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GOVERNMENT OF VICTORIA

LAND CONSERVATION COUNCIL

464 ST. KILDA ROAD MELBOURNE VICTORIA 3004

REPORT

MELBOURNE AREA, DISTRICT 1 REVIEW

This Report is published to allow all who are interested in the use of public land the opportunity to comment by making written submissions to the Land Conservation Council.

All such submissions must reach the Secretary no later than Monday 19 August 1985.

These submissions will be considered by the Council before proposed recommendations are made on the use of public land in the study area.

Blackman

for I. KUNARATNAM
SECRETARY
LAND CONSERVATION COUNCIL

REPORT ON
on the
MELBOURNE AREA, DISTRICT 1 - REVIEW

Land Conservation Council, Victoria
Melbourne: June, 1985

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FOREWORD

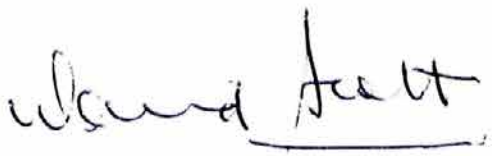
The *Land Conservation Act* 1970 established the Land Conservation Council, whose function is to 'carry out investigations and make recommendations to the Minister with respect to the use of public land in order to provide for the balanced use of land in Victoria'.

This report provides information for the review of the use of public land in the Melbourne area, District 1. It describes and assesses the resources of public land 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 itself will study, and so make informed and constructive suggestions to the Council for its consideration.

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

The Council will make its proposed recommendations only after due consideration of those submissions. This will then be followed by a period for further submissions which will again be considered by the Council before its final recommendations are presented to the government.

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 Victorian *Government Gazette*. All submissions received by the Council will be available for inspection at the Council's offices 10 days after the closure of the submission period.



DAVID SCOTT
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 4 of the *Crown Land (Reserves) Act* 1978, State forest and parks within the meaning of the *National Parks Act* 1975;

(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 investigation 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 of which any part of the area or 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.

Government departments and public authorities to give effect to recommendations

(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 be given to 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* can be obtained from the Government Printer Sales Office, 41 St Andrews Place, East Melbourne, 3002.

ACKNOWLEDGEMENTS

This report covers so wide a field that its compilation would not have been possible without the generous assistance and co-operation of a great many individuals and organizations.

Information for maps and chapters was supplied by: the Departments of Conservation, Forests and Lands, Agriculture, and Minerals and Energy; the Rural Water Commission; the Victoria Archaeological Survey; the Aboriginal Affairs Unit; and the State Electricity Commission.

The following staff from these organizations were involved in the preparation or revision of chapters for the report: J. Backholer, A. Bennett, B. Ebbs, J. Enright, D. Hooley, R. King, R. Knott, M. Lane, G. LeGet, S. Margetts, R. Paul, J. Poulter, G. Presland, P. Robertson, J. Rowan, P. Stahle, J. Taylor, G. Vercoe, and G. Vivian.

Special studies were carried out for this area by the following consultants: history of the Aboriginal people - F. Black; study of historic sites - D. Bick; vegetation - D. Frood.

Many others also readily gave information, checked drafts, or contributed valuable discussion and advice. They include other Victorian government bodies such as the Ports and Harbors Division, the Port of Geelong Authority, Department of Community Welfare Services, and the Melbourne and Metropolitan Board of Works, representatives of various industries, outdoor recreation and sporting organizations, and individuals with expert knowledge of specific disciplines or particular localities. Their assistance is gratefully acknowledged.

PART I

INTRODUCTION

1. INTRODUCTION

The Land Conservation Council commenced the first investigation of the Melbourne area in 1971 and published a descriptive report in 1973. The final recommendations for the use of public land in the area were published in 1977.

Since 1977 a number of studies undertaken in the region have provided extra information on the resources of public land and several parcels of land have been acquired by government instrumentalities. Also, awareness of the significance of even small blocks of public land for conservation and recreation purposes has increased, and there is a need to regularly review current land uses to establish whether changes are necessary to meet new or altered community demands.

Advertisements stating that the Council intended to review the Melbourne area, District 1, appeared in the *Government Gazette* and in local and Victorian newspapers on 27 June 1984.

In re-assessing the uses of public land in the region, the present publication takes into account the revised information and community expectations.

Aims and Methods

This review briefly describes the physical and biological characteristics of the land, examines alternative forms of land use, and assesses the hazards and conflicts associated with such uses. To give a proper perspective, it considers the general regional characteristics of freehold lands as well as the specific nature of the public land.

It draws heavily on information contained in the original 'Report on the Melbourne Study Area', published in 1973. Where necessary, information has been up-dated, and additional material that was not then available has been incorporated. For a more comprehensive description of the study area, however, readers are referred to the original report, copies of which are held in many libraries and by many government departments. A copy is also available for inspection at the offices of the Land Conservation Council.

The present report is the first stage in the decision-making process. It does not contain recommendations - rather, it presents factual information on which land use decisions can be based. It is divided into four main parts: Part I is an introduction; Part II describes the physical and biological nature of the land; Part III deals with the major forms of land use; and Part IV provides more detailed information. In Part IV the study area has been divided for convenience into four descriptive blocks, and a consistent format of headings is used to that the reader can readily find specific information for any block and compare one with another.

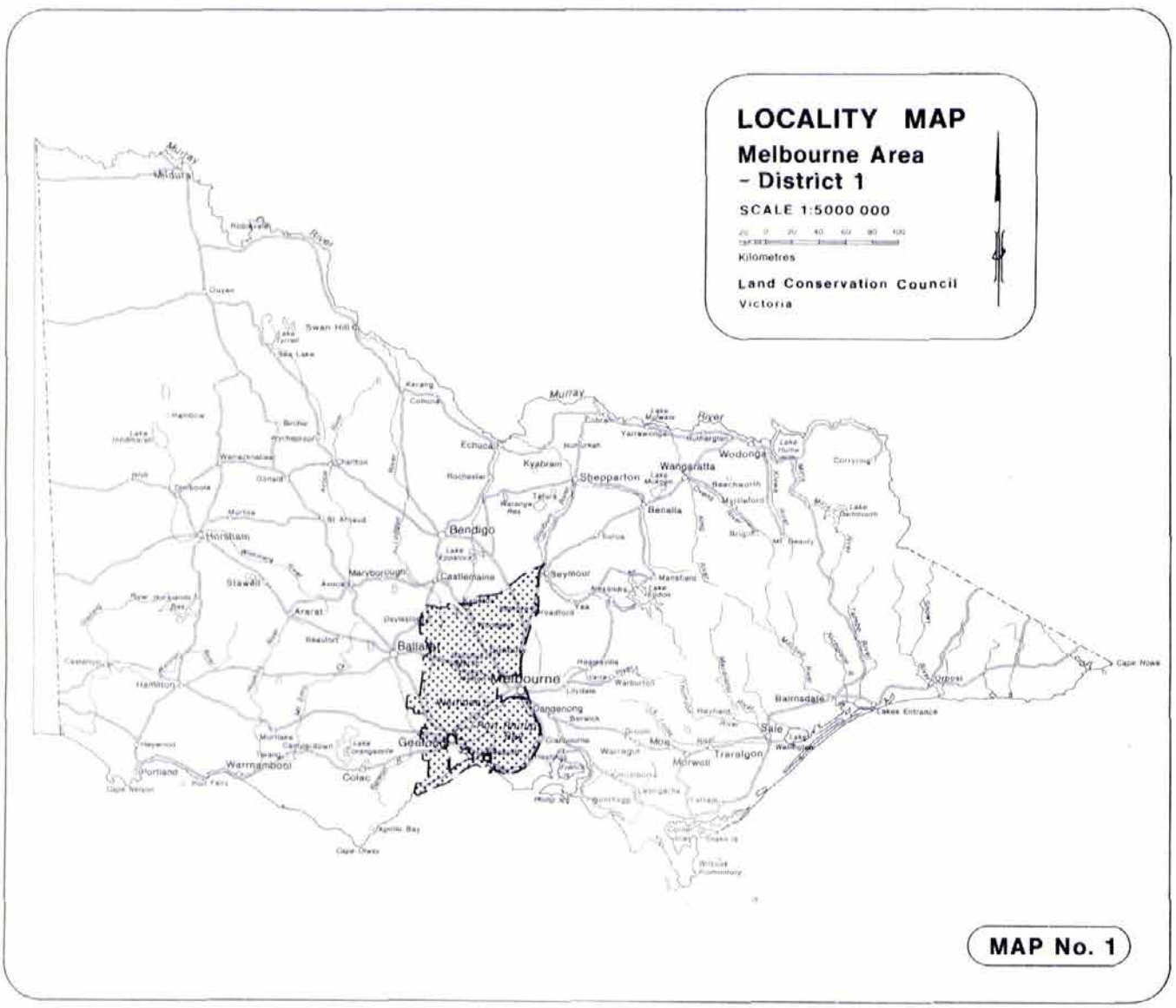
Explanatory tables, maps, and a number of appendices complete the report.

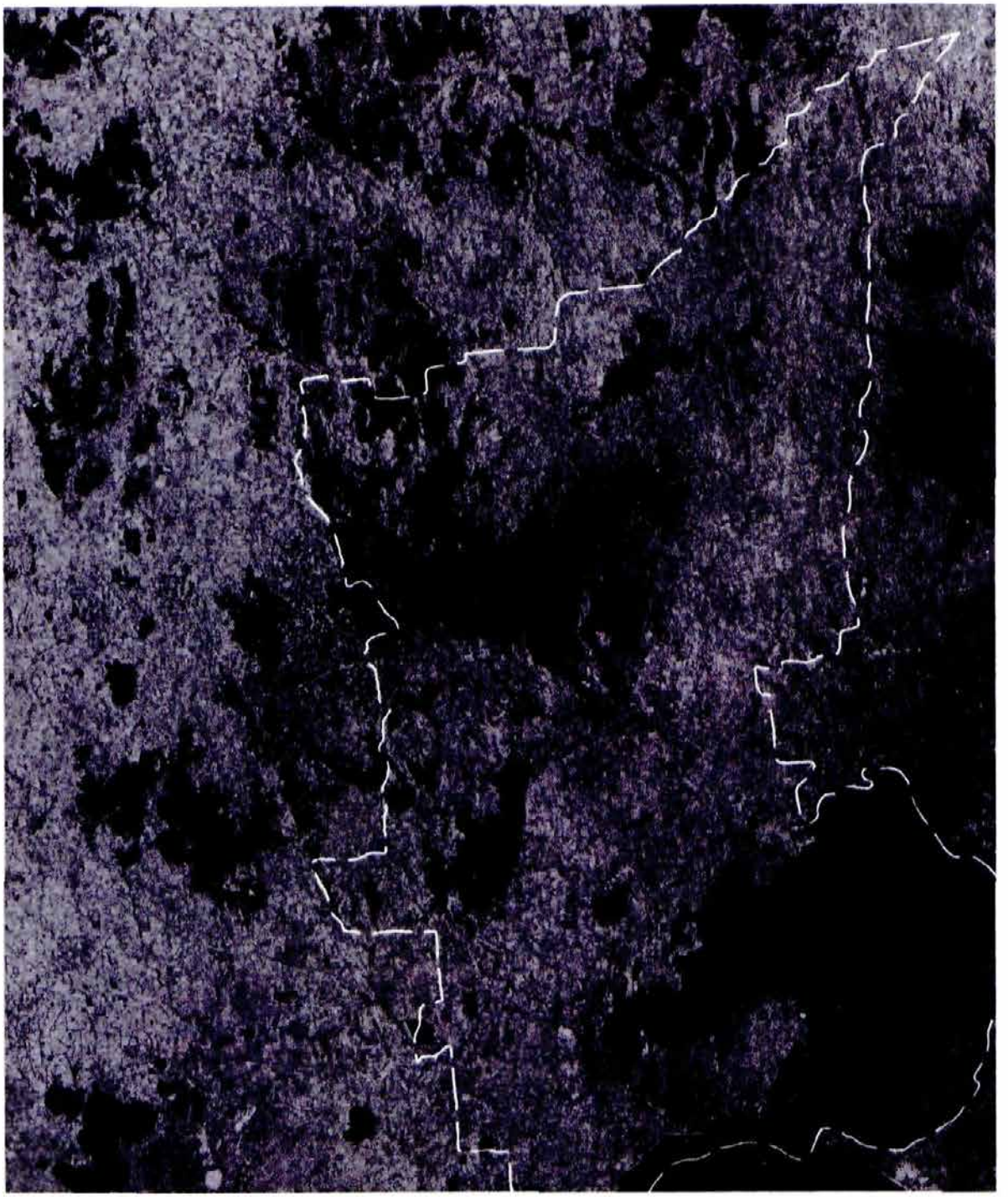
Information has been supplied by government departments, public authorities, and interested individuals, and has also been obtained from published reports and other sources.

The study area

To facilitate a detailed investigation, particularly of the small blocks of land, the original Melbourne area has been divided into two districts. The present one, Melbourne area District 1, comprises the region bounded by (and including) the Shires of Barrabool, Bannockburn, Ballan, Daylesford and Glenlyon, Kyneton, and Pyalong, plus portion of the Shire of Seymour along its western and northern boundaries, and by the Hume Freeway in the east; it includes Port Phillip Bay (see Maps 1 and 2). The district contains 15 shires and portions of three others.

The Melbourne and Geelong metropolitan areas, the City of South Barwon, and the Borough of Queenscliffe are excluded





Landsat image of the study area showing many of the features mentioned in the report - particularly the extent of cleared freehold lands. (Landsat imagery provided by the Australian Landsat Station, Division of National Mapping, Department of Resources and Energy.)

from the study. Population trends within these, however, have a strong bearing on the pressures placed on public land in the study district for recreation and resources.

Covering some 9,260 sq.km of land surface and about 2,300 sq.km of coastal and embayed waters, the study area encompasses a broad range of natural environments. It extends from intertidal platforms and mud-flats, sea-cliffs, and sheltered bays in the south to the strongly dissected forested country on the Great Dividing Range near Daylesford.

More than half of the land lies below 300 metres elevation and comprises the dry, flat to undulating coastal and basalt plains - almost all of which are cleared for agriculture.

The district extends north of the Great Divide and includes the upper catchments of the Campaspe and Loddon Rivers and portion of the mid catchment of the Goulburn River. Only two main drainage basins are wholly contained within the study area - those of the Werribee and Maribyrnong Rivers, both of which flow into Port Phillip Bay. The lower tracts of the Barwon River and its major tributary, the Moorabool River, flow through the south of the area into the estuarine Lake Connewarre, which has its outlet to the sea at Barwon Heads.

Public land occupies less than 15% of the study area, and the bulk of it lies in the north-west along the Great Divide. Other large blocks include the Brisbane Ranges National Park, the Melbourne and Metropolitan Board of Works sewage farm at Werribee, and forested land near Anglesea, which is contiguous with the Otway forests to the south-west. Vegetation types range from tussock grasslands on the basalt plains, to heaths in the Brisbane Ranges and near Anglesea, to open forests of messmate stringybark and peppermint on the ranges in the north.

Population

During the decade 1971--81, the populations of the inner metropolitan areas of Melbourne and Geelong continued to decline (see Map 2). The number of people living in the fringing sub-urban cities increased over the same period, however, such that the populations of the greater cities of Melbourne and Geelong increased by an annual average of 0.1% and 0.2% respectively (see Table 1).

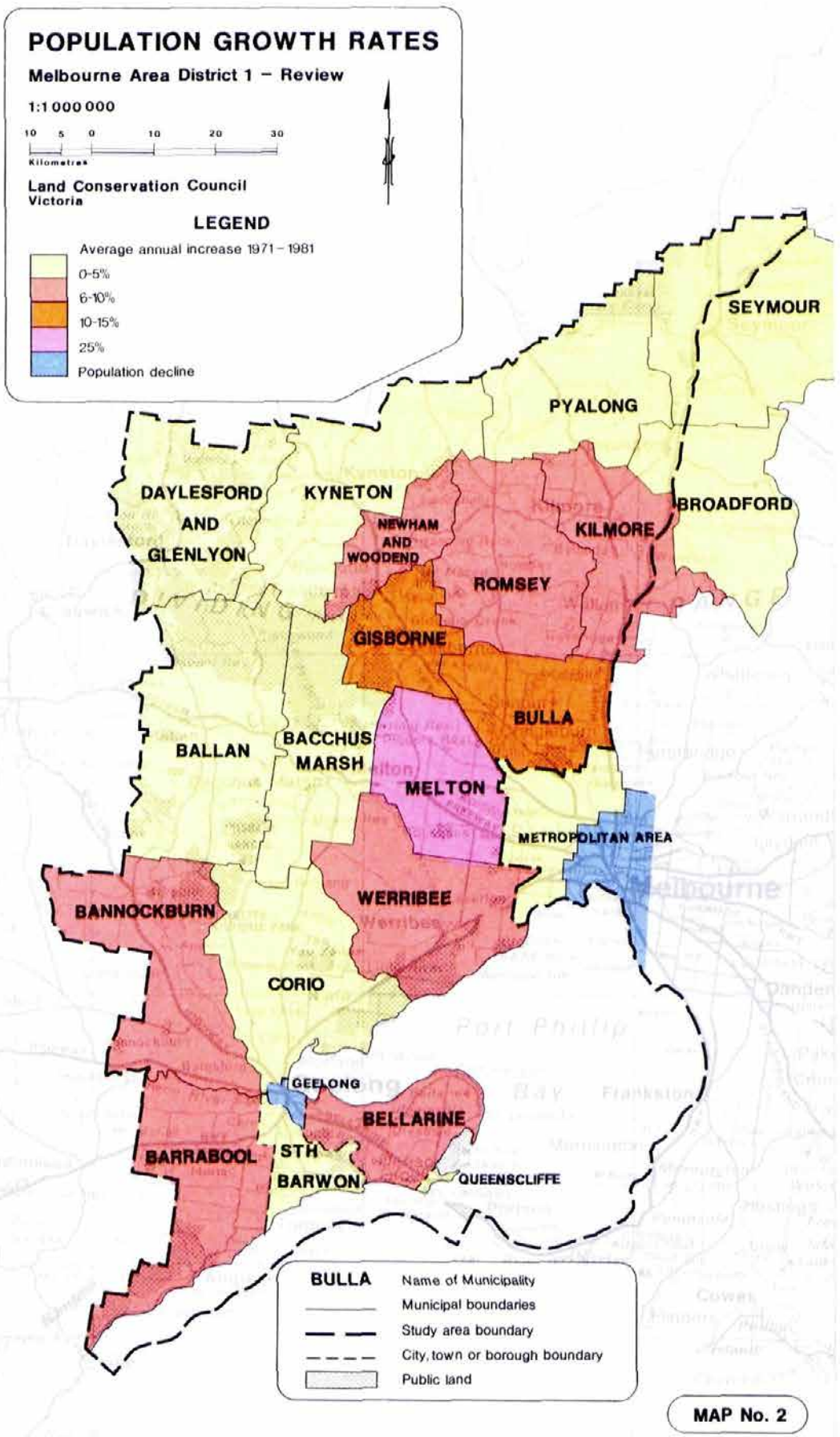
Table 1

POPULATION GROWTH

Region	Population (thousands) 1971	1981	Average annual growth (%)
Shires within ambit of study area	143	222	5.5
Geelong urban area and Borough of Queenscliffe	76	78	0.2
Melbourne urban area	2,265	2,290	0.1
Victoria	3,496	3,832	1.0

Source: Australian Bureau of Statistics

For the same period, all the shires within the study area have shown population increases, averaging 5.5% per annum against a background of about 1% per annum increase for the


POPULATION GROWTH RATES
Melbourne Area District 1 – Review
1:1 000 000
10 5 0 10 20 30
Kilometres
Land Conservation Council
Victoria
LEGEND
Average annual increase 1971 – 1981
0-5%
6-10%
10-15%
25%
Population decline
SEYMOUR
PYALONG
DAYLESFORD AND GLENLYON
KYNETON
NEWHAM AND WOODEND
KILMORE
BROADFORD
ROMSEY
GISBORNE
BULLA
BALLAN
BACCHUS MARSH
MELTON
METROPOLITAN AREA
WERRIBEE
BANNOCKBURN
CORIO
GEELONG
BELLARINE
BARRABOOL
STH BARWON
QUEENSCLIFFE
BULLA Name of Municipality
Municipal boundaries
Study area boundary
City, town or borough boundary
Public land
MAP No. 2

State as a whole. This reflects the continued encroachment of urban development into farmlands and the increase in the number of small sub-commercial holdings.

The most spectacular population growth in the region was achieved by the Shire of Melton, with an average annual increase of almost 25%. Most of this growth is attributable to the residential growth centre of Melton.

Suburban expansion has placed increasing pressure on the nearby areas of public land to provide for the industrial and domestic requirements of the community. Many of these areas are also used heavily for recreation, and, where they contain remnants of the native vegetation, many have considerable conservation significance.

2. HISTORY OF THE ABORIGINAL PEOPLE

One of the difficulties in describing pre-contact Aboriginal culture , particularly for those closely settled areas such as Victoria, is the paucity of information. Much of the evidence of traditional concepts and culture has been lost - due to the dispersion of the Aborigines during settlement and the imposition of western culture.

This chapter uses, in the main, information from a report commissioned by the Land Conservation Council describing the past and present associations of Aboriginal people with the study area. Research for and compilation of the report were carried out by Mr Frank Black, a post-graduate research student in social anthropology at Deakin University. The full report, which gives Mr Black's interpretation of Aboriginal associations with the area, is available for inspection at the Council's offices. Additional information has come from an unpublished thesis by Dr D.E. Barwick, and from Mr J. Poulter of the Victoria-Aboriginal Affairs Unit, while details concerning material culture and archaeological sites have been provided by the Victoria Archaeological Survey.

Pre-contact History

The physical artefacts of Aboriginal occupation in southern Victoria comprise a variety of prehistoric archaeological sites, of which about 200 have been recorded in the study area; most have been found during the last 10 years.

The most frequent types of sites are surface camp-sites, which are usually indicated by flaked stone tools, shell middens along the coast or bayside, and scarred trees. Isolated artefacts such as hatchet heads and grinding stones have also been found. Other examples include rare types such as hatchet-grinding grooves, where an edge was ground on a stone blank, the stone quarry at Mount William, where hatchet blanks were excavated, and a group of what were possibly ceremonial sites near Sunbury. Sites such as these are particularly valuable, both because of their rarity and for the information they can provide about traditional Aboriginal life.

Recent archaeological studies within and close to the district have demonstrated a diverse and complex prehistoric Aboriginal life style, and one that has a great antiquity. Radiocarbon dates from the Dry Creek site near Keilor give an age of about 36,000 years for a camp-site hearth.

Other early sites are recorded at Green Gully (Keilor) and on the Werribee River, both of which are burials that have been dated to 7,000--8,000 years before the present (B.P.). The surface camp-sites indicated above mostly date to within the last 5,000 years. Excavations of a burial at Springfield Gorge have yielded such organic remains as emu feath-

ers and woven fibre. This site has been dated to about 350 years B.P.

Aboriginal origins

Aboriginal and non-Aboriginal explanations of the origins of man on the Australian continent diverge considerably.

On the one hand, geological evidence of sea-level fluctuations during the Pleistocene epoch indicate a number of periods over the last 100,000 years when the level of the sea was sufficiently low to enable accidental or deliberate travel from the Indonesian islands across relatively narrow stretches of water to Australia. Some archaeologists have linked this evidence with the identification of two forms of modern man - an early 'robust' form and a more recent, delicately boned, 'gracile' form - which co-existed some 30,000 years ago. These archaeologists propose that immigration onto the continent occurred in waves during the periods of reduced sea level.

Other modern tools of enquiry, however, such as investigation of genetic markers and linguistics, indicate that the Australian Aborigine is distinct from the rest of the world.

Aboriginal mythology and legend in the study area support the archaeologists' view that the culture is extremely old

Stone arrangement by Aborigines, presumably for ceremonial purposes

and that it developed in isolation over many thousands of years; but further contend that Aboriginal man has always been in Australia. The co-existence of both a 'robust' and 'gracile' form of man is explained in terms of physiological adaption to the environmental and dietary differences between desert-dwelling and southern, colder-climate tribes. This is also explained in the creation mythology within the study area.

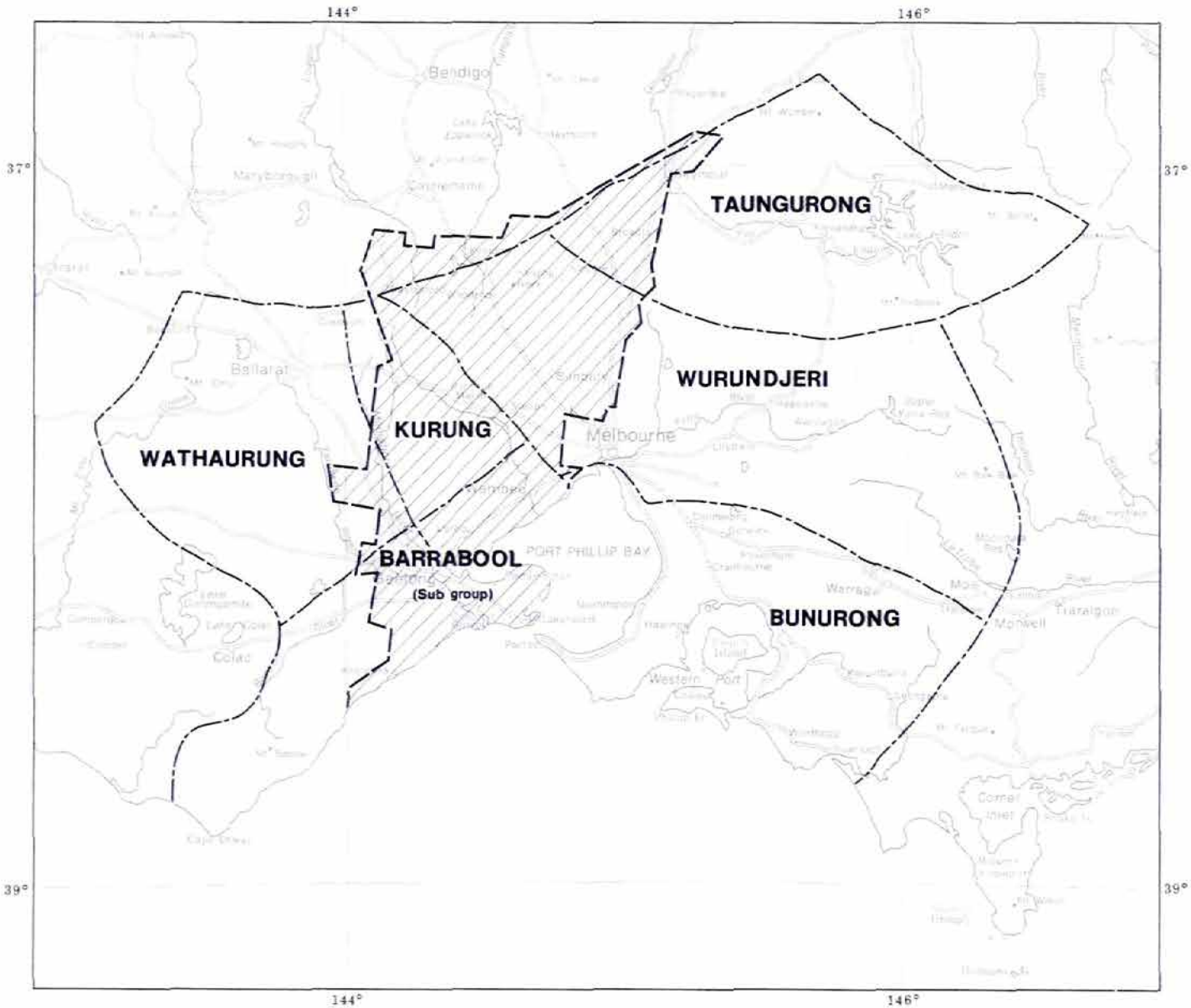
Aboriginal cosmology

Over the thousands of years before European contact, Aboriginal society had developed a system of living together that was based upon universal consensus - expressed through religion. Although explanations on origins differed between regions, the themes were similar. All life derives from the creative acts of Dreamtime heroes. The world and the universe were not simply formed from a vacuum, but were always there. The earth existed as a featureless place with no trees, mountains, water ... yet life was already present (in a foetal state), although in this primordial period all was totally unstructured. At some indeterminate time of their own choosing, the Dreamtime heroes (extraordinary beings) emerged, creating order within this unstructured universe. Where they walked, they created trees and rocks and set tribal boundaries.

Various categories of Dreamtime stories can be differentiated. These can be grouped into three main themes: first, the primary Dreamtime creation stories, in which basic religious concepts are imbedded; second, heroic stories in which past events and figures are totemically symbolized; and third, morally instructive totemic stories, in which customary law is reinforced.

Each tribe probably possessed a number of more secret primary creation stories. These stories have less-frequently been preserved in areas of close European settlement such as the study area because of the extensive disruption to tribal life. Also, as Aboriginal law is subject to various levels of secrecy, only the most senior elders were privy to the deeper symbolism and intricacies of the Dreamtime myths, and they rarely shared this deeper knowledge with Europeans. Thus, interpretation of Dreamtime stories by the uninitiated tends to be on a more superficial basis with a lesser awareness of the imbedded totemic symbolism. (In European fables, for instance, the fox is equated with cunning, the dove with peace.)

Such myths extant in the study area include stories of: the creation; the original making of mankind; the original division of labour between man and woman; the fall of mankind; the flood (whereafter man begins anew); and the concept of good and evil. The myths also explain the dispersion of Aboriginal tribes throughout the continent and why they are confined strictly to set tribal areas. Tindale used unpublished information about the various tribal groups to determine these areas. Four such tribal territories overlap with the boundaries of the study area - as shown on Map 3.



ABORIGINAL TRIBAL AREAS

Melbourne Area District 1- Review

SCALE
1:2 000 000
20 0 20 40 60 80 100
Kilometres

Land Conservation Council
Victoria

LEGEND

KURUNG	Tribal area name
—·—·—	Tribal area boundary
— — —	Study area boundary
▨	Study area

MAP No. 3

Aboriginal religion throughout Australia divides all things, living or not, into two opposing but complementary halves termed moieties. Commonly, these moieties are symbolized by Black Cockatoo and White Cockatoo, or in some areas (as is the case in central and eastern Victoria) by Eagle and Crow. Within each moiety, a further dual classification appears to be universal among Aboriginal tribes. The resultant 'four worlds' within the two halves are known as 'skin groups'. Each of the four skin groups has a special structural relationship with each of the other three. Moieties determined many social relationships, marriage customs, and descent.

Language, descent groups, and marriage

The basic social unit in traditional Aboriginal culture was the band, or clan. This comprised several extended families who co-operated in food-gathering, hunting, and fishing. A number of clans occupying a territorial unit and speaking a common language or with similar dialects made up a tribe.

A number of tribes - sharing a range of economic, social, and cultural relations that were reaffirmed through episodic mass meetings and the sharing of rituals - formed a nation. The tribes of the study area comprised the Kulin nation.

Cultural descent could occur through either the male line or the female line. Members of the local patrilineal descent group, for instance, could trace their lineage through the father to a common ancestral being. The local descent group identified itself with a particular area and was related to a number of sacred ceremonial sites, for which it had responsibility. Within Victoria, descent groups occupied five different zones - two zones where patrilineal descent was practised, and three where the tribes followed matrilineal descent patterns.

Tribes within the study district followed the patrilineal descent pattern. This particular descent pattern/language zone extended through much of central Victoria and included the Murray Valley.

All moiety and skin systems have both spiritual and secular components, and descent can be determined by reference to either. Children's spirits must first find their way into the physical world through the guidance of their father, who dreams the finding of their spirits. Entry to the physical world can only occur through the body of the mother, who creates their flesh within hers. The father, therefore, must in his dream direct the spirit-child to the body of the mother.

It is these two concepts, then, that form the basis of the division of responsibility between the sexes, with spiritual responsibilities going to men and secular ones to women. From this it seems apparent that, while the spirit belongs to the father and the flesh belongs to the mother, it is the individual's 'skin' that reflects his or her individuality.

Intermarriage occurred not only between the tribes of the study area, but also within the patrilineal descent zone,

but not between similar totems. Marriages were often worked out before the children concerned were born, and it was the women who exercised authority in these arrangements. Wife-gifting was, it seems, only a fill-in arrangement if the original plans went astray for any reason.

The giving of a wife from one area involved the return of a wife to that area, in order to maintain equal reciprocity and regional stability. The exogamous giving and receiving of women increased kinship ties with other selected groups, who would then become allied. Also the recipient of a bride had an obligation to make presentations to the bride's family over long periods of time.

Demography

Statistics on the demography of Aboriginal populations from before contact are sparse and variable. Even the earliest estimates were made following some period of occupation by Europeans and the Aboriginal population had already begun to decline. On the basis that each tribal territory could support about 400 people, however, it is possible that the four tribal areas together supported 1,200--1,800 people, about one-quarter of whom might have been in the study area at any one time

Economic base

Each tribal unit occupied an area of land that was adequate for its survival. Local autonomy was ensured by common traditions, a common language, and common religious beliefs, which determined that the land of other tribes was 'outside the paths of the local ancestor spirits'.

Maximum use was made of the natural resources within each tribal area. The Aboriginal society was a hunter--gatherer one in which the people followed the ripening of edible vegetables, fruits, and grains, and the availability of food animals. They set up base camps at regular places in the course of two or three major seasonal movements within a year. In some cases, in the swamps and marshes of the Yarra River for instance, the group might spend a month in one area while exploiting the plant foods, bird-life, fish, and eels.

The women and children were charged with the collection of edible roots, tubers, plants and fruits, grains, and small animals, as well as shellfish from along the shoreline. The men speared, clubbed, or netted the larger food animals.

Although meat was an important component of Aboriginal diet, plants provided the staple foods and were also utilized to the maximum to provide materials for spears, woomeras, and other weapons, fish poisons, fibre for dilly bags and nets, adhesives, clothing, digging sticks, and canoes and housing. Some 70 species of plants in the study area could have been used for these purposes.

The Aborigines had a diverse and highly adapted material culture. For use in hunting and fishing, they made portable

hides, lures, nooses, traps, and nets of wood and fibre; they hafted edge-ground stone hatchets to wooden handles; and they used canoes for fishing in streams and close inshore. They also used a great deal of personal adornment - with kangaroo claws entwined in the hair, possum-skin and kangaroo-skin cloaks, emu and eagle feather decoration, head bands and arm bands, fibre belts, bone and reed pieces through the nose septum, reed necklaces, and loin coverings of animal skins. The tool kit in daily use by the men consisted of a set of spears (some with stone tips), a throwing stick, a club, and a stone hatchet. Stone tools such as scrapers and knives were quickly made as the need arose, using a hammerstone and suitable flaking stone such as quartz, flint, or silcrete. The women carried a digging stick (with a fire-hardened tip) and a string bag woven of fibre or reeds. Food was prepared with grinding stones (mortars and pestle) and wooden dishes and buckets.

In addition, modest engineering projects were undertaken, in the form of eel traps, cooking ovens, and shelter construction.

It can be seen that Aboriginal society, prior to contact, was highly complex and educated, and conditioned to ensure the survival of the tribe in the particular environment in which the tribal territory lay.

Colonial History

Undoubtedly, the exploration and exploitation of the resources of the Victorian coastline from the end of the 18th century resulted in many sightings and contacts between Aborigines and Europeans. The earliest known was in 1778, when the Krauetunalun people at Lakes Entrance helped survivors of a shipwreck. Lieutenant John Murray also made contact when he made the first cursory map of Port Phillip Bay, in 1802. No permanent settlement occurred in the study area, however, until after John Batman's party arrived in 1835, from Van Diemen's Land.

Resistance

Aboriginal resistance to occupation of their tribal lands commenced early in Victoria's history of settlement. In 1802, a group of Bunurong people were fired upon when they attempted to oppose a landing by Lieutenant Murray's men at Portsea.

Skirmishes and atrocities escalated until, in 1836, the then Governor of the Colony of New South Wales, Bourke, brought down the *Aborigines Protection Act* 1836 and proclaimed in a *Government Gazette* of that year:

> '. . . all persons residing, or being within the same, are subject to the laws in force in the said colony, and the promptest measures will be taken by me to cause all persons who may be guilty of any outrage against the ABORIGINAL NATIVES, or any breach of the said laws, to be brought to trial before the Supreme Court of New South Wales, and punished accordingly.'

Protectorates set up under the 1836 Act to 'civilize' and to provide physical protection of the Aborigines proved ineffective, and the protectors were unpopular with the settlers.

With expansion of settlement from Port Phillip and the Murray River, troubles between Aborigines and the settlers increased. In early 1838, attacks by Aborigines on stations and travellers began in the region of Geelong, moved to Werribee, and then to the north-east, where in April of that year between 11 and 14 of G. and W.P. Faithfull's party were speared and clubbed to death and a large number of sheep were killed and eaten.

Revenge killing began in the following week and Aboriginal deaths possibly exceeded a hundred. In his journals of 1841, G.A. Robinson (Chief Protector of Aborigines in the Port Phillip district) further describes battles between Aborigines and shepherds or whalers, and the extreme measures then taken by settlers to reduce Aboriginal resistance.

The missions and reserves

At the request of the Colonial Secretary for New South Wales, Mr G. Langhorne of the Episcopal Church Mission Society of Sydney set up the Yarra Mission in 1837. At the same time the Dandenong Native Police Camp came into operation. Both establishments closed in 1839.

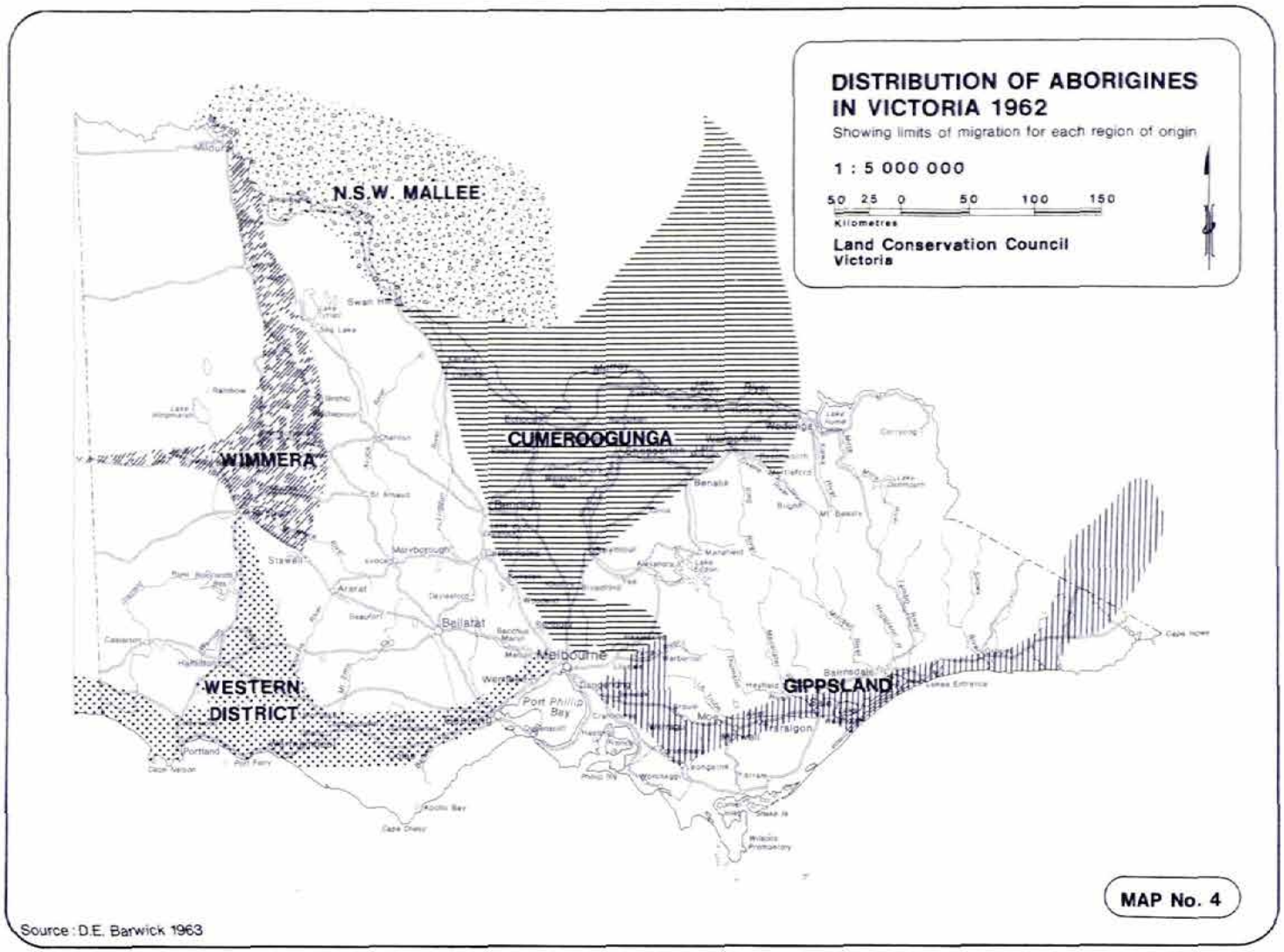
A number of other missions were subsequently opened in the region but only one, the Mount Franklin Mission (1841--64), lay within the study area.

Resistance by the Aborigines to confinement to a permanent settlement, however, brought about the collapse of many of the missions after only a few years' operation.

In 1860 a Central Board for the Protection of Aborigines was set up. It established a number of stations and reserves throughout the State, totalling some 100,000 ha. Steiglitz (1860--1902) and Duneed (1861--1907) were the only two in the study area. The *Land Acts* of 1862 and 1869 permitted the continued selection of land throughout Victoria, which further confined the Aborigines to the reserves. The missions and reserves themselves, however, were progressively closed and taken up by selectors, until only one at Framlingham and one at Lake Tyers remained.

The birth rate among Aborigines began to climb in the 1880s and, following a review in 1886 of the *Aborigines Protection Act*, the concept of 'protection' was replaced with one of 'assimilation'. In essence this meant that those whose blood had not been diluted by white contact were officially 'State wards'. Others were considered 'citizens'.

Under this new Act the managers of reserves in effect had the power to break up Aboriginal families there and send the children into unpaid domestic service or other employment, or to other reserves. Conditions within the reserves were highly restrictive and demoralizing. Although only two of these persisted, the legislation remained in force until



Source : D.E. Barwick 1963

1957, when an enquiry found that the regulations and practices established under the Act were illegal and had flagrantly exceeded the powers provided by the Act.

The Contemporary Scene

The loss of tribal lands, enforced dispersion, and intermarriages have meant that the racial composition and tribal affiliations of the Aborigines in Victoria have undergone considerable change.

Census data and other estimates of population from before settlement to the 1960s show a progressive drop in the number of people of full Aboriginal descent in the State and an increase in the number of people of mixed descent, such that by 1962, of a total population of 2,989 people of Aboriginal descent in the State, 10 were classed as 'full-bloods'.

The old languages, no longer relevant in the new environment, have languished and died. The Aborigines have retained their affiliations with the land, however, although now they generally identify with such areas as Lake Condah, Framlingham, or Cumeroogunga - the Aboriginal reserves and missions. Their regional associations as identified in 1962 (indicated on Map 4) are strongly reminiscent of the language/descent zones of traditional life and are located in the Wimmera, the Western District, Gippsland, and, based on Cumeroogunga, in the central Murray and Goulburn Valley regions.

The boundaries of these regions are determined largely by the limits within which workers and their families regularly travel in search of employment. The workers would be familiar with the type of work available in their respective regions, where the prospective employers would know them; also they would be close to other family members. The shapes of the regions show an expansion towards Melbourne into the large towns that have developed along the major transport routes. The study area includes portions of both the Cumeroogunga and Western District regions.

To date, almost 200 archaeological sites have been identified in the study area. Little or nothing is known of the mythology specific here, however, and the Aborigines' historical memory does not appear to pre-date the mission era. There is little, therefore, to indicate sites of ceremonial significance, although outstanding landscape features such as Hanging Rock may, if archaeologically investigated, suggest a ceremonial significance consistent with similar features found elsewhere in Australia.

The major proportion (about 85%) of Aborigines in Victoria now live in urban rather than rural locations and, probably as a result of the greater availability of job opportunities and public housing in the larger centres, this situation is reflected in the study area. About 280 people in the study area identify themselves as Aborigines, 220 of whom reside in Geelong and Werribee. However, unemployment among the Aborigines here is high, possibly in excess of 60%, and at present few have academic or trade qualifications.

During 1983, the Department of Aboriginal Affairs provided funds to build and staff the Geelong and District Aboriginal Co-operative at Norlane. This is staffed and administered entirely by Aborigines, who include a welfare worker and a teacher's aide. It is operating successfully as a cultural and social centre for the Aborigines of the region, who hope that, as a resource centre for the collection of information and artefacts, it will assist them in achieving stewardship over their own history.

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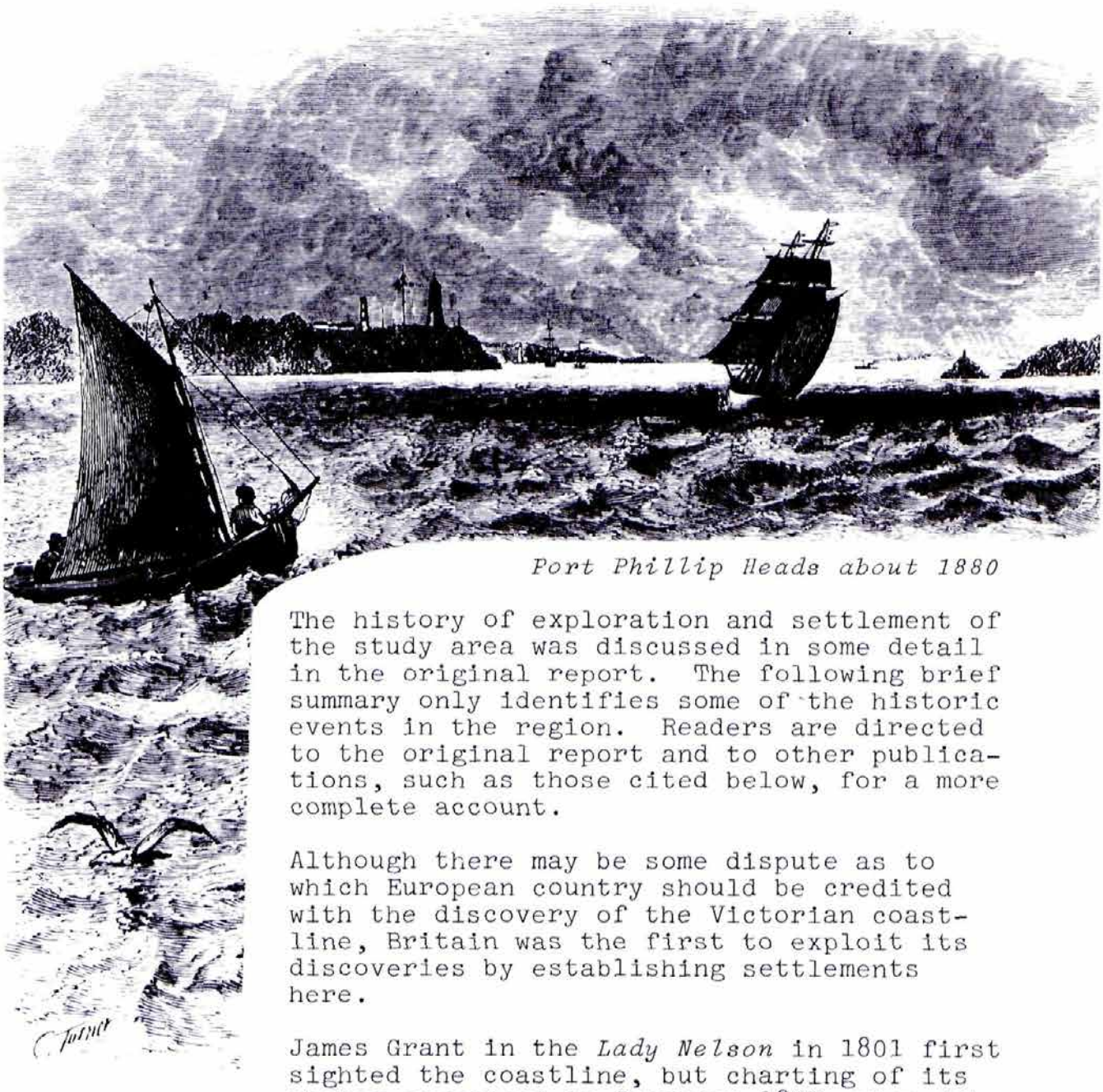
Duncan, J.S. (ed.) (1982). 'Atlas of Victoria.' (Victorian Government Printing Office: Melbourne.)

Barwick, D.E. (1963). 'A Little More than Kin: Regional Affiliations and Group Identity among Aboriginal Migrants in Melbourne.' Thesis, Australian National University, Canberra.

3. EXPLORATION AND SETTLEMENT



Port Phillip Heads about 1880

The history of exploration and settlement of the study area was discussed in some detail in the original report. The following brief summary only identifies some of the historic events in the region. Readers are directed to the original report and to other publications, such as those cited below, for a more complete account.

Although there may be some dispute as to which European country should be credited with the discovery of the Victorian coastline, Britain was the first to exploit its discoveries by establishing settlements here.

James Grant in the *Lady Nelson* in 1801 first sighted the coastline, but charting of its shores commenced in February 1802, when John Murray entered Port Phillip Bay and named Arthurs Seat, Swan Bay, and Point Nepean. Within a few weeks Matthew Flinders also charted part of the coastline of the bay, and explored inland to the You Yangs. In 1803, Surveyor-General Charles Grimes and Lieutenant Robbins walked along parts of the shores of the bay and for short distances along the Yarra and Maribyrnong Rivers.

Following his escape in 1803 from Lt. Col. Collins' short-lived settlement at Sorrento, the convict William Buckley lived with the Aborigines of the Geelong district until 1835

when he made contact with the newly established settlement of Batman's party at Indented Head.

Batman was attracted to the Port Phillip district by the reports of Hume and Hovell, who travelled overland from near Yass to Corio Bay in 1824. Batman negotiated a treaty for land with a local Aboriginal group and initiated the Port Phillip Association pastoral settlement scheme. Within 10 years, the population at the settlement reached 224.

With the influx of other pastoralists, land sales were conducted and within 2 years of Batman's settlement runs had been taken up as far afield as Winchelsea, Inverleigh, and Bacchus Marsh, in the west, and Woodend and Kilmore in the north. Most of the plains and foothill country south of the Divide were alienated from the Crown by 1840. Growth further afield was slower. The first shipload of wool left Melbourne for London in January 1839. By this time Melbourne had grown into a town of about 4,000 residents, many substantial buildings, and a surveyed street layout.

Gold's discovery in Victoria in 1851 had a profound impact on the rate of development. Between 1851 and 1861, the population of the colony increased from 77,345 to 540,322, an annual average rate of increase of more than 21%. Most of the immigrants landed at the ports of Melbourne and Geelong, and at one time in 1851 Port Phillip Bay contained 500 ships.

Economic activity that gold-mining generated stimulated both the building of railways, roads, and telegraph lines and local manufacturing. Industrial development increased with the availability of labour in the 1860s, following the exhaustion of the richer alluvial goldfields.

Many areas of historical interest remain on public land in the study district, particularly in relation to gold-mining activities, but their documentation to date has been inadequate. The Land Conservation Council has commissioned a study to identify those sites and artefacts on public land in the district associated with the various historical events, such as exploration, pastoral settlement, transport, and mining. Finance for the study has been granted under the Victoria National Estate program.

The study is being conducted by Mr D. Bick concurrently with the preparation of this descriptive resources report. Its results will be available for inspection at the Council's offices shortly after the publication of this report.

Information from the study will be considered by the Council when it formulates its recommendations for the area.

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PART II

PHYSICAL AND BIOLOGICAL RESOURCES

4. GEOMORPHOLOGY AND SOILS

Landscape Evolution

In the previous descriptive resources report, the geology, physiography, and soils of the region were described in separate chapters. The following account attempts to integrate these and indicate how contemporary land forms express geological processes, while Appendix II relates soil to these land forms.

This brief description of landscape evolution in the review area is more readily understood by reference to Table 2 (Geological Time Scale), Map 5 (Geomorphology), and the geological map sheets for the area (available from the Department of Minerals and Energy).

Table 2

GEOLOGICAL TIME SCALE

Era	Period	Epoch	Age (million years)
Cainozoic	Quaternary	Recent	0.01
		Pleistocene	1.8
	Tertiary	Pliocene	5
		Miocene	24
		Oligocene	37
		Eocene	54
		Palaeocene	65
Mesozoic	Cretaceous		143
	Jurassic		212
	Triassic		247
Palaeozoic	Permian		289
	Carboniferous		367
	Devonian		416
	Silurian		446
	Ordovician		509
	Cambrian		575
Precambrian	Not outcropping in Victoria		

Palaeozoic

For most of the Palaeozoic era the area was submerged under the sea. The Cambrian period saw the extrusion of igneous rocks (such as the greenstones outcropping at Mount William) from submarine volcanoes and was followed by the deposition of marine cherts and shales into a long wide trough extending from Tasmania to Queensland, known as the Tasman Geosyncline.

Sedimentation continued without interruption for some 100 million years through the Ordovician, Silurian, and early Devonian periods, producing rhythmically interbedded sandstones, siltstones, and black shale. In the middle of the Devonian, these sediments were folded during a period of deformation known as the Tabberabberan Orogeny.

After the Tabberabberan Orogeny, during the late Devonian, acid igneous rocks were intruded into or extruded over the folded sediments at many locations in the area. The Macedon Range consists of acid volcanics that were extruded as ignimbrite or welded tuff. Later intrusions of granodiorite occurred to the south-west. Other granitic intrusions of a similar age occur at Cobaw, the You Yangs, Bulla, Ingliston, and Geelong.

Palaeozoic granites appearing as tors at Cobaw

The Permian period saw the deposition by glaciers of sediments known as tillites. In several cases these deposits overlie striated and grooved pavements that were formed by the movement of ice over the Palaeozoic land surface. The sediments are interbedded with sandstones and siltstones, mainly of fluviatile origin, and contain plant fossils. Several horizons of marine shelly fossils occur in the sequence, indicating partial marine sedimentation.

Outcrops of the Permian deposits are limited, and occur mainly around Bacchus Marsh. It is believed that they were originally more extensively distributed in the area but have since been removed by erosion.

Mesozoic

The only rocks preserved from the early part of this era to the present form a small outcrop of Triassic sediment at

Bacchus Marsh. However, the Triassic and Jurassic were generally times of erosion that probably reduced the area to a landscape of low relief. Remnants of this old surface, now considerably uplifted, are referred to as the Baw Baw surface.

Just before the Cretaceous period, the long east--west trough known as the Otway Basin formed in southern Victoria. This trough rapidly filled with a thick sequence of feldspathic sandstones, mudstones, and conglomerates, portions of which were lifted by faulting later in the Cretaceous to form the Otway Ranges and Barrabool Hills, with the down-faulted section forming the trough of the Torquay Basin.

Meanwhile, further uplift followed by stream dissection in the highlands to the north resulted in the formation of another erosional surface some 300 m lower than the Baw Baw surface. Remnants of this also have persisted to the present and are referred to as the Kinglake surface.

Already the remnants of the previously widespread Baw Baw surface were becoming restricted to plateau areas as yet relatively unaffected by erosion.

By the close of the Cretaceous the fundamental topography of the study area as we know it today had been formed. Earth movements had given rise to an upwarped highland region trending east--west, flanked by depressions to the north and south that correspond to the present Murray Basin and Bass Strait.

Cainozoic

During the Tertiary period, the western uplands, the Otway Ranges, the Barrabool Hills, and the smaller Bellarine horst persisted as uplifted higher regions within the area.

In the early Tertiary, further uplift of the western uplands and subsequent stream dissection led to the formation of partial peneplains on the less-resistant rocks. Some large massifs of resistant rocks remained as high residuals, thus preserving relics of the earlier erosional surfaces - the Kinglake and the older (and more elevated) Baw Baw surfaces.

Sedimentation was confined mainly to the southern part of the area, particularly within the Torquay, Ballan, and Port Phillip sunkland areas. The Port Phillip sunkland had begun to subside, initially between the Selwyn Fault in the east and the Bellarine Fault in the west.

In general, three main phases of Tertiary deposition can be distinguished: an early Tertiary phase of terrestrial sedimentation; marine sedimentation in the mid Tertiary; and a return to terrestrial sedimentation in the late Tertiary. Intermittent volcanic activity took place during each of these.

The early Tertiary terrestrial phase is represented by a sequence of sands, silts, gravels, and brown coal seams, which are now mined at Anglesea and Bacchus Marsh.

The sands, silts, and gravel are fluviatile, whereas the coal seams were deposited in extensive swamp systems. The sediments are of Palaeocene to perhaps Oligocene age. Near Anglesea, the Palaeocene terrestrial sediments underlie a sequence of marine dark carbonaceous and pyritic silty sand, sandy silt, and infrequent gravel of marine origin. The rocks contain foraminifera and plant microfossils indicating a late Eocene age.

During the Eocene (and continuing into the Miocene), basalts comprising the older volcanic sequence were extruded. In some cases they formed thick layers in down-faulted basins, as in the Ballan sunkland.

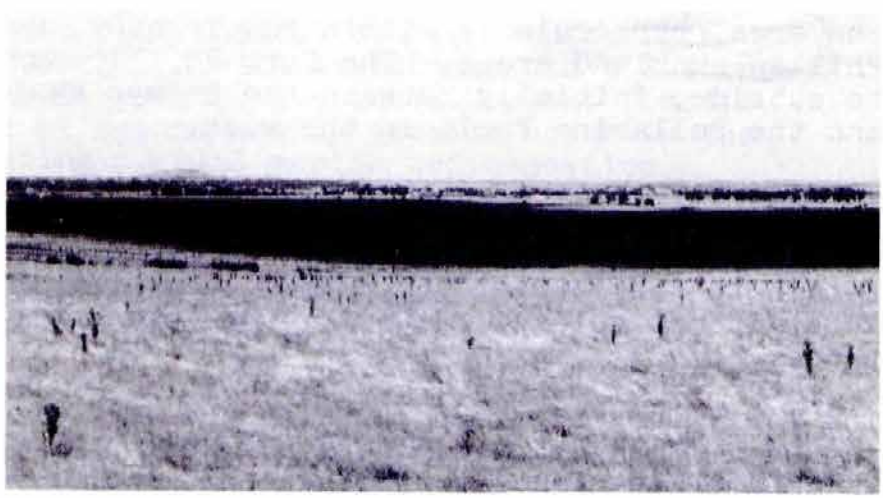
The middle phase of marine sedimentation commenced in the late Oligocene with the advance of the sea into the southern part of the Port Phillip sunkland. During this time, a uniform sequence of silt and silty clay - grading locally into bioclastic limestones - was deposited in the basin.

At the peak of the marine transgression, during the early Miocene, the sea had deepened and extended at least as far inland as Maude, as evidenced by a series of calcareous silts and minor limestones there.

During the middle Miocene the sea began to retreat, and by the late Miocene gradual uplift had forced it to retreat well to the south of the present coastline. However, it then began to advance, inundating the land in the vicinities of Lake Connewarre, Melbourne, and westward from Geelong to Shelford beyond the western boundary of the area.

Towards the early Pliocene, the sea again retreated from the Melbourne and Geelong areas and the final phase of continental deposition began. The marine silts were overlain by a widespread thin sequence of mainly terrestrial sand, gravel, and silt. Deposition mainly occurred in the lower reaches of stream systems draining the higher country to the north.

Lava flows comprising the newer volcanic sequence followed this period of fluviatile sedimentation, beginning in the late Pliocene. Those lavas in the north occurred mainly as valley flows, locally merging into lava sheets, but in the south the flows formed the very extensive sheets of the Wer-



Extensive Pliocene lava sheets now form the broad plains west of Melbourne

ribee Plains. The lava flows originated from a large number of small vents, many of which are still preserved as low hills throughout the plains. The newer volcanics mostly comprise basalt, although more acidic lavas (mainly trachite) occurred in the Macedon district.

Tectonic movements together with the basalt flows altered many drainage patterns. For example, lava flows to the north of the Barrabool Hills diverted the Barwon River from its old course to the south.

The Werribee River was also progressively diverted to the east by a series of flows; and lava from Mount Cottril would have diverted it even further eastward, but the river, which had been dammed by the lava flows at Exford, managed to cut through to the south-east. Remnants of the old lake floor are still evident south of Melton.

To the north, the basalts formed from lava that flowed down the valleys proved more resistant to erosion that the surrounding Palaeozoic sediments, and the streams were diverted to either margin of each flow - forming twin-lateral streams. Eventually, with continued down-cutting by the lateral streams, the basalts became broad crests or plateaux rather than valley floors. The band of basalt between Darley and Mount Bullengarook lying between the Pyrites and Coimadai Creeks provides a typical example of this inverted topography, and the Bald Hills north-east of Kilmore another.

Many streams - including the Moorabool, Werribee, and Lerderderg Rivers and the Parwan Creek - were rejuvenated by the uplift of the land west of the Rowsley Fault. The fault, which now marks the western boundary of the Port Phillip sunkland, is probably Pliocene in age for, while it has warped the Pliocene basalts at Rowsley and Bacchus Marsh, the rejuvenated river valleys suggest an age older than Pleistocene.

Other geological processes that occurred during the Quaternary were mostly restricted to small areas. Following the early Pleistocene, the developing modern drainage systems dissected the Pliocene sediments and volcanics. The main watercourses eroded wide valleys, in which relatively thin veneers of alluvial sediments were deposited. Colluvial aprons formed along some of the faults - especially those to the west of Port Phillip Bay - and Pleistocene sedimentation in the Werribee delta and in Port Phillip reflects the influence of the sea-level changes that occurred during the last Ice Age.

During the Pleistocene, sea levels fluctuated greatly and Port Phillip Bay emerged to various degrees according to the stages of glaciation.

A reduction of the polar ice sheets, which commenced about 18,000 years ago, marked the close of the last Ice Age and resulted in a rise in sea level of about 80 m, to near the present level. This flooded the Port Phillip sunkland and separated Tasmania from Victoria. The bay assumed its present configuation about 10,000 years ago.

Geomorphic Regions

Three major geomorphic regions occur in the area - western uplands, southern uplands, and central lowlands.

The highlands to the north form the eastern extremities of the western uplands - the oldest recognizable geomorphic entity in the area. They originated in alternate periods of erosion and uplift, which produced a series of stepped plateaux. Limited occurrences of these older erosion surfaces representing the Baw Baw and Kinglake surfaces can be recognized. These are more extensive to the east of the study area. By far the major part of the western uplands consists of surfaces formed by the later fluviatile erosion of the Tertiary period. These surfaces are discussed in more detail below.

In contrast to the western uplands, the southern uplands, originated as a result of block faulting. Within the area, they comprise the Barrabool Hills, the deeply dissected, steep, eastern end of the Otway Ranges horst, and the Bellarine horst consisting mainly of Tertiary basalts slightly elevated above the surrounding plains. They are bordered to the north by low-lying volcanic or alluvial plains, and in the south by Bass Strait.

The area between these two upland regions may be referred to as the central lowlands. Although its borders are often ill-defined, particularly towards the north-east, this region occupies the trough between the Greendale Fault in the north and the Barrabool and Bambra Faults along the northern edge of the southern uplands.

Within the central lowlands, several sub-regions can be recognized, including:

* the Port Phillip sunkland, encompassing the bay and the Werribee Plains area
* the Ballan sunkland - now elevated west of the Rowsley Fault
* the Brisbane Ranges horst, bordered by the Rowsley and Spring Creek Faults
* the Moorlap sunkland in the south

Geomorphic Surfaces and Associated Land Types

The previous section mentioned several geomorphic surfaces. In Map 5 the type of geomorphic surface has been used as the primary parameter to delineate land type. The four main land surfaces present are:

* erosional
* depositional
* newer volcanic
* coastal

In Appendix II, these categories have been divided further on the basic of the particular surface type, the geological

Eroding indurated sediments - Point Lonsdale

material from which the soils have been formed (soil parent material), and topographic features (especially slope). A specific final numeral has been used to separate areas that are similar with regard to the first three divisions but have quite different types of soil. This last division often also reflects different climatic zones.

Erosional surfaces

It is possible to distinguish between several erosional surfaces within the study area.

The oldest and highest, the Baw Baw surface, takes its name from the Mount Baw Baw plateau and probably developed during Triassic times. Although well represented further east, it has only one occurrence within the study area - on the broad crest of Mount Macedon. The hard resistant rocks have largely protected the crest area from erosion and weathering despite repeated uplifts.

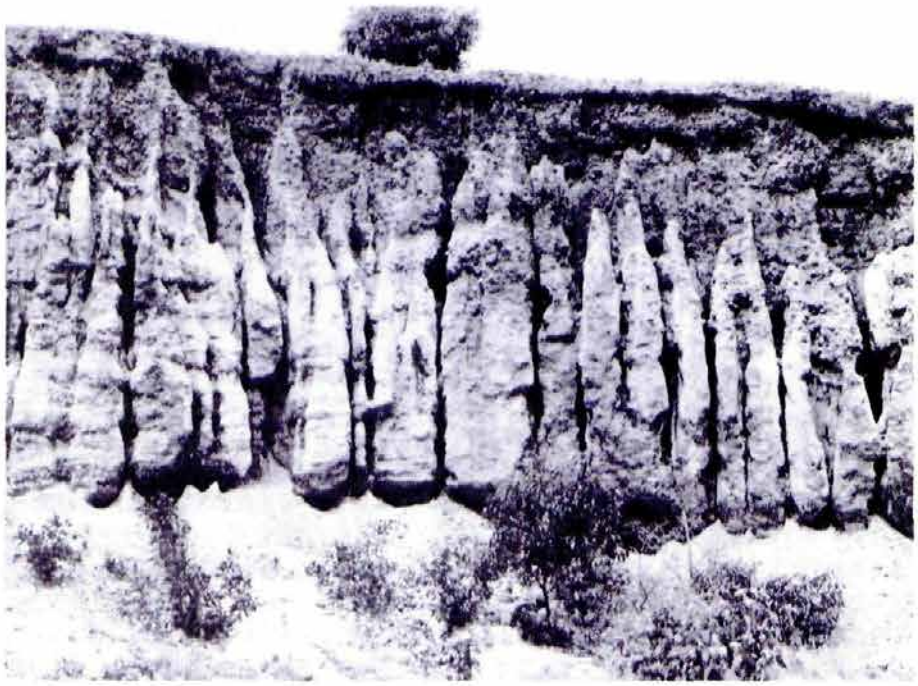
Also on resistant rocks but at a somewhat lower level are remnants of the Kinglake surface. This probably developed during Cretaceous times when fluviatile erosion had again reduced the landscape to a subdued relief. However, subsequent uplifts and erosion have restricted its extent to hard plateau areas around Mount Macedon.

As the Kinglake and Baw Baw surfaces have been protected from erosion, weathering, and sedimentation for so long, they are usually associated with very old soils. Although not as old as the surfaces themselves, the soils may date to Tertiary times, and are commonly red-brown kaolinitic gradational soils with a fine structure.

In the Tertiary period, fluviatile erosion developed more widespread surfaces across many rock types. These may still be recognized, despite subsequent dissection, faulting, and

other processes. West of Melbourne, most surfaces on the Palaeozoic rocks were developed during the early Tertiary (30--70 million years ago), including the Blackwood and Brisbane Ranges. The Barrabool Hills, and some of the other southern areas, may have developed later as a result of further upward movements in the later part of the Tertiary.

Differential erosion of exposed duplex soil



The group referred to as 'other surfaces' in the legend to Map 5 and in Appendix II have been segregated partly because they do not conform with the other Tertiary surfaces and partly on the basis of land form. The two river valley units EsV and EmV represent abrupt and narrow steep-sided stream valleys and gorges that have largely been cut since the newer volcanics. They usually contain a sandwich of geological layers, with basalt commonly at the top lip of the valley and rocks often as old as Palaeozoic towards the bottom. Both the EmM and EmS units represent areas of relatively recently eroded late Tertiary marine plain remnants, which are delineated by the unit DmP2. For the same reason EnS1 and EnS2 are included in this group, except that the underlying sediments are non-marine.

Depositional surfaces

This category contains three main subdivisions, based on age of deposition; all tend to have flat to undulating surfaces.

Late Tertiary plains here correspond to the final retreat of the sea during the Pliocene. They consist of broad, mainly marine plains in the south, and non-marine plains, fans, and terraces to the north; these latter plains particularly have been dissected by down-cutting streams. The Tertiary deposits here remain as broad, relatively flat cappings on crests and ridge-tops.

Aeolian sand sheets and low dunes also occur on the Tertiary plains. Examples include the lunette-type dunes now on the east side of the Durdiwarrah reservoirs, the dunes of the

Inverleigh Common, and the sands near Drysdale now used for potato-growing.

Depositional surfaces of Pleistocene origin include deltas, fans, higher terraces, and plains. Those indicated on Map 5 by DfP1, DfP2, DfP3, and DfP5 comprise plains and gentle slopes derived from fault scarps or other areas of uplift. The unit DfP4 represents the silts and sands of the Werribee River delta, while DaP refers to the southern extent - to Seymour - of the broad Murray River plains.

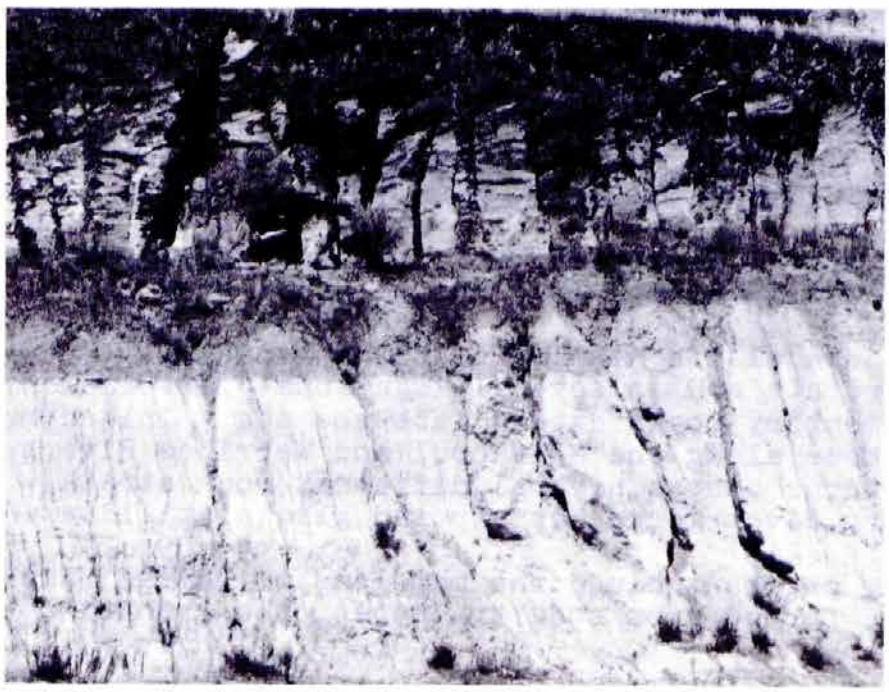
The larger areas of Recent alluvium (prefixed by DaR) are shown on the map - but many other smaller areas occur, which at the scale of mapping are not shown, and these are incorporated with the adjoining larger zones. The Moorabool River flats, for instance, are included with EmV. Alluvial flats at Bacchus Marsh (DaP2) are valuable for irrigated agriculture.

Newer volcanic surfaces

These surfaces all date from late Pliocene--early Pleistocene times. They have been mapped separately from the older volcanic surfaces because of their dramatic effects on the physiography of the area, particularly the drainage and deposition patterns.

The flat to gently undulating plains have been separated from those with more strongly undulating, sometimes rolling, terrains. Broad patterns of soil types have also been indicated in Appendix II, although considerable variation occurs within those patterns.

Separate land forms have been delineated to include those volcanic vents that now form significant hills. The types of volcanic cones, however, have not been separated. Both the steep-sided scoria and ash cones with their associated red gradational soils and the somewhat more gentle lava cones with shallow, stony dark soils have been mapped as one unit.



Newer volcanic basalt over Tertiary sediments

In addition, the map indicates small areas of moderately steep slopes that are generally associated with post volcanic activity along fault lines. Gorges cut by the major watercourses have been indicated either as NbV, where the stream has not yet cut through the basalt, or as EsV, where considerable exposures of Palaeozoic rocks occur.

Some of the examples of inverted topography caused by the lateral erosion of valley lava flows have been mapped as NbR, representing ridges and crests with basalt caps. The largest area of valley lava flow now forming a broad crest lies between the Pyrites and Coimadai Creeks. This has been mapped as NbG5, however, because the basalt cap is as broad as the plains basalt further west, and has similar soils.

Coastal land forms

Only those coastal land forms that occupy large areas have been indicated on the map. Others, including sandy beaches, shore platforms, cliffs, and intertidal sand and mud flats, are too narrow to be shown.

Coastal dune and beach ridges vary in age from Recent to Pleistocene, comprising calcarenite and siliceous sand, such as at Point Nepean. The coastal salt-marshes, on the other hand, are low-lying flat areas of mainly saline soils, and the extensive occurrence near Lake Connewarre represents the latest areas of incursion by the sea onto the Bellarine Peninsula.

Coastal dune, showing erosion initiated by pedestrian traffic

A number of features of geological and/or geomorphological interest are located on public land in the study area.

Along the coast, sea cliffs display sections across a variety of rock strata and in several locations platforms on basaltic or sedimentary rocks extend into the sea. Inland, gorges such as those along the Moorabool and Werribee Rivers also display sections across several different rock strata, and the Lerderderg River gorge has exposed glacial tillites.

Other interesting places include the mamelons of Camels Hump and Hanging Rock, formed from soda trachytes, the granitic

tors at Gellibrand Hill and the Cobaw Ranges, the prominent monadnock of the You Yangs, and the volcanic cones of Mounts Blackwood and Franklin. Small natural lakes partly fringed by lunettes are found at Durdidwarrah, and columnar jointing and tessellated pavement are exposed in the Organ Pipes National Park. Several fossil beds have been identified in naturally occurring exposures or in road or railway cuttings.

Throughout the study area, several quarries and road or railway cuttings have also revealed geologically interesting features.

Map 5 was produced with reference to other maps relating to the area, including: 1:250,000 Geological Series sheets for Queenscliff and Melbourne (Geological Survey of Victoria); Physiography of Melbourne and the Bays (J.J. Jenkin); Land Zones (J. Rowan); Terrain Analysis and Classification for Engineering Purposes for the Melbourne and Queenscliff areas (CSIRO Division of Geomechanics); and unpublished soils maps of the western plains prepared by the Department of Agriculture, Victoria.

5. CLIMATE

Generally, the study area enjoys a temperate climate with warm, dry summers and cool winters. Comparison of temperature and rainfall records from a number of stations distributed across the area (as shown in Table 3) indicates that a range of localized conditions prevail; these may be attribu-

Table

MONTHLY AVERAGE MAXIMUM, MINIMUM, AND MEAN DAILY

Station	Elevation (m)	Parameter	Jan.	Feb.	Mar.	Apr.	May
Geelong	3	Max. temp.	23.1	24.0	22.7	18.9	16.3
		Min. temp.	12.7	13.8	12.3	9.9	8.0
		Mean temp.	17.9	18.9	17.5	14.4	12.2
		Rainfall	30	40	43	44	49
Werribee	46	Max. temp.	25.7	25.3	23.3	19.5	16.5
		Min. temp.	12.7	13.2	11.6	9.3	7.0
		Mean temp.	19.2	19.2	17.4	14.4	11.7
		Rainfall	36	48	40	47	47
Ballan (Fiskville)	442	Max. temp.	24.3	23.5	21.6	17.1	13.8
		Min. temp.	9.6	10.2	9.3	7.1	5.0
		Mean temp.	16.9	16.8	15.4	12.1	9.4
		Rainfall	35	49	34	56	48
Macedon	503	Max. temp.	21.9	22.0	19.5	14.6	10.6
		Min. temp.	11.2	12.0	10.2	7.8	5.7
		Mean temp.	16.6	17.0	14.8	11.2	8.2
		Rainfall	47	55	58	69	79
Kyneton	509	Max. temp.	26.5	24.6	22.5	18.1	13.1
		Min. temp.	10.3	10.5	9.2	5.5	3.9
		Mean temp.	18.4	17.5	15.8	11.8	8.5
		Rainfall	37	39	46	54	75
Seymour	142	Max. temp.	29.6	28.4	25.6	21.1	15.9
		Min. temp.	14.3	14.4	12.1	8.5	5.7
		Mean temp.	21.9	21.4	18.8	14.8	10.8
		Rainfall	33	36	42	47	57

Source: Bureau of Meteorology (1975). 'Climatic Averages,

ted to combinations of altitude, regional topography, and/or proximity to the sea.

Precipitation

Map 6 indicates the average annual isohyets within the district. These clearly show the influences of the Otway Ranges to the south-west, which produce a rain-shadow effect across the plains west of Melbourne, and of the mountains of the Great Dividing Range, which force moisture-bearing winds to rise, thereby causing rain to fall in their vicinity. Rockbank (100 m elevation), for instance, falls within the

3

TEMPERATURES (^{o}C) AND AVERAGE MONTHLY RAINFALL (mm)

June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Rainfall	
							Annual total	Years of recording
13.1	12.2	13.7	15.5	17.9	19.5	21.1		
5.4	5.1	5.9	7.9	9.1	10.0	12.7		
9.2	8.6	9.8	11.7	13.5	14.7	16.9		
46	50	51	50	51	47	42	543	77
13.7	13.3	14.6	17.0	19.4	21.7	24.4		
5.2	4.5	4.9	6.0	7.7	9.4	11.6		
9.4	8.9	9.7	11.5	13.5	15.5	18.0		
39	42	45	48	56	49	46	543	61
10.7	10.3	11.6	13.8	16.2	18.8	22.0		
3.6	2.9	3.4	4.3	5.6	6.8	8.7		
7.1	6.6	7.5	9.0	10.9	12.8	15.3		
45	47	56	52	58	47	46	573	41
7.4	6.7	8.2	11.5	15.1	18.2	21.2		
3.7	2.7	3.2	4.8	6.5	8.2	10.1		
5.6	4.7	5.7	8.2	10.8	13.2	15.7		
85	83	86	87	83	65	56	854	81
10.9	9.3	11.1	13.8	17.1	20.6	22.8		
2.9	1.9	2.8	3.4	5.5	6.9	8.6		
6.9	5.6	6.9	8.6	11.3	13.8	15.7		
89	82	84	74	69	52	50	751	94
13.3	12.2	13.8	16.3	20.2	23.7	25.9		
3.4	2.8	3.9	5.1	7.1	9.4	11.3		
8.3	7.5	8.8	10.7	13.6	16.5	18.6		
67	59	63	56	54	45	37	596	93

Victoria.' (A.G.P.S: Melbourne.)

rain-shadow of the Otways and receives an average of only 423 mm of rain annually, making it the driest region in Victoria south of the Divide. Trentham, on the other hand - 50 km to the north-west and on the Divide (686 m elevation) - receives 1,089 mm of rain.

Rainfall along the coastal region is fairly uniformly distributed throughout the year as the figures given in Table 3 for Geelong and Werribee indicate. Kyneton and Macedon, however, near the Divide, experience a winter maximum. Seymour also receives its greatest monthly falls during winter, although the annual total is not as great here as for those stations nearer the Divide.

Snowfalls are frequently recorded down to an altitude of 600 m, but are generally light. The Macedon Ranges receive regular falls and because they are relatively high (Camels Hump - the highest point in the study area - is 1,011 m and Mount Macedon 1,001 m), the snow may lie for several days.

Temperature

Table 3 also shows mean daily temperatures for each month (averaged over a recording period of some 15 years) for six stations in the study area.

Throughout, the records reveal a consistent seasonal pattern, with the highest average temperatures in February and lowest in July. The moderating influence of the coast can be seen in the records for Geelong and Werribee, which have a smaller range of average mean daily temperatures throughout the year (10.3°) than other lowland areas inland. For example, Seymour, where summer temperatures are higher and winter temperatures generally lower, has a range of 14.4°. Temperatures also reduce with increasing elevation.

Growing season

The mean monthly temperature below which plant growth is considered to be restricted is 10°C. Thus, on the basis of temperature alone, it would be expected that plant growth could be inhibited during June, July, and August at Geelong, Werribee, and Seymour and from May to September at Ballan, Macedon, and Kyneton.

The length of the growing season in an area also depends on available soil moisture - which is related to rainfall, evaporation, ground slope, soil type, and plant species. It can, however, be roughly estimated in terms of rainfall, and lack of rainfall alone would inhibit growth at Ballan and Macedon during February. At Kyneton the restriction would include January as well as February, while at Seymour drought conditions would normally inhibit growth from December to March inclusive.

Thus, the combined effects of summer drought and low winter temperatures would confine the growing season throughout most of the study area to spring and autumn, totalling about 5 to 6 months each year. Rainfall and temperature, however, are not the only determinants of growing season, The

characteristics of the particular plant species or variety, local topography and soils, and the availability of irrigation also contribute.

Frosts

This characteristic of climate has important implications for some forms of agricultural production. Its occurrence depends on temperature and humidity of the air, on wind, and on cloud cover, and also on the surface condition of the ground, its slope and aspect, its vegetation cover, and its water content. As a consequence, site selection for frost-sensitive crops is most important.

Frosts occur frequently inland during the winter months, but are rare on the coast. At Bacchus Marsh, for instance, the first frost would, on average, be expected about April 13 and the last on October 31. Nearer the coast, at Werribee, the respective dates would be May 12 and October 7.

Reference

Australia, Bureau of Meteorology (1968). Port Phillip, Victoria. *Climatic Survey Region* No. 10.

6. WATER RESOURCES AND UTILIZATION

Surface Water

Yield of run-off water from a catchment is related to both precipitation rate and the percentage of this precipitation lost as evaporation, transpiration, deep seepage, and impounded water.

The highlands in the north of the study area and the Otway Ranges to the south-west receive high rainfalls (1,000 mm and 1,200-1,400 mm per annum respectively) compared with the bulk of the region, and thus contribute most of the stream flow of the area.

Drainage basins

Map 6 shows the eight major drainage basins occupying the region, each of which may contain a number of streams - as indicated by Appendix VIII. Only two of these basins lie wholly within the study area - those of the Werribee and Maribyrnong Rivers, both of which flow into Port Phillip Bay. The Goulburn, Loddon, and Campaspe Rivers flow north out of the area and only portions of their headwaters are represented here. The lower reaches of the Barwon River (which has its headwaters in the Otway Ranges) and its major tributary, the Moorabool River, flow through the south and west of the area to enter the sea via the large Lake Connewarre estuary. Short streams draining the seaward slopes of the Otway Ranges comprise the Otway Basin. Many of these streams also enter the sea through estuaries.

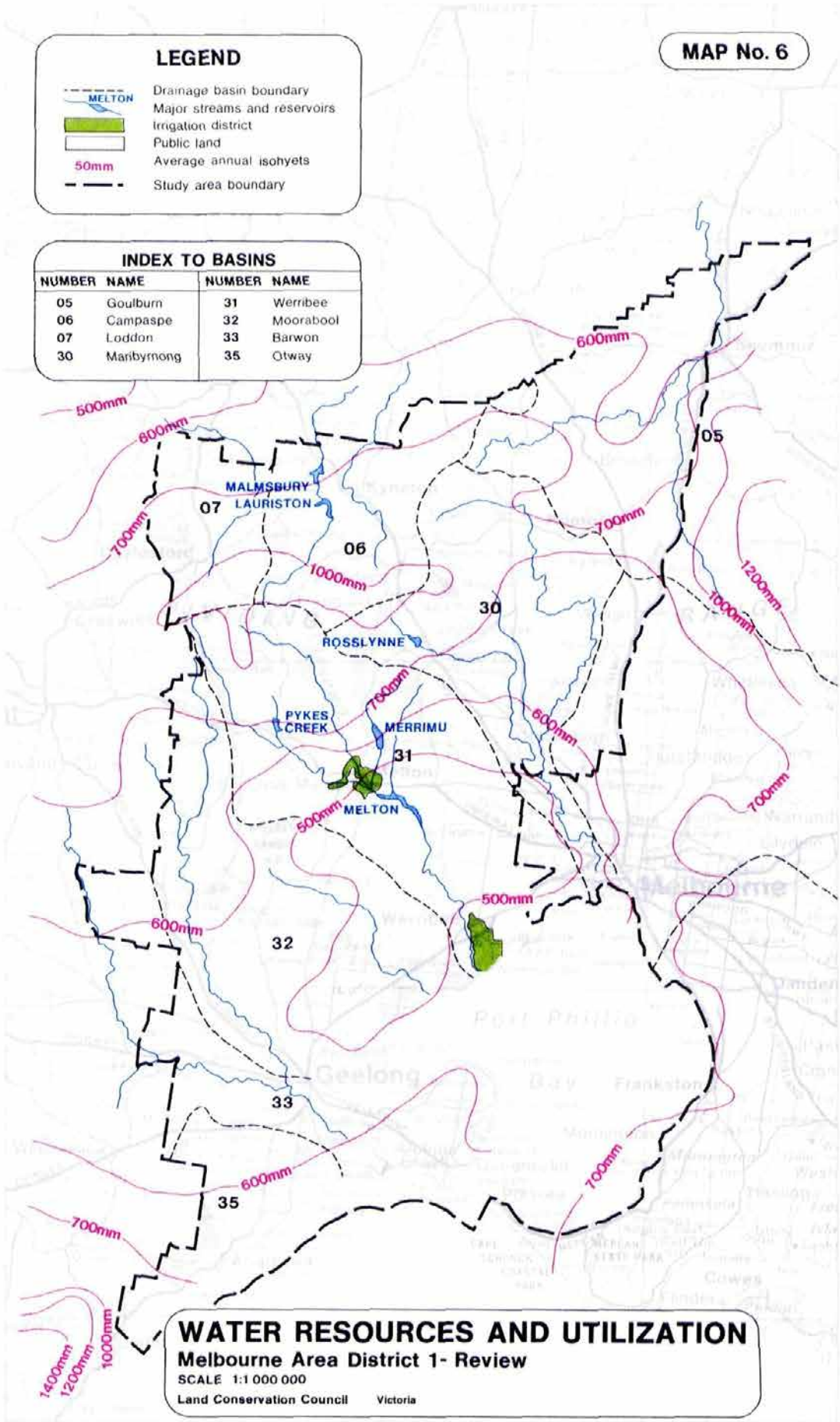
The water resources of the Barwon River basin are reasonably reliable by Australian standards; the natural flows of the Maribyrnong and Werribee Rivers, however, vary greatly from year to year.

Gauging stations

A number of gauging stations have been established on streams in the area. Appendix III presents records of annual discharge and salinity for each of these stations.

Water quality

The factors characterizing water quality include temperature, hardness, turbidity, levels of dissolved oxygen, colour, organic matter content, and the concentration of total dissolved solids (TDS). The last is the most commonly used indicator of the chemical quality of water and serves as a means of comparing streams. Table 4 illustrates how rising TDS levels limit the uses to which water can be put. In general, 1,000 mg TDS per litre is the upper limit for water for domestic use, while under certain conditions sheep can tolerate up to 16,000 mg per L. From Appendix III it can be


LEGEND
MELTON
Drainage basin boundary
Major streams and reservoirs
Irrigation district
Public land
50mm
Average annual isohyets
Study area boundary
MAP No. 6
INDEX TO BASINS
NUMBER NAME
05 Goulburn
06 Campaspe
07 Loddon
30 Maribyrnong
31 Werribee
32 Moorabool
33 Barwon
35 Otway
500mm
600mm
700mm
1000mm
1200mm
1400mm
MALMSBURY
LAURISTON
ROSSLYNNE
PYKES CREEK
MERRIMU
MELTON
05
06
07
30
31
32
33
35
WATER RESOURCES AND UTILIZATION
Melbourne Area District 1- Review
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Land Conservation Council Victoria

seen that the median level of TDS for streams within the study area ranges from 80 mg per L (Goulburn River at Seymour) to 3,970 mg (Toolern Creek at Melton).

Table 4

WATER SALINITY

Salinity (mg TDS per L)	Usage
Less than 1,000	Commonly suitable for domestic and industrial use, and for livestock and irrigation. The limit for vegetable production is about 1,000 mg per L. (The salinity of Melbourne's water is 100 mg per L; Adelaide's is 300 mg per L.)
1,000--3,000	Brackish water. Maximum salinity humans can normally tolerate is around 2,000 mg per L. The threshold salinity for the growth of most plants is 3,000 mg. This water is suitable for all livestock, and some domestic and limited industrial uses. Use for irrigation is possible under favourable conditions.
3,000--7,000	Increasingly brackish water. Suitable for most livestock (poultry, up to 3,500; pigs, up to 4,500; horses, ewes with lambs, and dairy cattle, up to 6,000 mg per L), but very limited for domestic and industrial purposes.
7,000--16,000	Salty water. Beef cattle will tolerate up to 10,000 mg per L. The maximum for sheep on green pasture is 16,000 mg per L.
More than 16,000	Unsuitable for livestock.
35,000	Sea water.

Storages and supply zones

A number of major water supply storages in the area (indicated on Map 6) provide water for either irrigation or domestic and industrial purposes, or both.

Table 5 lists information about the main on-stream storages in the study area. All of these are controlled by the Rural Water Commission. The Merrimu Reservoir is currently being enlarged to 35,000 ML to secure supplies to the Melton urban area and the Werribee Irrigation District, and further enlargement is proposed. This reservoir is located on Coimad-

Table 5

MAIN ON-STREAM WATER STORAGES

Storage	Capacity (ML)	Stream	Catchment area (sq. km)	Use *	Areas serviced
Rosslynne	24,000	Jackson	83	I, D	Sunbury, Gisborne, Riddells Creek, and private diverters
Pykes Creek	24,000	Pykes	130	I, D	Bacchus Marsh, Werribee
Lauriston	20,000	Coliban	223	D	Bendigo, Maldon, Castlemaine
Merrimu	19,000	Coimadai	85	I, D	Bacchus Marsh and Werribee Irrigation Districts, Melton urban
Malmsbury	18,000	Coliban	290	I, D	Bendigo, Castlemaine, and smaller towns
Melton	17,000	Werribee	1,114	I	Werribee

* D = domestic and industrial
  I = irrigation

Source: Rural Water Commission

Melton Reservoir on the Werribee River

ai Creek, but also receives water from Goodman Creek and the Lerderderg River.

The only major off-stream storage here, the Greenvale Reservoir (27,000 ML), is controlled by the Melbourne and Metropolitan Board of Works and stores water for Melbourne's domestic supplies.

A large number of smaller storages, weirs, and offtakes on streams throughout the district also provide domestic water. Many of the catchments are subject to a multiplicity of uses and in some cases treatment of the water is necessary. Appendix IV identifies the sources of supply for the principal towns of the area and indicates the degree of treatment of the water.

Water supplies for the Bellarine Peninsula and for some 60% of Geelong's needs are derived from the upper reaches of the Barwon River - outside the study area. The balance of Geelong's water supply is drawn from reservoirs on the Moorabool River - one of which, the Lal Lal Reservoir, is also outside the study area and supplies both Geelong and Ballarat.

The Natural Resources and Environment Committee of the Parliament of Victoria is conducting an enquiry on proposals for the future management of all water resources in the State's south-western region. This region includes the basins of the Moorabool, Barwon, and Hopkins Rivers and those of Lake Corangamite and the Otways. The first stage - to report on proposals for augmenting the water supply system of the Geelong and District Water Board, which should be implemented to ensure continuity of supply through to 1995 - was completed in November 1984. The enquiry established that additional water resources will be required before 1995 and that the first stage of augmentation will need to be in

service by 1988. How this may best be achieved will be considered during the next stage of the enquiry. The committee has recommended that management of the demand for water should be rigorously introduced in a co-ordinated manner by the water supply authorities.

Legislation

Section 5 (1) of the *Land Conservation Act* 1970 and section 20(1) of the *Soil Conservation and Land Utilization Act* 1958 provide for water supply catchment areas to be proclaimed by the Governor-in-Council. Such proclamations are usually made where the catchments serve a multiplicity of uses. The most suitable uses (in the public interest) of all lands in catchment areas, and the conditions under which various forms of use may be permitted, may then be set by determination. Similarly, such determinations also delineate protective strips around storages and along major watercourses. Land Use Determinations now cover 15 of the 22 proclaimed water supply catchments partly or wholly within the district. Three of these, for Rosslynne Reservoir - on Jackson Creek, Stony Creek, and Painkalac Creek - have been introduced since the Council's previous recommendations for the area.

Irrigation

The rain-shadow cast by the Otway Ranges embraces two areas of rich alluvial flats along the Werribee River. These areas, at Bacchus Marsh and Werribee, are served by irrigation systems supplied by the Pykes Creek, Merrimu, and Melton reservoirs. Table 6 sets out the quantities of water delivered to these areas during 1984/85, and the irrigation districts supplied are shown on Map 6.

Table 6

WATER DELIVERED TO IRRIGATION DISTRICTS (ML)
1983/84

Irrigation district	Gross supply at district offtakes	Total water right	Users within district			Users * outside district	Total delivered
			Water right	Sales	Total delivered		
Bacchus Marsh	7,420	3,760	3,207	1,341	4,548	1,687	6,235
Werribee	13,774	9,680	8,891	2,311	11,202	123	11,325
Total	21,194	13,440	12,098	3,652	15,750	1,810	17,560

* Users here include those drawing from the Rural Water Commission irrigation system but located outside the districts.

Source: Rural Water Commission

Private diversions

Landholders may obtain water for private diversions under riparian rights, licences, or permits.

Where a watercourse has no Crown frontage reserve, the owners of the abutting properties have riparian rights, which entitle them to take water, free of charge, for domestic purposes and for the watering of stock. Further, if the riparian allotment was alienated from the Crown before 15 December 1886, the owner may use the water to irrigate a domestic garden, not exceeding 1.2 ha, on the land. This irrigation right does not extend to the watering of a garden from which the produce is sold, nor does it permit the watering of grass grazed by stock kept for profit.

A licence would normally be issued for irrigation purposes when supplies are assured, except during periods of extreme drought, and the stream is regulated by Rural Water Commission structures. The usual period of issue is 15 years and, in 1983, the annual charge was $3.00 per megalitre. Because the water resources of all of the regulated streams in the study area are fully committed to meet existing demands, no new licences have been issued for many years.

Annual water-diversion permits are issued primarily for irrigation, domestic, or stock-watering purposes. Irrigation permits may be issued on unregulated streams. The summer flow in almost all the streams in the area is fully committed to meet existing demands, however, and new permits for irrigation purposes are only issued in circumstances where the landholder constructs on on-stream or off-stream reservoir and stores winter flows for use during the irrigation season. Current annual charges are $1.50 per megalitre for on-stream permits and $0.75 per megalitre to fill an off-stream storage.

Domestic and stock permits may be issued to persons who have no riparian entitlements. The holder of a domestic and stock permit is entitled to divert up to 2.2 ML per year, at a cost of $19.00 from streams and $28.50 from Rural Water Commission storages.

Table 7 indicates, for June 1984, the volumes of water that could be diverted under annual licences and permits from the major streams of the study area - other than from the Bacchus Marsh and Werribee irrigation systems.

The water resource of the Werribee River system is heavily committed to supplying the Bacchus Marsh and Werribee irrigation districts and the domestic water requirements of the rapidly expanding urban area of Melton. As a result, strict controls of the diversion of water from streams within the Werribee basin have been imposed and, even during the winter months, the filling of off-stream storages is restricted to periods when Melton Reservoir is overflowing.

In addition, pumping facilities at the Newlyn Reservoir (on Birch Creek, in the Ballarat study area) enable the diversion of water over the Divide into the headwaters of the

Table 7

AUTHORIZED DIVERSIONS 1984

Stream	Irrigation		Domestic & stock	Others
	Area (ha)	Volume (ML)	(ML)	(ML)
Barwon River	122.7	795.5	15.4	198.7
Tributaries	31.9	191.0	2.2	-
Little River	46.7	308.3	6.6	20.0
Tributaries	2.0	12.3	-	-
Moorabool River	115.4	721.0	24.2	8.4
Tributaries	-	-	4.4	-
Werribee River	116.0	459.6	24.2	8.0
Lerderderg River	65.6	405.8	26.4	169.0
Tributaries	23.5	292.0	48.4	80.0
Maribyrnong River Tributaries*	187.5	1,413.4	110.9	53.0
Goulburn River Tributaries	112.9	321.2	2.2	1,185.0
Coliban River	180.3	266.0	30.8	-
Tributaries	12.5	75.0	19.8	-
Loddon River	-	-	8.8	-
Tributaries	68.0	364.1	15.4	-
Campaspe River	16.7	100.0	6.6	-
Tributaries	22.0	105.0	11.0	-
Total	1,123.7	5,830.2	357.3	1,722.1

* Diversions from Maribyrnong River controlled by MMBW

Source: Rural Water Commission

Moorabool River, thence by Geelong and District Water Board facilities to an offtake that re-diverts the water to the Werribee River and on to Pykes Creek Reservoir. This scheme was constructed in 1961 to safeguard the supply of water to the hardboard plant at Bacchus Marsh, but could be used to augment irrigation water supplies.

On the other hand, the water resources of the Maribyrnong River basin have not been developed to any significant extent. Currently only about 5% of the average annual flow of

the Maribyrnong River is being used for such purposes: 2% for town water supplies; 2% for irrigation by private diversion, and 1% for a variety of other rural uses.

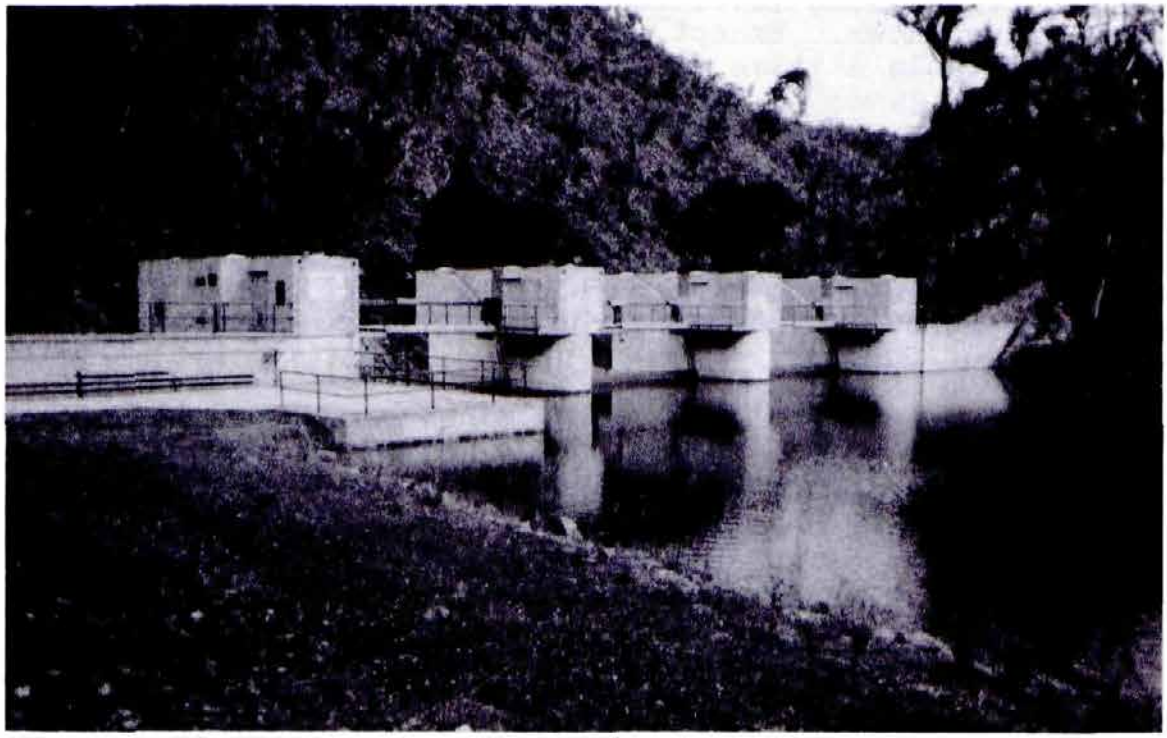
The state of the rivers

Over the past 150 years, many of the rivers in the area have been adversely affected by settlement. Removal of the native vegetation for agriculture has increased run-off, which, in turn, caused erosion within the catchment and of the watercourses. Together with drainage and gold-dredging works and other activities, this erosion has caused the deposition of silt and sand in the lower reaches of the rivers. In addition, clearing of the original vegetation has allowed water tables to rise, and saline groundwater has moved into the streams. The current condition of the Barwon, Moorabool, Werribee, and Maribyrnong Rivers is described below.

The Barwon--Moorabool river-basin system drains a total area of some 4,300 sq. km, with headwaters both in the Otway Ranges to the south-west and the Central Highlands to the north. Water in that portion of the Barwon River within the study area has limited potability, with salinity levels increasing from 500 mg TDS per L in the middle reaches to 800 mg in the lower part.

Good-quality water from the Moorabool River (TDS of about 240 mg per L) is stored in the Lal Lal Reservoir, but downstream the salinity progressively increases, with readings in excess of 1,300 mg per L being recorded under normal flow conditions.

Irrigation works within the Werribee River basin commenced soon after settlement and a number of reservoirs have been



A weir on the Lerderderg River diverts water for the Merrimu Reservoir

constructed here to supplement water supplies during periods of low rainfall.

The wide, steep-sided valley known as Werribee Vale, immediately below the Werribee Gorge, is subject to extensive sheet, tunnel, and gully erosion, and sections of the northern escarpment suffer mud flows and earth slips.

In addition, about 70% of the valley of Parwan Creek, the western tributary of the Werribee River, is affected by severe sheet, rill, tunnel, and gully erosion and by soil salting. Stream-bed and bank erosion have also resulted from the increased run-off due to land use changes. The combination of these has led to siltation of Melton Reservoir, reducing its capacity by approximately one-third.

The Land Protection Service of the Department of Conservation, Forests and Lands has undertaken extensive bed-erosion control works in Whitehorse Creek - a tributary of Parwan Creek. The Service has also carried out bank-erosion control works along Parwan Creek and, in conjunction with the Rural Water Commission, is investigating additional works here.

Land in much of the Maribyrnong River basin remains relatively stable, although the numerous roads and tracks and the small areas where land deterioration has occurred have contributed significantly to stream turbidity and sedimentation. These areas are the moderately to severely eroded slopes and drainage lines upstream of Sunbury and Darraweit Guim and extending down the valley to Bulla.

The Riddles Creek group of streams within domestic water supply catchments have low salinity levels (100 mg TDS per L). Downstream, the level increases due to the inflow of saline groundwater. Except during peak flows, turbidity is at an acceptable level.

Streams in the eastern part of the basin - such as Maribyrnong River, Boyds Creek, Konagaderra Creek, and Emu Creek - have high salinities that limit their use for domestic or irrigation purposes. The salinity of Jacksons Creek increases markedly with distance downstream. The majority of streams here also have high turbidity, particularly the southern reaches of the Maribyrnong River and Jacksons Creek downstream of Sunbury.

Hydrological research

Two hydrological research stations are located in the district:

* Parwan - west of Bacchus Marsh in the Parwan Creek catchment (White Elephant Reserve)
* Stewarts Creek - south of Daylesford in the Wombat State Forest

Both areas have meteorological stations and are equipped with a variety of instruments to record water flow. Data from these stations are collected regularly by the Hydrolog-

ical Section of Land Protection Service (Department of Conservation, Forests and Lands).

Parwan hydrological research station deals with six 1.5-ha sub-catchments established in 1956 to monitor yield and quality of run-off water under three land use treatments. Three sub-catchments have a northerly aspect and the others face south. The three land use treatments are basically native woodland, native grassland, and improved pasture.

Analyses of the data reveal the following conclusions.

* The three south-facing sub-catchments have better soils and consistently higher soil moisture - resulting in denser, more vigorous vegetation and consequently less soil erosion and reduced water yield - compared with the sub-catchments facing north.
* Run-off (yield) from the two native grassland sub-catchments is consistently much greater than from the other two treatments.
* To date, run-off is greater from the improved pasture than from the native woodland, but the pasture is still being developed.
* Water samples collected during a typical rain-storm in March 1983, following a prolonged drought, gave turbidity readings that clearly indicated the soil protection afforded by regenerating native vegetation on the native woodland sub-catchments.

In summary, the Parwan experiments indicate that land with a northerly aspect is more vulnerable to erosion and that native woodland affords better soil protection and yields less run-off than native grassland or moderately developed improved pasture.

Stewarts Creek hydrological research station monitors five sub-catchments, varying in size from 4 ha to 25 ha, selected in 1958 to study the hydrological effects of changing land use from native forest to pasture or pine forest. This is one of the few such hydrological research programs in Australia. The study was initiated by the Land Utilization Advisory Council and advice provided by representatives from the then State Rivers and Water Supply Commission and the Forests Commission, which also implemented the forest operations.

Instruments were installed to measure climatic factors, precipitation above forest canopy, stemflow down the tree trunks, precipitation at ground level (using both conventional and trough rain gauges), soil moisture at varying depths, surface run-off, and sediment load. Following a 10-year calibration period, changes in land use were implemented in 1969.

Two of the five sub-catchments were retained under the native uneven-aged eucalypt forest, one was converted to improved pasture (grazed perennial species), and one was converted to pine forest (*Pinus radiata*), at a density of about 1,600 stems per hectare; the fifth sub-catchment was discar-

ded due to water leakage through the base rock. Sediment load measurement did not eventuate until late 1978, however.

Analyses of results indicate the following conclusions.

* Pasture uses less water than eucalypt forest in the circumstances of this type of country - resulting in about a doubling of the run-off. At Stewarts Creek the amount of run-off from pasture catchment is 120% of that from eucalypt forest catchment.
* Pine forest, during the early stages, uses less water than eucalypt forest in this type of country, resulting in about a doubling of the run-off. At Stewarts Creek the amount of run-off from pine catchment during that early stage was 115% of that from the eucalypt forest. However, this effect is decreasing with the gradual development of the pine trees.
* It is difficult to make long-term predictions based on a few years' data - firstly because hydrological processes and effects are long-term, and secondly because the land use changes themselves take some time to reach a stable state. There are complex interrelations between damage to soil porosity, stage of development of pasture and pine trees, different rates of evapotranspiration between pasture, pines, and eucalypts, various rainfall intensities, soil characteristics, root depths, and climatic types.
* Nevertheless these studies indicate that water yield increases substantially after conversion from eucalypt forests to either pasture or pine forests, at least initially, but it must be recognized that this situation is not yet stable.

Groundwater

Except for studies of the mineral springs area to the north, little detailed investigation of the groundwater status of the study area has taken place. Tests on a small number of bores, however, and observations of private bores, have indicated a large resource.

Yield and quality vary considerably throughout the region according to geology, rainfall, elevation, use of the overlying land, proximity to the sea, and the local level of use of the resource.

Palaeozoic rocks forming the basement strata of the district contain groundwater in fractures, joints, and shear zones, and in the weathered zone. Yield is generally low. The mineral springs around Daylesford are located in these rocks and recharge here probably comes from local creeks. The Newer Volcanics, which comprise the bulk of the district, contain a large reserve of groundwater. Salinity varies (in the general range of 1,000 to 3,000 mg TDS per L). Mesozoic sediments in the south - in the Bellarine Peninsula and the Barrabool Hills - contain poor-quality groundwater (more than 1,500 mg per L). Local sands and gravels over the basalts generally contain good-quality water at a relatively shallow depth (about 1.3 m), although near Port Phillip Bay

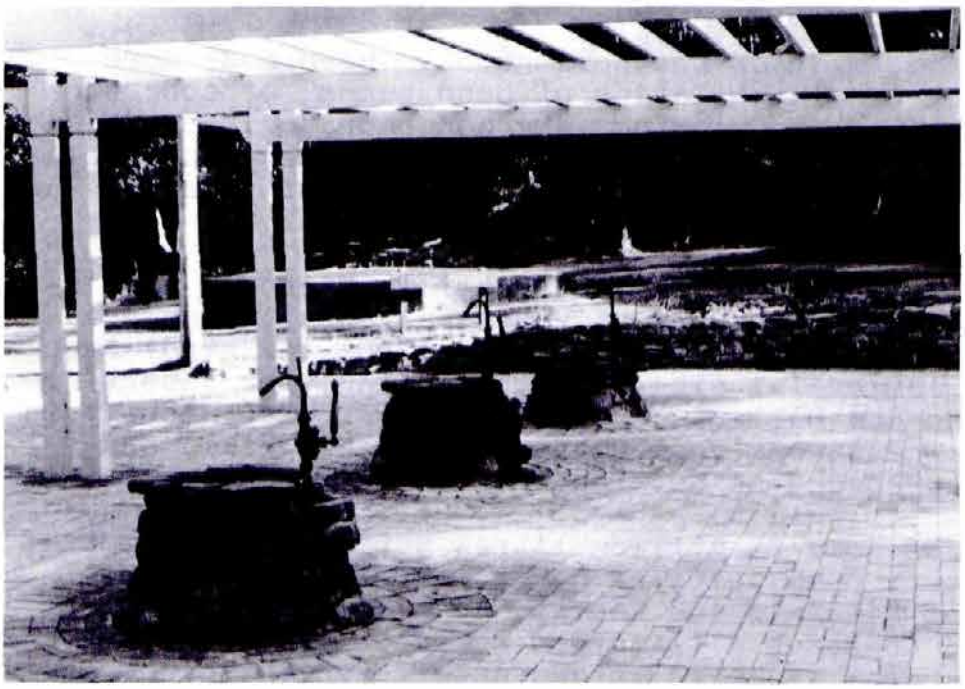
some salt-water intrusion is occuring where a number of bores have extracted faster than the fresh-water recharge rate.

At Werribee, the water table has risen since 1948, when readings were first made, and salinity has fallen almost 30% to about 1,000 mg TDS per L. This could be a result of the recharge of the water table with irrigation waters.

In the Daylesford region groundwater of low salinity (200 mg per L) is found in the Quaternary and Pliocene sediments and Newer Volcanics. Spring Creek, which flows through Hepburn Springs, is fed from this resource. Some pollution of this groundwater is thought to occur, as up to 50 mg of nitrate salts per L have been found here.

Mineral Springs

Mineral (spa) water is water naturally impregnated with a mineral substance. In the study area it is found at Clifton Springs and Geelong in the south and in a region of some 4,700 sq. km around Daylesford, Kyneton, and Blackwood in the north.



Central Springs at Daylesford

The mineral waters in the north usually appear as springs where stream gullies intersect the water table and are also found in bores sunk into the bedrock nearby. None of the springs are artesian. Most discharge directly from folded, faulted, and fractured Ordovician rocks (usually sandstones), which are thought to extend from the water table to a depth of 1,000 metres or more.

The dissolved carbon dioxide that characterizes these waters is probably derived from some source at considerable depth and is thought to be the last manifestation of the volcanic activity of Pliocene--Pleistocene times. Sometimes the gas is hydrogen sulphide. As the water rises to the surface, it effervesces, making it a natural soda water (similar in con-

tent of carbon dioxide and dissolved salts to European spa water). It has an average salinity of about 2,500 mg per L, but ranges from 600 to 10,250 mg. The low chloride content, however, contrasts with most groundwater of similar salinity. Salinities low in the range indicate a higher rate of recharge of the aquifer by surface waters, and *vice versa*.

Dissolved iron in the waters usually precipitates after standing, and this may cause discoloration of the container. Other minor ions such as those of lithium, silicon, and magnesium may impart a distinctive taste to water from particular springs. Some of the waters carry extremely minute traces of radioactive minerals and/or radon gas.

Victoria contains most of the known regions of mineral water in Australia; a few scattered springs are found in South Australia, New South Wales, and Queensland. The study area contains some 85% of the Victorian total.

The springs were mainly located and named by squatters and prospectors. Captain Hepburn (Hepburn Springs) was an early squatter who overlanded along the Murray River with Joseph Hawdon; Sutton (Sutton Spring) was an early Cornish prospector.

On public land, most of the springs have been made more accessible by the installation of hand pumps, or concrete pits where one or more springs are concentrated. Some, such as the Hepburn Springs and Central Springs, were in use last century when spa resorts, after the fashion of those in Europe, became popular.

Commercial production of mineral water in Victoria has increased considerably in recent years; all of it, under a total of 14 licences at present, comes from the study area. Of the four commercial sites on public land, the waters from two, Glenlyon and Bullarto, are bottled off-site, mostly in Melbourne. The waters from Daylesford (Table Hill) and Kyneton are prepared in bottling plants at the site.

During 1981/82 some 25 million litres were removed commercially. Recent pump tests of bores, carried out by the Department of Minerals and Energy, concluded that total yields would approach a litre per second. It was estimated that, for natural recharge to adequately replenish the aquifer, extraction would have to be limited to 89,000 litres per day.

The Hepburn Springs area, for instance, is very sensitive to prolonged pumping from bores and there is a risk of permanent damage to the resource. It is also possible that pollution from effluent could be drawn down into the groundwater system.

Some of the money collected as a surcharge on commercial production of mineral water is used to finance the upgrading of some of the old spa facilities. The bath house at Hepburn, for instance, is to be extensively renovated and proposals are being considered for the establishment of a spa therapy centre incorporating the bath house.

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7. VEGETATION

The previous descriptive report for the Melbourne area discussed the biogeography and nature of the vegetation on public land in some detail. In that report, vegetation was classified and mapped by a number of structural forms that were based on the height and form of the tallest stratum and on the percentage of projected foliage cover. That classification, used again in Table 8, is a modification of the one developed by Specht.

While the previous report gave a brief list of the understorey species occurring in association with each structural form, it did not group the vegetation into communities.

In order to add to the information about plant communities for the current review, and to identify occurrences of plant species with particular botanical significance, the Land Conservation Council commissioned an investigation of the vegetation of the study area. This was carried out by a botanical consultant, Mr D. Frood. Mr Frood has refined the information previously available and has provided a more comprehensive description of vegetation, including information about the location of specific species and the grouping of species into plant communities.

The system of classifying vegetation by structural form is one that is readily recognizable in the field, and it has been retained for the current report. Map 7 depicts the distribution of vegetation on public land by the major species comprising the tallest stratum. The scale of mapping used (1:250,000) has necessitated some approximations. The Council holds a set of maps showing the vegetation units at a scale of 1:100,000, and these are available for inspection at the Council's offices.

Based on information provided by the consultant, this report comprises three sections: the first describes the components of the major vegetation units shown on Map 7; the second section describes the understorey components and their relations with the overstorey; and the third indicates those species of particular botanical significance. The bulk of the third section is included in Appendix V.

Vegetation Units - Based on Major Species of Tallest Stratum

Units 1a--1b

A complex range of open forest I types with a crown height of less than 15 m occurs on sites where soil moisture availability is low. To the north and west of Melbourne these types grow on sodic duplex soils where rainfall is less than 700 mm annually. The tallest stratum is variable in composition, and can include a wide range of eucalypts. On poorer

Table 8

Structural Forms of Vegetation
[Modified from Specht (1970)]

Form and height of tallest stratum*	Projective foliage cover of tallest stratum			
	Dense (70--100%)	Mid dense (30--70%)	Sparse (10--30%)	Very sparse (<10%)
Trees**				
>40 m		Open forest IV		
20--40m		Open forest III	Woodland III	Open woodland III
15--28m	Closed forest	Open forest II	Woodland II	Open woodland II
5--15m	Closed forest	Open forest I	Woodland I	Open woodland I
Shrubs**				
2--8m	Closed scrub	Open scrub	Tall scrubland	Tall open shrubland
0--2m	Closed heath	Open heath	Low scrubland	Low open shrubland
Herbs, including grasses, moss, ferns, lichens	Closed herbland, including closed: tussock grassland; grassland; herbfield; sedgeland	Herbland, including: tussock grassland; grassland; herbfield; sedgeland		

Notes:

* Isolated trees (emergents) may project from the canopy of some communities. Heights are of mature communities.

** A tree is defined as a woody plant more than 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.

sites (such as steep ridge slopes), open forest I grades into woodland. Understoreys range from tussock grassland to variously heathy or shrubby, and can be very sparse on poor sites.

Unit 1a

Red stringybark--long-leaf box--red box open forest I to woodland I represents the drier end of the range of open forest I types. Eucalypt associations variously dominated by combinations of these species are widespread on both sides of the Great Dividing Range at elevations below 600 m. Red stringybark (*Eucalyptus macrorhyncha*) is prominent at elevations of less than 600 m, forming mixtures with long-leaf

box (*E. goniocalyx*) and red box (*E. polyanthemos*) on progressively drier sites. Red box associations may grade into a low woodland of yellow gum (*E. leucoxylon*), such as at the southern end of the Lerderderg Range. In moister, more fertile sites canopy height increases, and species such as yellow box (*E. melliodora*) and broad-leaf peppermint (*E. dives*) occur. Delineation of boundaries to these complexes is difficult.

Open forest of red stringybark and red box - map unit 1a - Fryers Ridge

Other associated overstorey species include red ironbark (*E. sideroxylon*), yellow gum, brown stringybark (*E. baxteri*), scent-bark (*E. aromaphloia*), and silvertop (*E. sieberi*) at the western limit of its distribution in the Pyrete Range. Species such as messmate stringybark (*E. obliqua*) and swamp gum (*E. ovata*) are mostly restricted to moister sites, such as drainage lines, within this open forest I complex.

Unit 1b

Broad-leaf peppermint--red stringybark or long-leaf box open forest I represents the moister range of these open forest I types. Its main occurrences (dominated by broad-leaf peppermint, often in mixture with red stringybark and/or long-leaf box) occupy crests and drier ridges in comparatively higher-rainfall areas (for example, Lerderderg--Wombat forests, Mount Charlie, Brisbane Ranges). Associated species include candlebark gum (*E. rubida*), messmate stringybark, and brown stringybark.

Unit 2a

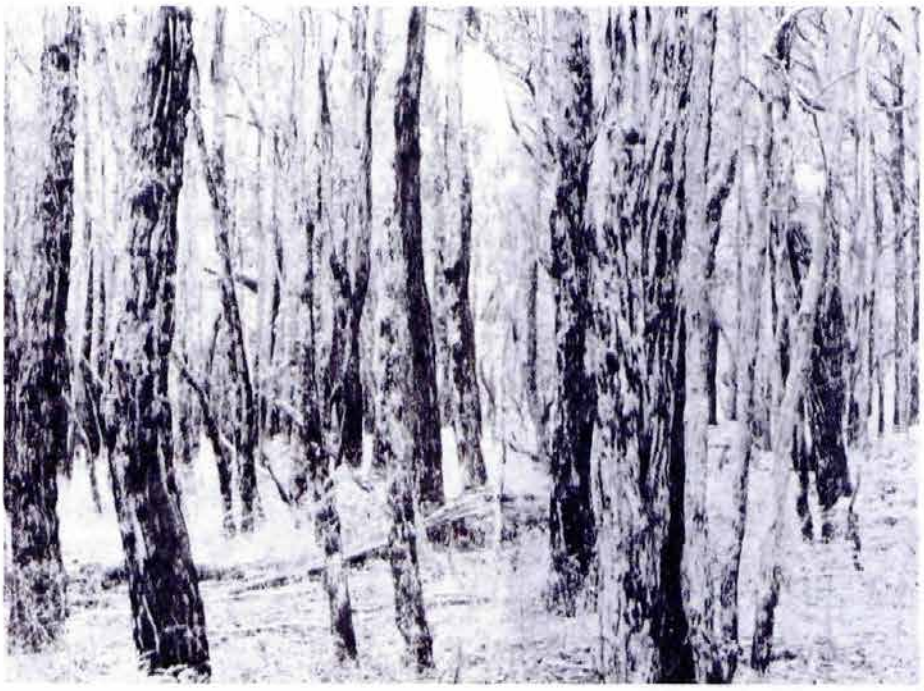
Red stringybark--long-leaf box--yellow box--red box open forest II (grading into woodland II), dominated by various mixtures including a range of associations of these species grows on those sites with more favourable soil fertility or moisture, particularly in valleys and on lower slopes. This unit represents the extension of unit 1a into such sites, and occurs within the Brisbane Ranges, near Moranding, and

the Wombat--Loddon forests. It grades into woodlands such as yellow gum--yellow box and narrow-leaf peppermint--candlebark on the more fertile areas, which are now used for agriculture.

Composition of the tallest strata is highly variable and associated species include broad-leaf peppermint, manna gum (*E. viminalis*), messmate stringybark, red ironbark, yellow gum, candlebark, and narrow-leaf peppermint (*E. radiata*), with swamp gum along some drainage lines. An association of red stringybark, blue gum (*E. globulus* ssp. *pseudoglobulus*), and red box occurring on the lower slopes of the Lerderderg Gorge is also included in this unit. Understoreys are typically tussock grassland, with a variable shrub component (notably *Acacia* spp.).

Unit 2b

Messmate stringybark forms an open forest II - varying to open forest I or III - and, rarely woodland I--II. It occurs in varying degrees of association with a range of other eucalypt species in forests of top height between 15 and 28 m. The habitat of each forest is typically hilly country below 600 m elevation, with rainfall between 700 and 1,000 mm, and generally on yellowish gradational soils. Distribution includes the Wombat--Loddon forests, Brisbane Ranges, Cobaws, Mount Charlie, Mount Macedon, and the Lal Lal and Bungal forests. Small pockets of related vegetation also occur in sheltered sites amid drier forest types such as at Mount Piper, and the Werribee Gorge. A related set of overstorey types in the eastern Otway Ranges is discussed separately (units 2c and 2d).



Messmate stringybark, map unit 2b, Cobaw Ranges

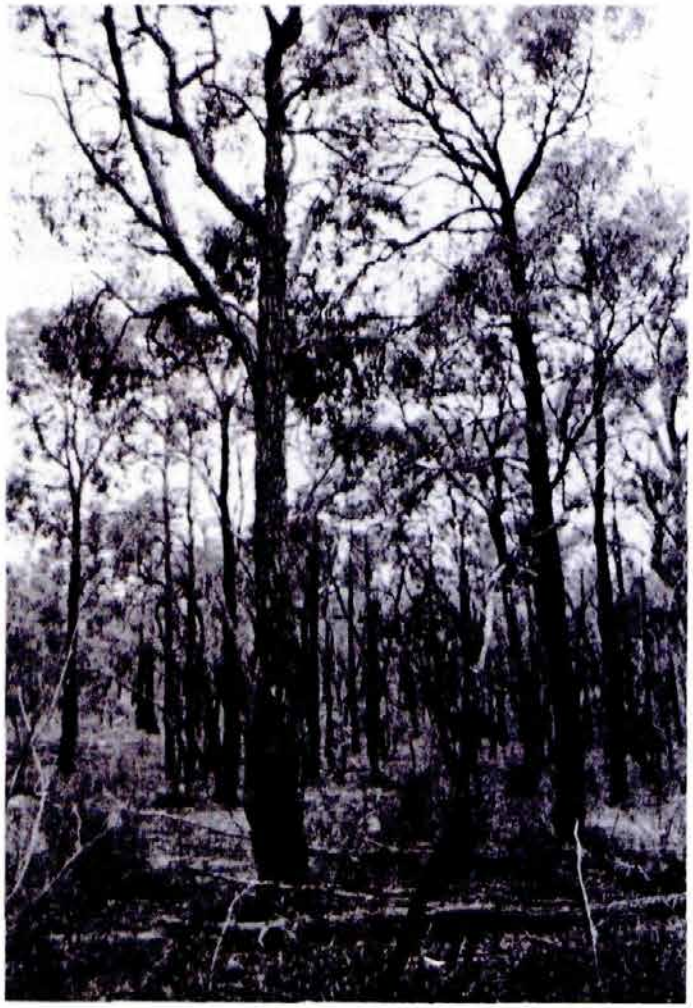
Major associations of messmate stringybark in open forest II formation occur with manna gum, narrow-leaf peppermint, broad-leaf peppermint, and brown stringybark. Other associated eucalypt species include long-leaf box, scent-bark, red ironbark, candlebark, and red stringybark.

The messmate stringybark--manna gum association is characteristic of moister forests (and sometimes sandier soils), and includes areas of swamp gum--manna gum associations on wet flats. The messmate stringybark--broad-leaf peppermint association is characteristic of relatively dry sites. Distribution of narrow-leaf peppermint is complex - and related to soil moisture and fertility factors. Brown stringybark can be conspicuous on lighter soils. Understorey character ranges from open tussock grassland to variously heathy or shrubby.

Units 2c--2d

Messmate stringybark--blue gum--red ironbark--shining peppermint open forest II - ranging from I to III - occurs in the eastern Otway Ranges. Under conditions of higher elevation and rainfall, gradational soils support an open forest II or III, dominated by messmate stringybark and blue gum (*E. globulus* ssp. *bicostata*).

Associated species include narrow-leaf peppermint and mountain grey gum (*E. cypellocarpa*) on the higher-altitude and higher-rainfall sites, and also shining peppermint (*E. nitida*). On less favourable sites, forest height decreases and messmate stringybark, blue gum, and/or shining peppermint variously dominate. At lower altitudes, red ironbark also occurs, becoming a local dominant in the rain-shadow areas close to the coast from near Lorne to Point Addis. In



Red ironbark becomes a local dominant - in the rain-shadow area near Point Addis

harsh sites, stunted red ironbark and blue gum extend into open forest I formation.

At the eastern edge of the distribution of this vegetation complex, an open forest II, which includes messmate stringybark, brown stringybark, red ironbark, and shining peppermint associations, occurs on gradational and duplex soils developed on Tertiary sediment, and grades into heathy woodland (unit 7).

Manna gum and swamp gum can occur near drainage lines within this complex. Understoreys are variously grassy to heathy, and can also include small areas of wet sclerophyll shrubland.

Unit 3

Messmate stringybark--narrow-leaf peppermint and manna gum open forest III with crown height between 28 and 40 m occurs on the ranges of the study area where rainfall approaches 1,000 mm or more, typically on yellowish to reddish gradational soils (Wombat Forest, Mount Macedon, Cobaws, and Mount Charlie).

Major species of the tallest stratum is messmate stringybark, with narrow-leaf peppermint and/or manna gum variously present and becoming dominant in certain habitats (as on riparian alluvium). Associated species include mountain grey gum, blue gum (*E. globulus* ssp. *pseudoglobulus*), candlebark, and broad-leaf peppermint.

On drier sites, these overstorey types grade into those categorized as unit 2b. Understoreys range from ferny wet sclerophyll shrubland, or layered with small trees, to tussock grassland, which can be variously shrubby or sedgy.

Units 4a and 4b

Alpine ash (unit 4a) and mountain ash (unit 4b) open forest IV is restricted in this study district to Mount Macedon at elevations above 950 m. Alpine ash (*E. delegatensis*) and mountain ash (*E. regnans*) have separate occurrences below snow gum (*E. pauciflora*) open forest I on southerly aspects. The open forest IV comprises a succession from alpine ash to messmate stringybark interspersed with pure pockets of mountain ash in the moister gullies.

Rainfall here exceeds 1,050 mm, and soils are deep loams developed on acid volcanic rocks. Understoreys are shrubby to ferny (gully vegetation).

Unit 5

Snow gum open forest I to woodland I has restricted occurrences in the study district at Mount Macedon at an elevation above 1,000 m. Rainfall here exceeds 1,200 mm annually, with irregular winter snow-falls that seldom persist. Mild summers, cold winters, and strong winds characterize the climate. Understoreys are tussock grassland, with a variable herbaceous to shrubby component.

Woodlands

A range of types of woodland with an open or grassy understorey formerly occurred in areas with an annual rainfall of less than 600 mm. These have been mostly cleared for agriculture, and only remnants persist in the study district.

The natural grassy ground layer has usually been grossly altered by such factors as addition of fertilizers, grazing by domestic animals, soil disturbances such as ploughing, and invasion by exotic plants, in particular annual grasses.

Unit 6a

Manna gum woodland I--II occurs on sandsheets in the region of Inverleigh and Bannockburn, and also in parts of the Brisbane Ranges, where it grades into open forest I--II formation. At the former localities, small areas of river red gum (*E. camaldulensis*) are interspersed with manna gum on the wetter sites.

River red gum woodland (map unit 6a) Bannockburn

In the Brisbane Ranges snow gum and swamp gum occur with manna gum on yellow solodic soils near Durdidwarrah, with small pure stands of manna gum on drier sites (for example, sandy soils of lunettes and outlying granitic areas).

Unit 6b

Examples of yellow gum--yellow box woodland I--II were formerly widespread in lower-rainfall areas, characteristically on duplex soils. They are now mostly confined to scattered relics on the roadsides and margins of tracts of drier mixed-species open forest (such as in the Brisbane Ranges, Werribee Gorge, and the forests in the Loddon basin). Near Bannockburn, a relic area of yellow gum woodland occurs adjacent to manna gum woodland. In the You Yangs, yellow gum woodland occurs in granitic outcrop habitat, formerly merging into river red gum on the surrounding plains.

Yellow gum (map unit 6b) - Mangalore

Unit 6c

Woodlands I--II of grey box (*E. microcarpa*), in association with yellow box and merging into river red gum on the wetter sites, once occupied the more fertile sodic duplex soils of the lower valley slopes in the northern part of the study district. Only scattered minor occurrences remain (such as near Tooboorac and west of Mangalore), usually on the margins of tracts of other forest types.

South of the Dividing Range, grey box occurs in the region of Bacchus Marsh. At Coimadai, relic stands of this species grow in complex with bull mallee (*E. behriana*) stands, and associated with yellow box, yellow gum, and long-leaf box. Blue box (*E. bauerana*) has restricted representation in this area. Small stands of grey box also occur at Gellibrand Hill and, with long-leaf box, at Werribee Gorge.

Unit 6d

Formerly widespread across the volcanic plains north and west of Melbourne and along valleys in drier parts of the study area, public land examples of river red gum woodland I--II and grassland are now restricted to scattered disturbed relics (such as near Tooboorac, Goulburn River, and Gellibrand Hill), often along narrow streamside reserves.

Soils that supported this vegetation include grey loams, grey and black clays, and sodic duplex types. On the grassy volcanic plains, river red gum woodland of varying stature apparently graded into extensive tracts of open grassland. Small trees of *Acacia* species, especially blackwood (*A. melanoxylon*) and black wattle (*A. mearnsii*), and honeysuckle (*Banksia marginata*) and she-oak (*Casuarina* spp.), also occurred in woodland formations.

Relatively intact examples of these grassy herb-rich vegetation types are now effectively restricted to narrow railway reserves. An isolated remnant of kangaroo grass (*Themeda* sp.) grassland grows on public land near Laverton, on

reddish calcareous duplex soils receiving about 500 mm of rain annually.

Woodlands of river red gum graded into grassland or a wide range of other woodland types such as yellow gum, grey box, yellow box, manna gum, or swamp gum depending upon soil and moisture factors. In favourable conditions, such as sites along the Goulburn River, it would have attained open forest or woodland III structure, in mixture with yellow box and grey box.

Unit 7

In the eastern Otways, a complex of heathy low open forest to woodland or heath and shrubland occurs on very infertile sandy soils, often with an impeding horizon that causes waterlogging in winter and drought in summer. It comprises brown stringybark--shining peppermint--messmate stringybark heathy woodland I to open forest I. In extremely waterlogged or infertile soils, eucalypts may be absent or restricted to isolated shrubs (especially in the cases of swamp gum around some wet heaths and shining peppermint). The lower strata are heathy and characteristically highly species-rich.

Unit 8a

Substantial tracts of treeless (or nearly so) heath or shrubland are restricted primarily to the Otway region. The floristics are often very diverse, with a range of heathy shrub and sedge species present. Major species include tea-trees (*Leptospermum* spp.), a wide range of peas (such as *Dillwynia* spp., *Pultenaea* spp., and *Platylobium* spp.), members of the Proteaceae (*Hakea* spp., *Isopogon* spp.), guinea flowers (*Hibbertia* spp.), rushes and sedges (such as *Hypolaena fastigiata*, *Lepidosperma* spp.) and dwarf she-oak (*Casuarina pusilla*). An extremely rich orchid flora is also present.

The wetter sites of the Anglesea River catchment support an extensive tract of scented paperbark (*Melaleuca squarrosa*) shrubland with a diverse range of associated species, including various sedges (such as *Gahnia* spp.), tea-trees, pink swamp heath (*Sprengelia incarnata*) and coral fern (*Gleichenia* spp.).

Unit 8b

Heathland or shrubland outcrop vegetation has its only major occurrences on granitic outcrops within yellow gum woodland in the You Yangs. Major shrub species include snowy mint-bush (*Prostanthera nivea*), black wattle, and hop bush (*Dodonaea cuneata*). A range of herbaceous species also occurs. Boneseed (*Chrysanthemoides monilifera*) has become an established weed in this vegetation type and is locally dominant over much of the outcrop vegetation.

Unit 9a

Low-lying areas of the coast (near Point Wilson, Point Lonsdale, and Lake Connewarre) carry a wet coastal complex

vegetation on saline soils, often with sharp zonal boundaries between structural forms and plant assemblages. Main factors influencing the zoning are tide levels (or water levels around saline lake margins), soil salinity, and site wetness. Within the study area (for example, in the Barwon River estuary) - white mangrove (*Avicennia marina*) has restricted distribution at the low-tide position.

More widespread is a shrubland sequence of glassworts (*Halosarcia* spp. and *Sclerostegia arbuscula*); herbfields including pigface (*Disphyma* spp.), beaded glasswort (*Sarcocornia* spp.), *Wilsonia* spp., brook-weed (*Samolus repens*), and swamp-weed (*Selliera radicans*); and grassland and sedgelands (with a range of dominant species). At Lake Connewarre, estuarine conditions create a diverse range of communities (tolerant of various salinity levels and degrees of inundation) that is not replicated elsewhere.

Unit 9b

This vegetation type (dry coastal complex) occurs on leached sands and calcareous sands along much of the coast of the study district. Well-marked zones characterized by particular structural forms and plant assemblages spread progressively from the high-tide level inland.

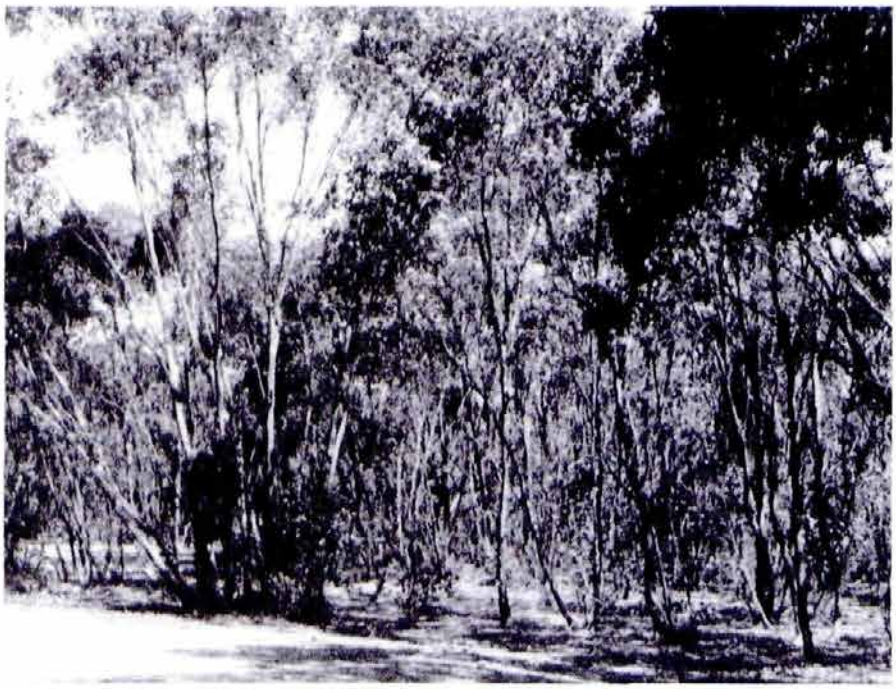
These zones resulted from the variation in degree of exposure to salt-laden winds and from the range of soil moisture conditions and soil salinity. Grassland (major species being *Spinifex hirsutus*, *Ammophila arenaria*, *Poa poiformis* and *Stipa* spp.) is found on the most exposed situations, such as on the frontal dune. The secondary dunes often support scrubs or shrubland depending on exposure, while the sheltered interdune areas support shrubs or woodland.

Major shrub or small tree species include:

coast beard-heath	*Leucopogon parviflorus*
coast daisy-bush	*Olearia axillaris*
coast everlasting	*Helichrysum paralium*
coast tea-tree	*Leoptospermum laevigatum*
cushion bush	*Calocephalus brownii*
moonah	*Melaleuca lanceolata*
sweet bursaria	*Bursaria spinosa*
seaberry salt-bush	*Rhagodia baccata*
white correa	*Correa alba*

Unit 10

The only example, south of the Dividing Range, of vegetation dominated by bull mallee occupies an area of about 800 ha near Melton. Here, this mallee and an associated shrubby sparse to grassy understorey, with a number of species typically found north of the Divide, grow in complex with box eucalypt species on sodic duplex soils receiving about 600 mm of rain annually. Formerly entirely on freehold land,



Bull mallee shrubland (map unit 10) - Long Forest

some 147 ha have been acquired and recently dedicated as the Long Forest Flora and Fauna Reserve.

Units 11a and 11b

Plantations of exotic softwoods (unit 11a) have been established principally at Macedon and near Daylesford, mainly on sites formerly occupied by narrow-leaf peppermint and messmate stringybark open forest III.

The largest hardwood plantation (unit 11b) in the study district is in the You Yangs, where 655 ha have been planted with various species of eucalypts, and a further 92 ha have been established nearby at Bannockburn. These principally use sugar gum (*E. cladocalyx*).

Unit 12

This unit comprises disturbed or altered sites, including other areas where land use has effectively displaced the indigenous plant species, although a sparse component of the more durable native species may persist.

Other vegetation types

Tallest-strata vegetation associations not mapped include small areas of some wetland associates such as sedgelands of *Lepidosperma longitudinale*, in the Brisbane Ranges, and riparian and gorge shrublands (principally as relics on the volcanic plains).

Some of the woodland--open forest types do not adequately describe the range of vegetation that was present at settlement, and roadside or unused road and private land relics of unusual composition may be found - such as candlebark woodland I near the Cobaw Range, snow gum woodland north of Mount Macedon, Murray pine (*Callitris columellaris*) at Werribee Gorge, and an isolated occurrence of silver-leaf

stringybark (*E. cinerea* ssp. *cephalocarpa*) near Mount Charlie.

Grassland complexes formerly widespread on the basalt plains are discussed under woodland units.

Understorey Vegetation

The wide diversity of interrelated floristic structures forming the understorey vegetation of the study area stems from the diversity in environmental conditions. Understorey character ranges from tussock grassland, through grassy and shrubby structures of varying dominance, to heaths or shrublands with few graminoid (grass-like) plants.

Variations in habitat support different suites of herbaceous species that can be highly diverse, particularly in the inter-tussock spaces of grassy understoreys. Most species of fern are restricted to sheltered moist sites such as wet gullies, although bracken can extend into the drier forest types. The degree of ground cover ranges from minimal (on rocky or very dry sites) to complete (closed vegetation). Plant communities in the region form a mosaic that reflects differences in fire and grazing regimes, soil characteristics, and the availability of moisture (which in turn is influenced by such factors as rainfall, aspect, slope, and soil type).

A complete description of all the components of the highly complex understorey vegetation is beyond the scope of this report. The following description covers the more common vegetation units that may be identified in the region. It differentiates the units by species that should be considered only as selected elements of the far more diverse plant associations present. The units tend to be characteristic of certain habitats.

The relation between the understorey units and the overstorey units previously described is shown in Table 9, which also indicates those ground-cover units that form the tallest stratum under certain conditions.

A. Grassy or sedgy understoreys (including grassy components of mixed grassy--shrubby (understoreys)

G1a:

Major (characteristic) species: *Phragmites communis--Juncus* spp./*Typha* spp./*Triglochin procera/Lepidosperma Longitudinale*.

Habitat and distribution: Reed-, rush- and/or sedge-dominated communities of fresh-water wetland, extending to wetter riparian situations. Scattered throughout the study area in swampy habitat, mostly at lower elevations.

Variation: Floristic composition varies with extent and duration of inundation and soil type. A range of aquatic herbaceous species can be present. Intergrades or bounds with various lower-slope units.

Table

OCCURRENCE OF UNDERSTOREY

Understorey units	Overstorey								
	1a	1b	2a	2b	2c	2d	3	4a	4b
Grassy									
G 1a				(X)			(X)		
1b			(X)	X			X		
2a			X	X			(X)		
2b				X		X	X	X	
3a			(X)						
3b	(X)		X	(X)	(X)				
4	X	X	X	X		X			
5a	X	X	X	X	X	X	X		
5b	(X)		X	(X)	X	(X)	(X)		
6		(X)		X		X	X		
7					(X)				
8a									
8b									
8c									
8d									
Shrubby									
S1				(X)		(X)	X	X	X
2	(X)	(X)	X	X	X	X	X		
3a	X		X						
3b			X						
3c	X								
3d									
4a									
4b			(X)	X			X		
5a	X	X	X	X			X		
5b		(X)		(X)	X				
6	X		X	(X)					
7a									
7b									

Key to symbols:

X denotes typical occurrences.
( ) denotes minor or atypical occurrences.

9

UNITS WITH OVERSTOREY UNITS

units											
5	6a	6b	6c	6d	7	8a	8b	9a	9b	10	A
				(X)							X
				(X)							(X)
	X			X							X
					(X)						
	X	X	X	X							X
	(X)	X	(X)	(X)	X						
	X	X	X	X	X					X	
X		(X)	(X)								
					X						
					X	X					
									(a)		X
									X		X
								X			X
								X			X
					(X)						
			X								X
	X			X							X
			X							X	X
		X					(a)				X
											X
						(a)					(X)
(X)			X								
						(a)					X
	X	X	X	X							(X)
								X			X
									X		X

Column 'A' and symbol 'a' refer to those ground-cover units that form the tallest stratum in certain locations.

Grassy understorey of manna gum woodland - Inverleigh

Associated overstorey types: Typically treeless, but extending into habitats occupied by river red gum, swamp gum, or manna gum.

G1b:

Major (characteristic species: *Carex* spp. (principally *C. appressa*).

Habitat and distribution: Sedgy understorey, typically as a riparian zone, extending up minor drainage lines (where *Gahnia* spp. may become prevalent). Widespread within the study area under suitable moisture regimes.

Variation: A range of wetland herbaceous species and riparian shrub species can be present. Boundary with unit G1a can be indefinite.

Associated overstorey types: Overstorey is variable and depends on the forest type the drainage line traverses, which includes narrow treeless bands adjacent to watercourses. Major tree species include swamp gum, manna gum, messmate stringybark, and narrow-leaf peppermint.

G2a:

Major (characteristic) species: *Poa labillardieri*, with species including *Phragmites communis*, *Themeda australis*, *Juncus* spp., and *Amphibromus neesii*.

Habitat and distribution: Tussock to sedgy or reedy ground layer on moist lower slopes and wet flats. Formerly widespread on the better-quality soils - particularly in the

grassland to woodland formations of the plains - but greatly reduced by agriculture.

Variation: Floristics vary with moisture levels, grazing history, and soil type. A range of herbaceous species (such as *Calocephalus lacteus*, *Plantago* spp., and *Senecio* spp.) can be present.

Associated overstorey types: Varying from part of the treeless plain complex, to a range of woodland types (including river red gum and swamp gum, and extending into the overstoreys of unit 2a, with a variable composition of tree species).

G2b:

Major (characteristic) species: *Poa labillardieri--Lepidosperma elatius--Poa tenera*, with species including *Juncus* spp., *Schoenus apogon*, *Carex* spp., *Lomandra longifolia*, and *Tetrarrhena juncea*

Habitat and distribution: Sedgy-tussock understorey of the wet flats in moister forests (mostly drainage lines of the Wombat forest), and extending to sheltered slopes such as in the Otways and at Macedon, but with a simpler floristic composition.

Variation: Shrubs and a range of moist forest herbs can be present as can sphagnum moss at some sites. Floristics vary with the degree of waterlogging, soil fertility, and history of disturbance. Grades into lower-slope understorey types.

Associated overstorey types: Characteristically occurs beneath open forest II or III; the major species being swamp gum, manna gum, narrow-leaf peppermint and messmate stringybark.

G3a:

Major (characteristic) species: *Themeda australis--Poa* spp.*--Danthonia* spp.*--Stipa* spp.

Habitat and distribution: Tussock grassland of fertile soils and mostly of gentler terrain, particularly on the volcanic plains to the north and west of Melbourne. Formerly extensive in grassland to open woodland formation, but now principally restricted to railway reserves and occasional roadsides. Highly vulnerable to disturbance - ultimately being displaced by exotic species, principally annual grasses.

Variation: A wide range of herbaceous species, notably various daisies, is present in relatively undisturbed sites. Shrub content is variable, but sparse. Floristics vary with soil moisture, fire regime, and history of disturbance (particularly grazing by domestic stock).

Associated overstorey types: Ranging from absent to various woodland types (units 6a to 6d, also occasionally unit 2a in higher-rainfall areas).

G3b:

Major (characteristic) species: *Themeda australis--Microlaena stipoides--Poa* spp.

Habitat and distribution: Tussock grassland of fertile soils supporting woodland or open forest types in valleys and on lower slopes. This unit represents the extension of unit G3a into the margins of forest areas. Formerly widespread in hilly areas, but *Themeda* is frequently displaced by grazing.

Variation: Grades into tussock-heathy understoreys of dry forest types. Major herbs include *Senecio* spp. Shrubby species include various acacias (notably *A. dealbata* and *A. pycnantha*). Floristics vary with fertility, moisture, and history of disturbance.

Associated overstorey types: Ranging from various woodland types to low open forest. Major species include yellow gum, yellow box, narrow-leaf peppermint, candlebark, red box, and red-stringybark. (Range of units include 6a to 6d, 2a and 1a.).

G4:

Major (characteristic) species: *Danthonia* spp.--*Poa sieberana/Stipa* spp., with a range of graminoid species including *Poa* spp., *Dichelachne* spp., *Echinopogon ovatus*, *Dianella revoluta*, and *Lomandra* spp.

Habitat and distribution: Tussock grassland component of open forest--woodland units. Occurs in a complex range of habitats; widespread in the study area - from near the coast to inland, typically on well-drained sites intermediate in fertility or moisture availability between sites occupied by units G3a or G3b and unit G5a; also the grazed sites that formerly supported units G3a or G3b.

Variation: Floristics are highly variable across the range of distribution. This unit intergrades with a range of heathy and shrubby communities and related grassy communities. Herbaceous content also highly variable.

Associated overstorey types: Woodlands of the poorer soils and disturbed sites, and ranging to open forest units such as 1a, 1b, 2a, 2b, and 2d.

G5a:

Major (characteristic) species: *Danthonia pallida* or *Poa sieberana*, with range of other graminoid species including *Lomandra* spp., *Lepidosperma* spp., and *Dianella revoluta*.

Habitat and distribution: Tussock grassland or components of grassy--shrubby understoreys, characteristic of dry slopes and ridges throughout the study area.

Variation: Floristics are highly variable. This unit intergrades with a range of heathy or shrubby communities.

Associated overstorey types: Typically drier open forest (units 1a--b, 2a--d, and marginal sites like unit 6c).

G5b:

Major (characteristic) species: *Gahnia* spp.--*Danthonia* spp. or *Poa* spp.

Habitat and distribution: Tussocky or sedgy understorey of open forest types. Related to unit G5a, but apparently occurring on sites where soil moisture is higher; also related to soil type. Similar range to unit G5a, but less common (found in the Otways and parts of the Loddon forest).

Variation: As for unit G5a.

Associated overstorey types: Variable, most conspicuous with units 2a and 2c.

G6:

Major (characteristic) species: *Tetrarrhena juncea* and including *Danthonia* spp., *Dichelachne* spp., *Poa* spp., *Gahnia* spp., and *Lepidosperma elatius*.

Habitat and distribution: 'Wire-grass'-dominated understorey component of open forests, prevalent in highland areas (such as the Wombat forest and the Otways).

Variation: Grades into heathy or shrubby communities of the moister forest types. Floristics and dominance of *Tetrarrhena* communities related to soil moisture and infertility, fire regime, and macropod grazing pressure.

Associated overstorey types: Mostly units 2b, 2d, and 3.

Grassy understorey (G4) of red stringybark--red box open forest I

G7:

Major (characteristic) species: *Hypolaena fastigiata*, *Empodisma minus*, and *Gahnia* spp. or *Lepidosperma* spp. (including the grasses *Stipa* spp., *Danthonia* spp., and *Themeda australis*).

Habitat and distribution: Graminoid component of near-coastal heathland, largely on infertile Tertiary sands.

Variation: Grass-species content sparse except in relatively high-fertility conditions. Typically dominated by sedges and low sclerophyllous shrubs (units 5c and 4a).

Associated overstorey types: Units 7, 8a.

G8a:

Major (characteristic) species: *Spinifex hirsutus*--*Ammophila arenaria* (an introduced species).

Habitat and distribution: Primary colonizing species in sandy coastal habitats (on the foredune). Part of the dry coastal complex (see unit 9b).

G8b:

Major (characteristic) species: *Poa poiformis* or *Stipa stipoides*.

Habitat and distribution: Coastal tussock grassland of relatively stable but exposed sites such as cliff-tops. Part of the dry coastal complex, and intermixes with a range of shrubby communities of this unit (see unit 9b).

G8c:

Salt-marsh grassland or herbfield components: Major graminoid species include *Distichlis distichophylla*, *Sporobolus virginicus*, *Scirpus* spp., *Schoenus* spp., *Puccinellia stricta*, *Triglochin* spp., *Juncus* spp., *Leptocarpus tenax*, and *Stipa stipoides*.

Habitat and distribution: Components of a group of communities forming the wet coastal complex (see unit 9c).

G8d:

Estuarine wetland components: Major graminoid species include *Eleocharis* spp., *Schoenus* spp., *Scirpus* spp., *Phragmites communis*, and *Poa labillardieri*.

Habitat and distribution: Complex range of communities of estuarine conditions, primarily within the Barwon River estuary (Reedy Lake). Mapped within unit 9c.

G8e:

Sea-grass communities: *Heterozostera tasmanica*, *Posidonia australis*, and *Halophila ovalis*.

Habitat and distribution: Marine; intertidal mud flats or subtidal zones of the coastal strip.

G9:

Exotic species: Various exotic grasses, predominantly annual pasture species, have invaded or displaced indigenous vegetation within the study area. Major genera include *Bromus*, *Avena*, *Hordeum*, *Anthoxanthum*, *Polypogon*, *Agrostis*, *Vulpia*, *Stenotaphrum*, *Phalaris*, and *Ehrharta*. Other major exotic graminoid weeds include *Juncus acutus*, *Asphodelus fistulosus*, and *Romulea* spp.

B. Shrubby understoreys (including the shrubby components of mixed grassy--shrubby understoreys)

S1:

Major (characteristic) species: *Olearia argophylla* or *Pomaderris aspera--Acacia melanoxylon*, with various associated species including *Hedycarya angustifolia*, *Coprosma quadrifida*, *Polyscias* (*Tieghemenopanax*) *sambucifolius*, *Prostanthera lasianthos*, *Correa lawrenciana*, *Olearia* spp., and *Tasmannia* (*Drimys*) *lanceolata*.

Habitat and distribution: Wet sclerophyll forest; tall shrubby or small tree understorey of high-rainfall sheltered sites or gullies; sometimes riparian pockets in sheltered sites - such as gorges in somewhat lower-rainfall areas. Occurs in suitable habitat at Mt Macedon, in the Wombat--Lerderderg forests, and the Otway Ranges, with small pockets of comparable (but species-poor) vegetation in the more favourable sites of the Brisbane Ranges.

Variation: Floristic composition and diversity varies with site quality and with the reliability of moisture and degree of protection. In the more favourable sites, a number of moss and fern species may be present; the ferns may include *Cyathea australis*, *Dicksonia antarctica*, *Blechnum* spp., and *Polystichum proliferum*. Often restricted to narrow riparian bands, and grading into various shrubby or tussock understoreys.

Associated overstorey types: Units 3 and 4, marginal pockets within units 2a and 2b.

S2:

Major (characteristic) species: *Acacia* spp. in variable complexes with *Cassinia* spp., or *Helichrysum dendroideum*, or *Olearia* spp.--*Pultenaea* spp., or *Daviesia* spp.

Habitat and distribution: Relatively moist sites in dry sclerophyll forests and sheltered valleys; although somewhat more exposed or drier than the preceding unit. Covers a wide range of communities occurring on moist sites of the hilly country across the study area.

Variation: Typically shrubby communities of varying density - associated with a tussocky ground layer (*Danthonia* or *Poa*

spp.). Some characteristic species within various locations are as follows.

* Wombat forest: with *Acacia mucronata*, *A. verticillata*, or *A. dealbata*, according to habitat.
* Loddon forest: with individual species or combinations of *A. rhetinodes*, *A. stricta*, *A. dealbata*, *A. pycnantha*, and *A. mearnsii*.
* Brisbane Ranges: *A. dealbata*, *A. mearnsii*, *A. pycnantha*, and various other *Acacia* spp.
* Otways: *A. verniciflua* or other *Acacia* spp.--*Pultenaea daphnoides*--*Helichrysum dendroideum*.
* Macedon: *A. nano-dealbata* and various other associated shrubs.

Overstorey types: Typically units 2a, 2b or 3.

S3a and S3b:

Major (characteristic) species: Include *Bursaria spinosa*--*Cassinia* spp.; *Helichrysum* spp., *Acacia* spp., *Hymenanthera dentata*, *Callistemon paludosus* (in 3b), *Dodonaea* spp., *Leptospermum* spp., *Pomaderris* spp., and *Myoporum viscosum*.

Habitat and distribution: 3a: gorge or ridge outcrop shrubland complexes, scattered especially in the volcanic plains area where suitable habitat occurs (such as Jackson Creek and the Leigh, Moorabool, Werribee, and Lerderderg River gorges). 3b: riparian - scattered along watercourses.

Variation: The vegetation of these habitats occurs as related transitional communities, varying primarily according to moisture gradients and bedrock type (and hence also related to degree of soil development and exposure). A number of species of limited distribution within the study area are present in these habitats. Tussocky grasses, and herbaceous species, are variously present.

Overstorey types: Variable according to the habitat, and range from absent to open forest (units 1a, 2a) and extend into woodland types (units 6a, 6b, 6d).

S3c:

Major (characteristic) species: *Enchylaena tomentosa*--*Rhagodia parabolica*, with various other members of the saltbush family and *Acacia* spp. (*A. rotundifolia*, *A. verniciflua*, *A. implexa*, and *A. armata*).

Habitat and distribution: Dry gorge or shrubland communities of the Bacchus Marsh district, including parts of the Keilor Plains, Coimadai, and the lower Lerderderg River gorge area.

Variation: Comments as for units S3a and S3b.

Overstorey types: Range from the drier extremes of unit 1a, to units 6b, 6c, and 10, or virtually treeless.

S3d:

Major (characteristic) species: *Prostanthera nivea--Acacia mearnsii*, with *Dodonaea cuneata*, *Solanum laciniatum*, *Casuarina stricta*, *Bursaria spinosa*, *Hymenanthera dentata*, *Correa glabra*, *Acacia implexa*, *Cassinia longifolia*.

Habitat and distribution: Granitic outcrops of the You Yangs (see unit 8b).

Variation: Ranging from woodland understorey to scrub or shrubland with sparse emergents (including yellow gum, manna gum, and red box, with red stringybark, eurabbie, red ironbark, and long-leaf box on steep rocky declivities and among boulders). The introduced South African boneseed has invaded the bulk of this vegetation type. The herbaceous layer includes a range of grasses, orchids, austral tobacco, rock fern, and several small saltbush species. While the You Yangs support the only major occurrence of this vegetation type in the study area, some vegetation of gorge habitats may locally approach comparable floristic composition.

S4a:

Major (characteristic) species: *Melaleuca squarrosa* with a range of other shrub species, including *Leptospermum juniperinum*, *Sprengelia incarnata*, and *Goodenia ovata*.

Habitat and distribution: Wet heath scrub of the eastern Otway Ranges (wet flats in the catchment of the Anglesea River); see unit 8a.

Variation: A floristic gradation occurs from the coast inland, reflecting varying salinity levels and local soil moisture.

S4b:

Major (characteristic) species: *Leptospermum juniperinum*, with *Hakea* spp., *Acacia* spp. (particularly *A. verticillata*), and other *Leptospermum* spp.

Habitat and distribution: Wet heath of drainage lines, moist flats, and seepage areas, notably within the open forest of the ranges such as the Brisbane Ranges and Wombat forest.

Variation: Floristics vary with soil moisture and nutrient status and can grade into or form a mosaic with grassy or sedgy understorey types of wet flats, and the grassy or shrubby understorey types of adjacent slopes.

Associated overstorey types: Various open forest units (particularly 2b and 3).

S5a:

Major (characteristic) species: A diverse range of heathy shrubs, including various epacrids (*Brachyloma daphnoides*, *Epacris impressa*, *Lissanthe strigosa*, *Monotoca scoparia*,

Grass-tree and tussock grassland under red stringybark open forest I

Astroloma humifusum, *Acrotriche serrulata*, and *Leucopogon* spp.), peas (*Daviesia* spp., *Dillwynia* spp., *Pultenaea* spp. - notably *P. gunnii*, *Platylobium* spp., *Bossiaea* spp., and *Oxylobium procumbens*), *Grevillea* spp., *Hakea sericea*, and *Acacia* spp. Grass-tree (*Xanthorrhoea australis*) can often be a major component. In drier parts of the study area, such as the Loddon forest, *Cassinia arcuata* can become dominant, particularly after disturbance.

Habitat and distribution: A highly variable and very diverse complex of related dry sclerophyll forest understorey types of the ridges and slopes - found throughout the study area, such as in the Loddon--Wombat--Lerderderg forests, Brisbane Ranges, Macedon Ranges, Pyrete Range, Mount Piper, and near Moranding.

Variation: Mostly associated with a tussock ground layer of *Danthonia pallida* or *Poa sieberana*. The balance of the heathy or grassy composition varies with site factors, including the fire regime. The range of species represents the localized interaction of the many factors influencing soil moisture and fertility (rainfall, aspect, fire history, rock type, and so on). Delineation of discrete associations of this habitat is difficult. Further definition is provided in the consultant's report.

S5b:

Major (characteristic) species: A diverse range of heathy shrubs, including *Leptospermum* spp., various peas and epacrids, *Hibbertia* spp., *Isopogon ceratophyllus*, *Casuarina pusilla*, and austral grass-tree (*Xanthorrhoea australis*).

Habitat, distribution, and variation: A range of heathy vegetation types of the western Otway Ranges. Sedges

(*Lepidosperma* spp., *Gahnia radula*) and rape-rush (*Hypolaena fastigiata*) can be conspicuous. See unit 8a.

Soil parent material is an important determinant of floristics. Related (but discrete) understorey types occur on the Brisbane Ranges.

S6:

Major (characteristic) species: *Acacia* spp. (notably *A. pycnantha*, *A. verniciflua*, *A. implexa*, *A. armata*, and *A. acinacea*).

Habitat and distribution: A shrubby component of grassy woodland types, particularly on plains and margins of drier open forests; formerly widespread in areas now largely cleared for agriculture.

Variation: In addition to a variable strata of *Acacia* spp., a range of other shrub species appear to have been components of the grassy woodland--grassland units. These included species of *Grevillea*, *Daviesia*, *Dillwynia*, *Pultenaea*, *Pimelia*, and *Eutaxia*. *Cassinia arcuata* can be prevalent in grey box--yellow gum woodlands, particularly after disturbance. The floristic composition of the shrubby components of woodlands reflects fire and grazing history and moisture levels; it also varies with rainfall and soil type.

Associated overstorey types: units 6a, 6b, 6c, and 6d.

S7a:

Shrubby components of the wet coastal complex (see unit 9a)

* *Avicennia marina*: mangrove community

* *Sclerostegia arbuscula--Halosarcia pergranulata--H. halocnemoides*: salt-marsh, shrubby 'glasswort' communities - the dominant species reflecting site moisture and salinity levels, *H. halocnemoides* being characteristic of the drier sites. These occur as zonal communities bounded by herbfield or grassland, where major genera may be *Sarcocornia*, *Samolus*, *Selliera*, *Wilsonia*, *Distichlis*, *Stipa*, or *Puccinellia*.

* *Muehlenbeckia cunninghamii*: lignum swamp--brackish sites; the inland edge of salt-marshes and some drainage lines of the western plains, but now of very restricted distribution.

S7b:

Shrubby communities of the dry coastal complex (see unit 9b)

* *Leptospermum laevigatum--Leucopogon parviflorus--Melaleuca lanceolata*, with other species including *Bursaria spinosa*, *Acacia retinodes*, and *Casuarina stricta*: woodland to shrubland of the less-exposed coastal sites. *M. lanceolata* also formerly occurred as shrubland on the

boundaries of some of the wet coastal sites, and graded into one or other of the next two communities.

* *L. laevigatum--L. parviflorus*, with other species including *Olearia axillaris* and *Acacia longifolia* var. *sophorae:* dry coastal heath of shrubland; especially on exposed dunes.

* *Calocephalus brownii*, with *Helichrysum paralium*, *Correa alba*, and a range of other coastal shrub species: exposed sites, notably cliff habitat.

* *Atriplex cinerea* and *A. paludosa* occur over relatively small areas in strand or levee communities.

Wet coastal complex (map unit 9a-S7a) on the left and, above, dry coastal shrubland (map unit 9b)

S8:

Exotic species: Various exotic shrub species are established within the study area, and may dominate disturbed sites. Major species include: boneseed (*Chrysanthemoides monilifera*) on coastal and outcrop habitat; myrtle-leaf milkwort (*Polygala myrtifolia*) on coastal sands; gorse (*Ulex europaeus*); brooms (*Genista* spp. and *Sarothamnus scoparius*); box-thorn (*Lycium* spp.); and briar (*Rosa rubiginosa*) widespread.

C. Other Components of Understorey Vegetation

Xeric graminoids: The austral grass-tree (*Xanthorrhoea australis*) is a major species of dry ridges across the study area, often in association with *Danthonia pallida* forming heathy understoreys to dry open forest.

Herbaceous: A rich herbaceous flora occurs within the study area; distinctive groups of species characterize the following habitats, with floristic variation across the area:

* wetland (including seasonally inundated flats); floristics alter with salinity and extent of inundation
* grassland to grassy woodland
* dry forest (grassy or shrubby understoreys)
* moist forest
* wet forest or gully
* outcrop, gorge, riparian
* coastal communities
* disturbed sites - exotic species

Ferny: Ferns can be conspicuous in the following habitats:

* wet gully: diversity and abundance are related to available moisture and shelter (see unit S1)
* sheltered gorge to rocky crevice habitat: the range of species here may include *Asplenium flabelliforme*, *Pellaea falcata*, *Doodia* spp., *Adiantum aethiopicum*, and *Cheilanthes* sp., *Cheilanthes* can extend into shallow soils of drier open forest to woodland
* lower slopes to moist forest: in sites that are relatively sheltered but too dry for gully species, ground ferns (*Pteridium esculentum* and *Culcita dubia*) can be locally dominant; maidenhair (*Adiantum aethiopicum*) can be common in the moister sheltered sites within dry forest types
* bracken (*Pteridium*): this has a wide ecological range, and can be locally important in the ground layer of many communities; its abundance can reflect fire frequency
* wet heath: a distinctive group of ferns and related plants occurs within some wet heath communities; genera include *Gleichenia*, *Selaginella*, and *Schizaea*

Scrambling plants--vines--climbers: these can be notable in certain habitats:

* gorge or riparian: includes *Clematis microphylla* and *Rubus parvifolius*
* coastal: includes *Zygophyllum billardierii*, *Tetragonia* spp., and *Clematis microphylla*
* wet gully: includes *Clematis aristata*
* open forest to woodland: a sparse component of this habitat and may include *Hardenbergia* spp., *Glycine* spp., and *Cassytha* spp.
* disturbed sites include the exotic species: *Asparagus asparaginoides* and *Dolichos lignosus* on the coast; *Rubus* spp. widespread in the region, and *Salpichroa origanifolia* and *Galenia* spp. on the western plains

Species and Associations of Botanical Interest

Plant species of botanical significance are listed in Appendix V under categories that indicate their degree of rarity or vulnerability in the study area.

Seven plant species previously recorded for the area are now presumed to be extinct in the State. A further 20 species are considered to be extinct in the area but still occur elsewhere in Victoria.

Thirty-five species or varieties found in the area have been categorized as endangered, vulnerable to very rare, or extremely localized in distribution. A further 44 species fall into a lower category of vulnerability or rarity but nonetheless are important considerations when land use decisions are made. These species are listed in Appendix V with their common names together with a general indication of their location.

A large number of other species occur only uncommonly in the area, are declining in status, or are otherwise of interest in the region; a separate list of these is incorporated in the consultant's report.

8. FAUNA

Prior to European settlement, the study area contained a wide variety of vegetation types that supported a richly diverse vertebrate fauna. The habitats ranged from tall, wet open forests in the ranges to shallow marine environments in Port Phillip Bay. They included native grasslands on the flat basaltic plains, coastal heaths, fresh-water streams, and brackish estuaries.

Since settlement, marked changes have occurred in the distribution and status of many wildlife species. Urban expansion and clearing for agriculture favoured some native species - such as Australian magpie, Australian magpie-lark, and Richard's pipit - as well as a range of introduced birds and mammals such as the house mouse, black rat, fox, rabbit, starling, house sparrow, and Indian mynah. Most of the original native fauna, however, have declined in either range or abundance, or both.

The most severely affected faunal community was that associated with the grassland and grassy woodland habitats formerly occurring on the western basaltic plains. These plains were the first to be occupied by agricultural settlers in the middle of last century. Clearing, pasture improvement, grazing, rabbits, altered fire regimes, and exotic grasses have almost completely changed the environment and many of the original species, particularly the mammals, thus no longer remain here.

Of the original fauna, the wombat, dingo, Australian bustard, and emu are not now found in the study area. The white-footed rabbit-rat is believed to be totally extinct, while the eastern quoll, Tasmanian bettong, and plains rat are no longer present within Victoria. The eastern barred bandicoot occurs as a remnant population in Hamilton, Victoria. Other grassland and woodland vertebrates - including birds such as the plains-wanderer, bush thick-knee, and grey-crowned babbler and reptiles such as the earless dragon and the striped legless lizard (*Delmar impar*) - are still occasionally sighted here, but their future status is uncertain.

The drier open forest and woodland habitats north of the Great Dividing Range have also been extensively cleared for agriculture, with a consequent reduction in the range of the dependent native vertebrates. There have not been any recent sightings of the squirrel glider, for instance, which has been recorded in the past in this habitat at the northern margin of the study area, while the tiger quoll is now considered rare in the region.

Other species no longer present within the study area include the magpie goose, which formerly occurred in large numbers, and the bell miner, known historically to occur near the Werribee River.

The range of habitats in the study area and the major faunal species they support were described in the previous report for the Melbourne area (1974). A number of local surveys have listed the birds, mammals, and reptiles in various parts of the region, but as yet no broad-scale systematic surveys, similar to those in other study areas, have been conducted.

Of the fish, 37 species have been identified in the freshwater streams and reservoirs and the brackish estuaries of the study area. Appendix VIII lists these, together with the main waters of the district. Seven of them (goldfish and common carp, rainbow and brown trout, redfin, tench, and roach) are introduced species.

The following section sets out to explain the biogeographical importance of the region for terrestrial fauna and describes the distribution and habitat of certain significant vertebrate species.

Biogeography of Terrestrial Fauna

Melbourne area District 1 contains the western limit of distribution for many species associated with the tall open forest habitats of eastern Australia as well as the southern range limit for many species typical of the drier forests and woodlands in northern Victoria.

Western range limits

In south-eastern Australia the tall open forests, typical of the higher-rainfall areas of the highlands, extend in a belt down the eastern coast from Queensland and across south-eastern Victoria to terminate just north of Melbourne. Outlying areas of this habitat include the tall open forests of the ranges between Mount Macedon and Daylesford, and the Otway Ranges. Closely associated with these tall open forests are a range of faunal species adapted to the wet forest habitat. These include the greater glider, mountain brushtail possum, yellow-bellied glider, brown antechinus, dusky antechinus, superb lyrebird, pilotbird, eastern whipbird, Lewin's honeyeater, sooty owl, olive whistler, satin bowerbird, Wonga pigeon, Spencer's skink, McCoy's skink, and smooth froglet. Their distribution and occurrence reduce progressively from east to west across southern Victoria, with a number of species representing each of the following western range limits:

* in the forests east of Melbourne
* in the forests west of Melbourne, but not extending to the Otway Ranges
* in the Otway Ranges
* extending across Victoria into south-eastern South Australia

Species known to reach their western limits in the study area include the red-browed treecreeper, mountain brushtail possum, and greater glider. These are present in the tall open forests of the ranges between Macedon and Daylesford.

Southern range limits

Vertebrate fauna typical of the more-arid inland (Eyrean) zone are usually found in the drier open forest and woodland habitats inland of the Great Dividing Range. The study area extends across the Divide and includes some of this environment. In addition, the rain-shadow effect of the Otway Ranges has provided drier woodland and grassland habitats across the plains west of Melbourne.

Mammals and reptiles typical of drier inland habitats - but recorded within the study area - include fat-tailed dunnart, common dunnart, little mastiff-bat, thick-tailed gecko, and three-toed skink. The Murray tortoise reaches its southern limit in the Goulburn River. Numerous birds typical of inland habitats have been recorded here; some of them (such as hooded robin, spiny-cheeked honeyeater, weebill, and southern whiteface) are residents, but many other species (such as black falcon, letter-winged kite, red-capped robin, white-backed swallow, painted honeyeater, peaceful dove, and crested bellbird) are seen periodically, perhaps in response to seasonal conditions within their normal range.

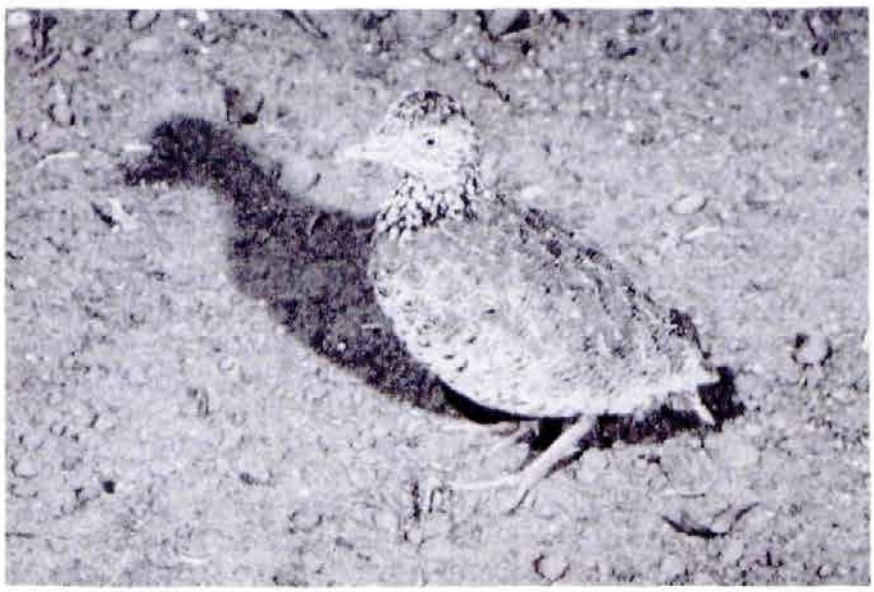
Significant and Notable Species

Seven species of vertebrates are considered significant within the study area, on the basis that this region is particularly important for their conservation and/or scientific investigation. A further 17 are considered notable due to their rarity, restricted distribution, or important conservation status.

Significant Birds

Plains-wanderer (*Pedionomus torquatus*)

The ground-dwelling plains-wanderer favour native grasslands that, in Victoria, are dominated by tussock grasses of the genera *Themeda*, *Danthonia*, *Stipa*, and *Poa*. The birds forage among the lower cover for insects and the seeds of grasses and herbaceous plants; they are most active at night.



Plains-wanderer

Prior to 1900, numerous records of the bird were made in the study area (in the grasslands of the basalt plains), and the species was widely distributed over the inland plains of western Victoria and southern New South Wales. The status of the plains-wanderer has declined dramatically, however, with increasing agricultural activity, and in Victoria is classified as an endangered species. Throughout its range it is now sparsely distributed and is seldom seen. The more recent records of the bird in the study area indicate that a small population may still exist - probably in relict native grasslands or in crop stubble.

Grey-crowned babbler (*Pomatostomus temporalis*)

Woodlands, scrublands, and the margins of open forests form the habitats of this species, which forages noisily and gregariously in the shrubs and trees, feeding on insects and other invertebrates. The birds live in small social groups of up to 12 individuals. The grey-crowned babbler was formerly widespread throughout much of eastern Australia, but with extensive clearing and grazing of the woodland habitat its numbers have declined, and in the study area it has been only rarely reported since about 1940.

Bush thick-knee (*Burhinus magnirostris*)

This ground-dwelling species feeds nocturnally on insects, amphibians, and small mammals. Tussock grasses, fallen timber, or litter frequently provide day-time resting places. The bush thick-knee belongs to the suite of native fauna, formerly occupying the drier woodland and grassland habitats, that has experienced a severe decline in both range and abundance since settlement, grazing and rabbits causing the greatest destruction of its habitat. The birds are also vulnerable to predation by foxes, cats, and dogs, because they nest on the ground.

Although distributed widely throughout Australia, the species is rare in the south and has been described as vulnerable in Victoria. It is rare in the study area - being last observed in the You Yangs in the 1960s - although occasional reports have come from the Bellarine Peninsula.

Orange-bellied parrot (*Neophema chrysogaster*)

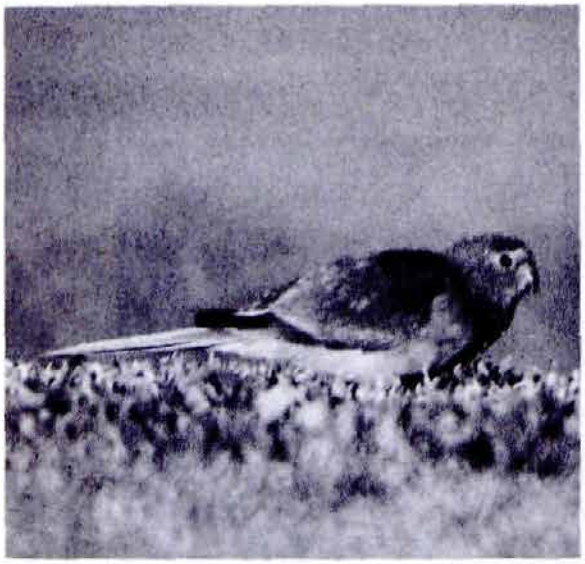
A summer-breeding resident of south-western Tasmania, the orange-bellied parrot migrates northwards via the Bass Strait Islands to the southern Victorian coast for the winter months. The species was at one time quite plentiful, but within the past few decades numbers have declined severely - principally because of the destruction of large areas of salt-marsh around Port Phillip Bay and trapping for avicultural purposes. Current population estimates suggest that fewer than 200 individuals remain, indicating that this is one of Australia's rarest birds. In Victoria it has been classified as 'endangered'.

The study area has particular significance for this species, as Point Wilson and the environs of Swan Island form its principal over-wintering sites. Since systematic study of

it began in 1978, up to 74 birds have been known to winter at Point Wilson and up to 42 at Swan Island. Habitats that orange-bellied parrots occupy here are salt-marshes characterized by *Sclerostegia arbuscula*, *Halosarcia halocnemoides*, and *Sarcocornia quinqueflora*. The birds feed on the seeds of these species, together with seeds of *Chenopodium glaucum*, *Frankenia pauciflora*, and some introduced plants.

In 1984, officers of the Tasmanian National Parks and Wildlife Service, working in consultation with officers from the Fisheries and Wildlife Service in Victoria and the South Australian National Parks and Wildlife Service, prepared a recovery plan for the orange-bellied parrot. This plan contains a proposed course of action for assisting the species' conservation, It recommends a broad range of management and research measures to:

* safeguard the existing population from disturbance and predation, and their habitat from degradation and detrimental development
* manage known habitats to ensure availability of adequate secure food resources
* improve and manage other areas of potential habitat



Orange-bellied parrot (above) and a pair of regent honeyeaters

Regent honeyeater (*Xanthomyza phrygia*)

One of the most beautiful Victorian honeyeaters, this bird has, during the last two decades, declined markedly in abundance throughout its former range to the point that it is now regarded as an endangered species in Victoria. Its habitat requirements are poorly understood, but many records come from the drier open forests and woodlands.

Regent honeyeaters appear to be highly nomadic, moving in flocks and fluctuating in local abundance in relation to the flowering of eucalypts, banksias, and other plants. This pattern of occurrence is typical of that observed in the study area.

Significant Reptiles

Earless dragon (*Tympanocryptis lineata*)

Although widespread in the arid regions of Australia, this small, prickly lizard reaches the south-eastern limit of its distribution on the basalt plains grasslands west of Melbourne. Here, the population is recognized as a separate sub-species, *T. lineata pinguicolla*, and further taxonomic research may show it to be a distinct species.

Most specimens of this form were collected early this century from areas to the north and west of Melbourne, many from localities such as Essendon and Saint Albans, now covered by urban development. The study area was a stronghold of this lizard, but agricultural and urban development have drastically reduced its populations. The last individual seen was at Little River about 20 years ago.

Striped legless lizard (*Delmar impar*)

This lizard occurs in native grasslands to the north and west of Melbourne, and in Victoria is largely restricted to the basalt plains. It is diurnal, but is rarely encountered as it is usually active only within the cover of grass tussocks and other ground debris. During periods of inactivity it shelters within large tussocks and under rocks.

Striped legless lizard

It is not known how agricultural practices affect the species, but changes in the native grasslands resulting in fewer tussocks, the introduction of herbivores, and the collection of rocks for suburban gardens all reduce the available habitat. Once locally common in some parts of the study area, it is now considered rare throughout its range and has disappeared from many localities.

Notable Mammals

New Holland mouse (*Pseudomys novaehollandiae*)

Research into the habitat requirements of the New Holland mouse suggest that the species favours mid-seral stages in heathlands regenerating following burning or clearing. This probably corresponds to the maximum availability of dietary items such as seeds, insects, and, to a minor extent, fungi and moss. As the heathland reaches maturity its suitability for the New Holland mouse diminishes.

New Holland mouse

This small rodent was once considered rare and restricted to the northern and central coasts of New South Wales, but over the last 15 years its known range has been extended westwards along the Victorian coastline from Lakes Entrance. In 1982 it was captured in the study area near Anglesea, which now represents the western-most known limit of the animal's range, Its current status in the study area is uncertain, however, as the Ash Wednesday wildfires severely burnt the known localities.

Brush-tailed phascogale (*Phascogale tapoatafa*)

Also known as the tuan, the species occupies a wide variety of habitats, but is most frequently recorded in dry open forests and woodlands having sparse understorey strata. It is largely arboreal, actively hunting for invertebrates and small vertebrates by night and resting in small tree hollows during the day.

Although its geographical range is wide, the abundance of this small dasyurid has declined considerably in the State with clearing and fragmentation of the woodland and forest habitats, and records are sparse and infrequent. Its status in Victoria is considered indeterminate and possibly threatened.

In the study area, records of the brush-tailed phascogale have come from the Bellarine Peninsula (before 1970), the

Brush-tailed phascogale

Brisbane Ranges, and the forests along and north of the Dividing Range.

Swamp antechinus (*Antechinus minimus*)

The geographical distribution of this species encompasses Tasmania and the coastal regions of the mainland from Wilsons Promontory to south-eastern South Australia. A small insectivorous marsupial, it inhabits closed wet heaths and tussock grasslands. In the study area, it occurs near Anglesea.

Notable Birds

Powerful owl (*Ninox strenua*)
Barking owl (*Ninox connivens*)

Large animals and/or those at the top of the ecological food chain are often the species most sensitive to changing land use patterns and the first to reach extinction. This may be attributed to their large home-range requirements, and the consequent difficulty they have in maintaining populations of sufficient size to withstand sudden environmental catastrophe, genetic deterioration, or chance population fluctuations. These owls are two such species. Estimates based on the abundance of prominent prey species suggest that one breeding pair of powerful owls, for instance, requires a home range of at least 800 ha. For its long-term survival, therefore, the species would require large tracts of bushland.

The powerful owl is the largest of Australia's owl species. It nests in tree hollows, preferably in steep, well-forested country. The bird's main diet consists of possums and gliders, but it also takes rabbits and small birds.

The barking owl is strictly nocturnal, hiding in thick foliage during the day. It nests mainly in tree hollows and

preys on insects and small birds and mammals.

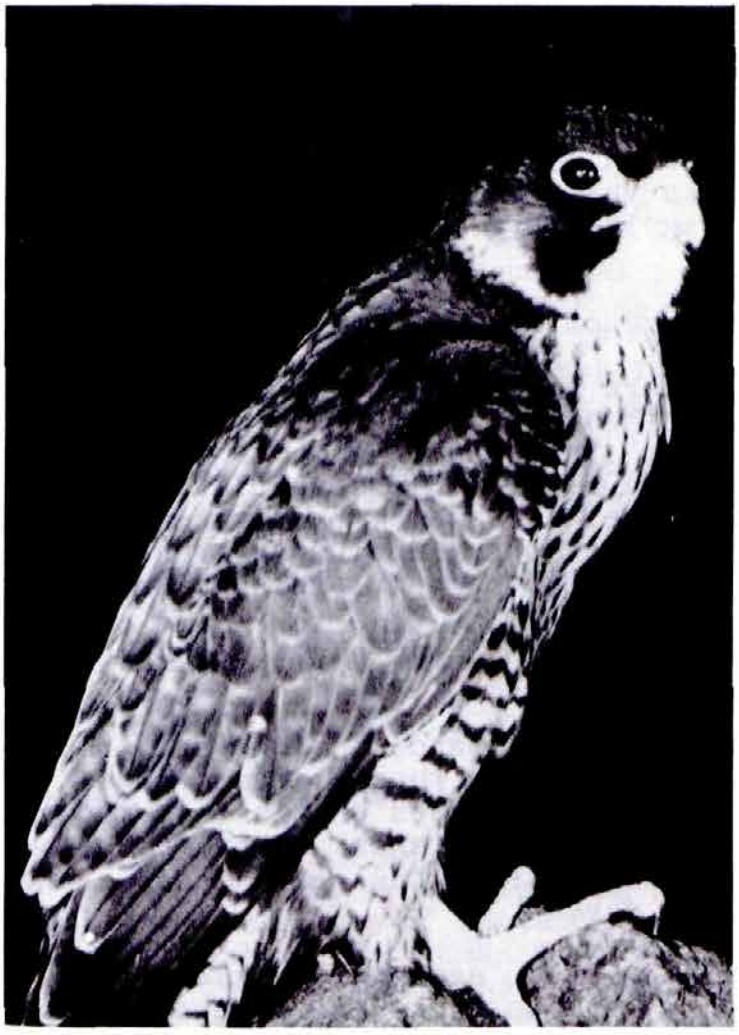
Both species have been recorded in the study area, but are now sparsely distributed and considered rare in the State due to the reduction of the mature forest and woodland habitats by agricultural development and timber-harvesting. Recently, powerful owls have been recorded breeding in the Macedon and Brisbane Ranges and in the Ironbark Basin near Anglesea. Irregular records of barking owls indicate that they may also be breeding in the forests of the district.

Powerful owl

Peregrine falcon (*Falco peregrinus*)

While distributed widely throughout Australia, the peregrine falcon occurs sparsely and requires a large area as a home range. Victoria's population of the species is estimated at some 300 to 350 breeding pairs with an average density of about 650 to 750 sq. km per pair.

The birds hunt singly or in pairs over coastal cliffs, densely vegetated country, or rugged mountainous terrain.



The peregrine falcon known to breed in the study district

Although preferring to nest on cliff-edges, they also nest in trees. Peregrine falcons fly extremely fast, and their prey consists mainly of other birds - which they take on the wing by diving or 'stooping' upon them from above.

Within the study area peregrine falcons are rare, but breed successfully at known eyries in the Brisbane Ranges, near Bacchus Marsh, Macedon, Anglesea, and Waurn Ponds, and in the You Yangs and Werribee Gorge areas. During the breeding season of the falcon, public access has been restricted - in parts of the Werribee Gorge since 1976 and near Staughton Vale in the Brisbane Ranges National Park since 1981 - to encourage successful breeding. Success has been greater at Werribee Gorge than in the latter area.

Threats to the future survival of this species include shooting, egg-collecting, and in particular the use of pesticides. (The accumulation and concentration of organochlorides via contaminated food chains has been linked to a reduction in egg-shell thickness. This in turn increases the chance of egg breakage in the nest, thus lowering the reproductive success of the species.)

Rufous bristlebird (*Dasyornis broadbenti*)

Distribution of the rufous bristlebird is restricted to a narrow coastal belt from Bells Beach near Torquay to south-eastern South Australia. The species is believed to be now extinct in the south-west of Western Australia. The study area contains the eastern limit of its geographical range. It typically feeds on or close to ground level, using dense heath and scrub as cover.

Although this bird may be locally common where suitable habitat is available, it is vulnerable to land uses (such as grazing and clearing for agriculture) that remove ground cover.

Grey goshawk (*Accipiter novaehollandiae*)

The grey goshawk, which occurs extensively throughout eastern and northern Australia, has two colour forms: a grey phase and a pure white form. The Otway region is well known as a stronghold for the white form. This magnificent pure-white bird breeds in the wetter forests of the ranges, but may move out to the more open country, including urban areas such as Geelong, during winter months. It preys on smaller birds.

Latham's snipe (*Gallinago hardwickii*)

These birds breed on the Japanese islands in June and July and migrate to southern Australia for the balance of the year, where they forage for invertebrates on the soft muddy bottoms of shallow-water swamps and marshes. They feed at night, and shelter in the low cover of tussocks, sedges, and shrubby thickets during the day.

Latham's snipe has world population estimated at less than 20,000, and there is concern at its declining status. Snipe

have been fully protected in Japan since 1974, when an 'Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment' was prepared. In Australia, however, seasonal hunting of the bird still occurs, although Victoria had no open season for it in 1983/84. Major threats to this species here are game-hunting and the modification or destruction of fresh-water wetlands.

The study area contains one of the six regions in southern Australia supporting major snipe populations. This includes Point Henry, Swan Island, Reedy Creek, and the sewage farm at Werribee.

Spiny-cheeked honeyeater (*Acanthagenys rufogularis*)

This honeyeater may be found feeding in almost any type of vegetation, and to its nectar diet adds insects and fruits of various kinds. The bird occurs widely throughout inland Australia, and in Victoria is most abundant in Mallee habitats - seldom occurring in the coastal regions and generally avoiding the heavily forested country.

The study area contains the south-eastern margin of the species' distribution, and resident breeding populations are known in the Bellarine Peninsula and the You Yangs.

Freckled duck (*Stictonetta naevosa*)

The status of the freckled duck in Australia is uncertain, perhaps due to the nomadic movements of this bird. It is considered to be one of the ten rarest waterfowl in the world and Australia's rarest duck, having an estimated population of 8,000 to 19,000 here in summer 1983.

Its habitats are usually natural permanent, open fresh-water wetlands; but it also utilizes saline lakes, fresh-water marshes, and reservoirs. It feeds mainly on aquatic plants. In the study area freckled duck have been recorded at Lake Modewarre, Reedy Lake, and the Werribee sewage farm.

Cox's sandpiper (*Calidris paramelanotos*)

Following observations of the wader in south-eastern Australia, Cox's sandpiper has recently been described as a new species.

The Werribee sewage farm is one of the major southern feeding grounds for international waders and can be expected to be an important resource for this species.

Hooded plover (*Charadrius rubsicollis*)

Although it has an extensive distribution along the southern Australian coastline, the hooded plover is locally limited by the availability of suitable habitats. These are sandy open beaches free of human disturbance, where the plovers nest in a scrape in the sand. Recreational use of beaches and other disturbance render these habitats unsuitable.

Notable Mammal

Squirrel glider (*Petaurus norfolcensis*)

The squirrel glider is rare within Australia and its present status within the study area is uncertain. One record (pre-1970) came from Seymour, but no recent records are known. Dry open forests and woodlands north of the Divide are its usual habitat, but remnants of these forests along streams and road reserves, particularly those with mature trees, are also valuable.

Squirrel glider

Notable Reptiles

Bearded dragon (*Amphibolurus barbatus*)

The large, conspicuous bearded dragon is often seen on roads and fence posts in northern Victoria. It inhabits woodlands and drier open forests, but has persisted, particularly where some trees remain, in many cleared agricultural areas.

In the long term, numbers of this dragon on farmlands appear to be declining along with the loss of trees and ground shelter (logs, low bushes), and remnants of suitable habitat along road reserves and streams are becoming increasingly valuable for its conservation.

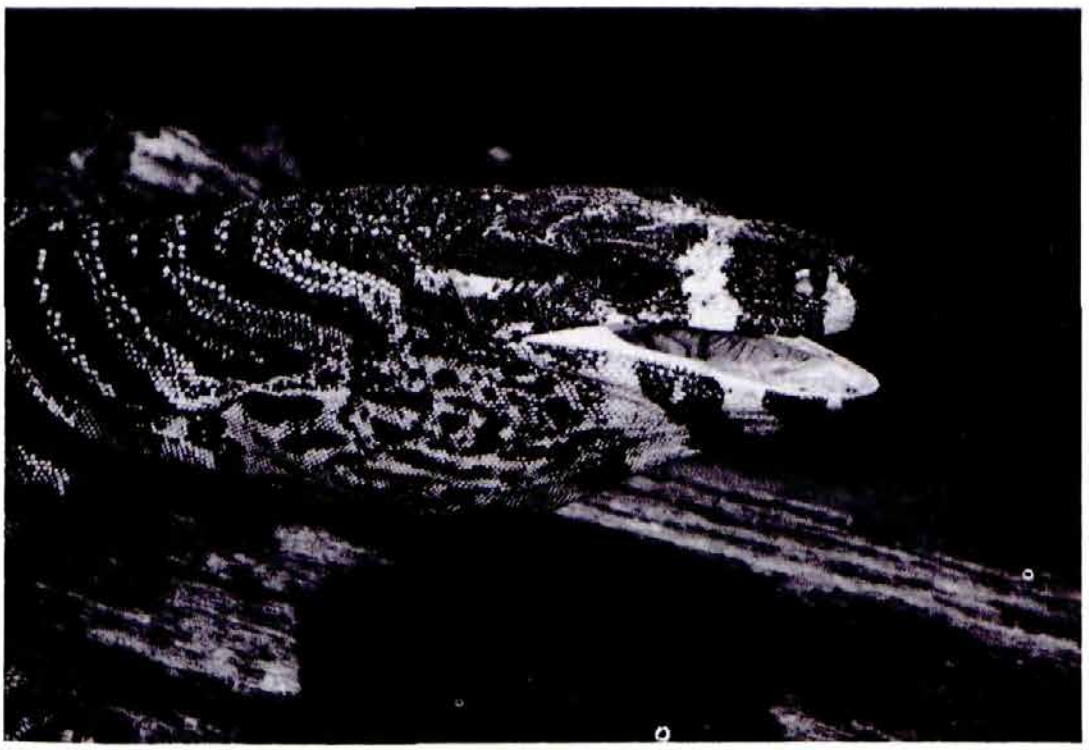
The species reaches the south-eastern limit of its distribution in the study area, where it is now considered rare.

Mountain dragon (*Amphibolurus diemensis*)

This small dragon typically inhabits heathy vegetation on dry ridges in the mountains of eastern Victoria. Despite a widespread distribution, it is locally restricted to relict patches of suitable habitat. Its occurrence in coastal heaths near Anglesea, in the study area, is of particular

The bearded dragon is now rare in the study area

Below: tree goanna



note, as this is the only lowland locality known in Victoria.

It appears to be vulnerable throughout its range, as many of the remaining areas of suitable habitat are infected with cinnamon fungus, a serious plant pathogen that rapidly kills

the heath vegetation. The effects that the recent fires in the Anglesea area may have had on the dragons of this region are not yet known.

Tree goanna (*Varanus varius*)

This large carnivorous lizard is distributed widely throughout woodlands and open forests of eastern Australia. It is very rare in the study area, however, where it is known to occur only in the ranges to the north-west.

The tree goanna is a long-lived species, but the absence of records of young individuals over much of its Victorian range is causing concern. It is possible that introduced predators (dogs, cats, foxes) and frequent fires are killing off the juveniles, with the result that populations are approaching senility.

References

References used in the preparation of this chapter are listed in Appendix I.

PART III

CURRENT LAND USE

9. PUBLIC LAND USE

The total area of public land within each major category of land use is indicated on Table 10. In all, public land, as defined under the *Land Conservation Act* 1970, occupies some 137,000 ha or almost 15% of the study area.

The following chapters and Part IV (on the descriptive blocks) provide details of many of the larger parcels of land that comprise the major land uses of the district. Their locations are shown on Map 8.

Table 10

PUBLIC LAND USE

Major land use category	Area (ha)
National parks[1]	7,600
State parks[2]	18,060
Regional parks	8,360
Reference areas	1,520
Flora, flora and fauna reserves[2,3]	3,820
Wildlife reserves	2,120
Marine reserves[4]	3,150 (marine)
Water production	4,860
Hardwood production	40,190
Uncommitted land	19,730
Softwood production and forest area[5]	2,630
Coastal reserve	2,100
Education areas	1,100
Mineral and stone production areas[6]	4,990
Other reserves (bushland, streamside, historic, recreation, scenic, utilities, etc.)[7]	18,840

Notes:

1. Included here are the Brisbane Ranges park, previously recommended by the Council to be set aside as a State park, and the Organ Pipes park - earlier recommended as a geological monument.

2. The total area takes account of the recommendation, for the North Central area (1981), that Fryers Ridge should be reserved as a flora reserve rather than a State park.

3. A further 670 ha of the Inverleigh flora reserve fall outside the study area. The recently proclaimed Long Forest Flora and Fauna Reserve (LFF on Map 8) is included.

4. Marine reserves have been declared over most of the areas previously recommended by the Council to be wildlife management co-operative areas. In addition, the Point Cook Marine Reserve has been declared recently - shown as PCM on the map.

5. Land acquired for softwood plantation extension purposes in the Parish of Bungal (shown as BSP on the map) is included.

6. This category includes land at Anglesea in the Alcoa lease, for which Council recommended a number of uses. A further 2,600 ha of the leased parcel fall outside the study area.

7. A number of other areas that were largely freehold at the time of the 1977 recommendations, and have been acquired by State Authorities subsequently, are included as 'other reserves'. These are shown separately on the map as:

   GHP - Gellibrand Hill Park
   PCP - Point Cook Metropolitan Park
   WER - White Elephant (soil conservation) Reserve
   WP - Werribee Park

8. A further 18,500 ha of Commonwealth land contained within this study area do not qualify as 'public land' according to the definition under the *Land Conservation Act* 1970. Some of this land, near Puckapunyal, was acquired recently from both freehold and State ownership.

9. The City of South Barwon was declared during the previous investigation; land in the City is not now 'public land' according to the Act.

10. In addition to the above, public land also includes water frontages (some of which are shown on the map), unused road easements, and other small areas that have not been measured but nonetheless make an important contribution to the rural environment; and, although not quantified, these amount to a large area of land.

11. The *Coastal Waters (State Powers) Act* 1980 and the *Coastal Waters (State Title) Act* 1980, passed by the Commonwealth government, vest in the State from 14 February 1983: the management of the sea bed and subsoil, air-space above, and the waters out to the 3-mile limit.

12. Figures are rounded.

10. NATURE CONSERVATION

This chapter deals with nature conservation, which includes the protection of native species, natural features, and landscapes. Protection of these attributes is important for a number of land uses, including reference, conservation of species, recreation, and education. None of them necessarily monopolizes the land; often conservation needs are compatible with each other or with commercially productive uses of land. Past alienation and clearing of much of the land in the district, however, has enhanced the importance of the residual uncleared areas for nature conservation.

In its 1977 final recommendations relevant to this district, the Land Conservation Council recommended various types of nature conservation reserves. Subsequent recommendations by the Council (North Central Area, 1981), Land Use Determinations, and government decisions have modified some of the original designations. In addition, the government has acquired a number of areas with conservation value. The various types of conservation reserves now approved are indicated in Table 10, Public Land Use, and their locations are shown on Map 8. The general categories are described below, and more detailed information on some of the reserves is given in the relevant sections of Part IV, Block Descriptions.

Parks

The study area contains nine parks, which cover some 34,000 ha of public land. These fall into three categories - national, State, and regional parks (see Table 11).

National parks

A national park is defined as an 'extensive area of public land, of nation-wide significance because of its outstanding natural features and diverse land types, set aside primarily to provide public enjoyment, education, and inspiration in natural environments'.

Two parks in the study area are scheduled for this use under the *National Parks Act* 1975 - the Brisbane Ranges National park, which was designated as a State park by the Land Conservation Council in 1977, and the Organ Pipes National park, designated by the Council as a geological monument.

State parks

A State park is 'an area of public land containing one or more land types, set aside primarily to provide public enjoyment, education, and inspiration in natural environments'. It is intended that such parks would include samples of land types not represented in national parks and would

complement the latter, so that together the two types form a State-wide system.

Regional parks

A regional park is 'an area of public land, readily accessible from urban centres or a major tourist route, set aside primarily to provide recreation for large numbers of people in natural or semi-natural surroundings'. Such areas can reduce the pressures on the biological systems in national and State parks.

The boundaries to the Melbourne study area were generally determined to coincide with a day-trip recreation zone for the urban population. The regional parks therefore provide a recreational resource for people from Melbourne, as well as for those from Geelong (You Yangs and Steiglitz parks) and Ballarat (Hepburn regional park).

Table 11

EXISTING PARKS

Name	Category	Area (ha)
Brisbane Ranges[1]	National	7,520
Organ Pipes[2]	National	85
Angahook--Lorne[3]	State	4,350
Werribee Gorge[1]	State	375
Lerderderg	State	13,340
You Yangs	Regional	1,940
Steiglitz[4]	Regional	670
Hepburn	Regional	2,820
Macedon	Regional	2,930

Notes:

1. These two parks were formerly recommended by the Council as a single State park.

2. Recommended by Council (1977) as a geological monument.

3. This park is contiguous with the 18,000-ha Angahook--Lorne State park in the Corangamite area.

4. This has been named the Steiglitz Historic Park.

Reference Areas

Finding a solution to problems arising from use of a particular land type is often helped by reference to an undisturbed example of the land type. Here the soils, vegetation, and fauna can be studied under natural conditions and the

knowledge gained about the basic relations operating between these components can help solve land use problems.

Reference areas therefore act as standards against which the progress and effect of human alteration and utilization of the land can be measured. They also provide a valuable gene pool of some plant and animal species.

The Council's previous recommendations set aside six parcels of land, totalling 1,520 ha, as reference areas. They contain representatives of many of the major land types found in the study district. As far as possible natural processes should be allowed to continue undisturbed within them; access is restricted, and experimental manipulation is not permitted. All of these areas have been proclaimed under the *Reference Areas Act* 1978.

Wildlife and Marine Reserves

Conservation of fauna depends on the conservation of habitat, and by far the largest remaining areas of relatively natural habitat are on public land. While many forms of use of this land do not have marked detrimental effects on habitat, some areas have been set aside specifically for wildlife conservation and for developing relevant techniques.

Koala, in the Brisbane Ranges National Park

Nine wildlife reserves (totalling 2,120 ha) in the Melbourne area, District 1 are managed primarily for the conservation of native fauna. All of these reserves provide breeding and feeding areas for large numbers of water-birds.

A marine reserve is an area of offshore under-water terrain and the waters above it - together with the associated flora and fauna - set aside to conserve and protect marine and/or estuarine ecosystems, and to provide opportunities for recreation and education based on the marine environment.

The Harold Holt Marine Reserves, encompassing five separate areas at the southern end of Port Phillip Bay, and the Point Cook Marine Reserve were proclaimed on 7 February 1979 and 1 December 1982, respectively.

Specific information on wildlife and marine reserves is included in the relevant block descriptions. Much of Lake Connewarre Wildlife Reserve, however, which was recommended by the Council in 1977, now lies within the boundary of the City of South Barwon and is therefore not considered as public land according to the *Land Conservation Act* 1970. Nonetheless, the diverse habitats contained in this complex of wetlands and the large number of bird species they support are of particular regional importance. A brief description of this lake system is provided here to give a comprehensive appreciation of the wildlife reserves in the region.

The 3,300-ha Lake Connewarre Wildlife Reserve contains an extensive wetland ecosystem, which shows gradual progression from saline to fresh-water environments with increasing distance from the sea. Of the 23 floristic associations identified here, a number - for example, Australian salt-grass (*Distichlis distichophylla*) grassland on the levees of the Barwon River and a large silky wilsonia (*Wilsonia humilis*) herbfield at Salt Swamp - are extensive in the reserve but are rare elsewhere in Victoria. Some 134 native vascular plants have been identified here, 17 of which are considered rare or significant. A further 78 exotic plants are also found here. In all, more than 90% of the Victorian salt-marsh flora is represented in the reserve.

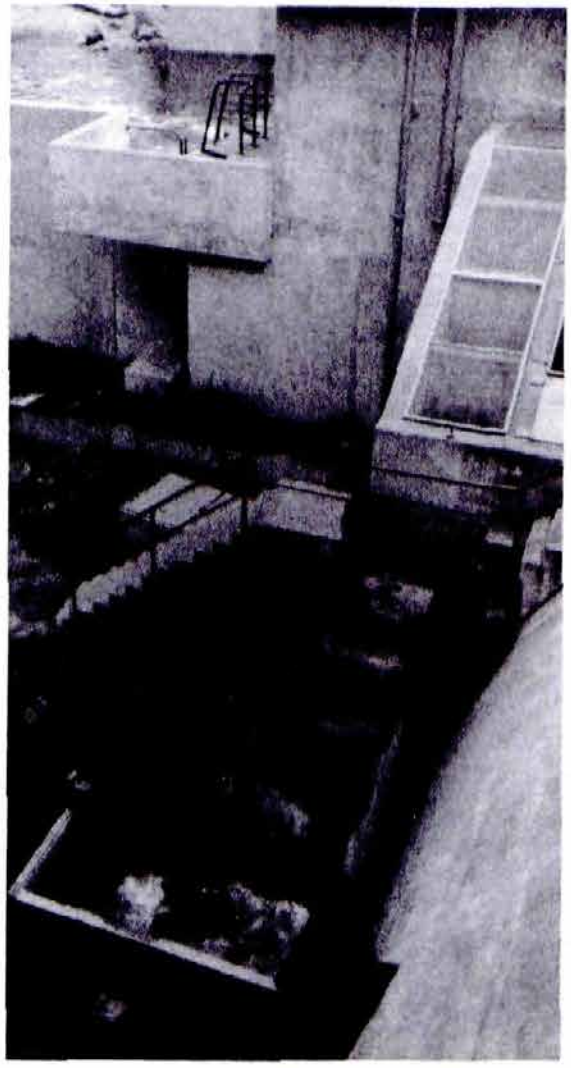
Wildlife habitats in the Lake Connewarre system include those of fresh-water rivers and lakes, estuarine lagoon and river complex, fringing mangrove complex, and wet and dry salt-marsh communities. Some 160 species of birds have been recorded in the reserve, including rare, unusual, and notable species such as the orange-bellied parrot, glossy ibis, Australasian bittern, and Baillon's crake.

The reserve has a high educational and scientific value. It also provides recreational opportunities in the form of bird-watching, fishing, sailing on Lake Connewarre, duck-hunting (chiefly on Reedy Lake and Hospital Swamp), and water-skiing on the lower reaches of the Barwon River.

The Lake Connewarre system is ranked highly as a habitat and conservation area for estuarine fish species. It also supports a number of other fish typical of fresh-water environments (see Appendix VIII).

A number of other estuaries and streams in the study area are also important for the conservation of native fish species; these too are noted in Appendix VIII. The Lerderderg River is valued highly for this purpose.

A 65-ML-capacity reservoir was constructed on the Lerderderg River in 1980 as part of the Merrimu Reservoir project. To assist in maintaining the aquatic ecosystem, an experimental fish ladder and pipe outlet system, which could be manipulated to minimize interference with the downstream environment, were incorporated into the structue of the weir of the reservoir. The fish ladder is, of necessity, versatile in design so as to meet the needs of different species of fish. It is the first in Victoria and will serve as a prototype for similar projects in the State. The relatively small size of this reservoir and its shallowness have meant that the stored water does not influence downstream water temperatures.



The fish ladder

Other Conservation Reserves

The study area also contains eight flora reserves (totalling 3,595 ha), two of which extend outside the area, and three flora and fauna reserves (totalling 254 ha). Flora reserves are managed to preserve plant species that may be rare or endangered and associations of native species that are poorly represented on public land. Flora and fauna reserves are significant because they provide valuable habitat for populations of native fauna and contain examples of native vegetation with considerable floristic value in a natural or semi-natural state.

These totals include the Long Forest flora and fauna reserve set aside in land acquired subsequent to the Council's previous recommendations, and also take account of the inclusion of Fryers Ridge area in the north as a flora reserve rather than a State park.

Gellibrand Hill Park (645 ha) and Point Cook Metropolitan Park (447 ha) were both declared on land acquired subsequent to the Council's recommendations. Both parks contain historical homesteads. The former contains grassy woodlands of the rolling basalt plains north of Melbourne; the latter includes grassy plains and wetlands along the shores of Port

Grey box in the Mangalore flora reserve

Phillip Bay. The Point Cook park will eventually extend north into the Melbourne metropolitan area and will cover about 933 ha.

Education is an important use of land in a natural or near-natural state. Forests, rivers, and other natural landscapes have many applications in education - from primary to post-graduate levels - giving students opportunities to see natural land forms, to observe, interpret, and monitor biological processes, and to collect specimens. In some cases, this may involve long-term studies or alterations to the environment for experimental purposes. The Council's previous recommendations set aside six parcels of land (covering 1,100 ha) as education areas to be developed specifically for outdoor educational purposes.

Bushland reserves are small areas of public land in predominantly cleared agricultural regions that support remnants of the original vegetation. Their major use is to provide diversity in the landscape and to maintain the distinctive Australian character of the countryside. They may also be important faunal habitat areas. Already, 34 such areas have been set aside in the district, although further small areas of public land, including road reserves, river and stream frontages, and small isolated blocks, are also important for nature conservation in those parts of the study area that have been extensively developed for agriculture. In many

cases they support the only remnants of the original vegetation.

Native forests reserved primarily for the production of hardwood timber and forested areas that are not yet committed to any primary use are important for the conservation of native plants and animals and the protection of water supply catchments, and provide scenic amenity.

The Melbourne and Metropolitan Board of Works' sewage farm at Werribee is important for wetland-dependant bird species.

The conservation value of small tracts of native vegetation increases greatly if they are inter-connected. Such connections allow native animals to move from one block of native vegetation to another and also assist migratory and nomadic birds. This is particularly important in the planning of pine plantations, as retention of inter-connected areas of native vegetation within the plantation complex greatly assists the conservation of native fauna.

Vegetation along streams, roads, and railways also facilitates movement of birds and animals between larger tracts of native vegetation, and often these strips contain the only remnants of a region's native plants. They are often useful in land studies, as they may permit scientists to piece together the original pattern of the vegetation. The manna gum and she-oak stands along roadsides of the Bellarine Peninsula provide one example. Such remnants are valuable for preserving species with restricted distribution, particularly those of the volcanic plains, much of which have been cleared for agriculture.

River red gums in the Gellibrand Hill park

11. RECREATION

Table 10 indicates the various land use categories for which public land in the study area has been set aside. It can be seen that the bulk of public land is available for recreational uses of some sort and that a variety of reserves provide for a range of recreational opportunities. While specific reserves have not been set aside for each form of recreation, most activities can be accommodated somewhere on public land. Most of the recreational usage of public land here involves people from the cities of Melbourne and Geelong, although those from the regional centres of Ballarat and Bendigo and from local towns also contribute to the total numbers of visitors.

Melbourne's primary coastal recreation resource is Port Phillip Bay, which in 1978 received some 13.7 million separate visits to the available sites along the shoreline - about 47% of all day-trip activity generated by the Melbourne population. The influx of people to the coastal resorts along Bass Strait is highly seasonal. During winter, recreationists comprise only 10% of the population there. In summer, the population of the resorts swells by more than 2,000%, most of the visitors coming from Melbourne.

Table 12 indicates the estimated numbers of visitors to each of the major parks and areas of State forest during 1981/82. Because of the dispersed nature of recreational activities pursued, and because most of the forested areas have a large number of entrances, many of the estimates are subjective and should be used as a guide only.

Each of the parks or areas of forest mentioned in the table provides for a range of recreational pursuits - the common activities throughout being the more passive ones of picnicking, sightseeing, and walking. Particular attributes of individual areas make them attractive for other activities such as:

* orienteering (Brisbane Ranges, You Yangs, Steiglitz, Hepburn, Cobaw)
* horse-riding (Brisbane Ranges, Angahook, You Yangs, Steiglitz, Hepburn, Bungal)
* rock-climbing (Brisbane Ranges, Werribee Gorge)
* gem-fossicking (Lerderderg, Wombat)
* sampling mineral water (Hepburn, Wombat)

Parks at the Organ Pipes and Werribee Gorge are popular destinations for geologically and environmentally oriented school excursions, while Steiglitz, Lerderderg, and Wombat offer opportunities for visitors interested in aspects of the history of gold-mining. Visitor use has continued to rise rapidly; between 1979/80 and 1983/84, an increase in

Table 12

ESTIMATED NUMBERS OF VISITORS TO PARKS AND STATE FORESTS 1981/82

Name	Area (ha)	Visitor days
Brisbane Ranges National Park	7,520	82,500
Organ Pipes National Park	85	91,500
Angahook--Lorne State Park[1]	22,350	52,000
Werribee Gorge State Park	375	6,200
Lerderderg State Park	13,340	35,500
You Yangs Regional Park	1,940	250,000
Steiglitz Regional Park	670	20,900
Hepburn Regional Park	2,820	32,000
Macedon Regional Park	2,930	236,000
Wombat State Forest[2]	59,000	36,000
Cobaw State Forest	2,500	1,300
Bungal State Forest	400	1,000
Gellibrand Hill Park	645	48,300

Notes:

1. Includes land in the adjoining Corangamite area
2. Includes both hardwood and softwood production areas

Source: Department of Conservation, Forests and Lands.

visitor days of some 80% was recorded for the areas managed by the National Parks Service. Gellibrand Hill park, opened in late 1980, sustained 64,300 visitor days in 1983/84. It

'Woodlands' homestead - Gellibrand Hill park

Swing mooring of pleasure craft in Port Phillip Bay

contains an early homestead and includes horse-riding as one of the permitted activities.

Recreational Activities

Fishing and hunting

Recreational fishing in the study area is dominated by that undertaken in Port Phillip Bay. Preliminary estimates from a survey in 1983 indicate that, during the peak of the summer period, up to 190,000 anglers per month fish here. Major target species include snapper, King George whiting, sand flathead, yellow-eye mullet, Australian salmon, and southern sea garfish. Calamari and arrow squid are also sought as well as mussels, scallops, and abalone.

Fishing is also an important recreational activity along the coastline outside the Bay. Anglers fish from boats, piers, headlands, rock platforms, sandy beaches, and river estuaries. Spear fishing also is locally popular where suitable access can be achieved.

Collection of fauna from the intertidal zone, particularly molluscs, has resulted in unacceptable damage to these communities and legislation has been enacted to prohibit such activities continuing.

Appendix VIII indicates those inland water bodies considered to be of value for recreational fishing and offers a general appreciation of the various species of introduced and native fish found and sought throughout the district.

The Lauriston and Malmsbury Reservoirs, Hepburn Lagoon, Jim Crow, Emu, and Jackson Creeks, and the Maribyrnong River are considered important waters for angling for brown trout. Lake Modewarre has importance for both brown and rainbow trout.

The estuaries of the Werribee River and Painkalac Creek are valuable for sport-fishing for black bream; the latter is

also important for long-snouted flounder, common galaxias, luderick, and sea mullet.

Game-hunting is widespread throughout. Both private and public water bodies are used by duck-shooters, while quail-hunting is confined principally to private grasslands.

Boating

The number of power boats registered in the State is increasing at an annual rate of 2% (compared with the population increase of 1% per annum), and in 1983 the total number of boats was approaching 100,000.

In 1983 also almost 9,000 yachts belonged to people affiliated with clubs and possibly a further 6,000 yachts were owned by people not associated with clubs.

It has been estimated that, during 1982/83, 51% of the boating population used Port Phillip Bay in activities such as water-skiing, fishing, off-shore diving, sailing, speed-boating, or cruising. Outside the Bay, waters close to the shoreline are often reasonably calm and also suitable for these activities.

The majority of boats are trailer-hauled and do not need wet storage. Launching facilities comprise public ramps, private or club ramps, crane-berths, and informal areas such as sheltered sandy beaches where access is suitable. Wet storage areas with either fixed or swing moorings have been set aside primarily within small estuaries and minor harbours or boat clubs within the Bay. At the Werribee River, Portarlington, Saint Leonards, and Swan Bay, for instance, a number of wet storage sites and boating facilities depend upon coastal public land.

The Ports and Harbors Division is responsible for all public harbour facilities, including jetties and navigation aids, within Port Phillip Bay and Barwon Heads; the Port of Melbourne Authority and the Port of Geelong Authority have similar responsibilities within their respective areas.

An 8-hectare marina at St. Kilda provides both dry and water storage facilities for some 350 craft.

Outside the Bay, boats may be moored at Barwon Heads and Lorne (just outside the study area); elsewhere, mooring depends upon weather conditions and a knowledge of the local waters. At both Torquay and Lorne, boat clubs have buildings and facilities located on public land.

Inland, power-boating is a popular activity on Pykes Creek and Melton Reservoirs.

Two streams in the study area are used for canoeing. On the Barwon River, the section most commonly used is between Inverleigh and Geelong and provides for a 1- or 2-day trip. The Maribyrnong River contains a number of blocks and rapids and is generally suited only to experienced canoeists. The upper reaches are suitable only after good rains. The most

frequently used portion of the stream lies within the metropolitan area.

Recreational driving and picnicking

Most recreational driving in the study area is done in conventional vehicles. For many people pleasure driving and sightseeing on a day-trip basis are the major activities, while for others driving provides access to areas where they engage in some other recreational activity.

Day-tripping is usually associated with picnicking, and facilities have been developed in most parks, adjacent to main roads, and on many other areas of public land such as streamside reserves.

Many people prefer facilities, such as parking, toilets, and tables, close to their picnic areas. The incidence of picnicking close to towns is therefore high. Natural features, views, water bodies, and ease of access, however, are often also important in determining the usage of a picnic area.

Around the Bay, pleasure driving, when combined with traffic generated by other recreational and business uses, often creates summer traffic congestion, and the demand for picnic spots imposes considerable pressures on the narrow foreshore reserve.

Inland, most of the parks and State forest areas listed in Table 12 are used by day-trippers. Many of these areas, particularly the Brisbane Ranges National Park, the Angahook --Lorne State Park, the Macedon Regional Park, and the Wombat State forest are popular with recreational drivers - principally for sightseeing. Wombat State forest is also a popular area in which to conduct car rallies and for trail-bike riding. Throughout the year about eight car trials are conducted in the forests to the north of the study district, with some 400 cars entered in the competitions.

Nature study

While many people visit public land specifically to study nature, a far greater number incorporate nature study with other activities such as bushwalking, picnicking, camping, and recreational driving.

Bird-observing is highly popular within the study area, mainly by reason of the close proximity of major population centres to areas of regional, national, and international significance for sea-birds and waders. The shoreline of Port Phillip Bay is the major area of interest, although the wildlife reserves - particularly Lake Connewarre - are also important. The more open forested areas such as the You Yangs and Brisbane Ranges parks are also popular for bird enthusiasts.

Floral displays such as those between August and November in the Brisbane Ranges National Park attract large numbers of people. Of both scientific and floral interest is the unusual occurrence of mallee scrub west of Melton.

Picnic facilities - Greenvale reservoir

Unusual geological formations also prove popular with visitors. The Organ Pipes National Park - which contains a dramatic set of basalt columns - attracted some 107,600 day visitors during 1983/84. The Werribee Gorge, within the Werribee Gorge State Park, was formed when the Werribee River was rejuvenated by the Rowsley Fault and cut down through more than 250 metres of rock, revealing volcanic rocks, glacial deposits, and ancient sandstones. This park received some 8,900 day-visits during 1983/84.

Nature study is a popular recreational pursuit in Port Phillip Bay. 'Scuba' divers, usually in groups organized by clubs, visit a number of locations, including the marine reserves, on a 'look-only' basis - no collection of aquatic flora or fauna is permitted.

Other recreational activities that utilize public land include camping in such areas as the Hepburn and Lerderderg parks and the Wombat and Cobaw State forests. Formal camps such as the DOXA Youth Welfare Foundation camp north of Glenlyon - which provides a week away from inner-suburban life for some 3,000 under-privileged children annually - and the camps run by the Department of Sport and Recreation at Rowsley and Anglesea are located on and/or utilize public land.

A number of bushwalking routes are available throughout this district: some extend short distances, such as those to specific sites in some of the regional parks; others have several days' duration, as along the Lerderderg River.

Golf, motor-racing, football, and cricket on formal developed recreation areas - and even hang-gliding from some of the coastal cliffs - may also utilize public land to varying degrees.

On 21 January 1985, the 212-ha Werribee Park was placed under the control of the Melbourne and Metropolitan Board of

Works. It includes an historic homestead, equestrian centre, golf-course, free-range zoo, and camping and picnic facilities.

Future demand

Recreation pressures on public land are expected to increase as the population of the region continues to grow. In addition, greater leisure time, mobility, environmental 'awareness', and disposable incomes, combined with improved access and facilities, will increase the demand.

With increasing intensity, conflicts and problems can arise and there is always the problem of recreation damaging the environment it seeks to use. Planning for outdoor recreation must cater for these increases, but must also be flexible in order to cope with possible changes in the nature of the demand.

12. PRIMARY PRODUCTION

A dominant feature of much of the landscape of the study area is the extent of agricultural activities. More than 80% of the land is in private ownership, encompassing a range of enterprises from pastoral and cereal production to local market gardens and poultry farms.

Statistics for 1973 and 1983 from the Australian Bureau of Statistics show that, between those years, the number of primary-producing landholders in the region apparently fell by more than 2,200 - to about 3,000 - the average size of holdings increasing from 135 ha to 192 ha. These figures, however, do not take account of the large number of small sub-commercial holdings (generally properties of less than 10 ha) that contribute, in part, to agricultural production.

Sub-commercial holdings, at Gisborne

Some estimate of the total number of primary-producing properties is possible using figures from the State Department of Agriculture's brucellosis eradication campaign, which indicate that some 4,300 properties are carrying cattle, for either meat or dairying. Together with the horse-only farms, market gardens, poultry farms, and cereal-growers, these bring the likely number of agriculturally productive holdings to about 6--7,000 - at least 3,000 of which would be sub-commercial enterprises.

Urban expansion is having an increasingly significant influence on agricultural activities in the district, particularly on those farmlands fringing the cities. (The rates of

Table 13

STOCK NUMBERS

Livestock	1972/73	1982/83
Dairy cattle	44,000	15,000
Beef cattle	222,000	97,000
Sheep	1,657,000	1,355,000

Source: Australian Bureau of Statistics

population increase in the municipalities of the district are shown on Map 2). Its effects can be seen in the economics of farming, the increasing competition for land and water for domestic purposes, increasing demand for land for recreation, and the nature of the agricultural enterprises.

As Table 13 shows, the numbers of livestock in the district have fallen considerably over the last decade as a result of a number of influences, including land subdivisions, previous overstocking, and poor seasons.

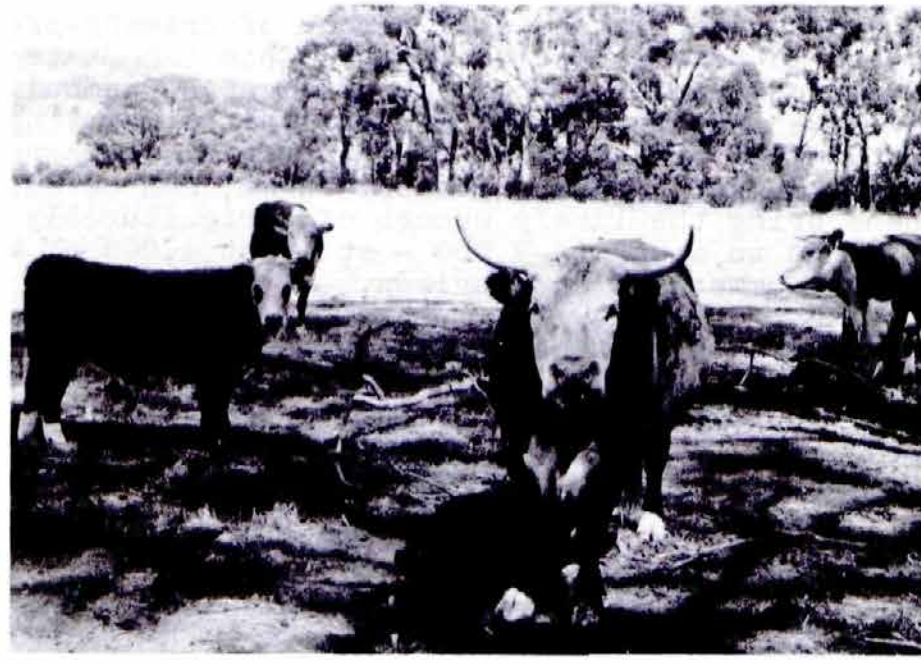
Dairying

The numbers of dairy cattle in the district have fallen by some 66% to 15,000, compared with a fall of about 25% (to 1,477,000) in the State as a whole. The greatest decline in dairying has been registered in the Shires of Barrabool, Bellarine, Bulla, and Werribee. This form of production has been largely replaced by vegetable production and subdivision for small-scale farming and grazing. It is expected that over the next few years investment of capital in dairying will fall further, the extent of reduction depending primarily upon the profitability of the industry.

Beef cattle

During the 'beef boom', which peaked in 1972/73, overgrazing caused severe damage to pastures in the area. The numbers of cattle now being grazed here (some 56% less than in 1972/73) more accurately reflect the long-term carrying capacity.

Beef cattle at Cobaw



Sheep

No single cause has been responsible for the 18% reduction in sheep numbers over the period. All Shires of the district recorded a reduction, which is a function of the economics of the industry, poor seasons (including two drought years), stock losses due to marauding dogs, and the changing tenure and use of farmlands.

Pigs

Suburban expansion has caused many piggeries to close and re-establish outside the urban fringe. Now only some 12,000 pigs remain, with the Shires of Werribee and Daylesford and Glenlyon having the largest numbers. This number represents only 3% of the State's pig population.

Poultry

The Australian poultry industry has grown rapidly and now ranks fifth - after red meat, wheat, wool, and dairying - in the gross national value of primary produce. Victoria contributes 23% of the nation's poultry products, and, of this, 15% is attributable to the study area. Most of the State's production of poultry products (97% of the broilers and 67% of the eggs) comes from the farmlands fringing Melbourne and Geelong.

Cereals

Although contributing only a small percentage of the State's production, the cereal crops on the low-rainfall basaltic plains north and west of Melbourne are important to the local economy. About 9% of the Victorian barley crop is grown on 23,000 ha in the Shires of Bannockburn, Corio, Melton, and Werribee. Production of oats for grain and hay is limited, although the Melton area maintains the tradition of supplying hay to the horse industry around Melbourne. Lupins are grown on some 400 ha of land in the region, largely replacing the growing of field peas for grain.

Overnight dews and cool weather in early summer often prevent early-morning cereal harvests in the region - making the stripped grain too moist for bulk storage. Nonetheless, bulk wheat is delivered to silos at Sunbury, Melton, and Geelong and barley is transported to silos at Sunshine and Geelong.

Vegetables

The most extensively grown vegetable here is potatoes. Of Victoria's production of 350,000 tonnes, some 33,400 tonnes or 9.5% come from the study area, with the main producing Shires being Bellarine, Daylesford and Glenlyon, Kyneton, and Ballan.

A significant proportion of the fresh produce offered for sale at the Melbourne Wholesale Fruit and Vegetable Market is derived from market gardens adjacent to the metropolitan area at Werribee, Keilor, Bacchus Marsh, Bellarine, and Bannockburn.

Public irrigation systems supply the necessary supplementary water at Bacchus Marsh and Werribee (see Table 14), the Maribyrnong River supplies Keilor, and reticulated water is used on the Bellarine Peninsula.

Altogether, some 4,500 ha of land support vegetable production - including potatoes. Two crops are often produced on

Sorting potatoes (left) and commercial strawberry production on the Bellarine Peninsula

the one area in a year, particularly in the Shires of Werribee and Keilor.

Fruit

Somewhat fewer than 500 ha carry apples, pears, wine grapes, and berries. Small areas on the Bellarine Peninsula support strawberry-growing, largely to supply tourists through the holiday season from December to Easter.

Cut flowers and nurseries

The industries grouped under 'nursery and ornamentals' are many. In general, they are labour-intensive and frequently highly capitalized. Within Victoria, they cover the production and distribution of about 3,000 plant species. Most production is oriented to supplying the domestic market, but the opportunity to develop increased exports is being explored.

Table

LAND USE WITHIN IRRIGATION

Irrigation district	Total area	Area suitable for irrigation	Total area irrigated
Bacchus Marsh	2,069	1,297	1,193
Werribee	3,760	3,510	3,012
Total	5,829	4,807	4,205

* Includes areas considered uncommanded by gravitation

Segments of these industries can be found throughout Victoria. However, due to a combination of suitable soils and climate as well as a large population of consumers nearby, most production nurseries are located in the fringe Shires of Corio and Bellarine.

Apiculture

Victoria as a whole produces honey and beeswax valued at $4.44 million, and 40% of this total is exported. The economics of the industry will probably militate against future expansion. For the study area, apiculture has only minor significance compared with other primary industries.

Public land forests to the north-west, and to a lesser extent the Brisbane Ranges, are the main honey-producing areas in the district, although many hives are located on private land where the bees assist in the pollination of agricultural crops. Heavy honey yields are obtained from river red gum, grey box, and red stringybark. The issue of bee site licences for the messmate stringybark forests tend to be cyclic, with the larger number of applicants coinciding with the 4-year flowering peak of this species. The pollen provides valuable over-wintering food for the bees.

Irrigation farmlands

The rich alluvial flats of the Werribee River - at Bacchus Marsh and Werribee - lie within a rainshadow, and irrigation systems have been employed here since soon after settlement. Some 5,800 ha of land in these two Irrigation Districts are suitable for irrigation - these are delineated on Map 6 'Water Resources and Utilization'. Table 14 shows the various crops raised under irrigation during 1983/84 and indicates that these occupy about 87% of the total area suitable for irrigation. The volume of water delivered for such purposes in the two areas over the same period is shown in Table 6.

14

DISTRICTS (ha), 1983/84

Area irrigated for:					
Cereal crops	Lucerne	Perennial pasture	Orchards	Market gardens	Fallow
2	132	584	256	218	1
-	69	830	15	2,080	18
2	201	1,414	271	2,298	19

Source: Rural Water Commission

Land values

The report for the Melbourne study area, in December 1973, recorded that agricultural land values were rising faster and to higher levels than elsewhere for several reasons, all associated with proximity to the concentrations of population in Melbourne, Geelong, and Ballarat. Adjacent rural land is being used for residential allotments, and land at a greater distance is being subdivided for commuter settlement. The intervening years have seen this process continue, with little likelihood at this stage (July 1984) of slackening.

Rising values of land and the increasing costs of production continue to make commercial farming financially unattractive and difficult to sustain, particularly if the landholder does not have a high (at least 90%) equity in the property.

Agricultural use of major soil types

The general characteristics of the broad soil groups found in the study area were described in the 1973 report, and the relations between the soils, parent rock, and topography are further discussed in Chapter 4 (Geomorphology and Soils) of the current report. The following section indicates the agricultural uses made of the various major soil types of the district. Soil types are grouped according to the primary form of soil profile - uniform, gradational, or duplex. Further information is contained in Appendix II - Geomorphic Surfaces and Associated Soils.

Uniformly textured soils
(Textural differences, if any, are small and boundaries are indefinable)

Sandy soils are limited in productivity by their low water-holding capacity, low nutrient status, and the leaching out of applied or accumulated nutrients. Such soils occur on the Bellarine Peninsula and in a band between Barwon Heads and Torquay. Potatoes, vegetables, berries, and flowers comprise the main agricultural enterprises.

Loam soils are relatively fertile but are restricted to alluvial flats, primarily at Bacchus Marsh and Werribee South. Fruit and vegetable production predominates, and small crops of lucerne are grown.

Clay soils usually have a high nutrient status, but - except for the more friable profiles - productivity is limited by low permeability, waterlogging, and compaction. Such soils are widespread through the Shires of Bannockburn and Corio. Either cropping with a little grazing or *vice versa* applies on these soils.

Gradational soils
(Progressively finer - more clayey - texture with depth)

Gradational soils are most widespread on the steeper slopes; usually with shallow, stony profiles of low to moderate water-holding capacity. Here, grazing only predominates.

The deep, friable, red volcanic soils of the Trentham--Romsey area are notable exceptions. Here, permeability is high and they are used for the more intensive horticultural crops such as potatoes, orchards, grapes, and lucerne.

Duplex soils
(Marked change in texture - clay content - with depth, producing definable horizons)

Duplex soils are generally slowly permeable and productivity is usually limited by seasonal waterlogging rather than by lack of nutrients.

Mottled acidic duplex soils with ironstone are older more-leached profiles, and differ from other duplex soils in that their physical properties are favourable for agriculture but fertility is particularly low. These soils persist on gentle land surfaces, notably the Tertiary sediments in the south-west and in the north along major watersheds on Palaeozoic sediments or granitic rocks. Grazing is the main use, and heavy dressings of fertilizer are required to maintain pasture growth.

Sodic duplex soils have alkaline dispersible subsoils, and those on slopes are prone to sheet and gully erosion; disturbance should therefore be kept to a minimum. These soils are used primarily for grazing, with little cropping.

Red calcareous duplex soils, often known as red-brown earths, are found on the alluvial and basaltic plains west of Melbourne. With the dry climate (500--550 mm annual rainfall), the surfaces tend to be poorly structured and very sensitive to compaction. These soils are cropped regularly with barley and wheat.

Duplex soils with a yellow clay subsoil characterize the central Bellarine Peninsula. Grazing predominates and pastures are retained for long periods.

Native vegetation on farmlands

Clearing of the natural vegetation from private lands is continuing, although at a slower rate than in the 1960s and '70s, and little of the original vegetation remains on these areas. Some revegetation work has been undertaken - generally on small sub-commercial holdings.

Where present, remnants of the original vegetation and the rehabilitated areas complement the scattered blocks of vegetated public land in maintaining some wildlife habitat and visual diversity. In some cases private land may contain the only remnants of the original vegetation of the local region - such as the grey box and buloke woodlands south of Exford.

Agricultural use of public land

Most agricultural production in the district occurs on private land, although the forests are used extensively for apiculture and some grazing. Some small blocks of public land support cropping, as well as grazing under licence, and

in many cases are indistinguishable from freehold land. Some 13,000 ha of public land are also used for agricultural research, sewage farms, and other purposes.

Licensed grazing areas usually adjoing the licensee's freehold property. Where forested public land is used it is usually to provide shelter for the stock; whereas on cleared public land, such as the recently purchased land in the Parish of Bungal, grazing reduces the fire hazard of excessive grass growth. For several months in the 1983 drought, up to 2,300 head of sheep from the Mallee and Wimmera were agisted in young softwood plantations in the district.

The Animal Research Institute, managed by the Department of Agriculture, occupies some 850 ha of public land at Werribee - some 700 ha of which carry crops and irrigated and dry pastures. The Institute studies such fields as animal husbandry, dairy practices, agricultural engineering, and fodder conservation. The Attwood Veterinary Research Laboratory, located on 65 ha of land at Westmeadows, is also managed by the Department. Research here concentrates on health aspects of farm animals.

At Sunbury, the Department of Community Welfare Services manages some 140 ha of grazing land. Stock from here provide meat for Pentridge prison.

Sewage from the northern and western suburbs of the Melbourne metropolis is piped to the Melbourne and Metropolitan Board of Works' Sewerage Farm at Werribee. The sewage is treated on the 11,600-ha farm by stabilization in lagoons or pasture irrigation during summer and grass filtration during winter. Beef cattle and sheep graze the irrigated pasture and provide a source of income to the Board. Studies have also been conducted to determine if other crops could be successfully grown in the area, and these studies could provide valuable information on the re-use of raw or treated sewage for agricultural purposes.

Commercial Fisheries

Some 24% of Victoria's commercial fish catch comes from or through Port Phillip Bay. The Bay itself supports commercial fishing of finfish, squid, scallops, abalone, and mussels.

Fishing boats moored at Queenscliff

Finfish and squid

The major commercial species of finfish obtained are southern anchovy, Australian salmon, rock flathead, sand flathead, southern sea garfish, yellow-eye mullet, long-finned pike, pilchard, snapper, King George whiting, and gummy shark.

Table 15

TOTAL ANNUAL CATCH OF FINFISH AND SQUID
(tonnes liveweight)

1978/79	1979/80	1980/81	1981/82
940	1,340	1,279	1,248

Source: Commercial Fisheries Branch - Fisheries and Wildlife Service; Department of Conservation, Forests and Lands.

Scallops

The availability of scallops in commercial quantities depends on the success of settlement of the larvae, which in turn depends on environmental conditions prevailing at the time of settlement. The abundance of this shellfish therefore varies with time and this is reflected in the levels of catch noted in Table 16.

Table 16

ANNUAL SCALLOP CATCHES PORT PHILLIP BAY
(tonnes liveweight)

1981	1982	1983
11,800	3,990	2,250

Source: Commercial Fisheries Branch - Fisheries and Wildlife Service; Department of Conservation, Forests and Lands.

Abalone

Approximately 200 tonnes (liveweight) per annum have been obtained from Port Phillip Bay during the last few years.

Mussels

Between 900 and 1,000 tonnes (liveweight) per annum of dredged mussels have been taken from Port Phillip Bay during the last few years.

Following initial trials of the artificial culture of mussels on floating rafts in the Bay, some 20 leases, each of 3

ha, have been issued for the commercial production of this species. It is expected that such commercial production may produce similar quantities of the shellfish to that obtained from dredging, without the consequent disturbance to the benthic communities.

Mussels are an important source of food for snapper, and it is possible that mussel-beds also harbour many of the other organisms eaten by this fish. Concern has therefore been expressed that commercial dredging for shellfish could destroy the food and habitat of snapper. Studies are progressing to determine the diet of snapper and, to date, these have shown the fish to be an opportunist feeder that adapts to the available food species.

Snapper netted from Port Phillip Bay

Outside the Bay, the commercial fishing industry is based on Barwon Heads, Torquay, Anglesea, and Lorne.

Barracouta and abalone comprise the main catch at Barwon Heads, with long-finned pike also important. Torquay has abalone and rock lobster as the main catch, but barracouta are also caught. Important species caught from Anglesea are barracouta, shark, rock lobster, and snapper. Barracouta also form the bulk of the total catch at Lorne, which is one of the largest centres for this species in Victoria but also has a substantial catch of rock lobster and snapper.

Catch sizes at both Barwon Heads and Lorne have declined in the last 10 years and those at Torquay and Anglesea have fluctuated. Nearby - at Apollo Bay - the catch has been increasing.

The Marine Science Laboratories at Queenscliff are investigating the feasibility of developing a new mariculture industry in Port Phillip Bay based on the native mud (Port Lincoln) oyster. Some 25,000 seed oysters have been suspended mid water in 'Japanese lantern' nets in the Bay, and for final development will be set out in trials at mid water and on the bottom. The current research program seeks to determine such factors as suitable materials and location for securing natural spatfall, the feasibility of natural hatcheries, growth rates in various locations, and suitable

clean waters.

Fresh-water fisheries

Eels form the major resource for commercial fishing in the rivers and estuaries of the study area. Nine water bodies are of commercial value here, the most important being the Moorabool River and the middle reaches of the Barwon River. Further details are shown in Appendix VIII.

References

Winstanley, R.H. (1983). The food of snapper *Chrysophrys auratus* in Port Phillip Bay, Victoria. *Department of Conservation, Forests and Lands, Commercial Fisheries Report* No. 10.

Department of Primary Industry Australia (1984). Possible oyster industry for Victoria. *Australian Fisheries*, 43 (10).

Coastal Management and Co-ordination Committee (1979). 'The Barway Coastal Study: 1, a Basis for Planning and Management.' (Government Printer: Melbourne.)

13. SOFTWOOD PRODUCTION

To meet a requirement for softwood sawn timber and long-fibre pulpwood, and to supplement the wood supply from native hardwood forests, the planting of softwoods in Victoria commenced late last century. Initially, establishment took place at a number of locations. At Macedon, a Forest Nursery was established in 1872, and the first commercial plantings followed in 1880. In the period 1880--1910 many exotic species were established in plantations at Macedon and the You Yangs south-west of Melbourne.

Radiata pine was the outstanding success on a number of soil types and through a range of climates. This led to the mistaken belief that the species would grow practically anywhere and a number of plantations were established in coastal regions without adequate knowledge of the essential requirements for good growth. Plantations established at Frankston (1910), French Island (1911), and Anglesea (1923) all failed, and only remnants persist today.

Based on the experience gained from those early plantings that were successful, further plantations were established on suitable sites as funds became available. This phase, which lasted until the early 1960s, provided a basis for the establishment of softwood sawmills at a number of centres. Not until funds became available on an assured basis from the Commonwealth government in the 1960s, however, could a sustained planting program be established.

The Forests Commission designated eight development zones for Victoria (in areas suitable for the growth of pines), in which planting was to take place. The aim in setting up the zones was to provide sufficient softwood resources to support the establishment of a range of permanent wood-using industries at suitable decentralized sites, thereby providing employment opportunities as well as supplying an important industrial raw material that would otherwise have to be imported.

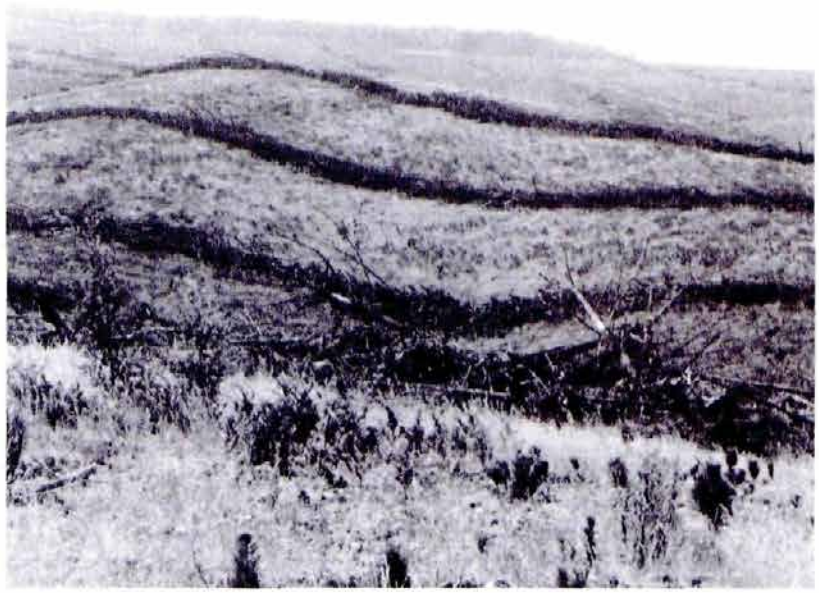
Management goal for the plantations is to grow trees for sawlogs, veneer logs, and roundwood, using a forest management strategy that will optimize sawlog and veneer log production.

The study area includes part of the Ballarat Softwood Development Zone, which is centred on plantations in the Ballarat --Creswick--Beaufort area, but also includes the softwoods in the vicinity of Daylesford and Macedon.

The bulk of the study area's plantations lie in the vicinity of Daylesford. Output from these plantations is currently at a low level because they are still young; an exception is the small area at Mount Franklin, which yields some sawlogs and pulpwood.

The 1983 Macedon fires burnt some 1,420 ha of softwood plantation. A total area of 20 ha not burnt in these fires will be harvested over the next 2 years. The bushfires on Ash Wednesday also burnt along the coast, from Apollo Bay to Torquay, and destroyed the remnant softwood plantations and research plots at Anglesea. Salvage logging of the research plots yielded 3,838 cu.m of sawlogs and pulpwood. These areas will not be replanted.

Macedon softwood plantation, following salvage logging and replanting



Existing plantations

Table 17 gives the net area of softwood plantations established on public and freehold land in the study area. It shows that the majority of plantations are publicly owned.

Table 17

SOFTWOOD PRODUCTION AREAS
As at 31 December 1984

	ha
State forest	
Established plantations	1,823
Burnt - awaiting replanting	1,343
Other government ownership	
Education Department	745
Geelong and District Water Board	407
Private plantations	
Farm forestry	648
other	473
Total:	5,439

Source: Department of Conservation, Forests and Lands

In 1981 the Commission purchased a further 327 ha (gross) of former farmland in the Parish of Bungal (shown as BSP on Map

8) on which to establish a softwood plantation. This area is at present grazed under licence.

Wood-based industry

Planation softwoods produce the raw material for a variety of end uses, including light and, in laminated form, heavy construction, flooring, weatherboards, joinery, furniture, veneers and plywood, particle-board, paper, and fencing materials. The timber is suitable for pressure treatment with preservatives, enabling it to be used in situations where it is exposed to insect and fungal attack.

Table 18 shows the various industries processing softwood material from the State forest of the study area. A number of these industries are based outside the review area, such as at Ballarat, Harcourt, and Keon Park, and also draw supplies from a larger region.

Table 18

INDUSTRIES PROCESSING SOFTWOOD FROM STATE FOREST

Centre	Industries		Volume entitlements[1] (cu.m)		
	Number	Type	Sawlog	Veneer log	Roundwood
Woodend--Macedon	2	Sawmill	7,400		
Harcourt	1	Sawmill	5,500[2]		
Keon Park	1	Veneer mill		15,000[3]	
Ballarat	1	Particle-board			37,760
Bungaree	1	Preservation treatment			(note 4)

Source: Department of Conservation, Forests and Lands, 1985

Notes:

1. The table shows each industry's total entitlement from all sources in and out of the study area. The roundwood figure is the Minimum Annual Supply of pulpwood for calendar year 1985, from all areas of supply, under the *Forests (Softwood Timber Agreement) Act* 1969.

2. Logs are obtained entirely from outside the study district. Additional parcels of sawlog are occasionally made available from the Mount Franklin plantation, within the study district.

3. About 800 cu.m of this material was formerly supplied from the Macedon plantations, prior to the 1983 Ash Wednesday bushfires.

4. Parcels of softwood timbers for preservation have from time to time been obtained from the district.

Softwood supply commitments

Annual commitments of sawlogs and veneer logs from the Macedon plantations totalled some 8,200 cu.m on a sustained-yield basis, prior to the 1983 Ash Wednesday bushfires. Provision was also made for the removal of round preservation timbers, and the supply of 3,000 cu.m of pulpwood to the particle-board plant in Ballarat. The only other source of material from the study district was a small plantation at Mount Franklin, which occasionally provided 1,200-cu.m parcels of sawlogs to a mill at Harcourt.

Mount Franklin plantation occasionally provides softwood sawlog material

Immediately after the fires some 117,000 cu.m of sawlogs and veneer logs and 22,000 cu.m of pulpwood had to be salvaged. Due to entitlement restrictions, only 12% of the logs could be converted at local mills; more than 40% was transported for conversion at Myrtleford, and 30% to Colac, with the balance being sent to plants in Ballarat and Melbourne. The salvaged pulpwood constituted the principal source of supply for the particle-board plant at Ballarat in 1983.

Until production can be resumed from the replanted areas at Macedon, the two local sawmills will be supplied from elsewhere in the State. Arrangements have already been made for alternative supplies for the veneer mill and particle-board plant. Young plantations in the vicinity of Daylesford have not yet attained merchantable size, and no sawlog commitments have yet been made from this area.

The government has entered into one legislated agreement to supply pulpwood from a zone of supply that includes study area plantations. The *Forests (Softwood Timber Agreement) Act* 1969 provides for supply to Australian Consolidated Industries Ltd over a period of 20 years. The company operates a particle-board factory at Ballarat. The present level of 37,760 cu.m per annum will be maintained until 1989. This material is to be supplied exclusively from the Ballarat Softwood Development Zone.

Future development

It is government policy that the clearing of intact native forests for softwood planting be phased out. To this end, new plantation areas are being established on purchased cleared farmlands, such as in the Parish of Bungal, as and when suitable land becomes available. Constraints on the availability of funds to purchase further areas in suitable locations may limit the extent of additional plantations.

14. HARDWOOD PRODUCTION

Hardwood forests and woodlands originally covered a substantial proportion of the study area, and have been used as a source of wood since early settlement; now they are confined principally to public land. In these mostly mixed-species foothill forests, the occurrence of the various eucalypt species is controlled by environmental factors such as temperature, soil type, and soil moisture status, which depend largely on aspect and rainfall.

Logging in State forest is carried out in accordance with prescriptions approved by the State Forests and Lands Service. These prescriptions set down operating procedures aimed at reducing the impact of logging on water quality and catchment values. They cover such matters as retention of strips of undisturbed vegetation along streams, log snigging, location of landings, road and track standards and maintenance, regeneration standards, and the responsibilities of supervisors. Their application results in 15--25% of any logging area, on average, being left undisturbed. They also protect identified floral and faunal values, special landscape features, recreation areas, and historical features. Logged and undisturbed areas are dispersed throughout the forests.

Substantial areas of hardwood forest (some of which contain trees of commercial quality) are located in reserves such as the Brisbane Ranges National Park and the Lerderderg and Angahook--Lorne State parks, where timber harvesting is not permitted. Also, other areas of forest such as at Hepburn Springs and Bungal support limited timber production, usually as minor products.

Wombat State forest near Daylesford--Trentham--Macedon provides the principal source of hardwood timber in the study area, as it has since earliest settlement. During the gold-mining era, some sections were so extensively cut over for mining and structural timbers that they were closed to utilization from early this century until the late 1940s. It is to these forests that the following comments principally relate.

Silvicultural systems

Logs are taken from the Wombat State forest mainly under the silvicultural method known as the 'shelterwood system'. This method is applied to forests containing trees of varying age and size. It involves two commercial fellings - a regeneration felling (removing sawlogs and pulpwood logs) and a removal felling, some years after establishment of the regeneration.

Regeneration fellings in a mature forest reduce the number of trees on a site to a density of between 25 and 40 per

Regeneration, established following silvicultural works, Wombat State forest

hectare. The retained trees are those of the highest quality (with respect to form) available on the site and provide the seed that is distributed - usually naturally - onto soil bared by either logging or burning, or both. The reduction in tree density must be sufficient to allow the satisfactory establishment and development of the regeneration.

Under this system, the potential of the site is distributed between growth of the large, high-quality trees and the development of the regeneration that has arisen from them. At some future time the removal felling will harvest these high-quality trees, leaving an even-aged replacement crop.

This system has been in operation here for almost 15 years. In its application to date, harvesting has been concentrated on regeneration fellings. The period of retention of the higher-quality trees is quite flexible and, if reasons exist for doing so, removal fellings could take place immediately regeneration is established. In order to achieve the desired growth on the better trees, however - and to achieve the benefits of conservation of landscape, faunal habitat, and catchment values that these trees supply - the system usually assumes a period of between 15 and 20 years between these fellings. The period between successive regeneration fellings on the one site could be about 80 years.

Scheduling of the regeneration and removal fellings can provide for a sustained yield of both pulpwood and high-quality sawlogs. It can also provide sufficient flexibility to compensate for periods, such as poor seed-years, when the establishment of regeneration is difficult.

Shelterwood silviculture is generally applicable throughout open forest III. It would also be applicable to parts of open forest II, but in poorer areas of this structural form, where it is not possible to achieve two economic harvestings, seed-tree silviculture would be more appropriate. This system retains a similar number of trees on the site (25 to

40 per hectare), but these trees are culls (unmerchantable). This form of silviculture is not fully instituted as yet, as the pulp yield would be in excess of that required from the region. Open forest I areas yield only minor products, such as posts and firewood, and single trees are selected for this purpose.

Forest types

The forest types discussed below correspond broadly with the units used in the description of the vegetation in chapter 7. Those types of little significance for timber production are not included, however. Also excluded is the small area of mountain forest on Mount Macedon - within the Macedon Regional Park.

Messmate stringybark--peppermint--gum

These forests generally occur at elevations between 50 m and 1,000 m in areas receiving between 600 and 1,200 mm rainfall annually. They tend to comprise stands of several species mixed together - the most important for timber production being messmate stringybark, narrow-leaf peppermint, and candlebark. Less-important species include brown stringybark, manna gum, and mountain grey gum.

Messmate stringybark, either as pure stands or in mixture with the other species, reaches its best development in the study area on the deep soils of the Wombat forest, which support rapid growth. These forests are the most important here for sawlog production and the better-quality stands are managed principally for this use.

Also, extensive areas of low open forests of peppermint--stringybark occur north of the Divide and in the south-west. The bulk of these forests occupy the drier aspects, where the predominant species are broad-leaf peppermint and red stringybark. Harvesting is intermittent, usually on a single-tree selection basis, and yields only minor products.

Box--ironbark

Red ironbark, yellow gum, and red stringybark mixed forests grow on poor soils below 500 m elevation, in areas where the annual rainfall is less than 700 mm. They are not well developed in the study area, occurring infrequently near Tooboorac and Anglesea, and in the Brisbane Ranges. Timber production occurs only in the former and yields durable wood for posts and poles. Mature stands rarely exceed 25 m top height, and in the drier areas form woodlands rather than forests.

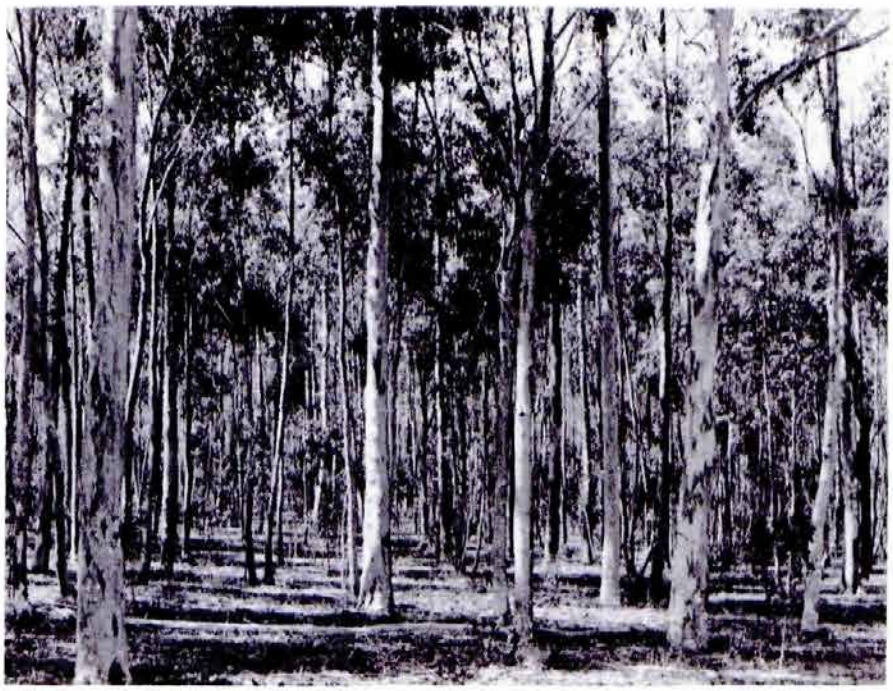
Plantations

Some of the earliest selections of grazing lands were in the vicinity of the You Yangs. Some 1,000 ha here was resumed for forest purposes in 1884, and during the next 20 years about 400 ha were planted to tree species. These early plantations largely comprised coniferous species, although a small proportion was planted to blue gum, sugar gum (*E.*

cladocalyx), and golden wattle. The foresters found that the climate was largely unsuited to pines, and during the period 1928--38 harvested most of the larger stands of these species and replanted the areas with sugar gum. Other eucalypts such as red ironbark, brown mallet (*E. astringens*), and swamp yate (*E. occidentalis*) were also tried, but proved unsuitable for commercial production.

The stands of wattle initially yielded large quantities of tan bark, but a gradual decline in the market for this material led to the conversion of these areas also to sugar gum - from the 1950s onwards.

These predominantly sugar gum plantations are currently managed to yield small quantities of farm timbers and firewood from low-intensity operations.



Sugar gum plantation in the You Yangs Regional Park

Between 1928 and 1932, another plantation was established on the Shelford Road west of Bannockburn. The original area has subsequently been reduced by excisions for a golf club, school plantation, and a rubbish tip. The most recent series of plantings at this site were made between 1961 and 1969.

Currently, the plantations comprise some 655 ha in the You Yangs Regional Park and about 92 ha at Bannockburn, mainly of sugar gum.

Timber Products

Sawlogs

The hardwood forests of the study area supply up to 60,000 cu.m of sawlogs annually, which is about 3--4% of Victoria's annual production from State forests. The present level of cutting is at or slightly above the sustainable yield determined for the public land from which production of hardwood timber is permitted.

Sawn timber produced at the 11 mills taking logs from the area (see Table 19) is sold locally and in metropolitan Melbourne for general construction purposes. Sawmills are located at Woodend, Kyneton, and Newlyn; the Lyonville--Daylesford--Korweinguboora district contains six mills, while another two are located at Ballarat. Together, these mills provide full-time employment for about 156 persons and part-time employment for a further 11, making them an important source of regional employment. It should be noted that the mills at Woodend, Newlyn, Daylesford, and Ballarat also draw a small proportion of their supplies from outside the study area.

Table 19

HARDWOOD SAWMILLS DRAWING SUPPLIES FROM STATE FOREST

Centre	No. of sawmills	Total direct employment[1]	Sawlog entitlement[2] (cu.m)
Daylesford--Leonards Hill--Korweinguboora--Newlyn	5	53	15,540
Bullarto--Lyonville	2	27	9,620
Ballarat	2	39	12,050
Woodend--Kyneton	2	48	23,300
Total	11	167	60,510

Source: Department of Conservation, Forests and Lands

Notes:

1. Employment figures include workers engaged in harvesting and sawmilling during the period 1983/84, as well as six part-time employees at Woodend and five at Lyonville.

2. Sawlog entitlements are the annual volumes allocated from the study district to the mills at the centres listed.

While private property has provided sawlogs in the past, clearing of land for agriculture has reduced the volume that can be obtained from this source. In those instances where a forest cover has been retained, ownership of the land has, in many instances, passed to individuals seeking to obtain a bushland retreat. The combined effect of these contrasting trends of clearing and vegetation retention has been to reduce the volumes of sawlogs becoming available from private property and to increase the dependence of sawmillers on supplies from public land.

Black Forest Sawmill uses logs such as those, from the Wombat State forest, shown below

Sawlogs - Wombat State Forest

The study area's hardwood mills mainly produce unseasoned structural timber, and sell lower grades for garden stakes or for use in pallet manufacture. Close proximity to the Melbourne market and the ability to produce and deliver house-lots of timber to individual building sites at relatively short notice go some way towards off-setting the advantages that larger mills elsewhere achieve through economies of scale. Some of the sawmills are investigating the production of stabilized timber.

Pulpwood

The other major timber product derived from the area's forests is hardboard manufactured from forest and mill residues at the Hardboards Australia Ltd Plant at Bacchus Marsh. ('Forest residues' comprise the upper sections of trees from which sawlogs have been cut and other material too small or defective to produce sawlogs that is felled during silvicultural treatment of a stand. There are no 'pulpwood only' logging operations in these forests. 'Mill residues' comprise offcuts and the outer curved slabs that are otherwise wasted during the conversion of logs to square-sawn timber.)

Pulpwood is supplied from public land under the *Forests (Pulpwood Agreement) Act* 1959. The area of supply fixed by this Agreement lies substantially within the study district, and includes all of the Wombat State forest. It supplied some 57,000 tonnes during 1983/84. In addition, raw material in the form of chips from residues of most of the sawmills in the region constitutes a sizeable proportion of the total wood intake to the plant.

Raw material is also obtained from private property although (as is the case with sawlogs) the company has experienced increasing difficulty in obtaining supplies from this source. Continued experimentation with the manufacturing process has resulted in wood now being accepted with bark on - thus reducing the visual impact following forest operations.

The company now has investments in Victoria valued at some $38 million, and provides employment in both the mill and forest operations for some 240 persons. It has rationalized its involvement in hardboard processing over the last 7 years, downgrading operations in some States, but increasing investment at Bacchus Marsh. The plant is currently operating on a 7-day 21-shifts-per-week basis.

Other wood products

Preservative-treated transmission poles and farm timbers have been an important product from the Wombat State forest for nearly 30 years. A creosote-treatment plant was established at Trentham in 1957 to pressure-treat timbers from the area's regrowth forests. While the operation was once a major source of treated poles to the State Electricity Commission, output has fallen from some 27,000 lineal metres in 1981/82 to only 289 lineal metres in 1983/84. This reduction is due to a number of factors, including the reduced demand from the Commission for creosoted poles, difficulties

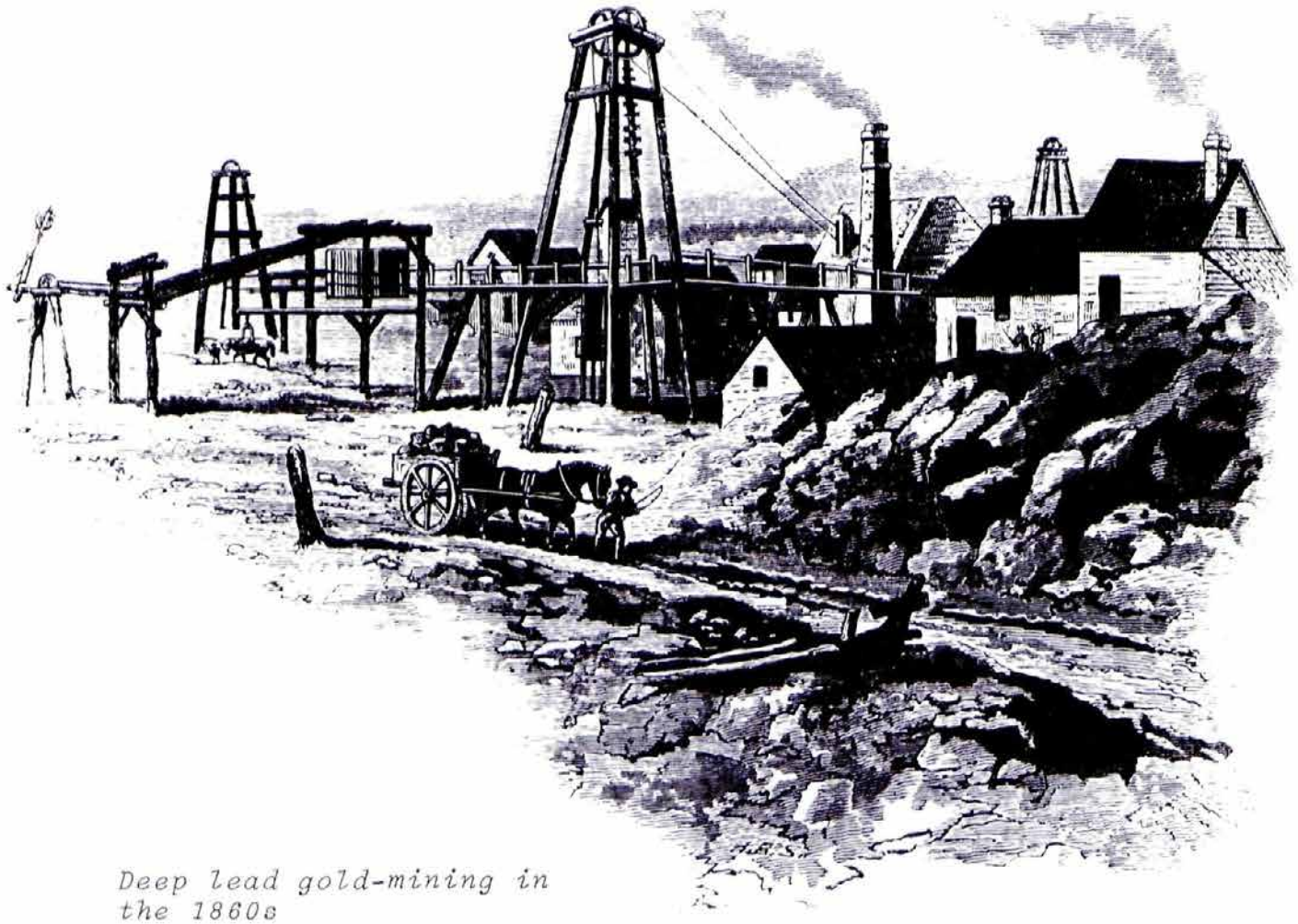
Pulpwood dump near Trentham - Wombat State forest

in handling the treated material, experiments with alternative preservatives, and a reduction in the availability of pole-class trees in the area's forests (the trees have achieved larger dimensions than the Commission requires).

Minor products, such as fencing materials, are also obtained from the area's hardwood forests. After going through a period of decline in the late 1960s and early '70s, firewood production is again increasing. An indication of the number of individuals seeking to cut firewood for their own use can be obtained from the number of licences issued - currently some 1,400 per year. At an average per licence of 5 tonnes, this represents some 7,000 tonnes of firewood per annum. Six commercial firewood-cutters also operate for at least some of the year in the Wombat State forest, where they cut a further 300 tonnes per annum. At present, firewood-cutting takes place following integrated logging operations, as dry firewood is the preferred material sought. Any substantial increase above this level may require the cutting of green firewood in areas specifically marked for this purpose, thus providing a means of silviculturally treating regrowth forests.

The plantations in the You Yangs and near Bannockburn also yield minor forest products - some 3,700 tonnes of firewood and 6,700 pieces of round timbers being cut in 1983, principally for local use. The plantations are managed for the production of high-quality poles and posts; firewood is cut from the heads of pole and post trees.

15. MINING AND QUARRYING



Deep lead gold-mining in the 1860s

Minerals

Mineral data used in the original Land Conservation Council report for the Melbourne area was compiled over the years 1971--73. The relevant chapter discussed all mineral occurrences in the area that were known at the time. It is intended that this chapter will summarize and update that original material where required, as well as provide a summary of mineral exploration activity over the last decade.

Tenements under the *Mines (Amendment) Act* 1983

Table 20 lists those tenements that have been issued or are the subject of applications under the *Mines (Amendment) Act* 1983. Tenements belong to a variety of types and, as at May 1984, there were 39 issued and 34 under application.

Mining

Brown coal extraction is the only large-scale mining activity occurring in the area. Alcoa of Australia Ltd mines

about 1.1 million tonnes of coal annually from its colliery on public land at Anglesea. The company uses this coal to generate power for its aluminium smelter at Point Henry, and surplus power is transferred to the State Electricity Commission grid. Economically recoverable coal reserves total approximately 100 million tonnes. Alcoa has a 50-year lease over this coal resource under the provisions of the *Mines (Aluminium Agreement) Act* 1961.

A subsidiary of Australian Paper Manufacturers Ltd mines about 100,000 tonnes of brown coal annually from its colliery at Maddingley, near Bacchus Marsh. This resource, which occurs on private land, has estimated reserves of some 60 million tonnes. Much of the coal is used in the furnaces of the hardboard plant at Bacchus Marsh.

Gold-mining on public land in the area is currently being conducted under Miner's Right claims. These small tenements are normally limited to 1 ha (but, with the consent of the Minister for Minerals and Energy, may range up to 5 ha), and have minimal expenditure and work requirements. Production returns are not required for these tenements, and there is therefore no record of how much gold is being produced from the 10 Miner's Right claims current on public land in the study area.

Three mining leases - a more substantial form of mining tenement - are current in the area and there are applications for 10 others, all of which contain at least some public land. Of the current leases, one supports a small alluvial gold-mining operation while the other two have recently been transferred to new operators and exploratory work is in progress. Gold is the main mineral of interest and all of the mining leases (including applications) are situated in the north-west of the area, mostly in the vicinity of the Blackwood and Daylesford goldfields (see Map 9).

Development leases are tenements mid way between an exploration licence and an actual mining lease, and are issued to allow the feasibility of putting a mineral deposit into production to be determined. Of the eight applications for development leases, six are at Mount Egerton and one each near Daylesford and Drummond. The last two occur exclusively on public land, while the applications at Mount Egerton cover mostly private land.

Tailings licences are only issued for mine dumps on public land, for either treatment on site or removal. As at May 1984, 14 tailings licences (including two applications) covered removal of mullock and tailings as a source of road-making material. Three applications were current for treatment of tailings to extract gold.

Mineral exploration

This activity undergoes constant and often rapid evolution and change. New ideas and concepts on ore genesis develop and these, backed by changing technologies, lead to constant re-evaluation of known mineralized areas. Tied in closely with this is a basic tenet of mineral exploration - that

Table

TENEMENTS UNDER THE *MINES (AMENDMENT)*

Type & number (a) - application (r) - renewal	Lessee
Mining leases	
35	Blackwood Mining & Exploration NL
512	McFarlane & Others
810	Queensland Alluvials Ltd
959(a)	Emmins
1004(a)	Emmins
1041(a)	Teem P/L
1042(a)	Teem P/L
1072(a)	Bird and others
1075(a)	Morris
1101(a)	Barry's Reef Gold Mine P/L
1181(a)	Ashworth
1182(a)	Ashworth
1184(a)	Ashworth
Development leases	
44 to 49(a)	WMC Ltd
52(a)	Ryan
85(a)	Daringa Mining & Exploration Co P/L
Miner's Right claims	
15	Bird and Bird
23	Hall
49	Ferguson
50	Bellett & Ollington
52	Coad
53	Ferguson
179	Treller
295	Barry's Reef Gold Mine P/L
312	Clark
468(a)	Cann & Morris
502	Goudie
526(a)	Shimmen
557(a)	Ryan
658(a)	Krieger
665(a)	Tunzi
666(a)	Papettas
679(a)	Duncombe
Tailings licences (treatment)	
182 - 184(a)	Fraser
Tailings licences (removal)	
4762	Department of Conservation, Forests and Lands
4763	Department of Conservation, Forests and Lands
4783	Bennett
4786	Germany

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ACT (1983) ON PUBLIC LAND (JUNE 1984)

Locality name	Parish	LCC Recommendations (see Map 8)
Simon's Reef	Blackwood	E2
Black Snake Mine	Blackwood	A4
Barrys Reef	Blackwood	E2
	Trentham	E2
Blue Mountain Mine	Trentham & Blackwood	E2
Simon's Reef	Blackwood	E2
Golden Hope, Ration Gully	Blackwood	E2
Comebak II	Moorabool East	E2
Blue Creek Mine	Trentham	E2
Red, White & Blue Mine	Blackwood	E2, A4
Morning Star Reef, Blackwood	Blackwood	E2, A4
Back Creek	Blackwood	E2
North Briton Mine	Blackwood	E2, A4
Mt Egerton	Bungal and Kerrit Bareet	E1, 045 & private
	Wombat	F1
Back Creek	Drummond	H27
	Moorarbool East	E2
	Wombat	G1
	Wombat	G1
	Wombat	A15
	Wombat	G1
	Wombat	G1
Mosquito Gully	Wombat	F1
Red, White & Blue Mine	Blackwood	E2
Dollys Creek	Borhoneyghurk	K
	Trentham & Coornmill	E2
Struck Oil Mine	Blackwood	E2
Struck Oil Mine	Blackwood	E2
Mopoke Gully	Wombat	G1
Blue Creek	Trentham	E2
Blue Creek	Trentham	E2
Blue Creek	Trentham	E2
Blue Creek	Trentham	E2
	Wombat	-
Yankee Mine	Blackwood	E2
North Briton Mine	Blackwood	E2
Ajax Mine	Wombat	-
Humbolt Mine	Drummond	H27

Table 20 (*continued*)

Type & number (a) - application (r) - renewal	Lessee
Tailings licences (removal) (continued)	
4811	Wallace
4829	Gill
4831	Daylesford Waterworks Trust
4851	Ring
4852	Ring
4865	Wallace
4915	Wallace
4916	Neville
4950(a)	Waldron
4959(a)	Shire of Ballan
Search licences	
2767	Stuart & Stuart
2893	Shimmen
Exploration licences	
812(r)	CRA Exploration
813(r)	CRA Exploration
827	Dampier (BHP Minerals)
889	CRA Exploration
939	Hardrock/Australia Anglo American
954(r)	CRA Exploration
1150(r)	CRA Exploration
1160	TEMCO
1292	Hardrock/Australia Anglo American
1307(r)	Nationwide Resources
1316	Rosscraft Minerals
1346(a)	Southern Continental
1357(a)	Resource Technology
1473(a)	New Resources
1481(a)	Great Fingal Mining
Special lease	
6829*	Alcoa of Australia Ltd

*this is a special Mineral and Reserve Lease under the provisions of

Source: Department of Minerals and Energy

mineral deposits currently regarded as uneconomic may become economically viable in the future, and some minerals not used at present may one day become important.

The new concepts and technologies have led naturally to investigations of land away from known mineralized areas. The search of hitherto-unsuspected ore bodies is an important element in many mineral exploration programs.

Locality name	Parish	LCC Recommendations (see Map 8)
New Specimen Hill Mine	Wombat	-
	Drummond	H27
	Wombat	A15
Maxwell Mine	Wombat	-
Nuggety Ajax Mine	Wombat	-
Central Ajax Mine	Wombat	-
Central Ajax Mine	Wombat	-
North Ajax Mine	Wombat	-
	Bungal	-
Egertons Dump, Barrys Reef	Blackwood	E2
	Blackwood	A4
Struck Oil Mine	Blackwood	E2
Werribee		
Bacchus Marsh - Derrimut		
Broadford		
Ballarat - Meredith		
Morrisons		
Bullarto - Drummond	Exploration licences cover	
Metcalfe - Kyneton	broad areas and all will	
Maude - Bannockburn	contain some public land	
Bungal		
Blackwood - Daylesford		
Lancefield		
Malmsbury		
Franklinford		
Ballan North		
Gordon		
Anglesea	Jan Juc, Angahook, Wormbete	Various

the *Mines (Aluminium Agreement) Act* 1961

Mineral exploration is a high-cost and high-risk activity. If a substantial ore body is found, it can produce a great economic return, but the chance of finding one is low. Victorian experience shows that since 1965 about 1,500 mineral exploration licences have been issued in the State and, although a number of mineral deposits have been discovered, only one of them has proved to be economic at the present time.

In this study area the major work being done by mining companies is exploratory. As at July 1984, 11 operational exploration licences and two search licences were current, all of which cover some public land. In addition, applications were current for a further four exploration licences that also include some public land.

During the last decade approximately $1,700,000 (in 1984 dollars) has been expended on mineral exploration under exploration licences in the study area. For the 1982/83 financial year expenditure was about $340,000. Both these figures exclude expenditures incurred under mining leases, search licences, and Miner's Right claims that are current or have operated in the past.

The continuing interest in mineral exploration is due to the association of mineral occurrences with particular geological environments in the area. These environments have yielded and continue to yield valuable ore deposits, notably gold and brown coal.

Exploration effort over the last decade has ranged from broad-scale activities, often on public land, to detailed exploration of specific prospects, either known (a past mine) or newly discovered, some of which have been on public lands. Exploration techniques have included geological mapping and geochemical and geophysical methods, as well as drilling in places. Map 9 shows the areas investigated since 1970, including a number of current prospects.

The more specific rock types and geological environments that have been actively prospected over the last 10 years are listed below. All of these environments contain some public land.

Gold-bearing quartz veins in Ordovician sedimentary rock

In the north-western part of the district, mineral exploration has centred on reef goldfields discovered in the middle of last century. The most productive goldfields - ranked in decreasing order of significance - are Daylesford, Egerton--Gordon, Lauriston--Taradale, Steiglitz, and Blackwood--Trentham. These goldfields have produced more than 50,000 kg of reef gold and they still rate highly in terms of mineral potential. Many of the areas prospective for gold, with the exception of Egerton--Gordon and Lauriston--Taradale goldfields (see Map 9), comprise large tracts of public land.

Exploration in the last two decades has been concentrated on the search for gold in large, low-grade disseminated or quartz stockwork deposits, and also continuations of small, high-grade quartz reefs. Exploration to date has failed to discover any gold deposits suitable for large-scale mining. However, five companies at present hold, or have applied for, exploration licences to search for reef gold.

The main areas explored for reef gold in recent years are shown on Map 9. Geological mapping and geochemical sampling have been undertaken in the Daylesford--Hepburn Springs area, at Mount Egerton and Ballark, and in a few prospects

near Blackwood, Lauriston, and Malmsbury. Diamond drilling has been used to test prospective quartz reefs north of Blackwood (the Yankee-Countess line of reef), and at Mount Egerton.

Deep lead and alluvial gold

Alluvial gold occurs in ancient stream channels that once drained the goldfields. These leads, as they are known, are now buried under varying thicknesses of younger sediments and/or basalt. Shallow, dry portions of leads were worked by individuals or small parties in the early days of mining on the Victorian goldfields. More extensive mining of gold from deep leads required specialized underground mining techniques to cope with the enormous quantities of water and weak ground conditions. Consequently, the resource remained largely untapped until around the turn of the century, and even then production was limited to relatively small areas of the deep lead systems.

Deep leads within the study area are mostly overlain by basalt valley flows. These areas have been largely cleared for agriculture and only small amounts remain as public land, mostly in the Daylesford--Trentham area. Tributaries of four main gold-bearing deep lead systems are known to occur in the study area. These are listed below and shown on Map 9. The leads have been worked in places and recent exploration has concentrated on previously untested parts as outlined below.

A tributary of the Loddon Deep Lead originates near Daylesford, where it yielded good returns of gold last century. The lead was also worked at Glenlyon, but other tributaries of the Loddon system in the area remain untested.

The stream that formed the Coliban--Campaspe Deep Lead System had its headwaters near Bullarto and flowed north-north-east through Kyneton and Malmsbury. The only significant mining of the lead took place near Malmsbury, but the system is currently under exploration licence and drill-testing is in progress.

A gold-bearing deep lead recently proved near Kilmore is probably a tributary of the Goulburn Deep Lead to the north-nor-east. Recent drilling (see Map 9) showed the lead to be auriferous; however, grades varied erratically.

Morrison's Deep Lead occurs near Meredith and has been worked to a small extent. It is not a lead as such, because the gold is widely distributed within the sub-basaltic sediments of the area. The prospect is currently under exploration licence.

Brown coal within Tertiary sediments

Within the southern half of the study area, brown coal is an important resource. It is being mined by Alcoa from public land adjacent to Anglesea, and by A.P.M. from private land south of Bacchus Marsh. There is further potential for discovering economic deposits of brown coal, and in the last 5

years more than $600,000 has been expended on coal exploration in the area.

Exploration has consisted mostly of drilling and has been concentrated into two main locations, shown on Map 9. The first covers a large area between Altona and Bacchus Marsh, where approximately 40 drill holes proved the existence of large coal reserves underlying basalt, and two exploration licences (812 and 813) are still current in the region. The second lies to the north of the existing Anglesea coal-mine. The 39 holes drilled there have indicated large reserves of brown coal, being intersected at depths ranging from 30 to more than 140 metres. Both locations comprise predominantly private land, but include small areas of public land. At present the coal deposits are uneconomic due to the large thicknesses of overburden; however, they may well be of significance in the future.

Other prospective geological environments

Siluro--Devonian sedimentary bedrock in the north-east of the district is prospective for antimony--gold mineralization within quartz veins. An exploration licence over such a prospect is current on public land at Mount Piper (an Education area), west of Broadford. A sequence of Cambrian rocks on private land near Lancefield is prospective for gold and base-metal mineralization, but this area has not been explored in the last decade.

Stone

'Stone', as defined in the *Extractive Industries Act* 1966, is a general term for sand, gravel, limestone, sandstone, slate, basalt, granite, clay, soil, etc.

Extractive industries fall into two main categories for the purposes of licensing and regulation - non-commercial and commercial operations. When municipal bodies or the Road Construction Authority (RCA) make non-commercial extractions they are not subject to leasing or licensing under the *Extractive Industries Act* 1966. They must however comply with the health and safety provisions of this Act. Non-commercial extraction may take place under a range of Acts, including the *Land Act* 1958, *Local Government Act* 1958, *Forests Act* 1958, and *Country Roads Act* 1958. As with commerical extractions, all operations less than 2 m in depth and more than 0.2 ha in extent are subject to the *Soil Conservation and Land Utilization Act* 1958.

Most of the stone produced from the study area is commercially quarried for use in Melbourne and, to a lesser extent, Geelong. Little public land remains adjacent to these cities, and consequently nearly all commercial production is from freehold land. Extraction for commercial purposes on both public land and freehold land is subject to the provisions of the *Soil Conservation and Land Utilization Act* 1958 for excavations less than 2 m deep and more than 0.2 ha in extent, and subject to the *Extractive Industries Act* 1966 for excavations deeper than 2 m. Operations less than 2 m deep on reserved Crown land are also subject to the provis-

ions of the *Land Act* 1958, while extractions of any depth on reserved forest are subject to the *Forests Act* 1958. Table 21 details stone production by category in the area from tenements under the *Extractive Industries Act* 1966. Of 42 producers under this Act, the three working public land account for only 0.1% of total stone production under the Act.

Table 21

STONE PRODUCTION UNDER THE *EXTRACTIVE INDUSTRIES ACT* 1966 - year ending June 1982 (tonnes)

Material	Land status	
	Freehold	Public
Basalt	2,695,900	
Scoria	488,900	
Sand/gravel	1,067,300	7,400
Limestone	1,842,800	
Clay	225,300	
Soil	16,600	
Total	6,336,800	7,400

Source: Department of Minerals and Energy

The basalts of the Newer Volcanics cover much of the area and lie almost entirely on freehold land. This unit is a major source of hard rock for the urban areas, with 18 current licensed operations, all of which are on private land.

Sedimentary deposits in the Bacchus Marsh area provide a major source of construction aggregate and specialist sand and clay for the metropolitan area. Again the resource lies almost entirely on private land, with none of the 20 or so producers in the area incorporating any surface public land.

Quarrying at Bacchus Marsh

Table

STONE EXTRACTION FROM

Locality		Tenement*
Yandoit		Ext. Industry Lease 239
Yandoit		Ext. Industry Lease 241
Yandoit		Ext. Industry Lease 244
Mollisons Ck	(S.W. of Pyalong	LD Licence 02700/138
	(S.W. of Glenaroua	LD Licence 02708/138
	(S.E. of Glenaroua	LD Licence 02803/138
	(E. of Glenaroua	LD Licence 02803/138
Sugarloaf Ck	(S. of Tallarook--Glenaroua Rd	LD Licence 219/138
	(N. of Tallarook--Glenaroua Rd	LD Licence L7/499
Hughes Ck		LD Licence L7/3283
Goulburn River	(N.E. of Northwood	LD Licence L7/3568
	(S.E. of Northwood	LD Licence 202/138
Pyalong		Agreement with Pyalong W.T.
Bostock Dam		Agreement with GWST
Banganie Bush		FD Licence
You Yangs		FD Licence
You Yangs		FD Licence
You Yangs		FD Licence
Bamba Rd		FD Licence
Bullengarook		FD Licence
Seereys Rd		FD Licence
Lal Lal State Forest		FD Licence
Bungil State Forest		FD Licence

* FD Forests Division) Both of the Department of Conservation, Forests
LD Lands Division)

** Volume figures are approximate only and are derived from the most all for the one year.

Source: Department of Minerals and Energy

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THE PUBLIC LAND

Annual extraction, cu.m (year)**		Operator	Comments
125	(1982)	Shire of Newstead	Quartz gravel quarry
4 040	(1982)	Shire of Daylesford and Glenlyon	Major quartz gravel quarry
408	(1982)	Wallace	Quartz gravel quarry
5 000	(1982)	Monier	Bulk of this angular free-running (clay 5%) sand used in Melbourne for filter sand, propagating sand, and concrete sand
8 700	(1981)	Monier	
10 000	(1983)	Monier	
-		Whyte	
3 000	(1983)	Monier	
2 000	(1983)	Baines	
1 400	(1983)	Monier	
600	(1984)	Parker Bros.	Gravel for road works
1 500	(1983)	Gianarelli	
1 500	(1982)	Sarson	Sand from reservoir at Pyalong
-		Shire of Ballan	Intermittent use
1 500	(1984)	Shire of Bannockburn	About 8% of Shire total
15 750	(1983)	Robbins	Supplying urban Geelong with construction sand; gravel for Corio Shire
40 000	(1983)	Barro	
442	(1983)	Department of Conservation, Forests & Lands	Road Maintenance
8	(1982)	Duff	Royalties indicate only 8 cu. m extracted since 1980
4 000	(1982)	Commonwealth and others	Quartz gravel, continuing demand
810	(1966--1984)	Barca	Castlemaine slate; Melbourne market
138	(1984)	Shire of Buninyong	Intermittent use
355	(1981)	Shire of Ballan	Intermittent use

and Lands

recent statistic available; it is difficult to obtain the information

Two large limestone quarries on private land near Geelong (Batesford and Waurn Ponds) cater for the major part of the cement market in Victoria.

Within the study district itself, there is a substantial and continuing demand for stone for road construction and maintenance, and to a lesser extent for other construction purposes. The RCA and the shires are the principal users of this stone. Of the 18 shires in the district, four (Ballan, Bannockburn, Corio, and Daylesford and Glenlyon) obtain some 5%, 8%, 95%, and 100% respectively of their gravel requirement from a single pit or quarry on public land within their municipality. The shires of Buninyong and Newstead - both lying outside the district - extract some gravel from public land within it.

Table 22 details those quarrying operations that are licensed under a variety of Acts on public land in the study district. Approximately 100,000 cu.m was extracted from these public lands in 1982/83, representing about 1.4% of the total quantity of stone extracted from both private and public land. Of this volume, about 58% came from the granitic sand pits in the You Yangs, 29% from the beds of Mollison and Sugarloaf Creeks, and 5% from the quartz gravel deposits at Yandoit.

You Yangs - Good-quality granitic sand forms part of the extensive colluvial slopes that surround the resistant granitic peaks of the You Yangs. The location of such a resource relatively close to urban Geelong has seen a continuing demand for access to this sand. Two occupation licences issued by the Department of Conservation, Forests and Lands are current at the You Yangs, with the Department also operating a pit for its own needs.

Mollison Creek - The sand in the beds of Mollison and Sugarloaf Creeks in the north of the area has been shed from the surrounding Cobaw granite. This sand is almost entirely angular quartz grains with a very low clay content, is free-running, and has a low compaction factor. The bulk of this material is transported to Melbourne for such uses as filter sand for septic tank drainage and propagating sand in nurseries. Minor amounts are used for concrete.

Yandoit - The only significant deposits of quartz gravels in the area occur in the north-west, and three tenements are operated in Yandoit Parish supplying gravel, mainly for road purposes. The deposits are thick, enabling the gravels to be removed from deep pits rather than by surface stripping.

Salt harvesting

Cheetham Salt Ltd uses three areas, totalling some 1900 ha, along the shores of Port Phillip Bay for the production of salt. Average annual production is about 700,000 tonnes. The salt is produced by solar evaporation of sea water from hundreds of basins, between 1 and 4 ha in size and separated by low earthen walls. Sea water enters the evaporation basins, being pumped to higher levels where necessary. It is then permitted to gravitate slowly down to the lower levels

Salt evaporation pans at Point Henry

as the concentration of the solution gradually rises. The impurity (calcium sulphate) precipitates out first, followed by crystallization of the salt. The residual mother liquid is drained back into the sea. It was once subjected to further fractional crystallization to recover the remaining salts - principally of magnesium and potassium - but this is no longer economic. Salt has been extracted in this way here since 1888 and is used for industrial and domestic purposes, as well as for salt licks for cattle.

The main requirements for this operation are broad, low-elevation areas to reduce pumping costs, and dry summers.

Most of the production area is freehold land, although long-term leases from the Department of Conservation, Forests and Lands and the Port of Geelong Authority have been granted over almost 600 ha of public land near the foreshore.

The shallow saline lagoons of the saltworks provide feeding areas for large numbers of waders such as red-necked stints, curlew, sharp-tailed and marsh sandpiper, green shanks, banded and black-winged stilts, and red-necked avocets. Prey species would include brine shrimp, brine fly larvae, and chironomid larvae. The salt-marsh areas now occupied by the evaporation basins might originally have been winter feeding sites for the orange-bellied parrot.

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16. UTILITIES

A number of utilities, in addition to water supply authorities, occupy public land and provide services such as roads, hospitals, prisons, churches, public halls, wharves, cemeteries, garbage depots, and sewage treatment works. In some cases the land they occupy may have additional values - such as for recreation or nature conservation.

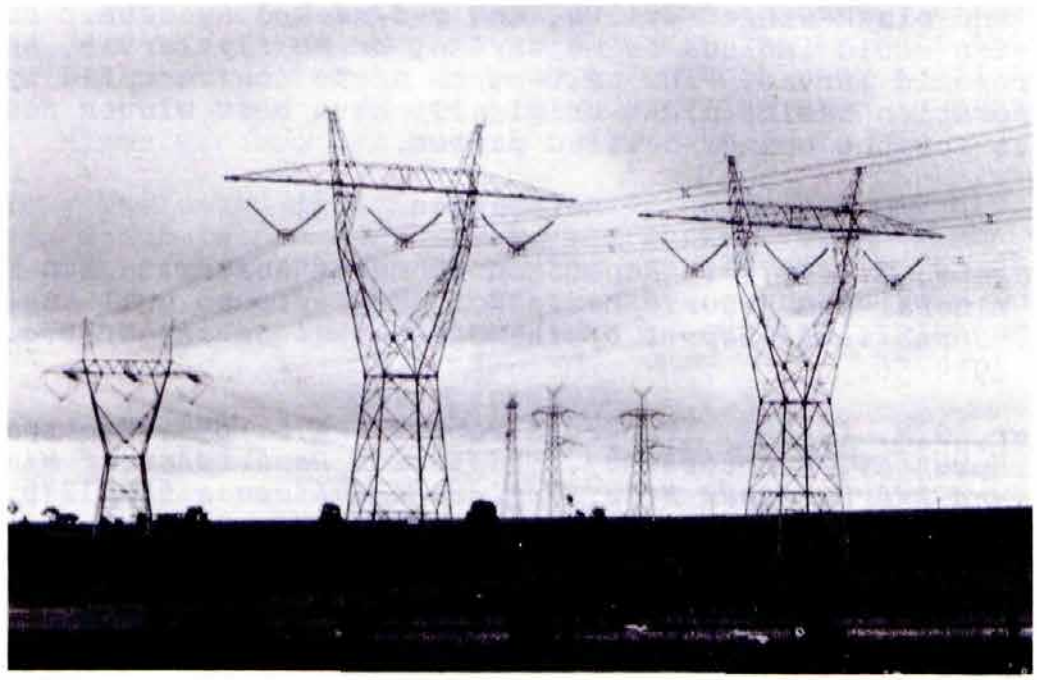
Electricity supply

At the time of the last report, the State Electricity Commission was investigating the siting of possible future power stations at Moorabool and in the regions of Breamlea and the sewage farm at Werribee. These projects are no longer being considered.

The 500-MW Newport 'D' thermal power plant came into operation in 1980. This plant uses steam turbines fired by oil or natural gas to provide intermediate to peak-load power requirements.

Also since the last report, two large transmission lines have been constructed; one leads from Moorabool to Portland, the other from Keilor to Deer Park and thence to Geelong and parallels the existing Sydenham--Trugannina--Moorabool route. Each of these easements has the capacity to carry more lines than at present.

The loss of power in transmission of electricity from point to point is minimized by using high voltages. For example, in sending 300 MW a distance of 100 km, the loss at 220 kV



Power transmission towers - Keilor

would be about 3%, but at 66 kV it would be nearly 9%. The Portland line is currently installed as a double circuit operating at 220 kV, but has the capacity to be increased to 500 kV. The other major lines in the district also operate at either 220 kV or 500 kV.

It is proposed to link Altona to the Trugannina Terminal Station via a 220-kV line in the future, but a suitable route has not yet been determined.

The peak annual demand for electricity in the study district (and including the city of South Barwon) is currently assessed at 328 MW. The average demand for energy is expected to be somewhat higher than the State average for a short period, possibly reflecting an increase in manufacturing industries in the area over that period.

Ports

The Ports and Harbors Division of the Ministry of Transport is responsible for the proclaimed ports of Barwon Heads and Port Phillip Bay. The Ports of Melbourne and Geelong are administered by the Port of Melbourne Authority and the Port of Geelong Authority respectively. Within their respective areas, each has responsibility for the design, maintenance, construction, and operation of all public harbour facilities - these include wharves, jetties, breakwaters, slipways, navigation lights, buoys, and other navigation aids and also the construction and maintenance of foreshore protection works and the preservation and improvement of the ports generally.

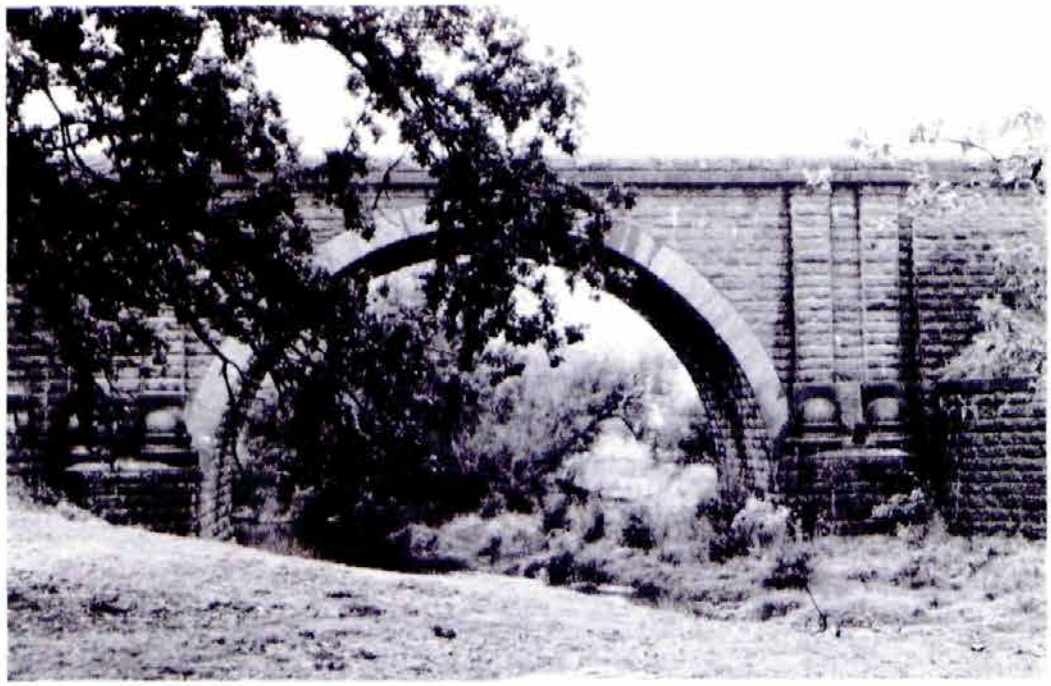
A number of land-based facilities such as the Werribee and Bellarine shore lights and markers and the Barwon Heads beacons are located within the foreshore reserve, and enough clearance is retained around these structures to provide lines of sight out to sea.

Portion of the frontage to Port Phillip Bay vested in the Port of Geelong Authority is licenced to Cheetham Salt Ltd and is used in conjunction with the company's saltworks. Large numbers of wading birds feed on the brine shrimp and other invertebrates that live in the saline evaporation lagoons. Further areas of public land vested in the Authority are also used for other than specifically port purposes.

Railways

A large number of railway lines radiate from Melbourne and Geelong across the study area. These are operated by V/Line (formerly Victorian Railways) and provide both passenger and freight services. In addition, V/Line retains responsibility for disbanded railways, such as the Queenscliff--Geelong line, through the Railway Construction and Property Board.

The railway easements crossing the volcanic plains north and west of Melbourne contain a number of important populations of rare and endangered indigenous plant species. Survival of these plants to the current time could be the combined result of infrequent soil disturbance along the easements,



Railway easements often contain remnants of native grassland and structures of historical importance

frequent burning, which has encouraged the relatively weed-free, species-rich native grassland, and lack of grazing.

Often, railway easements contain the only remnants of native grassland species within extensive tracts of agricultural land. Similarly, disused railways and railway land also often carry significant remnants of native vegetation, contain buildings of historical importance, or may be suitable for roadways or for cycling or walking tracks.

Other utilities and institutional uses

The Melbourne and Metropolitan Board of Works' sewage farm at Werribee was established in 1897 and, prior to the commissioning of the South-Eastern Purification plant (1975), treated all of Melbourne's sewage. It now treats about 70%.

The 11,600-ha farm receives domestic and industrial liquid waste from the central districts and the northern and western suburbs of Melbourne. The sewage is purified by land filtration, grass filtration, and lagoon treatment. Some of the sewage applied to land filtration areas and lagoons, and all the sewage applied to grass filtration areas, is pretreated by sedimentation in shallow basins to remove settleable materials. The sludge from the sedimentation basins is transferred to sludge-digestion lagoons, where it is stabilized by fermentation over a period of years - after which it is dried and used as land fill or as a soil conditioner.

Effluent from the land disposal areas is collected by a system of drains and discharged to Port Phillip Bay.

The land also supports grazing for sheep and beef cattle, which provides a source of revenue to the Board. The large number of wetlands here, in the form of lagoons, comprise one of the major southern feeding grounds for migratory

species of wading birds. As a result of its importance for birdlife, almost all of land in the Werribee sewage farm was declared a sanctuary for native game.

At Sunbury, public land is occupied by the Sunbury Mental Hospital, and a further parcel of land to the south is controlled by the Office of Corrections. The latter area, of 120 ha, is currently used to graze cattle to provide meat for Pentridge prison; in the future, a new prison may be built here. Recently the government acquired about 97 ha of land near Lara on which to establish a new prison.

More than 18,500 ha of land is occupied by various Commonwealth services (some 1,100 ha of which - near Puckapunyal - was recently acquired by the Army from both private and State ownership). This land provides for such purposes as Army and Air Force training grounds, for Telecom and radio installations, and for lighthouses (the historic Point Lonsdale Lighthouse is located on Commonwealth land, although it is managed by the Victorian Ports and Harbors Division). It is not public land according to the *Land Conservation Act* 1970, however.

Public land is also occupied by a number of other utilities for such purposes as roads, trigonometrical stations, radio and air-navigation installations, and fire towers; and larger tracts of forested public land at Bullengarook, Cobaw, and Salt Water Creek are Proclaimed Military Training Areas.

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17. HAZARDS

For the purposes of this report, hazards are those physical and biological processes that threaten the integrity of land and lower its productivity.

Prior to settlement, interactions between such factors as climate, topography, geology, and living organisms - and the actions of the Aborigines with fire and digging stick - had established a dynamic equilibrium between water regimes, soils, vegetation, fauna, and man.

The environment has been extensively changed by European settlement, however, and native vegetation and fauna have been removed or displaced by exotic pastures and introduced animals, soils have been cultivated, rivers dammed, and native forests managed for timber production or converted to softwoods.

The land has reacted in different ways, according to its characteristics and according to the type of use and management applied. Some land types are particularly sensitive to the changes being wrought on them; others are less so.

Known hazards associated with various land uses in the study area were discussed in the original report. This chapter seeks to expand where possible on the earlier information.

Recreation as a land use hazard

Outdoor recreation in general is an acceptable primary or secondary use of much of the public land and the various activities differ in their impact on the land. Generally, any activity pursued at a low level of intensity poses little

Clearing coastal vegetation for an access track and car park - Bells Beach

threat to the environment. As intensity increases, however, conflicts and problems can arise. There is always the problem of recreation damaging the environment it seeks to use.

In some areas - where the vegetation and soils are sensitive to damage (such as along the coast), where water quality may be affected, and where the natural environment or special features are being preserved - some controls on the levels or patterns of recreational use may be imposed.

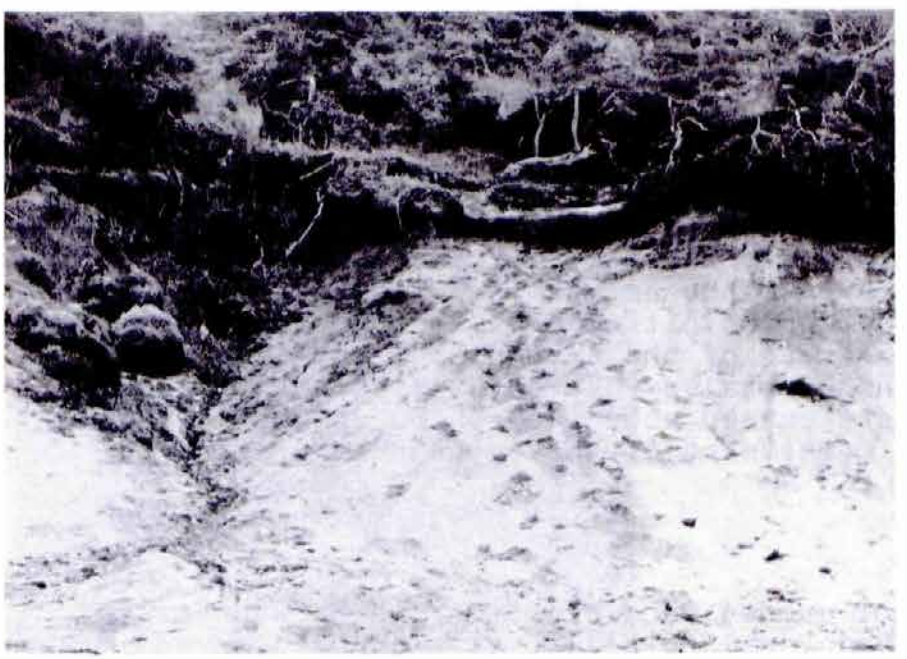
Deep rilling along access tracks is widespread throughout the forests to the north. This erosion is aggravated by excessive trail-bike and four-wheel-drive vehicle traffic. Closing access roads can assist erosion control, and has done so, but because most public land is unfenced, and has a large number of entrances, the illegal use of closed roads has continued.

Fencing public land and maintaining constant surveillance generally would be prohibitively expensive. Erosion control is the main alternative therefore and, at present, works are usually carried out only when the problem becomes acute.

Considerable expense has been incurred over the last 5 years in stabilizing the highly erodible land throughout the You Yangs Regional Park. Concerted efforts have been made towards surfacing and draining intensively used areas and roads, such as the Flinders Peak Track, and in the revegetation of old sand-extraction pits.

Temporary closure of access roads and increased surveillance have improved revegetation and reduced the erosion that had been accentuated by off-road vehicles along tracks in the Brisbane Ranges National Park, the Lerderderg State Park, and the Inverleigh Common.

The concentration of large numbers of people on the more unstable sections of the coast can result in considerable damage and loss of some coastal vegetation, which in turn ex-



Coastal dune erosion at Bells Beach - aggravated by pedestrian traffic

Fenced walkway restricting pedestrian traffic between sand dunes stabilized with marram grass

poses the soil to wind and water erosion. The uncontrolled movement of large numbers of people through primary dune areas, for example, will destroy vegetation and wind tunnels may form. If this is permitted to continue, large breaks may develop in the dunes.

Car parking and picnic activities at Jan Juc, Bells Beach, and other cliff-top vantage points have caused some serious soil erosion problems - usually in the form of gullying, tunnelling, or slumping. In some areas where the low coastal cliff has become denuded by intensive vehicular and pedestrian traffic, natural undercutting of the cliff by storm-wave action has been accelerated because the binding effect of plant roots is lost.

Two studies have been undertaken to determine the measures necessary for the protection, care, and use of the coastal region: the Barway Coastal Study (Cape Otway--Barwon Heads) by the Coastal Management and Co-ordination Committee, and the Barcliff Study (Barwon Heads--Queenscliff) by a committee sponsored by the Geelong Regional Commission. The latter study generated special funding and, since 1981, about $450,000 has been spent on revegetation, protective fencing, and access tracks.

Two other hazards that have resulted from recreational use include the collection of fauna, particularly molluscs, from the intertidal zone and fire. The former resulted in such unacceptable damage to the animal communities that legislation was enacted to prohibit such activities continuing. An analysis of the causes of the extensive fires of 1982/83 (see Table 24) has revealed that day visitors, travellers, and recreationists caused about one-third of the 71 fires attended by the Department of Conservation, Forests and Lands.

Soil erosion

Concentrations of eroded land occur in the Parwan Valley, Werribee Vale, and Pentland Hills, at the northern end of

the Cairn Curran catchment, in areas south of the Brisbane Ranges, in the upper reaches of the Maribyrnong River at Sunbury and Darraweit Guim, throughout the foothills west of Pyalong, and along the northern foothills of the Macedon Ranges.

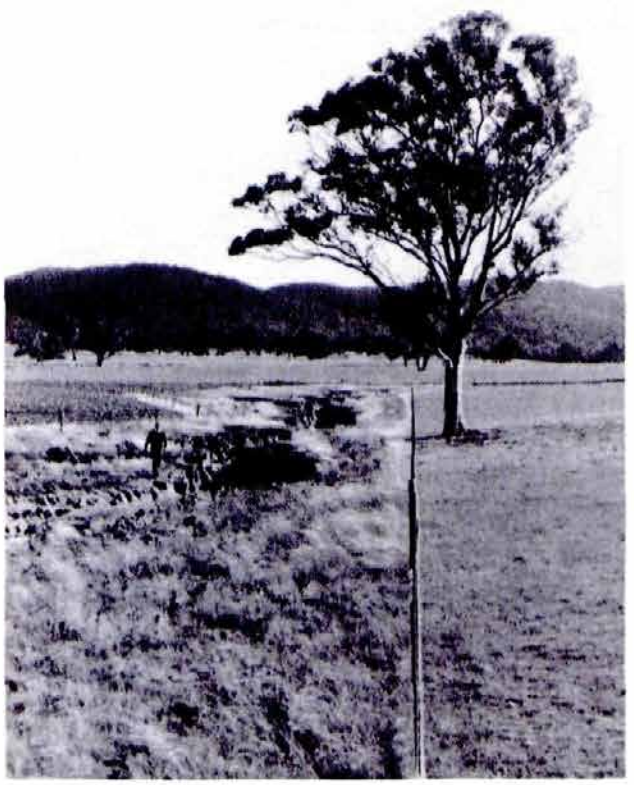
As mentioned previously, rill erosion along access tracks on public land, accentuated by trail-bikes and four-wheel-drive vehicles, is common. Another concentration of erosion problems occurs in the Fryers Ridge flora reserve, and a very high hazard of erosion exists in the You Yangs Regional Park.

Control works, including tree planting, gully-head structures, and gully revegetation (totalling some $200,000 in the last decade) have been or will be carried out in the Brisbane Ranges National Park, the Meredith education area, and at the Clydesdale reserve and Rise and Shine gravel pit.

During 1983--84, erosion-control structures costing $10,000 were built to protect roads crossing Hunters Creek and Tarilta Creek - tributaries of the Loddon River - and other works are planned in the catchment to Lake Merrimu and at Bamganie.

Gullying along roadsides under the control of municipalities is of concern, particularly on the granitic and sedimentary hills around Romsey. Some $20,000 has been expended on correcting such problems here over the last decade.

Considerable effort by the Soil Conservation Authority has been spent over the years on prevention and control of erosion on public land - chiefly on roadsides, coastal reserves, and stream frontages.



Gully stabilization - by protection from grazing

Streambank erosion - Parwan Creek
(note the landslip in the background)

Between 15% and 20% of freehold land in the study area is considered to have a high to very high potential for erosion. This mostly occurs throughout the steeper-sloping sedimentary and granitic land, whereas the extensive basaltic or alluvial plains around Geelong and Werribee - together with the inherently fertile and stable red gradational soils found at such locations as Ballan and Trentham - are relatively free of erosion.

The major problems are gullying, sheet, and tunnel erosion, with some soil salting throughout the more northern parts of the study area. Considerable resources of both time and financial assistance are expended on designing - and encouraging, advising, and assisting landholders to implement - erosion control on freehold land.

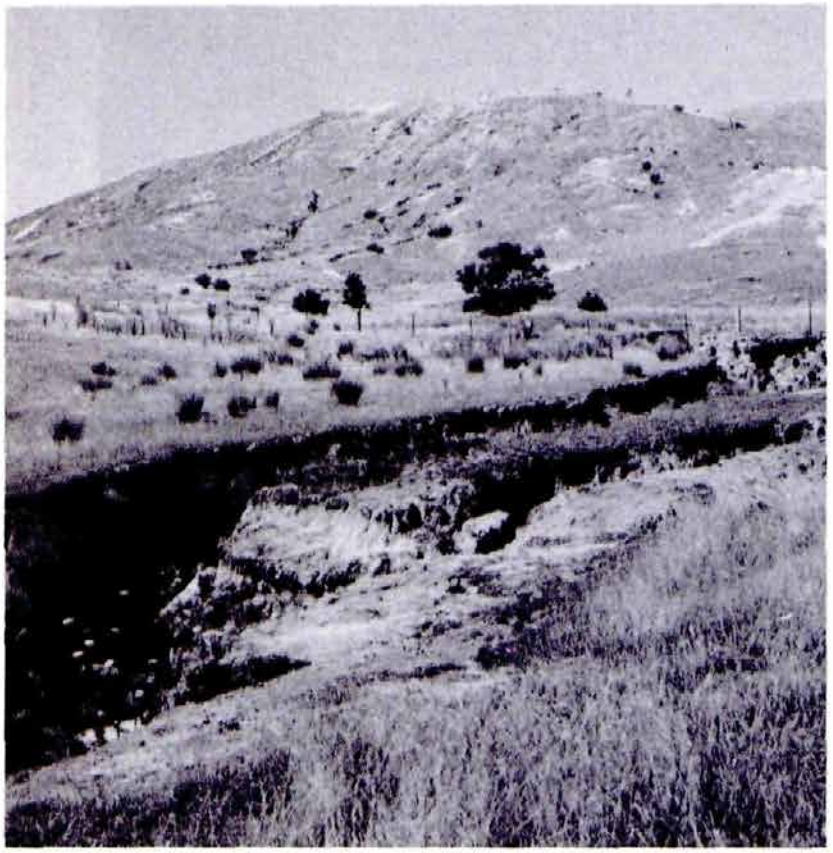
Further comments on erosion problems within the study area are made with respect to each major river basin in the section on 'The state of the rivers' in Chapter 6 (Water Resources and Utilization).

White Elephant (Soil Conservation Reserve)

In 1979, the Crown purchased 222 ha of land in the Parish of Yaloak from the Lady Northcote School Trust and reserved it for Soil Conservation purposes.

Extremely severe tunnel, sheet, and gully erosion - together with siltation, landslips and an extensive, highly erodible clay quarry - occur within this denuded ridge of land, which

Three forms of erosion: severe slumping of unconsolidated sediments Werribee River valley (above); tunnel erosion (left); and (below) gully erosion of a track on granitic sand - Cobaw Ranges



White Elephant - gully erosion in the foreground, sheet erosion on the slopes

is also prone to rabbit and weed infestation. The soils are predominantly mottled yellow duplex soils with a highly dispersible clayey subsoil.

It is locally known as the White Elephant due to the predominance of exposed subsoil.

As the Committee of Management, the Soil Conservation Authority has developed a management plan, to attain the following objects:

* maintain the Parwan Hydrological Research Station, which is located within the reserve, including all-weather access (see Chapter 6)

* provide a reference area, to demonstrate to student groups, parliamentarians, interstate and overseas visitors, trainee staff, and land managers the consequences of land mismanagement as well as the types and processes of erosion

* provide an area in which to conduct research and investigation into agronomic, afforestation, engineering, and soil stability aspects of erosion control and reclamation

Wildfire

The study area has a high risk of wildfires, due to the combination of hot dry weather during summer and the highly flammable nature of the vegetation.

The 1982/83 summer produced particularly bad fire conditions and four of the 71 fires in the district were major ones -

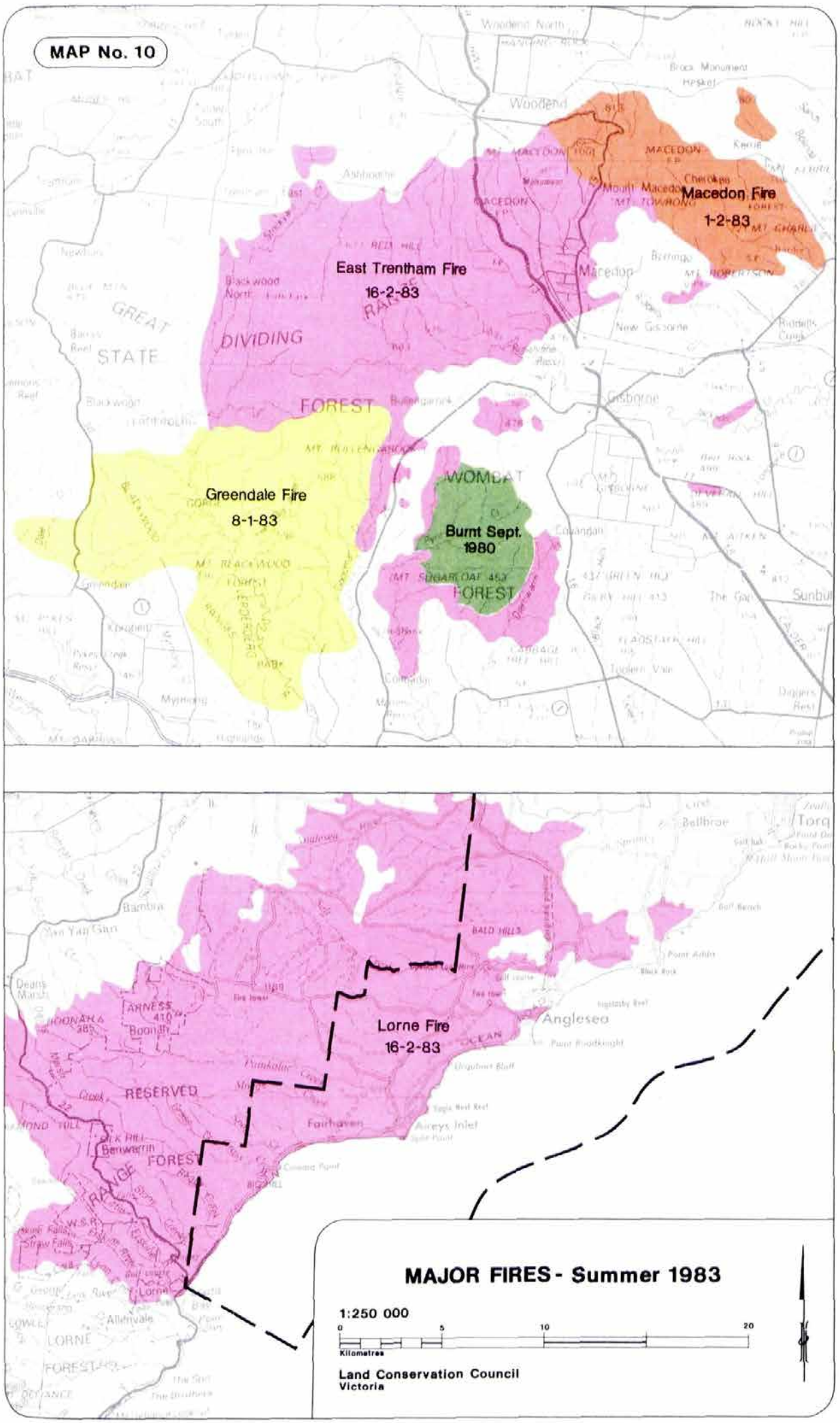

MAP No. 10
Macedon Fire
1-2-83
East Trentham Fire
16-2-83
Greendale Fire
8-1-83
Burnt Sept.
1980
Lorne Fire
16-2-83
MAJOR FIRES - Summer 1983
1:250 000
0
5
10
20
Kilometres
Land Conservation Council
Victoria

Table 23

AREAS BURNT BY MAJOR FIRES 1982/83

Location	Date (1983)	Forest types burnt (% of public land)			Class of land burnt (ha)[1]				Total (ha)
		Mixed Species	Soft-wood	Heath	RF	PF	OCL	PP	
Greendale	8 Jan	95	-	5	13,720	-	-	2,220	15,940
Macedon	1 Feb	91	8	1	1,864	-	-	3,636	5,500
East Trentham	16 Feb	89	11	-	13,330	40	30	9,100	22,500
Lorne[2]	16 Feb	24	-	76	1,200	4,500	4,950	1,300	11,950

Notes:

1. RF = Reserved Forest PF = Protected Forest
   OCL = Occupied Crown Land PP = Private Property

2. Only 29% of the Lorne fire (totalling 41,200 ha) was within the study area

3. The figures quoted, other than 'total', are approximate only

Source: Department of Conservation, Forests and Lands

culminating in the Ash Wednesday holocaust (16 February 1983), in which about 63,000 ha of mostly forested land were burnt as well as several hundred houses and many community assets.

Of the 71 fires recorded, 60% burnt an area less than 1 ha, 20% covered 1-5 ha, 8% were in the 5- to 10-ha range, and 6% burnt 10-25 ha; the remainder - four fires - burnt substantial areas in the study area and these are listed in Table 23 and their extent indicated on Map 10. Table 24 tabulates the causes of all 71 fires according to source and agency.

Approximately 75% of the area burnt on Ash Wednesday was within domestic water supply catchments, thus there was a significant risk that debris, ash, and silt would be washed into township reservoirs such as Lake Merrimu, the Painkalac Creek dam, and several small storages throughout the Macedon Range.

Within a fortnight of the fires the Soil Conservation Authority undertook emergency measures to avert this risk, using plastic mesh, stone and timber silt traps, contour ripping and sowing with cereal rye, and the spraying of an aqueous mixture of paper pulp, seeds, and fertilizer onto bare areas along roadsides - at a cost of about $100,000.

Generally, the opening rains were of moderate intensity and, combined with the protective works, facilitated the maintenance of good water quality, although a severe problem devel-

oped at Painkalac Creek (Aireys Inlet) during the autumn of 1984.

In January 1985, the State again experienced a spate of serious fires and the Department of Conservation, Forests and Lands recorded more than 20 for the study area. The largest here started on freehold land near Anakie on 15 January 1985 and burnt some 9,000 ha.

Table 24

CAUSES OF FIRES 1982/83

Source	Percentage of total	Agency	Percentage of total
Lightning	3	Lightning	3
Power transmission	3	Industry employee	4
Waste disposal	6	Recreationists	6
Campfire, BBQ	8	Children	7
Cigarette, match	16	Traveller	7
Deliberate lighting	25	Residents	13
Burning off	27	Day visitors	20
Miscellaneous - known	12	Farmer/farm employee	25
		Miscellaneous - known	15
Total	100	Total	100

Flooding

Although not a widespread problem, flooding in the major river basins has a significant local impact on both rural and urban areas in the district - particularly where urban development has been permitted to extend onto a flood-plain. It has little impact in those portions of the Loddon and Campaspe River basins within the study area. In the south, some flooding is experienced at Queenscliff and other parts of the coastal zone, particularly when heavy rains coincide with spring tides.

In the upper reaches of the Barwon River and its major tributaries the Moorabool and Yarrowee Rivers, flooding is generally confined to rural areas on fairly well-defined flood-plains. The townships of Winchelsea, Inverleigh, and Batesford, however, are at risk from larger floods.

At Geelong, flooding has been a problem almost from the time of settlement and between 1852 and 1978 13 major floods were experienced, as well as many small local events. Although industry, transport, and recreation have been disrupted, residential areas have largely been unaffected. A study in 1982 carried out by the then State Rivers and Water Supply

Commission has defined the flood-prone areas here and determined that, during both the 1852 and 1978 floods, the river reached its greatest known peak flow of 1,460 cubic metres per second. The average annual flood damage is estimated to be $200,000 (1980 values). The relevant municipalities are considering mitigation proposals for developed areas affected by floods.

Within the Moorabool River basin, new residential development at Lara on the flood-plain of Hovells Creek was damaged during the large 1973 flood, and extensive sheet flooding of rural land occurs south of the Princes Highway. A levee-bank system built to protect residences in Lara is being extended.

Major flooding in the Little River puts residential development in the township of Little River at risk and, further downstream, has cut the Princes Highway on several occasions.

Lollypop Creek inundated large areas of residential land on the western side of Werribee during the 1973 flood.

For much of its upper tract, the Werribee River is confined to steep-sided narrow valleys and gorges. At Bacchus Marsh, however, rural land, some of which is intensively cropped, is at risk from floods from the Lerderderg and Werribee Rivers. In extreme floods the township of Bacchus Marsh may be at risk.

Upstream of Werribee township, floodwaters flow westward to inundate extensive areas before entering Port Phillip Bay in the vicinity of the Werribee Sewerage Farm. Since the 1973 flood, which inundated large areas of residential land in the western part of Werribee, a floodway has been constructed to carry this breakaway floodwater safely through the residential zone. Several of the newer residential areas here are still at risk, however.

Residential development in the rapidly expanding township of Melton has encroached onto flood-plains and mitigation works to reduce the risk of flooding here from Toolern Creek and its tributaries, Arnold and Little Blind Creeks, are either completed or under investigation.

The main problems associated with flooding of the Maribyrnong River occur in the Melbourne metropolitan area. Its main tributaries - the Emu, Jacksons, and Deep Creeks - are all well incised, and flood-plains, where they exist, are narrow and well defined. Flooding in this part of the study area has only been a problem where urban development has encroached onto the flood-plain - such as on Jacksons Creek at Gisborne.

Parts of the existing residential and commercial development of Seymour are located on the flood-plain of the Goulburn River and have experienced serious damage from floods.

The catchment of Sunday Creek has been extensively cleared, and this stream is now noted for its severe run-off response

to heavy rainfall. It enters the Goulburn River just upstream of Seymour, and contributes substantially to flooding in the township. The worst damage, however, stems from peak flows in Whiteheads Creek - outside the study area.

Downstream from Seymour, the flood-plain of the Goulburn is wide but well defined. It supports rural land uses and is generally adapted to periodic flooding.

Hazards to water quality

The section on 'The state of the rivers' in Chapter 6 refers to the altered levels of turbidity and salinity in the major streams of the study area - caused principally by changes to the vegetation in the catchments.

Agricultural, domestic, and industrial land uses also contribute to pollution of surface water and groundwater.

Fouling of water by stock, erosion from ploughed surfaces, and leaching of nutrients and agricultural chemicals, for instance, may occur in agricultural lands.

Limited overseas literature indicates that losses of pesticides from agricultural land in water run-off may be as high as 5%. The behaviour and fate of such pesticides in streams is largely unknown; the receiving waters' potability, agricultural use, and ability to support aquatic ecosystems are therefore threatened.

In 1981, for instance, a pilot survey of the Werribee River and Little River catchments by the Environment Protection Authority indicated a significant input of DDT into the Werribee River upstream of its confluence with the Lerderderg River - within the Bacchus Marsh Irrigation District. It did not reveal, however, whether the presence of DDT and its breakdown products came from historical accumulations or from on-going applications. During 1981, DDT was listed as a prohibited constituent of agricultural chemicals used on crops, pasture, or food-producing stock.

Urban and industrial land uses can contribute to water pollution by erosion from construction activities, discharge of sullage and other effluents, seepage and overflow from septic and sewerage systems, and seepage into the groundwater from rubbish tips.

A marked deterioration in water quality occurs in the urban parts of the Kororoit Creek, for instance. Initially the problem is caused by the discharge of domestic waste-water and urban run-off. These inputs result in low levels of dissolved oxygen and high concentrations of nutrients and bacteria, as well as toxic levels of ammonia. Further problems occur in the industrial areas where industrial waste-water is discharged, causing high nutrient concentrations, high levels of heavy metals and other toxicants, and low dissolved oxygen levels. Intermittent problems are also caused by sewer overflow during peak flows. Reductions in total nitrogen and phosphorus levels have occurred in Kororoit Creek over the last decade as a result of control of industrial

discharge and some connections to the sewerage system.

Port Phillip Bay receives the outflow of many of the streams of the study area, including those mentioned above. The Bay therefore receives the pollutants leached or discharged into those streams as well as from some 300 drains that lead directly from metropolitan areas and terminate at various levels above or below mean high water mark. Water quality of the Bay is also affected by such practices as dumping of spoil, land fill operations, and the discharge of waste from some ships. (Modern ships hold liquid waste in waste-water tanks for discharge outside the 3-mile limit). The consumption of shellfish from around port areas is therefore not recommended, and, near some outlets, effluent discharges conflict with recreational activities.

The Environment Protection Authority is conducting studies into the various aspects of water pollution in the State and is progressively developing State Environment Protection Policies to help overcome identified problems.

Fungi

The root rot fungus *Phytophthora cinnamomi* was identified in Victoria in 1939 and has since spread to most areas in the State. The fungal inoculum survives in the soil and attacks the fine roots, larger roots, and even the root collar of trees, causing symptoms similar to drought - known as die-back. Plants on soils that lack organic matter (organisms living on the organic matter inhibit *P. cinnamomi* development) and have poor drainage are specially vulnerable to the disease. In the worst areas, an impervious clay horizon can be found close to the soil surface. Deeper well-drained and fertile soils have disease-suppressive effects, and injury is less extensive on these soils.

In areas such as the Brisbane Ranges and Angahook--Lorne parks, damage to the understorey may precede die-back in the overstorey, spreading several metres in advance of the damage to the forest canopy. Symptoms in the understorey flora include death, branch die-back, leaf scorch, withering, and discoloration of the foliage. Damage in susceptible eucalypts shows up as slow growth and die-back in the limbs. Infection produces changes in both species composition and numbers of plants in a forest. Evidence indicates, however, that these changes may not be permanent.

The spread of the disease can be detected in some areas by mortality in highly sensitive native flora like *Pultenaea* spp. and the grass-tree *Xanthorrhoea australis*, because 90--100% of these plants die in an infected area. The major eucalypts that *P. cinnamomi* affects are the stringybarks - members of the subgenus *Monocalyptus*. Species of the subgenus *Symphymyrtus* - gums, boxes, and ironbarks - appear to be tolerant to the disease.

As well as the Brisbane Ranges and Angahook-Lorne parks, *P. cinnamomi* has been found in patches throughout the Wombat forest and along road reserves. Care must be exercised during road-making and maintenance works and fire-protection

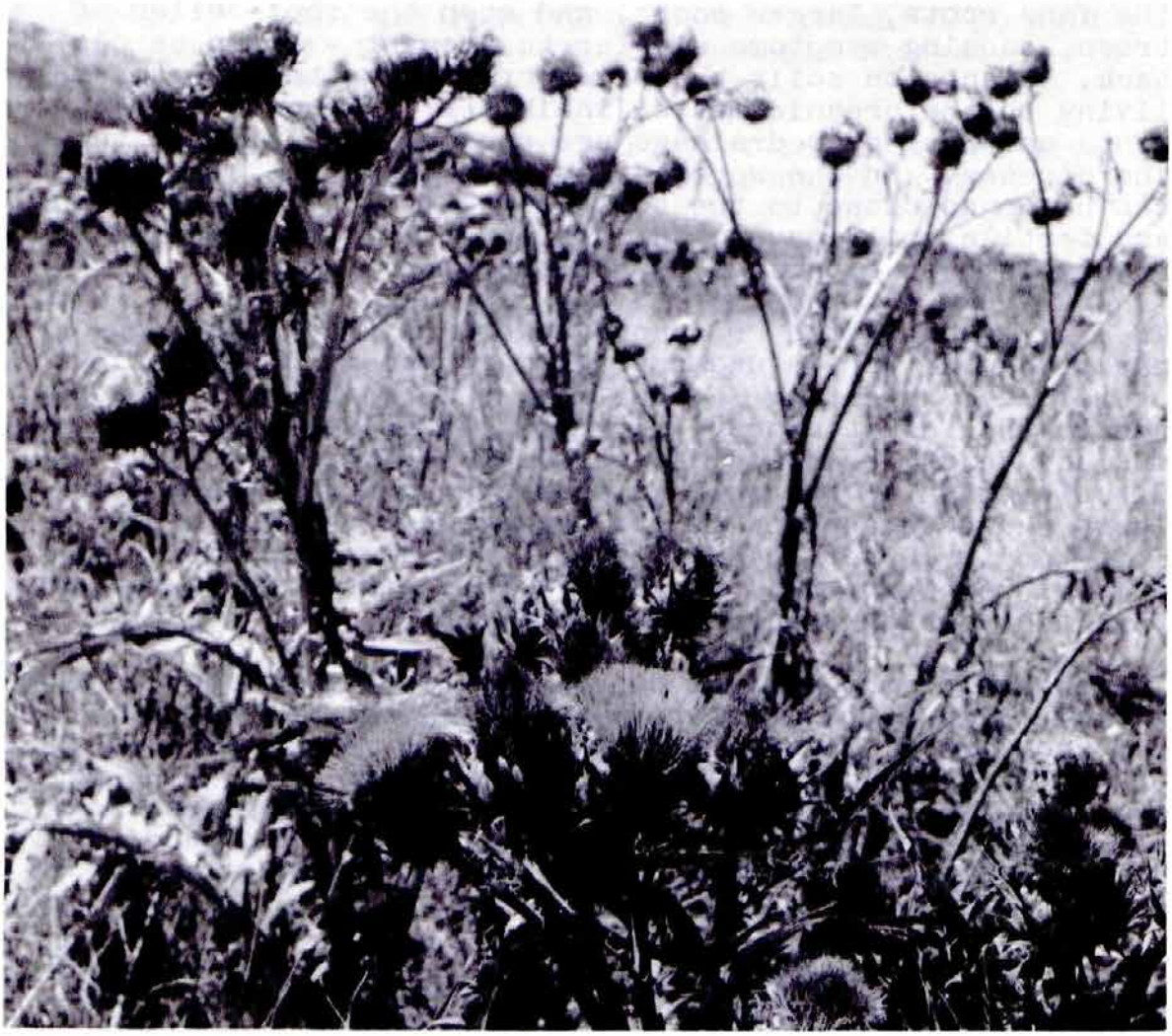
practices to ensure that these do not spread the pathogen further. Precautionary measures include the cleaning of infected soil from vehicles and road-making machinery, establishment of quarantine areas, prohibition of soil removal from infected sites, and the effective planning of drainage.

Three species of *Armillaria* have been recorded in the region but only *A. luteobubalina* is recorded as mildly pathogenic. This is a native fungus and usually does little injury. Damage, however, increases markedly in areas that are logged repeatedly on a selective basis.

The disease symptoms produced by *Armillaria* resemble those caused by *Phytophthora cinnamomi*. There are no known resistant eucalypts, but the impact of the disease can be reduced by clearfelling and regenerating the affected area.

Noxious weeds

The largest group of noxious weeds in Victoria consists of introduced species, which are often of little significance in their own country of origin but thrive in disturbed Australian habitats. (Boneseed, however, can establish and thrive in relatively undisturbed native communities.) Of the 109 plant species in the State that have been proclaimed



Artichoke thistle

as noxious weeds under the provisions of the *Vermin and Noxious Weeds Act* 1958, a survey in 1981 revealed that 50 occur in the study area. These are listed in Appendix VI, along with an indication of the sites of main infestation of each species.

Many of the weeds are of limited distribution, although they could be locally dense and cause problems at particular sites.

The thistles generally are common throughout the district, as are Bathurst burr and soursob. Artichoke thistle (*Cynara cardunculus*), a large blue-green thistle with distinctive purple flowers, is characteristic of much of the vacant land and some farmland to the immediate north and west of Melbourne. Strong identification of this weed with the local area is recorded in a song, which refers to the artichoke thistle as the 'Broadmeadow thistle'.

Shrubby noxious weed species - including furze (*Ulex europaeus*), boxthorn (*Lycium ferocissimum*), sweet briar (*Rosa rubiginosa*), and hawthorn (*Crataegus* spp.) - were originally planted as hedges and have subsequently spread onto grazing land and waste areas.

Boneseed

Boneseed (*Chrysanthemoides monilifera*) was introduced as an ornamental shrub from South Africa and has spread into bushland in the You Yang ranges and along the coast. Extensive dense infestations have developed, which exclude many of the native plant species.

Serrated tussock (*Nassella trichotoma*) poses a serious threat to grazing lands, as it is unpalatable to stock and can crowd out more useful pasture species. It is well established on the basalt plains in the north and west of the district and along the Moorabool River system. It can spread rapidly and is regarded as a major threat to grazing in much of Victoria.

Wild garlic (*Allium vineale*) is not common in the area; but a few plants in cereal crops can contaminate grain and make it unacceptable at silos. Wild garlic is a persistent weed once established, and a major potential problem to the small

grain industry.

Landholders are responsible, under legislation, for the control of noxious weeds both on their properties and on the half-width of road adjoining their respective properties.

In many cases weed control is an aspect of normal agricultural land management, and may include grazing, topdressing, pasture improvement, mowing, and ploughing. In other cases, the application of hormone-like herbicides or biological control may be used to supplement management practices.

Insect pests

Some insect pests attack certain agricultural crops almost wherever they are grown in Victoria. These include the white-fringed weevil (*Graphognathus leucoloma*) in lucerne; the red-legged earth mite (*Halotydeus destructor*) in clover; the spotted alfalfa aphid (*Therioaphid trifolii*), blue-green aphid (*Acyrthosiphon kondoi*), and pea aphid (*A. pisum*) in both lucerne and medics; and the sitona weevil (*Sitona discoideus*), which is found in lucerne, medics, and clover.

Other insect species have been recorded causing damage in the study area. These include the cereal aphid (*Rhopalosiphum padi*), *Sitobion miscanthi*, and the lucerne flea (*Sminthuris viridis*) in barley; and the potato scarab (*Cheiroplatys latipes*) in potatoes. Of these, only the potato scarab is endemic.

Control measures for insect pests may include the use of insecticides, the release of biological control agents, the development of resistant strains of crop, and the development of crop management techniques.

The lucerne aphids, for instance, are capable of enormous population explosions, as a result of which, following their introduction to Australia in the late 1970s, they quickly exceeded the capacity of native predators on the mainland (ladybirds, lacewings, and hoverfly larvae) to control them.

Australian research teams have developed aphid-resistant cultivars of lucerne; introduced the parasitic wasps *Trioxys complanatus* from America and *Aphelinus ervi* from Tasmania; and introduced fungal pathogens that complement the other control measures.

Animal pests

Marauding dogs from urban areas and some sub-commercial farmlands are a continuing problem to stock on the surrounding grazing properties. These dogs can also contribute to the feral dog population.

A study of the potential for foxes to act as hosts for rabies is in progress. The current work includes investigations of population density, movement, and control techniques. The bonus on fox scalps was lifted in 1980.

Also in 1980 the keeping of rabbits as pets was legalized.

Research into rabbit control is continuing and includes work on myxomatosis and other diseases, more selective baiting techniques, fumigation equipment, and the monitoring of regional populations. One such monitoring site is in the Parwan Creek Valley, where transects totalling some 11.5 km are assessed four times a year.

Hares, a proclaimed vermin species, are a minor pest in the study area - chiefly across the basalt plains and along the shores of Port Phillip Bay.

Although not proclaimed vermin in Victoria, feral cats continue to be a problem, and are aggressive predators on small native fauna.

From August 1977 wombats ceased to be 'vermin' in Victoria west of the Melbourne--Wodonga railway line, and since July 1984 they ceased to be classed as 'vermin' anywhere in the State. They are, however, classed as 'unprotected wildlife' in 193 parishes, including the Parish of Wallan Wallan south of Kilmore.

Cockatoos may occasionally cause damage to farmlands, particularly west of Geelong, by pulling up germinating plants and eating mature cereal crops.

Public land use

The form and intensity of land management that is applied may sustain or alter the natural ecosystems of an area. Hospital Swamp, for instance, in the Lake Connewarre system was characterized by a mosaic of fresh-water, sub-saline, and saline plant communities in a swamp that was usually dry from spring to late summer. These communities are undergoing rapid change following recent artificial modifications to the hydrology of the swamp such that it now holds water for most of the year. Damage to vegetation and the introduction of weeds as a result of stock grazing also present serious problems in several portions of the lake system.

Prolonged intensive grazing of native plant communities by domestic stock can also reduce the cover of shrubs and increase the proportion of introduced plant species, such that the habitats of native fauna are altered.

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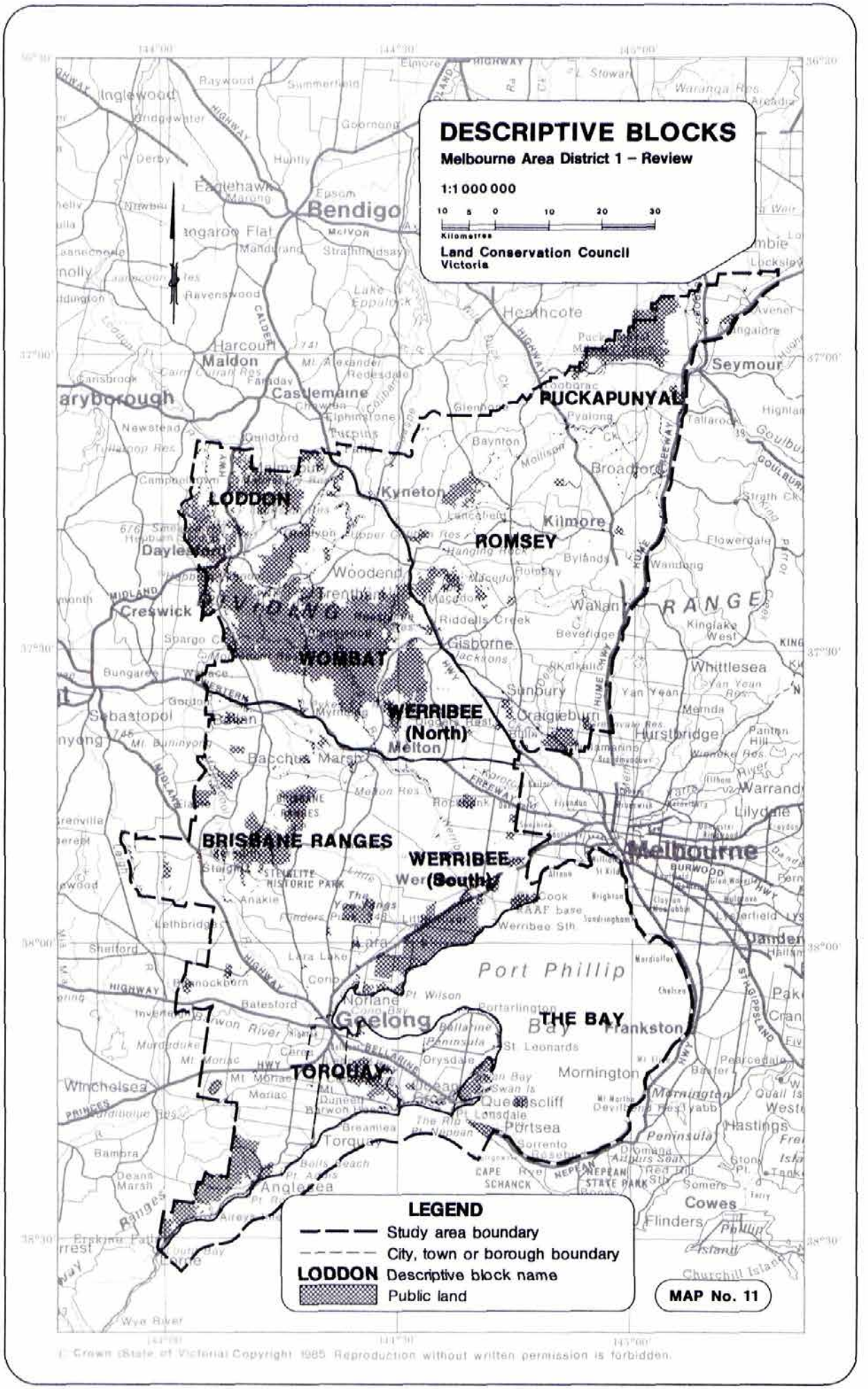
PART IV

BLOCK DESCRIPTIONS



BLOCK DESCRIPTIONS

The Land Conservation Council's original resources report on the Melbourne area divided the western part of the study area into seven blocks, to facilitate a detailed description and assessment of natural resources. In this review those seven blocks have been amalgamated into three groups that have broadly similar climate, soils, topography, and vegetation. The block names used in the original report have been retained for continuity, although some boundaries have been modified slightly.

Map 11 shows the location of the original descriptive blocks and the boundaries of the three groups into which these have been amalgamated. A fourth 'block' titled 'The Bay' briefly describes the environments of Port Phillip Bay and of the coast.

The present tenure, nature of the land, capability for various uses, and likely land use hazards are described for each group. A consistent format of headings and subheadings has been used, to enable the reader to compare specific data for various blocks. Information on land uses in this section of the report refers to public land except where explicit reference is made to private land. Where appropriate, specific parcels of land are identified by the same reference numbers as on Map 8 - Public Land Use.

Again, further details are available in the Council's 1973 Descriptive Report for the Melbourne area.

Capability

This term refers to the value of the land for the particular use to which it may be put. Present levels of use are generally described in the main text and give some indication of capability. Capability for some uses, such as nature conservation, is based primarily on the land's inherent characteristics. For others it also depends on inputs (such as fertilizer application) that raise the productivity.

Capabilities are assessed in general terms only, because the amount of information available varies from block to block and because some values are difficult to quantify. They also take into account the capabilities of land in other blocks and in other parts of the State.

1. LODDON--WOMBAT--WERRIBEE (North)

A. Tenure and Nature of the Land

1. Present tenure

Public land totals some 80,000 ha, almost all of which is contained in one tract of land, centred on the Great Divide. To the north a further parcel is contiguous with public land in the North Central area.

Conservation reserves in this block include the Lerderderg State park (13,340 ha), the Hepburn regional park (2,820 ha), and part of the Macedon regional park. Four reference areas - Musk Creek (125 ha), Ruths Gully (200 ha), Ah Kows Gully (440 ha), and Pyrete Range (360 ha) - are also located here. The Fryers Ridge flora reserve comprises 1,011 ha and extends north to include an additional 600 ha in the North Central area. The recently reserved Long Forest flora and fauna reserve (147 ha) also lies in this block.

The production of hardwood timber takes place in the 38,000-ha Wombat forest and in uncommitted land (in excess of 17,000 ha). Softwood plantations are located at Macedon (873 ha) and near Daylesford (2,367 ha).

Areas set aside for the production of water include the Malmsbury, Lauriston, Rosslynne, Pykes Creek, and Merrimu reservoirs as well as a number of smaller reservoirs, weirs, and diversions.

The Korjamunip and Tylden South education areas, four scenic reserves (Mount Steiglitz, and three containing waterfalls), a number of bushland reserves, and other small blocks of land comprise the balance of public land here.

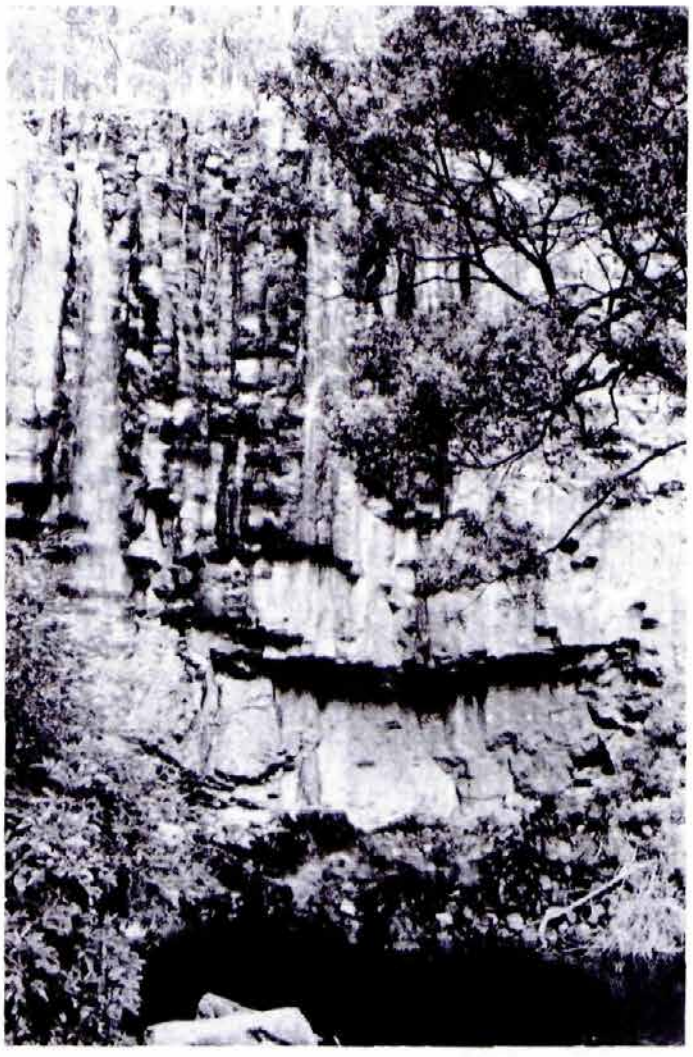
2. Climate

Average annual rainfall increases with elevation from about 600 mm to more than 1,000 mm along the Divide, decreasing to about 600 mm in the north, with a winter maximum. Snow occasionally falls on the Divide, but rarely persists on the ground for any length of time. Winters are cold and summers relatively hot and dry.

3, Geology, geomorphology, and soils

The most common rocks of the area are Ordovician sandstones, mudstones, and shales, which are usually associated with yellow mottled acidic and some sodic duplex soils; these tend to be shallow and stony on the ridges.

The Ordovician sediments are overlain with valley flows and cappings of the Newer Basalts in the west, and these broaden to sheet flows, forming plains, in the east and south.



Trentham Falls - located in one of the scenic reserves

Various sodic duplex soils dominate the basalt landscape, but black clays occur within depressions and shallow, stony gradational soils on the ridges. Around Trentham and Daylesford, the basalts are associated with friable red gradational soils that are highly productive for agriculture.

In the Ordovician country, flat ridge-tops, which range in altitude from about 400 m in the Pyrete Range to some 700 m along the Divide, slope gently down to the north and reflect an early Tertiary surface that was uplifted and arched. Strongly dissected mountainous terrain has developed where the Lerderderg River and its tributaries cross the Greendale Fault. Elsewhere the terrain is less strongly dissected. The highest peaks are the scoria cones of Blue Mountain (873 m) and Mossops Hill (803 m). Mount Franklin (635 m) is the most prominent of several volcanic cones near Daylesford.

The block contains the upper catchments of the north-flowing Loddon and Campaspe Rivers and of the south-flowing Werribee River, and the western portion of the Maribyrnong River basin. Waterfalls occur where several streams cross the edge of basalt flows.

4. Vegetation

Open forest III covers much of the public land along the Divide. The dominant eucalypts are messmate stringybark,

manna gum, and narrow-leaf peppermint, often in association with candlebark and broad-leaf peppermint; understorey trees are chiefly blackwood, and the taller shrubs include prickly moses, narrow-leaf wattle, silver wattle, hazel pomaderris, tea trees, tree everlasting, common cassinia, daisy bushes, various peas (*Daviesa* and *Pultenaea* spp.), and hop goodenia. Tree-ferns with associated smaller ferns and a range of shrub species and small trees - including musk daisy bush, hazel pomaderris, austral mulberry, blanket-leaf, and copious bryophytes and lichens - occur in sheltered gullies. Various smaller shrub species, sedges, herbs, and grasses are found in the shrubby tussock grasslands (usually *Poa* species) on slopes.

On drier sites open forest II is widespread and interspersed with the taller forest. The principal eucalypts are messmate stringybark, narrow-leaf peppermint, broad-leaf peppermint, candlebark, manna gum (particularly on valley floors, where it may associate with swamp gum), some brown stringybark and mountain grey gum in the east of the block, and occasionally scent-bark. Yellow box and occasionally grey box grow on some of the drier southern slopes; while red stringybark and broad-leaf peppermint, mixed with red box and long-leaf box, occur along moister ridges in the drier regions but more generally at lower elevations in the north.

Native vegetation along the banks of the Loddon River

Manna gum and yellow box once occupied drainage lines and alluvial flats in the north but have now largely been cleared. Also, occasional swamp gums occur along the creeks. Common understorey species include silver wattle, native cherry, daphne heath, drooping cassinia, mountain grevillea, gold-dust wattle, heath tea-tree, narrow-leaf bitter-pea, grey everlasting, and tussock grass.

Open forest I of rather stunted eucalypts covers much of the Pyrete Ranges. The most common tree is probably broad-leaf

peppermint, accompanied by red stringybark, red box, long-leaf box, and red ironbark.

Although much of it is not on public land, the occurrence of bull mallee over several hundred hectares between the Pyrete and Djerriwarrah Creeks is of great scientific interest.

The nearly treeless basalt plains in the vicinity of Melbourne that originally carried dry tussock grassland have been substantially altered by grazing and cultivation during the past 150 years.

Remnants of open forest I of white sallee and manna gum are found on private property and along roads around Trentham and Carlsruhe.

5. Fauna

The vertebrate fauna occurring in this block comprises primarily those species associated with the open forest habitats of the ranges. Local composition of faunal communities varies in relation to forest type. In the wetter regions, typical species include the dusky antechinus, swamp wallaby, mountain brushtail possum, White's thrush, rufous fantail, white-browed scrubwren, McCoy's skink, and Coventry's skink. For several species (such as the greater glider, mountain brushtail possum, and red-browed treecreeper) this block forms the western limit to their geographic range. Fauna characteristic of the open forests on the slopes, and in areas of moderate rainfall, include brown antechinus, common brushtail possum, brush-tailed phascogale, rufous whistler, yellow-faced honeyeater, eastern spinebill, striated thornbill, tree goanna, and red-bellied black snake.

A number of the species regarded as 'significant' or 'notable' within the study area occur in this block. These include the brush-tailed phascogale, powerful owl, barking owl, peregrine falcon (recorded breeding at Werribee Gorge), mountain dragon, and tree goanna.

B. Present Use and Capabilities

1. Nature conservation

The tract of public land in the Lerderderg--Wombat area has a high capability for nature conservation. It is the largest and most varied of a number of forests scattered through north-central Victoria, all of which are now isolated from each other by cleared land.

The Lerderderg State park contains a range of vegetation types associated with open forests of messmate stringybark, broad-leaf peppermint, narrow-leaf peppermint, red stringybark, and red ironbark. It includes a number of plant species that are either rare in Victoria or quite localized in the western half of the State - notably cane spear-grass, tortuous rapier-sedge (the only occurrence west of Melbourne), slender saw-sedge, swamp bush-pea, hairy beard-heath, and violet westringia. Tylden is one of the very few recorded localities for tall wallaby grass, as are Bullarto

and Blakeville for *Pultenaea muelleri* var. *reflexifolia* and South Bullarto for dwarf silver wattle.

The Pyrete Ranges also have a high capability for nature conservation. Silvertop occurs at its extreme western limit here, and many interesting orchids are also present.

In the north of the block, plant species of some interest include an isolated occurrence of scented bush-pea at Porcupine Ridge, fairy wax-flowers south-west of Taradale and at Porcupine Ridge, and occurrences of sticky boronia and a prostrate species of grevillea - Elphinstone grevillea.

At the 'Blowhole', on Sailors Creek near Hepburn Springs are found the twin-flowered beard-heath and *Hovea rosmarinifolia*, both of restricted distribution in western Victoria - as is the woolly wattle found between Shepherds Flat and Eganstown.

A number of rare or significant plant species are found in the south of the block, although mainly on private property. These include the cane spear-grass and East Gippsland blue box near Coimadai, pale twin-leaf along the banks of Pyrete Creek, and the salt-bushes *Atriplex stipata*, *Sclerolaena diacantha*, and *Maireana decalvens* near Bacchus Marsh. The last sizeable stand of grey box and bulloak, complete with ground flora of native grasses, covers about 160 ha of private property about 10 km south of Melton.

As would be expected with such diversity of habitat, the faunal population is also diverse. The block probably also forms a corridor used by inland birds moving south. Typical inland species, such as the crested bellbird and red-capped robin, have been recorded in the south.

The Wombat forest contains a number of possum species, two of which, the greater glider and the bobuck, are at the western limit of their range. The planarian *Artioposthia fletcheri* has only been recorded in dry open forest and conifer plantations in the block. The red-browed treecreeper has been recorded here at the western limit of its normal range, while two other eastern species, the brush cuckoo and the white-throated warbler, have also been recorded.

In the north of the block, the fuscous honeyeater and crested bellbird reach the limit of their range. The frog *Ranidella parinsignifera* occurs here at the southern limit of its range.

The four reference areas here are located on dissected Ordovician sediments and provide examples of several vegetation units growing on different aspects at various altitudes and within a range of rainfall zones.

Long Forest flora and fauna reserve contains portion of the only occurrence of bull mallee south of the Divide - the closest mallee scrubs to here being in the Whipstick State park near Bendigo. Associated with the bull mallee are yellow box, yellow gum, long-leaf box, and grey box, and a species normally found in East Gippsland, blue box. Some

130 species of birds have been recorded here, a number of which are common in the Victorian Mallee.

Fryers Ridge flora reserve is set aside to preserve the widely diverse understorey communities associated with the red stringybark, broad-leaf peppermint, and red box open forests.

2. Recreation

Forested landscape with a wide variety of vegetation types, a range of accessibilities, the rugged terrain occurring in the Lerderderg Gorge, relics of early mining and sawmilling operations, and the mineral springs combine to give the public land blocks here a moderate to high capability for recreation.

Activities include sightseeing, orienteering, horse-riding, gem and gold fossicking, car rallies, nature study, picnicking, and sampling mineral water.

Scenic waterfalls are found on the north-flowing Loddon and Coliban Rivers (Loddon and Trentham Falls respectively), and the rim of Mount Franklin is a popular lookout point. Pykes Creek reservoir is used for water-skiing and power-boating.

3. Water supply

Almost all public land in the block falls within water supply catchments for domestic and irrigation purposes.

The Merrimu Reservoir, for instance, is located on Coimadai Creek, which drains from the Pyrete Ranges but also receives water from Goodman Creek and the Lerderderg River. Its total catchment extends for almost 34,000 ha, 85% of which is public land.

4. Agriculture and apiculture

Public land generally has a low to moderate capability for agriculture. The most productive soils are found along the Divide, especially where developed on basalt. The periphery of some public land in this part of the block has good potential for agriculture. Elsewhere, slopes are generally steep and soils are poor and susceptible to erosion when cleared.

Capability for continued honey production throughout this block is high. Messmate stringybark is the dominant species used in the Wombat forest, while, in the north of the block, good nectar flows are harvested from red stringybark, red box, grey box, and yellow box.

5. Softwood production

Narrow-leaf peppermint open forest III and, to a lesser extent, purchased farmland, have provided the principal source of land for softwoods. It is government policy that the practice of clearing intact native forest for the establishment of softwood plantations be phased out.

6. Hardwood production

The Wombat forest forms a major source of hardwood structural timber for the western suburbs of Melbourne and the country areas to the west, including Kyneton and Ballarat. These forests have been heavily utilized for timber since the earliest days of settlement. They are generally in good condition, and produce a sustained yield of sawlogs, pulpwood for the Hardboards Australia Ltd (H.A.L.) plant at Bacchus Marsh, and poles and round timbers for treatment at a preservation plant at Trentham. Sawmills at Woodend, Kyneton, Korweinguboora, Bullarto, Daylesford, Newlyn, and Ballarat depend on the Wombat forest for resources, and most supply mill residues to H.A.L. The forest forms a large part of the area defined in the pulpwood agreement between the State government and the company.

7. Mining and quarrying

Gold has been obtained from alluvial deposits buried beneath basalt at Daylesford and from quartz reefs in the Daylesford and Blackwood areas. Reserves are not exhausted and may be worked again in the future. Parts of public land near Bullengarook are potentially suitable for gravel production. A few areas of public land are potentially suitable for scoria pits; these are, however, on volcanic peaks and would be visible above the general level of the basalt plain.

Small deposits of other minerals - including diatomite, stibnite, and iron - are found near Coimadai, but capability of public land for anything but small-scale extraction appears low.

8. Hazards and conflicts

Fire is a constant threat from late spring to autumn. The climate and vegetation type (messmate stringybark with candlebark and manna gum) of this area combine to produce an extreme fire hazard. The situation is aggravated by the presence of dwellings and towns within and surrounding the forest areas.

An appreciable erosion hazard exists on the steep hills east of Bacchus Marsh. The hazard is particularly high on the cleared slopes of Goodman and Pyrites Creeks (Merrimu Reservoir catchment), Pentland Hills, and Toolern Vale. To a lesser extent the Lerderderg State park is also affected Most of the hazardous country is on Tertiary and Ordovician sediments of glacial tillite.

Blackberry and furze are problems in some of the old mining areas. The cup moth *Doratifera vulnerans*, causes serious defoliation of eucalypts in the north of the block during dry years.

There are potential conflicts between recreational and timber uses and water production. Further development of farmlets and holiday homes adjacent to public land increases the risk of losses of native fauna to domestic animals.

2. PUCKAPUNYAL--ROMSEY

A. Tenure and Nature of the Land

1. Present tenure

Public land (totalling some 8,200 ha) comprises two large parcels (Macedon and Cobaw Ranges) and many smaller scattered blocks.

Conservation reserves include the Organ Pipes National Park (85 ha), Macedon regional park (2,930 ha), some of which extends into block 1, and four flora reserves (totalling 359 ha).

Gellibrand Hill park, comprising 645 ha, was recently acquired by the government and is an important addition to the conservation of examples of western plains flora. The recreation area at Hanging Rock is well known for its picnic horse races and for the film 'Picnic at Hanging Rock'. Mount Piper education area (56 ha) is located west of Broadford.

Hardwood timber is harvested from the Cobaw forest (2,550 ha) and from uncommitted land (338 ha). Softwood plantations lie within the Macedon regional park, and are included as part of that total area.

Smaller parcels of public land here include streamside reserves, bushland reserves, recreation areas, streamside frontage reserves, and land under the control of various utilities and social welfare and other authorities.

2. Climate

Average annual rainfall varies from about 600 mm in the south, rising with elevation to 1,000 mm at Macedon on the Divide, then declining to 550 mm in the north of the block.

Precipitation pattern shows a winter maximum; the rare snowfalls do not persist on the ground for any length of time.

Summers are warm to hot. Temperatures exceeding 30°C may occur from December to the end of March. Winters are cool, with severe frosts experienced on the Divide.

3. Geology, geomorphology, and soils

The block contains five main geological areas.

The Newer Basalts form extensive plains sloping southward and valley flows sloping northward from Kilmore and Woodend; these are associated with various sodic mottled duplex soils with expansive-clayey subsoils. Also, areas of cracking black clays occur on some flats and in depressions, and red

friable soils are found south of Lancefield. Many of the eruption points remain as prominent hills and may take the form of lava cones such as Pretty Sally (530 m), the steeper scoria cones like Mount Holden (415 m), or the steep-sided, rocky domes of Hanging Rock, Brocks Monument, and Camels Hump.

Palaeozoic sediments underlie most of the basalt areas and frequently protrude or have been exposed. In the Wallan--Seymour area, they are usually associated with sodic mottled duplex soils, with shallow stony gradational soils on the ridges.

A large intrusion of Devonian granodiorite has been uplifted to form portion of the Divide between Kyneton and Pyalong and includes the Cobaw Ranges (700 m). Yellow mottled acid duplex soils dominate the mid and lower slopes, with deep acidic sands being common among the granite outcrops on the steeper crests. Some of the high plateau areas north of Cobaw are remnants of the Kinglake Surface.

The broad ridge of Mt William Range near Lancefield is also a remnant of the Kinglake Surface, but here it occurs on up-faulted Cambrian greenstones (diabase) and cherts. Red friable gradational soils are common here.

Remnants of the even older Baw Baw Surface are found at Mount Macedon where Devonian acid volcanics have been uplifted and have resisted erosion. They form a steep-sided plateau at an elevation of about 920 m. Remnants of the Kinglake Surface occur about 200 m lower than this plateau - on the northern and eastern slopes. Both Surfaces are associated with red and brown friable gradational soils of strong structure.

4. Vegetation

Around Macedon and Cobaw, messmate stringybark--narrow-leaf peppermint--manna gum open forest II and III is widespread. These species occur in open forest III formation on sheltered aspects of Mount Macedon and Mount Charlie and more widely in the Cobaw Ranges. Elsewhere these species form an open forest II, with narrow-leaf peppermint becoming occasionally dominant.

Understorey species include blackwood, silver wattle, sweet bursaria, and bracken fern. Swamp gum occurs on damp flats.

A limited occurrence of mountain ash open forest IV at Mount Macedon has associated species such as tree-ferns, tough rice-flower, tree everlasting, and musk daisy-bush. Above this are small areas of alpine ash, while the highest points of Mount Macedon and the Camels Hump carry a woodland of snow gum with a grassy understorey and low shrubs.

Hanging Rock carries open forest II to woodland of manna gum, with some narrow-leaf peppermint and messmate stringybark and a scattered understorey including blackwood, silver wattle, sweet bursaria, and bracken fern. Public land near Oaklands supports woodlands of grey box (in its nearest nat-

Hanging Rock

ural occurrences to Melbourne) and river red gum on the wetter sites. River red gum is found along watercourses on the gentler terrain of the block, sometimes in conjunction with yellow box.

In the north, public land near Puckapunyal carries a grassy open forest or woodland. Eucalypts include long-leaf box, red stringybark, red ironbark, red box, grey box, and yellow box. Various wattles, including three spinescent species, provide a sparse understorey of taller shrubs; daphne heath may form a dominant low shrubbery on stony hillsides and ridge-tops; elsewhere, a tussocky ground cover of silvertop wallaby grass, tussock grass, and wire rapier-sedge is found.

Mount Piper - an isolated conical hill near Broadford - carries a similar tree cover, but has a sparse understorey of small wattles, including lightwood and spreading wattle, other leguminous shrubs, mountain grevillea, some heaths, and showy guinea-flower. Tussock-forming grasses (five being species of *Danthonia*) are also found here.

Rail reserves contain several important plants, such as pepper-cress (*Lepidium hyssopifolium*) and small milk-wort (*Comesperma polygaloides*), that are remnants of the original plains vegetation of the area.

5. Fauna

Public land at Macedon and Cobaw supports the habitats of the forest-dwelling species of the ranges, which are more widely represented in block 1. These include such species as sugar glider, common wombat, bush rat, chocolate wattled bat, white-throated treecreeper, eastern yellow robin, golden whistler, crimson rosella, garden skink, and water skink. The powerful owl and peregrine falcon, both significant species in the study area, have been recorded breeding in the region of Macedon.

North of the Dividing Range, the original vegetation was predominantly dry forests and woodlands - usually having a grassy understorey. Fauna typically associated with these habitats include species such as brush-tailed phascogale, squirrel glider, common dunnart, little mastiff bat, fuscous honeyeater, weebill, rainbow bee-eater, speckled warbler, three-toed skink, and bearded dragon. The habitats have now been almost entirely cleared for agricultural purposes, however, with only small disjunct remnants of native vegetation remaining. The exact status of the fauna in these refugia is not known.

Many bird species are probably still able to utilize remnants of vegetation present on private land, along road verges, and in stream frontages, but few mammal species are likely to persist in such isolated and fragmented habitats.

B. Present Use and Capabilities

1. Nature conservation

The Macedon regional park contains an isolated western outlier of wet open forest types, and as a result has a high capability for nature conservation. It is the only recorded locality in western Victoria for both alpine ash and small-leaf star-hair, and one of the two sites for hairy beard-heath. The endemic dwarf silver wattle grows on Mount Macedon and nearby Mount Charlie, while the uncommon grass *Amphibromus archeri* has been recorded near the foot of Mount Macedon. The shiny filmy-fern and veined bristle-fern are epiphytes on the trunks of soft tree-ferns in Stony Creek, Mount Macedon.

Black gum (*Eucalyptus aggregata*) has its only occurrrence on public land in Victoria in the railway enclosure about a kilometre south of Woodend. An isolated stand of silver-leaf stringybark on damp flats near Mount Charlie is the only occurrence west of Melbourne. Management of the Organ Pipes and Gellibrand Hill parks is directed towards the preservation and restoration of the indigenous flora of the basalt plains.

Other areas of public land have a low to moderate capability for nature conservation. Mallee species - white cypress pine, desert cassia, and pale twin-leaf - occur in declivities of Jacksons Creek near Sydenham. The rare purple diuris grows on railway land at Riddel.

In the north of the block, the uncommon lemon starbush has been recorded at Mount Piper, and the effects of elevation and aspect changes on open forest I types can be readily demonstrated in this education area. The blue finger-flower occurs in the small Boulton Wildflower Sanctuary near Tallarook, and an isolated occurrence of wire rapier-sedge is found near Puckapunyal.

The frog *Ranidella parinsignifera* occurs at the southern limits of its range, while *Litoria peronii*, a common frog on the Murray, reaches its southern limit on the Goulburn River near Seymour.

Both the cockatiel and dollar bird are uncommon visitors to the northern parts of this block during the summer months. The crested bell-bird also is restricted to these areas.

An Aboriginal axe-stone quarry at Mount William and an axe-grinding site about 3 km east of Macedon are important archaeological sites, both of which are on private land.

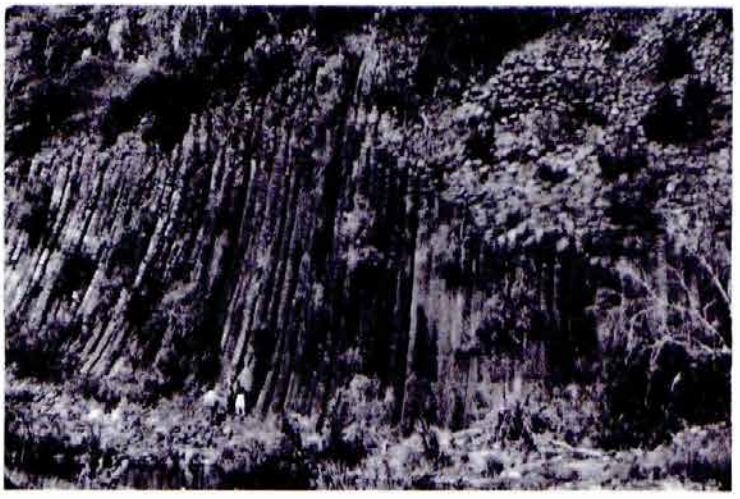
Columnar basalt exposed in the Organ Pipes National Park is of geological interest.

2. Recreation

The Macedon area has a high capability for recreation, which is reflected in its reservation as a regional park. Its main attractions are lookouts, rock outcrops, a variety of natural forests and softwood plantations, and the plant nursery. Following the devastating fires of 1982/83, extensive restoration and regeneration work was necessary throughout the area.

The Organ Pipes National Park near Keilor, named for the columnar basalt formations, receives more than 90,000 visitors a year. Gellibrand Hill park near Greenvale is also becoming popular for picnicking and walking. It contains Woodlands homestead - a large prefabricated timber house brought from Britain to Australia in 1843.

Organ Pipes National Park



Hanging Rock provides opportunities for picnicking, sightseeing, and rock-climbing. Koalas can be readily seen, and a racecourse on public land there provides the venue for the annual New Year's Day Picnic Races, attended by thousands of people.

The forest nursery at Macedon run by the Department of Conservation, Forests and Lands is again in operation following the destruction of buildings and some plants in the Ash Wednesday bushfires.

Elsewhere on public land, the recreation capability is moderate to low, and is associated with recreational driving. Stream frontages (for example, along the Maribyrnong River and Mollisons Creek, and in the north of the block) are used

for low-intensity recreation such as walking, and a number of streamside reserves have been set aside in some of the more accessible locations to facilitate picnicking. Land near Tooboorac is used for orienteering.

3. Water supply

Diversions from creeks and springs on the slopes of the Macedon Range provide water to a number of towns. The supply of water from public lands comprising the Macedon regional park is therefore an important use. This area also yields small quantities of high-quality groundwater, and the Woodend Water Board constructed three bores in 1982/83.

Greenvale reservoir, an off-river storage, is located close to the southern boundary of the block.

The Campaspe River basin drains into Lake Eppalock - public land in this block contributes little to the total run-off, however.

4. Agriculture and apiculture

Most public land is too steep and stony for agriculture. In general, the soils are highly erodible. However, the acidic duplex and yellowish gradational soils on the Cobaw Plateau would have a high potential for grazing and crop production.

Honey production is concentrated on public land at Mount Macedon and the Cobaw Ranges during late summer and autumn, when messmate stringybark flowers - a time when few alternative sources of honey and pollen are available.

The north of the block has a high capability for honey production as it forms the southern portion of a more extensive forest outside the study district. The important species here are grey box, red stringybark, and red ironbark, while red box and long-leaf box are also of value.

5. Softwood production

Narrow-leaf peppermint open forest II and III has provided the principal source for softwood establishment to the present. It is government policy to phase out the clearing of intact mature forest for softwood planting.

The Ash Wednesday bushfires of February 1983 destroyed all but a small area of the Macedon softwood plantations. Some of the younger plantations were totally destroyed. The older stands on Mount Macedon, however, while killed by the fire, were able to be salvaged in an operation in which logs were transported to mills as far afield as Colac and Benalla.

6. Hardwood production

The open forest III and IV areas on Mount Macedon have a high capability for timber production. These forests, however, comprise an important component of the Macedon regional park and are unavailable for harvesting - although con-

siderable quantities were salvaged following the 1982/83 fires.

Open forest III areas of messmate stringybark, manna gum, and narrow-leaf peppermint in the Cobaw Ranges have been harvested for timber since the early days of settlement. Capability of the lower-rainfall forests to the north for timber production is very low, but red ironbark, grey box, and yellow box areas could provide small-dimension durable timbers.

7. Mining and quarrying

In the south, extensive deposits of basalt and granitic sands occur - mainly on private land. Small deposits of diatomite have been mined near Newham, Moranding, and Mickleham.

The capability of public land in the north for mineral extraction is low. Antimony mineralization may be present.

8. Hazards and conflicts

Fire is a constant threat in the forested areas during summer. The 1982/83 fires in the Macedon area, which led to widespread destruction of both forests and buildings as well as loss of life, attest to this.

An appreciable erosion hazard exists on steep slopes, especially in the low-rainfall areas, where considerable gullying (and salting) or sheet erosion on steep basalt scarps can occur. Gullying along roadsides is also of concern, particularly around Romsey.

There are potential conflicts between recreation, water production, timber production, and nature conservation, because of the proximity of the larger areas of public land to Melbourne and the levels of demand that these uses may exert. Adherence to landscape guidelines in the conduct of timber operations and catchment prescriptions go some way to reducing this conflict. However, devastation by fire, as recently occurred in the Macedon area, may require that exceptional measures be taken in the short term to facilitate a rapid restoration of stable vegetative cover to an area.

3. BRISBANE RANGES--TORQUAY--WERRIBEE (South)

A. Tenure and Nature of the Land

1. Present tenure

Public land here covers some 45,000 ha and includes the Brisbane Ranges National Park (7,520 ha), the Werribee Gorge and portion of the Angahook--Lorne State parks (totalling 4,720 ha), and the You Yangs and Steiglitz regional parks (2,610 ha). The park at Point Cook (at present almost 450 ha) also forms part of the public land.

The Durdidwarrah and Stony Creek reference areas (395 ha) form part of a much larger area set aside for water supply purposes. Two flora and fauna reserves (80 ha), three flora reserves totalling 2,225 ha (one of which, at Inverleigh, extends outside the study area), and nine wildlife reserves totalling 2,064 ha protect native plant and animal populations. Several of the wildlife reserves complement portions of the Harold Holt Marine Reserves (described in block 4).

Hardwood timber is available from the Bungal forest (400 ha) and uncommitted land (2,224 ha), and minor timber products may be harvested from the regional park in the You Yangs and from near Bannockburn. Some 320 ha of land in the parish of Bungal has been acquired for the establishment of a softwood plantation and a 40-ha softwood seed nursery is located near Mount Doran.

The Werribee Sewerage Farm (11,600 ha), the Anglesea coal-lease area (4,580 ha), Bungal forest (400 ha), and some 2,200 ha of uncommitted land comprise the remaining larger parcels of public land here. Three education areas, at Eumeralla (313 ha), Ocean Grove (143 ha), and Meredith (236 ha), the Bostock and Melton water supply reservoirs (330 ha), and a number of smaller areas such as an historic reserve, bushland reserves, streamside reserves, and water frontage and coastal reserves make up the balance. Werribee Park (213 ha) is also included here, as is the 222-ha White Elephant (Soil Conservation) Reserve.

2. Climate

This relatively dry area lies in the rain-shadow of the Otway Ranges. Average rainfall varies from about 500 mm near Geelong to 800 mm near Lorne, with a winter maximum. Inland, precipitation is influenced by elevation, varying from about 500 mm on the plains to about 700 mm at the higher elevations in the Brisbane Ranges.

3. Geology, geomorphology, and soils

The block is dominated by the extensive flat to gently undulating plains of Pliocene basalt, Tertiary deposits, or

Quaternary alluvium. They are broken in places by up-faulted areas and the occasional isolated hills. Uplift along the western side of the Rowsley Fault - extending from north of Bacchus Marsh nearly to Geelong - has formed a long north--south scarp, dramatically marking the western edge of the Port Phillip sunkland.

The Newer Basalts are represented by sheet flows over much of the area, but with some valley flows in the south. They pre-date and occur on both sides of the Rowsley Fault. Soils are dark or of a yellow--grey sodic duplex type. Some areas of black cracking clays occur, mainly in the depressions, as well as some shallow stony-rise soils.

The land between the You Yangs and Melton, however, has mainly red calcareous, sodic duplex soils, some of which are extremely stony. Similar but stone-free soils occur on the Pleistocene alluvium of the Werribee delta, a relic of higher sea levels in the bay.

The Tertiary plains in the south are of marine origin, with brown mottled sodic duplex soils, red--yellow mottled duplex soils, and occasional sandy areas.

In the north, the Tertiary plains are alluvial in origin, and in many places erosion has dissected them, restricting their occurrence to thin cappings on the Palaeozoic ridges and hills. Yellow mottled acid duplex soils are common on these plains with some areas of leached white acid sands and red ironstone soils, particularly around the Brisbane Ranges and Steiglitz.

Four main up-faulted areas occur in the block, the most extensive being west of the Rowsley Fault. Here, the Ordovician sandstones and shales that underlie the Tertiary and basalt plains have been exposed - both along the Fault (the Brisbane Ranges) and along the courses of the rejuvenated Moorabool River and Sutherlands Creek at Steiglitz. Associated with this rock type are agriculturally poor yellow mottled acid duplex or shallow stony gradational soils - the latter occurring mainly on the upper ridge slopes.

Further south, the two streams cut through basalts, marine Tertiary deposits, and limestone. The black well-structured clays and red duplex soils on the valley sides and the broad alluvial flats here are far more useful for agriculture.

North of the Brisbane Ranges, also on the up-thrown side of the Fault, lies the Ballan sunkland, an area that was a basin long before activity along the Rowsley Fault elevated it to its present altitude. Deep deposits of Tertiary sediments, Tertiary basalts, and Permian tillites have been preserved within the sunkland, which has complex soil patterns.

The rejuvenated Parwan Creek has cut a broad steep-sided valley into the unconsolidated Tertiary sediments. Mottled yellow sodic duplex soils along this valley lie on some of the most erosion- and landslip-prone country within the study area.

The rejuvenated Werribee River also begins in a broad valley in Tertiary sediments, but this narrows quickly as the river enters the tillites and becomes a deep narrow gorge within the hard Palaeozoic rocks south of Myrniong.

The other three uplifted areas occur in the south. They include the eastern end of the very strongly dissected Otway Ranges, the Barrabool Hills, and the low Bellarine Horst. The first two are on Cretaceous sediments: the Otways are dominated by yellowish brown gradational soils on slopes too steep for agriculture, while the Barrabool Hills contain a complex of mainly duplex soils. The Tertiary basalts of the Bellarine Horst have black well-structured clays and dark duplex soils.

The Tertiary plains from Torquay to Fairhaven have also been somewhat uplifted and dissected by erosion, resulting in broad flat crests and remnant plateau areas overlooking moderate to steep-sided valleys. The soils on the steeper slopes - particularly the sands and poorly structured yellow gradational soils on non-marine Tertiary deposits at Bald Hills - have low capability for agriculture and, in general, remain uncleared.

Remnant Tertiary plateau at Point Addis

4. Vegetation

In the eastern Otways, messmate stringybark - with brown stringybark and shining peppermint - forms an open forest II and I on gradational and duplex soils developed on Tertiary sediments. Red ironbark, sometimes in mixture with blue gum, forms an open forest II and I in a rain-shadow area extending close to the coast from Grassy Creek to Point Addis.

Messmate - with mountain grey gum, narrow-leaf peppermint, and sometimes blue gum - forms open forest II and III on gradational soils developed on Cretaceous sediments in the extreme west where elevation and rainfall are higher. The taller understorey species are blackwood, silver wattle, and tree everlasting. Other common understorey species include tussock grass, large-leaf bush pea, and thatch saw-sedge.

Heathy woodlands are widespread on the Tertiary sediments in the south-west. Shining peppermint predominates on leached sands that have an impeding layer near the surface, while

brown stringybark is more common on the leached sands without an impeding layer or on sodic duplex soils.

A remnant of manna gum woodland is located in the Ocean Grove education area.

Typical dune communities of climbing lignum, coast wattle, white correa, coast tea-tree, coast beard-heath, coast daisy-bush, coast everlasting, cushionbush, and dune thistle are to be found along many parts of the coastal reserve between Anglesea and Point Lonsdale. Moonah forms a coastal scrub on sand at Anglesea and Airey's Inlet, providing a shaded habitat for the very rare and interesting fungus *Underwoodia beatonii*.

The diverse range of communities found at Lake Connewarre and the Barwon River estuary includes white mangrove scrub and extensive salt-marshes, with wilsonia, seablite, glasswort, noon-flowers (pigface), and other succulent/halophytic vegetation - the most westerly occurrence of mangrove in Victoria. Some areas of tangled lignum and beds of native reeds still occur at Reedy Lake.

Dry coastal vegetation (including mature stands of coast tea-tree and wirilda) grows at Edward's Point, while salt-marsh vegetation fringes Swan Bay and a number of small lagoons scattered along the coast on public land, from Breamlea to Portarlington.

The treeless basalt plains between Geelong and Melbourne originally carried tussock grassland, but are now profoundly altered by more than 100 years of grazing and cultivation. A few surviving vestiges of near-original vegetation, mainly on railway reserves, indicate that the main native grasses were species of kangaroo, tussock, wallaby, and spear grasses, with some windmill and panic grasses. A diversity of species, located inter-tussock, included a range of composites (such as everlastings, groundsels, and wrinklewort), bulbous lilies, and orchids, pussy-tails, tuberous crane's-bill, blue herons-bill, blue devil, blue bells, pink bindweed, and small semi-shrubs such as rice-flowers.

A range of swamp vegetation types included dense thickets of tangled lignum to 2 m high on depressed swampy ground.

Open forest I to low open forest II vegetation predominates on the flat upland areas of the Brisbane Ranges, and near Mount Doran and Bamganie, comprising messmate stringybark mixed with broad-leaf peppermint, red stringybark, or sometimes brown stringybark or scent-bark. The understorey ranges from variously heathy to grassy and includes silver-top wallaby grass.

In the Brisbane Ranges, particularly at the northern end, red ironbark grows widely - in mixture with red box (on shallow stony soils), or with red stringybark and a range of other eucalypts on better soils.

An open forest II of manna gum, snow gum, and swamp gum is found on lateritic duplex soils near Durdidwarrah. The

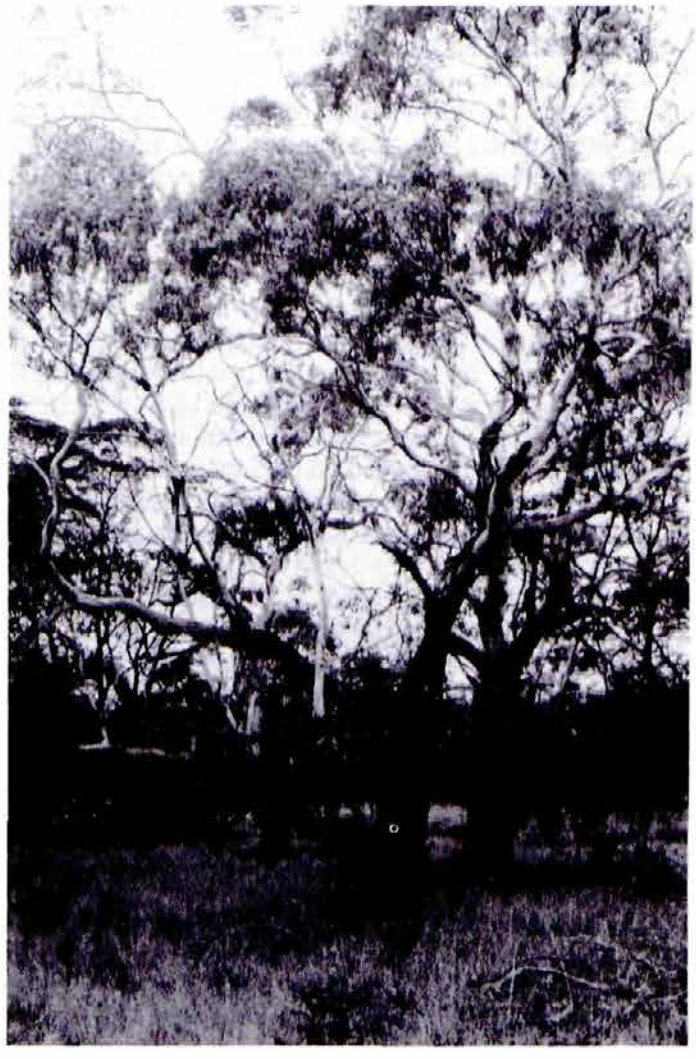
Grey box and bulloak woodland: part of the original vegetation of the basalt plains

understorey consists mostly of grasses and seasonal herbs, with rushes and sedges in wetter situations.

Sizeable patches of heathy woodland occur on leached sands between Steiglitz and Staughton Vale.

Bungal State forest contains open forest I and II of messmate and narrow-leaf peppermint, with tall riverine manna gums on the lower slopes and valley floors. Some broad-leaf peppermint grows on the drier ridge-tops with an understorey of tussock grasses (notably *Danthonia* and *Poa* species), a range of sclerophyllous shrubs (including peas and wattles), and herbaceous species.

The Inverleigh flora and fauna reserve supports woodlands of manna gum and, in low-lying situations, red gum. The understorey is predominantly grassy with occasional patches of



Manna gum woodland, in Inverleigh flora reserve

heath; at least 24 species of orchid and 13 lilies have been recorded in this area.

Much of the You Yangs regional park now comprises plantations of various eucalypts and wattles, but some indigenous manna gum, yellow gum, red box, and river red gum form a woodland with grassy to heathy understorey. Snowy mint-bush dominates the shrubby understoreys.

On the steeper rocky declivities and among boulders grow specimens of manna gum, blue gum, red stringybark, red ironbark, long-leaf box, lightwood, black wattle, and drooping she-oak. Boneseed has invaded much of this area, but components of the outcrop species persist.

Yellow gum and manna gum woodland with drooping she-oak occurs on public land near Bannockburn. Golden wattle is the dominant understorey here, with a ground flora of herbs and grasses and dwarf shrubs (parrot-peas, rice-flowers, and austral guinea-flower). There is a small hardwood plantation here also.

5. Fauna

The block encompasses a range of differing vegetation formations, each one of which supports a distinctive faunal community.

The grasslands and grassy woodlands that formerly stretched across the flat volcanic plains have almost entirely disappeared, with the consequent loss of a number of species - including eastern barred bandicoot, Australian bustard, eastern quoll, plains rat, and emu. Other species dependent on these habitats are now uncommon or rare. Four of these, the plains-wanderer, bush thick-knee, earless dragon, and striped legless lizard, are regarded as significant or notable species within the study area.

To the south, public land in the Anglesea area supports a variety of heaths and heathy woodlands. The fauna typically associated with these habitats include two small mammals - the New Holland mouse and swamp antechinus - and birds such as the rufous bristlebird, field wren, and southern emu-wren. Coastal heathlands here are the only known lowland locality in which the mountain dragon has been recorded.

Dry open forest and woodland habitats in the Brisbane Ranges and the You Yangs are well known for the diversity of birds that may be observed there. In addition to the ones commonly found in the open forests of southern Victoria, these birds include species usually associated with drier inland habitats. Some (such as the hooded robin, weebill, and southern whiteface) are resident, while others (such as red-capped robin, white-backed swallow, and peaceful dove) may occur seasonally or periodically.

This block also contains important habitats for many species of waterfowl and wading birds. Swamps, marshes, and other wetlands (such as the Lake Connewarre wildlife reserve) provide valuable habitat for birds such as ducks, ibis, herons, and egret.

Lands used for sewage treatment and salt extraction on the northern margin of Port Phillip Bay are also utilized by waterfowl, as well as being an important feeding ground for numerous species of overwintering migratory waders.

Salt-marsh vegetation at several locations along the shores of Port Phillip Bay (for example, at Swan Island and Point Wilson) form the primary overwintering habitat of the endangered orange-bellied parrot, which annually crosses Bass Strait from its breeding grounds in Tasmania.

B. Present Use and Capabilities

1. Nature conservation

The extensive agricultural development that has taken place in this block gives the residual parcels of public land very high capability for nature conservation.

The Brisbane Ranges National Park includes the steeply dissected slopes formed by the scarp of the Rowsley Fault and remnants of flat plateau terrain. It has a rich flora - associated with the open forests of messmate stringybark, red stringybark, broad-leaf peppermint, and red ironbark and woodlands of manna gum, white sallee, and swamp gum. The Brisbane Range grevillea (*Grevillea steiglitziana*) is only

found here and in the nearby Werribee Gorge State park. Golden grevillea is found elsewhere only in Gippsland.

Werribee Gorge State park contains several features of geological interest, which are exposed in a gorge cut by the Werribee River in a scarp of the Rowsley Fault. Tree species include red ironbark, grey box, manna gum, and white cypress-pine.

Most of the important landscape features occurring between Anglesea and Lorne are incorporated in the Angahook--Lorne State park.

The Durdidwarrah reference area is located on Tertiary sediments and represents open forest I to II of manna gum and white sallee. The nearby Stony Creek reference area, however, is located on Ordovician sediments and contains open forest I to II of brown stringybark, messmate stringybark, and broad-leaf peppermint.

Woodlands at Bannockburn and Inverleigh are important relics of the original vegetation of the region, and a number of significant orchid species are recorded here. The Inverleigh Common now forms part of a flora reserve (H9) of 1,050 ha, 375 ha of which lie in the study area.

A parcel comprising some 1,850 ha of land fringing the Alcoa lease area is included in the Mount Ingoldsby (H13) and Anglesea (H14) flora reserves and contains a diversity of environments not represented in the Angahook--Lorne State park. In addition, a number of very rare orchids also grow in the Anglesea area, notably in wet heath communities.

One of the few remaining areas of salt-marsh--white mangrove complex around Port Phillip Bay occurs in the Hovells Creek flora and fauna reserve (H21) at Limeburners Lagoon. A small lagoon and an area of coastal scrub and grassland near Point Richards (H23) incorporate the habitat of the short-nosed bandicoot.

Public land near the coast supports significant areas of heathy woodland and wet and dry coastal complexes - environments that have very restricted occurrence in the region. Most of those areas have been incorporated in either wildlife or flora reserves, or form part of the coastal reserve. The coastal reserve also includes a number of sites of geological and archaeological importance.

In its 1977 Final Recommendations, the Council listed a number of sites of special conservation significance on the coast. That list is reproduced as Appendix VII for those areas relevant to this review.

Water flow into the 37-ha Browns Swamp wildlife reserve (C1) is regulated by an off-take from Wurdiboluc Creek so that water can be retained over summer.

Reedy Lake (905 ha) forms part of the Lake Connewarre (C2) complex of fresh and brackish wetlands. It supports an extensive breeding colony of sacred ibis and, in season, is

one of the most favoured duck-hunting areas close to Melbourne.

Lonsdale Lakes (C3) comprise a series of shallow salt-lakes covering 150 ha, which are dry for some periods of the year. These are used predominantly by waders as the water recedes.

Edwards Point and the shoreline of Swan Bay (C4) contain one of the few areas of coastal tea-tree scrub remaining on the Bellarine Peninsula. Salt-marshes here merge with the marine flora of the Swan Bay section of the Harold Holt Marine Reserves. The peninsula of Edwards Point supports sand-dune flora and the rare and unusual wire mistletoe. This area provides excellent feeding and roosting areas for sea-birds and waders.

Mud Island (C5) is an integral part of the Mud Island section of the Harold Holt Marine Reserves, and is described in block 4.

Salt Lagoon (C6) near St Leonards is a 24-ha shallow salt-lake that is dry for periods of the year. As the water recedes this wetland forms an important feeding and roosting area for waterfowl. Refuse is blown into the reserve from a rubbish tip located on its western boundary. The tip also attracts large numbers of silver gulls, which discourage the use of the reserve by other bird species.

The Spit--Murtcaim wildlife reserve (C7), of 440 ha, contains salt-marsh and sand-dune flora and is one of the few overwintering areas for the orange-bellied parrot. It is also important as a feeding and roosting area for sea-birds and waders. This reserve and adjoining coastal land are managed primarily for the conservation of the orange-bellied parrot.

Serendip Wildlife Research Station (C8) is used to conduct investigations into the breeding biology of waterfowl (including Cape Barren geese and magpie geese) as well as Australian bustards and brolgas. Although most of the land area of the station is leased for farming, a considerable part has been developed into wetlands and planted with trees and shrubs. It is used to demonstrate wildlife conservation principles on farmlands as well as for public education activities.

The small (8 ha) Freshwater Swamp (C9) forms part of a much larger river red gum and lignum swamp - the major part of which is freehold.

Several important relics of grassland vegetation occur on railway land. Endangered species here include groundsel and button wrinklewort (Melbourne--Geelong line and near Bannockburn) and dwarf scurf-pea near Inverleigh. Many other now uncommon to rare species also occur in such refuges.

2. Recreation

A wide variety of recreational opportunities are available on public land here, and the close proximity of the cities

of Melbourne and Geelong means that recreational demands are high.

Many popular resorts are located along the ocean and sheltered bayside beaches, and their capability for swimming, fishing, and boating is very high. The forested hinterland to the ocean beaches is used for bushwalking, camping, picnicking, and nature study.

The rugged landscape found in parts of the Brisbane Ranges National Park limits access in some sections, although this adds to the area's popularity for bushwalking, picnicking, and nature study, particularly during spring, when the wildflowers are blooming.

Picnic facilities, Little River - Brisbane Ranges National Park

Steiglitz regional park also provides wildflower displays and contains artefacts of the gold-mining era. The courthouse and other old buildings here are remnants of a once-thriving 19th century town.

The You Yangs regional park receives extensive use for picnicking and the rocky granite peaks provide a stark contrast to the surrounding treeless plains.

Melton reservoir is used for boating and water-skiing, while Werribee Park provides for a variety of activities and includes an historic homestead, an open-range zoo, a camp park, golf-course, and tennis courts. Point Cook park provides for the more passive activities of picnicking and nature study along the bayside. It also includes an historic homestead.

Other small parcels of treed public land throughout this block are generally less accessible, but provide landscape diversity and contribute to the Australian character of the region.

3. Water supply

The Moorabool River provides water primarily to Geelong via the Bostock reservoir (D52) and the upper and lower Stony Creek reservoirs (D51) - which are now protected under a Land Use Determination - and from a diversion at She-Oaks (D105). This river also provides water to the Bannockburn Water Board.

Painkalac Creek in the south provides domestic water to Aireys Inlet and Fairhaven.

There is little capability for increasing the volumes of water provided by these systems.

4. Agriculture

The Animal Research Institute at Werribee contains croplands and irrigated and dry pastures, and the Werribee Sewerage Farm is used for intensive stock production for meat.

Agricultural capability of public land elsewhere is low. Limited rainfall, poor soils, and a high susceptibility to erosion preclude the You Yangs. Soils in the Brisbane Ranges are shallow and stony and the topography is generally steep. The eastern Otways are similarly too steep for agriculture, while along the coast the soils are generally infertile leached sands.

Apicultural capability of public land here is high, and apiarists provide pollination services for various local farm crops.

5. Softwood production

A seed nursery for softwood species is located near Mount Doran. Its isolation from other plantation areas is necessary, to prevent undesirable cross-pollination. To the north, near Bungal, 327 ha of farmland have been purchased for a plantation.

Public land elsewhere has a low capability for softwood production, principally due to low rainfall and poor soils. Also the clearing of intact mature forests for softwood plantations is contrary to government policy.

6. Hardwood production

Generally the capability for timber production is low to very low.

To the north, Bungal forest (E1) and uncommitted land provide pulpwood suitable for the hardboard plant at Bacchus Marsh and small volumes of sawlogs. Elsewhere, native woodlands of red ironbark, yellow gum, and yellow box are capable of providing small quantities of durable timbers. Plantations of various eucalypts (including sugar gum, swamp yate, and brown mallet) in the You Yangs regional park and at Bannockburn supply a local demand for minor timber products.

7. Mining and quarrying

Some 100 million tonnes of brown coal underlie public land near Anglesea. This resource is under a long-term lease to Alcoa of Australia and is used to generate power for the company's aluminium smelter.

Although considerable quantities of 'stone' are extracted from the area, little is derived from public land.

Salt is harvested from evaporation pans developed on low-lying freehold and public land near the shores of the bay.

8. Hazards and conflicts

Fire is a constant threat, particularly along the coastal fringe, where thousands of people are camped over summer. Map 10 graphically indicates this hazard.

Cinnamon fungus continues to threaten native vegetation, particularly on shallow soils in the Brisbane Ranges and Angahook--Lorne parks.

South African boneseed has replaced much of the native understorey vegetation of the You Yangs regional park.

Pedestrian traffic - not only through sand dunes along the coast, but also along walking tracks on the sandy soils of the You Yangs - has caused serious soil erosion.

Carpark and footpath development in coastal heathlands at Bells Beach

The White Elephant (Soil Conservation) Reserve (WER on Map 8) is used as a reference and educational resource with respect to soil erosion and techniques of reclamation.

4. THE BAY

A. Nature of the Area

1. Present tenure

Port Phillip Bay is a shallow marine basin of some 1,900 sq. km in extent, with a maximum water depth of about 20 metres. The balance of the block comprises underwater terrain and coastal waters from Point Nepean to Lorne, extending seaward 5.5 km (the 3-nautical-mile territorial limit) along the continental shelf, where water depths approach 50 metres.

Specific reservations within this block include the Harold Holt and Point Cook Marine Reserves (totalling 3,150 ha) and three above-surface wildlife reserves (totalling 100 ha), each associated with respective components of the Harold Hold Marine Reserves. A number of protected zones have also been declared over shipwrecks in the area.

2. Environment

The total annual flow of water into the bay as rain and stream-flow amounts to almost 1.4 cu.km or 5.5% of its total volume. Annual evaporation from the surface approximately equals total input, with the result that, except in localized areas adjacent to major streams, salinities in the bay remain close to oceanic concentrations.

The exchange of water between the bay and Bass Strait during each tidal cycle comprises almost 3.6% of the total volume.

The main sources of stream-flow into the bay are the Yarra and Werribee River systems; some 350 smaller streams, storm-water drains, and effluent discharges also contribute. As a whole, the waters of the bay are relatively unpolluted, although at some nearshore areas the discharge of water-borne wastes from creeks and drains conflicts with recreational use. Pollutant nutrient concentrations may be relatively high in the waters surrounding input sites but these rapidly diminish with mixing.

The Barwon River and streams of the Otway Basin (see Appendix VIII) discharge into Bass Strait, usually through their estuaries.

Wind is a major climatic factor affecting the use of the bay and, at any one time, strong winds may be experienced in some sections while calm exists in others - a situation that can change rapidly. Northerlies occur more frequently in winter, while southerly winds are more common in summer. Land surrounding the area is of low relief, with the result that wind affects water currents and wave action significantly.

3. Land forms

The bay is located in a depression (sunkland) formed principally by the actions of the Selwyn Fault in the east and the Rowsley Fault in the west. In the late Eocene epoch (50 million years ago), the region was a low-lying plain drained by one main river system, which flowed south-west from Point Nepean, linked with the Barwon River and the Westernport drainage systems, and eventually flowed into the sea south-east of Cape Otway. The plain subsequently submerged and the river system was betrunked.

Cliffs, shore platforms, and broad beaches with well-sorted sands comprise much of the eastern shoreline of the bay. The north-western shoreline is fringed almost continuously by narrow beaches of poorly sorted sands. Land behind these beaches is generally of low relief (6 m). On both sides of the Bellarine Peninsula, cliffs up to 15 m high in places form a backing for beaches and foreshores of varying widths, although at Queenscliff a broad beach with well-sorted sands has developed under the influence of tidal currents and ocean swells.

High cliffs and narrow beaches characterize much of the coastline in the study area

The coast outside Port Phillip is characterized by a series of prominent points separated by broad concave bays. Rock platforms are found at Black Rocks (basaltic) and, of sedimentary origin, between Torquay and Point Addis, at Point Roadknight, between Urquhart Bluff and Split Point, and south of Eastern View. Between Barwon Heads and Torquay the

Broad beaches backed by low-lying plains, near Torquay

hinterland comprises low-lying coastal plains, while further to the south the coastline is cliffed or steeply sloping, often fronted by beaches or rock platforms and interspersed with narrow alluvium-filled valleys.

The entrance to Port Phillip (between Point Nepean and Point Lonsdale) is some 3 km wide, although calcareous reefs and shallow rocky outcrops extend from both sides to reduce the navigable width to a little over 1 km. Immediately outside the entrance, the reef from Point Lonsdale extends some 3 km south-east to form a shelf (Rip Bank) about 12 m below the surface.

Just inside the entrance to the bay lies a bar of sand and gravels, normally covered by less than 5 metres of water and occupying more than 250 sq.km. Known as the Port Phillip Sands, this bar retards tidal inflow and outflow, thereby affecting the hydraulic behaviour of the whole bay. Together with similar sands off the Werribee shore, this material occupies some 30% of the floor.

Along the eastern margin, the bottom is generally composed of sands; clay has been deposited principally in the deeper section in the middle and comprises 20% of the floor. The balance, some 45% of the floor, comprises silty clay and silty sand.

4--5. Flora and fauna

Biological studies on plankton (minute floating organisms), benthos (ground-dwelling marine organisms), and fish indicate that the inputs of fresh water to Port Phillip Bay do not modify the flora and fauna sufficiently to consider the bay as a typical estuary. (Under most estuarine conditions, salinities fluctuate as sand bars close the mouths of the streams in summer and are broken when the resultant lagoon flushes with winter rainfall.)

The composition of phytoplankton (plant plankton) in the bay resembles that in many other estuaries and coastal waters

throughout the world. The diversity of zooplankton (animal plankton) is also comparable with that in coastal waters.

Maximum concentrations of phytoplankton are observed in areas close to water input sites, and these localized effects may indicate an incipient problem with pollution by nutrients. Generally, however, the quantity of phytoplankton in the bay normally reaches a peak in winter as a result of nutrient discharges from streams and drains; this is followed by a maximum in zooplankton quantities.

The nature and distribution of phytobenthos (seaweed) depend on the degree of exposure to wind and currents, the stability of the substrate, and the availability of light. Little plant growth takes place in the bay below 15 m, for instance - presumably because of reduced light. Deposition of weed on beaches is generally greater in the northern half of the bay and is most frequent in summer - the season of maximum algal growth.

Bottom-dwelling animals (zoobenthos) in the bay have a high species diversity, with a distribution closely related to the type of sediment. Four main groups of species have been identified in terms of distribution:

* those favouring sandy sediments - chiefly crustaceans (crabs)
* those found in silty sands - mostly the polychaetes (worms)
* those common to silty clay or clay substrates - predominantly polychaetes and echinoderms (sea stars and urchins)
* those species with a widespread distribution

A complete survey of the fish in the bay would be difficult, because of the variety of habitats they occupy - mid water, demersal (bottom), reef, weed, or shallows - and the number of separate fishing methods that would need to be employed. For instance, approximately 70 demersal fish species have been identified here - the common ones being flathead, stringarees, spiny gurnard, and spiky globefish.

Again, the distribution of these fish appears to be related to the nature of the bottom sediment.

The coast also exhibits a wide range of habitats, distinguishable by the nature of the substrate and the pattern and amount of water movement.

The richest and most variable of the benthic flora occur along the rocky coasts, as these provide firmer substrates for plant establishment than do muddy or sandy areas. The rocky habitats vary considerably according to the characteristics of the rock type - especially the weathering pattern.

Flora and fauna here must also adapt to, or avoid, wide variations in wave action and exposure to air or sun. The plants are often confined to distinct zones or bands, with different species showing a gradation between the lower and

higher tidal levels as well as being represented in the sublittoral and spray zones.

Common flora here include sea lettuce, which occurs widely in pools on the rock platforms, Neptune's necklace, which forms a dense cover on rocks in the mid intertidal zone, seaberries, fanweed, and kelp (all common brown algae), and colonies of blue-green algae, which form slippery growths on rocks in the upper tidal zone.

The mobile substrate and low nutrient levels of sandy beaches, and the resultant paucity of living plants, prevent the colonization of such areas by large numbers or varieties of animals. Those that do live in these areas usually bury themselves to some extent to minimize the chance of being washed out.

As on the land, invertebrates are the dominant faunal groups in the area and form a vital link in the food and detrital chain of the environment. Of these, the southern rock lobster, scallops, mussels, two species of abalone, and squid are fished commercially.

Estuaries are characterized by generally lower salinities than that of the sea and by considerable fluctuation in both salinity and flow of water. Salt-marsh communities usually occupy the lower reaches of estuaries, where they form part of a successional sequence between free-floating plants and thickets of melaleucas and tea-trees. Often algae form crusts on the surface of the ground in these areas.

More than 20 marine species and at least 10 estuarine species of fish are frequently found along the coast. Barracouta and gummy sharks are the most important of a large number of marine fish caught commercially. These and Australian salmon, sweep, parrot-fish, flathead, and yellow-tail kingfish, as well as snapper, leatherjacket, and trevally, are sought by amateur surf and rock fishermen. Many of these marine fish spawn in estuaries.

Black bream and dusky flathead are possibly the only species specific to estuaries.

B. Present Uses and Capabilities

1. Nature conservation

Important sea-grass communities have been identified and reserved, in part, in marine reserves. Little information is available, however, on the algal communities or other subtidal habitat types to indicate those other areas of high conservation significance.

Harold Holt Marine Reserves

These reserves comprise five separate areas of marine underwater terrain and superjacent water and, in association with the Mud Island and Duck Island Wildlife Reserves, provide representation of open-sea and embayed marine, intertidal, and island environments.

The Point Lonsdale and Point Nepean rock platforms form the entrance to Port Phillip and provide examples of open ocean (Bass Strait) habitat and intertidal associations.

More than 150 species of marine snails and sea-slugs have been recorded in the Point Lonsdale marine reserve, including some rare species not found elsewhere in Victoria. Plant life here and in the Point Nepean reserve is very rich and varied. The landward approach to Point Nepean lies within a restricted Department of Defence area and as a result this reserve is little disturbed by visitors. Point Lonsdale, on the other hand, attracts many visitors - school excursions, scientists, shell-collectors, and other people interested in nature study - and intertidal communities on the platform are suffering some damage.

Swan Bay contains shallow water-meadows of sea-grass, which, being protected from rough seas by sand pits and barrier islands, provide a sheltered breeding area for many fish species, including whiting, garfish, and flounder. For this reason, Swan Bay has been closed to commercial fishing for many years. Together with the Edwards Point, Duck Island, Mud Island, and Spit Wildlife Reserves, Swan Bay is a particularly important feeding and resting area for waterbirds and intercontinental migratory waders.

Pope's Eye, a semi-circular ring of bluestone blocks, rises more than 2 metres from the water on the crown of Pope's Eye Shoal. Originally intended as a fortress, this structure now provides an artificial reef on which marine plants and animals have lodged in an area of heavy seas and strong currents. Pope's Eye supports a richness and diversity of marine life unique in Port Phillip Bay. On the seaward side it carries heavy growths of such filter-feeding sedentary animals as sponges, corals, seafans, bryozoa, and sea squirts.

Australian fur seals; they colonize several man-made structures in the Pope's Eye area, in Port Phillip Bay

Mud Island is a group of low-lying mud and sand islands around a central shallow lagoon. Salt-marsh and low scrub on the islands provide important roosting and breeding sites for birds, and the surrounding sea-grass shallows support abundant food.

Notable species here include Caspian and crested terns, Australian pelican, white-faced storm petrels, and several wading birds such as oystercatchers. Orange-bellied parrots (an endangered species) have been recorded feeding in the salt-marsh areas. A large and increasing number of silver gulls breed on the islands and may be disrupting other sea-birds here.

Point Cook Marine Reserve

The basalt and sedimentary rock platforms adjacent to Point Cook provide intertidal and shallow-water environments, which are uncommon for the western shoreline of Port Phillip Bay. Elsewhere the substrate is usually soft and muddy.

This area supports a diverse and abundant community of marine plants (algae and sea-grass) and associated benthic invertebrate species (such as sponges, starfish, anemones, shellfish, and crabs) as well as skates, harmless sharks, and other fish. Until recently the area was closed to public access and so the marine communities have remained relatively undisturbed. They now provide a valuable aesthetic recreational, and educational resource.

The marine reserve also includes an important nursery area for the commercially utilized blacklip abalone; as a result, it is used for research into the biology and ecology of that species.

Mud and South Channel Islands are the only areas within a land-locked bay in this country where the white-faced storm petrel is known to breed. Only four gannetries for the Australian gannet are known in Australian waters; the one on the 'Wedge' harbour light east of Queensliff is the only known gannetry on a man-made object in the world.

Orange-bellied parrots feed in the salt-marsh areas of Mud Island and the intertidal flats and sea-grass beds form important feeding habitat for many water birds.

2. Recreation

The bay and coastal region have a very high capability for recreational uses and indeed comprise the primary summer recreational areas for people from Melbourne. Activities include boating, fishing, swimming, and skin and scuba diving, as well as more passive activities such as nature study along the tidal zones and bird watching.

A large number of facilities have been constructed to assist the launching and mooring of boats and, for the benefit of divers and fishermen, a number of artificial reefs have been placed in Port Phillip. These reefs are constructed variously from concrete pipes, rocks, sunken vessels, bundles of tyres, and steel or steel and concrete frames. A number of fish species normally attracted to reefs, such as snapper, ling, rock cod, and leatherjacket, are being caught there.

Historical shipwrecks are also becoming a popular recreational resource for suitably equipped people. Several such

wrecks occurred at the entrance to Port Phillip and at Barwon Heads between 1848 and 1900.

Those wrecks on rocky Bass Strait sites have usually broken up, but in the sheltered conditions of Port Phillip the entire ship may lie under the sand, with all its structures and artefacts preserved. Of some 14 vessels wrecked in Port Phillip, two - the 'William Salthouse' (1841) and 'City of Launceston' (1865) - lie in protected zones delineated under the *Historic Shipwrecks Act* 1981. Diving, except by authorized personnel, is strictly forbidden in these zones.

3--7. Commercial uses

A number of shipping channels have been established and marked from the entrance to Port Phillip to the international ports of Melbourne and Geelong. The Port of Melbourne provides general cargo and container facilities and specialized oil berths as well as an overseas passenger terminal. The Port of Geelong handles primarily bulk cargoes such as wheat, and includes specialized facilities to handle the raw materials for Alcoa of Australia's aluminium smelter.

Facilities in section of the Port of Geelong

Commercial fishermen operate both within the bay and along the outer coastline, catching finfish, squid, and shellfish. Leases have been issued in the bay for the artifical culture of mussels, and investigations into the feasibility of developing a mud oyster industry are under way.

The discharge of treated and untreated industrial and domestic waste-water into the bay and the effects on the marine environments are the subjects of studies by the Environment Protection Authority.

Salt production by the solar evaporation of sea-water is carried out at three sites along the shores of the bay. The quality of this salt depends upon the water of the bay remaining unpolluted.

8. Hazards and conflicts

Pollution of the bay could affect almost all uses of the water other than as a shipping channel, and the Environment

Protection Authority is monitoring water quality for compliance with the aims of the 1975 State Environment Protection Policy. Recreational uses - depending on their nature, intensity, and location - can interfere with each other and with marine ecosystems, especially along the tidal platforms. Fisheries can suffer from over-exploitation, and the use of shellfish dredges can damage historic shipwrecks. Recreational and commercial fishing can also conflict with each other in some areas.

APPENDICES

Appendix I

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Appendix

GEOMORPHIC SURFACES

Map Symbol	Soil parent material	Topographic features
1. EROSIONAL SURFACES - developed during different periods of the denudational		
	BAW BAW SURFACE - the oldest and highest remnant - Triassic in age	
BrP	Devonian rhyodacite	Broad crest of Mt Macedon
	KINGLAKE SURFACE - developed during Cretaceous times	
KrM	Devonian rhyodacite	Lower crests, plateau, and slopes
KrS	Devonian rhyodactite	Steep slopes and some broad lower slopes
KgM	Devonian granodiorite	Rolling high-level plateau area in the Cobaw Ranges
KgS	Devonian granodiorite	Very steep slopes and broad ridge crests adjacent to the Cobaw plateau
KcS	Cambrian diabase and chert	Broad-crested, north--south ridge (Mt William)
	TERTIARY SURFACES - developed mainly during the early Tertiary (30--70	
		STEEP TO VERY STEEP SLOPES
EcS1	Cretaceous sandstone and mudstone	Very steep high hills with strong dissection (Otway Ranges)
EcS2	Cretaceous sandstone and mudstone	Steep rounded hills (Barrabool Hills)
EgS1	Devonian granite	Very steep isolated rocky hills protruding from the plain (You Yangs)
EgS2	Devonian granodiorite	Steep rocky areas within the Cobaw Ranges
EsS1	Palaeozoic shale/sandstone with some Tertiary cappings	Strongly dissected fault scarp with steep valleys and flat crests (Brisbane Ranges)
EsS2	Palaeozoic shale/sandstone with some Tertiary cappings	Dissected areas of steep to moderately sloping valleys with broad crested ridges (Steiglitz area)
EsS3	Palaeozoic shale/sandstone	Strongly dissected country associated with rejuvenated Lerderderg River and neighbouring northern streams resulting in a land form of steep valleys, ridges, and occasional scarps

II

AND ASSOCIATED SOILS

Associated dominant soils	Approx. annual rainfall (mm)	Agricultural production
history of the Victorian Uplands		
Red-brown friable gradational soils	about 1,000	Mainly uncleared
Red-brown friable gradational soils and yellow mottled gradational soils	850--1,000	Grazing and mixed crops
Red-brown friable gradational soils and yellow mottled gradational soils	850--1,000	Mainly uncleared
Red and yellow gradational soils, uniform sands and granitic outcrops	800--900	Grazing and mixed crops
Uniform sands, granitic outcrops, red and yellow gradational soils	800--900	Mainly uncleared
Red friable gradational soils, yellow-mottled gradational soils	680--800	Mainly grazing; some crops
million years ago)		
Brown gradational and brown duplex soils	850--1,000	Uncleared
Various, including brown duplex soils	600--650	Grazing and forest
Shallow skeletal soils, uniform sands	450--500	Mainly unsuitable
Uniform sands, sandy yellow acid duplex soils	700--900	Low-intensity grazing
Shallow stony yellow/brown gradational with duplex soils	500--600	Uncleared
Shallow stony or quartz-gravelly yellow gradational soils, often with acid sand or ironstone ridge-tops	550--650	Mainly forest
Shallow stony yellow and brown gradational soils	600--1,000	Uncleared

Appendix II (*continued*)

Map Symbol	Soil parent material	Topographic features
EsS4	Palaeozoic shale/sandstone	Dissected hills of the western uplands around Blackwood with steep to moderately steep slopes
EsS5	Areas of mainly metamorphic rocks, aureoles and other erosion-resistant rocks	Steep-sided ridges usually at the edges of granitic areas but including steep ridge country east of Pyalong
EsS6	Palaeozoic sandstones and other interbedded sediments	Steep hills of the Kilmore gap, including the steep ridge to the east of the Maribyrnong River
EvS	Tertiary older basalt	Steep slopes caused by stream rejuvenation along the Rowsley Fault and further west
		MODERATELY STEEP AREAS
EcM	Cretaceous sandstone and mudstone	Elevated moderate slopes and rolling plain south of the Barrabool Fault
EgM1	Devonian granitic rocks	Low isolated hills in the volcanic plains, usually with granite outcrop on the crest
EgM2	Devonian granodiorite	Moderate slopes and rolling country with rocky crests in the Cobaw Ranges
EsM1	Palaeozoic shale/sandstone with some Tertiary cappings	Undulating to rolling country with occasional deeply incised drainage lines and gullies
EsM2	Palaeozoic shale/sandstone and tillite	Moderate to moderately steep foothills and outlying hills to the western uplands
EsM3	Palaeozoic sandstone and other interbedded sediments	Moderately steep hills and rolling slopes of the Kilmore gap
EsM4	Palaeozoic shale/sandstone	Strongly undulating to closely dissected country with moderate slopes in the western upland near Daylesford
EsM5	Palaeozoic sandstones and other interbedded sediments	Isolated exposures of undulating to moderately sloping Palaeozoic sediments with the Werribee plains
		GENTLE SLOPES AND UNDULATING PLAINS
EgG1	Devonian granodiorite	Gentle slopes of exposed granitic material isolated within the Werribee plains

Associated dominant soils	Approx. annual rainfall (mm)	Agricultural production
Yellow mottled gradational soils	700--1,100	Uncleared
Shallow stony red gradational soils with fine structure; yellow mottled duplex soils on lower slopes	700--900	Mainly uncleared; some grazing
Shallow stony gradational soils with sodic gully-prone yellow duplex soils on the lower slopes	630--750	Low-intensity grazing or uncleared
Black cracking uniform clays and some red gradational soils	600-750	Moderate grazing; some crops
Brown duplex and mottled yellow duplex soils	600--650	Grazing, minor crops
Mottled yellow neutral duplex soils that may be slightly sodic	450--600	Grazing, some areas uncleared
Mottled yellow acid duplex soils with deep sandy loam topsoil	680--850	Grazing
Brown mottled yellow sodic duplex soils, with uniform sands on some broad crest areas	550--650	Grazing, minor cereal crops
Mottled yellow acid duplex soils	650--750	Grazing, some forest
Yellow and brown mottled sodic duplex soils with shallow stony soils on the ridges	630--750	Grazing
Yellow mottled acid gradational and duplex soils	750--1,100	Mainly uncleared; some areas of grazing
Yellow and brown mottled duplex soils with coarse structure	550--650	Grazing
Brown coarse-structured acid duplex soils	500--620	Grazing

Appendix II (*continued*)

Map Symbol	Soil parent material	Topographic features
EgG2	Devonian granodiorite and shallow granitic alluvium	Gently sloping valley floor and colluvial lower slopes (Cobaw Ranges)
EsG1	Palaeozoic shale/sandstone Tertiary cappings	Undulating areas and broad crests bordering zones of strong dissection
EsG2	Palaeozoic shale/sandstone (with minor tillites and Tertiary deposits near Greendale)	Gently undulating areas mainly around the perimeter of the western uplands
EvG	Tertiary older basalts	Undulating to rolling plains
	OTHER EROSIONAL SURFACES - various ages, including late Tertiary	
EmM	Tertiary marine calcareous deposits of medium to fine texture	Moderate slopes including the Bellbrae valley, which has cut into the marine plains
EmS	Tertiary marine calcareous medium- to fine-textured deposits	Coastal moderately steep, rounded hills including occasional coastal scarps and moderately sloping valley floors
EmV	Dissection through various materials - mainly basalt, marine Tertiary calcareous sediments, and Palaeozoic rocks	Deeply entrenched valleys of the Moorabool River and Sutherland Creek; characterized by steep sides with level or terraced valley floors
EnS1	Tertiary non-marine sandy sediments	Strongly dissection former plain with steep-sided valleys and flat narrow crests representing the original surface (Bald Hills)
EnS2	Tertiary non-marine medium- to fine-textured sediment	Broad steep-sided valleys of the rejuvenated Parwan and Werribee Rivers; basalt capping around the valley margins restricts lateral fluviatile erosion; the valley widens by means of land slips and earth flows
EsV	Exposures of Palaeozoic sediments (some granites) with basalt margins	Moderate to deeply incised stream valleys within or at the margins of plains, which are mainly basaltic; the valley floor is generally narrow but may include alluvial flats and terraces

Associated dominant soils	Approx. annual rainfall (mm)	Agricultural production
Brown and yellow mottled duplex soils with deep sandy loam topsoils	680--850	Grazing, minor cereal cropping
Brown-mottled yellow duplex soils; localized sandy areas	550--650	Grazing
Yellowish-brown mottled duplex soils	700--750	Grazing
Dark duplex soils and uniform black clays	600--750	Moderately intense - some crops; grazing
Yellow-brown calcareous sodic duplex soils with coarse structure	600--650	Grazing
Yellow-brown duplex soils with coarse structure, red- and yellow-mottled duplex soils and other sodic soils	650--750	Mainly uncleared, some grazing
Black uniform cracking clays or red friable gradational soils on the sides, with brown loams and yellow mottled duplex soils on the alluvial floors and terraces	530--650	Grazing, mixed crops
Yellow and grey gradational soils with weak structure; grey uniform sands	580--700	Mainly uncleared
Yellow mottled sodic duplex soils	500--700	Low- to very low-intensity grazing
Various soils - often black uniform clays from the basalt on the upper slopes with mottled brown and yellow duplex soils on the lower slopes	570--700	Grazed or not cleared; larger flats sometimes cropped

Appendix II (*continued*)

Map Symbol	Soil parent material	Topographic features
2. DEPOSITIONAL SURFACES		
	OLDER ALLUVIAL AND MARINE PLAINS (TERTIARY)	
DmP1	Tertiary marine unconsolidated sediments	Flat to gently undulating plains with occasional areas of sand sheets; originated as marine plains
DmP2	Tertiary marine unconsolidated sediments	Remnant plateau areas and plains of uplifted marine plains close to the coast
DnG1	Tertiary non-marine unconsolidated sediments	Undulating plains and gently sloping areas
DnG2	Tertiary non-marine unconsolidated sediments	Remnant plateaux and broad crest areas where fluviatile erosion has caused strong dissection of the surrounding older sediments; slopes gentle to moderate
	PLEISTOCENE ALLUVIAL DELTAS, FANS, HIGHER TERRACES, AND PLAINS	
DfP1	Pleistocene unconsolidated fan material	Flat to gently undulating plain; some areas include the footslopes to fault scarps
DfP2	Pleistocene fan material and Recent alluvium	Flat plains
DfP3	Pleistocene granitic fan material	Gentle outwash slopes around granitic hills
DfP4	Quaternary silts and sands	Flat plains of the Werribee delta
DfP5	Pleistocene fans and higher terraces	Flat to gently undulating plains
DaP	Pleistocene alluvium	Broad alluvial plains of the Murray Basin
	RECENT STREAM DEPOSITS	
DaR1	Recent alluvium	Creek flood-plains that broaden near the coast behind dune barriers
DaR2	Recent alluvium	Broader areas of alluvial flats and terraces associated with major streams
DaR3	Recent alluvium	Broad valley floors in undulating to hilly Palaeozoic sedimentary country

Associated dominant soils	Approx. annual rainfall (mm)	Agricultural production
Yellow and red mottled duplex soils and brown sodic duplex soils, sporadic sandy areas may occur	580--650	Grazing and cereal crops
Yellow and red mottled duplex soils with ironstone; topsoils are generally loose and sandy	600--700	Grazing
Red mottled yellow acid duplex soils	560--720	Grazing or not cleared
Red mottled yellow, acid duplex soils; red duplex soils with ironstone; uniform sands	550--650	Grazing or not cleared; some cereal crops
Yellow and grey mottled sodic duplex soils with coarse-structured alkaline clays	500--600	Cereal crops and grazing
Dark sodic duplex soils and mottled yellow sodic duplex soils	450--500	Grazing and cereal crops
Yellow mottled acid duplex soils	450--550	Grazing; some crops
Red calcareous sodic duplex soils	500--550	Irrigated lands and cereal crops
Red calcareous duplex soils or yellow mottled duplex soils	500--700	Cereal crops and grazing
Yellow mottled, sodic duplex soils and red duplex soils	550--600	Grazing and cereal crops
Variable poorly drained sodic duplex soils	650--700	Largely uncleared
Variable soils, friable loams and clays, yellow and red mottled duplex soils	550--700	Irrigated mixed crops and grazing
Yellow mottled sodic duplex soils with coarse structure	550--600	Grazing

Appendix II (*continued*)

Map Symbol	Soil parent material	Topographic features
DaR4	Recent alluvium	Broad flood-plain of the Goulburn River, including meanders and oxbows
	AEOLIAN PLAINS	
DwP	Recent wind-blown sand	Undulating sand sheets and subdued dunes on the marine plains
3. NEW VOLCANIC SURFACES		
		PLAINS WITH MINOR UNDULATIONS
NbP1	New volcanics - olivine basalt	Flat to gently undulating plains, often stony, on which stony rises are common (Lethbridge)
NbP2	New volcanics - olivine basalt	Flat to gently undulating plains with occasional stony rises (Anakie--Mickleham)
NbP3	Newer volcanics - olivine basalt	Gently undulating plains with occasional areas of stony rises (Melton)
NbP4	Newer volcanics - olivine basalt	Stony plains with numerous stony rises (Little River)
NbP5	Newer volcanics - olivine basalt	Flat to gently undulating plains with few stony areas (Meredith)
		ULDULATING AND GENTLY ROLLING PLAINS
NbG1	Newer volcanics - olivine basalt	Undulating plains and broad valley flows in the north (Kyneton--Kilmore)
NbG2	Newer volcanics - olivine basalt	Undulating plains with occasional stony rises (Gisborne)
NbG3	Newer volcanics - trachytes	Rolling plain with low rises near Hanging Rock
NbG4	Newer volcanics - olivine basalt	Undulating to rolling plains and valley floors (Trentham)
NbG5	Newer volcanics - olivine basalt	Undulating plains with mainly long gentle slopes and few stony areas (Ballan)

Associated dominant soils	Approx. annual rainfall (mm)	Agricultural production
Brown loams on alluvium, various duplex soils on terraces	550--600	Grazing
Yellow or grey uniform sand soils	580--650	Grazing, mixed crops (including potatoes, Drysdale)
Black cracking self-mulching clays and yellow-grey sodic duplex soils with coarse structure	500--600	Grazing with cereal crops on less stony areas
Dark mottled sodic duplex soils, and yellow-grey mottled sodic duplex soils, both with coarse alkaline yellowish-grey subsoil at depth	500--700	Grazing with some cereal crops
Red calcareous sodic duplex soils, with alkaline coarse-structured clay	450--550	Cereal crops and grazing
Shallow stony red gradational or red calcareous sodic duplex soils	450--500	Grazing with occasional crops on less stony areas
Yellow-grey mottled sodic duplex soils with coarse-structured alkaline clays	600--700	Mainly grazing; some cereal (oat) crops
Brown mottled duplex soils with ironstone; red duplex or gradational soils on rises	600--850	Grazing and cereal crops
Dark mottled duplex soils, and yellow-grey mottled sodic duplex soils	550--750	Mainly grazing; some cereal crops
Variable soils including mottled grey duplex soils and friable red gradational soils	700--850	Mainly grazing; some mixed crops
Red friable gradational soils with strong fine structure	700--1,000	Mixed crops (potatoes, berries); some irrigation
Yellow-grey mottled sodic duplex soils	600--800	Mainly grazing; some cereal (oat) crops

Appendix II (*continued*)

Map Symbol	Soil parent material	Topographic features
		MODERATE TO STEEPLY SLOPING AREAS
NvC	New volcanics - basalt scoria, tuff, etc.	Major volcanic hills (cones) with moderate to steep, smooth to rocky slopes; note: minor eruption points not shown
NbM	Newer volcanics - olivine basalt	Moderate to steep slopes that are often stony and associated with fault scarps or lava field edges
NbV	Newer volcanics - olivine basalt; minor exposures of Palaeozoic rocks may occur	Moderate to deeply incised creek valleys and gorges within the volcanic plains and having alternating steep and moderate side slopes
NbR	New volcanic basalt overlying older Palaeozoic rocks	Remnant valley floor basalt flows now existing as relatively flat basalt cappings on ridges and higher areas; includes the often-steep upper side slopes
4. COASTAL LAND FORMS		
CwD	Quaternary calcareous and siliceous sands, dune limestone	Coastal dunes and beach ridges
CcP	Quaternary coastal, aeolian and estuarine deposits	Coastal salt marshes and mangrove swamps with occasional beach ridges

Associated dominant soils	Approx. annual rainfall (mm)	Agricultural production
Red friable gradational soils on most scoria cones, with dark cracking clays and red duplex soils on basalt cones; soils are often shallow and stony	450--1,000	Grazing, with some crops on lower slopes
Shallow stony red or dark brown uniform clays	550--650	Grazing
Shallow stony black clays or red to brown stony gradational soils	450--700	Grazing (some areas are unsuitable)
Variable - often shallow stony brown or black clays that extend to side slopes below the basalt	600--760	Grazing
Uniform yellow and brown calcareous sand soils	500--650	Generally not used
Saline soils, yellow and grey mottled sodic duplex soils, with some areas of grey sandy soils	500--650	Higher areas, grazing; lower areas unsuitable

Appendix III

STREAM GAUGING AND SALINITY

Stream name	Location	Catchment area (sq. km)	Mean annual discharge (ML)	Run-off per unit area (ML per sq.km)	Mean daily flow variability (ML per day) Max.	Min.	Median salinity (mg per L)
Maribyrnong R.	Keilor	1,303	112,000	86	40,600	0	1,360
Jackson Ck	Sunbury	337	36,800	109	10,900	0	830
Riddell's Ck	Riddell's Ck	80	9,070	113	1,960	0	270
Maribyrnong R.	Bulla	865	74,600	86	24,300	0	1,520
Maribyrnong R.	Darraweit Guim	350	40,700	116	12,000	0	950
Emu Ck	Clarkefield	97	10,300	106	4,410	0	1,070
Werribee R.	Werribee diversion weir	1,424	55,500	40	24,000	0	850
Werribee R.	Melton Reservoir	1,155	87,700	76	45,800	0	740
Lerderderg R.	Above Goodman Ck junction	233	31,900	137	6,230	0	1,030
Lerderderg R.	Sardine Ck (O'Brien's Crossing)	153	33,300	218	7,320	0	120
Pyrites Ck	Bacchus Marsh	101	4,080	40	1,770	0	980
Werribee R.	Ballan	106	22,500	212	2,860	0	220
Toolern Ck	Melton Reservoir	98	4,040	41	2,850	0	3,970

Appendix III *continued*

Stream name	Location	Catchment area (sq.km)	Mean annual discharge (ML)	Run-off per unit area (ML per sq.km)	Mean daily flow variability (ML per day) Max.	Min.	Median salinity (mg per L)
Little R.	Little River	417	10,900	26	17,500	0	6,510
Moorabool R.	Batesford	1,114	74,900	67	20,300	0	1,140
Moorabool R.	Morrisons	583	65,300	112	23,700	0	420
Moorabool R. (West branch)	Mount Doran	295	35,000	119	3,370	0	360
Barwon R.	Pollocksford	3,225	243,000	75	61,400	2	2,590
Leigh R.	Mount Mercer	593	57,600	97	20,800	3	1,250
Barwon R.	Inverleigh	1,269	140,000	110	32,300	0	2,090
Cumberland R.	Lorne	37.5	21,100	563	2,750	1	150
St George's R.	Allenvale	33.2	12,700	383	2,040	0	170
Painkalac Ck	Painkalac Ck dam	35.7	6,310	177	2,690	0	360
Goulburn R.	Trawool	7,335	2,520,000	344	132,000	420	-
Goulburn R.	Seymour	8,601	2,650,000	308	77,700	387	80
Sunday Ck	Tallarook	337	33,400	99	13,300	0	845
Mollison Ck	Pyalong	166	23,800	143	13,700	0	n/a
Sugarloak Ck	Ash Bridge	609	66,800	110	16,300	0	1,120

Source: Rural Water Commission

Appendix IV

DETAILS OF WATER AUTHORITIES

Name of authority	Towns supplied	Source of supply	Facilities	Population supplied 1983/84	Estimated consumption 1983/84 (ML)	Degree of treatment
Aireys Inlet Water Board	Aireys Inlet Fairhaven	Painkalac Creek	410-ML storage; 2.3-ML service basin	550	61	-
Bacchus Creek Shire Council	Bacchus Marsh	Pykes Creek	Pumped from Pykes Creek Reservoir (RWC) to 26-ML service basin; via treatment plant to 18.4-ML storage; proposed additional supply from Lake Merrimu	8,300	1,280	Sedimentation filtration softening chlorination
	Myrniong		Pumped from Pykes Creek Reservoir			
Ballan Shire Council	Ballan	Korweinguboora Creek Moorabool River	164-ML storage and pumped from Bostock Reservoir (G&DWB) to 1.64-ML service basin	2,150	300	Chlorination
	Gordon) Mount) Edgerton)	Bore	Bore at Gordon also provides emergency supply to Ballan (proposed supply to Blackwood)			
Bannockburn Water Board	Bannockburn Inverleigh Meredith Lethbridge Gheringhap Teesdale Shelford	Moorabool River	Pumped to several service basins - 48 ML total capacity	3,100	332	Proposed chlorination

Name of authority	Towns supplied	Source of supply	Facilities	Population supplied 1983/84	Estimated consumption 1983/84 (ML)	Degree of treatment
Broadford Water Board	Broadford	Sunday Creek	Weir on Sunday Creek (outside study area) to 133-ML service storages; constructing 1,700-ML storage on Sunday Ck - with Kilmore S.C.	2,000	341	-
Daylesford Water Board	Daylesford Hepburn	Kangaroo Creek Wombat Creek	Bullarto Reservoir (200 ML) and Wombat Reservoir (750 ML) to high- and low-level service basins (7.9 ML)	4,200	230	Proposed chlorination at Daylesford
Geelong and District Water Board	Geelong Anakie Batesford Lara Moriac	East Moorabool River system	Korweinguboora Reservoir (2,090 ML); Bostock Reservoir (7,460 ML) Channel to Stoney Creek Reservoirs (9,490 ML), thence to service basins; (system provides 20% of Geelong's needs)	250,000	32,750	Chlorination
		Barwon River system	West Barwon Dam (20,910 ML); Wurdee Boluc Reservoir (19,230 ML) (outside study area; provides over 60% of Board's water usage)			
		West Moorabool River system	Lal Lal Reservoir (59,060 ML); Bungal Dam (outside study area - water shared with Ballarat); water released to River and diverted at She Oaks to service basins			
Gisborne Water Board	Gisborne New Gisborne	Barringo and Jackson Creeks	Barringo Reservoir (105 ML) and pumped from the Rosslynne Reservoir --Sunbury pipeline to a service basin and tanks	3,000	391	Proposed chlorination

Name of authority	Towns supplied	Source of supply	Facilities	Population supplied 1983/84	Estimated consumption 1983/84 (ML)	Degree of treatment
Kilmore Shire Council	Kilmore Wandong Wallan	Hazel and Harper Creeks	Diverted to Hollowback Storage (114 ML) (outside study area) via Escreets Reservoir to Anderson basin (88 ML) and Wallan service basin (54 ML); constructing new Sunday Creek storage with Broadford W.B.	4,000	1,200	
Kyneton Water Board	Kyneton) Tylden)	Little Coliban River	Two reservoirs (354 ML) and pumped from Lauriston Reservoir (RWC) to 7.3-ML service basin	5,840	1,400	-
	Malmsbury	Coliban River	Pumped to two service storages			Chlorinated
	Trentham	groundwater	Artesian springs and bores to two reservoirs (69 ML)			-
Macedon Water Board	Macedon	Willimigongon (Stony) Creek	250-ML storage; smaller one plus Bowden and Kitty English storages (173 ML); water delivered direct to reticulation	2,000	255	-
	Mount Macedon	Willimigongon, Turritables, and Chapman Creeks	Storages (106 ML) and diversion weirs; additional supply from 250-ML storage on Willimigongon Creek	900	n/a	-
Melbourne & Metropolitan Board of Works	Werribee	Yarra River (Yering)	Winneke to Preston and/or St Albans reservoirs			Full treatment
	Little River Metropolitan sewage farm	Yarra River (Upper)	Silvan to Greenvale and St Albans reservoirs	36,500	6,000	Chlorination

Appendix IV *continued*

Name of authority	Towns supplied	Source of supply	Facilities	Population supplied 1983/84	Estimated consumption 1983/84 (ML)	Degree of treatment
Melton Shire Council	Melton Toolern Vale Rockbank	Djerriwarrh Creek	1,068-ML reservoir			Sedimentation filtration
		Coimadai Creek	Pumped from Lake Merrimu (RWC)	23,000	2,400	Iron removed chlorination
Pyalong Water Board	Pyalong	Mollison Creek	Pumped to reticulation and 1-ML service basin; access to brackish bore	190	26	Chlorination
Riddells Creek Water Board	Riddells Creek	Main Creek	Diversion to two storages (73 ML); pipeline to Sunbury system under construction	1,500	364	Proposed chlorination
Romsey--Lancefield Water Board	Romsey	Bolinda Creek	Kerri Reservoir (200 ML) to the Glenfern service basin (50 ML)	1,412	160	-
	Lancefield	Garden Hut and Monument Creeks	45-ML reservoir and diversion weir to offstream reservoir (68 ML); supplementary supply from a bore	887	77	-
Sunbury Water Board	Sunbury Diggers Rest Bulla	Jackson Creek	Pumped from Rosslynne Reservoir (RWC) and diversions from creeks on southern slopes of Mt Macedon to 320-ML service storages	15,000	2,854	-
Woodend Water Board	Woodend	-	Diversion from creeks and springs on northern slopes of Mt Macedon to three storages (150 ML); three bores constructed 1982/83	2,500	340	Sedimentation and chlorination
		Campaspe River	225-ML storage pumped via treatment plant to 4.6-ML service basin; proposal to instal further bores			

Appendix V

SIGNIFICANT PLANT SPECIES

The following is portion of a more extensive list of botanically interesting plant species provided by the consultant. It describes those species in three of six original categories.

Category 1 lists those once recorded in the study area but now presumed extinct, either within the State (1A), or within the study area or its general region (1B).

Category 2 includes those species found in the study area that, while not extinct, are endangered or vulnerable in status, very rare, or extremely localized in occurrence in the State.

Category 3 lists those species found in the study area that are rare or very localized in occurrence or are grossly depleted in extent in the State.

Categories 4, 5, and 6 are not included in this report, but lists of them are available for inspection at the Council's offices.

Category 4 lists those species that are uncommon to rare in occurrence, localized in extent, declining in status, poorly reserved, or very disjunct occurrences. Some plants within this group may be approaching category 3 in significance due to depletion of habitat.

Category 5 includes plants that are of disjunct occurrence or at the edge of their biogeographic range or other species of botanical interest.

A further category (6) provided by the consultant includes those species previously considered to be significant but now known to be more common or for which the records require verification.

Key to Symbols

* Denotes known occurrence close to, but outside, the study area and is of importance where similar habitats for the particular species occurs or occurred within the study area

? Indicates that either the land tenure or the survival of the population is uncertain

(a) Refers to those species for which the nomenclature or status is pending or requires revision, more than one entry is presumed to be involved, or the taxonomic status is uncertain

Notes:

1. Unless up-to-date information is not available, only those populations known to be still existing in the region are listed.

2. Where known, locality is shown in terms of the reference numbers on Map 8 - Public Land Use.

CATEGORY 1: SPECIES PRESUMED EXTINCT

Category 1A (Recorded for study area, now presumed extinct in the State)

Scientific name	Common name
Agrostis adamsonii	Blown grass
Caladenia pumila	Dwarf spider-orchid
Choristemon humilis	Choristemon
Diuris fastidiosa	Proud diuris
Eriostemon scaber	Rough wax-flower
Lampranthus tegens *	Little noon-flower
Nicotiana maritima	Coast tobacco

Category 1B (Recorded for study area, now presumed extinct there)

For these species, the status or category with respect to their distribution in the State is also indicated.

Ballantinia antipoda (2*)	Cuphonotus
Botrychium australe (2)	Austral moonwort
Brachycome trachycarpa (2)	Daisy
Bromus arenarius (2)	Sand brome
Cladium procerum (3)	Leafy twig-rush
Cyathodes juniperina (2)	Crimson berry
Discaria pubescens (2*)	Australian anchor-plant
Diuris palustris (2)	Swamp diuris
Eleocharis minuta *(2)	Variable spike-rush
Euphrasia collina ssp. *muelleri* (2)	
E. scabra (2)	Yellow eyebright
Lepidium aschersonii (2)	Spiny pepper-cress
L. pseudohyssopifolium (3)	Pepper-cress
Leptorhynchos elongatus (2)	Lanky buttons
Potamogeton australiensis (2)	Thin pondweed
Prasophyllum fuscum (2)	Tawny leek-orchid
Prasophyllum sp. *(?1)	Leek-orchid
Pterostylis mutica (2)	Midget greenhood
Swainsona oroboides (3)	Variable swainson-pea
Thelymitra epipactoides (2)	Great sun-orchid
Thesium australe (2)	Austral toad-flax
Zieria aspathaloides (2)	Whorled zieria

CATEGORY 2: SPECIES ENDANGERED, VULNERABLE, VERY RARE, OR EXTREMELY LOCALIZED

Scientific name	Common name	Locality
Adriana quadripartita	Rare bitter-bush	Between Barwon Heads and Point Nepean (J1)
**Amphibromus gracilis*	Graceful swamp wallaby-grass	Yarra River flats between Kew and North Balwyn (?)
Asperula subsimplex	Water woodruff	Eastern Otways (A2, R25); Brisbane Ranges (A3)

Scientific name	Common name	Locality
**Brasenia scheberi*	Water-shield	Goulburn River near Nagambie (?)
Burnettia cuneata	Lizard orchid	Eastern Otways (R25)
(a)*Caladenia filamentosa*	Daddy long-legs	Long Forest (LFF); Brisbane Ranges (A3); Anglesea (public land)
Corybas fordhamii	Helmet orchid	Anglesea (A2, R25)
Cyperus concinnus	Flat-sedge	Between Loddon River and Creswick Creek (?)
Danthonia richardsonii	Wallaby-grass	Corio (?) and Sydenham (Rail reserve)
Diuris punctata var. *punctata*	Purple diuris	One site for each variety; rail reserves, north-west of Melbourne
**D. punctata* var. *albo-violacea*	White diuris	
Eucalyptus aggregata	Black gum	Woodend region (road and rail reserve, private property)
Gahnia microstachya	Slender saw-sedge	Lerderderg (A4)
Glycine latrobeana	Clover glycine	Anglesea--Torquay (J1); Brisbane Ranges (A3); Inverleigh (H9)
**Lepidium hyssopifolium*	Pepper-cress	Rail reserve north of Melbourne
Leptorhynchos gatesii	Wrinkled buttons	Angahook--Lorne (A2)
(a)*Microseris* spp. (forms of *M. scapigera*)	Yam daisy	Laverton grassland reserve and rail reserve south-west of Melbourne
Myoporum insulare (plains form)	Common boobialla	Rail reserve south-west and west of Melbourne
Olearia pannosa	Velvet daisy-bush	Brisbane Ranges (A3); Steiglitz (A14); Ironbark Basin (nature reserve); Sanctuary (Barrabool Shire Council); road reserves - Bannockburn and Barrabool Shires
Platylobium alternifolium	Victorian flat-pea	Blackwood (?)
(a)*Podolepis* sp. (plains forms of *P. jaceoides*)	Showy podolepis	Rail reserves west and south-west of Melbourne
Psoralea parva	Small scurf-pea	Rail reserve west of Geelong

Scientific name	Common name	Locality
P. tenax	Tough scurf-pea	Rail reserve north-west of Melbourne
(a)*P.* (sp. aff.?) *adscendens*	Dusky scurf-pea	Wombat forest (E2)
Pterostylis truncata	Brittle greenhood	You Yangs (A13); south of Little River (S13); Long Forest--Coimadai (private and ? public land)
P. cucullata	Leafy greenhood	Queenscliff (?)
P. biseta	Rusty-hood	West of Melton
Rutidosis leptorhynchoides	Button wrinklewort	Rail reserve south-west and west of Melbourne; north of Werribee (cemetery)
Schoenus fluitans	Floating bog-rush	Brisbane Ranges (D51)
S. turbinatus	Bog-rush	Angahook-Lorne (A2)
**Senecio* sp. ?aff. *squarrosus*	Groundsel	Rail reserve north of Melbourne
S. macrocarpus	Groundsel	Rail reserve south-west and west of Melbourne
Stipa breviglumis	Cane spear-grass	Coimadai-Long Forest (LFF, private, and U1); Lerderderg (A4); Brisbane Ranges (A3)
Thelymitra matthewsii	Spiral sun-orchid	Angahook-Lorne (A2)
T. mucida	Sun-orchid	Anglesea (R25)

CATEGORY 3: SPECIES RARE, VERY LOCALIZED, OR GROSSLY DEPLETED

**Acacia penninervis*	Hickory wattle	Road reserve, private land
Amphibromus archeri	Pointed swamp wallaby-grass	Base of Mt Macedon (?)
Atriplex stipitata (5)	Kidney saltbush	Werribee Gorge (?); near Melton (private property)
Brachycome debilis	Daisy	Cobaws (E3
Caladenia tutellata	Caladenia	Anglesea (R25) and private land
C. patersonii	Common spider-orchid	Anglesea; Bannockburn (?) Gisborne (?)
Calochilus imberbis	Naked beard-orchid	Anglesea (R25); Macedon (?)

Scientific name	Common name	Locality
(a)*Chorizandra* sp.	Bristle-rush	Brisbane Ranges (A3, D51); Anglesea (R25)
Comesperma polygaloides	Small milkwort	Sunbury (? in process of reservation); rail reserves south-west of Melbourne
Danthonia procera	Tall wallaby-grass	Brisbane Ranges (A3)
Eriochloa pseudo-crotricha	Early spring-grass	Werribee (Q3)
Eucalyptus yarraensis	Yarra gum	Brisbane Ranges (A3); Steiglitz (A14)
Festuca eriopoda	Lanky fescue	Woodend (private property)
**Grevillea aquifolium* form	Variable prickly grevillea	North-west of Anglesea
(a)*G. glabella*	Grevillea	Brisbane Ranges (A3)
(a)*G. rosmarinifolia*	Rosemary grevillea	Rail reserve south-west and north of Melbourne
G. repens	Creeping grevillea	Wombat forest (E2, U1)
(a)*G.* sp. aff. *aquifolium*	Elphinstone grevillea	Loddon forest (U1, H27)
G. steiglitziana	Brisbane Range grevillea	Brisbane Ranges (A3)
(a)*Helichrysum* sp. aff. *acuminatum*	Lowland orange-everlasting	Brisbane Ranges (D51)
* *Hypsela tridens*	Hypsela	Yan Yean
Lepidium pseudotasmanicum	Pepper-cress	Brisbane Ranges (A3); Pyrete Range (U1)
Lepidosperma canescens	Hoary rapier-sedge	Mt Ingoldsby (H3)
L. tortuosum	Tortuous rapier-sedge	Lerderderg (A4); Wombat forest (E2)
Myoporum montanum (5)	Waterbush	Coimadai East (?)
Myriophyllum integri-folium	Water-milfoil	You Yangs (?); north of Ocean Grove (?)
Olearia ramulosa var. *rigida*	Twiggy daisy-bush	Granite hills north of Melbourne (?)
Pilularia novae-hollandiae (?1B)	Austral pillwort	Near Little River (?); possibly extinct in the study area

Scientific name	Common name	Locality
(a)*Prostanthera* (sp. aff.?) *decussata*	Dense mint-bush	Brisbane Ranges (A3); Werribee Gorge (A30); Lerderderg (A4)
* *Ptilotus erubescens*	Hairy tails	Inverleigh (H9)
Pultenaea graveolens	Scented bush-pea	Steiglitz (A14); Porcupine Ridge (U1)
P. muelleri var. *reflexifolia*	Mueller's bush-pea	Wombat forest (E3); possibly extending into reserves
P. weindorferi	Swamp bush-pea	Lerderderg (A4); Wombat forest (E3)
Rhagodia parabolica	Fragrant saltbush	Lerderderg (A4); Steiglitz (A14); Holden (H10); Long Forest (LFF)
Scirpus productus	Club-rush	Brisbane Ranges (A3)
**Senecio squarrosus*	Groundsel	Rail reserve west and north of Melbourne
S. platylepis	Groundsel	Pyalong (?)
Templetonia stenophylla	Leafy templetonia	South of Melton (private)
Tetrarrhena acuminata	Pointed rice-grass	Anglesea (R25)
Thelymitra fusco-lutea	Blotched sun-orchid	Anglesea (R25, H14, private)
T. luteocilium	Fringed sun-orchid	Clydesdale (?)
Tripogon loliiformis	Rye beetle-grass	Lara (?); Organ Pipes (A28)
Westringia glabra var. *bacchi*	Violet westringia	Lerderderg (A4); Werribee Gorge (?)
Wurmbea uniflora (5)	Early nancy	Wombat forest (E3)

Appendix VI

NOXIOUS WEEDS OF THE DISTRICT

Common name	Scientific name	Growth habit	Main infestations
Prickly acacia	*Acacia armata*	Native perennial shrub	Roadsides, railways; woodland species
Angled onion	*Allium triquetrum*	Perennial herb	Mainly in towns to the south
Apple of Sodom	*Solanum hermanii*	Perennial under-shrub	Sandy coastal areas
Artichoke thistle	*Cynara cardunculus*	Erect perennial	Plains north of Melbourne
Bathurst burr	*Xanthium spinosum*	Spreading annual	Plains west of Melbourne
Bindweed	*Convolvulus arvensis*	Perennial herb	Plains west of Geelong
Blackberry bramble	*Rubus fruticosus*	Perennial shrub	Bushland, especially along streams
Boneseed	*Chrysanthemoides monilifera*	Perennial shrub	You Yangs and the coast
Boxthorn	*Lycium ferocissimum*	Perennial shrub	Plains and open farmlands
Californian burr	*Xanthium orientale*	Spreading annual	Streambanks and flood-prone areas
Californian thistle	*Cirsium arvense*	Erect perennial	Roadsides and towns
Cape broom	*Genista monspessulana*	Perennial shrub	Along creeks and near western towns
Chinese scrub	*Cassinia arcuata*	Native perennial shrub	In disturbed bushland to the north
Drooping prickly pear	*Opuntia vulgaris*	Erect perennial	Roadsides and farmlands west of Geelong
English broom	*Cytisus scoparius*	Perennial shrub	Mount Macedon
Erect prickly pear	*Opuntia stricta*	Erect perennial	Throughout the basalt plains
Fennel	*Foeniculum vulgare*	Erect perennial	Coastal and bay-side
Five-spined saltbush	*Sclerolaena muricata*	Native spreading perennial	Roadsides and railways

Appendix VI *(continued)*

Common name	Scientific name	Growth habit	Main infestations
Flax-leaved broom	*Genista linifolia*	Perennial shrub	Bellarine peninsula
Furze	*Ulex europaeus*	Perennial shrub	(Except where used as a hedge); south and west
Golden thistle	*Scolymus hispanicus*	Erect perennial	Loddon River valley and other water-courses
Great mullein	*Verbascum thapsus*	Biennial herb	Roadsides on basalt plains
Hawthorn	*Crataegus monogyna*) *C. laevigata*)	Perennial shrub or small tree	Scattered near towns; along roads & rivers
Hemlock	*Conium maculatum*	Annual or biennial herb	Mainly along rivers
Hoary cress	*Cardaria draba*	Perennial herb	Railway easements to the west
Horehound	*Marrubium vulgare*	Perennial herb	Basalt plains
Nut grass	*Cyperus rotundus*	Perennial sedge	On roadsides near Melbourne
Onion weed	*Asphodelus fistulosus*	Annual, biennial, or perennial herb	Coastal region of Bellarine Peninsula
Paterson's curse	*Echium plantagineum*	Erect annual or biennial	Individual properties near Geelong
Prairie ground cherry	*Physalis viscosa*	Spreading perennial	Roadsides west of Geelong
Saffron thistle	*Carthamus lanatus*	Erect annual	West of Geelong
St John's wort	*Hypericum perforatum*	Perennial herb	Beside rivers and roads
Sand rocket	*Diplotaxis tenuifolia*	Erect perennial	Along southern railway easements
Scotch thistle	*Onopordum acanthium*	Erect annual or biennial	North of Melbourne
Serrated tussock	*Nassella trichotoma*	Perennial grass	Moorabool and Maribyrnong River basins

Appendix VI *(continued)*

Common name	Scientific name	Growth habit	Main infestations
Slender or shore thistle	*Carduus tenuiflorus*) *C. pycnocephalus*)	Erect annuals	Bellarine Peninsula and western areas
Soursob	*Oxalis pes-caprae*	Perennial herb	Throughout; mainly in croplands
Spear thistle	*Cirsium vulgare*	Erect biennial	Widespread in agricultural lands
Spiny emex	*Emex australis*	Prostrate annual	Bellarine Peninsula and western plains
Spiny rush	*Juncus acutus*	Erect perennial	Low-lying areas near watercourses
Stinkwort	*Dittrichia graveolens*	Annual herb	Roadsides
Sweet briar	*Rosa rubiginosa*	Perennial shrub	Roadsides of western plains
Thorn apples	*Datura ferox*) *D. innoxia*) *D. stramonium*)	Erect annuals	Along river banks
Tree of heaven	*Ailanthus altissima*	Perennial tree	Near towns and farmhouses
Tufted honeyflower	*Melianthus comosus*	Perennial shrub	Scattered throughout
Variegated thistle	*Silybum marianum*	Erect annual	Throughout agricultural lands
Wild garlic	*Allium vineale*	Perennial herb	Corio and western plains
Wild mignonette	*Reseda luteola*	Annual or biennial herb	West of Geelong
Wild teasel	*Dipsacus fullonum* ssp. *fullonum*	Erect biennial	Along major rivers
Wild watsonia	*Watsonia bulbillifera*	Erect perennial	Along roadsides throughout

Appendix VII

SITES OF SPECIAL CONSERVATION SIGNIFICANCE ON THE COAST

The following list contains known sites of special conservation significance on the coast between Lorne and Point Nepean. Many of these are included in the coastal reserve, wildlife reserves, and flora and fauna reserves. The reference numbers used for these are the same as on Map 8 - Public Land Use. As well as sites on public land (as defined in the *Land Conservation Act* 1970), the list includes those on private land, Commonwealth land, and land within cities and boroughs. The latter are included for the sake of completeness. The right-hand column of the list gives the present status of the sites.

LOCALITY AND SIGNIFICANCE	STATUS
Eastern View	Coastal Reserve (J1)
The geological contact of the Otways Mesozoic rocks with the Tertiary rocks to the east	
Moggs Creek	Coastal Reserve (J1)
The coastal heathland habitat of the rufous bristle-bird (near the eastern limit of its restricted range) and the uncommon beautiful firetail (confined to a restricted range of coastal habitats)	
Aireys Inlet to Eagles Nest	Coastal Reserve (J1)
The cliffs exposing a volcanic structure overlain by limestone; the rare ramphobranch polychaete worm on the intertidal rocks; and the distinctive landscape of the rocky promontory, cliffs, and sea stacks	
Urquharts Bluff	Coastal Reserve (J1)
The moonah trees on the bluff and the rare fungus *Underwoodia beatonii*, which occurs beneath them	
Hutt Gully	Coastal Reserve (J1)
The coastal heathland habitat of *Antechinus minimus* (this locality is one of very few Victorian records for this species)	
Point Roadknight	Coastal Reserve (J1)
The calcarenite headland, with its well-developed shore platforms and other interesting geomorphic features	
Anglesea River mouth	Coastal Reserve (J1)
The grove of moonah trees beside the river and the rare fungus *Underwoodia beatonii*, which occurs beneath the trees	
Demons Bluff	Coastal Reserve (J1)
The receding cliffs in carbonaceous clays, and the breeding site of the rather rare peregrine falcon	

LOCALITY AND SIGNIFICANCE	STATUS
Point Addis	Coastal Reserve (J1)
The cliffs, the fossils they contain (particularly molluscs), and the coastal heathland habitat of the rufous bristle-bird (at the eastern limit of its range), together with the distinctive landscape of the headland and sheltered crescent beaches backed by cliffs	
Half Moon Bay	Coastal Reserve (J1)
The fossil locality in the cliffs and the rich littoral communities of its waters	
Breamlea	Flora and Fauna Reserve - City of South Barwon
Coastal wetland habitat of international migratory waders and water birds	
Point Flinders	Coastal Reserve - City of South Barwon
The basalt and calcarenite bluff, and the uncommon metallic skink that inhabits it	
Barwon River estuary	Wildlife Reserve - City of South Barwon
The white mangrove (westernmost occurrence) and saltmarsh vegetation; international migratory waders and water birds; and aquatic fauna adapted to extremes of estuarine salinity	
Ocean Grove to Point Lonsdale	Coastal Reserve (J1)
The sand dune vegetation with moonah and tea tree, and the Aboriginal middens	
Salt Lakes	Wildlife Reserve (C3)
Habitat of waders, shrimps, and shellfish	
Point Lonsdale	Borough of Queenscliff and Harold Holt Marine Reserve (A34)
Calcarenite cliffs with well-developed stone platform and other coastal land forms; rich marine algae; rich littoral fauna, particularly opisthobranch molluscs; and a distinctive cliff and headland landscape	
Mud Island	Wildlife Reserve (C5) and Harold Holt Marine Reserve (A32)
Coastal saltmarsh and shrub vegetation; one of few breeding areas of the white-faced storm petrel; and feeding grounds of international migratory waders	
Swan Island	Commonwealth land (not public land)
A highly dynamic sandy shore with excellent examples of sandy coast land forms; saltmarsh, moonah and tea tree	
Swan Bay	Wildlife Reserve (C4) and Harold Holt Marine Reserve (A31) and Borough of Queenscliff
The extensive shell beds; saltmarsh, marine angiosperms and algae; fish, shellfish, and other fauna of sheltered marine environments; international migratory waders and water birds	
Edwards Point	Wildlife Reserve (C4)
The complex sand spit; saltmarsh, dune and strandline flora; international migratory waders, water birds, and the endangered orange-bellied parrot	
St Leonards Lagoon	Wildlife Reserve (C6)
International migratory waders, and water birds	

LOCALITY AND SIGNIFICANCE	STATUS
Point Richards .. .. Short-nosed bandicoot, in grassland	Flora and Fauna Reserve (H23)
Point Henry .. .. The saltmarsh habitat of international migratory waders and water birds	Coastal Reserve (J2)
Stingaree Bay .. .. The saltmarsh habitat of international migratory waders and water birds	Coastal Reserve (J2)
Limburner's Bay .. .. The white mangroves (only occurrence in Port Phillip Bay), and saltmarsh habitat of international migratory waders and water birds	Flora and Fauna Reserve (H21) and Coastal Reserve (J2)
The Spit .. .. Saltmarsh and tidal flats habitat of international migratory waders and water birds; the endangered orange-bellied parrot	Wildlife Reserve (C7)
Point Cook .. .. King quail and Aboriginal middens	Point Cook park (PCP)
Williamstown .. .. Lava blister in foreshore basalts	City
Point Nepean .. .. Calcarenite cliffs, extensive shore platforms and offshore reefs; marine algae, sand dune flora, and the rare *Adriana quadripartita*; rich littoral fauna and Aboriginal middens	Commonwealth land (not public land)

Appendix VIII

FISH SPECIES IN INLAND WATERS

The following table lists the fish species occurring in the major inland water bodies of the study area. The water bodies are grouped according to the drainage basin in which each occurs.

Where appropriate the value of the water to commercial or amateur fishermen is indicated, as is its value for the conservation of fish species.

Key to symbols

X fish species known to be present

S indicates that the water is of value to amateur (sporting) fishermen utilizing the particular species

C indicates that the water is of value to commercial fishermen utilizing the particular species

– the position of the bar relative to the letter S or C indicates a subjective ranking of the value of the water to commercial or amateur fishermen such that:

the bar below the 'S' (S) indicates that the water is highly valued by amateur fishermen

the bar through the 'S' (S) indicates a medium value of the water for fishing

the 'S' alone (S) indicates that, while still considered of value, it is not as high as the other two

a similar ranking applies to commercial fisheries (C)

* introduced fish species

Source: Tunbridge, B.R., and Glenane, T.G. (1982). 'Fisheries Value and Classification of Fresh and Estuarine Waters in Victoria.' (Fisheries and Wildlife Division: Melbourne.)

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Appendix VIII (ctd..)

FISH SPECIES IN INLAND WATERS

Drainage basin/ water body	Water type	blackfish, river	bream, black	carp, common*	carp, goldfish*	cobbler	eel, short-finned	flathead, dusky	flounder, greenback	flounder, long-snouted	galaxias, common	galaxias, mountain	galaxias, ornate mountain	goby, Tamar River	grayling	gudgeon, big-headed	hardyhead, small-mouthed	lamprey, short-headed	luderick	mosquito fish	mullet, sea	mullet, yellow-eye	mulloway	perch, estuary	perch, Macquarie	perch, southern pigmy	perch, Yarra pigmy	pilchard	redfin*	roach*	salmon, Australian	smelt, Australian	tench*	toad fish	tommy rough	trevally	tupong	trout, brown*	trout, rainbow*	Conservation value
GOULBURN RIVER																																								
Mollison Ck Weir	fresh																																						~~S~~		
Sugarloaf Creek	fresh																												S										S		
CAMPASPE RIVER																																								
Campaspe River	fresh	X											X												X	X						X						S	S	
Coliban River	fresh	X											X													X		X										~~S~~		
Lauriston Reservoir	fresh				X																							X				X					~~S~~		
Malmsbury Reservoir	fresh																											~~S~~									S		
Tylden Reservoir	fresh																											S									X		
Upper Coliban Reservoir	fresh																											~~S~~									~~S~~		
LODDON RIVER																																								
Daylesford Lake	fresh																											S				X							
Glenlyon Dam	fresh																																					~~S~~	
Hepburn Lagoon	fresh				X																							X				X					S		
Jim Crow Creek	fresh										X	X								X								X				X					S	X	Potential trout cod water
Loddon River	fresh				X								X		X													X				X	X				S		Nursery for brown trout
Wombat Creek Dam	fresh																											S											
MARIBYRNONG RIVER																																								
Deep Creek	fresh				X		X				X	X			X									X	X			X				X	X				X		Medium value for native fish
Emu Creek	fresh						X				X													X								X	X				S		
Hanging Rock Lake	fresh																																				~~S~~	~~S~~	
Jacksons Creek	fresh				X		X				X	X			X									X				X				X	X				S		
Maribyrnong River	fresh			X	X		X				X			X	X			X										X				X	X			X	S		Habitat for grayling
Riddells Creek	fresh						X																					X									S		
WERRIBEE RIVER																																								
Kororoit Creek	fresh						S																																	
Lerderderg River	fresh		~~S~~				X					X																		X		X						~~S~~		Habitat for native fish
Melton Reservoir	fresh			X	X		C																					S	X				X				X		
Merrimu Lake	fresh						~~S~~																																	
Pykes Creek Reservoir	fresh						X																					S											
Werribee River (upper)	fresh	X					~~C~~					X			X													~~S~~	X			X	X				S		
Werribee R. estuary	brackish		S				~~S~~	X																				X	~~S~~								X		
MOORABOOL RIVER																																								
Bolwarrah Reservoir	fresh						X																					S											
Bostock Dam	fresh				X		C																					~~S~~	X			X					~~S~~		
Moorabool River	fresh	X					C																					S			X	X					S		
BARWON RIVER																																								
Barwon River	fresh			X	X		C																					~~S~~									~~S~~		
Barwon R. estuary	brackish		~~S~~				X													X		X	X	~~S~~	X					X					X				
Connewarre, Lake	brackish		X	X		X	~~C~~			X	X		X			X	X					X	X	X	X			X	X	X		X	X	X			X	X	Important estuarine habitat
Lorne, Lake	fresh						X																					S											
Modewarre, Lake	brackish						~~C~~																					~~S~~									S	S	
Reedy, Lake	fresh						~~C~~																																	
OTWAY (coastal)																																								
Anglesea R. estuary	brackish		~~S~~																		~~S~~	X	X		~~S~~				X						~~S~~				Nursery for black bream
Painkalac Ck estuary	brackish		S			X			S	S		X			X	X				S	S	X		X				X	X		X					X			Nursery for bream and perch
Spring Ck estuary	brackish		~~S~~					X	X						X	X						~~S~~										X							Nursery for bream and mullet
Thompson Ck estuary	brackish		~~S~~				~~C~~	X	X	X					X	X						~~S~~										X							Nursery for bream