek*

Benalla plain. The soils on the Benalla plain are generally gilgaied, i.e. the surface consists of a series of rises and hollows each having different properties although the soils are usually strongly structured light to heavy clays. The rises are alkaline with free lime present and the hollows are slightly acid on the surface but become slightly alkaline at a depth of about one metre. The soils of the Mansfield plain are rarely gilgaied, and are generally more fertile and friable than those on the Benalla plain.

Gradational texture

Friable brownish gradational soils are typical of the higher-rainfall mountain areas. This group includes soils intergrading between the weakly bleached massive gradational soils and those with considerable humus accumulation. A typical profile has a thick litter layer overlying a dark-brown friable loam with strongly developed fine structure. With increasing depth, the colour becomes first paler then usually more reddish or a stronger brown and textures change to clay loam or light clay. Colours may be more yellowish on acid volcanic parent materials. Some profiles show little texture change and could be classified as uniform. The organic matter content decreases rapidly below the surface few centimetres.

These soils are porous, friable, well drained, permeable throughout, and usually deeply weathered. Such properties make surface run-off unlikely. Water held is about 50-60% of soil volume at saturation and about 35% at field capacity. The water available for plant growth is about 20-25% of soil volume. Flood rain storage is high, as a moist soil 1.5 m deep would absorb about 300 mm of steady rain before surface run-off would occur.

Plant nutrients are concentrated in the surface layers, where cation exchange capacity is moderately high, but this decreases with depth. Calcium is the dominant exchangeable cation near the surface, but magnesium becomes more important deeper in the profile. The soils are moderately to strongly acid. C:N ratios ranging from about 23 to 28 indicates low amounts of available nitrogen. Total phosphorus is low.

Friable reddish gradational soils may be divided into two groups. Those of the first group are usually associated with basic rocks such as basalt and diabase and have a well-structured subsoil. They mainly occur around Archerton, Bunston Hill, and the Spring Creek-Wrightley area.

The finely structured dark brown or greyish-brown loam to clay loam of the surface gradually changes to a moderately structured clay loam or light clay, and to progressively redder, well-structured clays with increasing depth. Most of the soils are reddish brown, but there may be yellowish variants in low topographic positions.

The clays are fairly dense and hold about 40% by volume of water at saturation and about 30% at field capacity. They have less ability to absorb flood rains than the other main soils - a moist soil 1 m deep would absorb about 100 mm of rain before run-off began but their generally greater depth may

*Friable reddish gradational soil (with well-structured subsoil) near Wrightley*

give them a high total storage capacity. The water available to plants varies from about 20% of soil volume in the surface soil to 15% in the subsoil. A profile 1 m deep could hold the equivalent of about 150 mm of rain for plant growth.

Cation exchange capacities are high to moderately high at the surface and

5762/73-5

decrease with depth. Exchangeable calcium decreases markedly down the profile, but magnesium remains fairly constant. The soils are moderately acid in the surface horizons and where the rainfall is high the subsoils are strongly acid. C:N ratios range from 20 to 15 with increase in depth. Relatively large quantities of ferric oxide and phosphorus are present.

A second group of friable reddish gradational soils, with less well-structured subsoils, occur on gentle topography at the upper elevations on a range of parent materials. Their colours are generally similar although the strongest reds do not occur. The textures show the same trend down to the subsoil, which, however, is usually not as thick and may become less clayey with depth. They are porous throughout, with water-holding capacities comparable with those of the friable brownish gradational soils - moist soil 1.5 m deep could absorb 300 mm of steady rain before surface run-off occurred. These soils are strongly acid (pH 5.0-4.8) and have medium to low cation exchange capacities. C:N ratios are high - 28 to 20. Total phosphorus is low.

Weakly bleached friable gradational soils vary, and are found mainly on lower slopes and low hills but also on steep scarps and hilltops and in the plains. They differ from the friable brownish group, being less friable and having an obviously bleached sub-surface horizon. Although exchangeable cations are concentrated in the first 4 cm, the humus-enriched layer is much shallower. Typically, a brown to greyish brown loam at the surface grades into a light reddish clay loam or light clay with a moderately developed structure. On wetter sites, a well-structured clay may lie at the base of the subsoil.

A moist soil 1 m deep could absorb about 130 mm of rain before becoming saturated. It would hold about 150 mm available for plant growth.

The soils are strongly to moderately acid (pH 5.0-5.5), with little variation with depth. Cation exchange capacity is low, and so is total phosphorus.

Duplex texture

Reddish duplex soils are widespread in this district; their main occurrence on public land is on the undulating surfaces of the Strathbogie and North Blue Ranges and the Tolmie plateau. The surface horizons consist of a dark greyish-brown or fine sandy loam, which grades into a greyish brown or brown loam. This overlies a reddish-brown clay subsoil with a clear to abrupt boundary. The surface soil has no structure and sets hard when dry, although it may be relatively porous. The subsoil clays have moderately well-developed structure and are friable when moist, but harden on drying. Weathered rock may occur at a depth of 1 m or less

and there may be much fragmented rock throughout the profile.

These soils have a low capacity for flood-rain storage. The surface loams have about 15% of soil volume available, but the subsoil clays have only about 5-10%. These tend to swell after a thorough wetting and this impedes further absorption. About 65 mm of rain would be available for plant growth in the first 50 cm of the soil and a further 50 mm in the next 50 cm. The soils typically have moderately to strongly acid subsoils (ph 5.5 to 5.0), with exchangeable magnesium dominant over calcium and measurable quantities of exchangeable sodium. Levels of available potassium are relatively high, but total phosphorus levels are low.

Yellowish duplex soils - easily distinguished from the reddish duplex by their yellow or yellowish-brown subsoils - occur in two recognizable forms. The more common form is widespread on the Mansfield and Benalla plains and its main occurrence on public land is in the Reef Hills. The surface soil varies in depth and is usually gilgaied, except where the layer is deep. The dark, gritty loam to loam becomes a pale grey, structureless, silty loam, with increasing amounts of small iron oxide concretions (buckshot) lower in the horizon. This abruptly overlies a strongly structured yellowish-brown heavy clay subsoil, usually with a wavy boundary between the two.

*Yellowish duplex soil in road cutting near Barjarg*

The soils have limited ability to absorb heavy rain and soon become saturated. They frequently remain waterlogged for long periods in winter. Surface soils may retain up to 20% available water by volume, but they are generally shallow and the subsoils have low capacities.

Although the surface horizons are usually moderately to strongly acid (pH 5.5

to 4.7), the subsoils vary. Acid subsoils are common, and neutral to alkaline subsoils less so. They are highly dispersible, due mainly to the dominance of exchangeable magnesium over calcium and the presence of measurable quantities of sodium.

Cation exchange capacities are medium to low throughout the profile. Subsoils may contain substantial reserves of available potassium, but total phosphorus is generally low. C:N ratios are moderate (20-15)

The less common form of yellowish duplex soils usually occurs on the plains or in the lower slopes of the foothills. The surface layer has a less abrupt boundary with the subsoil, which is usually yellowish-brown with reddish-brown mottles and is less dense. Clay content usually decreases below about 1 m. The soils are acid, but may have neutral to alkaline subsoils in low topographic positions.

B. Soils developed on recent alluvium

These soils have developed along streams or on young alluvial fans and are generally limited in extent. The sands, loams, and clays are uniform in texture and the remaining soils are gradational.

Uniform texture

Dark, structured, non-calcareous clays are typical of moist but well-drained creek banks and terraces. The surface horizons are usually dark-coloured clay loams to light clays with strongly developed structure. At 40-50 cm, grey mottled clays with weaker structure are encountered. They are moderately fertile and have good physical properties, although soil moisture storage capacities may be fairly limited. There is no free lime.

Alluvial brownish loams and greyish loams with gleyed subsoils occur near streams on the Benalla plain. They have a dark and strongly structured surface, becoming pale and weakly structured with depth. The soils harden as they dry out. They have been cultivated in many cases.

Undifferentiated sandy loams are found beside streams, and consist of relatively recent sediments. They typically have no profile development, except for darkening of the surface by organic matter.

Gradational texture

Weakly bleached massive gradational soils - pale and hard-setting - occur mainly in depressions and drainage lines but also spread from the bases of foothills onto the plains. A light grey sandy loam without structure grades into a yellowish light clay or clay loam containing numerous buckshot concretions, also with no structure. They are acid and have generally low fertil-

ity but moderately high soil-moisture storage capacities.

Alluvial reddish gradational soils are typical of alluvial fans but also occur on river terraces and in isolated patches on the plains. They are friable reddish loams to clay loams, with moderate fertility and excellent physical properties.

Alluvial yellowish-brown gradational soils are relatively common on river terraces. Their texture ranges from loam or sandy loam in the surface to light clay in the subsoil. They lack structural development except in the subsoil, where structure is weak to moderate. These moderately acid soils have moderately high fertility and soil-moisture storage capacities.

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# VEGETATION

This chapter deals with vegetation structure and floristics, then describes the native vegetation of the study district. This should be considered in conjunction with the vegetation map (in a pocket at the back of the report.)

With a few exceptions, the descriptions refer to vegetation on public lands, as very little native vegetation remains on private land in the study district.

## Vegetation Structure and Floristics

The structure of a plant community is defined in terms of three components:

* vertical arrangement of the species into strata
* horizontal arrangement of plants, or spacing
* abundance of each species

The study of floristics includes the grouping of associated plant species into more or less homogeneous units. One method of doing this is to collect data from carefully set-out plots, or quadrats, and process these data statistically in a computer. This method delineates groupings of species that are truly associated, which form useful units for defining habitats and indicating site conditions.

However, the method has the disadvantage that data collection is a painstaking and slow process (and the key species in any grouping may be a small plant that would be very difficult to map). It is impracticable for mapping and describing the vegetation of the study district.

This report therefore follows an alternative method, determining groupings subjectively, according to uniformity in structure and qualitatively uniform floristic composition of the dominant stratum (the one that exerts a controlling influence on other plants - usually the tallest stratum).

## The Study District

The native vegetation of the district was first grouped into a number of structural units, as set out in Table 9. These have been modified from a classification developed by Specht (1970) for use in the International Biological Programme. The modifications involve redefinition and subdivision of the height

Table 9

STRUCTURAL FORMS (NORTH-EASTERN AREA DISTRICT 2)

| Life form and height of tallest stratum | Projective foliage cover of tallest stratum | | |
|---|---|---|---|
| | Dense (70-100%) | Mid-dense (30-70%) | Sparse (10-30%) |
| Trees >40 m | | Open forest IV | |
| Trees 28-40m | | Open forest III | |
| Trees 15-28m | | Open forest II | Woodland II |
| Trees 5-15m | | Open forest I | Woodland I |
| Shrubs 2-8m | Closed scrub | Open scrub | |
| Shrubs 0-2m | Closed heath | Open heath | |
| Herbs (including moss, ferns, lichens) | | Mossland | Open mossland |

classes to better suit the vegetation of the study district and also to fit in with existing data for other areas. Table 9 groups the structural forms according to projective foliage cover, which is defined as the percentage of area covered by foliage, measured by a vertical point quadrat technique. It is not the same as crown cover. A tree is defined as a woody plant more that 5 m tall, usually with a single stem. A shrub is a woody plant less than 8 m tall, frequently with many stems arising at or near the base.

Within this structural framework, the native vegetation has been grouped according to commonly occurring combinations of tree species. These have been chosen subjectively and have been termed vegetation units to distinguish them from the groups determined by ordination methods. They are not based on a detailed study of species relations, but are readily recognizable in the field and each unit reflects the operation of a certain set of environmental factors.

Table 10 sets out these vegetation units, which also form the units for the map at the back of this report. The description and detailed mapping were undertaken because of the importance of vegetation in planning for conservation.

The map was drawn from information supplied by the Forests Commission, together with some aerial photo interpretation and field checking. The mapping units represent mature vegetation communities: stands of alpine ash have been mapped as open forest IV, even though some of these have not yet reached full mature height and form. However, symbols indicate whether stands are of regrowth or mature size. Appendix II contains a list of native plants common in this district. Variance between plant common names in Appendix II and those used in the previously prepared vegetation map is indicated.

The map makes no distinction between mountain gum *(Eucalyptus dalrympleana)* and candlebark *(E. rubida)*, as they are very similar both botanically and in their appearance in the field. Nor does it distinguish between the two forms of Blakely's red gum *(E. blakelyi)*. One form grows on the terraces and in drainage lines at low elevations, and the other, a stunted form sometimes referred to as hill gum, occupies some steep dry slopes where soils are shallow. Tussock or snow grass *(Poa australis)* shows a wide variation in morphology and the specific name has been used in an aggregate sense pending critical study. It has been termed snow grass where it occurs in sub-alpine vegetation units and tussock grass where it occurs elsewhere.

## The Native Vegetation Units

The district was originally covered by forests, except for some woodlands and small areas of grassland in the broad river valleys and on the plains.

Since early settlement much of the forests and the woodlands have been cleared or thinned out and pastures of introduced plants established. The other major vegetation change has been the clearing of native forests for pine plantations in recent years. The remaining native forests, while retaining their essential character, have been influenced to a greater or lesser extent by Man's activities, including logging, grazing, the introduction of weeds, and the incidence of fire.

TABLE 10

NATIVE VEGETATION UNITS

| Map symbol | Typical structural form(s) (at maturity) | Major tree species (common name of unit) | Associated tree species | Major understorey species |
|---|---|---|---|---|
| 1 | Open forest I | Candlebark : snow gum | Broad-leaf peppermint | Snow grass, button everlasting; purple eye-bright; dwarf geebung, gorse bitter-pea, silver wattle |
| 2<br>r: regrowth<br>m: mature | Open forest IV | Alpine ash | Candlebark, narrow-leaf peppermint | Snow grass; bracken fern; mother shield fern, hop bitter-pea; mountain tea-tree, austral mulberry, musk daisy-bush, soft tree fern |
| 3 | Open forest III and IV | Messmate stringybark | Manna gum, St.John's blue gum, narrow-leaf peppermint, candlebark | Bracken fern, fishbone water-fern, hard water-fern, silver wattle, musk daisy-bush, blackwood |
| 4 | Open forest III | Narrow-leaf peppermint | Candlebark, manna gum, St.John's blue gum, leaf peppermint, brittle gum, red stringybark | Tussock grass, austral crane's-bill violets, pennyworts; bracken fern, fishbone water-fern; silver wattle, common cassinia, austral king fern, soft tree-fern, hazel pomaderris, musk daisy-bush, austral mulberry, blackwood |
| 5a | Open forest II | Broad-leaf peppermint : candlebark | Brittle gum, St.John's blue gum, narrow-leaf peppermint | Tussock grass, pink-bells, guinea flower, spiny-headed mat-rush, handsome flat-pea, gorse bitter-pea, narrow-leaf bitter-pea, common beard-heath, mountain grevillea, small grass-tree |
| 5b | Open forest II | Broad-leaf peppermint : red stringybark | Long-leaf box, red box, brittle gum | Tussock grass, wallaby and spear grasses, violets, pennyworts, austral bugle, austral bear's ear, honey-pots; common beard-heath, varnish wattle, handsome flat-pea, bracken fern |
| 6 | Open forest I and II | Red stringybark : long-leaf box : red box | White box, yellow box, grey box | Tussock grass, wallaby and spear grasses, small grass-tree, silky guinea flower, digger's speedwell, daphne heath, grey bush-pea, mountain grevillea, box-leaf wattle, golden wattle, woolly wattle |
| 7 | Open forest I<br>Closed to open heath<br>Open mossland | Blakely's red gum (complex) | White box, long-leaf box, red stringybark, broad-leaf peppermint, grey box | Rock fern, rock isotome, modding blue-lily, daphne heath, mountain grevillea, common fringe-myrtle, lightwood, hairy geebung, cherry ballart |
| 8 | Open forest II | Grey box | Red box, red stringybark, white box, yellow box, long-leaf box | Silver-top wallaby-grass, orchids, golden wattle, rough wattle |
| 9 | Open forest II | River red gum | Blakely's red gum, grey box, yellow box, white box, but-but (apple box) | Silver-top wallaby-grass; hedge wattle |
| 10 | Open forest II | Mountain swamp gum | | Tussock grass, kangaroo grass, fish-bone water-fern, thatch saw-sedge, Ovens wattle |

Candlebark : snow gum open forest I and II

This vegetation unit has an overstorey of candlebark and snow gum, usually about 15-20 m high. Dry sites carry broad-leaf peppermint as an associated tree species. The understorey is usually a grassy layer composed of snow grass and herbs such as purple eyebright, with scattered shrubs such as gorse bitter-pea and dwarf geebung.

The unit is restricted to ridge tops and exposed locations above about 1,000 m. Its largest occurrence is on the Buckland spur, and its western-most at two localities near Mount Strathbogie. Snow gum, where it occurs on ridge tops, grows on shallow soils where drainage is rapid. It apparently tolerates low winter temperatures and summer drought.

Alpine ash open forest IV

Alpine ash is the dominant species of this unit. Its seeds require low winter temperatures to break their dormancy, which restricts it to areas that receive light winter snows - at elevations of about 900-1,100 m in this district. Precipitation here exceeds 1,140 mm per annum and the soils, which are deeply weathered and well drained, remain moist throughout the year. Summers are mild and winters cold.

Stands are usually pure, but tree species associated with alpine ash at

*Candlebark : snow gum open forest on the Buckland spur*

its lower limits include narrow-leaf peppermint and candlebark. The understorey varies - from snow grass with scattered hop bitter-pea, to bracken fern and mother shield-fern, to a moist gully type, which includes soft tree-fern, mountain tea-tree, austral mulberry, and musk daisy-bush.

Scattered alpine ash trees occur near

*Messmate stringybark open forest near Tallangalook*

Archerton and Bunston Hill, and stands - mainly regrowth 25-30 years old - are situated in the headwaters of Evans Creek.

Messmate stringybark open forest III and IV

Messmate stringybark occurs in pure stands or associated with manna gum, narrow-leaf peppermint, St. John's blue gum, and candlebark.

The understorey varies from dense bracken fern and silver wattle to a moister type - blackwoods 20 m high growing above a dense layer of musk daisy-bush 8 m high. A fern layer is common in the gullies and usually includes fishbone water-fern and hard water-fern.

Narrow-leaf peppermint open forest III

This vegetation unit covers a large proportion of the forest areas in this district. The major species, narrow-leaf peppermint, requires moderately high soil-moisture status throughout the year and usually grows in deep, well-drained soils at elevations ranging from 460 to 1,100 m where annual rainfall is about 1,020 mm to more than 1,270 mm. It may also be found in locally moist situations in lower-rainfall areas.

The moister sites usually carry candlebark and also manna gum and St. John's blue gum as associated species. On

drier sites, the associated species are usually broad-leaf peppermint and brittle gum, but can include red stringybark.

Candlebark and mountain gum have been mapped as one entity in this report and referred to as candlebark. These trees grow mainly on the plateaux and in areas of cold-air drainage at lower elevations. Pure stands occur around Tolmie and Mount Strathbogie. Manna gum commonly grows in mixture with narrow-leaf peppermint and is also common on basalt patches on the Tolmie highlands.

St. John's blue gum is found in the higher-rainfall areas or on sites with a high water table in lower-rainfall areas.

The understorey of the unit usually comprises a dense cover of bracken fern 1 to 1½ m tall with a taller (3-7 m) scattered to dense layer of silver wattle. On moister sites small trees and tall shrubs form a layer 4½-9 m tall composed of species that include hazel pomaderris, blackwood, austral mulberry, common cassinia, and musk daisy-bush, with soft tree-ferns and various others such as fishbone water-fern and austral king-fern underneath.

On drier sites the understorey is mainly a sward of tussock grass with herbs such as austral crane's-bill, ivy-leaf violet, austral bear's-ear, prickly starwort, stinking pennywort, and

*Narrow-leaf peppermint open forest on the Toombullup plateau*

bidgee-widgee. Scattered bracken and silver wattle may also be present.

Broad-leaf peppermint : candlebark open forest II

Broad-leaf peppermint occurs in mixture with a large number of other tree species and ranges from about 300 to 900 m. The vegetation unit delineated here, however, ranges from about 600 to 900, with an annual rainfall of more than 1,140 mm and generally shallow soils. Its main occurrence is on broad, gently sloping ridges in the Tolmie highlands. Where tree heights reach about 24-28 m, the understorey is usual-

*Broad-leaf peppermint : candlebark open forest near Blue Range Creek*

*Broad-leaf peppermint : red stringybark open forest near the Loombah Weir*

ly bracken and tussock grass with scattered common cassinia and silver wattles; where tree heights are lower (18-24 m), the understorey is grassy (tussock grass) with scattered shrubs and herbs including handsome flat-pea, gorse bitter-pea, mountain grevillea, narrow-leaf bitter-pea, pink-bells, milkmaids, musky caladenia, creamy stackhousia, and spiny-headed mat-rush.

Broad-leaf peppermint : red stringybark open forest II

This unit typically has red stringybark as a component, the main exception being broad-leaf peppermint : long-leaf box stands along the southern foothills of the Strathbogie ranges and Tolmie highlands. Red stringybark has a wide ecological range and is associated with

many plant species, generally on skeletal soils below about 760 m. Tree species associated with it and with broad-leaf peppermint include long-leaf box, brittle gum, and red box.

The understorey varies from bracken fern growing above scattered tussock grass to a dense sward of tussock grass with plants such as austral bear's-ear, honey-pots, ivy-leaf violet, purple violet, austral bugle, austral crane's-bill, and stinking pennywort, and scattered shrubs such as common beard-heath, varnish wattle, handsome flat-pea, and narrow-leaf bitter-pea.

Red stringybark : long-leaf box : red box open forest I and II

Dry rocky sites with annual rainfalls of 630-1,140 m - at such localities as the Reef Hills, Lightning Ridge, Mount Samaria, and the northern end of the Tolmie highlands - carry this unit.

White box, yellow box, and grey box grow as associated species.

The understorey may consist of a litter layer only, but is typically scrubby, with such species as daphne heath, grey bush-pea, mountain grevillea, silky guinea-flower, box-leaf wattle, small grass-tree, and digger's speedwell. In the Reef Hills it is mainly grasses, including tussock, wallaby, and spear grasses with scattered shrubs such as golden and woolly wattles.

*Red stringybark and long-leaf box with a heathy understorey on Lightning Ridge*

Blakely's red gum (complex)

The structural forms of this complex comprise open forest I, closed to open heath, and open mossland. It occurs on and around rock outcrops and on shallow rocky soils in low-rainfall areas.

Tree species in the open forest I include the stunted form of Blakely's red gum, locally known as hill gum, which tolerates soils that become waterlogged for considerable periods. On granite these conditions occur in stream lines and valley floors, and on much of the topography where the soil overlies unbroken granite close to the land surface.

*Grey box open forest in the Reef Hills*

In this district, the species is restricted to areas with an annual rainfall less than about 890 mm. It may be associated with or replaced by white box, grey box, long-leaf box, red stringybark, and broad-leaf peppermint.

A usually heathy understorey includes such species as daphne heath, mountain grevillea, common fringe-myrtle, and nodding blue-lily. Scattered shrubs 2-3 metres high include lightwood, hairy geebung, and cherry ballart.

The heaths usually consist of species such as common fringe-myrtle, violet kunzea, nodding blue-lily, austral stork's-bill, rock isotome, and rock fern. Mossland forms a cover over the rock outcrops and includes various mosses and lichens.

The main occurrence on public land lies in the western part of the district, particularly near Mount Wombat and Kelvin View. Occurrences on private land are on rocky hillsides between Lurg and Glenrowan.

Grey box open forest II

Grey box is the major tree species of this vegetation unit. It occurs on moderately well-drained soils where the annual rainfall is less than about 760 mm. Its main occurrence is in the Reef Hills near Benalla. Associated species include red box, white box, yellow box, and long-leaf box.

The understorey is often grassy with species such as silvertop wallaby-grass, although in some areas dry twigs and leaf litter form much of the ground cover. Many small and interesting plants, including a number of orchids (e.g.the large duck orchid) grow in the shrub and ground layers. Scattered wattles, such as golden and rough wattles, may be present.

River red gum open forest II

River red gum occurs in mixture with the tall form of Blakely's red gum and predominates along drainage lines and in swamps. The vegetation unit occurs mainly along lowland river frontages and in poorly drained situations in the Reef Hills. Scattered river red gums also occur extensively on private property on the Mansfield and Benalla plains.

Associated species, usually in the better-drained situations, include grey box, white box, yellow box, and but-but. The ground cover may consist chiefly of leaf litter and twigs or may have scattered grasses such as silvertop wallaby-grass and shrubs such as hedge wattle.

Mountain swamp gum open forest II

This vegetation unit is associated with flat-graded streams or areas of poor drainage, for example, in the headwaters of Holland and Junction Creeks and on the Blue Range plateau. Mountain swamp gum, the only eucalypt species present, is restricted to areas of poor drainage.

The undergrowth may consist of thatch saw-sedge and ferns (such as fishbone water-fern) with shrubs, which may include ovens wattle, prickly tea-tree, and blackwood, or may be only a ground layer with grasses such as kangaroo grass and tussock grass in mixture with various herbs.

Endangered Species

In a table of native Victorian plants in danger of extinction (Frankenberg 1971), J.H. Willis listed the following as occurring in the study district.

1. *Pterostylis hamata* (scaly greenhood) - a very rare and localized orchid, in Victoria found at Walwa and in the Benalla, Beechworth, and Springhurst districts.

2. *Acacia penninervis* (hickory wattle) - an extremely rare and localized plant restricted to the Avenel, Pranjip, and Euroa areas.

Significant Species for Conservation

In addition, Willis has designated the following species as being of significance for conservation. This list notes their general distribution in Victoria and indicates where they were recorded in this district. (The common plants also need to be conserved, and these are listed in Appendix II.)

1. *Diuris punctata* (purple diuris) - once a locally common orchid of lowland Victoria, but now with a much reduced range and becoming rare through destruction of its habitat; recorded in the Violet Town area.

2. *Caleana major* (large duck orchid) - a widespread but scattered orchid recorded in the Reef Hills.

3. *Spiranthes sinensis* (austral ladies' tresses) - a widespread but localized plant in Victoria; recorded in the Euroa and Gooram areas.

4. *Tetratheca glandulosa* (glandular pink-bells) - an uncommon plant, known only from a few widely spread localized areas; recorded in the Lima area.

5. *Acacia flexifolia* (bent-leaf wattle) - occurs in Victoria only in a limited band across central northern regions; recorded in the Reef Hills.

6. *Acacia difformis* - an uncommon species occurring in a belt that extends across Victoria north from Inglewood (through Bendigo, Graytown, and Benalla) into New South Wales; recorded in the Reef Hills.

7. *Acacia buxifolia* (box-leaf wattle) - restricted to a few isolated areas in north-eastern Victoria; recorded in Toorour block.

8. *Mirbelia oxyloboides* (mountain mirbelia) - found in the higher ranges from the Strathbogies to Bendoc.

9. *Pultenaea cunninghamii* (grey bush-pea) - a shrub occupying a belt of the north-eastern highlands between Glenrowan, Whitfield, and Mount Granya; recorded in the Toorour, Samaria, and Stockyard blocks.

10. *Pultenaea vrolandii* - an uncommon plant, limited to the north-east and very localized in distribution, recorded in the Strathbogie Ranges.

11. *Dillwynia juniperina* (prickly parrot-pea) - in Victoria confined chiefly to East Gippsland, its only north-eastern occurrences in the State being the Strathbogie and Warby ranges.

12. *Dodonaea boroniifolia* (hairy hop-bush) - although scattered widely throughout the State, this uncommon plant has a localized distribution; recorded in the Strathbogie Ranges.

13. *Brachycome ptychocarpa* - Victorian distribution appears very restricted and localized on granite mountains of the north-east and East Gippsland; recorded in the Strathbogie Ranges.

14. *Olearia ramulosa var. rigida* - a rare plant restricted to granite hills in northern and north-western areas: the National Herbarium type specimen was collected from Lima East.

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# FAUNA

This chapter details the presence and distribution of native birds and mammals, reptiles and amphibians, and fish, arthropods, and molluscs recorded in the study district. For most of the species, information is far from complete.

Those requiring special conservation measures because of their status as endangered or significant species have been highlighted. Conservation measures necessary for these and others are considered in chapter 15. Introduced species are briefly described.

## Birds and Mammals

The presence and distribution of bird species have been established from lists made by reliable observers. Information on mammals was obtained from surveys by the National Museum staff, the Benalla Field Naturalists Club, and the Mammal Survey Group. Appendix III lists native fauna of the district. This report uses bird names listed in the C.S.I.R.O. Index (1969) and mammal common names approved by the Victorian Fisheries and Wildlife Division.

Most birds and mammals of the forested ranges in the study district are typical of the stringybark : peppermint-gum forests of north-eastern Victoria. Also some residents and visitors have a range, centred about the woodlands and open forests of the northern plains, that extends to the fringes of the foothill forests.

### The forested ranges

The forests provide a habitat for many common and widespread birds. Those that use tree branches and shrubs as nest sites include the superb blue wren, striated thornbill, brown thornbill, white-browed scrub-wren, flame, scarlet, and southern yellow robins, grey fantail, rufous whistler, golden whistler, grey shrike-thrush, yellow-faced honeyeater, white-eared honeyeater, and red wattle-bird. Others - such as the kookaburra, sulphur-crested cockatoo, crimson rosella, gang-gang cockatoo, sacred king-fisher, white-throated treecreeper, and striated and spotted pardalotes - use tree hollows as nest sites.

Many of the smaller ones are insectivorous - catching insects in the air or seeking them among foliage and litter or

on tree trunks and branches. Others feed mainly on nectar and blossoms. The diet of some of the larger common birds, such as the gang-gang cockatoo, consists largely of seeds of native trees and shrubs. The sulphur-crested cockatoo supplements its diet by grain from adjacent croplands. The laughing kookaburra and sacred kingfisher on the other hand prey on a wide range of animals, including small reptiles, fish, insects, and crustaceans.

Some birds have restricted distribution because of habitat preferences. The rufous fantail, superb lyrebird, pilot bird, pink robin, and Australian ground-thrush, for example, mainly frequent moist, densely vegetated gullies. The spotted quail-thrush prefers dry ridges.

*Laughing kookaburra at nest hollow*

*Moist, densely vegetated gullies are frequented by many interesting birds*

*The feather-tailed glider*

Common terrestrial mammals of the forested ranges include the black wallaby, common wombat, echidna, long-nosed bandicoot, and bush rat. The eastern grey kangaroo and dingo occur less commonly. Arboreal species include the ring-tailed possum and greater glider, and the less common bobuck, koala, feather-tailed glider, sugar glider, brush-tailed possum, brown antechinus, and tuan.

Some mammals, such as the long-nosed bandicoot, bush rat, brown antechinus, koala, and black wallaby, are often observed close to streams or swampy areas, but others can occupy a range of situations. Brief surveys indicate that the ring-tailed possum, greater glider, common wombat, echidna, and eastern grey kangaroo are widespread in the forested ranges, but the bobuck, brush-tailed possum, tuan, sugar glider, feather-tailed glider, yellow-bellied glider, and dingo appear less so. The koala is found in various localities throughout the Strathbogie Ranges.

Some of the terrestrial species - the black wallaby, eastern grey kangaroo, and common wombat - are herbivores. Of the terrestrial carnivores, the echidna and long-nosed bandicoot are almost wholly insectivorous while the dingo and bush rat have a more varied diet.

Most of the arboreal species require hollow trees for nest sites, but their food requirements differ considerably.

The koala and greater glider, for example, depend entirely on eucalyptus leaves for food and are relatively sedentary animals. Others, such as the sugar and feather-tailed gliders, live on nectar and blossoms as well as insects and travel over greater distances to seek food. The tuan subsists almost entirely on insects and small vertebrates such as birds and rodents.

*The echidna is found in most habitats throughout the district but the koala is restricted because it feeds exclusively on eucalypt leaves and twigs*

Woodlands

The woodlands and foothill fringes also contain many birds of the forested ranges, such as the common bronzewing, yellow-faced honeyeater, rufous whistler, and laughing kookaburra. However, others here, including the peaceful dove, red-rumped parrot, noisy miner, and white-browed wood-swallow, are mainly restricted to this habitat. The only mammal in this district restricted to woodlands and foothill fringes is the squirrel glider. The echidna, sugar glider, ring-tailed possum, brush-tailed possum, tuan, eastern grey kangaroo, and others also frequent the ranges.

Wetlands

Birds frequent streams, swamps, and dams and lakes in the district. The pelican, grebes, spoonbills, cormorants, bitterns, and most ducks may be mainly restricted to this habitat, but the mountain duck, ibis, white-faced heron, white-necked heron, and egrets may also be found in adjacent grasslands. The platypus seems to be relatively common, occupying most streams in the study district. Its diet consists of small aquatic animals and it shelters and breeds in a burrow dug into the stream bank with an entrance usually 1-2 m above water level. The eastern water rat is also present in many streams.

*The squirrel glider*

Species Needing Special Measures

Frankenberg (1971) lists birds and mammals that require additional conservation measures. The public land in this study district could play a significant part in the conservation of seven of these, which are listed and described below.

The squirrel glider *(Petaurus norfolcensis)* occurs at Warrenbayne and in the Reef Hills. This widespread but uncommon animal of Victoria's grey box woodlands and open forest ranges from Horsham along the northern foothills to the Warrenbayne area. It is arboreal and nests in hollow limbs or tree trunks, living on blossoms, sap from stripped branches, insects, and small animals such as birds and rodents.

The king quail *(Excalfactoria chinensis)*, a very rare species in Victoria, has been recorded in the Reef Hills in river red gum open forest. It is nomadic, following the ripening seeds of grasses and various other plants, and builds its nest under a grass tussock or bush.

The turquoise parrot *(Neophema pulchella)*, also very rare in Victoria, frequents stony rises and ridges in open grassy country intersected with stands of timber. It nests in hollows in tree trunks or branches, and has been recorded in the northern section of this district.

The white-browed babbler *(Pomatostomus superciliosus)* is a common insectivorous bird of mallee scrub, open forests, and forest margins in northern and western Victoria. It reaches the edge of its range in this district, where (although uncommon) it frequents the Reef Hills and Warrenbayne foothills. In the former area it appears to use hedge acacia bushes for protection against predators and for nest sites, building in forks about 2m above the ground.

The grey crowned babbler *(Pomatostomus temporalis)* is uncommon in Victoria, living in the northern and western open

forests. Like the white-browed babbler, it frequents open forests and isolated belts of timber such as on roadside reserves or farmland. It forages for insects and nests in trees, up to about 7m from the ground. It has been recorded in the Lurg Hills, and in dry foothill forests near Boho South and Merton, where it reaches the edge of its range.

The dollar bird *(Eurystomus orientalis)* is a rare migrant species to Victoria, where it is found mainly in open forests, particularly along the Murray River valley in northern and north-eastern districts. Nesting takes place in tree hollows. It is regularly observed along the Broken River near Benalla.

The wonga pigeon *(Leucosarcia melanoleuca)* is rather uncommon in Victoria, where it is confined to the forests of eastern and north-eastern parts, but its range extends to eastern Queensland. It lives mainly on seeds of grasses and herbs, native fruits, and insects, and has been recorded in the Warrenbayne and Ryans blocks.

## Significant Species

An additional 13 birds are listed below as significant species for conservation in this district because, within Victoria, each is rare, uncommon, restricted in habitat, or at the edge of its range. Of course it is important to conserve the common birds (and mammals), and this is considered in chapter 15.

### Uncommon birds of peppermint-gum forests

The satin bower bird *(Ptilonorhynchus violaceus)* is mainly confined to forests in eastern Victoria and the Otway Ranges. In autumn and winter the species gathers into small flocks that frequently raid orchards. It builds its nest on a tree branch or in a clump of mistletoe. It has been recorded in Samaria and Hat Hill blocks, but not in the Strathbogie Ranges.

The king parrot *(Aprosmictus scapularis)*, although uncommon in this State, is found in wet open forests from the Otway Ranges through to eastern Victoria. It nests in hollow trees and feeds on native fruits and on seeds of native shrubs and trees. It has been recorded in the Warrenbayne block.

### Birds of the plains, at the edge of their range

The southern stone curlew *(Burhinus magnirostris)*, rare in Victoria, lives in open forests and forest margins. This nocturnal species feeds mainly on insects. It does not build a nest, but lays its eggs on the bare ground. It has been recorded in the Reef Hills and also the Mansfield district.

The black-eared cuckoo *(Chrysoccyx osculans)* is one of our rarest cuckoos.

It has been recorded in the Reef Hills, where it was observed parasitizing a colony of speckled warblers.

Summer visitors

The little friar-bird *(Philemon citreogularis)*, in Victoria, mainly frequents well-watered open forest and woodland areas in northern districts. Its diet consists mainly of nectar, native fruits, and insects. It has been recorded in the Reef Hills and along the Broken River near Benalla.

*The white-throated warbler*

The noisy friar-bird *Philemon corniculatus)* is mainly confined to the northern and north-eastern districts as far as Victoria is concerned. It has a similar diet to the little friar-bird and frequents stream-side trees and foothill forests, although it has also been recorded near Mounts Strathbogie and Samaria in moist open forest.

The white-throated warbler *(Gerygone olivacea)* is a summer migrant to Victoria, where it is regarded as being rather rare. Its strongholds in this State appear to be in east Gippsland and the north-east (including the study district), where it frequents the red stringybark : long-leaf box open forests, hunting insects in the outer twigs and foliage of the tree crowns. It has been recorded in the North Blue Range and the Strathbogie Ranges.

The brush cuckoo *(Cacomantis variolosus)*, a rare summer migrant found in this district, ranges from the Moluccan Islands through Timor and New Guinea to Australia. Common foster parents for the young birds are such species as robins and flycatchers. It has been recorded in the Reef Hills and Blue Range Creek.

Other species of significance

The peregrine falcon *(Falco peregrinus)*, although widespread, is uncommon to rare in Victoria. It nests in rocky cliffs, are frequents lightly timbered country and swamps in search of prey such as

ducks and parrots, which it takes on the wing. It has been recorded in the Warrenbayne and Dry Creek blocks.

The barking owl *(Ninox connivens)*, rare in Victoria, occurs in lightly timbered areas. It usually nests in hollow trees and subsists largely on small mammals, insects, and yabbies. It has been observed in red gums along roadsides and stream margins in the district and has also been recorded in the Reef Hills.

The spotted harrier *(Circus assimilis)* is a widespread but rare hawk in Victoria that has been recorded in the Reef Hills and Benalla area. It frequents open forest, grasslands, and croplands (mainly in northern districts) and nests in thick bushy trees.

The powerful owl *(Ninox strenua)* occurs rarely in Victoria, and is confined to heavily timbered country. Its main diet consists of possums and gliders, but it may also take rabbits and birds. The nest site is a hollow in a large tree. This owl, the largest in Australia, often roosts during the day in a blackwood or similar tree. It has been recorded at Mount Wombat.

The red-browed tree creeper *(Climacteris affinis)* is a rare species, which in this State is confined mainly to moist open forests and adjacent areas in eastern and central Victoria. It has been recorded in the Hat Hill, Samaria, and Bunston blocks.

### Introduced Birds and Mammals

Of the introduced birds recorded in the district, the house sparrow is common on farmlands and in towns, the tree sparrow frequents towns, and the goldfinch and starling are common throughout the district, as is the blackbird. Introduced mammals are the rabbit, sewer rat, black rat, house mouse, fox, feral dog, feral cat, goat, pig, and sambar deer *(Cervus unicolor)*. Most of these are considered to be pests, but feral goats and pigs may also be considered as game animals. Deer, including the sambar deer, are accepted as game species.

## Reptiles and Amphibians

Published information on the reptiles and amphibians of the district has proved to be sketchy and out-dated. Two reconnaissances of reptiles and amphibians were carried out, one under P.A. Rawlinson and the other by the National Museum staff. As with North-East District 1, most attention was directed towards the reptiles, and the data presented below are mainly the result of work carried out over the last year.

### Zoogeographic regions

Australia has been divided into four zoogeographic sub-regions, based on

animal distributions. Each has a characteristic fauna. Two of them, the Eyrean and Bassian, are represented in Victoria, and the boundary between these falls at about the 510-mm isohyet. The Bassian sub-region has been subdivided into warm temperate, cool temperate, and cold temperate zones based on climate, the main factor being temperature.

The warm temperate zone includes the inland margins of the Eastern Highlands, with elevations generally less than 300 m, average rainfalls less than 760 mm per annum, and a vegetation canopy of low density - for example woodland, open woodland, or grassland.

The cool temperate zone includes the Eastern Highlands below 1,200 m, with low surface temperatures and annual rainfalls of more than 760 mm. The vegetation includes open to closed forest.

The cold temperate zone consists of alpine and sub-alpine areas above 1,200 m, with very low temperatures, high precipitation (much of which falls as snow), and vegetation varying from closed to open forest to herbfields.

## The Study District

The district receives more than 510 mm average annual rainfall and therefore is included in the Bassian sub-region. However, no major physiographic barriers separate this area from the adjacent Eyrean sub-region. The map drawn by Rawlinson (1971) shows that most of the district lies in the warm temperate zone, although the cool temperate is represented in the higher, wetter, and more densely vegetated areas, especially in the Blue Range and further to the east.

The zoogeographic distribution of the reptile fauna is summarized in Appendix III. Of the 36 species recorded, 16 are exclusive to the Bassian in Victoria, 9 are transitional from the Bassian to the Eyrean and 11 are transitional from the Eyrean to the Bassian. The presence of exclusive Bassian species and the absence of any exclusive Eyrean species show that both the area and the nature of the reptile fauna are Bassian. However, the 11 transitional species indicate a much greater degree of Eyrean faunal intrusion into the district than was evident in North-East District 1 (which only contained 4 such species). The stronger Eyrean component is caused by the generally lower rainfall, the more open vegetation forms, and the large rocky outcrops in this district.

Warm and cool temperate Bassian zones are included in the district, and investigations have revealed a transition zone between the two in the Hat Hill block. Of the 36 recorded species, 30 occur in the warm temperate zone and 12 in the cool temperate. Thus the former zone has by far the greatest diversity.

The reptile fauna is very different from that of North-East District 1 and is a unique assemblage in Victoria. It comprises 21 of the 25 species found in District 1, plus an additional 15 species. As the areas of the two districts are similar and collecting techniques etc. were comparable, this difference is an important one. Five of the reptile species found are rare in Victoria and are known only from small, isolated populations.

Recent taxonomic work has revised some of the Victorian species discussed in Rawlinson (1971). As the reptiles concerned occur in the study district, the changes are listed below:

After Coventry (1971) the species *Denisonia nigrostriata* is synonymized with *D. brevicauda*, and *Denisonia gouldi* changes to *D. dwyeri;* after Smyth (1972) the species *Morethia lineoocellatus* in Victoria is separated into three species, *M. adelaidensis*, *M. boulengeri*, and *M. lineoocellata;* and after Whitten (1972) the species *Amphibolurus muricatus* in Victoria is separated into two species, *A. muricatus* and *A. nobbi coggeri*.

Although the amphibian survey is very incomplete, it appears that the district contains only one rare species, *Hyla maculata*. All other amphibians recorded are fairly widely distributed in Victoria and the fauna closely resembles that of North-East District 1.

Habitats

The vegetation units represent different habitats and have been divided into seven categories. Appendix III indicates the occurrence of the 36 reptile species in these major habitats, which can thus be graded in order of diversity of reptile species and therefore in order of importance to reptiles. This produces a very different order from that found for similar divisions in North-East District 1, where wet and dry open forests contained the most reptile species. In District 2 low scrub and rocky areas carry the most diverse reptile fauna by far (22 species, 7 of which are restricted to this habitat), followed by woodland (13), dry open forest (12), wet open forest (11), forest margins and semi-cleared land (7), grassland (6), and finally wetlands (5). The major reason for this gradient is the need for suitable thermal areas during activity (basking sites etc.) and shelters during inactivity.

As was the case in North-East District 1, no comparative data on the amphibians are available, but once again it is possible to state that almost the reverse situation would apply. About 13 species occur in the area and the greatest diversity would be in the wetlands (approximately 12 species, including the rare *Hyla maculata*, and the least diversity would be in the low scrub and rocky areas (probably only 4 species). The major reason for this

gradient is the need for free water for breeding and prevention of desiccation.

Endangered and significant species

As previously mentioned, five of the reptile species found in the district - the stone gekko, four-fingered skink, copper-tailed skink, carpet python, and bandy-bandy snake - are rare in Victoria and restricted to small isolated populations. The copper-tailed skink is fairly common and extensive in south-eastern New South Wales, but all the others are restricted in distribution outside Victoria and can be considered as endangered species.

In addition, three species - the sand goanna, lace lizard, and carpet python - reach a large size. The adult size alone makes populations of these species highly susceptible to habitat changes (they can have very large territories) and also to human interference (collecting for pets etc.). The sand goanna and carpet python reach the eastern limit of their range in the district.

*Hyla maculata* can be considered as an endangered species. The only known Victorian (and Australian) localities for this species (Copland 1961) are: Glenrowan, Lightning Creek, Omeo Highway, Woods Point, and Poowong.

Conservation of vegetation along stream banks in the Lurg block would be essential to maintain this species in the Glenrowan area.

## Fish, Arthropods, and Molluscs

The main river systems in the district are the Broken River and its tributaries (which include Ryans, Hollands, and Moonee Moonee Creeks); Seven Creeks; smaller streams that contribute to the Goulburn River, such as Hughes, Creightons, and Honeysuckle Creeks, and the tributaries to Lake Eildon, which include Brankeet, Tallangalook, Doolam, and Ford Creeks. Storages include Lake Nillahcootie and the Bonnie Doon arm of Lake Eildon.

Little is known of the smaller native fish in these systems. Game fish in streams and storages are predominantly the introduced species red fin, *(Perca fluviatalis)* brown trout, *(Salmo trutta)*, and rainbow trout *(Salmo gairdneri)*. Crucian carp *(Carassius carassius)* are also present in some waters. Introduced species have replaced some of the native ones to a considerable degree, and other native species may have had low population numbers before introduction of alien fish.

The most significant species in the district is the trout cod *(Maccullochella macquariensis)*, a rare and endangered species confined to the Seven Creeks and

a small lake near Beechworth. However, it may also occur in the upper Murray River system. Application has been made to have it placed on the world list of endangered species. Two other seriously threatened species are the macquarie perch and river blackfish. These also occur in the Seven Creeks. Macquarie perch are present in low numbers in Ryans Creek, Hollands Creek, Lake Nillahcootie, and Lake Eildon. River blackfish are present in Hughes and Creightons Creeks, the Broken River, and Ryans and Hollands Creeks.

The arthropods include such groups as arachnids (spiders, scorpions, mites, ticks, etc.), crustaceans, insects, and myriapods (centipedes, millipedes, etc.).

These groups all play a significant part in the ecology of most temperate environments. Insects are particularly important from an economic point of view. Some can damage and destroy crops, harm or kill domestic animals, or transmit diseases of plants and animals (including Man). Beneficial aspects include use of the honey-bee for honey production, control of pests, (plants and animals), and pollination of plants by bees and nectar-seeking blow-flies, beetles, and moths.

Insects are related to other members of the biological community in a number of ways. Plants, for instance, provide food for a wide range of insects. Some insects, such as the Australian sawflies (Pergidae), the spur-legged phasmatid *Didymuria violescens*, and the Australian plague locust *Chortoicetes terminifera*, are leaf-eaters. Some (aphids, scale insects, lerps, bugs, leaf-hoppers, and thrips), suck plant sap, and others form galls or attack the bark and wood of living or dead trees. This latter group includes jewel bettles, longicorns, weevils, ambrosia beetles, termites, and the larvae of various wood moths.

The action of insects in assisting the decomposition of dead wood, plant debris, fungi, animal cadavers, and faeces contributes a great deal to the cycling of nutrients.

Insects form an important part of the diet of a considerable number of terrestrial and fresh-water vertebrates. The Australian fauna includes a number of exclusively or largely insectivorous species, such as the echidna, the long-nosed bandicoot, Swainson's and brown antechinuses, and most species of bats. Many fish feed on aquatic insects, including caddis-flies, dragon-flies, and stone-flies.

Many invertebrates are also insectivorous. Spiders for example subsist mainly on insects, and many other arachnids and myriapods prey largely upon them.

Molluscs include terrestrial forms - such as land snails, slugs, and small

carnivorous snails - and the aquatic forms found in creeks, billabongs, and dams - such as fresh-water snails, the fresh-water limpet *(Ancylus tasmanica)*, and bivalves, which include the fresh-water mussel *(Velesunio ambiguus)*. Each plays a part in the food chain; for instance terrestrial molluscs are eaten by some birds, such as the lyrebird. Fresh-water molluscs form part of the diet of a number of birds and mammals, including herons, spoonbills, black duck, mountain duck, eastern swamphen, eastern water rat, and the platypus.

In the study district

Lack of knowledge makes it impossible to fully evaluate the arthropods and molluscs of the district, but collection and description are continuing.

Crustaceans of the district include the Murray crays *(Eustacus armatus* and *E. elongatus)*, which are found in most river systems, and the common yabbie *(Cherax destructor)* and white yabbie *(C. albidus)*, which are found in static water such as in billabongs and dams.

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# LAND SYSTEMS

Differences between land systems, and their consequent suitability for various uses, exist because of differences in topography, soil parent materials, climate, soils, and the organisms (both plant and animal) on them. But no one factor alone determines land use; it is their combined effect that controls the uses to which the land may be put.

The previous sections have described these environmental factors separately. This section brings them together to facilitate an understanding of different types of land.

The fundamental land unit in the sense described above may be regarded as an area in which the environmental factors do not vary enough to significantly influence any of the likely forms of use. To this extent they are subjective. Such a unit may be a section of a ridge-top. Because these units may be, and frequently are, small (say 5-20 ha), it is practical to define combinations of units for management purposes and as an aid to mapping. In the larger unit, such as a shallow basin of the order of 100 ha or more, the fundamental units show a predictable pattern - for example ridge-top site to basin floor site.

As an aid to mapping and general description, these larger units may be further grouped, as has been done for this report, into mapping units termed land systems.

Rundle and Rowe (in press) have described these. The land systems recognized in the Broken River catchment have been provisionally applied to the whole study district. These are presented in the Land Systems map opposite, and Table 11 lists the environmental factors associated with each.

Chapter 13 (Hazards) and Part IV of the report (Block descriptions) further consider the effects of the interacting environmental factors on land use. It should be pointed out, however, that the relations between the factors may be very much more complex than is at present known, and to a certain extent the present understanding is strongly influenced by experience.

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Table 11 LAND SYSTEMS

| Land System | Landscape | Annual Rainfall and Water Source | Geology | Major Soils | Native Vegetation | Erosion Hazard | Percentage remaining public land |
|---|---|---|---|---|---|---|---|
| Archerton | Rolling plateaux at about 760-1,100 m elevation | 1,140 mm to over 1,270 mm High water level | Tertiary basalt and phonolite | Friable reddish gradational soils (with well structured subsoils) | Narrow-leaf peppermint open forest III and messmate stringybark open forest III | Low; some likelihood of minor rilling on tracks | 70 |
| Wrightley | Steep slopes 300-700 m; plateau at 600-700 m | 750 mm to over 1,140 mm Low water yield | Cambrian greenstones and cherts | Friable reddish gradational soils (with well-structured subsoils); weakly bleached friable gradational soils and undifferentiated stony loams on some steep slopes | Narrow-leaf peppermint open forest III and broad-leaf peppermint : red stringybark open forest II | Low on plateau, high sheet erosion hazard on steep westerly slopes, mass movement hazard on steep slopes | 25 |
| Tolmie | Rolling, dissected plateaux and broad ridge tops from 500 to 1,100 m elevation | 1,020 mm to over 1,270 mm A source of useful water | Lower Carboniferous sedimentary rocks | Mainly reddish and yellowish duplex soils; some weakly bleached friable gradational soils and undifferentiated stony loams | Broad-leaf peppermint : candlebark open forest II and narrow-leaf peppermint open forest III; some messmate stringybark open forest III and mountain swamp gum open forest II | Generally low; some hazard of sheet erosion on ridge tops | 50 |
| Cambatong | Deeply dissected headwaters with steep slopes from 500 to 1,100 m elevation | 1,020 mm to over 1,270 mm A significant water source | Lower Carboniferous sedimentary rocks | Friable brownish gradational soils; weakly bleached friable gradational soils on foothills, undifferentiated stony loams on ridges and steep westerly slopes | Narrow-leaf peppermint open forest III; broad-leaf peppermint: candlebark open forest II, messmate open forest III, alpine ash open forest IV, candlebark : snow gum open forest I and broad-leaf peppermint : red stringybark open forest II | High sheet erosion hazard on steep slopes, otherwise low | 90 |
| Table-top | Long slopes and flat-topped ridges dissected by steep gullies - from 400 to 900 m elevation | 760 mm to 1,140 mm Little useable water | Lower Carboniferous sedimentary rocks | Yellowish duplex soils, weakly bleached friable gradational soils and undifferentiated stony loams | Broad-leaf peppermint : red stringybark open forest II, red stringybark : long-leaf box : red box open forest I and II; some narrow-leaf peppermint open forest III | Low erosion hazard on gentle lower slopes and plateaux; on other slopes high sheet, tunnel, and gully erosion hazards | 25 |
| Mansfield | Plain and associated questas and flat-topped ridges from 280 to 600 m | 630 mm to 760 mm Little useable water | Lower Carboniferous sedimentary rocks and Quaternary alluvium | Gilgaied yellowish duplex soils; weakly bleached friable and also massive gradational soils; some friable brown and reddish gradational soils on more dissected landscapes | River red gum open forest II | High stream and gully erosion hazard | 1 |
| Tiger Hill | Undulating plateaux and gentle slopes at elevations ranging from 500 to 900 m | 1,020 mm to 1,270 mm A major water source area | Upper Devonian acid volcanics (rhyolites and rhyodacites) | Friable brownish gradational soils; some friable reddish gradational soils (with weakly structured subsoils) | Messmate stringybark open forest III and narrow-leaf peppermint open forest III, mountain swamp gum open forest II | Low erosion hazard; disturbance by logging and roads may cause erosion | 75 |
| Loombah | Dissected foothills arising from about 300 m elevation to broad ridges to about 550 m and Mt. Samaria | 760 mm to 1,270 mm A minor water source area | Upper Devonian acid volcanics | Friable brownish (and yellowish) gradational soils, friable reddish gradational soils (with weakly structured subsoils) on broad ridges; yellowish duplex soils on slopes and foothills | Red stringybark :long-leaf box : red box open forest II and broad-leaf peppermint : red stringybark open forest II, narrow-leaf peppermint open forest III | Low erosion hazard on broad ridges, high hazard on steep northerly slopes; moderate sheet and gully erosion hazard on foothills | 40 |
| Strathbogie | Rolling to hilly plateaux at about 450-900 m | 630 mm to 1,270 mm A substantial source of water with slow delivery | Upper Devonian granite | Reddish duplex soils; weakly bleached friable gradational soils, friable reddish gradational soils (with weakly structured subsoils) | Messmate stringybark open forest III and IV, narrow-leaf peppermint open forest III; some mountain swamp gum open forest II | Generally low hazard; moderate stream-bank erosion hazard | 15 |
| Moonee -Moonee | Dissected slopes of high relief rising from about 240 m to 1,000 m | Less than 630 mm to 1,270 mm Major water source with slow delivery and significant summer flows | Upper Devonian granite | Reddish duplex soils; friable brownish gradational soils, reddish gradational soils (with weakly structured subsoils) | Narrow-leaf peppermint open forest III, broad-leaf peppermint: red stringybark open forest II, red stringybark : long-leaf box : red box open forest I and II; some messmate stringybark open forest III and IV, heaths and mossland | Low erosion hazard generally, moderate sheet erosion hazard on foothills and some steep slopes | 60 |
| Moorngag | Dissected slopes of high relief rising from about 300 m to 900 m | 760 mm to 1,140 mm Minor water source area | Devonian - Silurian sedimentary rocks | Weakly bleached friable gradational soils; friable reddish gradational soils (with weakly structured subsoil, friable brownish gradational soils, reddish and yellowish duplex soils) | Red stringybark : long-leaf box : red box open forest I and II, broad-leaf peppermint ; red stringybark open forest II; some narrow-leaf peppermint open forest III | High sheet erosion hazard on northerly aspects, low to moderate where rainfall is high | 15 |
| Swanpool | Rolling hills of low relief at about 230-360 m; valley slopes and floors at about 200 m | Less than 630 mm to 1,020 mm Useful water source | Upper Devonian granite and Quaternary alluvium | Yellowish duplex soils; weakly bleached friable and also massive gradational soils | Red stringybark : long-leaf box : red box open forest I and II, red gum open forest II | Generally low erosion hazard; moderate hazard in the west where rainfall is lower | 5 |
| Warby | Isolated hills from about 300 to 400 m in elevation | Less than 630 mm to 760 mm Low water yield | Silurian granite | Coarse sandy loams; weakly bleached friable and also massive gradational soils, some friable brownish gradational soils on hills | Blakely's red gum open forest I | Moderate sheet erosion hazard on steep slopes | 10 |
| Lurg | Rolling hills to undulating topography at about 170-450 m | 630 mm to over 760 mm Low water yield | Ordovician and Devonian Silurian sedimentary rocks | Undifferentiated stony loams on westerly slopes, reddish duplex soils on easterly slopes; weakly bleached, friable and massive gradational soils | Grey box open forest II red stringybark : long-leaf box : red box open forest I and II; some river red gum open forest II | High to moderate sheet erosion hazard on slopes, moderate stream-bank and gully erosion hazard | 10 |
| Benalla | Plain and broad valleys at about 170-350 m | 630 mm to 1,140 mm Low water yield | Quaternary alluvium | Friable reddish gradational soils (with weakly structured subsoil) and weakly bleached friable gradational soils on gentle slopes; yellowish duplex soils (some gilgaied) and reddish duplex soils on plain | River red gum open forest II and grey box open forest II | Generally low hazard, some gully erosion hazard on gentle slopes | 2 |

LAND CONSERVATION COUNCIL
VICTORIA

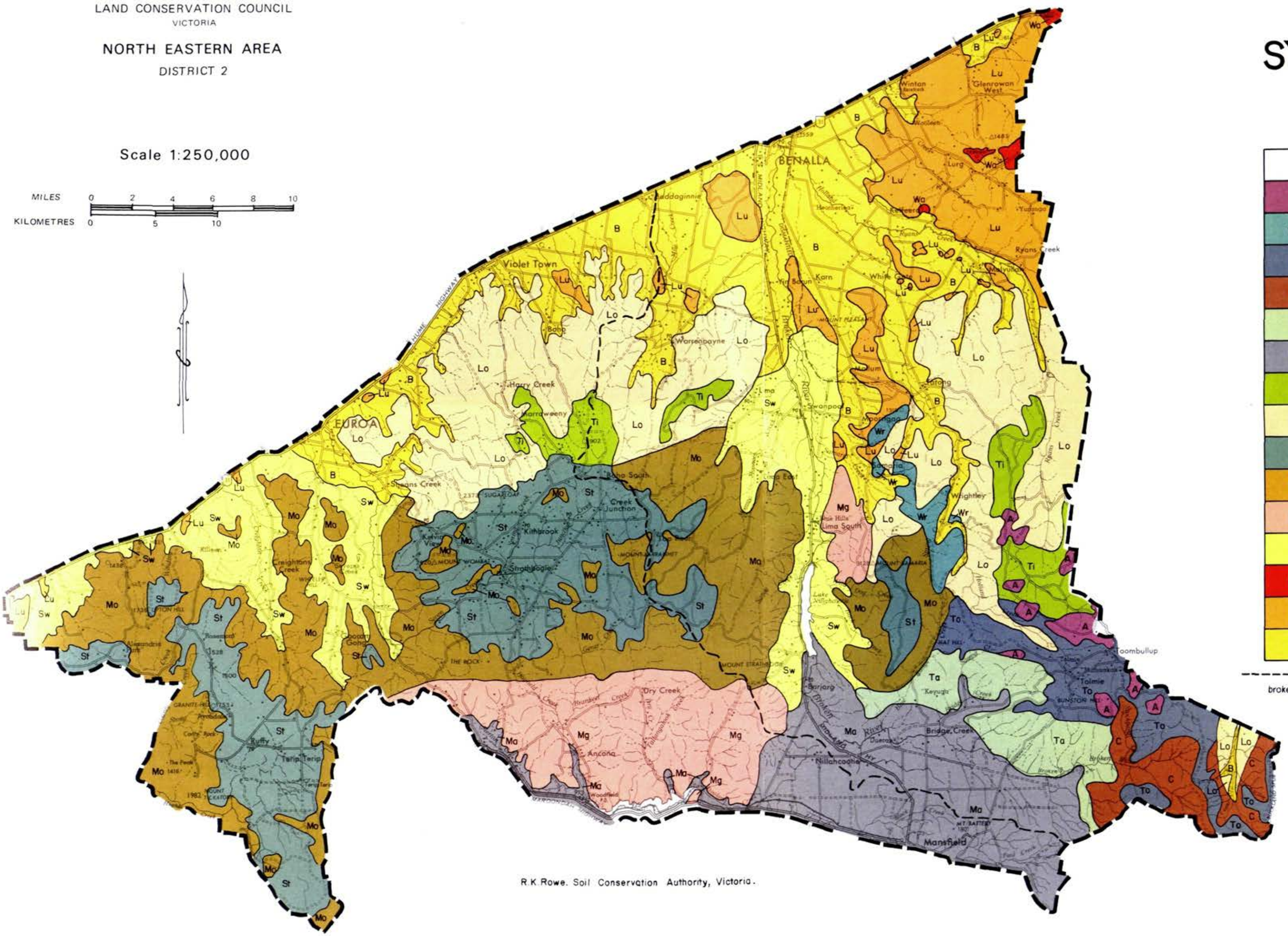
NORTH EASTERN AREA

DISTRICT 2

Scale 1:250,000

MILES 0 2 4 6 8 10

KILOMETRES 0 5 10




R.K.Rowe. Soil Conservation Authority, Victoria.

# LAND SYSTEMS

## LEGEND

| Land System | |
|---|---|
| A | ARCHERTON |
| Wr | WRIGHTLEY |
| To | TOLMIE |
| C | CAMBATONG |
| Ta | TABLE-TOP |
| Ma | MANSFIELD |
| Ti | TIGER HILL |
| Lo | LOOMBAH |
| St | STRATHBOGIE |
| Mo | MOONEE MOONEE |
| Mg | MOORNGAG |
| Sw | SWANPOOL |
| Wa | WARBY |
| Lu | LURG |
| B | BENALLA |

– – – – Land System boundaries to west of broken line are provisional only

# PART III

# LAND USE

# HAZARDS

A hazard in relation to the use of land may be defined as anything that threatens to reduce the land's ability to produce the chosen products at a satisfactory quality and at a sustained level, and may also threaten the productivity of adjacent land.

Some hazards arise from accidents or as an indirect consequence of a seemingly beneficial action, but some result from deliberate action, taken without consideration of the known consequences.

Because of the interdependence of the environmental factors, a change in one usually produces changes in others until a new stable relation is attained. The readjusted condition may be more or less productive. Of the factors considered in Part II, only soil, vegetation, and fauna are readily changeable. However, small changes in topography - such as gully erosion or construction of roads and dams - can also be readily made, and these in turn can affect the hydrological condition of the land.

It is possible to indicate a number of basic causes of deterioration in land productivity. These may act through the soil, the vegetation, the fauna, or the hydrological condition of the land.

## Hazards affecting soil

Soil is a basic resource. It cannot be replaced, and many of its attributes are subject to damage, which may not be easily remedied. Soil erosion is a hazard to most forms of land use and some of its effects are discussed below. It occurs in different ways and the hazards of these occurring are summarized in chapter 12 (Land Systems) Table 11.

The nutrient status of the soil may be reduced, the most obvious cause being sheet erosion, which removes the surface soil - where plant nutrients have become concentrated, either by biological activity or by fertilizer application. However, loss of nutrients may also occur if the natural recycling process is disturbed in such a way that the rate of release of nutrients from organic or mineral combinations increases to exceed the rate of uptake by plants. This may result from frequent burning or excessive cultivation. Nutrient capital may also be removed in the produce of the land, and this occurs under intensive cropping.

Soil moisture status may deteriorate, and again the most obvious cause is soil erosion, which may reduce the depth of the soil or, as in gully erosion, cause excessively free drainage. Increased subsurface drainage may also be expected from above side-cut roads in steep country. Breakdown of surface structure and compaction of the surface - such as may result from stock trampling or vehicular trafficking - can prevent the infiltration of water and reduce the moisture available to plants. In this case, surface run-off and erosion are also likely.

Excessive wetness results from a change from deep-rooted vegetation to plants that do not effectively utilize the available soil moisture. It may occur anywhere, but is more likely in higher-rainfall areas. It may simply reduce the area's accessibility or productivity, but may also lead to erosion of drainage lines and is the principal cause of mass movement erosion.

Chemicals can cause soil deterioration. Widespread and excessive use of insecticides to control pasture pests could destroy beneficial soil fauna. This could result in the locking up of nutrients in plant remains (which these animals normally decompose), leading to a drop in soil fertility.

Excessive applications of fertilizers can also have some detrimental effects. For example, heavy applications of lime can induce manganese deficiency in some soils.

Hazards affecting vegetation

Next to the deliberate clearing of native vegetation by Man, fire is the most destructive agent and may so damage a plant community that its character is completely changed. However, most native plants are resilient to fire damage and will recover in time. The effects of fire on nutrient availability and on soil physical condition could also cause changes in vegetation, but little is known of the nature and duration of such changes.

Undesirable plants may become successful competitors with the desired vegetation (native or introduced) and may reduce its value or even cause its elimination.

Animal pests may utilize the vegetation. The rabbit - the best-known example of such an animal pest - has had drastic effects on both native and introduced vegetation. Unregulated grazing animals in general may provide a similar hazard.

Insects may also be a hazard. For example, leaf-eating insects attack eucalypt forest, pastures, and crops. Wood-boring insects as well as leaf-eaters can reduce productivity in timber producing forests.

Disease constitutes another hazard. Pathogens such as fungi may be the prim-

ary agents in causing vegetation deterioration. However, some diseases are secondary, being induced by soil deficiencies or toxicities.

Hazards affecting fauna

Because of their dependence on habitat, which provides food and shelter, fauna are subject to a range of hazards similar to those listed for vegetation. The deliberate or accidental alteration or total destruction of habitat thus constitutes a major hazard.

Fire can be a most destructive agent and the recovery of animal populations may be slow, particularly if the fire covers large areas and/or the animals have low reproductive capacities.

Competition for habitat and food from animal pests is a major hazard. The rabbit and domestic animals rank foremost in this regard. Moreover, the larger introduced carnivores prey on native animals.

Deliberate or indiscriminate use of poisons (including pesticides, which may become concentrated in animal tissues *via* the food chain) poses hazards to all animal life, and these are frequently difficult to trace to their source.

Hazards affecting water resources

Changes in the quality, quantity, or flow regime of streams are closely associated with changes in vegetation or soils. In particular, all three stream characteristics can be altered by manipulating vegetative cover in the catchments. Depleted ground cover may result in rapid surface run-off, which leads to sediment-laden flash floods. Total yield may be increased, but both quality and regime suffer. The change from deep-rooting to shallow-rooting vegetation can increase water yield, as can the destruction of vegetative communities that draw upon the water table, particularly in summer, but associated undesirable changes in soil stability may occur.

Flooding of permanent streams may be accentuated by changes in vegetation on the catchments, and a decline in base flows is usually accompanied by an increase in flood peaks.

Contamination of surface water by discharge of pollutants is a hazard usually associated with settlement, particularly where industrial development occurs. Contamination of groundwater may also occur. As alluvial deposits are located in an intake region for both shallow local aquifers and the deeper aquifers of the Murray basin, care should be taken to minimize infiltration of potential pollutants such as pesticides.

## Present Condition of the Land

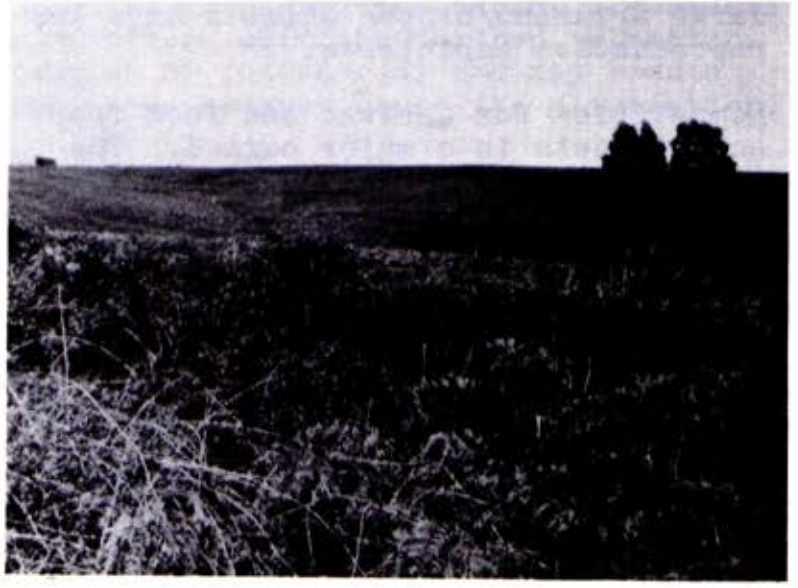
A complete understanding of the interrelations between the environmental

*Track erosion of weakly bleached massive gradational soil in the Loombah land system*

variables would enable one to predict changes that would cause a decline in productivity. However, at present (to a large extent) knowledge of the existence of hazards to land use comes only from experience. Consequently, a knowledge of the present condition of the land in relation to the way in which it is used has great value.

Soil erosion

Most forms of soil erosion are evident in the district, but erosion is serious in only a few areas. In some localities in the Table-top land system, steep slopes and highly erodable soils lead to slumping and gully erosion; the Mansfield land system has suffered considerable stream and gully erosion, due to excessive run-off from adjacent land systems; the Lurg land system suffers some sheet, streambank, and gully erosion; and in the Benalla land system serious stream-bank erosion is evident.



*Soil erosion is evident on this bracken and blackberry-covered land near Archerton*

## Fire

The forested public lands of Victoria are recognized as one of the world's most fire-susceptible areas. Fire hazard is related to the total amount of fuel available for burning, its combustibility at a given time, and the likelihood of fire starting.

Within this study district, conditions of terrain, long dry summers, and inflammable vegetation cover result in a fuel type capable of burning with great intensity during many months of the year. Fire behaviour is most severe on exposed aspects and steep slopes. Fires have occurred here regularly since settlement and the entire area has been burnt at one time or another, lightning having always been a causative agent. Major fires in the Strathbogie Ranges occurred in 1913/14 and again in 1942. Indiscriminate burning in and around private holdings, motivated by clearing and grazing interests, has given way to full community co-operation and help in fire situations. Illegal lighting in forests is largely a habit of the past.

In an endeavour to minimize the damage and extent of wildfires, the responsible fire-fighting authorities rely on pre-suppression (reducing the hazard by low-intensity burning under safe conditions), the ready detection of wildfire outbreaks, and up-to-date suppression methods using skilled fire-fighting forces and efficient equipment.

Fire dams, roads, and fuel-reduction burning are concentrated around forest assets and along forest margins to ensure the protection of the community from the threat of fire.

## Flooding

Flooding's main effects are felt in the city of Benalla, where it may inundate buildings and disrupt traffic. Effects on agricultural production are minor. Flooding of the Broken River near Benalla is indicated when the river gauge level at Casey's Weir rises above 3 m.

*Flooding of the Broken River at Benalla prior to the construction of Lakes Nillahcootie and Mokoan*

On this basis flooding was expected every 1.5 years, but will probably occur less often in the future because of the flood-mitigation effects of Lake Nillahcootie-Lake Mokoan. For a 4-m gauge level, flooding was expected once every 2.7 years. Analysis of long-term records indicate that July, August, and September are the most likely months for flooding to occur.

Floods depend on the following hydrological factors: the production of run-off, its concentration in the main channel, and channel condition. In this district it appears that floods occur when heavy or sustained rain falls and causes substantial surface run-off from the lowlands, which then supplements the high winter flows derived from the highlands. The rapid surface run-off from the lowlands is helped by the generally poor condition of pastures about August and the poorly vegetated drainage lines. Concentration in the main channel (the Broken River) is accentuated by the change from broad deep channels south of Moorngag to the more restricted channel of the Broken River. The following land systems are likely to contribute most to floods: Mansfield, Tolmie, Table-top, Lurg, and Benalla.

## Biological Hazards

Diseases and pests affect agriculture, timber production, and native plant and animal communities in the district. Internal parasites and footrot pose some hazards to sheep production in the cooler higher-rainfall areas.

### Pest animals

Up to the present, no reliable estimate has been made of the effects of wild dogs, foxes, and feral cats on native animal populations. However, Coman (1972) has recorded the diets of these animals. The largest component of the diet of dingoes and feral dogs in eastern Victoria was native mammals (45% by volume), comprising - in order of decreasing importance - the black wallaby, common wombat, eastern grey kangaroo, brush-tailed possum, greater glider, and echidna. Introduced animals such as rabbits, sheep, cattle, rats, and mice provided a relatively minor food source. Birds and reptiles were of secondary importance in the diet.

Dingoes and feral dogs occur only in a limited part of the study district - mainly the Bunston block. Although they live in forest, they will travel long distances to feed. They occasionally attack sheep and calves, but mainly live on native mammals, particularly wallabies and wombats. The hazard to sheep production is highest in the Barragunda and Tolmie localities.

Trapping and to a lesser extent poisoning partially control them. Population numbers remain fairly constant, however, because of the continual accretion from domestic dogs running wild.

Dingoes and feral dogs may be important hosts in the transmission of parasites affecting domestic livestock. The effect of predation on native mammal populations is unknown but could be significant.

Foxes, being opportunist feeders, will eat whatever food is available. They are generally found throughout the area, frequently on the fringe of agricultural land but also in forest. Table 12 shows results of investigations by the Keith Turnbull Research station staff into the feeding habits of foxes collected there.

Native mammals form an important part of the diet, particularly if the availability of sheep, rabbit, and other food items is low, as it appears to be in this

Table 12

MAJOR FOOD SOURCES OF FOXES IN AND ADJACENT TO THE STUDY DISTRICT

| Source | % Occurrence | % Volume * |
|---|---|---|
| Mammals: Rabbit | 29.40 | 13.91 |
| Sheep | 23.53 | 9.30 |
| Mice | 5.88 | 0.66 |
| Native mammals | 20.58 | 52.79 |
| Other | 11.76 | 0.59 |
| Birds | 14.70 | 5.39 |
| Insects | 44.12 | 12.72 |
| Herbage | 64.70 | 1.97 |
| Other items | 14.70 | 2.64 |

* Volume of food item as percentage of total volume

district, and this predation should be viewed with concern. While rabbits also make a substantial contribution, it is doubtful if foxes have any significant effect upon their population. Sheep in the diet is probably carrion, although foxes do kill lambs.

Rabbits occur mainly on freehold properties, but are found in low numbers throughout forest areas wherever they have cover and grass for feeding. Their numbers are kept at a low level by the combined effects of poisoning with 1080 on baits, myxoma virus, and the ripping and fumigation of burrows. Numbers only build up under unusual seasonal conditions such as occurred this year (1973), when kitten mortality was low, lack of mosquitoes made myxoma inactive, and the breeding season was extended.

Rabbits present a serious hazard: for apart from the loss of pasture on farms, they can destroy small trees in forestry operations and aid erosion through burrowing and destruction of vegetation.

Feral cats are widespread throughout the study district. They feed mainly on mice and rabbits, but predation probably exerts little influence on the rabbit populations. Cats also prey on native mammals and this is probably more common in undisturbed forest habitat. Since low population densities are characteristic of many of our smaller mammals, this predation may be significant. Birds, insects, reptiles, and herbage form only a very small part of the cats' diet.

Feral pigs are mainly concentrated in the Ryans Creek and Stockyard blocks of the study district, where they constitute a hazard to the water supply. They may live on the fringe of farmland, causing damage by rooting up pastures and crops, or in the forest, feeding on vegetation (e.g. roots and berries), insects, and carrion. They tend to frequent swampy areas, where they dig for roots and so pollute the water with sediment and bacteria.

Wombats are normally not regarded as pests, but can cause damage of local importance, mainly by knocking down fences as they move from their burrows (often on public land) to feed on pastures and crops. Broken fences open the way for other animals - such as wallabies, kangaroos, wild dogs, foxes, and rabbits - to enter the property and cause damage. Wombat burrows in gullies are also potential sites for erosion. Control is achieved by fumigating on and close to private land.

Pest plants

Pest plants occur mainly on, or adjacent to, the privately owned land. Most have been declared noxious weeds. They are found in hilly inaccessible areas and on properties where the management is poor. Although blackberries, sweet briar, and St. John's wort are mostly being kept

under control in the area, they require constant attention and pose a threat to any areas disturbed by Man.

A survey carried out in 1970 found 42 noxious weeds in the area. (Table 13 lists 36 of these, while Table 14 indicates the habitats of the main ones.)

Noxious weeds have not colonized undisturbed native vegetation and therefore are seldom found in the forested areas, except along some creeks and gullies, public land leased for grazing, and also former homestead sites, roadsides, and log landings. However, they have the potential to invade and become major problems should further disturbance occur and if current control measures are relaxed.

Blackberry is widespread throughout the area because of its efficient reproduction, rapid growth rate (which enables it to compete with other plants and to recover from damage), and prickles (which tend to protect it from grazing). It is prevalent along some streams, where it forms dense impenetrable thickets, and so is regarded as a problem by conservationists, fishermen, and farmers. It also harbours vermin such as rabbits. On agricultural land the problem occurs on inaccessible country where control cannot be carried out and on poorly managed country. Spraying with 2,4,5-T or picloram has kept most infestations under control, but many areas of public

*Blackberries invading abandoned farmland near Bunston Hill*

land are inaccessible and so are not treated.

Sweet briar occurs widely on agricultural land in the district and frequently on roadsides. Some dense patches occur in clearings and on abandoned farm sites. Birds occasionally spread plants from private to public land. Control on agricultural land is hampered on rocky

A. Widespread C. Infrequent

B. Scattered * Rare

Table 13

INCIDENCE OF NOXIOUS WEEDS

| Species | Ruffy | Wombat | Warrenbayne | Reef Hills | Lurg | Stockyard | Ryans | Hat Hill | Bunston | Dry Creek | Toorour | Samaria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bathurst burr | * | * | * | * | C | * | * | * | * | C | * | * |
| Bindweed | B | | * | * | * | | | * | | C | | * |
| Blackberry (Italian) | | C | C | B | C | A | A | A | C | * | * | C |
| Blackberry (cutleaf) | * | B | B | * | * | A | A | A | | | | * |
| Boxthorn | | * | * | * | * | | | * | * | | | * |
| Caltrop | * | | * | * | * | | | | * | | | |
| Cape broom | * | | * | | * | | | * | | * | | * |
| Chinese scrub | C | * | * | * | | | | * | | * | | |
| Fennel | | | | * | | * | | | | | | |
| Furze | * | * | * | * | | * | | * | * | C | * | * |
| Great mullein | * | | | * | * | * | * | * | | B | * | |
| Hawthorn | C | | * | * | * | * | | * | * | B | * | * |
| Hemlock | * | * | * | * | * | * | * | * | * | | | * |
| Hoary cress | * | | | | * | | | | * | | | |
| Horehound | C | B | B | * | * | * | * | * | * | * | | * |
| Nut-grass | * | | * | * | | | | * | | | | * |
| One-leaf Cape tulip | * | | * | * | * | | | * | | | | * |
| Two-leaf Cape tulip | * | | * | | | | | | | | | |
| Paterson's curse | B | B | B | C | C | * | * | * | * | B | * | * |
| St. John's wort | * | C | A | C | * | B | * | * | C | B | C | * |
| Skeleton-weed | B | * | | * | C | | * | * | * | * | * | * |
| Soursob | C | * | * | C | * | * | * | | * | | * | * |
| Spiny burr-grass | C | | | | | | | | | | | |
| Stinkwort | B | B | B | C | C | B | * | * | * | B | * | * |
| Sweet briar | A | B | C | C | C | A | * | A | A | A | C | A |
| Thistle - saffron | * | * | * | | | * | | | * | * | | |
| scotch | | | | | C | | | * | * | * | * | * |
| slender | B | A | A | A | B | B | B | A | A | A | B | A |
| spear | B | * | * | * | C | B | B | A | A | A | B | A |
| variegated | * | B | A | A | C | B | B | A | A | A | B | A |
| Thorn apple | | * | * | * | | B | | | | | | |
| Tree of heaven | C | B | C | C | | | | | * | C | * | |
| Tutsan | | * | | | | | | | C | | | |
| Wild watsonia | * | * | * | * | * | | | | * | * | | |
| Ragwort | | | | | | | | | | C | | |
| Spiny rush | C | C | * | | | | | | | | | |

Table 14

HABITATS OF THE MAIN NOXIOUS WEEDS IN NORTH-EAST STUDY DISTRICT 2

| Habitat | Blackberry | Sweet briar | Ragwort | St.John's wort | Paterson's curse | Thistles |
|---|---|---|---|---|---|---|
| Undisturbed native vegetation | | | | | | |
| Disturbed native vegetation (by logging, grazing, and recreation usage) | * | * | * | * | * | * |
| Cleared land | * | * | * | * | * | * |
| Roadside easements | * | * | | * | * | * |
| Stream frontages | * | | | | | |

inaccessible hills (particularly in the Wombat and Ruffy blocks).

St. John's wort is a toxic plant found throughout the district, but in many instances only as isolated patches on farms, clearings in the forest, or on roadsides. Significant infestations occur in the Lurg and Warrenbayne blocks. Spraying controls the weed in many instances, but unless followed up by pasture improvement does not achieve any results. It is impossible in rocky, timbered areas without the use of aircraft, which is often too expensive on small areas. The chrysomelid beetle, which feeds on the plant, is also used as a control measure. Many forested areas of public land around Warrenbayne previously leased for grazing carry infestations of this weed.

*St. John's wort growing in a forest clearing on the Toombullup plateau*

Thistles (short, variegated, and slender) are widespread in the district on agricultural land and are found occasionally in open areas on public land. The situation with Paterson's curse is similar, and it can be found wherever public land is grazed.

Ragwort has recently been found in the Dry Creek block (Parish of Borodomanin). This plant has the potential to increase if the areas are cleared and could severely restrict agricultural production here as in the South Gippsland and Otway areas. Stinkwort is widespread on agricultural land in the Strathbogie Ranges.

Bracken fern is a pest plant to agricultural production and is a particular problem on steep sheltered slopes and in the high-rainfall areas.

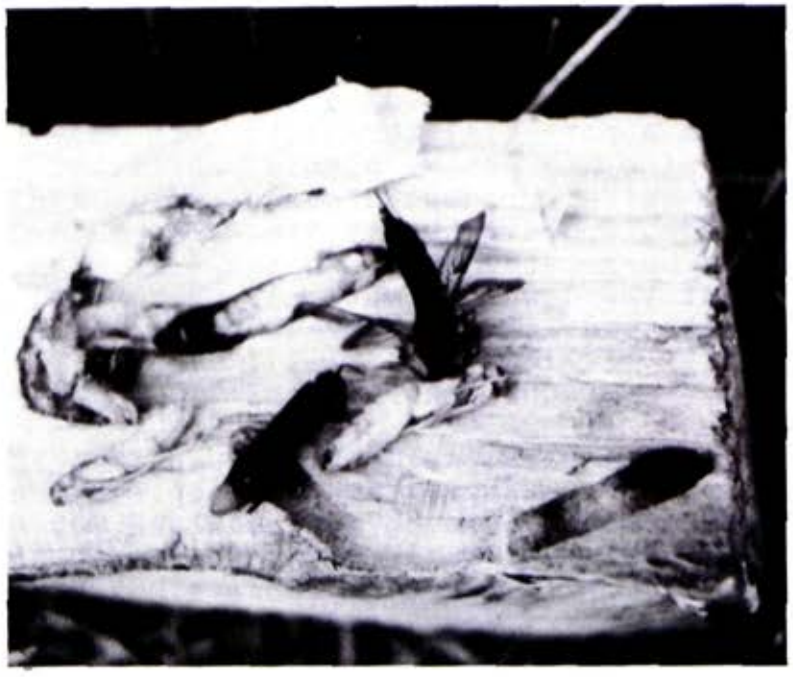
The pest plants in the district can be dealt with by spraying with herbicides, by mechanical methods such as slashing or cultivation, or by biological means. Indeed, their main cost at the moment is the money spent on controlling them.

These practices have relevance to future land use and management. They may upset a stable and balanced situation and result in problems not directly associated with, and perhaps more serious than, the original pest plant (or pest animal) problem. For example, soil erosion may follow weed removal, or herbicides may persist in soils or find their way into streams and so may damage other desirable plants. When measures to control weeds are being formulated, these associated problems should be considered and weighed against the benefits of control.

Insects

No serious insect pests infest the district. However, the introduced sirex wood wasp *(Sirex noctilio)* poses a potentially dangerous threat to the local pine plantations. It has attacked pines in this district, but its effects can be minimized by avoiding the drier sites in plantation establishment and appropriate plantation management practices. In drought years the hazard of attack from sirex populations increases. The *Ibalia* wasp, which parasitizes sirex eggs, is also present in this district and promises to exert significant control.

Outbreaks of the spur-legged phasmatid *(Didymuria violescens)* in native forests are rare in this district. Cup-moth *(Doratifera vulnerans)* causes minor damage on mixed-species eucalypts, as does the gum-leaf skeletonizer *(Eraba lugens)*



*The sirex wood wasp (adults and juveniles)*

on river red gum. Most of the common widespread pasture pests - including pasture cockchafers, red-legged earth mites, army worms, cut worms, and lucerne fleas - are present here.

Fungi

*Dipodia pinea* has attacked radiata pine plantations in the district, but only following mechanical damage such as inflicted by hail storms. It is of no great concern, except perhaps under drought conditions, when the resistance of the tree is lowered.

The root fungus *(Phytophthora cinnamomi)* has not been detected in this district, but is a potential threat to both radiata pine and native plants. Affected trees suffer gradual dieback and loss of foliage, and eventually die. The hazard would be greater where drainage is poor, and at the lower elevations, where soil temperatures are relatively high.

## Chemical Hazards

Pesticides have only limited use in this district. However, their widespread use to control pasture pests could destroy beneficial soil fauna and lead to a drop in soil fertility. They pose a hazard to colonies of bees and also to insectivorous amphibians and mammals. The use of 1080 poison is a hazard to fauna conservation. Research in New Zealand has demonstrated that it readily kills birds and mammals such as wallabies and brush-tailed possums.

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# NATURAL AREAS

In Australia, in less than 150 years of extensive settlement, we have established a viable and prosperous nation, but in the process we have greatly changed the whole environment. It is now difficult to find any large tract of country in its virgin state.

Fortunately the worst excesses of land exploitation, such as uncontrolled logging, overgrazing, and frequent burning, are now over. Nevertheless, a rapidly growing demand has developed here, as elsewhere, for land still carrying natural vegetation and wildlife to be set aside in special reserves in which all further development is kept to a minimum.

## The Need for Natural Areas

Such natural areas are required for many reasons and the list below is not exhaustive.

### Recreational

Many forms of outdoor recreation, including those related to enjoying and understanding natural environments and those requiring solitude, need natural reserves. These give people an opportunity to renew contact with the natural world where their ancestors once struggled for existence.

Tourism is one of the world's major industries, and natural areas that give a country its individual character are an important factor in attracting tourists. Visitors may put heavy pressure on an area and, if it is to remain "natural", access must be restricted.

### Aesthetic

The preservation of the beauty and regional diversity of the natural landscape should supplement our proper concern for the preservation and display of Man's own finest creations - art, music, buildings, and writing. Thus we must preserve characteristic Australian scenery and wildlife within an economic system that necessarily encourages the import and spread of exotic plants and animals, often in monocultures.

### Scientific

We need to preserve undisturbed samples of natural ecosystems, which provide basic data of value in understanding and improving the man-made systems used for

productive purposes. For example, solutions to problems of soil erosion or salting may be found through a comparison of the natural situation with the artificial farmland Man has developed.

We must also preserve species and varieties (a "gene pool") that one day may have profound value to Man, either directly or through his domesticated plants and animals. We must conserve a bank of parental material for improving our agricultural and forest species and for medicinal purposes. Some Queensland rain-forest trees are sources of useful drugs. Penicillium was a nuisance mould on bread until its antibiotic effects were discovered.

Educational

We need outdoor laboratories for education in the biological sciences, and an abundant and renewable supply of species and individuals. A large natural area gives opportunities not only for enjoying natural scenery, but for every variety of study, from simple natural history observation to the most sophisticated non-destructive experiments.

Many factors influence the viability of a natural area. In general, viable populations of plant species could be maintained on a smaller area than populations of large mammals. Natural areas must be large enough to absorb the impact of any proposed uses. Those set aside primarily to provide opportunities for solitude and primitive surroundings must be very large. In Canada it has been suggested that such an area should require 2 full days to cross on foot. This would usually involve about 50,000 ha, but 40 ha or less may be sufficient to preserve a particular small plant species.

Truly natural areas will need a buffer zone to reduce the impact of Man's activities in the surrounding countryside. The buffer zone could be affected by weed invasion, vermin, or fertilizer and pesticide applications. As well as hazards caused by Man's use of surrounding land (or the area itself), there are natural hazards such as fire, flood, and disease. The larger the area, the more likely it is to survive these. Protection may also be achieved by setting aside several separate examples of a particular land type. Communities that exist in more variable climatic zones usually require larger areas, or more examples set aside, to ensure survival.

"Natural" areas should be "managed". Although seemingly a contradiction in terms, this is often necessary as nature is dynamic. Management may take the form of controlling fire, culling animal populations, practising silviculture, strictly controlling the number of visitors, fencing to exclude introduced animals, or eradicating introduced species. The degree of management possible or necessary depends upon objective

interpretation of the environment, the techniques available, and the cost of implementing them. Careful management may enable small areas to remain viable.

## Choosing Areas

In addition to the considerations of viability outlined above, many other factors influence the selection of natural areas. These include the great diversity of interests among the people, and the possibilities of a number of compatible uses of a single area.

The biological content and diversity of the area must be considered. There is a need to conserve large communities of common species rather than just concentrating on the preservation of varieties in very small non-viable reserves. This does not mean that the remnants of previously more important communities should be ignored. The migratory and nomadic existence of some animals requires corridors of habitat (linking, for example, breeding and feeding grounds).

It is desirable to select an area with natural boundaries, such as a watershed. This type is usually the easiest to manage and maintain. Scenic or landscape values should also be assessed. In practice, a balanced system will probably include a few fairly large areas (more than 20,000 ha) in which the major communities are represented, supplemented by a greater number of smaller, more intensively managed areas.

*A relatively natural remnant of the Strathbogie land system*

## The Study District

### Land systems

Although large parts of the study district still remain in a relatively natural condition, certain types of land that are well suited to agriculture have been almost totally cleared. Remnants of the native vegetation that once covered these areas remain, as scattered pockets or along some river flats still kept as public land.

The largest pocket of land is the Reef Hills, parts of which represent both the

Lurg and Benalla land systems. Parts of the Swanpool land system (near Sandy Creek and Wild Dog and Back Creeks) remain public land. The Moorngag land system is mainly cleared, particularly north of Boonie Doon. Here the northern fringe of this system is public land. The bulk of the Strathbogie land system is cleared for agriculture. Remnants of native forest exist around Too Rour, the Barjarg road, the Blue Range, and Mount Wombat.

Most of the Wrightley land system has been cleared, for either agriculture or pine plantations. Some land remains near Spring Creek near the Blue Range Creek. No viable examples of the Archerton land system remain under native forest, as most of it either carries farms or consists of bracken and scrub lands on former farms.

Much of the Table-top land system is also cleared. Pine plantations are being established at present on the Loombah, Moonee Moonee, Wrightley, Tiger Hill, and Tolmie land systems. The reservation of representative samples of these systems for scientific and educational purposes, particularly the Tiger Hill and Strathbogie systems, is desirable.

The Cambatong and Tolmie land systems (steep montane slopes and flat-topped ridges) offer opportunities for hiking, camping, cross-country driving, and nature walks.

## Flora and Fauna Conservation

This aspect is closely linked with reservation of natural areas, which - together with appropriate management - will ensure flora and fauna conservation for most species.

In this district it is relatively easy to recognize the various vegetation units, and reserving viable samples of each type should ensure the conservation of the common plant species. Species requiring special conservation measures can also be catered for by including areas containing them in the samples or by creating flora reserves.

Fauna conservation involves other considerations. It requires an understanding of the species distribution, habitat requirements, and behaviour. Our knowledge of the presence, distribution, and status of fauna in the district is still incomplete, and hence any changes in land use must be approached cautiously.

As animals' vegetation requirements differ, a particular animal community probably occupies each vegetation type, within which various animals may occupy different habitats because they have different requirements of food and shelter. A classification of habitats (which incorporates a simplification of the vegetation classification used in this report) is presented in Appendix III. For the purposes of this section,

habitats for birds and mammals have been further simplified into forests, woodlands, and wetlands (streams, stream margins, lakes and lake margins, and swamps).

Forests

Conservation of flora and fauna can be achieved alongside other uses of forested land such as extensive hardwood production. In intensive hardwood production areas, the impact on fauna can be reduced by leaving numbers of large over-mature trees in some localities. These often contain hollows that serve as nesting sites - for such birds as the sulphur-crested cockatoo, gang-gang cockatoo, crimson rosella, king parrot, laughing kookaburra, and powerful owl - or as breeding sites and shelter for many mammals - such as the greater glider, brush-tailed possum, sugar glider, tuan, and some bats.

In the past, clearing of the plains and plateaux in the district had a major impact on the fauna and flora. The greatest change in land use at present is the clearing of native vegetation in order to establish pine plantations. This is adversely affecting the wildlife populations. Although it appears that some mammals and birds (such as the ring-tailed possum and white-winged chough) can continue to live in large areas of pine plantations, many others cannot survive. However, some of these will probably live within a plantation

*Pine plantation establishment in gully at Mount Bee*

area if adequate strips of undisturbed native vegetation are left along permanent streams.

The situation can be further improved by retaining areas of native forest on plateaux, hillsides, and ridges within the plantation, linking them where possible for animal movement. Two such areas have been left around Mount Bee near Warrenbayne, but their value for supporting a varied and viable wildlife population has been seriously impaired by clearing and pine establishment in a narrow gully between them.

The pattern of plantation establishment could also affect wildlife populations. For instance, the plantation at Warrenbayne has isolated the forested northern foothills and plateaux from the remainder of the forested Strathbogie ranges. Any mammal movement would be across plantation, vegetated roadside reserves, or cleared private property. This is undesirable for many species, particularly those (such as the sugar glider) that move considerable distances because of food or other requirements. A similar situation should be avoided in the Blue Range Creek area, where pine plantations could separate the Blue Range from the remainder of the Tolmie highlands.

The greatest threat to amphibians and reptiles is habitat destruction. In this district the most critical habitats for reptiles are the low scrub and rocky areas together with the adjacent vegetation. Alteration of these areas would result in a very substantial reduction of the species diversity of the district, as they provide a number of unique micro-environments. Activities such as grazing by cattle or sheep, fuel-reduction burning, vermin poisoning, and pesticide spraying are especially harmful to the reptiles in rocky habitats. Thus reservation of some large areas of rock outcrops and the exclusion of grazing animals is the top priority for conservation of reptiles here. Areas of public land that deserve special consideration are the outcrops in the Warrenbayne and Samaria blocks and Hat Hill in the Hat Hill block. The second priority would be to reserve some substantial tracts of the characteristic vegetation units, which would ensure conservation of most of the common reptile (and amphibian) species of the district.

Another land use factor of major importance to amphibians and reptiles is that all species are primary and secondary carnivores and all ultimately depend on insects for food. Thus any land use that involves the use of insecticides will provide a direct threat to the reptiles and amphibians.

Woodlands

The Reef Hills comprise the only public land area of any size in the district that carries a cover of grey box and river red gum woodlands. The nearest large areas of public land with similar box type vegetation are north of Wangaratta - at Killawarra and Chiltern - and west of the Goulburn River - near Rushworth.

Conservation of bird and mammal species in the Reef Hills area would entail its maintenance as forest and retention of over-mature trees, which in many cases would provide sites for such species as the tuan, sugar glider, squirrel glider, barking owl, eastern rosella, and dollar bird. Maintenance of ground cover is also important here. For instance the

white-browed babbler uses hedge acacia bushes as nesting sites and as protection from predators, while the common bronzewing lives mainly on seeds from such plants as hedge acacia and golden wattle. The spotted quail-thrush and king quail nest in grass tussocks and low shrubs. Thus management would require the careful use of fuel-reduction burning and exclusion of grazing. This type of management of course also conserves the flora.

Wetlands

The greatest threat to both introduced and native fish is probably stream pollution. Apart from obvious forms caused by some industrial sewage affluents, pollution can be caused by the misuse of agricultural chemicals on adjacent land and the raising or lowering of stream temperatures. Other adverse effects are the altering of the extent and pattern of flooding, removal of snags, and siltation of stream beds that primarily influence spawning.

*White-browed babbler's nests in hedge wattles*

There is little or no chemical pollution of streams in the district. However, where it does occur, even at low levels, it can affect some sources of food, such as freshwater shellfish. The construction of large dams, with consequent lowering of water temperatures and reduction of flooding, is considered to have adversely affected some native fish such as the macquarie perch.

The removal of snags and siltation of the stream bed through unwise land use practices - including disturbance of stream-bank vegetation, trampling of stream banks by cattle, and uncontrolled timber harvesting on nearby sites - have probably been the major factors affecting the river blackfish. Conservation of such a rare and localized species as the trout cod could involve exclusion of angling.

Streams and lakes and their environs provide an essential habitat for a number of water-birds,(such as egrets, herons, ducks, swans, and bitterns) and also aquatic mammals (such as the eastern water rat and platypus). Adverse

changes in habitat affect these fauna also. The presence of stream-side trees and ground vegetation is also of great importance to some migratory birds such as the dollar bird, noisy friar-bird, and little friar-bird, which frequently use these habitats in their migration and for shelter, food, and nesting sites.

Streams in addition provide watering places for many birds and non-aquatic mammals. The stream-side environment provides cover from predators and nesting sites in the form of ferns and shrubs for many small birds and mammals. Where it is necessary to construct stream crossings in a forest or pine plantation, these should disturb the vegetation as little as possible and should not disturb the natural flow of the stream. Logging refuse should not be left in streams following timber harvesting. The protection of wetlands is of major importance in the conservation of amphibians.

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# RECREATION

Recreation involves activity undertaken by choice for the pleasure of the individual. Obviously it takes a multitude of forms, and individual preferences vary.

This chapter concerns recreation on public land, which can involve such activities as skiing, hunting, hiking, picnicking, or simply sight-seeing. Some of these may require large tracts of land, but can occur together with uses such as timber production, cattle-grazing, or mining, provided certain restrictions are imposed.

## Factors Affecting Demand

The increasing demand for land for recreation can be attributed to a number of factors, some of which are listed below.

### Population

The size and local density of the population will influence the demand for land for recreation. Victoria's population has doubled in the past 35 years and is now about 3,500,000. An overwhelming proportion is concentrated in the metropolitan area.

### Income and leisure time

In general, the bulk of the population has more money to spend after paying essential expenses. Many spend some of this money on recreational activities.

As working conditions improve, individual periods of leisure such as week-ends, annual holidays, and retirement years are lengthening.

### Transport and communications

Improvements in transport increase the mobility of populations, making areas more accessible and increasing the effective length of individual periods of leisure. More efficient communications disseminate information and ideas more freely, and increase people's knowledge about places of interest and things to do.

### Location of cities and towns

The geographic locations of cities and towns in relation to available natural features of recreational interest, such as beaches and snow-fields, influence the types of activities pursued.

## Life style

Life style cannot really be considered in isolation from the factors outlined above. However, additional factors such as education, age, and fashion can influence the degree of participation in outdoor recreation.

Evidence indicating the increasing demand for outdoor recreation in recent years can be obtained from the few Victorian figures available. These indicate that, while the population has been increasing at 2% per year (doubling every 35 years), the number of people using developed areas of national parks and other outdoor recreation areas, the number of car and motor-boat registrations, and similar indices are all increasing at 10%-15% every year (doubling in less than 7 years).

More than 725,000 people visited Victorian national parks in 1971/72, compared with about 350,000 visits in 1966/67.

Although it may be clear that the demand is increasing, the nature of this increase is difficult to predict. It has been suggested that by the end of this century the Australian population will total 22 million, a 3- or 4-day working week will be common, *per capita* income will have trebeled in real terms, and the 3 million cars will have increased to 10 million - which will be used nearly twice as often as today.

Activities that are popular now may not be so in the future, and completely new types are certain to emerge. All that can be done is to plan for an increased demand for outdoor recreation and keep the plan as flexible as possible to cope with the changes in its nature.

## Choosing land for outdoor recreation

As previously mentioned, outdoor recreation is often compatible with other forms of land use. However, sometimes specific areas must be set aside for it.

The area and nature of the land chosen will depend upon the type of recreation to be pursued. At one extreme, small areas that retain little of the natural environment are used for such activities as tennis, golf, and picnicking. Major usage occurs after work and at weekends, and they are invariably located close to the population that uses them.

At the other extreme, areas of thousands of square kilometres provide for such activities as hiking, deer-hunting, sight-seeing, camping, fishing, and nature study, mainly during vacations. Development is usually limited to a small part of the area, the rest being undisturbed. These areas are located where outstanding natural features occur, often far from the population using them.

Obviously a complete range exists between these extremes. One intermediate

example is duck-hunting, in which concentrations of hunters congregate on defined wetlands that may range from 20 to 2,000 ha. These areas must contain good-quality waterfowl habitat to support waterfowl populations and thus attract hunters.

American statistics indicate that the greatest increase in demand for recreation lands will be for areas outside large urban centres but within 2 hours' driving time of them.

Area of land required

In many respects, an area's carrying capacity for outdoor recreation can be assessed by physical terms in the same way as a farmer determines the optimum stocking rate for his farm. A particular site can accommodate a certain number of cars and people, and above this level damage to the vegetation and soil will occur, leading to deterioration of the land.

Moreover, a psychological element must be considered; over-crowding detracts from people's enjoyment of the area, although the land may not suffer physical damage.

The analogy with the determination of stocking rates on a farm over-simplifies the case to some extent, because attractive and accessible parts of a recreational area tend to be heavily used while large parts are little used. An added complication is that people use these areas intensively for brief periods and not at all for longer periods. This results from the interaction of available leisure and weather conditions with the distance of the recreational areas from the population.

Requirements of land for various types of recreation are set out in Table 15.

Accessibility

The district lies within 2 to 2½ hours' drive from the eastern and northern Melbourne suburbs and is thus within range of week-end visitors. Road counts on the Hume, Midland, and Maroondah Highways are difficult to interpret. They indicate, however, that usage on the Midland Highway has increased relative to that on the Maroondah Highway at Merton, which in turn has increased relative to that on the Hume Highway at Euroa.

In the 12 months August-July 1971/72. about 1.5 million vehicles travelled through Balmattum on the Hume Highway, and 2.4 million cars through Coldstream on the Maroondah Highway. Some proportion of the vehicles using the Maroondah Highway would be recreation traffic travelling to Mansfield, Mount Buller, and the upper reaches of Lake Eildon. It is estimated that the Maroondah Highway carries about 2½ times as much traffic on a week-end as on a week-day.

Table 15

MAIN TYPES OF OUTDOOR RECREATION IN THE STUDY DISTRICT AND THEIR REQUIREMENTS

| Types of Recreation | Requirements |
|---|---|
| Organized outdoor sport | Some areas of public land may be required for golf courses, football grounds, and airfields close to urban centres |
| Caravanning | Provision of facilities in pleasant surroundings |
| Driving for pleasure | General protection of diversity in the landscape |
| Sight-seeing | Preservation of historic points, scenic lookouts, and outstanding natural features |
| Picnicking | Provision of suitable facilities in open-space surroundings readily accessible from urban centres |
| Nature walks | Preservation of natural areas, provision of walking tracks and interpretative service, and exclusion of vehicles |
| Walking for pleasure | General protection of diversity in the landscape, and provision of access to areas of public land, including stream frontages and shoreline; exclusion of vehicles from some areas |
| Horse-riding | Provision of open space with paths |

Table 15 (contd.)

| Types of recreation | Requirements |
|---|---|
| Cross-country driving (4-wheel drive vehicles, trail bikes, etc.) | Provision of open-space areas that can withstand this type of recreation, some distance from areas being used for other forms of recreation |
| Hiking | Preservation of extensive areas of open space, particularly areas with diverse landscape and outstanding natural features; exclusion of vehicles from some areas |
| Camping | Provision of suitable facilities in areas of open space close to water and outstanding natural areas |
| Swimming or sun-bathing | Provision of access and suitable facilities at safe beaches and other swimming areas, particularly those close to urban areas |
| Boating or water-skiing | Provision of access and suitable facilities along stream frontages and shorelines |
| Fishing | Provision of access to stream frontages and shorelines; protection of stream banks and aquatic habitats |
| Hunting | Management of habitat for game species |

*Lakeside environment at Lake Nillahcootie*

Shepparton (1971 population 19,400) and Wangaratta (1971 population 15,500) are nearby cities whose populations may be a source of visitors to this distirct. This is particularly significant for Shepparton, which is located 61 km by road from Benalla, and has a high average annual growth rate (2.1% over the last 5 years). The district constitutes the nearest point of the Eastern highlands to Shepparton.

## Recreation Resources in the Study District

Recreation resources have been presented in the accompanying recreation map and are discussed below.

### Environments

Four general environments are apparent to the visitor. Lakeside environments are centred on the Bonnie Doon arm of Lake Eildon and at Lake Nillahcootie. The rural environment provides a setting for Lake Eildon and is extensive over most of the lowlands and in the western part of the Strathbogie massif. The native forest environment provides a backdrop for Lake Nillahcootie and predominates over the Tolmie highlands and eastern Strathbogie massif. A softwood forest environment is obvious from a distance in the Warrenbayne - Boho south area and less so in the Blue Range Creek - Holland Creek area.

### Features

Rock outcrops provide enjoyment for hikers, nature study groups, or rock climbers. The main outcrops are near Kelvin View, Mount Sugarloaf near Too Rour, and near Mount Samaria on the Blue Range.

There are also a number of waterfalls - on Seven Creeks at Gooram, Sandy Creek near Mount Strathbogie, Mountain Hut Creek near Kelvin View, Sams and Watch-

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 2

Scale 1:250,000

MILES 0 2 4 6 8 10
KILOMETRES 0 5 10

# RECREATION

## LEGEND

**Environments**

- Lakeside environment
- Rural environment
- Softwood forest environment
- Native forest environment

**Features**

- Rock outcrop or rocky scarp
- Waterfall
- Open water
- Fishing stream
- Outstanding wildflower area
- Outstanding wildlife area
- Gemstone site
- Scenic lookout

**Historical**

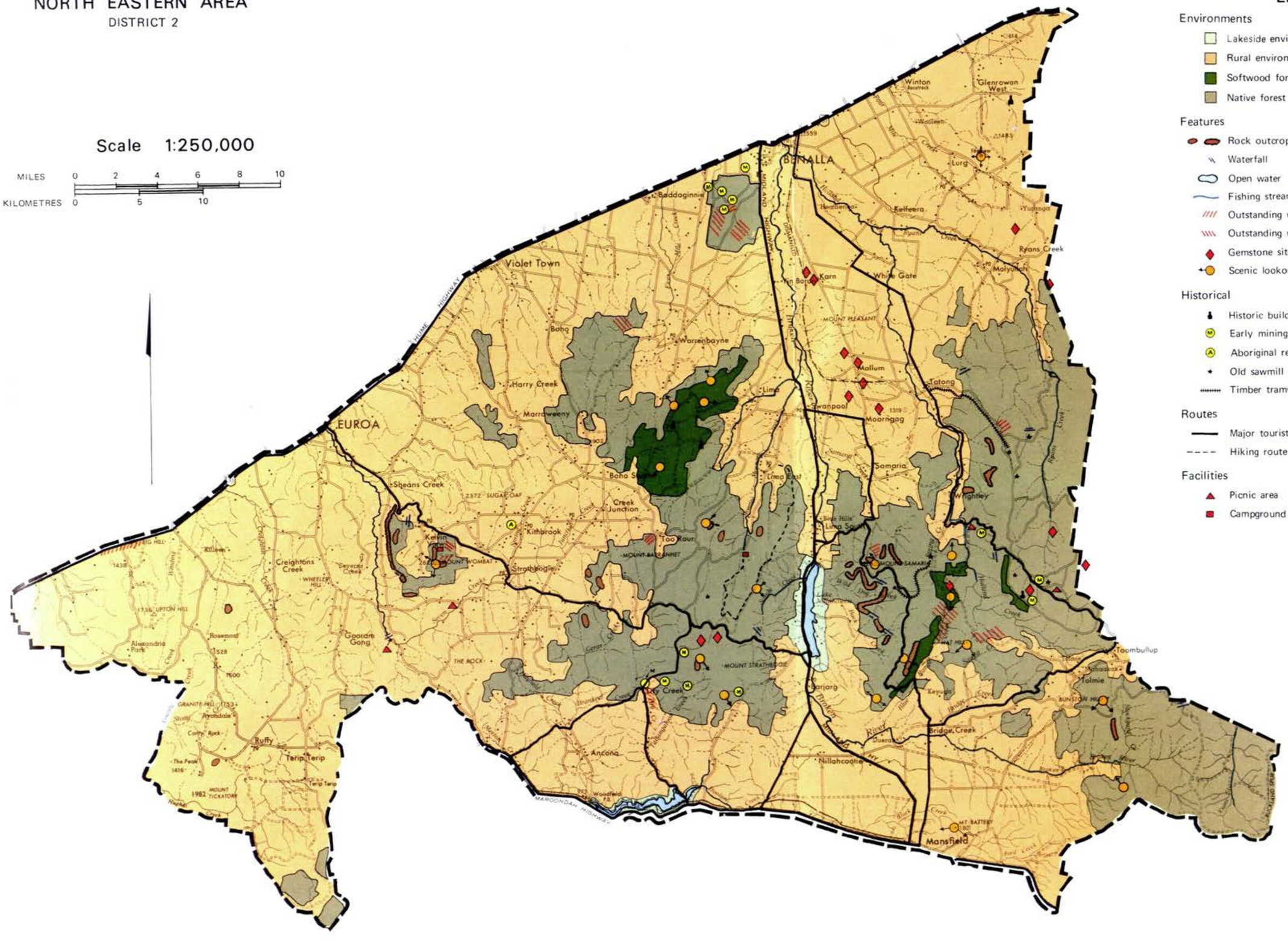
- Historic building or site
- Early mining site
- Aboriginal relics
- Old sawmill site
- Timber tramway

**Routes**

- Major tourist route
- Hiking route

**Facilities**

- Picnic area
- Campground



box Creeks near Tatong, Wild Dog and Back Creeks near Mount Samaria, a tributary of Holland Creek near Wrightley and the west King River near Toombullup.

Lake Nillahcootie and the Bonnie Doon arm of Lake Eildon provide opportunities for boating, water-skiing, fishing, swimming, and sunbathing. Sheltered conditions at Bonnie Doon make this water surface ideal for water-skiing; the 300 camp sites near here, which are fully booked during the Christmas and Easter holiday periods, indicate the popularity of the area.

Road counts taken at Lake Nillahcootie between June and December 1972 indicate that an average of 220 cars per week visit the picnic area, with a maximum figure of about 300 cars per week.

Principal fishing streams include the lower reaches of Seven Creeks, the Broken River, and Holland, Ryans and Evans Creeks.

*The Bonnie Doon arm of Lake Eildon*

*A quiet stretch on the Broken River*

*View towards Benalla from Mt. Samaria*

Lake Nillahcootie caters for about 500 duck-shooters on opening day, and an average of about 5 shooters use it regularly during the open season. Common game birds frequenting the lake (and Lake Eildon) include grey teal, black duck, wood duck, chestnut teal, and mountain duck. These use it as a resting area between Lake Mokoan and Lake Eildon, and some birds breed in its upper reaches and in the Fords Creek arm of Lake Eildon.

Deer and feral pigs are hunted in the Tolmie highlands and feral goats in the Strathbogie Ranges.

A number of outstanding wildflower areas located in the district include an area along the Hume Highway near Big Hill, Mount Wombat, Too Rour, Mount Samaria, the Tiger Hill road near Tatong, and the Reef Hills.

Outstanding wildlife areas are situated at Mount Wombat (koalas, greater gliders, and ring-tailed possums), Warrenbayne (sugar gliders and tuans), Reef Hills (eastern grey kangaroos and various birds of the open plains), Blue Range Creek (various mountain forest birds), and adjacent private property near Hat Hill (large numbers of eastern grey kangaroos).

The district is well known as a source of gemstones. The Crystal King mine near Tallangalook is visited by Melbourne lapidary clubs as well as clubs from Shepparton and a number of private individuals.

Other localities south of Benalla and near Tatong yield agates, red jaspers, and black and green cherts. Turquoise is found near Molyullah, and rubies, sapphires, emeralds, topazes, garnets, and red zircons are found in the Tolmie highlands near the headwaters of Ryans and Middle Creeks. These attract local people and clubs from further afield.

The many scenic lookout points located in the district include Mount Wombat, Golden Mountain, Wild Dog Bluff, Mount Sugarloaf, Lightning Ridge, and Pitty

Hill in the Strathbogie Ranges; and Mount Samaria, Back Creek falls, Rocky Point, Bunston Hill, and Hat Hill in the Tolmie highlands.

Historical

Old sawmill sites and timber tramway routes also provide points of interest for some visitors.

Historic sites at Glenrowan West and on Stringybark and Kelly's Creeks remind visitors of the bushranging era, when the Kelly gang operated in this and neighbouring districts.

Early mining has an attraction for some visitors, both for gold-panning and for exploring old workings and townships. Foremost among these localities are the areas around Tallangalook township, the Glen Creek and Stringybark Creek localities, and the Reef Hills.

Routes

Major tourist routes are the Hume, Midland, and Maroondah Highways. In addition, the Dry Creek-Tallangalook road, the Euroa-Strathbogie-Barjarg road, the Mansfield-Blue Range Creek-Mount Samaria road, and the Mansfield-Toombullup-Tatong road carry tourist traffic. Occasional trips are also taken through the Warrenbayne plantation but internal access is currently restricted on week-ends and holidays during the summer period.

Most visitors to the district travel by private transport, but occasional "Kelly Country" day tours visit Benalla, Glenrowan, and Mansfield.

Little hiking is done, but the Moonie Moonie Creek - Lightning Ridge track provides a good 1-day hiking route.

Facilities

Camp grounds by Moonie Moonie Creek and Mountain Hut Creek provide forest camping and adventure experience for organized groups. Caravan parks are situated at Bonnie Doon, Benalla, and Euroa. Picnic sites are provided at Gooram falls and Polly McQuinns on Seven Creeks, at Lake Nillahcootie, by the Bonnie Doon arm of Lake Eildon, and at

*Camp grounds near Mt. Wombat*

Fords Bridge on Hollands Creek, as well as along the main highways and some secondary roads.

## Future Usage

Examination of social and economic factors and present trends indicates that the present low general level of recreation activity will increase greatly in the future, particularly near the population centres on the Hume Highway and around the lakes. Decisions to reserve adequate land resources for recreation should be made now.

*Picnic site at Lake Nillahcootie*

The most popular localities are around the Bonnie Doon arm of Lake Eildon and Lake Nillahcootie. These have attractive forest environments close by, which could well provide an alternative to water sports on some occasions. Particular features likely to attract visitors are the rock crystal mines near Golden Mountain, the old gold-mining township of Tallangalook near Bonnie Doon, and Mount Samaria and Lightning Ridge near Lake Nillahcootie. Local people and others from outside the district visit the Mount Wombat area (about 16 km from Euroa) and the Reef Hills (about 5 km from Benalla) fairly frequently.

The route from Mansfield to Mount Buffalo and Bright *via* Tolmie, Power's Lookout, and Whitfield also could assume more importance in the future as a scenic alternative to the Hume Highway for access to north-eastern Victoria.

It is also conceivable that recreation usage could increase markedly in the headwaters of the Broken River and Evans Creek, due to the nearby attractions of Lake William Hovell and Mount Buller and Mount Stirling snow-fields.

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# AGRICULTURE

Livestock production is the predominant rural land use in the district (see primary production map facing page 116). Horticulture and grass-seed production are significant in some localities, but there is little cereal production.

Pastures are largely based upon subterranean clover, with white clover and perennial grasses being sown more frequently in the higher-rainfall zones. Annual forage production of district pastures would vary from about 4,500 kg per ha in the drier areas on poor soils to 10,000 kg per ha in more favourable situations.

## Livestock

In the past, the beef industry was concentrated in the wetter areas, with wool and lamb production more common elsewhere. With a marked increase in the area of improved pasture and a greater return for beef relative to wool and/or lamb, the recognized potential for increasing production on farms has been met by a spectacular growth in beef cattle numbers, while sheep and dairy cattle numbers have declined.

Most properties now have beef breeding herds and produce weaner stores or

Table 16

Livestock Statistics, Shire of Benalla

| | 1964-65 | 1966-67 | 1968-69 | 1970-71 | 1971-72 |
|---|---|---|---|---|---|
| Beef cattle | 22,101 | 26,106 | 41,498 | 50,307 | 59,198 |
| Dairy cattle* | 11,553 | 10,359 | 9,287 | 8,582 | 7,786 |
| Sheep | 460,312 | 466,864 | 455,080 | 424,935 | 357,974 |

* Cattle kept for the commercial production of milk or cream

*Beef cattle grazing near Mansfield*

*Sheep grazing on the Strathbogie plateau*

2-year-old fat steers. Vealer production is only feasible on well-improved or fertile country, or in above-average seasons. Although published statistics are not available for the district as a unit, Table 16 presents figures for the Shire of Benalla as an indication of recent changes in the livestock population. Recent improvements in market conditions for the sheep industries should reduce the trend towards beef production.

Traditionally, wool and lamb production have been the main farm enterprises, the former from Merino and comeback flocks in the undulating higher country in the western part of the district. Lambs have largely been raised on the productive pastures to the north-east. This enterprise is based on first-cross ewes (normally purchased from breeders in New South Wales) mated to Dorset Horn or Southdown rams (from studs in the Goulburn Valley or the adjacent sheep-

Table 17

AGRICULTURAL ENTERPRISES IN NORTH-EASTERN PART OF DISTRICT 2, 1972

| Locality | Dairy farms | | | Farms in the other enterprises | | |
|---|---|---|---|---|---|---|
| | No.of farms | Area (ha)* | Total cows | Beef & veal | Sheep | Other |
| A. Lurg | 9 | 1,034 | 470 | 3 | 4 | 1 (passion-fruit and cherries) |
| B. Molyullah-Whitegate | 15 | 1,606 | 794 | 6 | 5 | 1 (tobacco) |
| C. Tatong-Samaria | 17 | 2,774 | 893 | 3 | 5 | 1 (grass seed) |
| D. Lima South -Swanpool | 18 | 1,737 | 1,013 | - | 3 | - |
| E. Lima East | 15 | 1,266 | 854 | 2 | - | - |
| F. Warren-bayne | 8 | 877 | 492 | 2 | 1 | - |
| TOTALS | 82 | 9,294 | 4,462 | 16 | 18 | 3 |

* 1 hectare (ha) = 2.47 acres

wheat areas). Lambs are usually born between May and July, with about 70-90% marked. The extended spring growing season in the south-east allows greater flexibility in time of lambing than is possible in the north-west.

Wool from this district is usually of 58s to 70s quality - the finer wools being grown in the Strathbogie area. Merino rams are normally brought from the Western District of Victoria and New South Wales. Lambing percentages are lower than in crossbred flocks, and lamb losses are often aggravated by cold, wet weather at lambing. Under good husbandry, young sheep are well grown as weaners, and are mated to lamb at 2 years. Cast-for-age ewes and wethers provide some mutton production.

Dairying is largely confined to the valleys in the north-east of the district, except for the customary one or two dairy farms near each small town. Dairy cow numbers have declined in the past decade. Table 17 summarizes 1972 agricultural enterprises in this region. Since the introduction of bulk milk collection in the late 1960s, the trend has been away from the Jersey breed towards Freisians.

Seed production

Pasture seed is produced in the Mansfield, Strathbogie, and Warrenbayne areas. The reliable rainfall and fertile soils of the Mansfield area suit the production of perennial grass seed, and Victorian perennial ryegrass, Australian *Phalaris tuberosa*, Siro seedmaster tuberosa, Currie cocksfoot, and demeter fescue are grown. About 54,500 kg of Victorian perennial ryegrass seed were produced on 2,400 ha in 1970/71. Small quantities of seed of the above varieties are also grown in the Merton, Woodfield, and Bonnie Doon areas. The Strathbogie tableland produces these species as well as Mount Barker subterranean clover, but little certified Victorian perennial ryegrass because of frequent contamination with other varieties. About 12 properties produce

*Hop gardens along Ryans Creek*

*Potato production on friable soils at Archerton*

Mount Barker subterranean clover seed, but production is spasmodic. Warrenbayne was formerly a substantial phalaris seed area, but production has declined in recent years.

Horticulture

Hops, tobacco, cherries, passion-fruit, various nuts, potatoes, and other horticultural crops have local significance. However, of these, only passion-fruit constitutes a substantial part of Victorian production. Oilseed rape, although varieties are being tested in the area, is not yet a proved cash crop here.

Development Potential of Private Lands

The substantial development in improved pastures in the district since 1960 is indicated in Table 18, which presents land use data for the Shire of Benalla.

Table 18

Agricultural land use - Shire of Benalla

| Agricultural land-use areas (ha) | | |
|---|---|---|
| | 1960/61 | 1970/71 |
| Crop * | 18,162 | 14,781 |
| Fallow * | 2,136 | 2,211 |
| Native pasture | 76,322 | 21,615 |
| Sown pasture | 57,816 | 122,468 |
| Balance | 17,186 | 5,376 |
| Total area occupied | 171,622 | 166,451 |

* The areas to crop and fallow generally lie to the north of the study district, while the areas of native and improved pasture generally lie within it.

Many individual farms and some localities have been developed and operated at a level appropriate to the economic and

physical environments. However, some parts of the district still have scope for profitable increases in fertilizer use, pasture production, and livestock numbers, particularly the private lands of the Ruffy block, the Harrys Creek and Boho areas, and much of the high country in the east of the district. In the Ruffy area many holdings exceed 1,000 ha, and stocking rates are well below the optimum carrying capacity of 10-12 dry-sheep-equivalents per ha on improved pastures. Steep terrain, rock outcrops, rabbits, and the erosion hazard would reduce average carrying capacity on a property basis compared with what can be achieved on smaller, highly developed areas.

*Unproductive land on a rocky site near Strathbogie*

*Recent clearing of private property for agricultural production near Bridge Creek*

Market Outlook for Agricultural Products

The prospects for most livestock products appear favourable in the short to medium term. Meat - especially beef - production will probably remain profitable in this district for many years. In the medium term, wool prices may be expected to retreat from the high levels of early 1973, but the extent of such a retreat remains a matter of conjecture.

Dairy production appears to face less favourable markets than other livestock products.

In general, the feasible horticultural industries have a poor market outlook. There may be exceptions to this generalization where a particular crop is not commonly grown elsewhere.

Agricultural Capability of Public Land

The individual block descriptions at the end of this report cover the capability of specific areas of public land for agriculture. Physical and economic factors should be considered in any such assessment.

Topography, climate, soil type, present vegetation, and location are relevant physical factors. Much of the public land in this district has a low capability for agriculture, largely due to its high relief - slopes are so steep that normal agricultural operations could not take place safely. The public lands with a higher capability largely occur on broad ridges or plateaux.

The rainfall range in this district is consistent with a moderate to high grazing potential. Winter temperatures in the higher, wetter country are low enough to halt pasture growth for several months. Such areas (above about 750 m elevations) could best be used for spring-summer-autumn grazing in conjunction with lower country.

Physical characteristics of the soils found on land of moderate slope are adequate for pasture growth. The deep gradational soils associated with basalt in the Tolmie highlands have excellent physical characteristics. On the other hand, all soils in the district require added phosphorus and molybdenum to promote clover growth and so build up nitrogen and organic matter content. Generally, 1.0 to 1.5 tonnes of superphosphate per ha and 0.1 kg of molybdenum per ha must be applied over a period of years before perennial pastures could achieve full production. Maintenance applications of these fertilizers would also be required. Reddish and yellowish duplex soils in the Tolmie/Bunston Hill area would require up to 2 tonnes of superphosphate per ha to establish improved pasture with annual maintenance dressings of about 200 kg per ha.

Access is poor in much of the public land, and the cost of road development must be taken into account for forms of land use that require better access. Clearing and pasture development costs would vary according to the locality, but would often be of the order of $200 per ha. This does not include livestock, fencing, or buildings required.

Reference

Anon. "Rural Industries." (Commonwealth Bureau of Census and Statistics, Victorian Office: Melbourne 1960/61-1970/71.)

# HARDWOOD PRODUCTION

The hardwood forests of the district mostly comprise mixed eucalypt stands. Narrow-leaf peppermint forests predominate on the plateaux and moist slopes, usually with a stand height of 28-34 m, on well-drained soils with rainfalls of more than 890 mm per annum. Associated species include St. John's blue gum, manna gum, and candlebark. Messmate stands (either pure or mixed with other species) are confined to the plateaux and sheltered sites where soils are deep and annual rainfall exceeds 1,020 mm. The largest areas covered by this forest type are along the Barjarg-Lima East road on the Strathbogie massif and in the headwaters of Ryans Creek on the Tolmie highlands. Stand heights usually range from 30 to more than 37 m. Forests of almost pure candlebark occur around Mount Strathbogie and around Tolmie.

Alpine ash forests are limited to the Evans Creek catchment in sheltered aspects, where light winter snow is frequent, annual rainfall exceeds 1,140 mm, and soils are deep and well drained. Broad-leaf peppermint: candlebark forest mainly occurs on gentle slopes and flat ridges where the soil parent material is Lower Carboniferous sediments and rainfall is high. Red stringybark occurs in mixture with a number of species, including broad-leaf peppermint, long-leaf box, and red box. Stand heights usually vary from about 15 to 28 m. These forests cover the foothills and dry montane slopes.

A remnant of the grey box and red gum forests that once covered the plains is found in the Reef Hills near Benalla. Stand heights vary from 15 to 24 m.

*A stand of messmate stringybark*

*Highly productive alpine ash stands near the Buckland spur*

Sawlog production

Alpine ash, messmate stringybark, candlebark, manna gum, St. John's blue gum, and narrow-leaf peppermint have the most commercial importance for sawlogs. Past utilization has concentrated on removing these species from the plateau areas and moist southerly slopes in the Strathbogie Ranges, in the Blue Range, in the headwaters of Stockyard and Ryans Creeks, and around Tolmie.

At present forests within the study area provide sawlog supplies for eight mills in the Euroa, Benalla, and Mansfield localities, with yearly allocations varying from 1,500 to 7,500 cu m. (1 cubic metre = 332.89 super feet, Hoppus log volume). Of the total allocation of 40,800 cu m per annum, 21,450 cu m (53%) comes from Warrenbayne and the Blue Range Creek plantation conversion areas. Three mills in the Mansfield area draw annual supplies totalling approximately 600 cu m from the forest, in addition to supplies drawn outside the district.

Supplies of mixed eucalypt sawlogs from forest on public land have averaged 30,000 cu m per annum over the past 13 years. It is estimated that more than 840,000 cu m of sawlogs have been removed since the first sawmills were established in the Toombullup, Too Rour, and Barjarg localities in the 1916-18 period.

Sawlogs have come in a reasonably steady flow from these forests and have been sawn into timber at nearby mills and marketed in the Murray and Goulburn Valleys and in southern New South Wales.

About 90,000 cu m of sawlogs have been removed from 6,000 ha converted to radiata pine - a yield of 15 cu m per ha.

The resource of sawlogs remaining in the study district is assessed at 450,000 cu m, of which 150,000 lie in the Blue Range and Toombullup region. The total area suitable for intensive hardwood production is estimated to have a sustainable yield of at least 9,000 cu m per annum.

The sawmilling industry in the district employs 200 men; at Benalla one mill with associated planing works employs 80 men. However, a number of the mills draw additional sawlog supplies from outside the study district.

Logging has been on a selection basis, due to the mixed nature of the stands and the effects of fire. The present stands have a high proportion of cull material.

Where practicable and economically feasible, cull falling and silvicultural work has been undertaken. From the early 1950s to 1960, cull falling was carried out on some 1,200 ha to encourage messmate, St. John's blue gum, and manna gum stems. Regeneration treatments in messmate stands have had little success to date, partly because moisture stress in the dry summer period kills seedlings.

Pulpwood

The estimated standing pulpwood resources of the study district total 1,840,000 cu m, principally in mixed-eucalpyt stands that have been utilized for sawlogs.

*Hardwood logging in manna gum stand near Ryans Creek*

In a survey covering the study district, 55% of the pulpwood was assessed in trees 40-80 cm diameter breast height (D.B.H., i.e. diameter of a tree measured at standard height (4'3") above ground) and about 5% in trees larger than 127 cm D.B.H. The yield of pulp-

wood averaged 63 cunits per ha, ranging from 28 - 133 cunits per ha. About 90% occurs in stands that would yield in excess of 35 cunits per ha. Only a small portion of the pulpwood resource is on slopes greater than 25°, since such slopes usually carry low-volume forest except in the most sheltered situations.

Other wood products

Over the years the local community has relied on the forest area for the supply of fencing materials - strainers, posts, droppers, rails, and stays - together with poles and building materials. The study district has produced poles for the State Electricity Commission, and a few P.M.G. poles, averaging 800 per annum over the last 10 years.

Firewood traditionally has been obtained from forest areas, but this market is rapidly vanishing. The Reef Hills (totalling 2,040 ha) has produced about 418 cu m of firewood annually in recent years, together with an annual average of about 5,500 poles, posts, strainers, and stays over the last 10 years. Revenue from wood products has returned an average annual sum of $1,640.

The blue gum stands have been a useful source for the supply of bridge timbers - girders, beams, and decking. Hop poles for use in the Ovens Valley have been produced from forests in the eastern margins of the study district.

Capability

Intensive hardwood production involves the growing of merchantable hardwood species in perpetuity under intensive management to produce desired wood products. Suitable areas for intensive hardwood production satisfy the following criteria.

* They contain hardwood stands capable of economic production, with mature top height exceeding 29 m and basal area of potentially merchantable trees exceeding 18 sq m of adequately stocked regrowth per ha. (Table 19 broadly classifies the forests in terms of productivity. Continuous forest inventory plots have been established in the region, and existing productivity has been calculated from limited plot information for messmate, candlebark, and narrow-leaf peppermint stands. Potential productivity has been estimated from this and other available information.)

* They form a continuous compact unit of at least 80 ha, containing predominantly suitable or potentially suitable stands.

* They generally have a slope of less than 20°.

* They do not contain significant scientific or scenic values that would be permanently degraded by timber production.

TABLE 19

HARDWOOD TIMBER PRODUCTION

| Category | Native vegetation | Major soils | Productivity (C.A.I. & M.A.I.)* cu m/ha/year ** |
|---|---|---|---|
| A | Alpine ash open forest III (28-40 m) candlebark stands more than 40 m high | Friable brownish gradational soils | Estimated actual C.A.I. 2.8 Potential M.A.I. 4.2 (sawlogs and pulpwood) |
| B | Messmate stringybark open forest III and IV (28-40+m) | Friable brownish gradational soils; reddish duplex soils | Estimated actual C.A.I. 2.0 Potential M.A.I. 3.2 - 3.9 (sawlogs and pulpwood) |
| C | Narrow-leaf peppermint open forest III (20-40 m) | Friable brownish gradational soils; friable reddish gradational soils (with weakly structured subsoils); reddish duplex soils | Estimated actual C.A.I. 1.0 Potential M.A.I. 2.0 - 2.8 (sawlogs and pulpwood) |
| D | Broad-leaf peppermint and red stringybark open forest II (15-28 m) | Yellowish duplex soils; weakly bleached friable gradational soils; reddish duplex soils | Estimated actual C.A.I. 0.7 Potential M.A.I. 1.4 (sawlogs and pulpwood) |
| E | Grey box open forest II (24-28 m), river red gum open forest II | Reddish and yellowish duplex soils; gilgaied yellowish duplex soils | Posts, poles, and firewood only |
| F | Blakely's red gum open forest I (<15 m); mountain swamp gum open forest II (15-28 m) | Coarse sandy loams; weakly bleached massive gradational soils | Firewood only |

* C.A.I. = current annual increment of logs only
M.A.I. = mean annual increment = $\frac{\text{total volume production (cu m/ha)}}{\text{number of years in rotation}}$

** 1 cubic metre per hectare = 14.29 cubic feet per acre

# SOFTWOOD PRODUCTION

## Outlook

In 1971/72 the Commonwealth Forestry and Timber Bureau estimated that Australia consumed 16.7 million cubic metres round wood equivalents (r.w.e. - that is, the gross volume of logs) in the manufacture of various products. Of this volume, it is estimated that 73% (12.2 million cu m r.w.e.) came from sources within Australia and 27% (4.5 million cu m r.w.e.) from imports. In the same period Australia exported about 0.3 million cu m r.w.e. of wood.

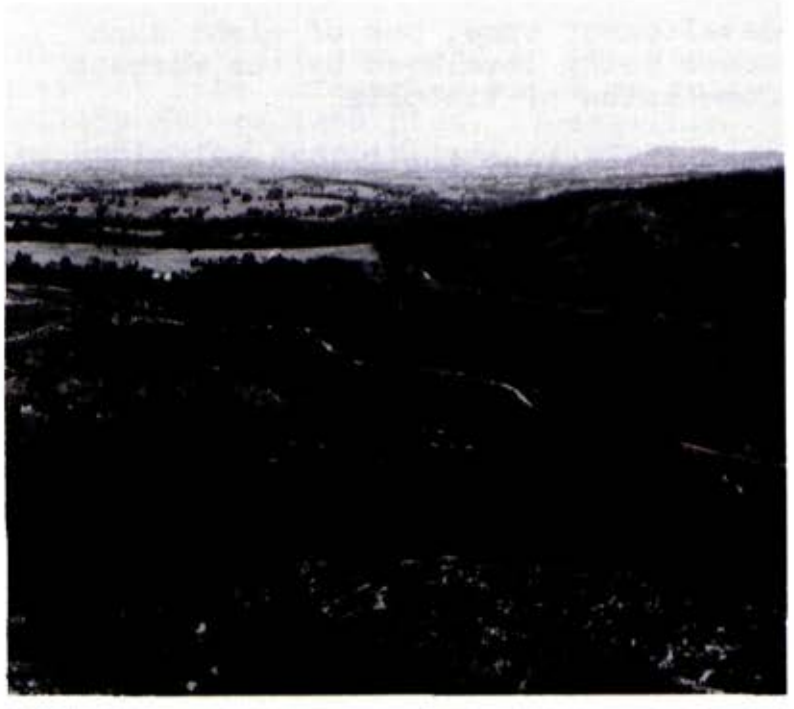
One demand figure projected (Australia, Forestry and Timber Bureau 1970) for the year 2000 is 30.5 million cu m r.w.e. Routley and Routley (1972), using different assumptions, set a figure of the order of 20 million cu m r.w.e. The Commonwealth Government supports an increase in Australia's forest resources, to cater for greater demand and to decrease the proportion of imported wood consumed. It gives financial assistance to State forest services to encourage softwood planting, the target being 1.2 million ha by the year 2000. This target is subject to periodic adjustments and, as it stands, has been criticized on various grounds as being too high.

Australian consumption of pulp and paper in 1971/72 was estimated by the Forests Commission of Victoria to be 4.16 million cu m (r.w.e.). Imports provided 2.72 million cu m (65%) of this total. In 1971, the Forestry and Timber Bureau estimated projected consumption for the year 2000 at 14 million cu m (r.w.e.), a threefold increase.

## Industry requirements

In general, the industry requires plantations in large compact blocks, close to centres of population and served by good transport facilities. In Victoria, only about eight areas meet these requirements. Large plantations enable the owner to benefit from economies of scale in establishment, fire protection, roads, and maintenance costs. The generally flat to gentle terrain of uplands assists planting and harvesting. As log transport costs make up a high proportion of the cost of raw materials, it is desirable that plantations be located close to the milling centre.

The most efficient utilization of raw materials is achieved by a complex of integrated industries, which can handle small-size material from thinnings as



*Two pine plantations - on the eastern flank of the North Blue Range (left) and near Boho South*

well as logs and in which one industry can utilize the by-products of another. However, modern wood-processing plants such as sawmills and particle-board plants are capital-intensive, and an assured supply of raw material is a prerequisite to their construction.

In general, economies of scale are realized in plantations larger than 4,000 ha, and a plantation resource of the order of 16,000 ha is necessary to support an integrated complex of industries, the main components of which would be a large sawmill and a groundwood pulp factory. Such industries need guaranteed supplies of volumes of timber. Continuity of supply has been guaranteed for establishment of such industries in the past in Victoria.

## The Study District

Two pine plantation schemes are in operation in this district, one in the Strathbogie Ranges and the other in the Tolmie highlands. Together they comprise the Benalla/Mansfield plantation

development zone, one of eight such zones being developed by the Forests Commission of Victoria.

The plantations the Commission plans for this and adjacent areas (totalling about 28,000 ha) would form an economically attractive resource capable, together with local hardwood resources, of supporting large integrated industries including a major pulp mill. It follows that the plantations will provide an economic basis for decentralized development.

History

Between 1964 and 1967, the Forests Commission completed site appreciation surveys on some 67,800 ha of country in the study district, which indicated that about 34,000 ha of public land and adjacent private property would be suitable for radiata pine culture. First plantings took place near Warrenbayne in 1964 and in the Blue Range Creek valley during 1969. The current annual planting rate for the district is 700 ha, and 3,837 ha net had been planted to December 1972.

During the past 10 years, the Commission has purchased some 2,012 ha of adjacent farmland in the Strathbogies for inclusion into the planting programme, at an average cost of $66 per ha. Of this, 1,900 ha have been planted. However, the availability of further farmland at economic prices is unpredictable.

Requirements of radiata pine

Sites for commercial radiata pine plantations in north-eastern Victoria need:

* a minimum annual rainfall of 760 mm
* an acid soil of at least moderate nutrient status
* soils with physical characteristics that allow vigorous root growth and with sufficient volume to support an adequate root system
* soils with good drainage but adequate soil-moisture storage characteristics

Rainfall

The map facing page 34 indicates that most of the district has a rainfall of 760 mm or more.

Soil fertility

Phosphorus, which is important in pine nutrition, is present in adequate amounts on the friable reddish and brownish gradational soils on which most pines are grown. There have been no significant pine growth responses to experimental superphosphate treatments in the Blue Range Creek plantation.

Physical soil properties

The physical properties of most soils on the uplands permit vigorous root growth

and have reasonable soil-moisture storage characteristics.

Capability

Although radiata pine grows quite rapidly in this region by world standards, wide variations in growth rate occur due to differing site factors. Growth rates can be expressed in terms of site quality, which is a measure of the total volume of timber produced. Plantations are assessed and placed into site quality classes (SQ) at about 10 years, to form the basis for calculating growth rates and the quantities of the various classes of log material that will become available for industry.

Seven qualities have been defined. Five (SQI - SQV) cover healthy stands; SQVI means marginally healthy, and SQVII ranges from marginal to failed.

The site quality of a stand can be estimated from the height of the trees at the age of 20, called Site Index: a stand with a Site Index of 90 would fall into class SQIII. Table 20 sets out the productivities of the different classes.

It is not possible to classify a site accurately until a stand of trees has actually grown on it. However, the form or composition of native vegetation and soil, climatic, and topographic factors are useful indicators of suitability for radiata pine.

Table 21 divides the land in the study district into categories based on suitability for radiata pine. These form the basis for descriptions of pine potential in Part IV.

Other softwood species

On sheltered sites at the higher elevations, where rainfall is high (1,140-1,270 mm), temperatures are cool, and soils are deep and rock-free, Douglas fir *(Pseudotsuga menziesii)* would be

*Douglas fir experimental plot in the Tolmie highlands*

Table 20

SITE QUALITY FOR RADIATA PINE

| Site quality (SQ) | Site Index height (ft) at age 20 | Total yield over 30 years (cu m under bark to 4 in. ØSE per ha)* | Average annual yield+ (units as in col.3) |
|---|---|---|---|
| I | 102 | 955 | 32 |
| II | 96 | 850 | 28 |
| III | 90 | 745 | 25 |
| IV | 85 | 645 | 22 |
| V | 79 | 535 | 18 |
| VI | 71 | 380 | 13 |
| VII | 61 | 237 | 8 |

* ØSE - small-end diameter of the log

\+ Approximately half of this volume comprises sawlogs with a small-end diameter exceeding 8 in. (8 in. ØSE)

TABLE 21

RADIATA PINE PRODUCTIVITY CLASSES

| Category | Native Vegetation | Major soils | Indicated pine potential |
|---|---|---|---|
| A | Narrow-leaf peppermint open forest III above about 900 m | Friable reddish gradational soils (with well-structured subsoils), friable brownish gradational soils | Site quality I to II (very susceptible to snow damage, however, giving lower volumes than SQ indicates) |
| B | Messmate stringybark open forest III and IV | Friable brownish gradational soils, reddish duplex soils | Site quality II |
| C | Narrow-leaf peppermint open forest III below about 900 m | Friable reddish gradational soils (with weakly structured subsoils), friable brownish gradational soils, reddish duplex soils | Site quality II to IV |
| D | Broad-leaf peppermint : candlebark open forest II | Reddish and yellowish duplex soils, weakly bleached friable gradational soils | Site quality V to VI (could be raised by fertilizer applications) |
| E | Broad-leaf peppermint : red stringybark open forest II | Reddish and yellowish duplex soils, weakly bleached friable gradational soils, undifferentiated stony loams | Site quality V to VI (could be raised by fertilizer applications) |
| F | Red stringybark : long-leaf box : red box open forest I and II | Undifferentiated stony loams, weakly bleached friable gradational soils | Site qualities V to VII (could be raised by fertilizer applications) |
| G | River red gum open forest II, grey box open forest II, Blakely's red gum open forest I, mountain swamp gum open forest II | Various | Site quality VI to VII |

suitable as a softwood plantation species.

The expected yields would be of the order expected from radiata pine site qualities II and III. Results from experimental plots in the district will establish productivity in due course.

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# ECONOMIC MINERALS

Around the turn of the century, the area was a fairly important gold-producing region with numerous mines, but now production has all but ceased. At present it contains only a small amount of extractive industry.

*Gravel pit at Mt. Pleasant*

## Extractive Industry

Little extraction of materials occurs on public land at present, but an application for gravel extraction is current at Mount Pleasant and gravel has recently been removed from the Reef Hills. On private land, two quarries in the town of Glenrowan are providing granite.

A 48-ha basalt quarry, with crushing plant, operates about 13 km north-east of Euroa, and another smaller one is situated 13 km to the south near Seven Creeks. An open-cut clay pit established at Euroa has estimated reserves of about 440,000 cu m.

## Minerals

The locations of most minerals occurring in the district are displayed on the map facing page 134.

### Gold

Five major gold-bearing areas occur in the district, centred around the Reef Hills, Toombullup and Archerton, Barjarg and Maindample, Tallangalook and Bonnie Doon, and Merton. A lease near Merton is still operative.

At the Golden Mountain mine at Tallangalook, gold was extracted by both open-cut and underground stoping methods. Gold along joints and fault fissures enriched the low values of the ore, but this mine has now been abandoned. The intrusion of granite caused dissemination of gold through the Silurian country rock, in addition to metamorphic effects resulting in quartzites, hornfelses, and micaceous sandstones. There was also introduction of pyrite and arsenopyrite. Quartz veins were rare, and where present contained little gold. Abandoned mines such as the Golden Mountain mine, Woolf's mine at Tallangalook, and the Main Reef mine at Maindample may reopen under more suitable economic conditions.

Much alluvial gold-mining also took place around the turn of the century. North of Tallangalook, in the Tallangalook Creek, sluicing produced very fine gold with a little cassiterite and rounded topaz and garnets. Gold-bearing wash dirt was traced for 1.2 km along the Ryan's Creek watershed in the Toombullup region. Two types of gold were recovered - ragged small fragments adhering to small pieces of quartz, and larger waterworn pieces obtained from lower levels. Much fine-grained cassiterite was associated with the gold.

Antimony

The most important occurrence of antimony occurs at Tatong in a lode 1½ m wide, striking 300° and dipping 65°S, where the antimony occurs as stibnite in a quartz matrix. The bunches contain only small quantities of ore. The country rock has been metamorphosed and mining is difficult. No parallel lodes have been discovered. Gold yields associated with the stibnite are low.

Near Hayfield Creek, east of Merton, a reef 1 m thick (strike NE and dip SE) has been worked to a depth of 70 m. The quantities of stibnite increase with depth. Some of the recovered ore was burnt in order to obtain gold. An application to mine in this area is current. Stibnite also occurs near Tiger Hill in the Tolmie highlands.

Felspar

Massive orthoclase felspar outcrops at a locality 13 km north of Maindample in a coarse pegmatite dyke. The pegmatite is almost completely free from quartz, mica, and iron oxides. Tests indicate that the felspar could be readily marketed, and is of sufficient quality to enable it to be used in the manufacture of ceramics. Other uses of felspar are as a glaze for certain types of glass, chinaware, and tiles.

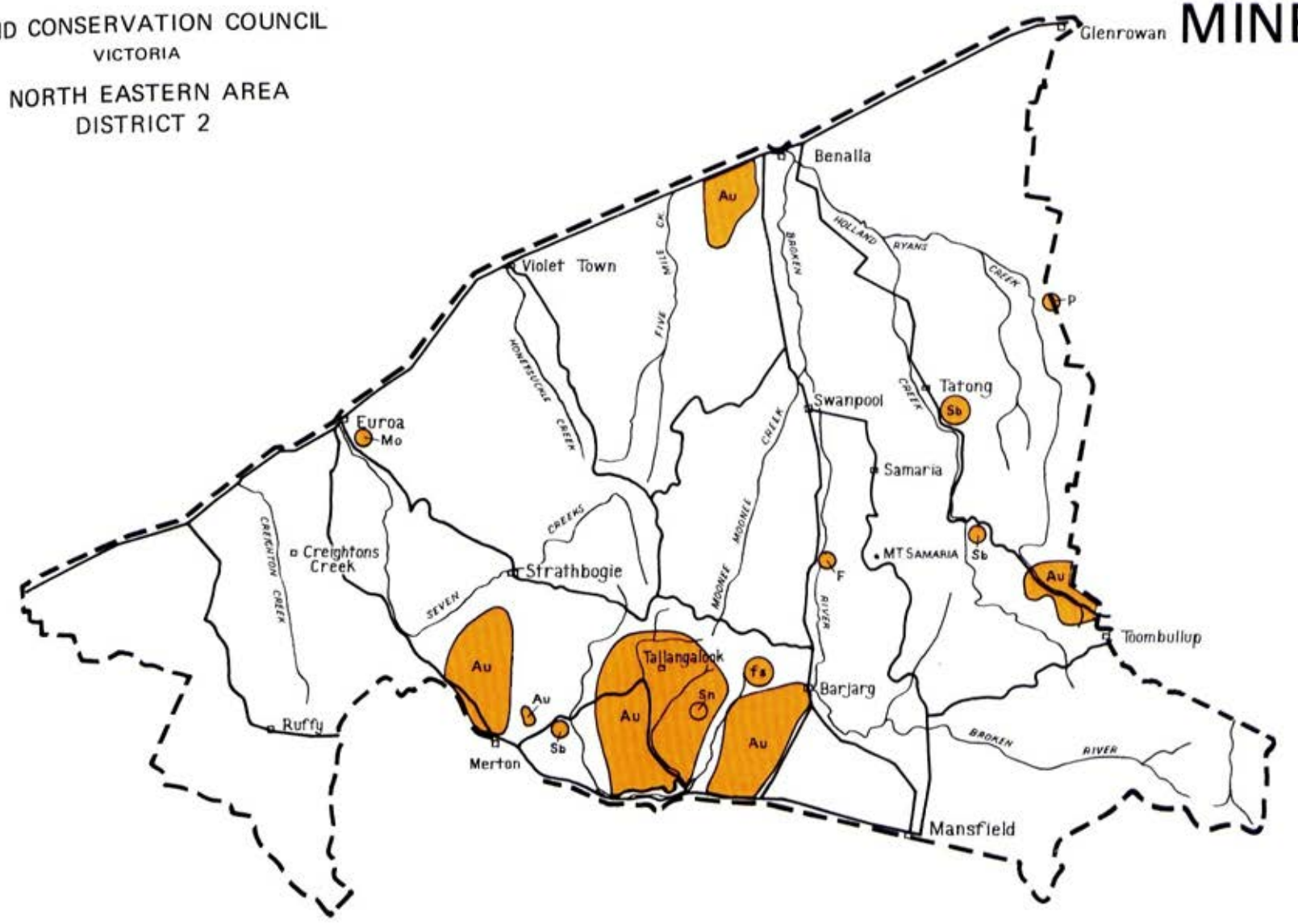
Quartz

Piezo-electric quartz was previously mined at the Crystal King mine, Tallangalook, from pipes in coarse-grained biotite granite. Quartz bodies occ-

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 2

# MINERALS




LEGEND

| | | | | | |
|---|---|---|---|---|---|
| Outcrop area | | Sb | Antimony | Mo | Molybdenum |
| Minor deposit | | fs | Felspar | P | Phosphate |
| Occurrence | | F | Fluorine | Sn | Tin |
| | | Au | Gold | | |

Scale 1:500,000

MILES 0 5 10 15

KILOMETRES 0 5 10 15

Adopted from "Mineral Deposits, VICTORIA, JULY, 1970",
MINES DEPARTMENT, MELBOURNE

vughs in the pipes, smaller in diameter than the latter, and concentric with them. Four pipes are located in the area and quartz was extracted from each. Most of the crystals recovered from the workings have diameters from 8 to 15 cm and short stumpy shapes due to poor development of prism faces. Doubly terminated crystals are absent.

The crystals are colourless, smokey grey, or brown. Defects, including twinning, liquid inclusions, and inclusions of rutile and muscovite rosettes, render them useless as piezo-electric crystals. However, those at Tallangalook are highly prized by gemstone collectors.

Tin

An alluvial deposit at Tallangalook composed of granite drift, granite boulders, quartz wash, and consolidated granite detritus contains samples of tourmaline and cassiterite. Several prospects failed to give any trace of larger quantities of tin.

Titanium

Titanium has been recorded as titanite in dish prospects from the alluvium in some streams in the district.

Fluorite

Applications have been made for a mineral lease to mine fluorite beside the Broken River just downstream of Lake Nillahcootie and for mineral search licences along Sandy Creek, which flows into the lake.

Chromite

Chromite (an oxide of iron and chromium) has been recorded from the Cambrian diabases at Tatong and also in stream sands from Benalla.

Molybdenum

Molybedum, in the form of molybdenite, occurs at Euroa as films along joint veins in the granite. A preliminary investigation of the deposit has been made.

Tungsten

Wolframite was mined at Samaria. This lease has now been abansoned but another nearby has been applied for, to seek bismuth.

Phosphate

A minor phosphate occurrence, similar to the more important deposits at Mansfield, has been reported near Molyullah. Fossiliferous phosphate rock, commonly associated with black cherts, has been folded and crumpled by intense movement. Secondary changes and complete induration of the rock took place. Aluminium from adjacent clayey sediments may have replaced the calcium and formed aluminium phosphates in certain beds. Sec-

ondary minerals associated with the deposit are turquoise, dufrenite (a phosphate mineral), and quartz with very small quantities of pyrites. Some phosphate nodules found in conjunction with the turquoise and dufrenite assay up to 15% $P_2O_5$.

## Gemstones

### Turquoise

Turquoise occurs as thin veins in dark grey slate in the Ryan's Creek area. The country rock strikes 325° and dips 80°NE, with the turquoise veins 6 mm to 8 mm thick. Weathering on the surface of the outcrops has given the mineral a bleached appearance, but a few centimetres deeper the characteristic sky-blue colour shows out. Extensive mining operations have been carried out further to the east.

### Jasper and chert

About 2 km south-west of Tatong lies an area of highly indurated sedimentary beds of various colours. The beds, striking 320°, are, in some cases, red jasper, black cherts, and green vitreous cherts, containing disseminated pyrites and approaching chalcedony in places.

A green hornblendic dyke (containing calcite and pyrites) trends northwards, cutting the jasper beds, and apparently accounts for the green coloration of the vitreous cherts.

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# WATER UTILIZATION

Very low rainfalls in 1968 and 1972 have resulted in a greater interest in water supply than ever before. Farmers' organizations and local groups are encouraging the construction of water conservation schemes wherever practicable and, among farmers whose land does not adjoin streams, the construction of farm dams has never been more popular.

*Spray irrigation of pasture along the Broken River*

At the same time, the water needs for rural towns are rapidly expanding and some areas will need additional storages.

## Utilization in the Study District

### Irrigation

Diverters in this district who irrigate receive authority (either by permit or licence) to irrigate a specific area or to use a specific volume of water. Most irrigators from regulated streams have their supply metered, but for irrigators from unregulated streams the quantity of water used in any one irrigation season is arrived at arbitrarily - the formula varies with rainfall and type of crop being irrigated.

Until all diversions of water are metered, no accurate assessment of water usage can be made. Table 23 shows the present permit and licence situation and indicated purpose of irrigation.

Of the area irrigated from the Broken River, about 360 ha lie within the district. In addition, about 300 ha are irrigated from the Broken Creek (outside

the study district), which receives most of its water from the Broken River catchment. The whole licensed area is seldom watered in any one season. Most of the unregulated streams in this district are unreliable during summer, and cannot support extensive irrigation.

Most of these unregulated streams are considered to be fully committed. That is, no further authority to take water for irrigation direct from the stream will be issued. The completion of Lake Nillahcootie has made more water available to land-owners adjacent to the Broken River and Broken Creek.

Table 22

PRESENT TOWN WATER USAGE

| Town | Average daily rate (Ml) | Maximum daily rate (Ml) |
|---|---|---|
| Benalla | 3.64 | 13.64 |
| Euroa | 0.91 | 4.00 to 4.55 |
| Violet Town | N.A. | N.A. |
| Mansfield | 1.14* | 3.18 |
| Glenrowan | 0.16 | 0.23 |

* No measurements - approximate figures

*The Loombah Weir*

Domestic supplies for towns

Table 22 sets out present usage for the principal towns in megalitres (Ml).

Benalla derives its supplies from the Loombah Weir - 45 km away on Ryans Creek. The water is piped to a service basin 13 km from Benalla and thence to an elevated tank in the town. An additional 1,000-Ml storage is currently being constructed on Ryans Creek upstream from the Loombah Weir.

Euroa draws the bulk of its supply from Polly McQuinn's Reservoir on Seven Creeks. The water is released and piped from a diversion weir at Gooram to Mountain Hut Dam, then piped to Euroa *via* a service basin.

Table 23 - WATER USE

| Source | Number of irrigation permits and licences | Number of other permits | |
|---|---|---|---|
| | | Domestic permits | Industrial permits |
| Broken River catchment | | | |
| * Broken River | 83 | 24 | 1 |
| ++Broken Creek | 21 | 12 | - |
| Back Creek | 7 | 2 | - |
| Warrenbayne Creek | 1 | 1 | - |
| Four Mile Creek | 1 | - | - |
| Chinamans Creek | 2 | - | - |
| Hollands Creek | 8 | 2 | - |
| Moonee Moonee and Lima Creeks | 15 | 2 | - |
| Ryans Creek | 4 | 15 | - |
| Spring Creek | 1 | - | - |
| * Lake Nillahcootie | 1 | - | - |
| Unnamed tributaries | 2 | 1 | - |
| Lake Eildon tributaries | | | |
| Brankeet Creek | 1 | 2 | - |
| Fords Creek | 3 | - | - |
| Tallangalook Creek | - | 4 | - |
| Glen Creek | - | 1 | - |
| Upper Goulburn tributaries | | | |
| Castle Creek | 2 | 1 | - |
| Creightons Creek | 1 | 2 | - |
| Faithful Creek | 2 | - | - |
| Pranjip Creek | 1 | - | - |
| Seven Creeks | 15 | 17 | - |

* Not fully committed ++ Outside the district, but deriving water from it

Table 23 (continued)

| Area of agricultural enterprise irrigated (ha) | | | | |
|---|---|---|---|---|
| Perennial pasture | Annual pasture and crops | Lucerne | Market gardens, tobacco, vines orchards, nursery, etc. | Total |
| 759 | 118 | 284 | 23 | 1,184+ |
| 177 | 47 | 79 | ½ | 303½ |
| 20 | - | - | 5 | 25 |
| 4 | - | - | - | 4 |
| - | - | 2 | - | 2 |
| 1½ | - | - | ½ | 2 |
| 8 | - | 8 | 4 | 20 |
| 47 | - | - | 2 | 49 |
| 6 | - | - | ½ | 6½ |
| 2 | - | - | - | 2 |
| 8 | - | - | - | 8 |
| 6 | - | - | - | 6 |
| 6 | - | - | - | 6 |
| 13 | 1 | - | - | 14 |
| - | - | - | - | - |
| - | - | - | - | - |
| - | - | 19 | - | 19 |
| - | - | - | 2 | 2 |
| - | - | 8 | - | 8 |
| - | - | - | 4 | 4 |
| 74 | - | 8 | 3 | 85 |
| + Approx 360 ha within the district are irrigated | | | | 1,750 |

*Dam construction on Ryans Creek will impound water to augment Benalla's water supply*

Violet Town has water piped from two small dams on Honeysuckle Creek *via* a service basin at the town. Mansfield derives its water from a diversion weir on the Delatite River. The water is piped to two service basins and thence to the town's reticulation system.

Water quality has been considered in chapter 7. Treatment of the water supply is proposed for both Euroa and Mansfield

Future requirements

The trend of an increase in irrigation area is likely to remain slow in most places. However, development along the Broken River system below Lake Nillahcootie could increase significantly if the returns from irrigated pastures continue to improve and stabilize. The drought conditions during the latter part of 1972 have stimulated interest in irrigation, and the Broken River system is one of the few areas where water is available direct from the stream. Pastures for dairying and for stock fattening appear to be the most likely usage, while some limited areas may be developed for market gardening.

Elsewhere, the cost of storage must be included in the initial outlay, and the total area of land irrigated will propably not increase significantly.

Smaller storages for domestic and stock supplies will no doubt increase in number and size. These may be either for single farms or for groups of farms.

Water conservation within the Broken River system is propably reaching an optimum now that Lake Nillahcootie and Lake Mokoan are completed and it will take some years before the water conserved in these storages is fully utilized. The McCall Say Dam - an addition-

al 1,000 Ml storage under construction on Ryans Creek, upstream of the Loombah Weir - will augment supplies to the City of Benalla. Possible future town water supply storages will be required in the upper reaches of Seven Creeks for Strathbogie and in the lower reaches for Euroa.

Increased urban and industrial use may eventually dictate the construction of more costly water conservation projects. This district has sufficient water resources, mostly in surface streams, to meet urban and industrial requirements for many times the present population.

# APICULTURE

Apiculture is a small but important primary industry producing honey and beeswax.

## The industry

Honey is used mainly as a food for humans, but also as food for stock and in the preparation of meat, vinegar, some types of tobacco, and some pharmaceutical and cosmetic products. Beeswax is used in a wide variety of industries, the most important consumers being polish and cosmetic manufacturers. Pollen is being sought after as a protein health food.

Apiculture contributes to the welfare of some other primary industries; many fruit, vegetable, and seed crops of commercial importance depend almost completely upon the honey bee for pollination. Such crops include apples, cherries, plums, pears, pumpkins, cabbages, clovers, rape, and sunflowers.

The number of apiarists registered in Victoria in 1970/71 was 1,278. Many of these, however, have few hives and make an insignificant contribution to the industry. About 300 apiarists produce 90% of the State's honey and beeswax.

## Level of production

The Victorian annual production of honey during the last 5 years has averaged 3.3 million kg (with a net value of $750,000), and represents just over 18% of the total Australian production of 18.1 million kg. A large proportion of Australian honey is exported to the United Kingdom, and in 1970/71 Victoria produced 4.45 million kg, of which 2.95 million kg (66%) was exported.

Beeswax is also exported, Japan and the United Kingdom being the main buyers. Of the 54,400 kg produced in Victoria in 1970/71, 45,800 kg (83%) was exported. This represents about one-third of the Australian exports.

The level of production can fluctuate considerably due to climatic conditions. For example, as a result of the 1967 drought, the 1968/69 production figure for honey was only 1.6 million kg, compared with the 1970/71 figure of 4.45 million kg.

## Outlook

World demand for honey has increased noticeably in recent times. One reason

for this is that people in many countries now regard honey as a health food. It is a natural food that is unlikely to be contaminated by insecticides.

Supply has not been able to meet demand this past year, so present prices are high. Demand will probably increase in the future.

## Industry Requirements

### The honey bee

Australia contains a number of indigenous bee species. The honey bee used in apiculture, however, is the European species *Apis mellifera*.

Efficient production of honey requires that colonies of bees be kept healthy and at top strength, and that the colonies be relocated periodically so that they can readily harvest a continuous series of nectar flows.

### Maintaining the colony

Bees collect nectar, water, pollen and propolis. They convert the nectar into honey, which is the major energy-producing food for the hive, and use water for drinking, for diluting honey to make food for the bee larvae, and for cooling the hive. Pollen is the bee's sole source of protein. Propolis, a resinous exudation from certain plants, provides a general-purpose cement or putty about the hive.

*Robbing the hives*

In the natural state, bees collect and store sufficient nectar and pollen over the summer months to provide themselves with food for winter and for rearing young bees in spring. Thus, when a beekeeper manages bees for honey production, he never harvests all the honey the colony makes, but leaves a large quantity (up to 80 kg a year) for the prosperity of the colony. The beekeeper's crop is the surplus honey over and above the basic requirements of the hive.

Adequate stores of pollen and honey must be available to the bees if they are to survive the winter and produce a full strength of young bees ready to commence harvesting the first nectar flows in the following season.

## Importance of eucalypts

The principal supply of nectar in Victoria comes from eucalypts and a few other native trees and shrubs. The native ground flora, although important in other countries, is of relatively little importance as a source of nectar in most parts of Victoria. Introduced ground species such as cape weed and Paterson's curse contribute to honey yields, however.

The value of particular eucalypt species to the apiarist depends on its flowering periods and its yield of nectar and pollen. Flowering periods vary, not only between species but also within species from district to district, depending on local climatic conditions.

Flowering intensity varies from year to year, poor flowering being caused by low levels of food reserves within the tree, by adverse weather, or by insect attack or fire resulting in defoliation. As a general rule, however, the majority of important eucalypts flower heavily every second or third year. Some species are valued for their yield of either nectar or pollen, others for their yield of both.

## Migratory beekeeping

Because of its dependence upon flowering eucalypts, beekeeping must be migratory or nomadic. For maximum production of honey, hives are moved from district to district to coincide with peak nectar flows of various eucalypts over the summer months. Hives must be placed not only close to the nectar source, but also close to a reliable water source. An adequate source of pollen must be available too, especially in autumn when bees are storing food for winter.

The best localities for over-wintering hives are warm coastal districts or the so-called desert areas of western Victoria and south-eastern South Australia. However, other localities in northern Victoria, such as the Warby ranges near Wangaratta, provide good wintering conditions.

## Beekeeping in the District

This district is mainly used by local apiarists, but migratory beekeepers also come here to harvest red stringybark flows.

## Pattern of use

Many colonies using the area would be wintered in localities such as the Lurg Hills and Violet Town, Gooram, and Mollyullah areas within the district and the Warby ranges to the north of it.

The nectar and pollen from capeweed and other ground flora (mainly introduced species) builds up the strength of the hives ready for the spring and summer nectar flows.

Every second year, the Blakely's red gum of the rocky hills produces nectar flows from October to November. This constitutes the first honey crop of the season. Red box also produces nectar flows in spring. From early December to January, honey can be harvested from river red gums about once every 3 years.

During the summer and into autumn, the hives would then be moved to the higher areas to harvest flows from narrow-leaf peppermint, St. John's blue gum, red stringybark, messmate, long-leaf box, candlebark, and manna gum, the sequence depending on budding and flowering cycles. Red stringybark for instance is harvested about one year in four and St. John's blue gum one in three.

When no summer crops are available, these high areas provide valuable breeding conditions for bees once the ground flora has dried off on the lower foothills and plains.

In early autumn, bees may be moved to the lower country to harvest crops from grey box and red ironbark.

The bees breed prolifically during the flowering of all species (with the exception of red box) because of the abundance of pollen produced.

Important plants

Table 24 lists the plant species important to apiarists in decreasing mag-

*Beehives on a site in grey box open forest*

nitude of total honey yield. It also indicates the usual flowering period, and the honey and pollen yields, of these species.

Value of area to the industry

Figures collated from apiarists' records and checked by the Department of Agriculture indicate that the district provides a livelihood for the equivalent of 36 beekeepers and employees and returns a total of $132,000 gross a year, based on an average wholesale price of 12 cents per lb of honey. This is a conservative valuation, as 1973 wholesale prices average more than 20 cents per lb and this level is likely to continue. The average annual production is about

500,000 kg-approximately 15% of the State's production.

In any one of the last 12 years, up to 200 sites have utilized flora of forest areas, 22 sites utilized stream frontages, 22 sites utilized road reserves, 16 sites utilized small parcels of public land, and 25 sites utilized private property.

Usage in the district is close to its capacity now, although an increase would result from better access in the Ryans, Stockyard, and Samaria blocks.

Bunston, Ryans, and Hat Hill blocks have some potential for the breeding of queen bees and commercial pollen production. The relative isolation of these areas is one requirement for queen been breeding, and the peppermint-gum forests provide the adequate sources of pollen necessary for good breeding conditions and for commercial pollen production.

Considerations

Land clearing in the past has largely removed the grey box, river red gum, yellow box, red box, white box, and red ironbark of the plains and broad valley floors, and also some red stringybark and long-leaf box forests on the low hills.

The Reef Hills near Benalla and various stream frontages and road reserves are the main remaining areas of the former groups of species. River red gum in the Mansfield plain is important to apiarists because it flowers at variance with other red gum flowering cycles. The remaining red gums are either along road reserves or on private property. Considerable areas of red stringybark forest remain, and these form the primary source of honey in the district.

The establishment of pine plantations at Warrenbayne and in the Holland Creek area has reduced honey production in this locality, due to the removal of native species.

Large areas of public land are becoming increasingly important to apiarists as private property is progressively cleared and as insecticides, especially those applied by aerial spraying, are more widely used in agriculture. This is evident in the Lurg block.

Beekeeping is compatible with almost all forms of land use that retain a cover of suitable flowering plants. Nectar and pollen crops can be harvested from such areas repeatedly without detriment to most other values. There is a lack of knowledge of the relations of bees with birds and mammals that also utilize nectar and pollen from blossoms or with native predators.

References

Anon. The honey industry. *Victorian Year Book*, 1972, 86, 353-4

TABLE 24

IMPORTANT HONEY- AND POLLEN-PRODUCING PLANTS OF THE DISTRICT

| Species | Flowering periods | Average Honey yield* (per hive per usage) | Pollen yield |
|---|---|---|---|
| Red stringybark | Feb - Apr | Good: 30 - 80 kg | Good |
| St. John's blue gum | Jan - Feb | Good: 14 - 40 kg | Good |
| River red gum | Dec - Jan | Good: 30 - 55 kg | Good |
| White gum (candlebark and manna gum) | Feb/Mar - May | Fair: 9 - 18 kg | Good |
| Grey box | Feb/Mar -Apr | Good: 40 - 55 kg | Good |
| Hill gum (Blakely's red gum) | Oct - Nov | Good: 14 - 30 kg | Good |
| Narrow-leaf peppermint | Dec - Jan | Fair: 20 - 23 kg | Good |
| Capeweed | Sep - Oct | Fair/poor: 4 - 14 kg | Good |
| Long-leaf box | Mar - Apr | Good: 14 - 30 kg | Good |
| Messmate | Feb - Mar | Good: 9 - 30 kg | Good |
| Red box | Sep - Oct/Nov | Good: 14 - 30 kg | Poor |
| Red ironbark | Mar - Sep | Good: 30 kg | Good |
| Mountain swamp gum | Apr - May | Poor: 2 - 4 kg | Good |
| White box | Apr - Aug | Fair: 10 kg | Good |
| Broad-leaf peppermint | Sep - Oct | Poor: 4 kg | Good |
| Yellow box | Dec | Good: 14 kg | Good |

* 1 Kilogram = 2.2 lb

Anon. "Apiculture - Season 70-71." (Commonwealth Bureau of Census and Statistics (Reference No. 35: Melbourne 1971.)

# LAND USE RELATIONS

The preceding chapters of this report have described the natural resources of the study district and discussed the potential uses of public land. This chapter examines the relations between these various uses.

Uses are said to be competitive when an increase in one leads to a decrease in another based on the same set of resources; they are supplementary when the increase in one does not lead to any change in another, and complementary when an increase in one benefits another.

Often a given set of uses can be complementary, supplementary, or competitive - depending on the level of each. The most flexible uses are often those that are complementary or supplementary with many others over a wide range of levels.

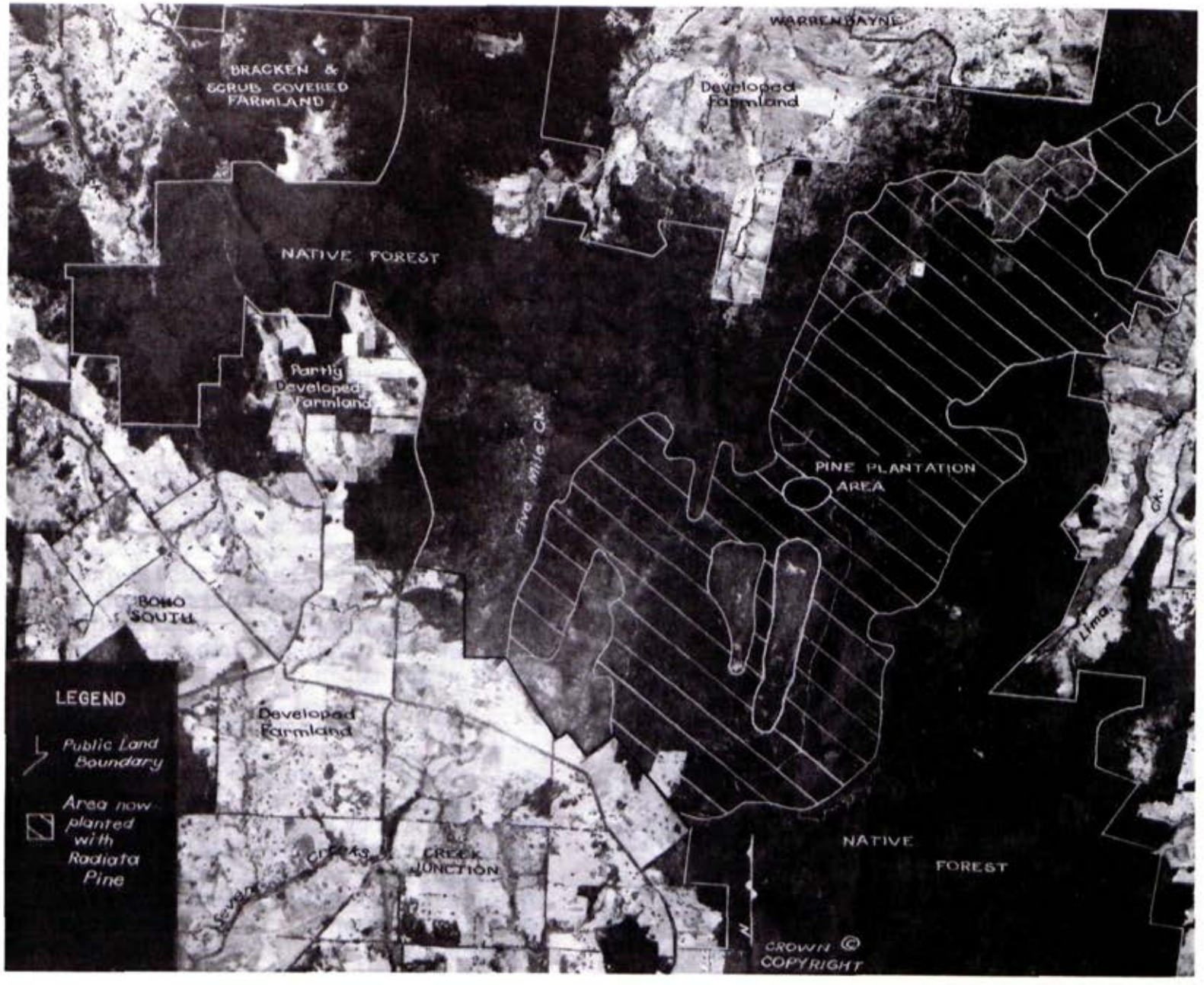
## Agricultural production

Mixed grazing of medium intensity on the Benalla plain, Mansfield plain, and the eastern section of the Strathbogie massif gives way to grazing at an extensive level in the foothills.

On the Mansfield plain, uses supplementary to grazing include honey production and recreation activities such as driving for pleasure and picnicking, because many mature native trees have been retained.

Agriculture also favours some aspects of nature conservation, as some animal species have benefited from the expansion of grassland habitat that has been brought about by clearing and the creation of forest/grassland margins. Species such as the stubble quail, brown hawk, black-backed magpie, and eastern grey kangaroo profited at the expense of others inhabiting the original vegetation.

However, the use of additional land for agricultural production at Warrenbayne and Boho South would compete with land requirements for softwood plantations in this locality. Agricultural production is also competitive with production of high-quality water in the Seven Creeks, Mountain Hut Creek, and Honeysuckle Creek catchments, with recreation activities requiring timbered country of solitude, and with many aspects of nature conservation.




*Patterns of land use near Warrenbayne/Boho South*

Softwood timber production

Softwood timber production in plantations is an inflexible land use. It is competitive with agricultural production, honey production, nature conservation, some types of recreation, and hardwood timber production. It may also be competitive with water production, as pine plantations may use more water than the native forests in their growth. Research of this topic is continuing.

Hardwood timber production

Hardwood timber production on an extensive level constitutes a major use of public land in the study district. The present low level of production allows many complementary and supplementary uses, including grazing, honey production, all but the strictest aspect of nature conservation, most forms of outdoor recreation, and water catchment protection.

Even at high levels of utilization, hardwood timber production is still only slightly competitive with many other uses, particularly as intensive production is at present feasible on limited areas only. For example, most native plants and animals will still be conserved (perhaps with altered abundance), and opportunities for many forms of outdoor recreation will still exist.

It is competitive with agriculture and softwood timber production.

Mineral extraction

Although mining and extractive industries operating in the district at present have little impact on the environment generally, they are competitive with other uses in their particular locality. This includes extraction of gravel from stream beds.

Some quarries may be complementary with the study of some aspects of natural history. For example, the quarry at Nillahcootie, which exposes the contact between sedimentary and igneous rocks, affords geological interest.

Honey production

As previously mentioned, honey production is a supplementary use with agricultural production that retains many native trees and also with extensive hardwood production. It is competitive with certain agricultural enterprises (such as hop gardens) in which pesticides are used to a large degree, and with land uses (such as softwood production) that replace native forest. Substained high concentrations of bees may also compete with some native birds, mammals, and insects for nectar and pollen supplies.

Water production and conservation

Water production is another major use of the public lands of this district. It is to some extent competitive with agri-

culture, and with softwood and hardwood timber production, depending upon the intensity of production and the management techniques employed

The competition applies especially to the quality of water and the seasonal distribution of yield. Logging or clearing activities and overgrazing may increase stream turbidity and siltation of reservoirs.

Experience in Victoria confirms that the salinity of streams is relatively high where their catchments have been cleared for agriculture. However, the relations may not be as simple as they appear, because areas that have been favoured for clearing are often those with more salt in the soil and/or rocks to begin with.

Water storages increase the opportunities for some forms of recreation. However, they conflict with most forms of nature conservation, due not only to inundation at the storage site but also to the alteration of flood regimes and stream characteristics.

Floods in major and minor streams, with consequent inundation of the flood plains of such streams, have a beneficial effect on fish and wildlife habitat. This is particularly important for native fish and water-bird populations. While stream regulation tends to decrease the intensity and frequency of floods, it may also have removed some beneficial effects on fish and wildlife populations under certain circumstances, such as in times of severe drought. The removal of snags from streams and similar works as flood control measures may also be competitive with nature conservation.

Scientific study

Areas set aside for strict nature preservation and for scientific purposes related to the study of natural areas are competitive with all other uses, except perhaps water production. Even where parts of these areas are devoted to education and recreation, only a low level of use for activities directly related to enjoying and understanding natural environments is compatible.

# PART IV

# BLOCK DESCRIPTIONS

# BLOCK DESCRIPTIONS

The following chapters enumerate for each block the general features, the nature of the land, its capabilities for various uses, the likely hazards and conflicts involved with such uses, and the significance of the block. Each topic has the same classifying symbol in every block description, for ease of identification. The notes in most cases refer only to public land. For example, in the case of each section devoted to land systems (section B6), the percentages quoted refer to the relative amounts of public land in the block that fall within a particular land system. Sections A 1 and 3 (location and general description) and B 1 and 2 (climate and physiography and geology) describe all the land in the block.

## Capability

This term refers to the value of the land for the various uses to which it may be put. In the strict sense it refers to potential productivity, but as used here it also includes present production. For some forms of use, such as water production and nature conservation, the term refers to the inherent characteristics of the land; but for others, such as beef cattle production or softwood production, the value of the land will depend both on its inherent nature and on inputs that will raise productivity, such as fertilizer applications. Practical levels of inputs have been considered in assessing the capabilities for various uses.

In most cases, this report has dealt with assessment of capabilities in general terms, because the amount of information has varied from block to block and/or because the values are difficult to quantify.

Where productivity measures have been used, various categories have been defined and given capability ratings. These have been used in conjunction with other factors such as slope, area and location in arriving at a general block rating. Ratings for hardwood, softwood, and agricultural production are shown in Table 25, on page 156. The ratings for various uses cannot be directly compared with each other.

## Significance

The purpose of this section is to highlight the outstanding capabilities of each block.

Table 25

LAND USE CAPABILITY

| Rating | Agriculture | Softwood production | Hardwood production |
|---|---|---|---|
| High | Suitable for cropping or horticulture. Suitable for grazing - greater than 10 dry - sheep equivalents per ha | Categories A, B, and C | Categories A and B |
| Moderate | Suitable for grazing - 5-10 dry-sheep equivalents per ha | Category D | Category C |
| Low | Suitable for grazing - less than 5 dry-sheep equivalents per ha | Categories E, F, and G | Categories D, E, and F |

# 1. RUFFY

## A. General

### 1. Location

An area south of Euroa and the Hume Highway and west of the Euroa-Merton road containing 12 parcels of public land totalling 415 ha in the Counties of Delatite and Anglesea, Parishes of Ruffy and parts of Monea South, Tarcombe, Longwood, Dropmore, Branjee, Euroa, Gooram Gooram Gong, and Garratanbunell.

Boundaries: Western boundary of Goulburn Shire from Hume Highway to its southernmost limit, southern boundary of Euroa Shire to divide between Merton Creek and Seven Creeks, Merton-Euroa road to Euroa, Hume Highway from Euroa to Goulburn Shire boundary.

### 2. Present tenure

Unreserved crown land - 397 ha
Water reserve, Burnt Creek - 5 ha
Water reserve, Winding Creek - 2 ha
Public purposes reserve, Mitre Rock - 9 ha
Recreation reserve, Creightons Creek - 2 ha
Various roadside reserves and stream frontages

### 3. General description

A predominantly rural landscape of broad valleys in the north is flanked by steep dissected slopes rising to an undulating plateau in the south.

### 4. Present use

There is little use on the public land. About 180 ha of grassland adjoining Hughes Creek is grazed. Another 60 ha supports grazing near Longwood and 20 ha near Wheelers Hill. Up to eight bee sites utilize vegetation on road reserves and up to two on stream frontages.

## B. Nature of the Land

### 1. Climate

Average annual rainfall in the block ranges from about 510 mm in the north to 1,020 mm in the south. The growing season for pastures at the highest elevations is probably March to May and September to December.

### 2. Physiography and geology

Most of the block forms part of the

Strathbogie massif. Lowlands extend up the main streams - Seven Creeks Castle Creek, Creightons Creek, and Reedy Creek. The lowlands are replaced by steep dissected slopes that rise to an undulating plateau surface, which extends south from Upton Hill through Ruffy towards Mount Concord. Hughes and County Creeks are the main streams draining the plateau. Upper Devonian granite underlies all of the uplands.

3. Soils

On the plateau, reddish duplex soils, friable yellowish gradational soils, and weakly bleached friable gradational soils predominate, while the dissected landscapes mainly carry undifferentiated stony loams, weakly bleached massive gradational soils, and reddish or yellowish duplex soils. Yellowish duplex soils are dominant on the lowlands.

4. Vegetation

Some public land allotments are now grasslands. Allotments with native vegetation in the dry northern section have stands of long-leaf box. The understorey may be grassy or may have sparsely scattered shrubs where the ground is rocky. Two allotments in the south have narrow-leaf peppermint open forest III and another has messmate stringybark open forest III with a bracken fern understorey.

5. Fauna

Little is known of the native fauna. Common birds of the grasslands include the black-backed magpie and Australian pipit. The grey currawong has also been recorded. Streams contain redfin, brown trout, river blackfish, and crucian carp.

6. Land systems

Strathbogie 20%; Moonee Moonee 70%; and Swanpool 10%.

## C. Capabilities

1. Flora

Each public land allotment has a low capability for flora conservation due to its small size. There is a wildflower reserve beside the Hume Highway near Big Hill, and the endangered species hickory wattle *(Acacia penninervis)* has been recorded near Longwood.

2. Fauna

The capability for fauna conservation on public land is low because of the small size of the allotments.

3. Hardwood production

The capability is low in all but the southernmost allotment, where it is high (category B) because of the highly productive timber species (messmate stringybark), the young age of the

stand, and the fact that there is little hardwood forest nearby.

4. Softwood production

Capability is low because of the small areas involved and the marginal to unsuitable sites in the north.

5. Agriculture

The capabilities for agriculture are generally low because most remaining public land is rocky or has stony soils. In contrast, much of the private land in this block has considerable scope for increased production. Cleared public land adjacent to Hughes Creek and a parcel of land carrying messmate stringybark would have moderate to high capability as pasture land.

6. Apiculture

Ruffy block has a low capability for honey production. However, it serves as a valuable build-up area in spring because of capeweed and Blakely's red gum flows. Up to 20 sites utilize public land and the annual average production is valued at $4,900.

7. Water

The southern portion of the district is part of the Hughes Creek catchment, which supplies Avenel. However, the public land component is small and so has low capability.

8. Minerals

The block does not contain any known mineral deposits.

9. Recreation

The capability is low.

D. Hazards and Conflicts

Apart from a moderate sheet erosion hazard on the foothills and some steep slopes, and a moderate stream-bank one on the plateau, erosion hazard is low. Clearing of the southernmost public land allotment for agriculture would preclude its use for hardwood production.

E. Significance

This block has little significance with regard to use of the public land.

## 2. WOMBAT

### A. General

1. Location

Most of the Seven Creeks catchment east of Euroa, with a total of 2,894 ha of public land in a number of parcels, the largest being in the Mount Wombat - Kelvin View and Mount Barranhet - Too Rour localities; all within the County of Delatite, Parishes of Marraweeny, and Strathbogie and parts of Balmattum, Euroa, Gooram Gooram Gong, Shadforth, and Wondoomarook.

Boundaries: Euroa-Merton road from Euroa to divide between Merton Creek and Seven Creeks; road to Violet Town *via* Bonnie Doon road, Toor Rour, Boho South, Marraweeny, and Harry Creek; Hume Highway from Violet Town and Euroa.

2. Present tenure

(a) Mount Barranhet: Reserved forest - 975 ha

(b) Mount Wombat: Reserved forest- 923 ha
Unreserved Crown land - 538 ha
Wildflower reserve

(c) Other: Unreserved Crown land - 364 ha
Public park and recreation reserve, Euroa - 77 ha
Stone and gravel reserve - 4 ha
Water reserves, Faithful Creek - 10 ha
Caravan park, picnic ground reserve, Strathbogie - 1 ha
Recreation reserve, Strathbogie - 2 ha
Various stream frontages and road reserves

3. General description

Farmland on the lowlands near the Hume Highway and on the Strathbogie uplands with several forested areas, the main areas centred on Mount Wombat and Mount Barranhet.

4. Present use

The Mount Barranhet area is used for hardwood production, and also forms the headwaters of Seven Creeks, which supplies water to Euroa township. Part of the area at Mount Wombat (the Moun-

tain Hut Creek watershed) also supplies Euroa with water.

The Mount Wombat area is used for hiking and sightseeing, and a camp-site has been established on the public land. A Forests Commission fire tower and P.M.G. repeater station are sited on Mount Wombat itself. Parts of Seven Creeks are used for fishing, and two picnic sites have been established - at Gooram Falls and at Polly McQuinns. Up to 14 bee sites utilize forest areas, and up to four use vegetation on stream frontages.

## B. Nature of the Land

### 1. Climate

Average annual rainfall ranges from about 630 mm to more than 1,020 mm. The growing season for pastures at the higher elevations is March to May and September to December.

### 2. Physiography and geology

Most of the block is part of the Strathbogie massif. The parcels of land at Mount Barranhet and Mount Wombat itself are steep granitic hills above the gently undulating landscape of the plateau around Strathbogie. The peaks rise to elevations of 823 m and 799 m respectively. A scarp to the east of Seven Creeks and south of Sheans Creek is underlain by aplite and granite. This continues east from Sheans Creek for about 10 km, where it forms the boundary between granitic and acid volcanic rocks, and approximates the watershed boundary between Seven Creeks and north-westerly flowing streams, such as Faithful Creek. Public land to the north of the scarp is hillslopes on acid volcanics.

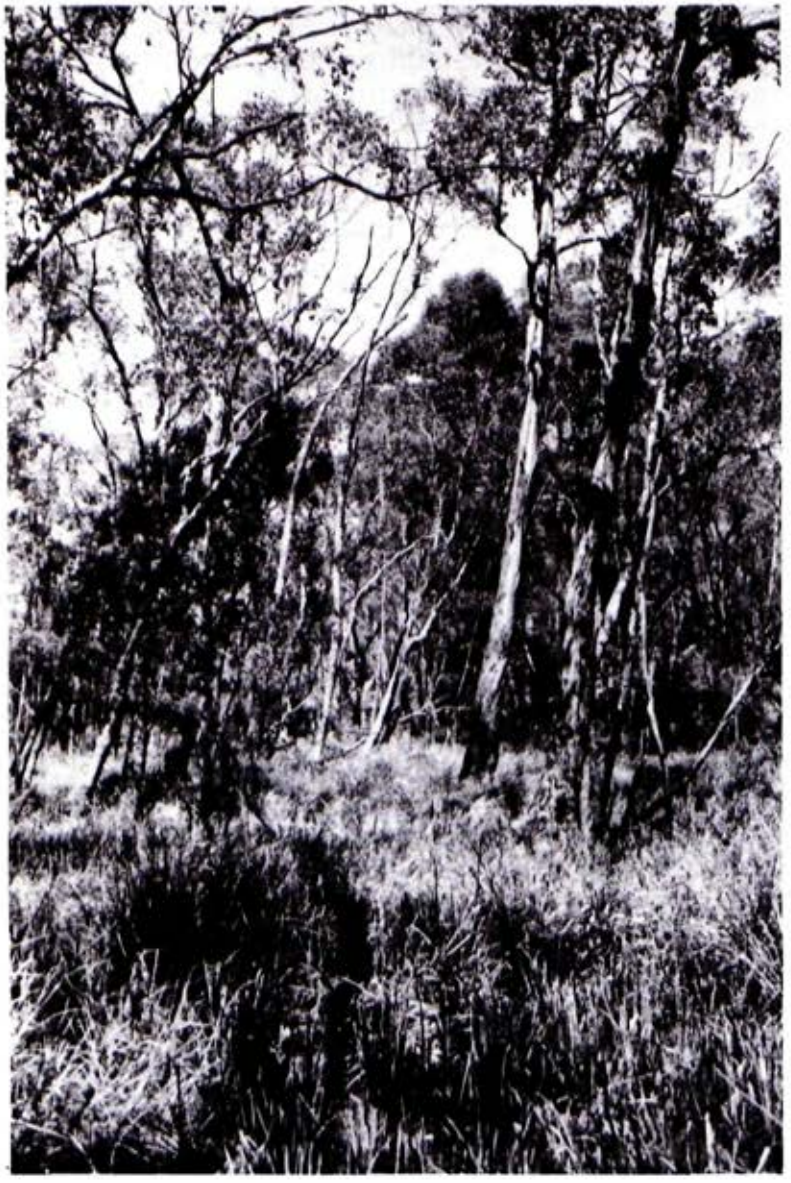
Geological features on private land include Devonian-Silurian sedimentary inliers on the Strathbogie plateau, and low hills of Tertiary limburgite along Seven Creeks and north of Gooram Gong.

### 3. Soils

Soils of the public land on granitic parent materials include undifferentiated stony loams and coarse sandy loams on steep slopes, friable reddish and brownish gradational soils on less-steep slopes, and some reddish duplex soils. On hillslopes where parent materials are acid volcanics, reddish and yellowish duplex soils and coarse sandy loams predominate.

### 4. Vegetation

The major vegetation unit of the Mount Barranhet area is narrow-leaf peppermint open forest III. The understorey usually consists of bracken fern and silver wattle but may be grassy (tussock grass). Messmate stringybark open forest III (with an understorey of ferns and musk-daisy bush or bracken fern, common cassinia, and silver wattle) is



*Mountain swamp gums in the headwaters of Seven Creeks*

confined to sheltered situations. The wettest sites carry mountain swamp gum open forest II with an understorey of thatch saw-sedge and the driest carry broad-leaf peppermint: red stringybark open forest II with a grassy understorey. Some small rocky areas are partly covered by open to closed heaths, which include fringe-myrtle, hedge wattle, violet kunzea, and mountain grevillea.

The Mount Wombat area and the scarp along Seven Creeks together have a variety of vegetation types. Messmate stringybark open forest III and IV usually has a bracken fern and silver wattle understorey. Narrow-leaf peppermint open forest III has a bracken fern or grassy understorey. Considerable areas of bare rock face lie near the summit of Mount Wombat. Associated open heaths include plants such as fringe-myrtle, violet kunzea, silky guinea flower, nodding blue-lily, and rock fern. Red stringybark: long-leaf box open forest I and II with a grassy or heathy understorey dominates the drier sites such as along the scarp. Blakely's red gum open forest I with a heathy understorey is also present on rocky hillsides near Kelvin View. Understorey plants include daphne heath, mountain grevillea, hairy geebung, lightwood, and cherry ballart.

Among other public land parcels, the area just east of Euroa has a vegetative cover of white box and grey box with a

grassy understorey. An allotment further east has similar tree species, with grasses and scattered hickory wattle and lightwood as an understorey.

5. Fauna

(a) Mount Barranhet area: The common birds of this area include the crimson rosella, grey fantail, laughing kookaburra, sulphur-crested cockatoo, superb blue wren, grey thrush, and white-throated scrub-wren. Common mammals include the greater glider, ring-tailed possum, and common wombat. The brush-tailed possum is not commonly observed. The southern blue-tongue is the only reptile recorded in this area.

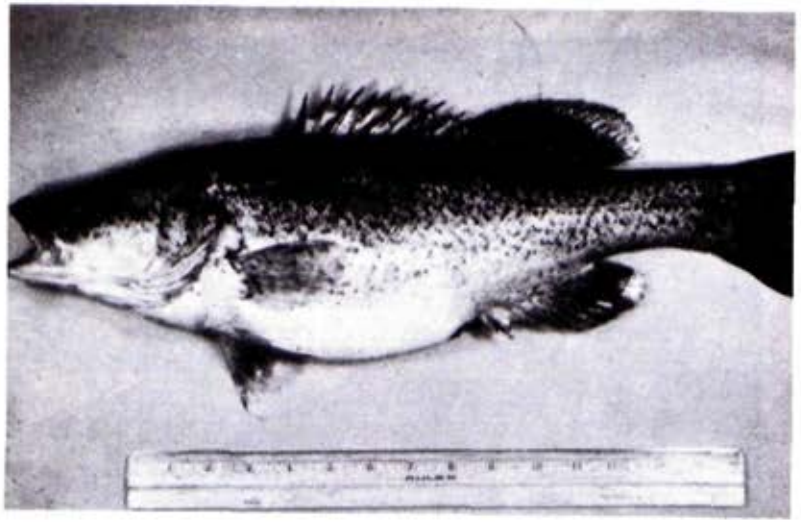
(b) Mount Wombat area: Birds include the commonly occurring spotted pardalote, sulphur-crested cockatoo, white-throated tree-creeper, rufous whistler, and laughing kookaburra, and the less common powerful owl, golden whistler, and flame robin. Mammals include the eastern grey kangaroo, tuan, greater glider, ring-tailed possum, koala, echidna, sugar glider, brush-tailed possum, common wombat, and long-nozed bandicoot.

Reptiles include the brown snake, black rock-skink, and marbled gekko.

(c) Other: Little is known of the fauna of other public land areas in

*Hedge wattle growing on a rocky site*

*Powerful owl roosting in a blackwood tree*



*The trout cod - an endangered species*

this block. Seven Creeks contains rainbow and brown trout, macquarie perch, river blackfish, and trout cod. The bandy-bandy snake has been observed near Euroa.

6. Land systems

Moonee Moonee 60%; Strathbogie 26%; Loombat 10%; and Tiger Hill 4%.

C. Capabilities

1. Flora

(a) The Mount Barranhet area has a moderate capability for flora conservation, as most vegetation types found on the Strathbogie massif are represented here, but contains no significant recorded species.

(b) The Mount Wombat area has a moderate to high capability for flora conservation. Most of the mountain and foothill vegetation units are represented and, in addition, the Blakely's red gum unit. It has many heathy species either as an understorey or as a heath. Plants include rock isotome, hedge acacia, violet kunzea, austral stork's-bill, nodding blue-lily, and silky guinea flower. There is a wildflower reserve near Kelvin View.

(c) Other: Hickory wattle - an endangered species - occurs on a public land allotment to the east of Euroa.

2. Fauna

(a) The capability for fauna conservation at Mount Barranhet is moderate. The forested area is large enough to sustain populations of most bird and mammal species.

(b) The capability for fauna conservation at Mount Wombat is moderate to high. The powerful owl - a significant bird species - has been recorded here.

(c) Seven Creeks has high capability because it contains the trout cod - an endangered species, at present

known only for the Seven Creeks and a lake near Beechworth - and two other endangered species - river blackfish and macquarie perch. The capability for other areas is low due to the small size of the allotments

3. Hardwood timber production

(a) The capability is moderate, due to some stands of messmate stringybark and St. John's blue gum.

(b) The capability is moderate. Stands of messmate stringybark grow south of Mount Wombat and near Mountain Hut Creek. There are also some small stands of St. John's blue gum.

(c) Other: The capability is low.

4. Softwood production

(a) The capability is high, as site qualities would be suitable (SQ II to IV), the area is relatively large, and it adjoins a large area of public land also suitable for softwood growth.

(b) The Mount Wombat area has a moderate capability for softwood production. The messmate, narrow-leaf peppermint, and red stringybark: broad-leaf peppermint areas are suitable for softwood growth (SQ II to IV), but this area is limited and isolated from other public land. The drier steeper sites are marginal to unsuitable for softwood production.

(c) Other: The capability is low due either to small area or to unsuitability of site for softwood growth.

5. Agriculture

(a) The capability is generally high in the Mount Barranhet area. Slopes are relatively gentle and any pastures that are established should support the equivalent of about ten dry sheep per ha. However, altitudes are higher than most of the surrounding pastureland, thus reducing winter carrying capacity.

(b) The capability varies from low to high. The steep, dry slopes have low capabilities, and the less-steep areas with deeper soils are capable of grazing about ten dry sheep equivalents per ha after clearing and pasture establishment. The winter carrying capacity around Mount Wombat would be lower than on the surrounding private property.

(c) Other: The capabilities of the isolated allotments of public land are generally low because of steep topography and/or rocky sites.

6. Apiculture

The capability for honey production is moderate, although the lowlands from Violet Town to Gooram have high capabilities for pollen build-up and wintering. Here the main species are capeweed, Blakely's red gum, river red gum, and white box. On the plateau, the main honey producing species is St. John's blue gum. The estimated average annual value of production is $10,200, coming from up to 20 sites utilizing public land and 11 sites utilizing private property. There is little potential for further production.

7. Water

Wombat block's capability for water production is high. It contains almost all the Seven Creeks catchment that supplies Euroa as well as the whole of Mountain Hut Creek catchment, also supplying Euroa.

8. Minerals

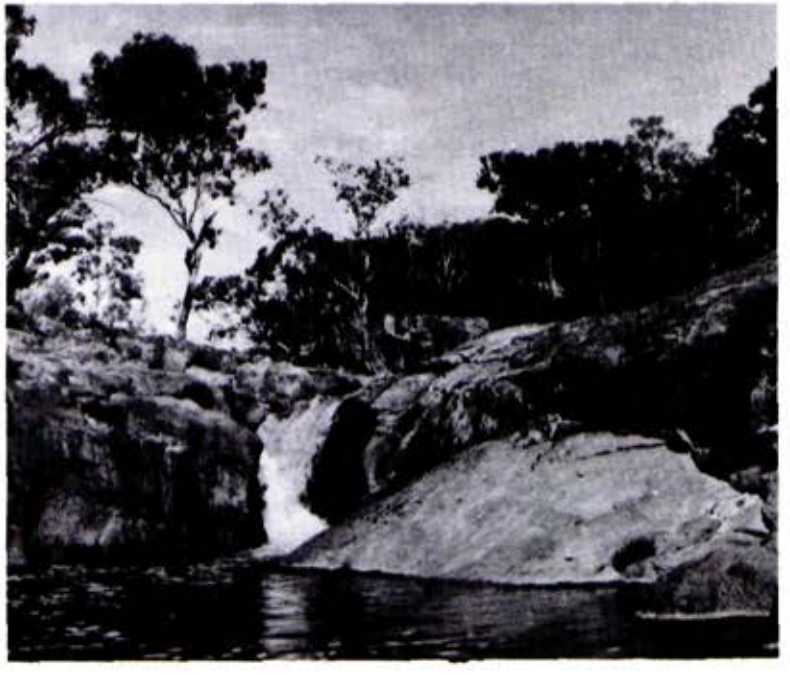
The block has a low capability for mineral production, with a minor occurrence of molybdenum near Euroa and a limburgite quarry on private property near Seven Creeks.

9. Recreation

(a) The Mount Barranhet area has a moderate capability for recreation.

(b) The Mount Wombat area has a high capability for recreation. It has values for sightseeing, picnicking, nature walks, camping, and rock-climbing. Features include a scenic lookout point, rock outcrops and scarps, a waterfall, and outstanding wildflowers and wildlife.

(c) Other: The Seven Creeks environs provide opportunities for nature walks, camping, swimming, picnicking, and fishing. Features include the Gooram Falls and the picnic site below Polly McQuinn's storage.



*Gooram Falls on Seven Creeks.*

## D. Hazards and Conflicts

The sheet erosion hazard is high on steep northern slopes in the north of the block, and moderate on steep slopes and foothills in the western section. On less steep slopes the erosion hazard is low. The fire hazard is moderately high. The Sirex wood wasp would pose a threat to any softwood plantations established in the block. Water production is likely to conflict with agriculture and, to a lesser extent, recreation. Water quality is lowered by the agricultural use of land in the catchment, and by the clearing of stream-side vegetation and breaking down of stream banks by cattle. Fishing in the Seven Creeks could conflict with conservation of the trout cod.

## E. Significance

The main significance of this block is the value of the Mount Wombat area for recreation and nature conservation, the value of the Mount Barranhet area for softwood production or pasture establishment for grazing, and the value of the Seven Creeks as a water supply for Euroa and a habitat of the extremely rare and endangered trout cod.

# 3. WARRENBAYNE

## A. General

### 1. Location

This block to the south-east of Violet Town comprises 12,826 ha of public land in the County of Delatite, Parish of Boho and parts of Shadforth, Warrenbayne, Samaria, Balmattum, and Lima.

Boundaries: Violet Town-Too Rour road; Too Rour to Swanpool *via* Police Track; Swanpool to Baddaginnie *via* Midland Highway and Warrenbayne-Baddaginnie road; and Hume Highway to Violet Town.

### 2. Present tenure

Reserved forest - 8,078 ha
Occupied Crown land - 1,141 ha
Unreserved Crown land - 3,598 ha
Recreation reserve, Swanpool - 4 ha
Recreation reserve, Warrenbayne - 3 ha
Camping and picnic reserve, Harry's Creek - 2 ha
Various stream frontages and road reserves

### 3. General description

Farmland on the plain gives way to steep foothills, mainly forested, and undulating uplands forested with native and softwood forests.

### 4. Present use

The major use is for softwood production involving some 3,075 ha. About 200 ha of grassland and forest near Boho is leased for grazing. Up to 16 bee sites utilize red stringybark forest and up to five sites utilize river red gum and red box on stream and road reserves. The Honeysuckle Creek watershed supplies water for Violet Town.

## B. Nature of the Land

### 1. Climate

Average annual rainfall is from 630 mm to more than 1,140 mm. Growing season for pastures is August-December and March-May in lower areas and September-January and February-April at upper elevations.

### 2. Physiography and geology

This block forms part of the Benalla plain and the Strathbogie massif. The massif is moderately to strongly dissected, but has a few plateaux, such as

north of Boho South, near Police Track, and south-east of Warrenbayne. The many peaks include Mount Albert, Mount Bee, Mount Separation, Mount Lindsay, and Mount Victoria. The main streams are Lima, Five Mile, Warrenbayne, and Honeysuckle Creeks. North of a line between Boho South and Lima, the geology is Upper Devonian rhyodacite and south of this it is Upper Devonian granite.

3. Soils

The rhyodacite plateaux and broad ridges predominantly carry friable brownish gradational soils and friable reddish gradational soils (with weakly structured subsoils). Yellowish duplex soils predominate on the slopes and foothills. Where granite is the parent material on the plateaux, reddish duplex soils predominate. The steep slopes have undifferentiated stony loams, the rolling ridge tops and major valleys have friable brownish or reddish gradational soils, and the foothills at lower elevations have reddish or yellowish duplex soils.

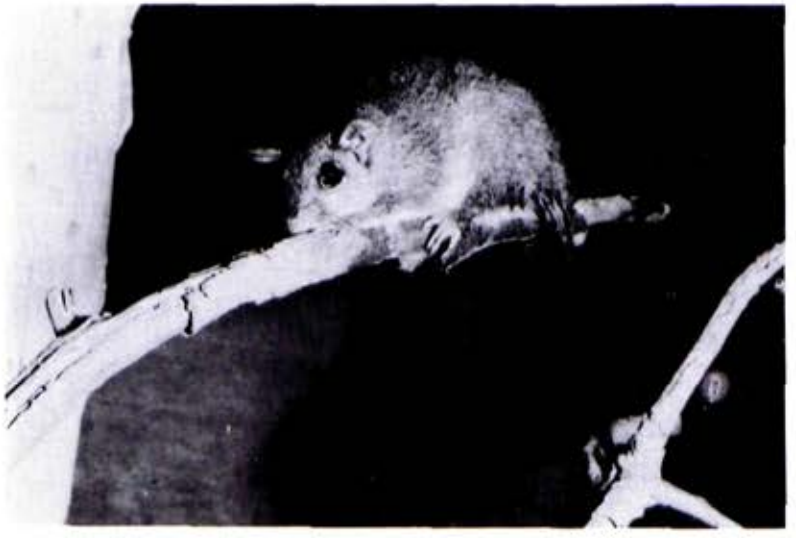
4. Vegetation

The vegetation of about 25% of the public land has been converted to softwood plantation. This had been mainly narrow-leaf peppermint open forest III. The little of this unit now remaining in the block is situated mainly on undulating landscapes, and here the understorey is usually bracken fern and silver wattle. Messmate stringybark open forest III with a similar understorey is situated on the plateaux and some sheltered situations.

The montane slopes and foothills have either a cover of broad-leaf peppermint: red stringybark open forest II or red stringybark : long-leaf box : red box open forest I and II. The understoreys of both are typically grassy, but in the drier situations may consist chiefly of a litter layer.

5. Fauna

The fauna of the block is quite varied. Common birds include the sulphur-crested cockatoo, white-browed scrub-



*The tuan frequents foothill forest near Warrenbayne*

*The koala is an inhabitant of narrow-leaf peppermint - St.John's blue gum stands in this block*

wren, red wattle-bird, spotted pardalote, and rainbow bee-eater. Uncommon ones include the wedge-tailed eagle, peregrine falcon, white-winged chough, and wonga pigeon.

Sixteen mammals have been recorded in the block, commonly including the greater glider, ring-tailed possum, and common wombat, and more rarely the koala, bobuck, tuan, and sugar, squirrel, and feather-tailed gliders.

Sixteen reptiles have also been recorded. These include the lace lizard, tree dragon, bearded dragon, blind snake, black snake, marbled gekko, black rock-skink, bougainville's skink, white's skink, and the southern blue-tongue.

6. Land systems

Loombah 56%; Moonee-Moonee 27%; Tiger Hill 12%; and Strathbogie 5%.

## C. Capabilities

1. Flora

The main area of public land has a moderate capability for flora conservation, with the western portion having interest because the vegetation units range from messmate stringybark forest to red stringybark forests, with some gullies of red box and white box in the far north. The significant species *Tetratheca glandulosa* has been recorded near Lima. Other areas of public land have low capabilities because of their small extent.

2. Fauna

The capability is high for the main area of land. The wonga pigeon and peregrine falcon both frequent these forests. The

white-browed babbler and grey-crowned babbler have been recorded. A large variety of ground-dwelling and arboreal mammals also inhabit the area including the squirrel glider - a species requiring special conservation measures.

Other areas of public land are relatively small and capabilities are likely to be low.

3. Hardwood production

The capability for hardwood production is generally low, except on the plateau between the Five Mile and Honeysuckle Creeks, where it is high. The main timber-producing trees here are messmate stringybark and St.John's blue gum (category B timber production).

4. Softwood production

The capability for softwood production is high to the south and west of the present plantation area. The largest area is to the west of Five Mile Creek. Site qualities on messmate stringybark and narrow-leaf peppermint sites are expected to be about SQ II to IV (categories B and C). Elsewhere site qualities are marginal (SQ VI) to unsuitable (SQ VII)

5. Agriculture

In the north the steep slopes of the Loombah land system have a low capability for agriculture. However, on the Tiger Hill land system and part of the Moonee Moonee system, where topography is not limiting, the capability is high; potential carrying capacity on improved pasture would be about 10 dry-sheep equivalents per ha. About one-quarter of the public land in this block would lie in this high-potential area.

6. Apiculture

Capabilities for honey production and pollen build-up are moderate; wintering capability is low. The industry has little potential for expansion in this block. Red stringybark forests provide the main honey crop. Average annual production is estimated at $9,300 from up to 21 sites utilizing public land.

*Recent clearing of native forest for softwood production*

7. Water

The capability to produce water is moderate to low. Honeysuckle Creek supplies water to Violet Town and the main streams are the Five Mile, Warrenbayne, and Lima Creeks.

8. Minerals

The capability is low, as there are no known mineral deposits.

9. Recreation

The capability is low to moderate. Features include scenic viewpoints and an interesting wildlife area near Warrenbayne. Lima Creek provides some fishing. The pine plantation is of interest to visitors.

## D. Hazards and Conflicts

There is a high sheet erosion hazard on steep northerly montane slopes and a moderate sheet and gully erosion hazard on the foothills. Erosion hazard is generally low on the plateau, but erosion can result from road construction and disturbance by logging operations. The fire hazard is moderate to high. Sirex wood wasp is a hazard to softwood production.

Conflicts may occur between water production in the Honeysuckle Creek catchment and any further clearing of forests for agriculture or softwood production. Softwood production and nature conservation also conflict. This can be minimized by leaving adequate strips along permanent streams, corridors for animal movement, and representative areas of the plateaux, broad ridges, and upper slopes. Softwood production and apiculture conflict.

## E. Significance

The main significance of the block is its capability for softwood production. Other values of significance are for fauna conservation, particularly in the north-west section of the public land, and for water production in the Honeysuckle Creek catchment. It is contiguous with a larger area of public land to the south (in the Toorour and Dry Creek blocks).

# 4. REEF HILLS

## A. General

### 1. Location

This block comprises 2,087 ha of public land - mainly in one consolidated parcel (Reef Hills) - on the Benalla plain south of Benalla - in the County of Delatite, Parishes of Rothesay and parts of Benalla, Warrenbayne, Kelfeera, Samaria, and Tatong.

Boundaries: Benalla-Kelfeera road; Kelfeera-Tatong road to Tatong; the Midland Highway and Warrenbayne-Baddaginnie road; and Hume Highway from Baddaginnie to Benalla.

*Gravel pit in the Reef Hills*

### 2. Present tenure

Reserved forest - 2,032 ha
Occupied Crown land (rifle range) - 10 ha
Unreserved Crown land - 32 ha
Gravel reserve - 10 ha
Police reserve - 1 ha
Public purposes reserve, Broken River - 2 ha
Various stream frontages and road reserves

### 3. General description

An area of low forested hills and flats (the Reef Hills) surrounded by farmland.

### 4. Present use

The Reef Hills is a useful source of poles, fence posts, and firewood for local consumption. It is used often by local field naturalists and by week-end motorists. An area adjacent to the Midland Highway is used as a rifle range. The local pistol club also has a range. The armed forces use this area as a training ground.

*River red gums with hedge wattle and grassy understoreys in the Reef Hills*

Sixteen bee sites utilize grey box, river red gum, and Blakely's red gum nectar flows. Eighteen sites utilize stream frontages and road reserves. A gravel pit is situated in the Reef Hills near the Midland Highway, and another near Mount Pleasant.

Ryans and Holland Creeks and the Broken River provide fishing.

## B. Nature of the Land

### 1. Climate

Average annual rainfall ranges from 630 mm in the north to 760 mm in the south. The growing season for pastures is March to May and September to November.

### 2. Physiography and geology

The block forms part of the Benalla plain, which includes some low outlying hills. The low hills are of Devonian-Silurian sedimentary rocks and the plains are Quaternary (Pleistocene) alluvial deposits. Some low hills of Ordovician sedimentary rocks and Upper Devonian granite lie in the south-east.

### 3. Soils

The predominant soils of the low hills are undifferentiated stony loams and reddish duplex soils. Gently sloping areas have reddish gradational and weakly bleached friable gradational soils, and flat areas have gilgaied yellowish duplex soils.

### 4. Vegetation

Most of the vegetation of the Reef Hills differs entirely from that in the remainder of the district. The ridges have stands of red stringybark : long-leaf box : red box open forest about 15 m tall, with a grassy understorey (tussock, wallaby, and spear grasses) and

some scattered shrubs such as golden wattle and woolly wattle. Grey box open forest II occupies the lower slopes and better-drained sites on the plain. The ground layer is grassy (silvertop wallaby-grass) with orchids and other wildflowers and a scattered layer of shrubs, which include golden wattle and rough wattle.

In low-lying areas and along watercourses on the plain, the main tree species are river red gum and Blakely's red gum in mixture with various box-type eucalypts. The understorey mainly consists of silvertop wallaby-grass and scattered hedge wattles.

5. Fauna

A large variety of birds - resident, nomadic, or migratory - inhabit the Reef Hills, and many of these frequent the northern forests. Between 1969 and 1972, B. Weston compiled a list of 118 birds in the Reef Hills, a number of which are significant species.

Eleven mammals have been recorded: the eastern grey kangaroo, black wallaby, squirrel, sugar, and feather-tailed gliders, tuan, brush-tailed possum, ring-tailed possum, common wombat, echidna, and grey-headed fruit bat.

Reptiles include the lace lizard, bearded dragon, tree dragon, marbled gekko, frazer's legless lizard, striped skink, snake-eyed skink, common bluetongue, brown snake, and black snake. The Broken River contains macquarie perch, brown trout, rainbow trout, redfin, and river blackfish.

6. Land systems

Lurg 70%; and Benalla 30%.

C. Capabilities

1. Flora

The area known as the Reef Hills has a high capability for flora conservation. As well as being a viable remnant of the original vegetation on the northern plains, it contains a number of significant species: *Acacia flexifolia*, *Caleana major*, and *A. difformis*.

*The sugar glider*

*The white-browed babbler is a resident species in the Reef Hills*

In addition, 18 orchids and many wildflowers - including blue pincushion, bluebell, guinea flowers, swamp isotome, tall lobelia, pink-bells, chocolate lily, creamy stackhousia, digger's speedwell, and trigger-plant - occur here.

2. Fauna

The Reef Hills area has a high capability for fauna conservation , as many species of the northern forests are found here and in close proximity to Benalla. Significant birds include the white-browed babbler, little friar-bird, noisy friar-bird, dollar bird, brush cuckoo, southern stone-curlew, black-eared cuckoo, king quail, spotted harrier, and barking owl. The squirrel glider occurs in the area. Significant reptiles include the lace lizard.

The vegetation along the Broken River provides habitat for a number of migratory birds, including the dollar bird and little friar-bird. Native fish in the Broken River include macquarie perch and river blackfish.

*The barking owl - a rare species in Victoria*

3. Hardwood production

The capability of the Reef Hills is moderate. This area, particularly the grey box forest, provides a convenient source of firewood and naturally durable roundwood close to Benalla.

4. Softwood production

The capability is low because of low site qualities (SQ VI to VII) due to low rainfall or soils that become waterlogged in winter.

5. Agriculture

The Reef Hills area consists of a gently undulating section of the Lurg land system and, at the southern end, a flat and swampy sample of the Benalla land system. The relatively low rainfall and infertile, stony soils give the land a low capability for agriculture. High superphosphate and molybdenum applications would be necessary to establish and maintain a pasture capable of carrying 7 dry-sheep equivalents per ha. Winter waterlogging would seriously hinder pasture development on the gilgaied yellowish duplex soils of the southern end of the area. The land provides a small amount of supplementary grazing.

6. Apiculture

The capability for honey production is high and gives apiarists the highest financial return per ha in the district. Up to 34 sites utilize public land, and up to six utilize private property. Grey box, river red gum, and Blakely's red gum provide the principal source of nectar, and a conservative estimate of $20,500 has been given as the average annual yield. The capability for pollen build up and wintering is moderate.

7. Water

The capability is low because of the low rainfall.

*Beehives adjacent to the Reef Hills*

8. Minerals

The capability is low.

The Reef Hills have been worked in the past for reef and alluvial gold, and reserves are probably low. Many sites have gravel deposits, some of which have been worked out. An area near Mount Pleasant contains reserves of gravel.

9. Recreation

The capability of the Reef Hills for recreation related to enjoying the native environment is high, primarily because this large area of forested land lies close to Benalla and is surrounded by agricultural land. It has a number of features including the remains of early gold-mining, and a number of interesting animals and plants. Its importance is likely to increase in the future with increase in tourist traffic along the Hume Highway and the growth of Benalla.

Gemstone deposits near Karn and Mallum are present in streams or in gullies on private property.

## D. Hazards and Conflicts

The erosion hazard is generally low; however, the hazards of sheet erosion on slopes, gully erosion on gentle slopes, and stream-bank erosion are moderate. The fire hazard becomes high in the summer when the grasslands surrounding the Reef Hills dry off. However, no serious fires have been through this area for many years. Shooters pose a hazard to wildlife and rubbish dumpers to the natural beauty of the area. Conflicts are likely to arise between nature conservation and any gravel extraction. Most forms of recreation are unlikely to conflict with nature conservation. Fuel-reduction burning, if not too frequent and if covering small scattered areas in any one year, should not conflict with nature conservation, and is preferable to grazing as a means of reducing the amount of grass fuels.

Stream-bank clearing and channel works in the Broken River could conflict with conservation of birds and native fish.

## E. Significance

The prime significance of the Reef Hills lies in the fact that it is a relatively large area of forest in an otherwise agricultural landscape, close to Benalla and the Hume Highway, supporting a number of interesting and/or rare plants and animals, and with high capabilities for recreation and apiculture and moderate capabilities for hardwood production.

# 5. LURG

## A. General

### 1. Location

South of the Hume Highway between Benalla and Glenrowan; public land totals 79 ha in the County of Delatite, parts of Parishes of Lurg, Winton, Greta, Glenrowan, Benalla, Kelfeera, and Tatong.

Boundaries: Hume Highway from Benalla to Glenrowan; Benalla Shire boundary from Glenrowan to Ryans Creek; and Ryans Creek to Benalla road.

### 2. Present tenure

Recreation reserve, Glenrowan - 24 ha
Recreation and racecourse reserve, Winton - 42 ha
Quarry reserve, Wattle Creek - 2 ha
Quarry reserve - 9 ha
Gravel reserve, Winton - 2 ha

Various roadside reserves and strean frontages

### 3. General

Mainly farmland with some isolated, timbered hills.

### 4. Present use

The reserve at Winton is used as a racetract, and part of the reserve at Glenrowan is used as a football ground. Up to seven bee sites utilize vegetation on roadside reserves (mainly red ironbark and grey box).

## B. Nature of the Land

### 1. Climate

Annual average rainfall is about 760 mm. The growing season for pastures is from March to May and September to December.

### 2. Physiography and geology

Most of the block comprises the maturely dissected Lurg hills, which descend to the Benalla plain. It contains the headwaters of the Four Mile Creek. Most of the hills are of Ordovician sedimentary rocks, but some of the higher ones are of Silurian granite. The plains comprise Quaternary alluvial deposits.

### 3. Soils

The major soils are undifferentiated stony loams and reddish duplex soils on

the slopes together with weakly bleached friable and also massive gradational soils in the valleys. The soils of the plains resemble those of the Reef Hills block.

4. Vegetation

Most of the native vegetation has been removed. Blakely's red gum open forest I predominates on the uncleared property. Some remnants of red ironbark forest and grey box forest remain on some roadisde reserves.

*Picturesque roadside vegetation near Kelly Gap*

5. Fauna

Little is known of the fauna, but native fauna are likely to be scarce. Grey-crowned babblers and noisy miners have been recorded along some roadside reserves. The endangered amphibian *Hyla maculata* is found in wetlands near Glenrowan. The sand goanna, lace lizard, stone gekko, four-fingered skink, and carpet python are found on rocky hills in the block.

6. Land systems

Benalla 50%; Warby 30%; and Lurg 20%.

C. Capabilities

1. Flora

Capability is low.

2. Fauna

The capability is moderate. *Hyla maculata* is an endangered species associated with streams near Glenrowan. Five endangered or significant reptile species are found mainly on rocky hills on private property.

3. Hardwood production

Capability is low.

4. Softwood production

Capability is low.

5. Agriculture

Capability is low.

6. Apiculture

Capability is low for honey production but high for pollen build-up and wintering. Up to seven sites on public land and five sites on private property return an average annual yield valued at $3,000. The main species for honey production are red ironbark and grey box.

7. Water

There is a low capability for water production. However, water quality is important, as most of this block drains directly into Lake Mokoan.

8. Minerals

Capability is low.

9. Recreation

Capability is low. The main features are the Winton racetrack on public land, and the fire tower at Lurg and the remains of the Kelly homestead at Glenrowan west, both on private property.

D. Hazards and Conflicts

Lurg block has a high to moderate sheet erosion hazard on steep slopes, moderate gully erosion hazard on gentle slopes and a stream-bank erosion hazard along water courses. The fire hazard is high. Little conflict is likely. Although nature conservation, apiculture, and recreation values are low, the preservation of roadside vegetation will maintain these capabilities.

*Kelly homestead site*

E. Significance

There is little of significance in the block. However, if the site of the Kelly homestead attracts sightseers, the preservation of the roadside vegetation on routes to the site will enhance the historical values of any tours.

# 6. STOCKYARD

## A. General

### 1. Location

A block to the south of Molyullah and east of Holland Creek, comprising 8,146 ha of public land in the County of Delatite, parts of Parishes of Tatong, Myrrhee, and Toombullup North.

Boundaries: Road from Ryans Creek 8 km towards Benalla; road to Tolmie *via* Tatong and Wrightley to its junction with the Tiger Hill road; Tiger Hill road to Loombah Weir road junction; Loombah Weir road to Loombah Weir; and Benalla Shire Boundary to Ryans Creek.

### 2. Present tenure

Reserved forest - 5,069 ha
Unreserved Crown land - 3,077 ha
Various stream frontages and road reserves

### 3. General description

The farmland in the lower valleys of Holland and Ryans Creeks gives way to steep, dry, forested montane slopes, which flatten out to form forested plateaux and broad ridges.

### 4. Present use

Some stands of hardwood forest are being logged in the headwaters of the Watchbox Creek. About 100 ha of forest adjacent to Ryans Creek are leased for grazing and up to 18 bee sites utilize red stringybark forests on public land.

## B. Nature of the Land

### 1. Climate

Average annual rainfall ranges from 760 mm to 1,270 mm. The growing season for pastures on the broad ridges and plateaux in the south of the block is from about October to April. In the north, the growing season on the uplands starts earlier and finishes later, but a period of summer drought checks growth.

### 2. Physiography and geology

Most of the block forms part of the Tolmie highlands. Two broad ridges form the divides between Ryans, Watchbox, and Sam Creeks, but become narrower and more dissected towards Molyullah. The divide between the Ryans Creek headwaters and Holland Creek is an elongated plateau,

bounded by montane slopes on the east and west. Most of the uplands overlie Upper Devonian volcanics, with outcrops of Ordovician sedimentary rocks, Tertiary basalt, Upper Devonian granite and Cambrian greestone being relatively minor in extent.

3. Soils

The dominant soils of the plateaux and broad ridges are friable brownish gradational soils and friable reddish gradational soils (with weakly structured subsoils). There are some reddish and yellowish duplex soils where the rainfall is less than about 1,140 mm, and yellowish duplex soils predominate on steep northern slopes. The foothill soils are mainly weakly bleached massive gradational soils and yellowish duplex soils. Isolated ridges in the north have undifferentiated stony loams and the lower slopes have yellowish duplex soils.

4. Vegetation

Red stringybark : long-leaf box : red box open forest I and II is the predominant vegetation type in the northern and western sections of the block. These sections are generally steep and dry and have shallow soils. The understorey may be grassy, but is typically heathy with such species as daphne heath, grey bush-pea, mountain grevillea, silky guinea flower, violet kunzea, and small grass-tree. Broad-leaf peppermint : red stringybark open forest II has a predominantly grassy understorey (tussock grass) and is found on the broad ridges where rainfall is less than about 1,140 mm.

The plateau and broad ridges, where rainfall is high, usually carry narrow-leaf peppermint open forest III with an understorey of bracken fern and silver wattle. Minor stands of mountain swamp gum open forest II (with an understorey of thatch saw-sedge, prickly tea-tree, and blackwood) and stands of messmate stringybark open forest III with a bracken and silver wattle understorey also occur on the plateau. Some small stands of Blakely's red gum are found in the driest situations in the north.

*Violet kunzea - a heathy understorey species*

5. Fauna

Forest-frequenting birds are well represented in this block. The white-throated tree-creeper, grey fantail, crimson rosella, spotted pardalote and grey thrush are common. Uncommon birds include the olive whistler, sacred kingfisher, little friar-bird, and noisy friar-bird. Common mammals are the greater glider, black wallaby, and common wombat. The ring-tailed possum, eastern grey kangaroo, brush-tailed possum and long-nosed bandicoot are less commonly observed. Amphibians include the golden bell frog, leseur's frog, peron's tree frog, brown froglet, smooth froglet, bull frog, spotted marsh frog, spadefoot toad, and bibron's toadlet.

*The stone gekko - an endangered species*

Reptiles recorded for the block include the brown snake, black snake, little whip snake, small-eyed snake, blind snake, lace lizard, fraser's legless lizard, coppertail skink, stone gekko, and marbled gekko.

Fish in Ryans Creek and adjacent streams include brown trout, river blackfish, and macquarie perch.

6. Land systems

Loombah 76%; Tiger Hill 17%; Archerton 4%; and Lurg 3%.

## C. Capabilities

1. Flora

The capability for flora conservation is high in the north of the block and moderate elsewhere. A locality on the Tiger Hill road was found to contain at least 36 plant species, which included a number of wildflowers and shrubs, e.g. early nancy, woolly grevillea, mountain grevillea, hairy pink-bells, common wedge-pea, indigo, blue pincushion, and silky guinea flower.

2. Fauna

The capability is moderate to high. Recorded birds include two significant species. The amphibian and reptile fauna is interesting and includes the stone gekko and the coppertail skink in rocky areas.

3. Hardwood production

The capability is low in the north but high in the headwaters of Watchbox Creek and the broad ridge along the south-eastern side of the block, where messmate stringybark, St. John's blue gum (category B), and narrow-leaf peppermint stands (category C) are found.

4. Softwood production

The capabilities for softwood production are high (categories B and C) in the same areas as for hardwood production. An area along the Loombah Weir road and one in the headwaters of Sam Creek are suitable (category C) and suitable to marginal (category E) respectively for radiata pine growth.

5. Agriculture

The public lands of this block largely lie within the Loombah land system and have a low capability for agriculture due to steep slopes and a moderately high erosion hazard. In the south-east, the land within the Tiger Hill land system has a moderate to high potential for agriculture. The relatively high annual rainfall (more than 1,100 mm) and friable gradational soils of the plateaux and ridges can support perennial pasture with a carrying capacity around 10 dry-sheep equivalents per ha. However, this could require accumulated superphosphate applications up to 1.5 tonnes per ha. The high-potential land would comprise less than 20% of the total area of public land in this block.

6. Apiculture

The capability is high to moderate for honey production and wintering and moderate for pollen build-up. Up to 18 sites utilize red stringybark forest and produce an annual average crop valued at $11,300. Better access would give some potential for further production.

7. Water

The capability is moderate. Principal streams are Sam and Watchbox Creeks.

8. Minerals

The capability is low. A minor deposit of antimony occurs near Tatong.

9. Recreation

The capability for recreation is moderate. Features include two waterfalls, outstanding wildflower areas, old sawmill sites, and the remains of a timber tramway.

D. Hazards and Conflicts

Stockyard block has a high sheet erosion hazard on the steep montane slopes, a moderate sheet and gully erosion hazard on the foothills, and a low erosion hazard on the broad ridges and plateaux. The fire hazard is high. Blackberries

are a hazard in disturbed areas. Fuel-reduction burning in the event of pine plantation establishment could conflict with apiculture. The establishment of pine plantations on the plateaux and broad ridges would conflict with nature conservation to some extent.

E. Significance

The block is primarily of significance for nature conservation and for softwood production and agriculture on the broad ridges and plateaux where rainfall is relatively high.

# 7. RYANS

## A. General

### 1. Location

An area between the Loombah Weir and the Ryans Creek headwaters at Archerton in the Tolmie highlands, comprising 8,039 ha of public land in the County of Delatite, parts of Parishes of Toombullup and Toombullup North.

Boundaries: Benalla Shire boundary from the Loombah Weir to Archerton; Old Tolmie road; Tiger Hill road to Loombah Weir road junction; and Loombah Weir road to Weir.

### 2. Present tenure

Reserved forest - 6,606 ha
Water reserve (at Loombah Weir) - 155 ha
Benalla water works trust land - 1,278 ha

### 3. General description

The forested catchments of Ryans Creek and part of Middle Creek catchment, which are deeply incised in the north but form an undulating plateau in the south.

### 4. Present use

The main use is a water catchment for the Loombah Weir. A second storage (Lake McCall Say) is presently under construction some 10 km upstream of the Weir. Some hardwood production occurs in the block just north of the Tatong-Tolmie road. Gemstone sites are visited by lapidarists, and motorists sometimes use the Tatong-Tolmie road as a scenic

*Lake McCall Say under construction*

*Rufous fantail*

route. Up to 13 bee sites are sited on public land.

B. Nature of the Land

1. Climate

Average annual rainfall is from 1,020 mm to more than 1,270 mm. The growing season for pastures at the higher elevations is from October or November to April.

2. Physiography and geology

Three plateaux may be distinguished: one at Tiger Hill, one in the headwaters of Ryans Creek, and a third in the headwaters of Stockyard Creek. Broad ridges extend north from the latter two plateaux forming the divides between the deeply incised Watchbox, Ryans, and Middle Creeks.

Upper Devonian volcanics are the base rocks for most of the block, but smaller outcrops of Lower Carboniferous sandstones and conglomerates and Tertiary basalts also occur in the south. Drainage is to the north.

3. Soils

The plateaux and broad ridges predominantly carry friable brownish and friable reddish gradational soils (with weakly structured subsoils). Soils associated with the basaltic parent material are friable reddish gradational soils (with well-structured subsoils). The steep slopes have undifferentiated stony loams, friable brownish gradational soils, and yellowish duplex soils.

4. Vegetation

The main vegetation units on the plateaux and broad ridges are messmate stringybark open forest III and IV and narrow-leaf peppermint open forest III. Understoreys are typically bracken fern and silver wattle. Narrow-leaf peppermint open forest also occurs on the moister slopes and extends down the valley floors. The understorey on gullies and stream banks may include hazel

pomaderris, musk daisy-bush, mountain correa, forest lomatia, mountain tea-tree, and blackwood.

A number of mountain swamp gum open forest II stands are situated along Ryans Creek and its tributaries. The understorey may be grassy or may be dense with such plants as prickly tea-tree, thatch saw sedge, ovens wattle, and blackwood.

Some steep scarps in the north of the Ryans Creek valley have broad-leaf peppermint : red stringybark or red stringybark : long-leaf box : red box open forests with grassy to scrubby understoreys.

5. Fauna

Birds that have been recorded include the wonga pigeon, rufous fantail, lyre-bird, yellow-tailed black cockatoo, golden whistler, gang-gang cockatoo, sulphur-crested cockatoo, and striated pardalote. Many water-birds, such as wood duck, white-faced herons, and black cormorants, frequent the Loombah Weir.

Mammals include the eastern grey kangaroo, black wallaby, brush-tailed possum, bobuck, yellow-bellied, greater, and feather-tailed gliders, ring-tailed possum, long-nosed bandicoot, common wombat, and the platypus.

Fish include rainbow trout and brown trout.

6. Land systems

Loombah 55%; Tiger Hill 35%; and Archerton 10%.

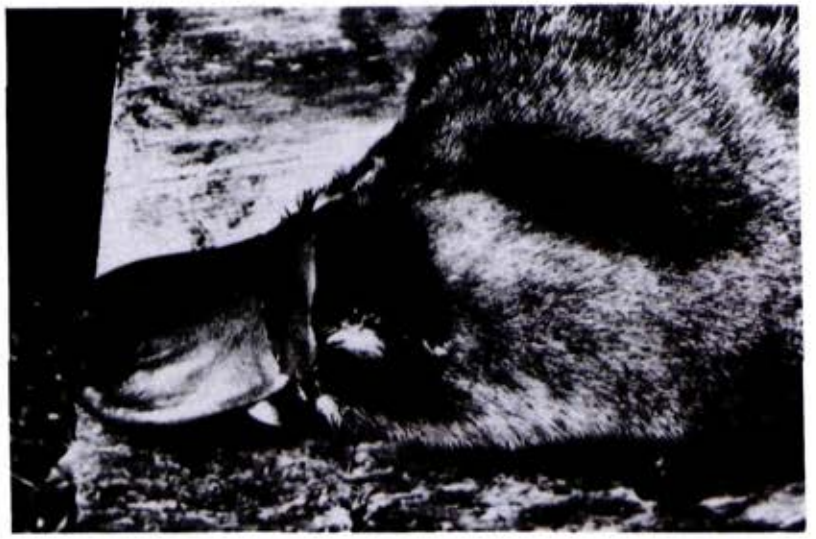
## C. Capabilities

1. Flora

Ryans block has moderate capability for flora conservation. Six vegetation types are represented, but no significant species are recorded.

2. Fauna

Little is known of the fauna, but the capability is probably moderate to high. The wonga pigeon has been recorded in the block.



*The platypus*

*Small waterfall on Ryans Creek*

3. Hardwood production

The capability for hardwood production is high on the plateaux and low elsewhere. The plateaux support some of the largest stands of messmate stringybark, St.John's blue gum, and manna gum in the district - an aggregate of about 1,130 ha in the Ryans Creek headwaters and 220 ha in the Stockyard Creek headwaters. Alpine ash stands could probably be established at the higher elevations.

4. Softwood production

The capability for softwood production (both radiata pine and douglas fir) is high on the plateaux and less-steep slopes in the south. Site qualities here could be expected to range between SQ II and IV (categories B and C). Actual yields from radiata pine grown at the higher elevations would be reduced due to damage by snow.

5. Agriculture

The northern part of this block is generally too steep for agricultural use. The southern part is characterised by the Tiger Hill and Archerton land systems. It is undulating country with friable brownish and friable reddish gradational soils and an annual rainfall about 1,200 mm. However, cold winter conditions restrict pasture growth, and grazing potential is moderate. If grazed in conjunction with lower, warmer

pastures, the potential for spring/ summer pasture production would be high - about 15 dry-sheep equivalents per ha for the pasture growing season. Land that has received about 1.0 tonne of superphosphate and 0.1 kg of molybdenum per ha could support perennial pasture. Potash fertilizer may also be required. Deep soils with excellent physical characteristics and high rainfall give a moderate to high capability for potato production.

6. Apiculture

The capability for honey production, pollen build-up, and wintering is low. However, there is potential for commercial queen bee breeding and for the commercial production of natural pollen. Narrow-leaf peppermint, candlebark, manna gum, and St.John's blue gum are the principal nectar-producing species. Average annual production is valued at $5,100.

7. Water

Capability for water production and water conservation is high. A storage in addition to the Loombah Weir is in the course of construction.

8. Minerals

The capability is low to moderate. The Toombullup and Archerton goldfields are likely to have little remaining gold or cassiterite.

9. Recreation

Capability for many forms of recreation is high to moderate. The Loombah Weir is closed to fishing, but trout may be caught further upstream in Ryans Creek. A number of gemstone sites exist in the headwaters of Ryans Creek, and the historical sites of Stringybark and Kelly's Creeks provide additional interest to the visitor.

*The "Kelly Tree" near Stringybark Creek*

## D. Hazards and Conflicts

The sheet erosion hazard on steep dry slopes in the north of the block is high. There is also a gully erosion hazard. Steep slopes in the central section of the block have a low to moderate erosion hazard because of the permeable nature of the soils, but roads and tracks should be carefully constructed to avoid rilling and slumping of road betters. The erosion hazard is low on the plateau because soils are permeable. However, maintenance of ground cover is important because the heavy and frequent storms can cause sheet and rill erosion. The fire hazard is moderate to high. Feral pigs in the catchment disturb the soil around swampy areas and near streams, which constitutes a hazard to water quality. Water and hardwood production are unlikely to conflict if correct management practices are followed. Similar comments apply to softwood production. Gem-seekers digging along stream banks and in stream beds may conflict with high-quality water production. Some areas could support agriculture, but this would conflict with hardwood and softwood timber production and perhaps water quality to some extent.

## E. Significance

The main significance of the block lies in the fact that it is a complete ecological unit (a watershed), with high capabilities for water, hardwood, and softwood production, and high to moderate capabilities for nature conservation, recreation, and agriculture. It adjoins Stockyard and Hat Hill blocks and a large area of public land to the east and south-east.

# 8. HAT HILL

## A. General

### 1. Locality

An area to the north of Mansfield embracing Bridge Creek and the headwaters of Holland Creek, comprising 7,550 ha of public land in the County of Delatite, parts of Parishes of Moorngag, Toombullup, and Dueran.

Boundaries: Blue Range Creek road from Bridge Creek, Spring Creek road to Tatong - Tolmie road; thence along this road and Old Tolmie road to Archerton; and Archerton to Bridge Creek *via* Bunston Hill and Barwite.

### 2. Present tenure

Reserved forest - 3,759 ha
Unreserved Crown land - 3,791 ha
Various road reserves and stream frontages

### 4. General description

Farmlands in the Broken River valley rise to a plateau in the Holland Creek watershed west of Tolmie. Forests occupy rugged topography in the north of the block.

### 4. Present use

Some areas in the headwaters of Blue Range Creek and near the Old Tolmie road are being used for softwood production. An isolated allotment of about 100 ha south of Hat Hill provides forest grazing. Parts of Holland Creek are used for fishing. Up to 12 bee sites utilize the forests on public land. Hardwood logging operations are current.

*Recently established pine plantation with Hat Hill in mid-background*

## B. Nature of the Land

### 1. Climate

Average annual rainfall is from about 760 mm to 1,270 mm. The growing season for pastures at Table-top is about March to May and September to November. Around Tolmie it is October to April.

### 2. Physiography and geology

The block forms part of the Tolmie highlands. The plateau adjacent to the headwaters of Ryans Creek is separated from another plateau (which extends westwards from Tolmie to the headwaters of the Blue Range Creek and south to Table-top) by a scarp that descends to Holland Creek. The lower plateau is separated from the Mansfield plain by long gentle south-westerly slopes or by much-dissected topography. The main streams flowing through the block are Holland, Blue Range, Sawpit, and Bridge Creeks and the Broken River.

The main geological features are a phonolite plug east of Hat Hill, Lower Carboniferous sedimentary rocks in the south, Upper Devonian volcanics and Tertiary basalt in the north, and Cambrian greenstone and chert in the north-west.

### 3. Soils

The major soils on the Tolmie plateau are reddish and yellowish duplex soils, while those of the slopes descending to the Mansfield plain vary from yellowish duplex soils and weakly bleached friable gradational soils to undifferentiated stony loams. On Upper Devonian volcanics in the Holland Creek watershed, friable brownish gradational soils predominate. Friable reddish gradational soils (with well-structured subsoils) are dominant in the Spring Creek area on Cambrian parent materials.

### 4. Vegetation

Narrow-leaf peppermint open forest III and IV predominate at the upper elevations. Understoreys vary from dense bracken fern and silver wattle to fishbone water-fern, soft tree-fern, mountain tea-tree, and hazel pomaderris or musk daisy-bush and blackwood. Some narrow-leaf peppermint open forest may have a grassy understorey. Stands of broad-leaf peppermint : candlebark open forest II occur in the higher-rainfall areas where Lower Carboniferous sedimentary rocks are the base rocks. The understorey is typically grassy (tussock grass and spear grasses) with scattered small grass-trees, mountain grevilleas, and mat-rushes. The sharp boundary between narrow-leaf peppermint open forest and broad-leaf peppermint : candlebark open forest coincides with the geological boundary between acid volcanics and sedimentary rocks.

Drier sites carry either broad-leaf peppermint : red stringybark open forest II or red stringybark : long-leaf box :

red box open forest I and II. The understoreys are usually grassy and the tussocks may be sparsely scattered. A small stand of alpine ash exists near *Archerton*.

5. Fauna

Local bird observers have commonly recorded the white-browed scrub-wren, grey thrush, laughing kookaburra, and grey fantail. Uncommon birds include the lyrebird, pilot bird, noisy friar-bird, olive whistler, satin bower-bird, cuckoo, and banded landrail.

Mammal surveys by staff of the National Museum indicate that greater gliders occur in large numbers near the Blue Range creek. They have also been found near Holland Creek and on the divide between the two streams. Large numbers of eastern grey kangaroos were observed near the margins between farmland and forest near Hat Hill and have also been recorded in the Blue Range Creek valley. Mammals recorded for the creek margins include the long-nosed bandi-coot, brown antechinus, ring-tailed possum, greater glider, black wallaby, common wombat, and bush rat. The common wombat, greater glider, and brush-tailed possum have been recorded on ridge sites. The platypus has been observed in Holland Creek.

A survey of the reptiles and amphibians revealed that this area forms a transition zone between warm and cool

*The three-toed skink*

temperate Bassian zoogeographic zones. For example the three-toed skink, while present in the area, was not as wide-spread as the yellow-bellied skink, which replaces the former species in the cool temperate regions.

The yellow-bellied skink was found only in this area, although further surveys in the Tolmie highlands may reveal a wider distribution. Both cool and warm temperate forms of *Sphenomorphum tympanum* (southern water skink and eastern water skink respectively) are also present together only in this area.

Thirteen reptile species in all were noted, including the blind snake, copperhead snake, black whip snake, southern bluetongue, garden skink, grass

*The eastern grey kangaroo*

skink, weasel skink, and bougainville's skink. Amphibians recorded are the brown froglets *(Crinea signifera* and *C. victoriana)*, the toadlet *(Pseudophryne bibroni)*, lesueur's tree frog, and ewing's tree frog. Hat Hill is interesting, particularly for reptiles, because of the range in altitude and the amount of rock outcrops. Fish in Hollands Creek include rainbow trout, brown trout, river blackfish, and redfin.

6. Land systems

Loombah 32%; Tolmie 24%; Table top 24%; Wrightley 7%; Archerton 8%; and Tiger Hill 5%.

## C. Capabilities

1. Flora

The capability for flora conservation of the main parcel of public land is moderate. Five vegetation units are represented, but no significant plants have been recorded. The boundary between Lower Carboniferous sedimentary rocks and Upper Devonian acid volcanics is marked by a change in vegetation, and it would be of scientific interest to correlate this with soil changes. The capability of the two smaller parcels is low.

2. Fauna

The capability of the main area of public land is moderate to high. Sig-

nificant birds include the noisy friar-bird, satin bower-bird, and brush cuckoo. The area supports large numbers of eastern grey kangaroos. It appears from studies of reptiles that the area forms a transition zone between the warm and cool temperate Bassian zoogeographic zones and as such is of scientific interest. The capability of the small parcels of land is likely to be low.

3. Hardwood production

The capability of the main parcel of public land is moderate to high. Some messmate stringybark stands located near the Old Tolmie road are currently being converted to softwood plantations.

Regrowth and mature stands of St.John's blue gum in the headwaters of Bridge and Hollands Creeks total about 400 ha. The capability of the isolated allotments is low.

4. Softwood production

The capability of the broad-leaf peppermint : candlebark open forest sites on the Holland Creek - Blue Range Creek divide is low to moderate; site qualities are likely to vary from marginal to suitable for radiata pine (SQ VI to IV). Narrow-leaf peppermint open forest and messmate stringybark open forest are mainly found in the Holland Creek valley. Site qualities on these areas are suitable for radiata pine growth (SQ II to IV).

5. Agriculture

Most of the public land is steep and has a low capability. The capability on the flatter areas south of Hollands Creek (Tolmie land system) is generally moderate to high. The soils formed on the sedimentary rocks are physically satisfactory but not particularly fertile. They can support perennial pastures. Winter cold limits the growing season, which nevertheless is a long one, extending from spring to autumn.

Limited areas of the Archerton land system have a high capability for potato production and may prove suitable for other horticultural crops not affected by the low winter temperatures.

6. Apiculture

The capability is low to moderate for honey production and pollen build-up, although there is some potential for queen bee breeding and commercial production of pollen. Up to 12 bee sites utilize the forest - mainly narrow-leaf peppermint, messmate stringybark, and candlebark - producing an annual average yield valued at about $3,500.

7. Water

The capability for water production is high, as this area is a significant source of water for the Broken River. The main streams are Holland, Blue Range, Sawpit, and Bridge Creeks.

8. Minerals

The capability for mineral production is low. Antimony occurs near Wrightley, and there are indications of fluorite along Holland Creek.

9. Recreation

The capability for recreation is moderate to low. Attractions include the scenic viewpoint from Hat Hill, the numbers of eastern grey kangaroos near forest margins, a waterfall and an antimony mine near the Tatong-Tolmie road, and fishing in Holland Creek.

10. Other

Near Barwite, Lower Carboniferous fossil fish are of high scientific interest.

D. Hazards and Conflicts

The erosion hazard (sheet, gully, and tunnel erosion) is high on the steeper slopes in the Table-top land system, but low on the gentle lower slopes and plateaux, and generally low in the Tolmie land system. Steep slopes south of Wrightley have a high sheet erosion hazard, and mass movement of soil tends to occur.

The fire hazard is moderate to high. Sirex wood wasp poses a potential threat to softwood plantations in the block. Conflicts could arise between softwood production, agriculture, and nature conservation. The conflict between the first two uses and nature conservation can be minimized by ensuring that adequate corridors are left between the Toombullup plateau and the Blue Range and by leaving strips of vegetation on either side of Holland Creek and along other permanent streams.

E. Significance

The block is primarily of significance for water production, softwood plantations, nature conservation and scientific study. It forms a link between the Blue Range and the Toombullup plateau.

# 9. BUNSTON

## A. General

### 1. Locality

An area to the north of the Maroondah Highway near Mansfield comprising 12,703 ha of public land in the County of Delatite, Parish of Barwite and parts of Nillahcootie, Doolam, Maindample, Mansfield, Beolite, Gonzaga, Dueran East, Merrijig, Cambatong, and Mirimbah.

Boundaries: Mansfield Shire boundary from Toombullup to the Buckland Spur; track along Buckland spur and around the headwaters of Evans Creek; the divide between the Broken and Delatite Rivers; the divide between Ford Creek and a stream to the east of it; the Maroondah Highway to Maindample; the Maindample to Barjarg road; and Barjarg to Toombullup *via* the Midland Highway and Bunston Hill.

### 2. Present tenure

Reserved forest - 11,757 ha
Unreserved Crown land - 908 ha
Water reserve, Bridge Creek - 13 ha
Racecourse and public recreation reserve, Mansfield - 25 ha
Various road reserves and stream frontages

### 3. General description

Farmland on the Mansfield plain and on gentle slopes north-east of Mansfield gives way to forested land in the headwaters of the Broken River and Evans Creek.

### 4. Present use

The Broken River and Evans Creek catchments serve as water sources for Lake Nillahcootie and Lake William Hovel (sited on the King River) respectively. There is little hardwood logging. Bees harvest nectar flows on up to 12 sites from forest and on six sites from vegetation on roadside reserves. Evans Creek and the Broken River provide some fishing.

## B. Nature of the Land

### 1. Climate

Average annual rainfall is from less than 760 mm to more than 1,270 mm. The growing season for pastures is from

October to April on the gently sloped uplands and from November to April at the highest elevations around Bunston Hill.

2. Physiography and geology

This block comprises part of the Tolmie highlands and the bulk of the Mansfield plain. The highlands in the vicinity of Mount Battery and Bunston Hill consist of long, gentle slopes, which descend to the Mansfield plain in a south-westerly direction. The headwaters of the Broken River and Evans Creek are deeply dissected. Some small high-altitude plateaux are located around the Bunston Hill and Toombullup areas. The three river systems in the block comprise the Broken River, Evans Creek (which flows into the King River), and Ford Creek, (which flows into Lake Eildon).

*View north along the Evans Creek valley*

The major geological features are the Lower Carboniferous conglomerates, red sandstones, siltstones, and shales. Underlying Upper Devonian volcanics are exposed in the Evans Creek valley, and overlying Tertiary basalts are located at Bunston Hill and a few nearby localities. Quaternary alluvial deposits cover most of the Mansfield plain.

3. Soils

The dominant soils of the long, gentle upland slopes are yellowish and reddish duplex soils. Where slopes are steep, undifferentiated stony loams are common. The deeply dissected landscapes mainly have these latter soils and also friable brownish gradational soils. Friable reddish gradational soils (with well-structured subsoils) are associated with the basaltic plateaux.

The Mansfield plain is almost wholly private property. The dominant soils here are gilgaied yellowish duplex soils and weakly bleached friable gradational soils.

4. Vegetation

This block has the most diverse vegetation in the district, ranging from candlebark : snow gum open forest I with a grassy understorey to red stringybark: long-leaf box : red box open forest I with a sparse litter layer or grassy understorey. Other units are as follows:

* alpine ash open forest III and IV, which consists mainly of regrowth stands; the understorey is typically grassy, but may have scattered hop bitter-pea or - in gullies - fishbone water-fern, soft tree-fern, and mountain tea-tree

* messmate stringybark open forest III and IV with an understorey of ground ferns, musk daisy-bush, and black-wood, or bracken fern and silver wattle, or hazel pomaderris, blanket-leaf, musk daisy-bush, austral mul-berry, and rough tree-fern in gullies.

* broad-leaf peppermint : candlebark open forest II on the flat ridges, with an understorey that includes tussock grass and spiny-headed mat-rush with scattered narrow-leaf bitter-pea, gorse bitter-pea, common beard-heath, handsome flat-pea, and mountain grevillea

* red stringybark : broad-leaf pepper-mint open forest II with a grassy understorey

* mountain swamp gum open forest II (which in some situations approaches a woodland formation) with a dense sward of tussock grass and kangaroo grass and with scattered ovens wattle and blackwood

5. Fauna

Common birds recorded for the block include the laughing kookaburra, grey thrush, crimson rosella, white-browed

*An alpine ash stand*

*Satin-bower bird*

scrub-wren, white-throated tree-creeper, grey fantail, brown thornbill, and pied currawong. Less common birds include the satin bower-bird, pilot bird, Australian ground-thrush, red-browed tree-creeper, crescent honeyeater, and noisy friar-bird.

The eastern grey kangaroo, black wallaby, bobuck, ring-tailed possum, sugar glider, yellow-bellied glider, greater glider, common wombat, long-nosed bandicoot, tuan, and dingo have been recorded.

Fish in the Broken River and Evans Creek include redfin, brown trout, rainbow trout, river blackfish, and crucian carp.

6. Land systems

Tolmie 40%; Cambatong 40%; Table-top 7%; Loombah 8%; Benalla 3%; and Archerton 2%.

## C. Capabilities

### 1. Flora

The capability for flora conservation is high to moderate because the vegetation units are diverse and range from vegetation characteristic of the driest sites to alpine ash and snow gum communities at the highest elevations. In addition, the Broken River watershed is relatively undisturbed. However, no significant species have been recorded in the block.

### 2. Fauna

The block probably has a diverse fauna and so rates as having a moderate capability. Significant birds include the satin bower-bird and noisy friar-bird

### 3. Hardwood production

The capability in the Broken River watershed is low, except for messmate stringybark, St. John's blue gum, and candlebark stands (categories B to C) situated to the south and east of Bunston Hill, where the capability is high.

It is generally moderate to high in Evans Creek and West King River watersheds due to the narrow-leaf peppermint

stands, interspersed with messmate stringybark and alpine ash stands.

4. Softwood production

The capability on gentle slopes south of Bunston Hill is high (SQ II). This area totals about 350 ha. The largest consolidated area in the block suitable for softwood production, where slopes are not too steep, totals about 3,000 ha, Of this area, about 300 ha are situated north of Bunston Hill (SQ I and II), 1,000 ha in the headwaters of Stockyard Creek and Broken River (north branch) (on which site qualities vary from SQ II to V), 500 ha along the Barrangunda ridge (SQ V to VI), 600 ha in the West King River headwaters (SQ II to IV), and 600 ha in the Evans Creek valley (SQ II to V).

However, some of this area is subject to regular, if light, snowfalls, and snow damage would reduce actual volume yields from radiata pine. Douglas fie could be an alternative species for these sites. Capabilities for softwood production are low to moderate elsewhere because of steep slopes, the dissected nature of the country, or high elevations.

5. Agriculture

The soils on the Archerton land system have a high capability for horticulture, but are mainly located on private property. Gentle slopes near Tolmie and to the south of Bunston Hill (Tolmie land system) would be suitable for improved pasture establishment. About 2 tonnes of superphosphate per ha would be necessary to establish an improved pasture, and annual dressings of about 200 kg per ha would be necessary to maintain it. Carrying capacities of at least 15 dry-sheep equivalents per ha can be expected during the spring, summer, and autumn. Low temperatures limit production during winter. Areas of gentle slopes exist in the headwaters of the Broken River, but these are remote and growing seasons are short. Elsewhere slopes are generally too steep for agriculture.

6. Apiculture

The capability for honey production and pollen build-up is low to moderate for the Tolmie highlands, but there is considerable potential for commercial queen bee breeding and pollen production. The river red gums on the Mansfield plain provide a valuable honey source, particularly as these trees flower at variance with other red gum flowering cycles. However, most trees are on private property. Up to 12 sites utilize forest and 7 sites utilize red gums on private property. The total annual average production is valued at $7,000.

7. Water

The capability for water production is high. The forested areas are valuable water source areas for both Lake Nillahcootie and Lake William Hovell.

8. Minerals

No minerals are known in this block.

9. Recreation

The capability for recreation activities such as hiking, camping, fishing, and cross-country driving are high because of the dissected nature of the country, the sub-alpine environments, the relatively undisturbed nature of the forested land, and the presence of fishing streams. The capabilities are enhanced by the position of the forest. It lies about 29-30 km from Mansfield, 6-12 km from Lake William Hovell, about 15 km from Mount Stirling, and 26 km from Mount Buller. Its eastern boundary - the Buckland spur - forms part cf a walking route from Mount Buller, Mount Stirling, and the Razorback spur to Lake William Hovell on the King River. Sambar deer range into this block from the highland areas to the south-east, providing sport for shooters.

*Gorge on the West King river*

D. Hazards and Conflicts

The erosion hazard is low on gentle slopes under high-rainfall conditions, and high to moderate on steep slopes. The maintenance of an adequate vegetative cover on steep slopes will reduce the risk of sheet erosion.

The fire hazard is moderate. Blackberries and rabbits are hazards to nature conservation, and to some outdoor recreation activities. Conflicts are likely between softwood production and recreation, but neither of these uses is likely to conflict with water production if careful management is practised.

E. Significance

The block's prime significance is as a water source area. It also has high capabilities for recreation, nature conservation, softwood production, and hardwood production. It is adjacent to large areas of public land in the Eastern Highlands.

# 10. DRY CREEK

## A. General

### 1. Location

This block to the north of the Maroondah Highway near Bonnie Doon comprises 9,227 ha of public land in the County of Delatite, Parishes of Borodomanin and Tallangallook and parts of Parishes of Too Rour, Wondoomarook, Merton, Brankeet, Nillahcootie, and Doolam.

Boundaries: Midland Highway from Maindample to Barjarg; Barjarg road, Bonnie Doon road to near head of Hayfield Creek; road to Merton Creek-Seven Creeks divide; Euroa-Merton road from divide to Merton; and Maroondah Highway from Merton to Maindample.

### 2. Present tenure

Reserved forest - 7,017 ha
Unreserved Crown land - 2,210 ha
Public land around edges of Lake Eildon
Various stream frontages and road reserves.

### 3. General description

Cleared valleys and steep foothills rising from the Maroondah Highway and passing into forested montane slopes and plateaux in the far north.

### 4. Present use

Public land in the Mount Strathbogie area mainly supports hardwood production, with some forest grazing near the Dry Creek-Tallangalook Creek junction. Up to 38 bee sites utilize St. John's blue gum, candlebark, and red stringybark on public land. Most of the public land serves as a water source area for Lake Eildon and Lake Nillahcootie. Lake Eildon and its foreshores are used for water sports and picnics, and the forests are used for recreation activities such as driving for pleasure and gem-seeking.

## B. Nature of the Land

### 1. Climate

Average annual rainfall is less than 760 mm near Bonnie Doon and Merton and increases to more than 1,270 mm near Mount Strathbogie. The growing season for pastures at the upper elevations is September-January and February-April on the rolling ridge tops and March-May and September-December on the high plateaux.

*Candlebark and snow gums near Mt. Strathbogie*

2. Physiography and geology

The block forms part of the Strathbogie massif and the Mid-Goulburn terrain. Mount Strathbogie (1,007 m) is the highest point of the Strathbogie massif, and much of the higher country is above 600 m. The massif is characterized by rolling topography where the underlying geology is Upper Devonian granite. Most of the Mid-Goulburn terrain overlies Devonian-Silurian mudstones, siltstones, and sandstones, which form a much-dissected landscape. Streams flowing into Lake Eildon include Merton, Hayfield, Gerar, Brankeet, Dry, Tallangalook, and Glen Creeks.

3. Soils

The rolling ridge tops at the higher elevations typically carry friable brownish gradational soils or reddish gradational soils (with weakly structured subsoils). The midslopes and plateau areas where rainfall is high are dominated by reddish duplex soils. Mid-elevation slopes under lower-rainfall conditions have undifferentiated stony loams and weakly bleached friable gradational soils, and lower slopes and ridges have weakly bleached friable gradational soils and reddish and yellowish duplex spils.

4. Vegetation

The predominant vegetation is narrow-leaf peppermint open forest III. Its

understorey varies from bracken fern, common cassinia, and silver wattle in the eastern portion to tussock grasses around Gerar Creek in the west. Some gullies have a dense understorey of musk daisy-bush, hazel pomaderris, austral mulberry, and blackwood.

Scattered within the area occupied by this unit are pockets of messmate stringybark open forest III and IV, with an understorey varying from dense bracken fern and silver wattle to musk daisy-bush and blackwood. Broad-leaf peppermint : red stringybark open forest II is found on dry spurs with southern aspects and east of Glen Creek. The forest floor typically has only leaf litter or is grassy (tussock grass). Mount Strathbogie and an adjacent high point carry candlebark : snow gum open forest I with a grassy or mossy understorey.

5. Fauna

The fauna is typical of mountain forests in the north-east of Victoria. Common birds include the sulphur-crested cockatoo, crimson rosella, laughing kookaburra, grey fantail, rufous whistler, white-throated tree-creeper, and spotted pardalote. White-winged choughs are relatively common in foothill forests.

Uncommon birds include the pied currawong, flame robin, sacred kingfisher, superb lyrebird, peregrine falcon, and noisy friar-bird. The commonly observed mammals comprise the ring-tailed possum, greater glider, and common wombat. Less common mammals are the black wallaby, eastern grey kangaroo, koala, and echidna. Little is known of the reptiles in this block. Fish in Lake Eildon and adjacent streams include redfin, brown trout, rainbow trout, crucian carp, and macquarie perch.

6. Land systems

Moonee Moonee 56%; Moorngag 34%; and Strathbogie 10%.

## C. Capabilities

1. Flora

The capability for flora conservation is moderate to high. The seven veget-

*Peregrine falcon*

ation units represented in the block range from red stringybark : long-leaf box : red box open forest to candle-bark : snow gum open forest, but no significant plant species have been recorded.

2. Fauna

The capability is moderate to high. Large numbers of sulpur-crested cockatoos nest in the forest area. Significant birds are the peregrine falcon, noisy friar-bird, and grey-crowned babbler.

3. Hardwood production

The capability is moderate over most of the block, but is high in the Tallangalook road-Barjarg road locality, where messmate stringybark and St. John's blue gum stands total about 200 ha. Other isolated messmate stringybark stands total about 320 ha.

4. Softwood production

Capabilities are high for most of the block. A total of about 3,000 ha in the western part and 600 ha in the eastern part are suitable for radiata pine or douglas fir plantations. For most areas, site qualities of radiata pine are likely to be SQ II to V. However, site qualities of IV to V may be more typical of grassy narrow-leaf peppermint forest with poorly structured soils near Gerar Creek.

5. Agriculture

Most of the public land has a low capability because of moderate to steep slopes, combined with a summer drought at the lower elevations and severe low temperatures at the high elevations. However, some areas of less-steep slopes occur on isolated parcels of public land and in the Gerar and Brankeet Creek headwaters. These probably have carrying capacities on perennial pastures of about 10 dry-sheep equivalents per ha, giving them moderate to high capability.

6. Apiculture

The capability is high for honey production and pollen build-up but low for wintering. Up to 40 sites utilize forest - the main production being from St. John's blue gum, manna gum, candle-bark, red stringybark, river red gum, and messmate stringybark, in descending order of importance. Total average annual production is valued at $21,500.

7. Water

Capability is high, as the public land serves as a water source for Lake Eildon and for the Broken River up-stream and downstream of Lake Nillahcootie. Yields per unit area are relatively high.

8. Minerals

Dry Creek block contains considerable areas of gold-fields, but reserves are

likely to be low. It also has a minor deposit of felspar and occurrences of tin, antimony, and rock crystal. However, the general capability is low to moderate.

9. Recreation

The capability for many forms of outdoor recreation is high to moderate. The greatest attraction to visitors is Lake Eildon, which provides water sports - including angling for trout and redfin. A number of people also visit the old gold-mining township of Tallangalook, the gold diggings here, at Dry Creek, and at Glen Creek, and the crystal mines near the Barjarg road. The forest environment and scenic viewpoints from Golden Mountain and Wild Dog bluff offer attractions to hikers and campers.

D. Hazards and Conflicts

The erosion hazard is low generally, but the sheet erosion hazard is moderate on the foothills and some steep slopes. The fire hazard is moderate to high.

The main conflicts likely to occur are between agriculture and softwood production and between both of these and nature conservation and/or recreation.

*View towards Lake Eildon from Golden Mountain*

Water production is unlikely to conflict with the most probable uses. Apiculture would conflict with agriculture and softwood production, but not nature conservation and recreation.

E. Significance

The block has significance for most uses i.e. nature conservation, recreation, water production, softwood and hardwood production, and apiculture. It adjoins the Toorour block.

# 11. TOOROUR

## A. General

### 1. Location

This block, immediately to the west of Lake Nillahcootie, comprises 10,388 ha of public land in the County of Delatite, parts of Parishes of Too Rour, Lima, Nillahcootie, and Tallangallook.

Boundaries: Midland Highway from Barjarg to Swanpool; Swanpool to Too Rour *via* Police Track; and Too Rour to Barjarg *via* Bonnie Doon and Barjarg roads.

### 2. Present tenure

Reserved forest - 8,717 ha
Unreserved Crown land - 1,671 ha

Various stream frontages and road reserves

### 3. General description

Mainly forested montane slopes rising from cleared farmland in the Broken River and lower Moonee Moonee Creek valleys, and culminating in forested plateaux in the south-west of the block.

### 4. Present use

Hiking and nature study groups use the forest surrounding a camping ground sited near Moonee Moonee Creek. There is some utilization of messmate stringybark stands. Up to 38 bee sites produce honey crops, mainly from red stringybark. Some cleared public land near Too Rour is leased for cropping and grazing. Part of the land serves as a catchment for Lake Nillahcootie and provides a scenic backdrop for visitors to the lake. Fishing takes place in Moonie Moonie and Sandy Creeks.

## B. Nature of the Land

### 1. Climate

Average annual rainfall ranges from less than 890 mm to 1,270 mm. The growing season for pastures at the upper elevations is September-January and February-April on the rolling ridge tops and March-May and September-December on the high plateaux.

### 2. Physiography and geology

This block forms part of the Strathbogie massif and the Benalla plain. A plateau

*The "Devils Jacks" near Lima South, 1910*

*Messmate stringybark forest*

in the south-west of the block gives way to a series of major ridges and valleys, drained by streams that flow into the Broken River or Lake Nillahcootie. Moonee Moonee, Rocky Ned, Parlor's and Sandy Creeks are the main streams. The plateaux and ridges overlie Upper Devonian granite. Granite tors are common.

3. Soils

Reddish duplex soils are dominant on the plateaux; friable brownish gradational soils or reddish gradational soils (with weakly structured subsoils) are dominant on the rolling ridge tops and the upper-level major valleys. Reddish or yellowish duplex soils are common on low foothills, and yellowish duplex soils dominate in the low-elevation valleys.

4. Vegetation

Stands of messmate stringybark open forest III and IV grow at the higher elevations on the plateau or on sheltered sites. The understorey on the plateau is typically a dense layer of bracken fern 1 m high, over-topped by a layer of silver wattle 5 m high. On sheltered sites, such as in gullies, the understorey is typically a ground layer of litter or low ferns, a dense layer of musk daisy-bush 8 m high, and scattered blackwoods 20 m high.

Narrow-leaf peppermint open forest II predominates in the higher-rainfall

areas. The understorey is typically bracken fern and silver wattle, but may be grassy on the drier sites. On the dry montane slopes broad-leaf peppermint : red stringybark open forest II is predominant. The understorey is typically grassy (mainly tussock grass) with various herbs, but may consist of bracken on the moister sites and various heathy species on drier sites. Red stringybark : long-leaf box : red box open forest I and II occurs mainly on the northern extremity of Lightning Ridge. The understorey is typically

*Silver wattle*

*The greater glider is a common inhabitant in tall forests of the block*

heathy, with such species as daphne heath and mountain grevillea.

5. Fauna

The fauna is typical of peppermint-gum forests in the north-east of Victoria. Common birds include the sulphur-crested cockatoo, white-throated tree-creeper, laughing kookaburra, rufous whistler, crimson rosella, grey thrush, white-browed scrub-wren, and grey fantail. Uncommon birds include the orange-winged sitella and spotted quail-thrush. Common mammals are the greater glider, ring-tailed possum, and common wombat, while the black wallaby, eastern grey kanga-

roo, and echidna are uncommon, and the koala and eastern water rat are seen only rarely. Reptiles include the red-bellied black snake, water skink, garden skink, and southern bluetongue.

6. Land systems

Moonee Moonee 80%; Strathbogie 16%; and Swanpool 4%.

C. Capabilities

1. Flora

The block has a moderate to high capability for flora because of the diversity of vegetation types. Significant species include grey bush-pea, twiggy daisy-bush, and box-leaf wattle.

*Eastern water rat*

2. Fauna

The fauna capability is high because this large area of relatively undisturbed forest is inhabited by species typical of the north-eastern peppermint-gum forests.

3. Hardwood production

The capability is high to moderate on the plateaux and low to moderate elsewhere. The main timber-producing areas are messmate stringybark stands. One, comprising 120 ha, is in the headwaters of Sandy Creek, the other, of 360 ha, adjoins a stand of 200 ha in the Dry Creek block.

4. Softwood production

The capability is high over most of the block, with radiata pine site qualities of II and IV expected on messmate stringybark and narrow-leaf peppermint sites. Douglas fir plantations in the higher-rainfall areas could be expected to yield volumes comparable to radiata pine site qualities II and III. The northern section of Lightning Ridge is unsuitable to marginal for radiata pine plantations. Most of the Sandy Creek watershed is suitable to marginal for softwood production (SQ III to VI).

5. Agriculture

Most of the public land forms part of the Moonee Moonee land system and has a

low capability for agriculture due to steepness. It resembles the public land of the Dry Creek block.

However, about 10% of the public land in the south-west forms part of the Strathbogie land system, which has a high capability for agriculture. Perennial pasture, capable of carrying around 10 dry-sheep equivalents per ha throughout the year, could be established on this rolling tableland.

6. Apiculture

This block as a whole shows the largest return from honey production in the district, and has high capability for honey production and pollen build-up. Up to 40 bee sites utilize forest, the main species being red stringybark and St. John's blue gum, with an average annual production valued at $27,200.

7. Water

The capability for water production is high. Sandy Creek flows directly into Lake Nillahcootie, and Moonee Moonee Creek (with its tributaries) joins the Broken River upstream from the Lake Mokoan take-off channel.

8. Minerals

There are no known minerals in the block. However, mineral-search licence applications for fluorite along Sandy Creek are current.

*View of Lake Nillahcootie from Lightning Ridge*

9. Recreation

Toorour block has a high to moderate capability for recreation. The highest values pertain to the Moonee Moonee Creek valley and Lightning Ridge. This area affords hikers an interesting route along the creek and scenic views of Lake Nillhacootie, the Broken River valley, and the Blue Range. Lightning Ridge also provides a scenic backdrop for visitors to Lake Nillahcootie or sight-seers driving along the Midland Highway. Features include a waterfall on Sandy Creek, fishing along Moonee Moonee and Sandy Creeks, and a scenic viewpoint and rockface at Mount Sugarloaf.

D. Hazards and Conflicts

There is a moderate sheet erosion hazard on the foothills and on some steep slopes. On most of the less-steep slopes and on the plateaux the erosion hazard is low. The fire hazard is high to moderate. Sirex wood wasp would pose a threat to the productivity of any softwood plantations established in the area. Conflicts could arise between water production and agriculture adjacent to Lake Nillahcootie. Nature conservation and recreation would conflict with softwood production and agriculture, but not with hardwood production. Agriculture and softwood production would conflict with apiculture.

E. Significance

This block has significance for a number of uses. It has a total high capability for nature conservation, water production, and apiculture. Lightning Ridge has high values for recreation, and the plateaux have high values for hardwood production, softwood production, and agriculture. The block is contiguous with large areas of public land to the north and south (Warrenbayne and Dry Creek blocks respectively).

# 12. SAMARIA

## A. General

### 1. Location

An area to the east of Lake Nillahcootie comprising 10,242 ha of public land, mainly in two large parcels of land, all in the County of Delatite, parts of Parishes of Nillahcootie, Moorngag, and Dueran.

Boundaries: Midland Highway from Nillahcootie to Swanpool; Swanpool to Tatong road *via* Moorngag; Tatong to Bridge Creek *via* Tatong-Tolmie road, Spring Creek track, and Blue Range track; and Bridge Creek to Nillahcootie.

### 2. Present tenure

Reserved forest - 5,403 ha
Unreserved Crown land - 4,711 ha
Public purposes reserve, Mt. Samaria - 86 ha
Water reserve, Moorngag - 6 ha
Reserve, Moorngag - 5 ha
Water supply reserve, Lake Nillahcootie - 31 ha
Public land around margins of Lake Nillahcootie
Various stream frontages and road reserves

### 3. General description

A steep forested range with a narrow plateau at the summit, which rises from undulating farmland in the Broken River and Holland Creek valleys. A low range of forested hills lies between Samaria and Wrightley.

### 4. Present use

The public land in the Blue Range Creek watershed serves as a catchment for Lake Nillahcootie. About 500 ha support softwood production. Local field naturalists use the block for outings. Lake Nillahcootie provides water sports, and fishing takes place in the Lake and along the Broken River. About 300 ha of forest are grazed to the east of Lima South, and a further 150 ha north-west from Wrightley. Up to 23 bee sites utilize red stringybark forest.

## B. Nature of the Land

### 1. Climate

Average annual rainfall is from about 760 mm to 1,270 mm. The growing season for pastures on the plateau is March-May and September-December. On the montane

*The North Blue Range with Lake Nillahcootie in foreground*

slopes, it is September-January and February-April at the higher elevations and August-December and March-May at the lower.

2. Physiography and geology

The block comprises the part of the Tolmie highlands known as the North Blue Range and part of the Benalla and Mansfield plain. The Blue Range has steep montane slopes rising to a north-south oriented plateau, which reaches its highest point at Mount Samaria (953 m) in the north. The Range is dissected in the north by Samaria Creek to form two low ranges of hills, one extending towards Tatong and the other towards Swanpool. Most streams draining the range have steep grades where they plunge down the scarps. The geology is the most complex in the district. The North Blue Range mainly comprises Lower Devonian granite, but also Upper Devonian acid volcanics, Devonian-Silurian sedimentary rocks, Cambrian greenstone and chert, and Ordovician sedimentary rocks. Lower Carboniferous sedimentary rocks form an undulating landscape south of the North Blue Range.

3. Soils

Soils are diverse. On the granitic plateau, reddish duplex soils and weakly bleached friable gradational soils predominate. On the granitic slopes the predominant soils are undifferentiated stony loams, which, together with yellowish duplex soils, also predominate on acid volcanic slopes. The foothills of acid volcanics have stony loams, yellowish duplex soils, and weakly bleached massive gradational soils, whereas foothills of Devonian-Silurian sedimentary rocks have mainly weakly bleached friable gradational soils and reddish duplex soils.

On Cambrian parent materials the rolling plateaux and upper valleys carry friable reddish gradational soils (with well-structured subsoils) and the steep slopes have undifferentiated stony loams and weakly bleached friable gradational

soils. Yellowish duplex soils are chatacteristic of the undulating landscapes east of Barjarg on granites and sandstone and mudstone parent materials.

4. Vegetation

The vegetation of the plateaux and eastern slopes of the North Blue Range is predominantly narrow-leaf peppermint open forest III with a bracken fern, silver wattle, or grassy understorey. The understorey in sheltered gullies may include austral king-fern, soft tree-fern, musk daisy-bush, and blackwood. Messmate stringybark open forest III and IV occurs on sheltered sites on the plateau. The understorey is typically scrubby, with plants that include fish-bone water-fern, mountain tea-tree, blanket-leaf, and hazel pomaderris. The vegetation on some small swampy areas on the plateau is mountain swamp gum open forest II with an understorey of thatch saw-sedge and prickly tea-tree.

The predominant vegetation on the western scarp and the northern section of the Range is red stringybark : long-leaf box : red box open forest I and II. The understorey may be virtually absent - consisting mainly of a litter layer - but is more usually heathy, with plants including grey bush-pea, mountain grevillea, silky guinea flower, digger's speedwell, narrow-leaf bitter-pea, and daphne heath. Broad leaf peppermint : red stringybark open forest II is found at some high elevations and also on gentle footslopes. The understorey may be grassy or heathy with such species as small grass-tree and common star-hair. A forested range of low hills near Wrightley mainly carries red stringybark : long-leaf box : red box open forest I and II with a grassy or heathy understorey.

5. Fauna

The birds of the North Blue Range are typical of peppermint-gum forests in north-eastern Victoria. Common birds

*The bobuck*

include the sulphur-crested cockatoo, grey fantail, grey thrush, striated thornbill, brown thornbill, white-throated scrub-wren, spotted pardalote, and white-throated tree-creeper. The red-browed tree-creeper, noisy friarbird, wonga pigeon, leaden fly-catcher, brush cuckoo, regent honeyeater, and satin bower-bird are less common. Common mammals are the black wallaby, greater glider, common wombat, and ring-tailed possum. The bobuck is infrequently observed.

A survey in the Blue Range Creek bordering the block recorded the brown antechinus, bush rat, and eastern grey kangaroo. Another in Spring Creek recorded the following reptiles: yellow-bellied skink, bougainville's skink, garden skink, three-toed skink, and the black rock-skink. The brown froglet (*Crinea victoriana*) and ewing's tree frog have been recorded in the nearby Blue Range Creek. The coppertail skink, lace lizard, and stone gekko have been observed in the block.

*Black duck and young*

Birds in the forested public land near Wrightley include the sacred kingfisher, rufous whistler, leaden fly-catcher, laughing kookaburra, golden bronze-cuckoo, and white-throated tree-creeper. Little is known of other fauna.

Lake Nillahcootie and its margins support the yellow spoonbill, pelican, black swan, black cormorant, silver gull, mountain duck, black duck, musk duck, and white-fronted chat.

Fish in Lake Nillahcootie and the Broken River include redfin, brown trout, river blackfish, and macquarie perch.

6. Land systems

Moonie Moonie 36%; Strathbogie 19%; Loombah 17%; Moorngag 16%; Wrightley 5%; Swanpool 4%; and Table-Top 3%.

## C. Capabilities

1. Flora

The capability of the North Blue Range for flora conservation is high to mod-

erate. A brief survey by Miss D. Nason along the main track through the area listed 110 plants. This list includes a number of wildflowers and attractive shrubs, for example, finger flower, rough bush-pea, common wedge-pea, purple coral-pea, common hovea, coral heath, dwarf boronia, bluebell, blue pincushion, rock isotome, silky guinea flower, violet kunzea, ivy-leaf violet, showy violet, common bird-orchid, and musky caladenia.

Elsewhere the capability is low to moderate.

2. Fauna

The capability for fauna conservation is high to moderate on the main parcel of public land in the block, as this large, consolidated, and relatively undisturbed area contains a range of habitats. Significant birds noted include the wonga pigeon, brush cuckoo, and satin bower-bird.

The capability of the parcel west of Wrightley is low. Lake Nillahcootie has a moderate to low value for water-bird conservation.

3. Hardwood production

The capability is low to moderate over most of the main parcel of public land. Messmate stringybark forests in three main stands on the plateau, totalling 485 ha, have a high capability. The

*Wonga pigeon*

capability on the public land near Wrightley is low.

4. Softwood production

Steep and/or dry slopes render most of the main parcel of public land unsuitable for softwood plantations. However, much of the plateau is suitable for softwood growth, with site qualities of II to IV being indicated.

The public land near Wrightley is mostly marginal to unsuitable for radiata pine growth (SQ VI to VII).

5. Agriculture

Steep slopes render most of the public land unsuitable for agriculture. The

plateau south of Mount Samaria has moderate to high capability for pasture establishment and grazing - with a carrying capacity estimated at 10 dry-sheep equivalents per ha during the growing season - but access is difficult and the growing season would be limited by winter cold. Establishment and maintenance of improved pasture would involve heavy fertilizer applications.

Smaller areas at lower elevations, which have gentle slopes, are situated around a private property inlier by Samaria Creek and just to the south-west of Samaria. These have a moderate capability for pasture establishment and grazing, with an estimated carrying capacity of up to 10 dry-sheep equivalents per ha.

6. Apiculture

The capability is high for honey production and moderate for pollen build-up and wintering. Up to 23 sites utilize forest - mainly red stringybark and long-leaf box - returning an average annual yield valued at $16,900.

7. Water

The capability is high to moderate. The Blue Range Creek drains the south-eastern portion of the block and flows into Lake Nillahcootie. Streams flowing into Broken River below Lake Nillahcootie include Back, Wild Dog, Samaria, Spring, and Holland Creeks.

8. Minerals

The capability is moderate to low. Mineral lease applications for a fluorite deposit near the Broken River and to mine tungsten and bismuth near Wrightley are current.

9. Recreation

The main parcel of public land has a high capability for most forms of outdoor recreation, including driving for pleasure, sight-seeing, picnicking, nature walks, hiking, and camping. The main features include rocky scarps; two waterfalls; scenic lookouts for viewing Lake Nillahcootie, the Benalla plain, Lightning Ridge, the Mansfield plain, and Mount Buller; and a timber tramway connecting two old sawmill sites. The Blue Range provides a scenic background to Lake Nillahcootie.

Fishing takes place along the Broken River, and also on Lake Nillahcootie, where capability for most water sports is high to moderate, despite the limited area for sail-boat racing and water-skiing. The lake is also exposed to winds blowing up and down the Broken River valley.

## D. Hazards and Conflicts

The sheet erosion hazard is high on steep northerly aspects and moderate on the foothills and other dry steep slopes. It is generally low on the

plateau, although this has a moderate streambank erosion hazard.

The fire hazard is high to moderate. There is little likelihood of conflict over much of the public land, but recreation and nature conservation may conflict with agriculture and softwood production on the plateau.

E. Significance

The block is primarily of significance for nature conservation and recreation.

These values would be diminished to some extent if the main parcel of public land did not remain linked to the remainder of the Tolmie highlands.

Appendix I

Climatic Data

Table A

Average Rainfall in Millimetres

(Standard 30-year period 1931-60)

| Month | Station | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Archerton | Benalla | Euroa | Mansfield | Strathbogie | Strathbogie North | Warrenbayne | Lima East | Whitlands* | Tolmie-Langley | Barjarg |
| January | 58.9 | 41.7 | 37.1 | 46.2 | 45.7 | 58.4 | 42.4 | 47.5 | 66.3 | 54.1 | 38.6 |
| February | 59.7 | 39.4 | 34.3 | 45.5 | 44.5 | 42.7 | 41.7 | 46.7 | 66.0 | 49.3 | 45.7 |
| March | 87.9 | 53.8 | 50.3 | 57.7 | 67.8 | 78.5 | 51.1 | 61.2 | 44.7 | 57.9 | 58.9 |
| April | 95.3 | 53.1 | 54.1 | 63.0 | 85.1 | 80.5 | 61.5 | 74.9 | 111.3 | 69.4. | 71.4 |
| May | 144.0 | 54.6 | 56.6 | 57.4 | 90.7 | 109.2 | 63.5 | 84.1 | 138.4 | 63.0 | 66.3 |
| June | 150.1 | 70.6 | 65.5 | 65.8 | 116.3 | 132.3 | 82.0 | 112.8 | 184.7 | 85.1 | 85.3 |
| July | 179.8 | 75.2 | 71.4 | 71.6 | 124.0 | 134.1 | 94.7 | 122.4 | 189.7 | 89.2 | 95.8 |
| August | 147.6 | 68.8 | 67.1 | 75.4 | 115.0 | 109.7 | 83.3 | 110.2 | 177.5 | 90.7 | 78.5 |
| September | 125.7 | 54.9 | 54.6 | 62.0 | 92.5 | 98.3 | 60.5 | 80.8 | 124.0 | 73.2 | 67.1 |
| October | 142.2 | 67.8 | 66.5 | 72.6 | 95.8 | 103.4 | 73.2 | 84.8 | 137.4 | 89.2 | 77.0 |
| November | 110.2 | 52.8 | 48.0 | 64.0 | 71.9 | 81.3 | 54.6 | 66.3 | 99.6 | 72.9 | 54.9 |
| December | 69.1 | 38.4 | 32.0 | 45.4 | 48.7 | 50.8 | 37.8 | 45.7 | 72.6 | 50.3 | 32.8 |
| Year | 1370.5 | 671.0 | 637.5 | 726.6 | 998.0 | 1079.2 | 746.3 | 937.5 | 1462.2 | 844.1 | 772.2 |

* Outside study district  Note: Figures for Archerton and Strathbogie are based on 21-year and 26-year averages respectively.

Appendix 1

Table B

Average Rain per Wet Day (Millimetres)

| Month | Station | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Benalla | Euroa | Mansfield | Strathbogie | Whitlands* | Warrenbayne | Lima East | Tolmie-Langley |
| January | 10.41 | 9.27 | 9.25 | 11.43 | 13.26 | 10.62 | 9.50 | 10.29 |
| February | 9.86 | 8.59 | 9.09 | 11.13 | 13.21 | 10.41 | 9.35 | 10.49 |
| March | 10.76 | 10.06 | 9.60 | 13.56 | 15.80 | 10.21 | 12.24 | 11.56 |
| April | 6.63 | 7.72 | 7.01 | 10.64 | 13.92 | 7.70 | 9.37 | 8.48 |
| May | 6.07 | 6.30 | 5.74 | 8.26 | 13.84 | 5.77 | 7.65 | 8.00 |
| June | 6.43 | 5.97 | 5.05 | 10.57 | 15.40 | 6.30 | 8.69 | 8.20 |
| July | 5.79 | 5.49 | 4.78 | 8.86 | 13.56 | 6.32 | 8.15 | 6.71 |
| August | 4.93 | 5.16 | 5.03 | 8.20 | 12.67 | 5.56 | 6.88 | 7.09 |
| September | 5.49 | 6.07 | 5.16 | 8.41 | 12.40 | 5.49 | 7.34 | 7.67 |
| October | 6.17 | 6.65 | 6.05 | 8.71 | 11.46 | 6.65 | 7.72 | 8.92 |
| November | 6.60 | 6.86 | 7.11 | 7.98 | 12.45 | 6.83 | 8.28 | 9.30 |
| December | 6.40 | 5.33 | 6.50 | 8.13 | 10.39 | 6.30 | 6.53 | 8.89 |

* Outside study district

Appendix 1

Table C

Average Daily Mean Temperature ($^{o}C$)

| Month | Benalla | Euroa | Mansfield |
|---|---|---|---|
| January | 22.9 | 21.8 | 19.9 |
| February | 23.4 | 22.5 | 19.6 |
| March | 20.3 | 20.0 | 16.9 |
| April | 15.6 | 15.3 | 12.7 |
| May | 11.9 | 11.8 | 9.0 |
| June | 8.8 | 8.9 | 7.3 |
| July | 8.3 | 8.2 | 5.8 |
| August | 9.6 | 9.6 | 7.6 |
| September | 12.4 | 11.9 | 10.2 |
| October | 15.7 | 14.6 | 12.7 |
| November | 18.8 | 17.6 | 15.6 |
| December | 21.5 | 20.3 | 18.1 |
| Year | 15.8 | 15.2 | 12.9 |

Source: "Climatic Averages, Australia." (Commonwealth of Australia, Bureau of Metrology, 1956).

Conversion formula: $^{o}C = \frac{5}{9} (^{o}F - 32)$

Appendix 1

Table D

Percentage Frequency of Occurrence

of Effective Rainfall

| Month | Benalla | Whitfield* | Strathbogie | Euroa | Mansfield |
|---|---|---|---|---|---|
| January | 24 | 47 | 25 | 20 | 30 |
| February | 26 | 40 | 28 | 21 | 30 |
| March | 41 | 62 | 57 | 46 | 53 |
| April | 59 | 71 | 68 | 59 | 68 |
| May | 81 | 90 | 92 | 82 | 89 |
| June | 97 | 98 | 99 | 95 | 96 |
| July | 96 | 100 | 100 | 96 | 100 |
| August | 42 | 96 | 96 | 94 | 94 |
| September | 90 | 96 | 91 | 87 | 96 |
| October | 71 | 85 | 80 | 73 | 85 |
| November | 36 | 68 | 48 | 33 | 54 |
| December | 28 | 62 | 26 | 28 | 43 |

* Outside the district

Appendix II

List of Common Native Plants

* Common names in brackets are alternative names that have been used in the vegetation map accompanying this report

| Scientific name | Common name |
|---|---|
| PTERIDOPHYTA (ferns) | |
| Filicinae | |
| Osmundaceae | |
| *Todea barbara* | Austral king-fern |
| Gleicheniaceae | |
| *Gleichenia circinnata* | Pouched coral-fern |
| *G. microphylla* | Scrambling coral-fern |
| Hymenophyllaceae | |
| *Hymenophyllum cupressiforme* | Common filmy-fern |
| *Mecodium australe* | Austral filmy-fern |
| Cyatheaceae | |
| *Cyathea australis* | Rough tree-fern |
| Dicksoniaceae | |
| *Dicksonia antarctica* | Soft tree-fern |
| Dennstaedtiaceae | |
| *Culcita dubia* | Common ground-fern |
| *Pteridium esculentum* | Bracken fern |
| Adiantaceae | |
| *Adiantum aethiopicum* | Common maidenhair |
| *Cheilanthes tenuifolia* | Rock fern |
| Aspleniaceae | |
| *Asplenium flabellifolium* | Necklace fern |
| Aspidiaceae | |
| *Polystichum proliferum* | Mother shield-fern |
| Blechnaceae | |
| *Blechnum nudum* | Fishbone water-fern |
| *B. procerum* | Hard water-fern |
| ANGIOSPERMAE | |
| Juncaginaceae | |
| *Triglochin procera* | Water-ribbons |
| Gramineae | |
| *Microlaena stipoides* | Weeping grass |
| *Poa australis* (agg.) | Tussock grass (snow grass)* |
| *Agropyron scabrum* | Common wheat-grass |
| *Dichelachne crinita* | Long-hair plume-grass |
| *Agrostis avenacea* | Blown grass |
| *Echinopogon ovatus* | Hedgehog-grass |
| *Eragrostis brownii* | Common love-grass |
| *Phragmites australis* | Common reed |
| *Danthonia pallida* | Silvertop wallaby-grass |
| *D. auriculata* | Lobed wallaby-grass |
| *D. penicillata* | Slender wallaby-grass |
| *Stipa variabilis* | Variable spear-grass |
| *S. nervosa* | Tall spear-grass |
| *Isachne globosa* | Swamp millet |
| *Themeda australis* | Kangaroo grass |
| Cyperaceae | |
| *Cyperus brevifolius* | Globe kyllinga |
| *C. lucidus* | Leafy flat-sedge |
| *Schoenus apogon* | Common bog-rush |
| *Gahnia radula* | Thatch saw-sedge |
| *Lepidosperma laterale* | Variable sword-sedge |
| *Carex appressa* | Tall sedge |
| *C. gaudichaudiana* | Sedge |
| Centrolepidaceae | |
| *Centrolepis strigosa* | Hairy centrolepis |
| Juncaceae | |
| *Luzula campestris* (agg.) | Field woodrush |
| *Juncus australis* | Austral rush |
| *J. planifolius* | Broad-leaf rush |
| *J. holoschoenus* | Joint-leaf rush |
| Liliaceae | |
| *Xanthorrhoea minor* | Small grass-tree |
| *Lomandra filiformis* | Wattle mat-rush |
| *L. longifolia* | Spiny-headed mat-rush |

| Scientific name | Common name |
|---|---|
| *Arthropodium milleflorum* | Pale vanilla-lily |
| *Dichopogan strictus* | Chocolate lily |
| *Thysanotus patersonii* | Twining fringe-lily |
| *T. tuberosus* | Common fringe-lily |
| *Bulbine bulbosa* | Bulbine lily |
| *Tricoryne elatior* | Yellow rush-lily |
| *Dianella revoluta* | Tasman flax-lily |
| *D. tasmanica* | Black-anther flax-lily |
| *Stypandra glauca* | Nodding blue-lily |
| *Anguillaria dioica* | Early nancy |
| *Burchardia umbellata* | Milkmaids |
| Orchidaceae | |
| *Thelymitra pauciflora* | Slender sun-orchid |
| *Diuris maculata* | Leopard orchid |
| *D. sulphurea* | Tiger orchid |
| *Microtis parviflora* | Slender onion-orchid |
| *Chiloglottis gunnii* | Common bird-orchid |
| *Caladenia carnea* | Pink fingers |
| *C. angustata* | Musky caladenia |
| *Glossodia major* | Wax-lip orchid |
| *Pterostylis nutans* | Nodding greenhood |
| *P. longifolia* | Tall greenhood |
| *Dipodium punctatum* | Hyacinth orchid |
| Urticaceae | |
| *Urtica incisa* | Scrub nettle |
| Proteaceae | |
| *Persoonia rigida* | Hairy geebung (stiff geebung) |
| *P. chamaepeuce* | Dwarf geebung |
| *Grevillea lanigera* | Woolly grevillea |
| *G. alpina* | Mountain grevillea |
| *Lomatia ilicifolia* | Holly lomatia |
| Santalaceae | |
| *Exocarpos cupressiformis* | Cherry ballart (native cherry) |
| Loranthaceae | |
| *Amyema pendulum* | Drooping mistletoe |
| *A. miquelii* | Box mistletoe |
| Polygonaceae | |
| *Rumex brownii* | Slender dock |
| *Polygonum strigosum* | Spotted knotweed |
| *P. hydropiper* | Water-pepper |
| Caryopyllaceae | |
| *Stellaria pungens* | Prickly starwort |
| Ranunculaceae | |
| *Clematis aristata* | Australian clematis |
| *Ranunculus lappaceus* | Australian buttercup |
| *R. sessiliflorus* | Australian small-flower buttercup |
| Monimiaceae | |
| *Hedycarya angustifolia* | Austral mulberry |
| Lauraceae | |
| *Cassytha glabella* | Tangled dodder-laurel |
| *C. melantha* | Coarse dodder-laurel |
| Droseraceae | |
| *Drosera auriculata* | Errienellam |
| *D. peltata* | Pale sundew |
| Crassulaceae | |
| *Crassula sieberana* | Sieber crassula |
| Tremandraceae | |
| *Tetratheca ciliata* | Pink-bells |
| Pittosporaceae | |
| *Bursaria spinosa* | Sweet bursaria |
| *Cheiranthera linearis* | Finger-flower |
| *Billardiera scandens* | Common apple-berry |
| Rosaceae | |
| *Rubus parvifolius* | Small-leaf bramble |
| *Acaena anserinifolia* | Bidgee-widgee |
| *A. ovina* | Sheep's burr |
| Mimosaceae | |
| *Acacia aspera* | Rough wattle |
| *A. armata* | Hedge wattle |
| *A. gunnii* | Ploughshare wattle |
| *A. pravissima* | Ovens wattle |
| *A. pycnantha* | Golden wattle |
| *A. verniciflua* | Varnish wattle |
| *A. lanigera* | Woolly wattle |
| *A. melanoxylon* | Blackwood |
| *A. implexa* | Lightwood |

| Scientific name | Common name |
|---|---|
| *A. mearnsii* | Black wattle |
| *A. dealbata* | Silver wattle |
| Papilionaceae | |
| *Mirbelia oxyloboides* | Mountain mirbelia |
| *Gompholobium huegelii* | Common wedge-pea |
| *Daviesia latifolia* | Hop bitter-pea |
| *D. virgata* | Narrow-leaf bitter-pea |
| *D. ulicifolia* | Gorse bitter-pea |
| *Pultenaea cunninghamii* | Grey bush-pea |
| *P. daphnoides* | Large-leaf bush pea |
| *P. gunnii* | Golden bush-pea |
| *P. juniperina* | Prickly bush-pea |
| *P. procumbens* | Bush-pea |
| *Dillwynia juniperina* | Prickly parrot-pea |
| *D. sericea* | Showy parrot-pea |
| *D. retorta* | Small-leaf parrot pea |
| *D. glaberrima* | Smooth parrot-pea |
| *Platylobium formosum* | Handsome flat-pea |
| *Bossiaea buxifolia* | Matted bossiaea |
| *B. prostrata* | Creeping bossiaea |
| *Hovea heterophylla* | Common hovea |
| *Goodia lotifolia* | Golden-tip |
| *Indigofera australis* | Australian indigo |
| *Desmodium varians* | Slender tick-trefoil |
| *Kennedia prostrata* | Running postman |
| *Hardenbergia violacea* | Purple coral-pea |
| *Glycine clandestina* | Twining glycine |
| Geraniaceae | |
| *Pelargonium australe* | Austral stork's-bill |
| *Geranium solanderi* | Austral crane's-bill (cut-leaf crane's-bill) |
| Oxalidaceae | |
| *Oxalis corniculata* | Yellow wood-sorrel |
| Linaceae | |
| *Linum marginale* | Native flax |
| Rutaceae | |
| *Boronia nana* | Dwarf boronia |
| *Asterolasia asteriscophora* | Lemon star-bush |
| *Correa reflexa* | Common correa |
| Polygalaceae | |
| *Comesperma ericinum* | Heath milkwort |

| Scientific name | Common name |
|---|---|
| Euphorbiaceae | |
| *Poranthera microphylla* | Small poranthera |
| Stackhousiaceae | |
| *Stackhousia monogyna* | Creamy stackhousia |
| Sapindaceae | |
| *Dodonaea angustissima* | Wedge-leaf hop-bush |
| Rhamnaceae | |
| *Pomaderris prunifolia* | Pomaderris |
| *P. aspera* | Hazel pomaderris |
| *Spyridium parvifolium* | Australian dusty miller |
| Dilleniaceae | |
| *Hibbertia stricta* | Erect guinea-flower |
| *H. sericea* | Silky guinea-flower |
| Hypericaceae | |
| *Hypericum japonicum* | Matted St.John's wort |
| *H. gramineum* | Small St.John's wort |
| Violaceae | |
| *Viola betonicifolia* | Showy violet |
| *V. hederacea* | Ivy-leaf violet |
| Thymelaeaceae | |
| *Pimelea axiflora* | Bootlace bush |
| *P. humilis* | Common rice-flower |
| *P. glauca* | Smooth rice-flower |
| *P. linifolia* | Slender rice-flower |
| Myrtaceae | |
| *Eucalyptus macrorhyncha* | Red stringybark |
| *E. obliqua* | Messmate stringybark |
| *E. delegatensis* | Alpine ash |
| *E. pauciflora* | Snow gum |
| *E. St. johnii* | St. John's blue gum (Victorian blue gum) |
| *E. viminalis* | Manna gum |
| *E. rubida* | Candlebark(candlebark gum) |
| *E. dalrympleana* | Mountain gum |
| *E. sideroxylon* | Red ironbark |
| *E. radiata* | Narrow-leaf peppermint |
| *E. dives* | Broad-leaf peppermint |
| *E. camphora* | Mountain swamp gum (swamp gum) |
| *E. goniocalyx* | Long-leaf box |
| *E. bridgesiana* | But-but |

| Scientific name | Common name |
|---|---|
| *E. mannifera* | Brittle gum |
| *E. camaldulensis* | River red gum |
| *E. blakelyi* | Blakely's red gum (forest red gum) |
| *E. albens* | White box |
| *E. melliodora* | Yellow box |
| *E. microcarpa* | Grey box |
| *E. polyanthemos* | Red box |
| *Leptospermum juniperinum* | Prickly tea-tree |
| *L. grandifolium* | Mountain tea-tree |
| *L. lanigerum* | Woolly tea-tree |
| *Kunzea parvifolia* | Violet kunzea |
| *Calytrix tetragona* | Fringe-myrtle (common fringe-myrtle) |
| Onagraceae | |
| *Epilobium cinereum* | Variable willow-herb |
| Haloragaceae | |
| *Haloragis elata* | Grey raspwort |
| *H. tetragyna* | Common raspwort |
| Araliaceae | |
| *Astrotricha ledifolia* | Common star-hair |
| *Tieghemopanax sambucifolius* | Elderberry panax |
| Umbelliferae | |
| *Hydrocotyle laxiflora* | Stinking pennywort |
| *H. hirta* | Hairy pennywort |
| *Daucus glochidiatus* | Austral carrot |
| Epacridaceae | |
| *Epacris microphylla* | Coral heath |
| *Astroloma humifusum* | Cranberry heath |
| *Melichrus urceolatus* | Urn heath |
| *Leucopogon virgatus* | Common beard-heath |
| *Monotoca scoparia* | Prickly broom-heath |
| *Acrotriche serrulata* | Honey-pots |
| *Brachyloma daphnoides* | Daphne heath |
| Boraginaceae | |
| *Cynoglossum suaveolens* | Sweet hound's-tongue |
| *Myosotis australis* | Austral forget-me-not |
| Convolvulaceae | |
| *Dichondra repens* | Kidney weed |
| *Convolvulus erubescens* | Pink bindweed |
| *Calystegia sepium* | Large bindweed |

| Scientific name | Common name |
|---|---|
| Scrophulariaceae | |
| *Gratiola peruviana* | Austral brook-lime |
| *Veronica derwentiana* | Derwent speedwell |
| *V. perfoliata* | Digger's speedwell |
| *Euphrasia collina* | Purple eyebright |
| Labiatae | |
| *Ajuga australis* | Austral bugle |
| *Prostanthera lasianthos* | Victorian christmas bush |
| *Lycopus australis* | Australian gipsywort |
| *Mentha australis* | River mint |
| Plantaginaceae | |
| *Plantago varia* | Variable plantain |
| Rubiaceae | |
| *Coprosma hirtella* | Rough coprosma |
| *Asperula scoparia* | Prickly woodruff |
| *Galium gaudichaudii* | Rough bedstraw |
| Campanulaceae | |
| *Wahlenbergia quadrifida* | Sprawling bluebell |
| *W. stricta* | Tall bluebell |
| Lobeliaceae | |
| *Isotoma axillaris* | Rock isotome |
| *I. fluviatilis* | Swamp isotome |
| Goodeniaceae | |
| *Goodenia ovata* | Hop goodenia |
| *G. geniculata* | Bent goodenia |
| Brunoniaceae | |
| *Brunonia australis* | Blue pincushion |
| Stylidiaceae | |
| *Stylidium graminifolium* | Grass trigger-plant |
| Compositae | |
| *Lagenophora stipitata* | Common lagenophora |
| *Brachycome diversifolia* | Tall daisy |
| *B. aculeata* | Daisy |
| *Vittadinia triloba* | Common New Holland daisy |
| *Olearia argophylla* | Musk daisy-bush |
| *O. lirata* | Snowy daisy-bush |
| *O. rammulosa* | Twiggy daisy-bush |
| *Gnaphalium luteo-album* | Jersey cudweed |
| *G. involucratum* | Star cudweed |
| G. japonicum | Creeping cudweed |

| Scientific name | Common name |
|---|---|
| *Cassinia aculeata* | Common cassinia |
| *C. longifolia* | Shiny cassinia |
| *Helipterum albicans* | Hoary sunray |
| *H. anthemoides* | Chamomile sunray |
| *Helichrysum apiculatum* | Common everlasting |
| *H. semipapposum* | Clustered everlasting |
| *H. scorpioides* | Button everlasting |
| *H. bracteatum* | Golden everlasting |
| *H. leucopsideum* | Satin everlasting |
| *H. obcordatum* | Grey everlasting |
| *Podolepis jaceoides* | Showy podolepis |

| Scientific name | Common name |
|---|---|
| *Craspedia glauca* | Billy buttons |
| *Cotula australis* | Common cotula |
| *Centipeda cunninghamii* | Common sneezeweed |
| *Senecio linearifolius* | Fireweed groundsel |
| *S. lautus* | Variable groundsel |
| *S. minimus* | Fireweed |
| *S. quadridentatus* | Cotton fireweed |
| *S. hispidulus* | Fireweed |
| *Bedfordia salicina* | Blanket-leaf |
| *Cymbonotus preiseianus* | Austral bear's-ear |
| *Microseris scapigera* | Yam daisy |

APPENDIX III

NATIVE FAUNA

NORTH-EASTERN AREA, DISTRICT 2

NATIVE BIRD AND MAMMAL LIST

This appendix lists native birds and mammals recorded in the area and indicates the habitats in which they are most likely to be observed, with their status. Records of accidental or rare visitors have been omitted, as land use changes in the study district will have no significant effect on the populations of these species.

Records of birds have been obtained from reliable observers and have been checked with Museum staff. Records of mammals have come mostly from official collections; those of other mammals included in the list have come from reliable sources.

Bird names and groupings follow the "Index of Australian Bird Names" (C.S.I.R.O. 1969), and mammal common names, the Victorian Fisheries and Wildlife Division's nomenclature.

Species that have special significance in this district and are referred to in chapter 11 are indicated with an asterisk (*).

General habitat type

1. Wetland (swamps, streams, lakes, dams)

2. Open forest (wet) (candlebark:snow gum, alpine ash, messmate stringybark, narrow-leaf peppermint, broad-leaf peppermint:candlebark, mountain swamp gum open forests)

3. Open forest (dry) (broad-leaf peppermint:red stringybark, red stringybark:long-leaf box:red box, Blakely's red gum open forests)

4. Woodland (grey box, river red gum open forests)

5. Semi-cleared areas and forest margins

6. Grassland

7. Air (birds only)

Status

The codes given below are used to denote status or relative abundance, with reference to available habitat within the study area. The estimates are based on general experience rather than actual counts. The situation is changing constantly.

The first letter in the code indicates distribution of suitable habitat;

W = habitat widespread in the study district
R = habitat restricted to relatively few parts of the study district

The second letter in the code indicates apparent abundance within areas of suitable habitat:

C = common
U = uncommon
R = rare
N = nomadic, number observed varying greatly from time to time

Additional letters may be used to indicate the following:

S = migratory species observed in the study district during summer
W = migratory species observed in the study district during winter
H = commonly uses hollows in trees for nest site

BIRDS

| | Habitat | | | | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Pelican | x | | | | | | | RU |
| Darter | x | | | | | | | RU |
| Black cormorant | x | | | | | | | RC |
| Little black cormorant | x | | | | | | | RC |
| Pied cormorant | x | | | | | | | RR |
| Little pied cormorant | x | | | | | | | RC |
| Little grebe | x | | | | | | | RC |
| Hoary-headed grebe | x | | | | | | | RR |
| Great crested grebe | x | | | | | | | RR |
| White-necked heron | x | | | x | | | | WC |
| White-faced heron | x | | | x | | | | WC |
| Cattle egret | x | | | x | | | | WR |
| White egret | x | | | x | | | | WC |
| Little egret | x | | | x | | | | WR |
| Plumed egret | x | | | x | | | | WR |
| Nankeen night heron | x | | | | | | | RU |
| Little bittern | x | | | | | | | RR |
| Brown bittern | x | | | | | | | RR |
| White ibis | x | | | x | | | | WC |
| Straw-necked ibis | x | | | x | | | | WC |
| Glossy ibis | x | | | x | | | | WR |
| Royal spoonbill | x | | | | | | | RU |
| Yellow-billed spoonbill | x | | | | | | | RC |
| Black swan | x | | | x | | | | WC |
| Mountain duck | x | | | x | | | | WU,H |
| Black duck | x | | | | | | | RC |
| Grey teal | x | | | | | | | RC,H |
| Chestnut teal | x | | | | | | | RU |
| Blue-winged shoveler | x | | | | | | | RU |
| Pink-eared duck | x | | | | | | | RU |
| White-eyed duck | x | | | | | | | RU |
| Wood duck | x | | | | | | | RC,H |
| Musk duck | x | | | | | | | RR |
| Black-shouldered kite | | | | x | x | | | WN |
| Whistling eagle | x | | | x | x | x | | WC |
| Australian goshawk | | x | x | x | x | | | WC |
| Collared sparrowhawk | | x | x | x | | | | WU |
| Australian little eagle | | | | x | x | x | | WU |
| Wedge-tailed eagle | | x | x | x | x | x | | WC |
| *Spotted harrier | | | | | | x | | WR |
| Swamp harrier | x | | | | | x | | RC |
| Black falcon | | | | x | x | x | x | WR |
| *Peregrine falcon | | x | x | x | x | x | | WU |
| Little falcon | | x | x | x | x | | | WU |
| Nankeen kestrel | | | | | | x | x | WC |
| Brown hawk | | | | | | x | x | WC |
| Stubble quail | | | | | | x | | WC |
| Brown quail | x | | | | x | | x | WU |
| *King quail | x | | | | x | | | RR |
| Painted quail | | | | x | x | x | | WU |
| Brolga | x | | | | x | | | RR |
| Banded landrail | x | | | | | | x | RU |
| Marsh crake | x | | | | | | | RU |
| Australian spotted crake | x | | | | | | | RR |
| Black-tailed native hen | x | | | | | | | RU |
| Dusky moorhen | x | | | | | | | RC |
| Swamp hen | x | | | | | | | RC |
| Coot | x | | | | | | | RC |
| Spur-winged plover | x | | | | | | x | WC |
| Banded plover | x | | | | | | x | WU |
| Black-fronted dotterel | x | | | | | | | RC |
| Japanese snipe | x | | | | | | x | RU,S |
| *Southern stone curlew | | | | | x | x | x | WR |
| Silver gull | x | | | | | | | RU |
| Peaceful dove | | | | | x | | | RU |
| Common bronzewing | | x | x | x | x | | | WC |
| Brush bronzewing | | x | | | | | | WR |
| Crested pigeon | | | | | x | | x | WU |
| *Wonga pigeon | | x | x | | | | | WU |
| Rainbow lorikeet | | | x | x | x | x | | WN,H |
| Musk lorikeet | | | x | x | x | x | | WN,H |
| Purple-crowned lorikeet | | | x | x | x | x | | WN,H |
| Little lorikeet | | | x | x | x | x | | WN,H |
| Swift parrot | | | x | x | x | x | | WN,H |

| | Habitat | | | | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Yellow-tailed black cockatoo | x | x | | | | x | | WU,H |
| Gang-gang cockatoo | x | x | | | | | | WC,H |
| Sulphur-crested cockatoo | | | x | x | x | x | | WC,H |
| Galah | | | | x | x | x | | WC,H |
| Cockatiel | | | | x | x | x | | WR,H |
| *King parrot | x | | | | | | | RR,H |
| Crimson rosella | x | x | x | | | | | WC,H |
| Eastern rosella | | | | x | x | | | WC,H |
| Red-rumped parrot | | | | x | x | x | | WC,H |
| Blue-winged parrot | | | | | x | x | | WU,H |
| *Turquoise parrot | | | | | x | | | WR,H |
| Budgerygah | | | | x | x | x | | WN,H |
| Pallid cuckoo | x | x | x | x | x | | | WC,S |
| *Brush cuckoo | x | x | | | | | | WR,S |
| Fan-tailed cuckoo | x | x | x | | | | | WC,S |
| *Black-eared cuckoo | | | | x | x | | | WR,S |
| Horsefield bronze cuckoo | | | | x | x | | | WC,S |
| Golden bronze cuckoo | x | x | x | | | | | WR,S |
| *Powerful owl | x | | | | | | | RR,H |
| *Barking owl | | | x | x | x | | | WR,H |
| Boobook owl | x | x | x | x | | | | WC,H |
| Barn owl | x | x | x | x | | | | WU,H |
| Tawny frogmouth | x | x | x | x | | | | WC |
| Owlet-nightjar | | | x | x | x | | | WU,H |
| Spine-tailed swift | | | | | | x | | WC,S |
| Fork-tailed swift | | | | | | x | | WU,S |
| Azure kingfisher | x | | | | | | | RR |
| Laughing kookaburra | | | x | x | x | x | | WC,H |
| Sacred kingfisher | x | | | x | x | | | WC,SH |
| Rainbow bee-eater | | | | | x | x | | WC,S |
| *Dollar bird | | | | | x | x | | WU,SH |
| Superb lyrebird | | | x | | | | | WC |

| | Habitat | | | | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Singing bushlark | | | | | | x | | WU,S |
| Welcome swallow | x | | | | | | x | WC |
| Tree-martin | x | | | x | x | | x | WC,HS |
| Fairy-martin | x | | | x | x | x | x | WC,S |
| Australian pipit | | | | | | | x | WC |
| Black-faced cuckoo-shrike | | x | x | x | x | | | WC |
| Little cuckoo-shrike | | | x | x | x | | | WU |
| White-winged triller | | | | x | x | | | WU,S |
| Australian ground-thrush | | x | | | | | | RU |
| Spotted quail-thrush | | | x | x | | | | WU |
| *Grey-crowned babbler | | | | x | | | | RR |
| *White-browed babbler | | | | x | x | | | WU |
| Golden-headed fantail-warbler | x | | | | | | | RC |
| Little grassbird | x | | | | | | | RC |
| Red warbler | x | | | | | | | RC,S |
| Brown songlark | | | | | | x | | WC,S |
| Rufous songlark | x | | | x | x | | | WU,S |
| Superb blue wren | | x | x | x | x | | | WC |
| *White-throated warbler | | | x | x | x | | | WR,S |
| Weebill | | | | x | x | | | WU |
| Striated thornbill | | x | x | x | x | | | WC |
| Little thornbill | | | | x | x | | | WU |
| Brown thornbill | | x | | x | x | | | WC |
| Buff-rumped thornbill | | | x | x | x | | | WC |
| Yellow-rumped thornbill | | | | x | x | x | | WC |
| White-browed scrub-wren | | x | x | x | x | | | WC |
| Speckled warbler | | | x | x | x | | | WU |
| Pilot bird | | x | | | | | | RR |
| White-fronted chat | x | | | | | x | | RU |
| Jacky winter | | | x | x | x | | | WC |
| Scarlet robin | | x | x | x | x | | | WU |
| Flame robin | | x | x | x | x | x | | WC |
| Pink robin | | x | x | | | | | WR |
| Rose robin | | x | x | | | | | WR |
| Hooded robin | | | | x | x | | | WU |
| Southern yellow robin | | x | x | x | | | | WC |

| | Habitat | | | | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Grey fantail | | | x | x | x | x | | WC |
| Rufous fantail | | | x | | | | | RU,S |
| Willie wagtail | x | | | | x | x | | WC |
| Leaden flycatcher | | | x | x | | | | WU,S |
| Satin flycatcher | | | x | x | | | | WU,S |
| Restless flycatcher | | | | x | x | x | | WC |
| Golden whistler | | | x | x | x | x | | WC |
| Rufous whistler | | | x | x | x | x | | WC |
| Olive whistler | | | x | | | | | RR |
| Grey shrike-thrush | | | x | x | x | x | | WC |
| Shrike-tit | | | x | x | x | x | | WC |
| Eastern whipbird | | | x | | | | | RU |
| Orange-winged sittella | | | | x | x | x | | RU |
| Brown tree-creeper | | | | | x | x | | WC,H |
| White-throated tree-creeper | | | x | x | x | x | | WC,H |
| Red-browed tree-creeper | | | x | x | | | | RU,H |
| Mistletoe bird | | | x | x | x | x | | WC |
| Spotted pardalote | | | x | x | x | x | | WC |
| Eastern striated pardalote | | | x | x | x | x | | WC |
| Striated pardalote | | | x | x | x | x | | WC |
| Grey-breasted silvereye | | | x | x | x | x | | WC |
| Fuscous honeyeater | | | | x | x | x | | WU |
| Yellow-faced honeyeater | | x | x | x | x | | | WC |
| White-plumed honeyeater | | | | | x | x | | RC |
| White-eared honeyeater | | x | x | x | | | | WC |
| Yellow-tufted honeyeater | | | | | x | x | | WU |
| Brown-headed honeyeater | | x | x | x | x | | | WC |
| White-naped honeyeater | | x | x | x | x | | | WC |
| *Little friar-bird | | | | x | x | x | | WR |
| *Noisy friar-bird | | | | x | x | x | | WR |
| Crescent honeyeater | | x | | | | | | WU |
| New Holland honeyeater | | | x | | | | | WU |
| Regent honeyeater | | | | | x | x | | WN |
| Eastern spinebill | | x | x | x | x | | | WC |
| Noisy miner | | | | | x | x | | WC |
| Red wattle-bird | | x | x | x | x | | | WC |

| | Habitat | | | | | | | Status |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Diamond firetail | | | | | x | x | | WU |
| Red-browed finch | | | x | x | x | | | WC |
| Zebra finch | | | | | x | x | x | WR |
| Olive-backed oriole | | | | | x | x | x | WU,S |
| Magpie lark | | | | | x | x | | WC |
| White-winged chough | | | | | x | x | x | WC |
| White-breasted wood-swallow | | | | | x | | x | RR,S |
| Masked wood-swallow | | | | | x | x | | WU,S |
| White-browed wood-swallow | | | | | x | x | | WU,S |
| Dusky wood-swallow | | | | | x | x | | WC |
| Pied currawong | | | x | x | | | | WC |
| Grey currawong | | | x | x | x | | | WU |
| Grey butcher-bird | | | x | x | x | x | | WU |
| Black-backed magpie | | | | | x | x | x | WC |
| White-backed magpie | | | | | x | x | x | WU |
| *Satin bower-bird | | | x | x | | | | WU |
| Australian raven | | | | | x | x | x | WC |
| Little raven | | | | | | x | x | WC |

MAMMALS

| Common Name | Scientific Name | Habitat 1 2 3 4 5 6 7 | Status |
|---|---|---|---|
| Echidna | *Tachyglossus aculeatus* | x x x x x | WC |
| Platypus | *Ornithorhynchus anatinus* | x | RC |
| Tuan | *Phascogale tapoatafa* | x x | WR,H |
| Yellow-footed antechinus | *Antechinus flavipes* | x x x | WR |
| Brown antechinus | *Antechinus stuartii* | x x x | WC |
| Long-nosed bandicoot | *Perameles nasuta* | x x x | WC |
| Brush-tailed possum | *Trichosurus vulpecula* | x x x x | WU,H |
| Bobuck | *Trichosurus caninus* | x | WU,H |
| Ring-tailed possum | *Pseudocheirus peregrinus* | x x x | WC |
| Sugar glider | *Petaurus breviceps* | x x x | WC,H |
| *Squirrel glider | *Petaurus norfolcensis* | x x | WR,H |
| Yellow-bellied glider | *Petaurus australis* | x | WR,H |
| Greater glider | *Schoinobates volans* | x | WC,H |
| Feather-tailed glider | *Acrobates pygmaeus* | x x x | WU,H |
| Common wombat | *Vombatus ursinus* | x x x | WC |
| Koala | *Phascolarctos cinereus* | x | WU |
| Eastern grey kangaroo | *Macropus giganteus* | x x x x | WC |
| Black wallaby | *Wallabia bicolor* | x x x x | WC |
| Bush rat | *Rattus fuscipes* | x x x x | WC |
| Eastern water rat | *Hydromys chrysogaster* | x | RC |
| Gould's wattled bat | *Chalinolobus gouldii* | x x x x | WC,H |
| Grey-headed fruit bat | *Pteropus poliocephalus* | x x | WR,N |
| Dingo | *Canis familiaris dingo* | x x | WR |

AMPHIBIANS

| Common name | Scientific name |
|---|---|
| | Hylidae |
| Golden bell frog | *Hyla aurea raniformis* |
| Ewing's tree frog | *H. ewingi* |
| Lesueur's tree frog | *H. lesueuri* |
| Tree frog | *H. maculata* |
| Peron's tree frog | *H. peroni* |
| | Leptodactylidae |
| Froglet | *Crinia parinsignifera* |
| Brown froglet | *C. signifera* |
| Froglet | *C. victoriana* |
| Bull frog | *Limnodynastes dumerili* |
| Spotted grass frog | *L. tasmaniensis* |
| Striped marsh frog | *L. peroni* |
| Spadefoot toad | *Neobatrachus pictus* |
| Toadlet | *Pseudophryne bibroni* |

NATIVE FISH

| | |
|---|---|
| Trout cod | *Maccullochella macquariensis* |
| Macquarie perch | *Macquaria australasica* |
| River blackfish | *Gadopsis marmoratus* |

REPTILES

| Species recorded in North-Eastern Area, District 2 | Common name | Distribution in Zoogeographic regions: Eyrean: True Eyrean | Eyrean: River corridors | Basian: Warm temperate zone | Basian: Cool temperate zone | Basian: Cold temperate zone | 1 | 2 | 3 | 4 | 5 | 6 | Low scrub and rocky areas | Biological characteristics |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chelonia | | | | | | | | | | | | | | |
| Chelyidae | | | | | | | | | | | | | | |
| *Chelodina longicollis* | Long-necked tortoise | - | + | + | - | - | + | - | - | - | - | - | - | TO |
| Squamata | | | | | | | | | | | | | | |
| Lacertilia | | | | | | | | | | | | | | |
| Agamidae | | | | | | | | | | | | | | |
| *Amphibolurus barbatus* | Bearded dragon | + | - | + | - | - | - | - | - | - | + | + | - | HO |
| *A. muricatus* | Tree dragon | - | - | + | - | - | - | - | + | + | - | - | + | HO |
| Gekkonidae | | | | | | | | | | | | | | |
| Diplodactylinae | | | | | | | | | | | | | | |
| *Diplodactylus vittatus* | Stone gekko | + | - | + | - | - | - | - | - | - | - | - | + | TO |
| Gekkoninae | | | | | | | | | | | | | | |
| *Phyllodactylus marmoratus* | Marbled gekko | + | - | + | - | - | - | - | + | + | + | - | + | TO |
| Pygopodidae | | | | | | | | | | | | | | |
| *Delma fraseri* | Fraser's legless lizard | + | - | + | - | - | - | - | - | + | - | + | + | TO |
| Scincidae | | | | | | | | | | | | | | |
| Lygosominae | | | | | | | | | | | | | | |
| *Anotis maccoyi* | Yellow-bellied skink | - | - | - | + | - | - | + | - | - | - | - | - | TO |
| *Carlia maccoosyi* | Four-fingered skink | + | - | + | - | - | - | - | - | - | - | - | + | HO |
| *Ctenotus robustus* | Striped skink | + | - | + | - | - | - | - | - | + | + | + | + | HO |
| *C. taeniolatum* | Copper-tailed skink | - | - | + | - | - | - | - | - | - | - | - | + | HO |
| *Hemiergis decresiensis* | Three-toed skink | - | - | + | - | - | - | + | + | + | + | - | + | TV |
| *Leiolopisma entrecasteauxi* | Grass skink | - | - | - | + | + | - | + | + | - | - | - | - | HV |
| *L. guichenoti* | Garden skink | - | - | + | + | - | - | + | + | + | + | - | + | HO |
| *L. mustelinum* | Weasel skink | - | - | + | + | - | - | + | - | - | - | - | - | TV |
| *L. weekesae* | Skink | - | - | - | + | + | - | + | - | - | - | - | - | HV |
| *Lerista bougainvilli* | Bougainville's skink | + | - | + | + | - | - | - | + | + | - | - | + | TV |
| *Morethia boulengeri* | Snake-eyed skink | + | - | + | - | - | - | - | - | + | - | + | + | HO |
| *Sphenomorphus tympanum* (cool temperate form) | Southern water skink | - | - | - | + | + | + | + | - | - | - | - | - | HV |
| *S. tympanum* (warm temperate form) | Eastern water skink | - | - | + | - | - | + | + | + | - | + | - | - | HV |
| Scincinae | | | | | | | | | | | | | | |
| *Egernia cunninghami* | Cunningham's skink | + | - | + | - | - | - | - | - | - | - | - | + | HV |
| *E. saxatilis* | Black rock skink | - | - | + | + | - | - | + | + | - | - | - | + | HV |
| *E. whitei* | White's skink | - | - | + | + | + | - | + | + | - | - | - | + | HV |
| *Tiliqua nigrolutea* | Southern bluetongue | - | - | - | + | - | - | + | + | - | - | - | - | HV |
| *T. scincoides* | Common bluetongue | + | - | + | - | - | - | - | - | + | - | - | - | HV |
| Varanidae | | | | | | | | | | | | | | |
| *Varanus gouldii* | Sand goanna | + | - | + | - | - | - | - | - | - | - | - | + | HO |
| *V. varius* | Lace lizard | + | - | + | - | - | - | - | + | + | - | - | + | HO |
| Ophidia | | | | | | | | | | | | | | |
| Boidae | | | | | | | | | | | | | | |
| Pythoninae | | | | | | | | | | | | | | |
| *Morelia argus variegata* | Carpet python | - | + | + | - | - | - | - | - | - | - | - | + | TO |
| Elapidae | | | | | | | | | | | | | | |
| Elapinae | | | | | | | | | | | | | | |
| *Demansia textilis* | Brown snake | + | - | + | - | - | - | - | - | + | + | + | + | HO |
| *Denisonia dwyeri* | Dwyer's snake | + | - | + | - | - | - | - | - | - | - | - | + | TV |
| *D. flagellum* | Little whip snake | - | - | + | - | - | - | - | - | - | - | - | + | TV |
| *D. nigrescens* | Small-eyed snake | - | - | + | - | - | - | - | + | - | - | - | + | TV |
| *D. superba* (highlands form) | Copperhead snake | - | - | - | + | + | - | + | - | - | - | - | - | HV |
| *Notechis scutatus* | Tiger snake | - | + | + | + | - | + | - | - | - | - | - | - | HV |
| *Pseudechis porphyriacus* | Black snake | - | + | + | - | - | + | - | - | + | - | - | - | HV |
| *Vermicella annulata* | Bandy-bandy snake | + | - | + | - | - | - | - | - | - | - | + | - | TO |
| Typhlopidae | | | | | | | | | | | | | | |
| Typhlopinae | | | | | | | | | | | | | | |
| *Typhlops nigrescens* | Blind snake | + | - | + | - | - | - | - | - | + | - | - | + | TO |
| | TOTALS 36 | 16 | 4 | 30 | 12 | 5 | 5 | 11 | 12 | 13 | 7 | 6 | 22 | |

T = Thigmotherm non basking
H = Heliotherm basking
O = Oviparous egg laying
V = Viviparous live bearing

C. H. Rixon, Government Printer, Melbourne

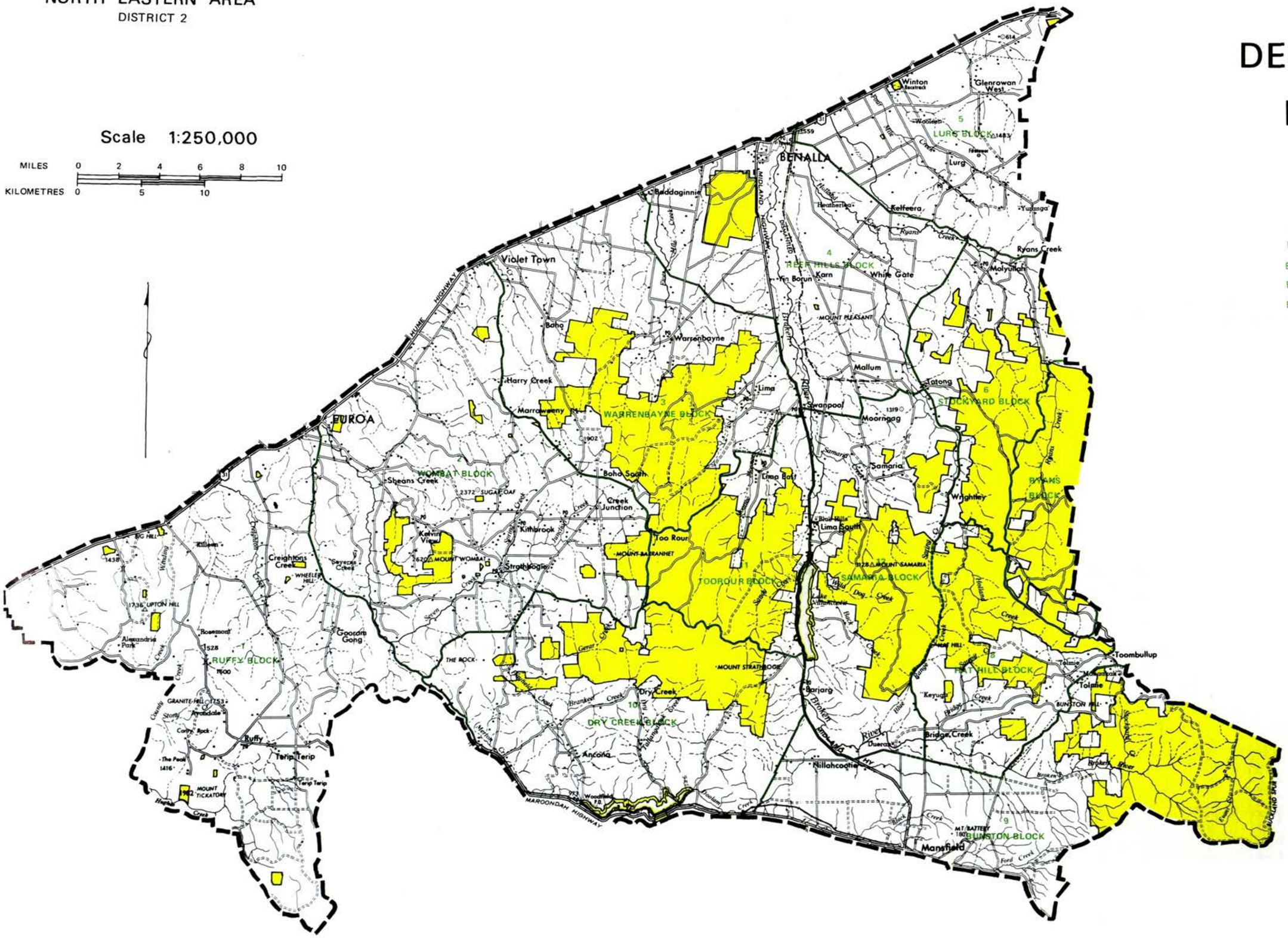
LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA
DISTRICT 2

# PUBLIC LAND AND DESCRIPTIVE BLOCKS

Scale 1:250,000

MILES 0 2 4 6 8 10
KILOMETRES 0 5 10




## LEGEND

PUBLIC LAND
BLOCK BOUNDARY
Block Number 1
Block Name RUFFY BLOCK

LAND CONSERVATION COUNCIL
VICTORIA

NORTH EASTERN AREA

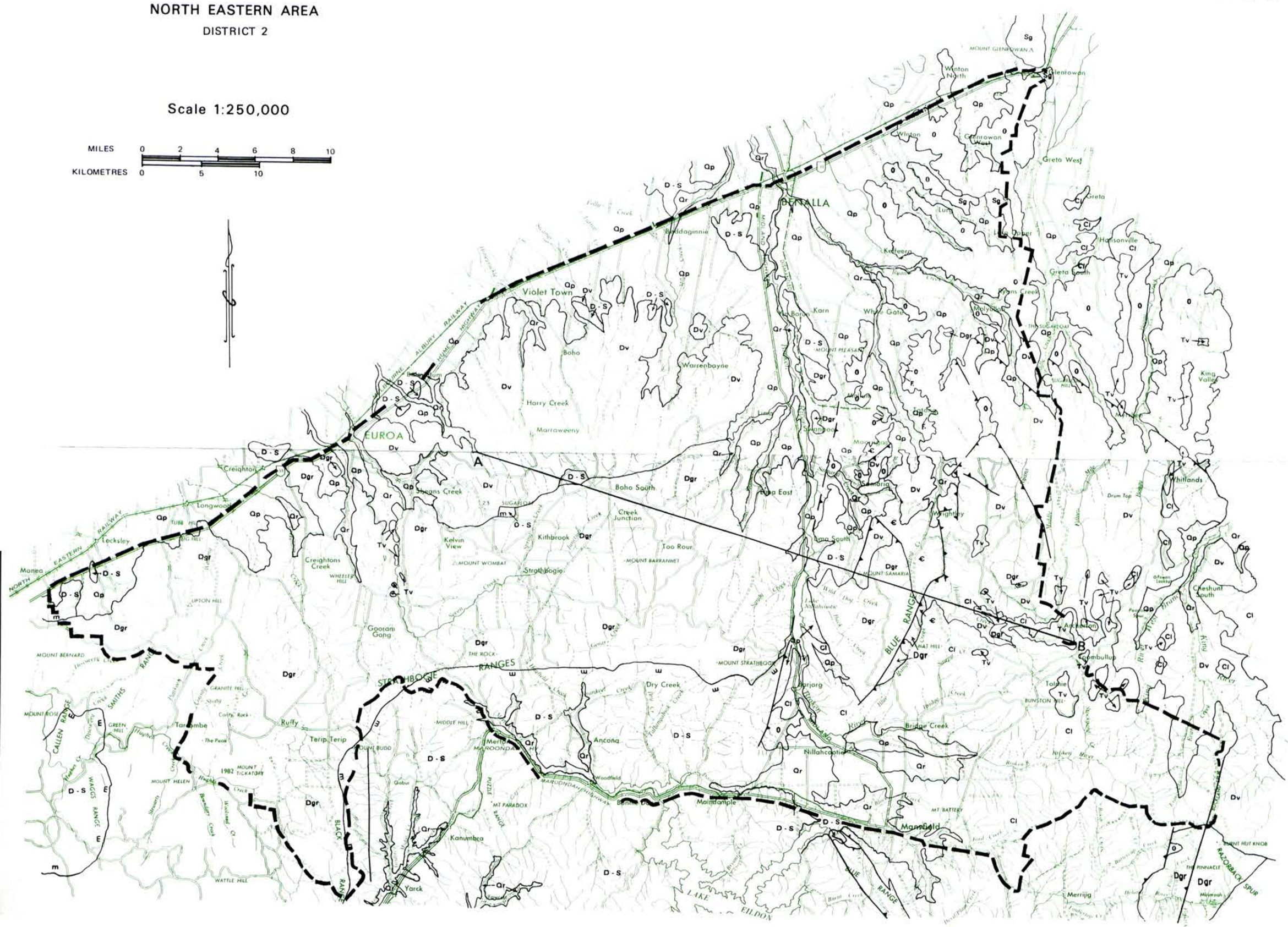
DISTRICT 2

# GEOLOGY

Scale 1:250,000

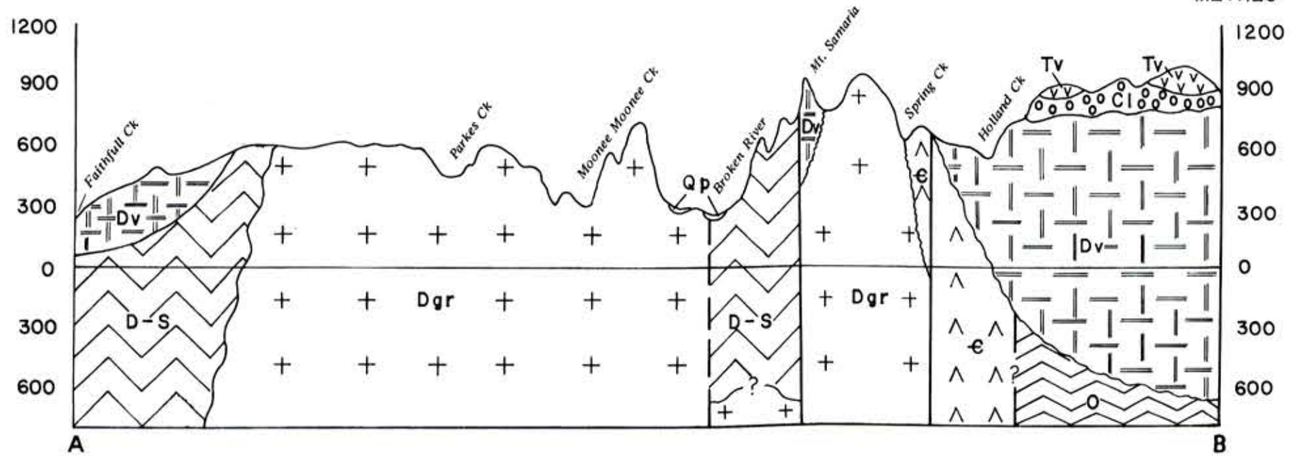
MILES 0 2 4 6 8 10

KILOMETRES 0 5 10




## DIAGRAMMATIC SECTION

Scale $\frac{V}{H}$ = 9.53




## Reference

DISTRICT BOUNDARY

*Geological boundary*

*Fault*

*Fault showing direction of dip*

*Zone of contact metamorphism* m

*Fossils* F.

| | | SEDIMENTARY | | | | IGNEOUS | | |
|---|---|---|---|---|---|---|---|---|
| | | Colluvial | Alluvial | Lacustrine | Marine | Extrusive | Intrusive | |
| QUATERNARY | RECENT | | Qr | | | | | Qr *Alluvial flats, lake and swamp deposits; clay, silt, sand and gravel.* |
| | PLEISTOCENE | | Qp | | | | | Qp *Plain, alluvial, lake and stream levee deposits; high river terraces and alluvial fans; clay, silt, sand, minor gravels and conglomerates.* |
| TERTIARY | | | | | | Tv | | Tv *Basalt, limburgite, and phonolite. (?).* |
| CARBONIFEROUS | LOWER | | Cl | | | | | Cl *Conglomerate, red sandstone, siltstone and shale.* |
| DEVONIAN | UPPER | | | | | | Dgr | Dgr *Granite, adamellite, aplite; granodiorite porphyrite and hornblende porphyrite.* |
| | | | | | | Dv | | Dv *Rhyodacite, rhyolite; includes conglomerate and minor sediments.* |
| DEVONIAN – SILURIAN | | | | | D-S | | Sg | D-S *Mudstone, siltstone and sandstone.* Sg *Granite.* |
| ORDOVICIAN | | | | | O | | | O *Sandstone, siltstone, mudstone, shale and chert.* |
| CAMBRIAN | | | | | € | | | € *Greenstone (diabase); tuff, chert, cherty shale.* |

COMPILED FROM INFORMATION AND MAPS SUPPLIED BY THE GEOLOGICAL SURVEY OF VICTORIA.

# VEGETATION

## LAND CONSERVATION COUNCIL

VICTORIA

## NORTH EASTERN AREA

DISTRICT 2

VEGETATION UNITS

| Map Symbol | Typical Structural Form(s) (at Maturity) | Major Tree Species (Common Name of Unit) | Associated Tree Species | Major Understorey Species |
|---|---|---|---|---|
| 1 | Open forest I | Candlebark gum : snow gum. | Broad-leaf peppermint | Snow grass, button everlasting, eyebright; dwarf geebung, gorse bitter-pea; silver wattle. |
| 2<br>r–Regrowth<br>m–Mature | Open forest IV | Alpine ash | Candlebark gum, narrow-leaf peppermint. | Snow grass; bracken fern; mother shield fern, hop bitter-pea; mountain tea-tree, austral mulberry, musk daisy-bush, soft treefern. |
| 3 | Open forest III and IV | Messmate stringybark | Manna gum, victorian blue gum, narrow-leaf peppermint, candlebark gum. | Bracken fern, fishbone water-fern, hard water-fern; silver wattle, musk daisy-bush; blackwood. |
| 4 | Open forest III | Narrow-leaf peppermint | Candlebark gum, manna gum, victorian blue gum, broad-leaf peppermint, brittle gum, red stringybark. | Tussock grass, cut-leaf crane's bill, violets, pennyworts; bracken fern, fishbone water-fern; silver wattle, common cassinia, austral king fern, soft treefern, hazel pomaderris, musk daisy-bush, austral mulberry; blackwood. |
| 5a | Open forest II | Broad-leaf peppermint: candlebark gum | Brittle gum, victorian blue gum, narrow-leaf peppermint. | Tussock grass, pink-bells, guinea flower; spiny-headed mat-rush, handsome flat-pea, gorse bitter-pea, narrow-leaf bitter-pea, common beard-heath, mountain grevillea, small grasstree. |
| 5b | Open forest II | Broad-leaf peppermint : red stringybark | Long-leaf box, red box, brittle gum. | Tussock grass, wallaby and spear grasses, violets, pennyworts, austral bugle, austral bear's ear, honey pots; common beard-heath, varnish wattle, handsome flat-pea, bracken fern. |
| 6 | Open forest II<br>Open forest I | Red stringybark : long-leaf box : red box | White box, yellow box, grey box. | Tussock grass, wallaby and spear grasses, small grasstree, silky guinea flower, digger's speedwell, daphne heath, grey bush-pea, mountain grevillea, box-leaf wattle, golden wattle, woolly wattle. |
| 7 | Open forest I<br>Closed to open heath<br>Open mossland | Forest red gum complex | White box, long-leaf box, red stringybark, broad-leaf peppermint, grey box. | Rock fern, finger flower, nodding blue lily, daphne heath, mountain grevillea, common fringe-myrtle; lightwood, stiff geebung, native cherry. |
| 8 | Open forest II | Grey box | Red box, red stringybark, white box, yellow box, long-leaf box. | Silver-top wallaby grass, orchids; golden wattle, rough wattle. |
| 9 | Open forest II | River red gum | Forest red gum, grey box, yellow box, white box, but but (apple box). | Silver-top wallaby grass; hedge wattle. |
| 10 | Open forest II | Swamp gum | – | Tussock grass, kangaroo grass; fishbone water-fern; thatch saw-sedge, ovens wattle, alpine bottlebrush, prickly tea-tree; blackwood. |
| 11 | Softwood | | | |
| 12 | Grassland and/or bracken | | | |

Redrawn from Vegetation map supplied by Forests Commission, Victoria, 1972.

LAND CONSERVATION COUNCIL
VICTORIA

# NORTH EASTERN AREA

DISTRICT 2

# SUBMISSIONS

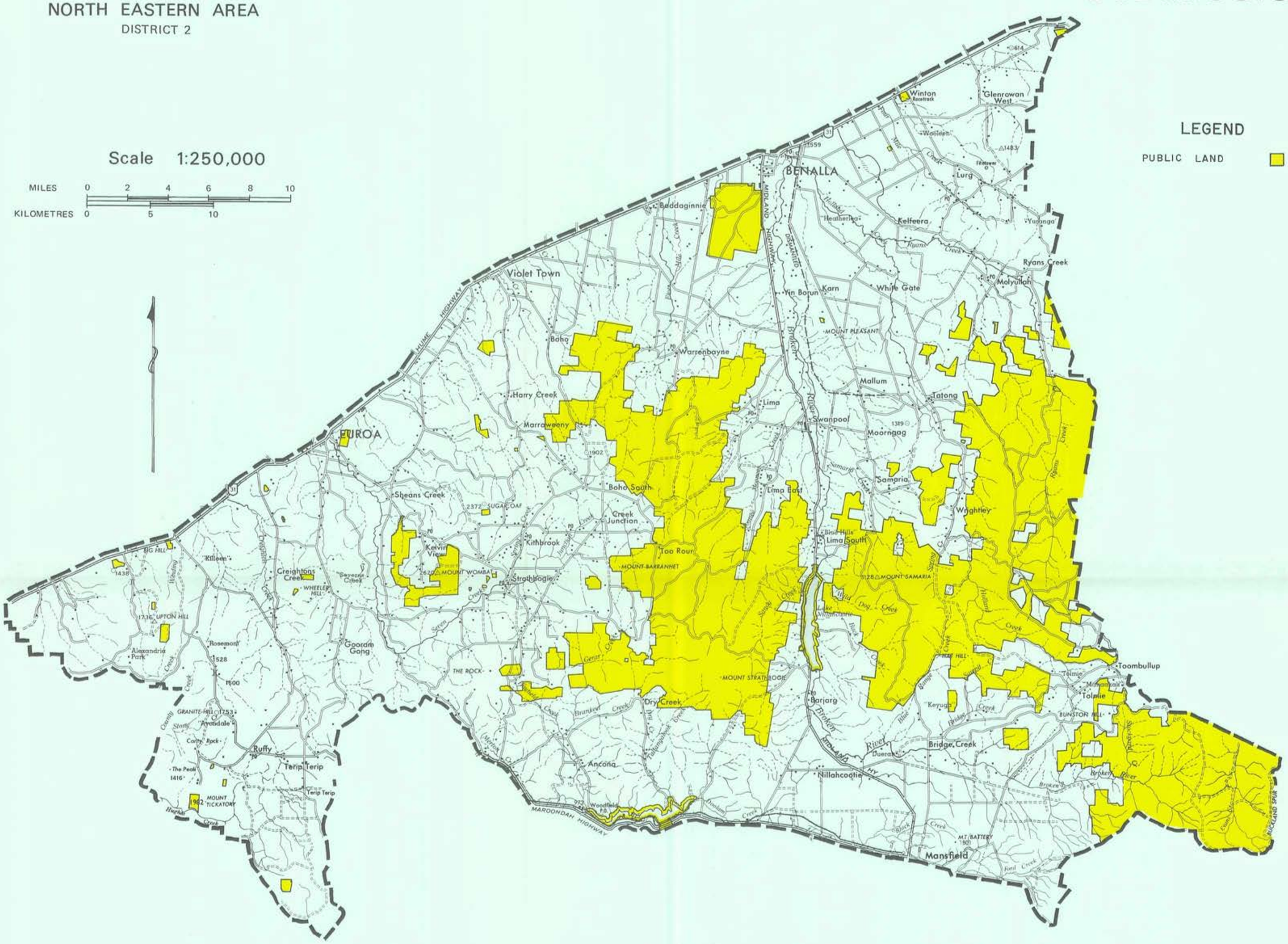
Scale 1:250,000

MILES 0 2 4 6 8 10

KILOMETRES 0 5 10

LEGEND

PUBLIC LAND



# LAND CONSERVATION COUNCIL

## DISTRICT 1 AND 2 OF THE NORTH EASTERN AREA

Reserved Forest
Forest Reserves
Protected Forest (Unoccupied Crown Land)
National Parks
Boundary of District

NEW SOUTH WALES

DISTRICT 1

DISTRICT 2

Yarrawonga
Numurkah
Wodonga
Tallangatta
Corryong
SHEPPARTON
WANGARATTA
BENALLA
Myrtleford
Mitta Mitta
Euroa
Bright
Mt. Beauty
Seymour
Mansfield
Eildon
Jamieson
Omeo

MURRAY VALLEY
Murray
Lake Mulwala
HIGHWAY
Lake Hume
Murray River
VALLEY
Goulburn
Lake Eildon
GOULBURN VALLEY
HIGHWAY
MIDLAND
Broken
Lake Mokoan
WARBY RANGE
OVENS
King
Kiewa
KIEWA VALLEY
Ovens
Mitta Mitta
Warrenga River
Goulburn Weir
HUME
HIGHWAY
River
Buffalo
BUFFALO RANGES
Black
Lake William Hovell
STRATHBOGIE RANGES
MOUNT BUFFALO NATIONAL PARK
THE HUMP 5654
THE HORN
FRASER NATIONAL PARK
Lake Eildon
BOGONG HIGH PLAINS
BARRY MTS
GREAT DIVIDING RANGE
Wonnangatta River
SNOWY RANGE
Dargo River
Buchan River
Lake Omeo
BOWER RANGE
MTS
PENDERGAST LOOKOUT 4120
MT COBBERAS No 2 4736
MT COBBERAS No 1
MT PENDERGAST
MT BENAMERA 4841
MT CUDGEWA 3601
MT STANLEY 3947
MT TAWONGA 4109
MT BOGONG 6516
MT COOPER 5324
MT WILLS 5760
MT NELSE 6175
MT FEATHERTOP 6307
MT COPE 6028
MT HOTHAM 6108
THE TWINS 5592
MT BUFFALO 5719
MT HOWITT
MT McDONALD
MT TORBRECK 4088
MT SKENE 5155
MT TONGIO 2562
MT LIVINGSTONE 1025
FLAGSTAFF HILL 2048
BIG HILL 2214
MT BALDHILL 4518
MT BUDDONG 4853
MT TALGARNO 2116
MT GRANYA 2057
MT WOMBAT 3628
MT SAMARIA 3179
MT STEWART 2605
MT CONCORD 2131
MT TALLANGOOK 2041
MT DISAPPOINTMENT 2067
THE PINNACLE

PREPARED BY FORESTS COMMISSION VICTORIA